ACKNOWLEDGEMENTS

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1.0 EXECUTIVE SUMMARY
EXECUTIVE SUMMARY

INTRODUCTION
Over 5,000 students benefited this year from the high quality educational opportunities offered at the University of Washington Bothell (UW Bothell). The local economy and business community were also enriched by qualified candidates for employment with over 400 bachelorettes and master degree graduates in high demand fields within Science, Technology, Engineering, and Mathematics (STEM). UW Bothell’s educational framework of Cross Disciplinarity, Connected Learning and Community Engagement embodies the institution’s commitment to integrative research and scholarship, the importance of a human connection in teaching and learning, and hands-on education that directly results in improved outcomes for UW Bothell’s diverse students.

While UW Bothell has historically managed to do a lot with little, this model is proving unsustainable as the campus surpasses the limit of its available academic space. UW Bothell now enrolls over 5,000 students or 4,932 full-time equivalents (FTE) in academic facilities designed for a capacity of 2,800 FTE’s. A study performed in 2014 indicated an average campus standard for State of Washington higher education institutions was approximately 360 square feet per FTE, while UW Bothell operates at 140 square feet per FTE. With limited additional square footage and exponential growth, UW Bothell is continuing to fall behind in the physical space required to deliver quality education. Without additional space, UW Bothell may be forced to limit the opportunities it can provide. Thus, UW Bothell has developed a plan for a $75 million Phase 4 building, not to directly address existing capacity concerns across campus, but to allow for continued growth in the School of STEM through 2020 by accommodating 1,000 new full time equivalent (FTE) students and increasing annual graduation by 500 FTE students.

UW Bothell
UW Bothell was founded in 1990 with just 126 students, 13 faculty and a liberal arts program. UW Bothell was envisioned primarily as a local-serving institution that could offer four year degrees to place-bound students transferring from two year community colleges, increasing the opportunity for four year degrees to a diverse population of residents of the State of Washington. Today, UW Bothell serves 5,279 students (4,932 FTE) with 353 (262 FTE) faculty, and offers more than 45 degree programs. Since 2010, UW Bothell has experienced an 83% increase in student enrollment, surpassing its 2020 target for growth goals 6 years ahead of its target. Of the 4,932 FTE, nearly half begin as first year students, and the student population remains diverse.

In 2015, UW Bothell was ranked #1 in the Northwest for quality, affordability, and outcomes by Money Magazine. Part of that success is due to faculty who are committed to teaching and class sizes that allow for personal connections between students and faculty and support student-centered learning.
UW Bothell has been remarkably successful and is currently the fastest growing postsecondary institution in the state and the fourth fastest growing public university in the United States. Student enrollment has more than doubled since 2007. By 2020, UW Bothell projects to grow by an additional 1,286 FTE, or an additional 33%. Most of the growth between 2015 and 2020 is anticipated to be within the School of STEM. The School of STEM is the fastest growing program at UW Bothell with 14 new degrees added in the last 5 years. The graph below shows the steady growth (in grey) of UW Bothell FTE relative to the much more dramatic growth of the STEM FTE (in blue).

**CAPACITY CONCERNS**

UW Bothell has continued to grow its programs and opportunities despite significant limitations on space. The Higher Education Coordinating Board (HECB) standard of 22 Student Contact Hours per seat for existing general classrooms on campus would suggest an enrollment capacity of 3,687 FTE (reference black line on graph above). In 2015, actual enrollment of 4,932 FTE exceeds the HECB recommended capacity by 1,245 FTE, or 34%. If UW Bothell adds the proposed 584 classroom seats with Phase 4, the campus capacity would be 4,703 FTE (reference red lines on graph above), which would help the current deficit, but would still not bring the campus capacity up to HECB standard for the 2020 projected enrollment of 5,078 FTE. In addition to this shortfall in classroom space, UW Bothell lags behind every other state university campus as well as the Washington State Board of Community and Technical Colleges (SBCTC) benchmark in overall campus square foot per FTE, despite having 562,947 sf of campus space. It is simply not possible for the UW Bothell to continue to add to their student FTE without additional teaching space. Classrooms are an institution-wide resource and critical to the continued education of STEM graduates.

**UW BOTHELL - SCHOOL OF STEM**

In 2013, the University of Washington Bothell merged the Computing and Software Systems (CSS) and the Science and Technology (S&T) Programs to form the School of Science, Technology, Engineering, and Mathematics (STEM). In the last two years, the School of STEM has experienced the largest increase in student enrollment with growth expected to continue into the next decade. UW Bothell is also rapidly gaining a national reputation for its STEM program.

- UW Bothell has been nationally recognized as the third most accessible college for engineers and scientists and regionally recognized as the best Pacific Northwest education in terms of quality, affordability and outcomes.
- UW Bothell ranks second in Washington State for annual number of bachelor of science graduates in computer science.
- 40% of STEM students at UW Bothell are from racially/ethnically diverse backgrounds.
- 26% of UW Bothell STEM students are female. This trend is critical as, on average in the United States, women constitute fewer than 20% of all graduates in STEM and computer science.
PROGRAM SUMMARY
Based on recent growth patterns and projected growth already described, this predesign report represents the development of a building program to support the identified growth through 2020 by accommodating 1,000 new full time equivalent (FTE) students and increasing graduation by 500 FTE students. Per the 2011 UW Bothell master plan, the proposed location of the UW Bothell Phase 4 building is adjacent to the recently completed, Phase 3 building, Discovery Hall. This location creates efficiencies and strengthens existing circulation, infrastructure and programmatic adjacencies conducive for the proposed Phase 4 STEM building. The proposed site is adjacent to an existing stair climb that connects the upper campus to lower campus and provides multiple landings connecting Discovery Hall to the vertical spine. Discovery Hall also houses the School of STEM administration, offices, and teaching labs as well as several classrooms used by STEM students. The approximately 78,000 gross square feet (gsf) of Phase 4 program was developed to compliment those spaces that serve the School of STEM, adding spaces for students to interact, innovate, and collaborate, as well as space for faculty to support and mentor students.

In an effort to identify those spaces most critical to the campus’s continued growth, the design team formulated the ‘building blocks’ per STEM needs and pedagogical goals. These building blocks were given attributes related to FTE impact, cost, size, and space that allowed the University to add or subtract space type ‘blocks’ based on necessity, budget, and space demands.

Distribution of Proposed Program by Space Type

- **Interact** - Classrooms + Teaching Labs: 42%
- **Innovate** - Experiential Learning Labs: 35%
- **Mentor** - Faculty Collaborative Offices: 16%
- **Collaborate** - Student Collaboration Space: 7%

Approximately 35% of the program will be spaces to “Interact,” including interactive classrooms of various sizes and three teaching labs for mechanical engineering and computer science. All of these teaching and learning spaces will be designed to include multiple modes of learning and support active learning and team-based pedagogies. UW Bothell Phase 4 will add 584 classroom seats reducing the anticipated shortfall of 1,616 seats to 1,039 seats.

In addition to the more traditional teaching labs located in Discovery Hall and elsewhere on campus, UW Bothell places high value on Capstone projects and undergraduate research as part of their educational mission and keys to their successful retention and graduation outcomes. STEM curriculum requires spaces to “Innovate.” 42% of the program space in the proposed building will be devoted to these innovative spaces called “Experiential Learning Labs.” These learning labs provide much needed space for undergraduate research led by faculty as well as Capstone and student project space. Undergraduate research and Capstone project space is a critical component of the STEM programs as it fosters the growth and development of students in a hands-on setting. Three quarters of faculty at UW Bothell engage undergraduates in their research projects and all engineering students engage in a Capstone project, thereby providing practical, hands-on research and team project opportunities that help prepare students for careers in their fields.

With a student population that has more than doubled since 2007, there is a need for a collaborative office space that allows faculty to “Mentor” students as well as accommodate new and future faculty and staff. The growth in STEM will need to be supported with the addition of great tenure track, lecture track, and part time faculty. In an effort to maximize academic space, UW Bothell has elected to experiment with a variety of options for faculty and staff; hoteling-style stations, shared offices and smaller single offices that redistribute area towards a common space used for informal and formal support and mentoring opportunities between faculty and students. This “Mentor” space amounts to 16% of the area of the proposed Phase 4 building.
Finally, in all fields today, “third spaces” are critical to student academic experiences. Having spaces available for student to student, student to faculty, and faculty to faculty interactions are important to support both student and faculty growth. These are spaces where extended conversations can happen after class or impromptu meetings, tutoring sessions, or even big discoveries and breakthroughs can take place. These spaces also allow students and faculty to gather with industry partners to collaborate on research and mentor students for future employment. This space to “Collaborate” amounts to 7% of the proposed Phase 4 building area.

PROJECT SUMMARY
Placing the building on the site identified in the 2010 Master Plan (revised 2011) allows the campus to capitalize on infrastructure and planning resources completed during the Phase 3 project (Discovery Hall) in preparation for the next Phase 4 STEM building. Although an alternate site was considered, the ability to meet program and project goals, functional adjacency, pedestrian circulation and accessibility, solar considerations, and view corridors were instrumental in the decision to continue with the already earmarked site. Programmatically, the ability to connect teaching labs and offices, housed in the Phase 3 Discovery Hall, with the new STEM spaces proposed in the Phase 4 building made this site the most ideal.

Based on the development of a target value budget for the program spaces identified, the project is anticipated to cost $75 million, assuming the majority of the funding will be obtained in the 2019-2021 biennium. To improve schedule outcomes and enhance value, the University intends to deliver this project through a progressive design-build process. The University would enter into a preliminary agreement with the design builder during the 2017-2019 biennium to complete the design development phase in July 2019, and be ready to complete the design and construction in the 2019-2021 biennium. This approach will allow the University to optimize the schedule and budget efficiencies of a progressive design-build delivery. The progressive design-build delivery also allows the University to be involved early in the process and contribute to early design phase decisions. The UW Capital Planning and Development Office (CPD) will manage the Phase 4 project and is targeting the fall of 2021 for occupancy. Please reference Section 5 and Appendix D for further information on the budget and schedule.
From 2014 to 2015, the UW Bothell conducted a space capacity study that took into account the campus’s leased, owned and shared academic space, amounting to 642,094 gross square feet. During the period this study was performed, the UW Bothell supported 4,587 FTE students lending 139.9 GSF/FTE on campus. With the addition of the proposed STEM Phase 4 building of 78,000 GSF, the projected 2020 FTE count of 6,559, and assuming the 2014-15 study numbers, the overall UW Bothell sf/student would decrease to 117.8 GSF/FTE. Although the addition of the new Phase 4 project does not improve the GSF/FTE and remains well below the SBCTC benchmark for sf/student ratio, a new construction option is better than a ‘do nothing’ option. UW Bothell is known for its welcoming community and the intimacy of its learning environments. It is also a campus well known for the educational journey that its students take, grounded in the marriage of hands-on with theoretical learning. UW Bothell students benefit from connected learning with faculty and industry partners in a collaborative environment where students, faculty, and the community come together from different disciplines to interact. This project, with the mix of interactive classroom environments, space for mentoring, and experiential learning labs proposed, will make it possible for UW Bothell’s passionate educators to reach more students in the critical STEM fields and improve more lives in the region.
2.0 PROJECT ANALYSIS
2.1 OPERATIONAL NEEDS

ACADEMIC + INSTITUTIONAL CONTEXT
The legislative session of 1991-1993 established the UW Bothell/Cascadia College campus as the state’s first and only collocated baccalaureate and community college campus. To implement this vision, the Legislature funded shared campus facilities on a 50/50 basis between the University of Washington and the State Board for Community and Technical Colleges. Initially, there was a similar shared approach to the academic offerings on campus as well, with Cascadia College providing lower division courses while UW Bothell offered upper division courses. Although today UW Bothell is now a 4-year institution, the UW Bothell and Cascadia College remain a co-located campus with many campus buildings used jointly by both institutions.

As an institution, UW Bothell is dedicated to providing exceptional access to education in the Snohomish and North King County region. UW Bothell’s School of STEM is gaining a national reputation and was nominated third in a national list of “25 great, accessible colleges for aspiring scientists and engineers” (Money Magazine). Even with its growing reputation, UW Bothell remains accessible, serving a large percentage of first-generation college attendees and is one of the most ethnically diverse universities in the country. The number of women who have declared majors in the STEM fields at UW Bothell is increasing and 40% of current STEM faculty are female, far outpacing the national average. These defining characteristics of UW Bothell are reflected in the mission statement the University has established: to build an inclusive and supportive community of learning that incorporates multicultural content and diverse perspectives is a foundational mission of the institution. This project directly supports UW Bothell’s mission to:

- Serve college-age and established adult students, as well as the community at large, by providing access to a premier institution of higher education.
- Emphasize and develop critical thinking, writing, and information literacy, in order to graduate students with life-long learning skills.
- Actively recruit and support outstanding faculty scholars.
- Encourage and support collaborative, interdisciplinary, and cross-program initiatives.
- Provide quality curricula by making use of the best of educational technology in support of teaching and learning.
- Create and support excellence in student services, academic services such as library, writing center, computing services, and physical facilities.
- Foster productive relationships with the employment community and promote a strong public service commitment.

UW Bothell priorities as outlined in the institution’s 21st Century Initiative

<table>
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<th>GROWTH</th>
<th>RESOURCENESS</th>
<th>STUDENT-CENTERED</th>
<th>INNOVATION</th>
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<td>Serve the citizens of the State of Washington by providing increased access to a premier university education.</td>
<td>Build institutional sustainability through sound, creative use of financial and human resources.</td>
<td>Enhance student services to support academic success and enhance student life.</td>
<td>Support signature strengths in interdisciplinary scholarship and innovative teaching.</td>
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<td>Enhance campus commitment to diversity and inclusiveness.</td>
<td>Develop environmental and human sustainability as a signature initiative.</td>
<td>Deepen and broaden community engagement and research.</td>
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</table>
2.0 PROJECT ANALYSIS

UW BOTHELL + SCHOOL OF STEM GOALS
UW Bothell has grown tremendously since 2010, almost doubling its total student population by 2015. Such growth has created strains on campus space capacity. In particular, the School of STEM has seen a substantial increase in student enrollment with an increase of 255% since 2010 and an addition of 14 new STEM programs added in the last five years. Projected growth studies for UW Bothell and STEM will outpace the capacity of the campus, making physical space the limiting factor to UW Bothell’s continued growth.

STEM courses currently take place in at least five separate buildings dispersed on campus: Discovery Hall, Cascadia’s CC1, CC2, CC3, UW Beardslee Building (UWBB), UW1 and UW2. As the School of STEM continues to grow, the justification to consolidate program rests upon the effort to create efficiencies by sharing systems, facilities, and equipment. Consolidating disparate elements of the School of STEM will reinforce synergy between student culture and program and promote cross-pollination within the School of STEM and beyond.

While adding academic space is essential to growth, the UW Bothell maintains a high commitment to its distinctive practices of collaboration, engagement, rigor and extending opportunity in the context of the 3C’s: Cross-Disciplinarity, Connected Learning, and Community Engagement.

REGIONAL + STATE IMPACTS
UW Bothell impact at a glance:

- UW Bothell growth contributes $231.6 million to state and local economy; $82.7 million direct and indirect impact of $148.9 million
- $125.5 million is UW Bothell’s economic impact on the city of Bothell alone
- 1,700 jobs were directly and indirectly supported by UW Bothell throughout the state during the 2014 reporting period
- 9 out of 10 alumni live and work in the State of Washington; 13,000 are in King and Snohomish counties
- UW Bothell currently provides programs in Bothell, Bellevue, Everett and Seattle
- 55% of UW Bothell’s population comes from King County and 35% from Snohomish County
- UW Bothell is the fastest-growing public institution in the State of Washington and the sixth fastest in the nation
PROJECT SCOPE

The conceptual program for the Phase 4 facility includes a range of interactive teaching and learning spaces for the School of STEM, prioritized to accommodate the dynamic growth and expansion of Engineering and Computing Software and Systems (CSS) degree programs. This new facility will include a range of general classrooms, experiential learning labs (for faculty-led undergraduate research and capstone student projects), computer class labs, collaborative office space, and engineering instrument rooms, specific to these two fields. Other School of STEM programs outside of Engineering and CSS will use the facility when space is available.

Refer to Section 3 for a more detailed description of the preferred program spaces and their allocation of space in the proposed facility.

UW BOTHELL STEM REGIONAL PARTNERS

The School of STEM’s commitment to the 3C’s is manifested through engaging the business community. The STEM Advisory Board strengthens this relationship by providing guidance to the STEM director and faculty on issues related to STEM education and STEM-related industry needs while STEM students benefit from first-hand experience in collaborative capstone projects and student internships, an essential piece of the curriculum in STEM degrees.

UW Bothell Office of Research (OR) plays a critical role in nurturing an active and productive research campus community. Under the leadership of Assistant Vice Chancellor Carolyn Brennan, the OR has built a flexible and effective research infrastructure staffed by a dedicated and highly experienced team. Their programs and activities support:

- An active, visible research culture characterized by interdisciplinary, collaborative proposals
- Research administration capacity to support our investigators throughout the grant life cycle
- Undergraduate research that enlivens the educational pursuits of students

The Office of Research supports the idea that active engagement in cutting-edge research enriches teaching and learning allowing for continuous intellectual revitalization for students, staff, and faculty across UW Bothell. As a result of this commitment, School of STEM faculty members and their students often collaborate with industry partners on research of mutual interest and benefit. These local industry connections are critical to supporting the economy of the region with qualified future employees to fulfill needs for employers in math, engineering, and science-related professions.

STEM Industry research partnerships:

- Trout Unlimited
- 21 Acres
- Farmer Frog
- Friends of the North Creek Forest
- Teledyne
- Phillips
- UW School of Oceanography
- City of Kenmore, City of Bothell (water quality)
- Coding with Kids
- Seattle Children’s Hospital
- Adaptive Symbiogenics
- Spring Star
- Vertafore
- Intel
- limeade
- Seattle Lighting
- act.studio
- unity
- INRIX

STEM Advisory Board members:

- Silicon Mechanics
- InCluesive Technologies
- Halosource
- The Boeing Company
- CMC Biologics
- IslandWood
- Creekside Dental
- Olympus Respiratory America
- Adobe Systems
- VRstudios
- Battery Power Systems, Inc.
- Mirabilis Medica, Inc.
- Microsoft
- Airenote LLC.
STATEWIDE GOAL - PRIORITIES OF GOVERNMENT - STRATEGIC FRAMEWORK

As a publicly funded university, UW Bothell exists to serve the educational needs of the citizens of the State of Washington. In its 2008 Strategic Master Plan, the state’s Higher Education Coordinating Board (HECB) outlined two goals for providing what the people of Washington State want and need from their public higher education system:

- HECB Goal 1: We will create a high-quality higher education system that provides expanded opportunity for more Washingtonians to complete postsecondary degrees, certificates and apprenticeships.
- HECB Goal 2: We will create a higher education system that drives greater economic prosperity, innovation and opportunity.

The Phase 4 project will directly support expected statewide results in the areas of student achievement and postsecondary learning, and government efficiency and effectiveness. This project will contribute to student achievement by providing access to additional classroom and learning spaces required for the advancement and dissemination of knowledge.

Washington State government has also outlined extensive goals for promoting and supporting STEM education from early learning through postsecondary education. The state’s commitment to increasing learning opportunities and improving educational outcomes in STEM would be directly supported by this project. The projected growth in STEM graduates from UW Bothell is directly linked to the STEM career opportunities in the local area.

The proposed project will directly support the State’s desire to align STEM learning opportunities with best practices and local economic development. It will also help expand STEM professional development opportunities for educators and faculty by providing space for conducting research with undergraduates in an experiential learning lab setting and student team projects.

The legislature has noted that high technology is important to the state’s economy and the welfare of its citizens. The legislature also has found that certain groups, as characterized by sex or ethnic background, are traditionally underrepresented in mathematics, engineering, and the science-related professions in this state. Women and minority students have been traditionally discouraged from entering the fields of science and mathematics, including teaching in these fields. This project would help to expand awareness of the importance of STEM literacy and the opportunities presented by STEM education and careers, particularly for women, minority, and first generation higher education students that make up a large portion of the student body at UW Bothell.

2.2 ALTERNATIVES EXPLORED

ALTERNATIVES CONSIDERED

The Predesign effort considered several alternatives, resulting in the final alternative approach selected, Alternative 4. With the limited existing facilities and buildable land, and the need to allow for future growth of UW Bothell and the School of STEM, the alternative options are limited. Refer to section F for more information on Life Cycle Cost analysis of these options.

Alternative 1 – NO ACTION

Building no new facilities was considered as an option. However, considering UW Bothell’s increase in student population and the School of STEM’s increase in enrollment and its expansion of programs, a “no action” alternative is not a viable solution. If no action is taken, UW Bothell would not be able to effectively respond to projected FTE growth. The campus already has a very low square footage per FTE ratio, significantly lower than the recommended standard by the HECB. UW Bothell would be unable to expand current STEM programs or develop and implement critical new engineering and computer science programs in response to community and local business needs. High operational costs for existing facilities would continue, as would operational and programmatic inefficiencies.
Alternative 2 - LEASE
Leasing additional space off campus to satisfy STEM growth as well as alleviate a high classroom utilization rate currently experienced campus-wide was considered as part of the Predesign effort. As the need for additional classroom and lab space has grown, the University has leased space in office buildings surrounding the campus. In this case, leasing space at a more remote location would create an insurmountable disconnect between School of STEM functions in the Phase 3 Discovery Hall building and the expansion of the STEM program space with the Phase 4 building. A remote lease location could require duplication of program spaces and resources in an effort to meet adjacency requirements for loading, storage, or shops. Leasing space would require a re-evaluation of all existing facilities to find the most efficient use of the STEM spaces. Finally, leasing space for undergraduate research and student team capstone projects would require extensive investment in tenant improvement and could introduce additional operational costs associated with adding to the complexity of spaces spread throughout the co-located campus with Cascadia College and UW Bothell buildings and currently leased spaces.

Alternative 3 - PURCHASE / RENOVATION
Acquisition of additional property, such as the Beardslee Building which is currently rented to provide additional space for the Biology division and other schools, would be difficult. There is limited real estate for rent that is not residential surrounding the campus. The available office buildings surrounding campus already have existing long term leases, making rental or acquisition of those buildings and spaces very unlikely. In addition, similar to the lease option, rental or acquisition of existing commercial space for undergraduate teaching and research spaces would require extensive investment in tenant improvements.

Alternative 4 - NEW CONSTRUCTION
The preferred alternative, and the only one that fully meets the requirements for projected growth at UW Bothell, is the construction of a new building located adjacent to existing STEM facilities in Discovery Hall. The site adjacent to Discovery Hall was planned specifically to receive this next phase of campus development, including the extension and addition of infrastructure for mechanical, electrical, civil and storm water management. A new building does not bear the cost of renovating multiple spaces to provide desired functionality and efficiency without compromise. Reference section 2.3 for additional description of the preferred alternative.

2.3 PREFERRED ALTERNATIVE
After the consideration of several alternatives, the option to build new construction best fulfilled the project needs and long term goals for the campus while satisfying all project requirements including: critical adjacencies in a shared facility, development of the campus consistent with the UW Bothell 2011 campus master plan, efficient use of existing infrastructure, goal fulfillment for UW Bothell and STEM growth projections, and structural flexibility to allow for the potential to address re-purposing of space as the campus continues to grow. This option would provide the School of STEM with the needed facilities to accommodate programmatic needs and future growth, as well as relieve space deficiencies by providing classrooms to the existing inventory.

PROBLEM STATEMENT
Science, technology, engineering, and mathematics (STEM) are increasingly important areas of study and research in our State and region. To help meet this demand, UW Bothell proposes to increase its teaching and research program and construct a new facility to provide more access to students. The new proposed Phase 4 facility will focus on expanding engineering and computer science degree programs. The facility will contribute to meeting the following growth demands projected by 2020.

- Accommodate 1,000 new full-time equivalent (FTE) students in the School of STEM and
- Increase graduation in the School of STEM by 500 FTE, of which 300 FTE will be engineering and computer science majors.
2.4 PROJECT DESCRIPTION

The proposed Phase 4 facility project will provide approximately 78,000 GSF of teaching, learning, research, and faculty office space for the School of STEM. This new facility will include general classrooms, computer and engineering labs, project space, undergraduate research space, and collaborative teaching specific to Computer Science and Engineering divisions in the School of STEM.

PROJECT DATA

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Agency Contact: John Seidelmann, Director of Capital Planning
UW Office of Planning & Budgeting
University of Washington
UW Tower, T-12, Box 98195-9445
(206) 616-0590
(seidj@uw.edu)

BUILDING DATA

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2.5 IDENTIFIED ISSUES

ISSUE IDENTIFICATION
The Predesign is intended to be thorough in researching the critical design issues that may come up in the full design and construction process; but, inevitably, there are issues that will require further study and analysis and that may affect the final design. The following represent a few of the issues that the design team anticipates requiring further study in design.

20% Slope
On the preferred site, project will require substantial foundations, significant soil retention and potential mitigation of contaminated soils. It is anticipated that the building would be situated with its axis running parallel to the nearby Discovery Hall. The building will step up the significant 20% slope, creating a condition in which foundations, as well as grade-level elevations, will need to step. Vertical cuts along with temporary shoring and/or soil-nail walls will be required in order to complete the necessary excavations. The consistently sloping site requires that the building provide hill climb assistance to meet ADA requirements.

There is also evidence of potential groundwater issues, caused from a relatively high groundwater level as well as a possible artesian condition. Temporary dewatering measures will be required during construction. Additionally, the artesian flow will require a permanent, robust drainage system behind the foundations that step up the site.

Parking and PUD
The University of Washington Bothell/Cascadia College (UWB/CC) joint campus has been developed as a Planned Unit Development (PUD). The Preliminary PUD was first approved in 1996, and established the original Campus Master Plan. To date, seven Final PUD phases have implemented the Master Plan and developed the campus, and four Preliminary PUD actions have updated the Master Plan to better reflect the evolving goals and policies of the campus. Review of Final PUD applications generated minimal public comment and only a few community members attended the Formal Hearing Examiner proceedings. Construction of Phase 1 improvements began in July 1998. Phases 1, 2A, 3, 4, 5, 6, and 7 are now complete.

In June of 2016, the UW Bothell and Cascadia College began a master plan update with the intent of establishing a new campus zone within the City of Bothell’s comprehensive plan and land use code. The master plan will address future growth of the collocated campus including: future development sites, parking, campus infrastructure, campus housing, future acquisition goals and connection to downtown Bothell. The leadership of UW Bothell and Cascadia College want to engage the Bothell and campus community to ensure a positive future for the campus. The Phase 4 STEM Building project will be part of the master plan update and the UW Bothell expects it to be developed under the new campus zone.
Program Growth
At this point, the campus is unable to sustain any further growth without the addition of more classroom and office space. Though program information has been developed and included, room configurations and the number of experiential learning labs and STEM focused classrooms (which may impact mechanical system scale and components) could be adjusted significantly in the design phase.

Vibration & Lab Requirements
The percentage of classrooms that require laboratory designation will affect the design live loads, as well as establish the vibration criteria for the spaces. The UW FSDG recommends that all laboratory buildings support a live load of 100 PSF, plus provide an additional allowance of 30 PSF for equipment and 20 PSF for partition loads. This criteria is approximately 3 times higher than what is required for a typical, non-laboratory classroom design. Additionally, the UW FSDG outlines a minimum vibration parameter for laboratories of 2000 micro-inches/sec. Meeting this criteria requires a stiff structural framing system, which is generally achieved by providing larger floor slabs, beams, and columns. The type of labs currently planned do not require significant vibration control.

The elevated vertical load design parameters, along with the vibration criteria, will dictate a very robust structural steel system with tight column spacing (that typically does not work with classroom or laboratory room layouts), or a concrete framed system. Meeting these benchmarks will significantly increase the cost of the structural system.

Design and Construction Sustainability Issues
The following goals were established in the Predesign effort, but could change as the University of Washington or UW Bothell’s priorities shift:

- The project will aim to achieve at least Gold certification from the U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) program.
- Preserve existing trees where possible and incorporate felled trees into the design in a meaningful way.
- Seek to reduce energy consumption with considerations for the incorporation of energy-efficient mechanical and electrical systems.
- Aim to achieve UW Carbon Action Plan goals.
- Maximize the program space within the building to minimize the need for future construction.
- Develop the landscape and building in such a way that the new building and Discovery Hall work together, share systems, and complement each other spatially and functionally.
- Integrate material and system designs to create energy- and resource-efficient solutions for the entire project.
- Specify building materials that reduce the negative environmental impact of the project—this includes responsibly harvested and certified wood and low-toxic paints, finishes and adhesives.
- Use durable materials and systems that reinforce the high quality UW architectural and urban design standards, and the building’s connection to place on the campus.
- Consider the use of recycled, local, or sustainable materials during the design phase.
- Recycle construction debris wherever feasible.
2.6 PRIOR PLANNING AND HISTORY

UW BOTHELL PLANNING CONTEXT
The following is a quick look at UW Bothell’s history since 1990:
- 1990 University of Washington Bothell is founded
- 1996 CSS program is established with degrees in Computer Science and Software Engineering
- 2000 University of Washington Bothell and Cascadia College collocated campus opens on the Truly Farm site
- 2009 Science and Technology programs are established with degrees in Biology, Climate Science, and Electrical Engineering
- 2013 the School of STEM is established
- 2014 UW Bothell exceeds projected 2020 growth population

In 2008, the University of Washington Bothell established a set of goals outlined in ‘The 21st Century Campus Initiative’. One of the goals the institution set out to accomplish by 2020 was to reach a combined enrollment of 5,000 undergraduate and graduate students. In 2014, The University of Washington Bothell reached their 5,000 student enrollment goal, 6 years earlier than anticipated.

PHYSICAL SITE
UW Bothell and Cascadia College are co-located on a 128-acre campus situated northwest of the I-405 / SR 522 interchange. Of the total land area, 71 acres are preserved wetlands. Originally, the University of Washington Bothell was set up to serve upper division instruction while Cascadia College served lower division instruction. In 2005, the legislature directed UW Bothell to develop a comprehensive 4-year plus graduate program curriculum and in 2006 UW Bothell accepted its first freshman class.

In 2010-2011 UW Bothell and Cascadia College published a Master Plan to help guide the development to accommodate enrollment growth goals. In the 2011 Master Plan, (9) academic buildings ranging between 40,000-100,000 GSF for a total of 500,000 GSF were identified to serve UW Bothell’s rapid student and faculty growth. Since 2004, UW Bothell has identified the need for a STEM-focused project to provide additional capacity for the growth of experiential learning lab facilities, classrooms and academic support. The proposed project, UW Bothell Phase 4, was created in response to the projected enrollment growth.

TRAFFIC
Primary vehicular entrance to campus is from the south entry, where current and future parking garages are planned to minimize through-campus vehicular traffic.

ENVIRONMENTAL SENSITIVITIES
North Creek water quality and wildlife habitat functions have suffered from non-point source pollution and increased flows, resulting from increased impervious surfaces from development in the valley and upstream. North Creek originates near Everett in Snohomish County flows through the business parks, under I-405, through the University of Washington Bothell / Cascade College campus, under SR 522 and empties into the Sammamish River. North Creek is a ‘shoreline of the state’ which places it within the jurisdiction of the City’s Shoreline Master Program. The natural environment of the Subarea is dominated by North Creek and its associated wetlands as well as the slopes on the east and west portions of the Subarea.

Eastern edge of UW Bothell/Cascadia College campus. Wetlands east of the project site.
2.7 STAKEHOLDERS

Stakeholders from across the School of STEM and the larger UW Bothell community were engaged over the course of 15-20 stakeholder meetings in an effort to define the Phase 4 building. To establish the role of the stakeholders and set expectations for project priorities, the team began each meeting describing the general premise of the proposed project, and who prospective user groups might be. This helped generate feedback that was targeted toward the overall mission of the project, and for the team to “test” potential space prototypes and quantities.

As part of this gathering phase, the team met with the following groups over two months:

- Site, Facilities, and Sustainability
- Physical Sciences Division
- Earth Sciences Faculty
- UW Bothell Registrar and Classroom Utilization
- STEM Offices and Growth Needs
- Biological Sciences Faculty
- Experiential Learning Labs
- Business Partnerships in STEM
- Experiential Learning Labs / Support Spaces
- Active Learning
- Diversity and 3 C’s
- Academic Spaces in STEM
- Computer Science Faculty
- Engineering Faculty
- ASUWB Student Government
- UW Bothell Open House

The feedback and information gathered throughout these various focus groups was consistent across identified needs. The needs described in the focus groups were then discussed by both the Project Committee and the Executive Committees (see diagram below). In general, groups felt that Discovery Hall incorporated an adequate amount and variety of instructional labs, but that general classrooms and experiential labs for project/research activities were sorely needed. From the feedback, it was clear that all spaces should be designed to be pedagogically nimble, and not solely for lecture-style content delivery. Many stakeholders had participated in the Discovery Hall design effort, or were currently using the facility, so they were able to use those spaces as a reference point for the generation of space criteria and adjacencies for the proposed Phase 4 facility. They were also able to emphasize the need for adaptability within the Phase 4 facility, having seen the rapid change and growth in STEM since Discovery Hall was completed.

**Diagram of stakeholder engagement and method for gathering and filtering input in the predesign process**
2.8 IMPLEMENTATION APPROACH

A Project Manager from Capital Planning and Development (CPD) will work with the leadership in CPD and UW Bothell to identify a Responsible Party for the UW Bothell, an Executive Committee and a Project Committee to guide the project. The Executive Committee ensures the Project Committee’s input stays within the project requirements and provides direction to the group when issues are not resolved. Members of this committee include leadership from UW Bothell and CPD. In the event the Executive Committee cannot reach consensus, the Responsible Party provides direction. The Project Committee includes faculty, staff, and students who will participate with the design builder to design the building. A project agreement will be established between UW Bothell and CPD to establish goals, expectations, roles, responsibilities and identify risks to the project. This same approach was taken for the predesign study. A copy of the project agreement for the predesign is in Appendix D.

In addition to these formal committees, the Project Manager will establish partnerships with internal UW partners including Environmental Health and Safety, Campus Engineering, Information Technology and the University Architectural and Landscape Commissions for design review throughout the process.

The design team will work closely with UW Bothell Facilities to ensure the building design meets the operating standards and that the commissioning and transition of the building to UW Bothell Facilities is a smooth one.

2.9 PROJECT MANAGEMENT

MANAGEMENT ORGANIZATION

The Associate Vice President for Capital Planning and Development (CPD) is responsible for overall organization management. CPD procures and manages programming, predesign, cost estimating, design and construction services for building alterations, additions, new construction and grounds improvements for Bothell, Seattle, Tacoma, and remote field research stations.

Project Managers organize and administer the work of outside design consultants and construction contractors. They follow projects all the way through construction and work closely with UW Bothell representatives, occupants, project architects, designers, consultants, and other University groups related to servicing and maintaining facilities. In addition, they work with CPD construction coordinators and contractors to ensure that projects are delivered on time, within budget and meet specified quality standards and programmatic needs. CPD’s professional staff includes architects, engineers, cost estimators, project accounting staff, interior designers, the University architect and landscape architect, a contract specialist and an environmental planner.

Technical review and approval of design and construction work are the responsibility of Campus Engineering Services. This division of Facilities Services provides expertise on architectural, mechanical, structural, electrical, communications, utilities, asbestos, environmental, and commissioning issues. In addition, the departments of Computing and Communications and Environmental Health and Safety provide additional technical and safety requirements.
METHOD OF DELIVERY
The project will be delivered using the progressive design build delivery method to maximize taxpayer value. With progressive design-build, the Owner selects a design-build team prior to the start of design using a combination of qualifications and price factors. This method of procurement complies with RCW-39.10 and allows the Owner to maximize the benefits of design-build. The design build collaborative approach encourages the Owner to be involved in the design from the beginning. The process also allows for early involvement of sub contractors to help the team make the most cost-effective decisions concerning the configuration of the construction staging areas and method of construction. An integrated team incorporates constructability review, cost estimating, and schedule development during the design phase and encourages innovative solutions while minimizing the potential for cost or schedule overruns. Using progressive design-build, a Design-Build team has an even greater opportunity to streamline the project schedule, overlapping design and construction. Saving time saves money, allowing the team to maximize project value.

SCHEDULE
To maximize efficiency and take full advantage of the progressive design build delivery, it is important to maintain work flow for the design build team. Ideally the University could secure complete project funding in one biennium, but it is possible to start design in one biennium and complete the design build process in the next funding cycle. To accomplish this, the University would enter into a preliminary agreement with the design builder during the 2017-2019 biennium to complete the design development phase in July 2019. This would position the design build team to be ready to complete the design and construction during the 2019-2021 biennium. The milestone schedule below outlines the work flow. A complete project schedule and cash flow curve is located in appendix D.

MILESTONE PROJECT SCHEDULE

The benefit of progressive design build is that the owner and stakeholders are able to participate in the design process. This project will require complex scheduling to minimize disruption to the adjacent buildings, campus circulation and infrastructure. The design builder will help strategize phasing of the project and develop the schedule to address the campus operation issues. The design build collaborative approach allows for early involvement of sub contractors to help the team make the most cost-effective decisions concerning the configuration of the construction staging areas and method of construction. An integrated team incorporates constructability review, cost estimating, and schedule development during the design phase and encourages innovative solutions while minimizing the potential for cost or schedule overruns.
3.0 PROGRAM ANALYSIS
3.0 PROGRAM ANALYSIS

3.1 ASSUMPTIONS & PROJECT GOALS

This section of the predesign addresses historic and projected growth along with the academic spaces required to fulfill this growth while maintaining the values and mission unique to the University of Washington Bothell. Programmatic needs and space requirements are based on higher education organization standards for full-time equivalent (FTE) student populations. These standards are reinforced or adjusted as needed by established benchmarks at UW Bothell that aim to reinforce the mission to provide quality education through fostering close relationships between faculty and students.

The collocated campus is relatively young and is experiencing the fastest growth of any other public university in the State of Washington. For that reason, this study first evaluated the space needs required to allow the STEM programs continued growth followed by an analysis of the spatial needs of the campus as a whole. It also identified where general needs overlapped with those of STEM-specific needs in an effort to have the most impact with additional space. It was determined that the identified spaces most essential to the campus should reflect the qualities that make UW Bothell unique and also reflect the values and mission of the institution.

As the most diverse public university in the State of Washington, this unique student population plays a major role in defining the pedagogy at UW Bothell, communicating ideas via experiential learning. At UW Bothell 64% of incoming students are from diverse backgrounds and 89% of enrolled students are from the State of Washington. Building an inclusive and supportive community of learning is a top priority. Incorporating multicultural content and diverse perspectives on ethnic and racial groups, gender, sexual orientation, social class, and special needs is also highlighted as a top priority in UW Bothell mission.

Established in 2013, the School of STEM currently makes up 20% of UW Bothell’s FTE population. By 2020, the School of STEM population is expected to account for more than 50% of the UW Bothell FTE population. With this rapid growth, the institution established an initiative to help maintain and guide campus character as growth continues.

21ST CENTURY CAMPUS INITIATIVE

- **Growth:** Serve the citizens of Washington by providing increased access to a premier public education
- **Resourcefulness:** Build institutional sustainability through sound, creative use of financial and human resources
- **Diversity:** Enhance campus commitment to diversity and inclusiveness
- **Student-centered:** Enhance student services to support academic success and enrich student life
- **Community:** Deepen and broaden community engagement and research
- **Innovation:** Support signature strengths in interdisciplinary scholarship and innovative thinking
- **Sustainability:** Develop environmental and human sustainability

UW Bothell Access at a Glance, Autumn 2015

- Undergraduate headcount: 4,698 (4,402 FTE)
- Graduate headcount: 581 (530 FTE)
- Between 2010 and 2015 UW Bothell FTE population has increased by 71% and enrolled FTE’s have doubled and surpassed projected 2013 figures
- The number of faculty grew from 85 in 2007 to 353 in Fall of 2015
- 48% of incoming students are first generation college students
- 64% of the incoming first year class is comprised of students from diverse backgrounds
- 19% of women who have declared majors in STEM fields
- 251 students are U.S. veterans (or eligible for veteran’s benefits)
- The number of degree programs has grown from 10 in 2007 to more than 45 in 2015, with 23 new baccalaureate and 6 new master’s degrees in the last 5 years

UW Bothell’s Economic Impact at a Glance

- UW Bothell is the fastest-growing public university in the state of Washington
- 89% of enrolled students are from the State of Washington
- Nine out of 10 UW Bothell graduates live and work in the state of Washington
- UW Bothell’s economic impact to the state of Washington is $231.6 million and to the City of Bothell, $125.5 million
- 75% of UW Bothell faculty use students in their research

Established in 2013, the School of STEM currently makes up 20% of UW Bothell’s FTE population. By 2020, the School of STEM population is expected to account for more than 50% of the UW Bothell FTE population. With this rapid growth, the institution established an initiative to help maintain and guide campus character as growth continues.
UW Bothell STEM FTE Population
- Total STEM FTE: 1,191
- Engineering & Mathematics: 242
- Computing & Software Systems: 473
- Biological & Physical Sciences: 190

UW Bothell STEM at a Glance
- 93% are in-state students
- 35% are first generation four year college students
- 80% of incoming UW Bothell freshman have chosen to major in a STEM degree program
- 50% of STEM students at UW Bothell are from diverse backgrounds
- 25% of students are Husky Promise eligible
- 26% of STEM students are female
- 40% of STEM faculty are women
- By 2020 STEM is expected to account for 80% of UW Bothell student FTE population

“The 3 C’s” framework described below elaborates further on the sentiment of student engagement and its key role in fostering an inclusive culture at UW Bothell.

THE 3 C’S FRAMEWORK
Cross-Disciplinarity
Since the founding in 1990 UW Bothell continues its commitment to integrative and cross-disciplinary scholarship. An integral prioritization of UW Bothell’s pedagogy is the emphasis on research and teaching that cuts across disciplinary boundaries.

Connected Learning
UW Bothell has a belief that connected learning builds greater capacities for students, staff and faculty to connect theory to practice, exercise adaptive leadership skills across novel settings, and embrace the multiple contexts we all bring to our work. It recognizes that our ideas, discoveries, research, and institutional successes result from the relationships and human ecosystems that feed them.

Community Engagement
Community engagement involves collaboration among institutions of higher education and their larger communities for the mutually beneficial exchange of knowledge and resources in a context of partnership and reciprocity.

Throughout a series of focus groups and discussions (including those with the Registrar, faculty and staff groups, students, and the UW Bothell Executive Team), several types of spaces quickly came to the top of the essential list: classrooms, experiential learning labs, and offices. Also important were the spaces that promote the social connective tissue conducive to synergistic relationships and allows for the elaboration of ideas between students and faculty across STEM programs and beyond. With the primary spaces identified, all STEM growth should prioritize and reflect UW Bothell values of cross-disciplinarity, connected learning, and community engagement.
3.2 EXISTING CONDITIONS & CRITICAL IMPROVEMENTS

EXISTING CONDITIONS
Following the analysis of the School of STEM, the study focused on the existing conditions at the proposed building site and what critical improvements would need to occur to support a building of any scale on this site. The following analyses illustrate those discussions with UW Bothell Facilities groups and on site analysis.

GENERAL DESCRIPTION - EXISTING FACILITIES
The UW Bothell campus is adjacent to the North Creek Wetlands. View corridors to the wetlands have been established to help guide future projects benefit from this natural resource. The STEM project site has been identified along one of these view corridors and is in a position to take advantage of the view looking eastward, down the hill. The current UW Bothell academic facilities consist of three multi-story buildings with approximately 250,000 GSF combined. The existing buildings contain classrooms, public spaces, offices, and administrative space. The newest building on campus, Discovery Hall, houses a significant number of teaching labs and science facilities. The campus library and additional science labs are shared with Cascadia College, who also has facilities on the campus.

The quantity of academic spaces, including classrooms, undergraduate research spaces, faculty offices, faculty research space, and computer labs falls short on campus. Existing classrooms are not adequate enough to support growing enrollment and lower division courses. There are also not enough faculty offices or faculty and student research spaces to support growing enrollment and programs.

SITE + CIRCULATION
The 2010 Master Plan Upland Academic Zone is defined by sloping topography with a significant mature second growth forest. The forest scale and character establishes the identity for the zone. The landforms and forest are effective in placing the existing buildings in a consistent campus context and both help mitigate the scale of the existing buildings. They also provide a pedestrian campus environment. The protection of the slope and grove are important to the success of this part of the campus.

The steepness of the slope adjacent to the Crescent Path creates a potentially challenging grade transition given the probable location of entries, the objective of saving trees and preservation of the Crescent Path.
The existing road and path systems service the proposed building site. Loading areas are included in each building on campus. Loading at Discovery Hall is accessed from West Campus Drive. The building includes a hazardous waste room, gas delivery with a chained area for gas tank storage, flammable storage, and a mud room area for STEM discipline field trips. A similar space would likely need to be included in the Phase 4 building with access off West Campus Drive.

The adjacent Discovery Hall with direct connections to the hill climb stair offer the potential to continue the north-south pedestrian connections into the central forest grove, to gathering areas and to the northern Upland Academic Zone. The central forest grove can provide areas for small informal gatherings of up to 25 students as part of class work as well individual use, extending the available academic facilities to the north. The plaza with seating steps to the east provides a generous exterior gathering area for larger functions.

The significant grade change adjacent to the Crescent Path and adjacent to the proposed project site will require careful attention to grade transition to maintain sight lines and the connection to the path while limiting impact on the forest grove and avoiding a building entry which feels like it is set in the slope.

EXISTING SANITARY SEWER
Currently the sanitary sewer line serving Discovery Hall, to the south, ends in front of the Discovery Hall building. Sanitary sewer service will need to be extended to the planned building location. Option 1 is to extend the sewer line from the east side of Discovery Hall to the north to serve the new Phase 4 building. Option 2 is to route a new sewer line north of the new STEM Phase 4 building and then east to the existing sanitary sewer main located in Campus Way. Both options will require reconstruction of portions of the existing Crescent Path. Both options will provide gravity connection points for the required services of the new building. Extending the sewer line from in front of Discovery Hall, Option 1, will be the least costly and least impactful of the two options. A 6 inch sanitary connection is estimated to serve the building.

EXISTING STORMWATER TREATMENT
Existing stormwater runoff west of the proposed site in West Campus Lane is collected and treated by stormwater treatment facilities installed during the construction of West Campus Lane and Discovery Hall. Runoff from the new building will be treated at the building prior to routing it to the existing runnel located on the north side of Discovery Hall. Although roof runoff is typically considered clean water, the bird population on campus may be contributing pollution to the stormwater runoff. Treating the roof runoff will help reduce potential pollution. Runoff from areas adjacent to the building for loading/unloading and accessible parking off of West Campus Lane will also be treated before being routed to the existing West Campus Lane stormwater system.

Rooftops of the UWB1 and UWB2. With its close proximity to the wetlands, the campus has a large resident bird population that requires consideration for facilities and water treatment.
EXISTING STORM DRAINAGE
An existing 8-inch storm drain pipe runs north of Discovery Hall. A runnel system also runs along the stairs on the north side of Discovery Hall. This runnel system is part of the “clean” water system that is routed downhill. An existing 12-inch storm drain pipe is located in West Campus Lane.

Runoff from the new building will be routed to the existing runnel located on the north side of Discovery Hall. Runoff from areas adjacent to the building for loading/unloading and accessible parking off of West Campus Lane will be routed to the existing 12-inch storm drain in West Campus Lane. An 8-inch connection to the building will be required.

EXISTING CAMPUS CHILLED WATER PLANT
There is a chilled water plant that serves the campus. It was recently expanded to 1800 tons of nominal capacity during the Discovery Hall project 2 years ago. The plant has a future max capacity potential of approximately 3750 tons. The major equipment associated with the plant are 3 chillers (1000ton, 500ton and 300ton), 4 cooling towers, individual condenser water pumps per chiller, individual chilled water pump per chiller, central campus chiller water pumps, and a heat exchanger utilized for economizer conditions. As part of this study, review of the current operating conditions of the central plant will be conducted to determine what, if any scope of work is required to allow this central plant to serve the proposed STEM Phase 4 building.
EXISTING DOMESTIC WATER
An existing 8-inch water line is located in West Campus Lane, west of the site. An existing 8-inch water line is also located in the Crescent Walk, east of the site. Water service to Discovery Hall was provided from the water line located in West Campus Lane. We estimate a new 4 inch connection will be required with an estimated flow rate of 200 GPM. Domestic water and laboratory water will be distributed throughout the building independently.

EXISTING NATURAL GAS
There are gas lines near the site. It is assumed that a new meter will be provided on the exterior of the building and two PSI gas will be provided and routed in schedule 40 black steel piping to all gas fired equipment.

EXISTING ELECTRICAL SYSTEMS - POWER DISTRIBUTION
The campus has a PSE owned power distribution system to all buildings. Each building is provided with a PSE owned pad mount transformer. Emergency generation is provided for buildings on as needed basis. It is currently assumed that this building will be provided with a site generator to serve emergency lighting and communication loads, elevator, and optional loads associated with the program including any critical refrigeration, critical lab spaces, or general use receptacles. Generator will be exterior northeast corner of building with Quiet Site Level 2 enclosure and 48 hour base tank.

EXISTING COMMUNICATION SYSTEMS
The campus has a single mode fiber optic and copper loop for delivering all communications services to each building. It is assumed that this will be extended into the new building.

ELECTRONIC SAFETY AND SECURITY SYSTEMS - EXISTING FACILITIES
The campus has a fire alarm monitoring loop fed via single mode fiber. It is assumed that this project will connect to the fiber loop and upgrade some existing sites from single mode to multimode fiber. The campus Software House has a networked access control system to all buildings that will be extended to the new facility. The Student Rec building has a new Emergency Responder System that may be available for connection to this building. Coordinate with UW IT.
3.3 SPACE NEEDS ASSESSMENT

INTRODUCTION
Student enrollment at UW Bothell has nearly doubled since 2010, with consistent growth rates exceeding all other public universities in the State of Washington. The projected UW Bothell growth by 2020 is predicted to increase by 1,600 FTE students. Of that increase, an additional 1,000 FTE will be enrolled, and 500 will graduate in high-demand STEM degrees annually.

In response to the increasing number of students seeking STEM education opportunities and the growing demands from the many STEM-focused businesses and industry in the region, UW Bothell established the School of STEM in March of 2013 and completed the Phase 3 Science and Academic Building, Discovery Hall in 2014 which filled capacity immediately allowing a 200% increase of student FTE in STEM fields.

UW Bothell now enrolls 5,279 students (or 4,932 FTE) in academic facilities designed for a capacity of 2,800 FTEs. The 2014 average campus capacity for State of Washington higher education institutions was approximately 360 square feet per FTE compared to 140 square feet per FTE at UW Bothell.

STEM SPACE NEEDS - GENERAL
Throughout the predesign effort, input was solicited from a variety of student groups, School of STEM faculty, administration, and staff, Campus Facilities, Information Technology, and the Center for Diversity. In addition, a number of open houses were held to collect feedback from the entire campus community. For a complete list of focus groups, reference Section 2.8.

In addition, the Project Committee, the design team, and the cost estimator visited and researched several examples that represented recently constructed, state funded higher education buildings that house general STEM programs that serve pedagogically-similar (and smaller) classes in the Seattle area. It was valuable for the entire group to see how other STEM buildings are providing spaces for teaching, learning, and research and what qualities those spaces had. For more information on these benchmark projects, reference Section 5 & Appendix D.

Though Phase 4 proposes the construction of new academic space, the team also studied existing space to allow it to be leveraged and optimized to compliment new building uses. According to the space utilization studies of existing campus facilities compared to comments gathered throughout the various focus groups and meetings with the UW Bothell executive team, there was resounding agreement that classrooms, experiential learning labs, offices, and study space were most needed on campus and in particularly at the School of STEM. Due to an already pronounced deficit of space per student based on HECB standards, the overlap of functions played a critical role in how the team analyzed space needs in the context of making the most efficient use of any new facilities. The design team looked for opportunities to group space types in a way that reflected the types of uses and actions that would occur within them. The diagram on the adjacent page, using iconic, simple Lego blocks, highlights the verbs - “interact,” “innovate,” “mentor,” and “collaborate” that were used to categorize more specific spaces by the activities and learning outcomes they support. This simple approach allowed for an example of “building blocks” that helped stakeholders visualize and understand quantities of spaces as different scenarios were discussed.
Prioritized Characteristics for Program Spaces
When considering the general qualities of spaces in the fully built and occupied STEM facility, the team focused on a few key ideas:

1. Provide flexibility of spaces for simple conversion that may support the campus growth over time
2. Provide flexibility in layout of space and furniture arrangement to allow for a variety of pedagogical teaching methods
3. Provide flexibility for future elaboration on building systems should spaces require more robust infrastructure in the future
4. Reinforce cross-disciplinarity opportunities between STEM divisions, programs and with other UW Bothell Schools
5. Provide a variety of options for study and informal gatherings of a diverse user group to foster development and support instructor-student relationships

**INTERACT**
Classrooms and instructional teaching labs

**INNOVATE**
Experiential learning labs and support for Computer Science and Software and Engineering and Math, Capstone project labs and support, and collaborative shops

**MENTOR**
Faculty offices and single touchdown desk space

**COLLABORATE**
Seminar rooms, graduate student shared space, breakout space, cafe, STEM advising center
BUILDING EFFICIENCY FOR PHASE 4

Building efficiency is expressed as a net to gross ratio calculation, where assignable net square footage is multiplied by a space factor to get to a gross square feet total. The ratio of net assignable square footage to gross square footage is expressed as a percentage then that is the “building efficiency.” This project assumes that unassigned space contains circulation, mechanical/electrical/data spaces, structure, wall thicknesses, public restrooms, and unassigned building storage/loading areas.

The assumed Phase 4 building efficiency is ratio is 66.5%, which is considered to be within the average (65%) to high end (68%) efficiency for a STEM Instruction-focused higher education building. Maximizing building efficiency depends on the design and construction team’s ability to make efficient use of space, conserve resources, consolidate service spaces in a logical manner, and carve out useable program space in circulation zones. It is critical that the building efficiency at the predesign stage of the process be realistic and allow for an achievable design solution that is within the range of medium to high new construction efficiency. Based on the current program, there will be 23% of space that is dry and wet experiential learning labs, 19% that is computational experiential learning labs, and the remaining building consists of instructional (classroom), office, or collaborative open student study space.

The 66.5% efficiency ratio will be the target for the design and construction team for the Phase 4 project. As indicated in the WA State DES Space Allocation Standards Report, dated September 2011, maximizing building efficiency will be driven by the following factors on this project:

- Building design – size and shape of floor plate, structural system, and core/circulation locations
- Program requirements – unique requirements for specialized lab spaces
- Organizational philosophy – evolution in UW Bothell philosophy about alternative work styles, office space allocations, lab space allocations, and shared workspace ideas
- Configuration of space – maximizing efficiency in relationships and layouts
- Financial – making future changes to improve efficiency later is expensive

BUILDING FOR FLEXIBILITY + GROWTH

The proposed Phase 4 facility will focus on expanding within the Computer Sciences & Software and Engineering & Math divisions. This includes marine and civil engineering, as well as cross-disciplinary programs such as bioengineering and biomedical programs. Identifying programmatic overlap among Computer Sciences & Software and Engineering & Math spaces and other STEM divisions as well as general student population is a key priority. It presents the opportunity to maximize space needs and address classroom deficiencies across campus. Incorporating flexibility for the proposed Phase 4 building will allow the campus to consider consolidation of programs, accommodate different configurations, and maximize efficiencies via adjacencies. Flexibility in systems and program location should be considered by future design teams. Mechanical and plumbing systems may be zoned together in a module that serves multiple uses and can be ganged together to allow for expansion and contraction.

One method of flexibility can be achieved through a flexible structure that will allow the expansion or contraction of spaces to accommodate growth.
This chart illustrates how the Lego building blocks are broken down into quantities of spaces that emerged in the preferred program totals.

<table>
<thead>
<tr>
<th>INTERACT</th>
<th>(4) 1,050 SF CLASSROOM 30 PERSON</th>
<th>(3) 1,680 SF CLASSROOM 48 PERSON</th>
<th>(2) 2,500 SF CLASSROOM 100 PERSON</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INNOVATE</td>
<td>(2) 1,680 SF COMPUTER LAB 48 PERSON</td>
<td>(1) 1,080 SF THERMAL FLUID LAB 24 PERSON</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MENTOR</td>
<td>(69) OFFICE 80 SF EA. W/ 40 SF DEDICATED TO SHARED SPACES</td>
<td>(3) STATIONS TOUCHDOWN 50 SF EA.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COLLABORATE</td>
<td>(2) 480 SF SEMINAR</td>
<td>700 SF BREAK OUT SPACE IN CORRIDOR</td>
<td>50 SF/EA. GRAD STATIONS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,600 SF STEM ADVISING</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Miller Hull Partnership
FTE + GROWTH

STEM fields are increasingly important areas of study and research in our state and region. To help meet this demand, UW Bothell proposes to increase its teaching and research program and to construct a new facility to provide more access for students. The Phase 4 STEM Building will accommodate at least 1,000 new FTE students and increase graduation by 500 FTE annually. The building could help complete 60% of the UW Bothell's goal of 6,100 FTE capacity build-out on the 10,000 FTE UW Bothell/Cascadia College collocated campus. The following charts illustrate projected growth on campus.

### UW Bothell GROWTH

<table>
<thead>
<tr>
<th>QUARTER</th>
<th>HEADCOUNT</th>
<th>STUDENT INCREASE</th>
<th>% CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autumn 2007</td>
<td>1,589</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Autumn 2008</td>
<td>1,934</td>
<td>345</td>
<td>21.70%</td>
</tr>
<tr>
<td>Autumn 2009</td>
<td>2,429</td>
<td>495</td>
<td>25.50%</td>
</tr>
<tr>
<td>Autumn 2010</td>
<td>2,880</td>
<td>451</td>
<td>18.50%</td>
</tr>
<tr>
<td>Autumn 2011</td>
<td>3,379</td>
<td>499</td>
<td>17%</td>
</tr>
<tr>
<td>Autumn 2012</td>
<td>3,788</td>
<td>409</td>
<td>12.10%</td>
</tr>
<tr>
<td>Autumn 2013 (STEM est.)</td>
<td>4,216</td>
<td>428</td>
<td>11.30%</td>
</tr>
<tr>
<td>Autumn 2014</td>
<td>4,587</td>
<td>371</td>
<td>8.80%</td>
</tr>
<tr>
<td>Autumn 2015</td>
<td>4,932</td>
<td>345</td>
<td>7.50%</td>
</tr>
<tr>
<td>Autumn 2016</td>
<td>5,279</td>
<td>347</td>
<td>7%</td>
</tr>
<tr>
<td><strong>Revised Projected Growth</strong></td>
<td><strong>6,100</strong></td>
<td><strong>821</strong></td>
<td><strong>15.50%</strong></td>
</tr>
</tbody>
</table>

Average growth increase per year: 15.3%
Growth per year that needs to occur to reach projected growth in 2020: 205.25 student increase per year.

### STEM GROWTH

<table>
<thead>
<tr>
<th>QUARTER</th>
<th>HEADCOUNT</th>
<th>STUDENT INCREASE</th>
<th>% CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autumn 2007</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Autumn 2008</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Autumn 2009</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Autumn 2010</td>
<td>455</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Autumn 2011</td>
<td>546</td>
<td>91</td>
<td>20%</td>
</tr>
<tr>
<td>Autumn 2012</td>
<td>750</td>
<td>204</td>
<td>37.30%</td>
</tr>
<tr>
<td>Autumn 2013 (STEM est.)</td>
<td>1,037</td>
<td>287</td>
<td>38.20%</td>
</tr>
<tr>
<td>Autumn 2014</td>
<td>1,371</td>
<td>334</td>
<td>32.20%</td>
</tr>
<tr>
<td>Autumn 2015</td>
<td>1,617</td>
<td>246</td>
<td>17.90%</td>
</tr>
<tr>
<td>Autumn 2016</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Projected Growth</strong></td>
<td><strong>2,457</strong></td>
<td><strong>840</strong></td>
<td><strong>51.90%</strong></td>
</tr>
</tbody>
</table>

Average growth increase per year: 29.1%
Growth per year that needs to occur in order to reach projected growth in 2020: 168 student increase per year.
The UW Bothell/Cascadia College co-located campus contains 642,094 gross square feet of space. Of this 642,094 GSF, 91,006 GSF is dedicated to student housing. Considering only the UW Bothell student population of 4,587 (Autumn 2014) this academic space shared between both institutions provides 125 gross square feet per UW Bothell student or 139.9 GSF/FTE. If both Cascadia College shared space and the 91,006 GSF of student housing are not included then the total effective UW Bothell space inventory is 471,941 GSF. This brings the GSF/student even lower, to 122.7 GSF/FTE. A comparative benchmark of 150 GSF/FTE has been established by the Washington State Board for Community and Technical Colleges (SBCTC).

**Peer Institutions - Space per FTE (through 2014)**

<table>
<thead>
<tr>
<th>Institution</th>
<th>GSF/FTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>WSU</td>
<td>497</td>
</tr>
<tr>
<td>UW SEATTLE</td>
<td>480</td>
</tr>
<tr>
<td>TESC</td>
<td>384</td>
</tr>
<tr>
<td>CWU</td>
<td>318</td>
</tr>
<tr>
<td>WWU</td>
<td>245</td>
</tr>
<tr>
<td>EWU</td>
<td>246</td>
</tr>
<tr>
<td>SBCTC BENCHMARK</td>
<td>150</td>
</tr>
<tr>
<td>UW BOTHELL</td>
<td>139.9</td>
</tr>
<tr>
<td>UW BOTHELL EFFECTIVE</td>
<td>122.7</td>
</tr>
</tbody>
</table>

**361.6 combined average**

**BUILDING FOR STUDENT SUPPORT**

With 64% of incoming students from diverse backgrounds, it is even more critical to incorporate spaces that support students and help them persist in their studies. 48% of students at UW Bothell are first generation college students. The UW Bothell is committed to providing connections to services, opportunities, mentors, and faculty to support students. This support is offered through the Student Success Center, Diversity Groups, and advising, but every building on campus can help reinforce that support in the type of program spaces they include. If support is not visible, then it may as well not be there. So, the proposed Phase 4 facility includes a new combined STEM Advising Center, accessible and visible research spaces, and breakout and gathering spaces that give commuter students a place to be on campus.
GENERAL CLASSROOMS - NEEDS
The statistics below illustrate that, both for the whole campus and for the school of STEM, there is a deficit in intimate 30-48 person classrooms. There are very few classrooms on campus that will accommodate multiple modes of learning and enough space to move freely between groups of students. Classroom utilization is above standard rates established by the HECB across the entire UW Bothell campus. Recognizing the campus-wide deficiency in classroom spaces, this Phase 4 building predesign considers classrooms that can be used for a multitude of pedagogical functions for maximum flexibility.

Classrooms are a critical need for growth at UW Bothell and STEM growth specifically. The majority of STEM class sizes are 24, 30, and 48 seat classrooms. The UW Bothell campus contains a total of one assignable 24-seat classroom, seven 30-seat classrooms, and eighteen 48-seat classrooms. In Autumn of 2014, UW Bothell instructors requested a 24-seat classroom 64 times, of which 21 requests were from STEM instructors. A 30-seat classroom was requested 80 times, 32 of which were requests from STEM instructors. A 48-seat classroom was requested 64 times and, of these, 22 requests were from STEM instructors. STEM programs fill a large percentage of the classroom space available, and there is such a lack of these spaces campus-wide, providing 30 and 48-seat classroom spaces in the new building would fulfill future STEM growth while also alleviating current campus-wide demand.

In an effort to maintain enrollment growth and provide space in key pre-requisite STEM courses that will allow students to stage their academic courses without delay attributed to seat capacity deficiencies, the UW Bothell and the School of STEM will accommodate two 100-seat classrooms.
in the proposed Phase 4 STEM building. These 100-seat classrooms are intended to maintain the same pedagogical concept in facilitating close relationships between students and the instructor by providing the flexible furniture that is conducive to group work.

Most Requested Classroom Size on Campus and Percent of STEM Requests, Autumn 2015

- 24-seat classroom: 32% are STEM requests
- 30-seat classroom: 40% are STEM requests
- 48-seat classroom: 52% are STEM requests

This deficiency in space per student coupled with the growth rate that UW Bothell has been experiencing over the past 5 years demonstrates how enrollment growth has outpaced facilities growth. If not addressed, this deficiency in academic spaces will begin to be a limiting factor to provide student access at UW Bothell, especially with projected growth to continue.

GENERAL CLASSROOMS - SPACE
A recent study of space utilization on the UW Bothell campus, conducted by SRG in 2015, yielded a ratio of contact hours per seat for each size of classroom and instructional space. The Washington Student Achievement Council (formerly the Higher Education Coordinating Board, or HECB) uses 67% for the classroom utilization target for the percentage of hours per week a classroom is scheduled for use. This standard is then used as the basis for its standard of 22.0 Student Contact Hours (SCH) per seat for general use classrooms. We used this data to determine student capacity in existing and proposed classrooms, the number of stations required for existing enrollment and future projections, and the classrooms space required for projected enrollment by 2020 focusing on the growth target of 1000 FTE in the School of STEM.
The recommendations for square footage per student indicated in the Facilities Evaluation and Planning Guide were considered, though the ASF for moveable tables and chairs for the 30, 48, and 100 seat classrooms at 16-22 were deemed too low to accommodate the amount of space used by STEM faculty in active learning scenarios. The number used to determine the ASF is 35ASF per station for 30 and 48 person classrooms and 25ASF per person for 100 person classrooms.

INTERACT  [PROPOSED CLASSROOMS + TEACHING LABS]

UW Bothell is known for engaging students with interactive classrooms and active learning discussions in groups. The campus does not have graduate teaching assistants, so smaller classes help to ensure dynamic classroom interaction. Interactive classrooms at any size support diversity and under-served student groups allowing for flipped models that challenge the traditional hierarchy of faculty to students (teacher at the front of the room, and students with eyes forward). In the inclusion of classrooms in the Phase 4 program, UW Bothell is expanding upon this innovative teaching model.

The Phase 4 “Interact” spaces include general classrooms that allow for multiple layouts to support a variety of pedagogical teaching styles. Other interaction spaces include teaching labs with specialized equipment or software (such as the two computer teaching labs and the thermal fluids dynamics labs identified as space needs in this predesign document). The diagrams below depict how classrooms could be configured to allow multiple layouts.

About 30% of STEM classes fit in a 30 person space. There are thirty-one 30 person classes taught in 8 spaces on campus. This will likely increase proportionally. These classes are often taught in 48 person rooms because there is an insufficient number of 30 person classrooms. There are currently 55 STEM classes taught in the 22 shared 40-48 seat classrooms on campus. By 2020, there will be 70 more classes for a total of 125 STEM classes that need to be accommodated on campus at a time. Based on the ideal utilization of classrooms and future growth considerations, this project should provide (4) additional 30 person classrooms, (3) 48 person classrooms, and (2) 100 person classroom for a total of 27,682 GSF.

Incorporating a Flexible Concept in General Classrooms:
- Common structural module that allows similar ‘shells’ to be outfitted for future space conversions
- Common furniture in all layouts highlight flexibility
- Non-directional room orientation allows pedagogical options
- Electrical infrastructures to support variety of uses and technology
- Unobstructed writable surface
### 30-Seat Classrooms

**Area:** 1,050 SF  
**Attributes:** whiteboard with flexible furniture and monitors for group work, projector, ability for students to share content with class, classroom storage  
**Special Considerations:** microphones, video recording capabilities

### 48-Seat Classrooms

**Area:** 1,680 SF  
**Attributes:** whiteboard with flexible furniture and monitors for group work, projector, ability for students to share content with class, classroom storage  
**Special Considerations:** microphones, video recording capabilities, same size module as 48-seat Computer Teaching Lab
100-Seat Classrooms
Area: 2,500 SF
Attributes: whiteboard with flexible furniture and monitors for group work, projector, ability for students to share content with class, classroom storage
Special Considerations: with a flat floor, can be used for events and Capstone Project display
INTERACT  [PROPOSED COMPUTER TEACHING LABS]
The recent Discovery Hall project provided most of STEM’s traditional wet and dry 24 person teaching labs. Based on current and projected utilization through 2020 (in all STEM classes) the only teaching lab needs are the computer teaching lab and the thermal fluid dynamics teaching lab.

Computer Teaching Labs that accommodate specialized software and robust memory with connection for student laptops in Computer Sciences and Software Programs is essential. The Phase 4 building should provide two 48 person computer labs with an emphasis on group work. This entails the possibility of a common monitor to share content at group tables and flexibility. The diagrams below depict how classrooms could be configured to allow multiple layouts.

Incorporating a Flexible Concept in General Classroom:
- Common structural module that allows similar ‘shells’ to be outfitted for future space conversions
- Common furniture in all layouts highlights flexibility
- Non-directional room orientation allows pedagogical options

48-Seat Computer Teaching Lab
Area: 1,680 SF
Attributes: whiteboard with flexible furniture and monitors for group work, projector, ability for students to share content with class at group table, classroom storage
Special Considerations: same size module as 48-seat classroom
INTERACT  [PROPOSED THERMAL FLUID DYNAMICS TEACHING LAB]
A total of one of these spaces is required for the proposed Phase 4 building. The teaching lab should be consistent with other lab-like spaces for ease of space re-appropriation to satisfy future growth demands, though it should accommodate more of a traditional teaching lab configuration to allow for instruction in thermal fluid dynamics and other Mechanical Engineering classes. This space would require storage rooms adjacent, flexible furniture, and lab benches for quarterly reconfigurations, and ventilation that accommodates engine exhaust. The diagram below illustrates the possible layout of a Teaching Lab.

Incorporating a Flexible Concept in General Classroom:
- Common structural module that allows similar ‘shells’ to be outfitted for future space conversions
- Common furniture in all layouts highlights flexibility
- Non-directional room orientation allows pedagogical options

Thermal Fluid Dynamics Teaching Lab
Area: 1,080 SF
Attributes: whiteboard, classroom storage, power and data, 4 sink, projector
Special Considerations: based on same size module as Experiential Learning Labs. All casework doors possess the opportunity to provide additional whiteboard surface.
INNOVATE [PROPOSED EXPERIENTIAL LEARNING LABS + SUPPORT]

At UW Bothell, it is an integral part of STEM educational mission for undergraduate students to engage in an experiential, learning-based research. This required research portion of the curriculum is reinforced through Capstone projects which usually occur in the final year of the program. Typically students complete 10 credits (400 hours) of the Capstone in their final quarter(s). They learn by connecting classroom theory and community-based experience through the completion of an academic project. Project options consist of internships, research with faculty, individual projects, or group projects. Currently the research that occurs on campus is limited due to critical space deficiencies. Research space throughout the School of STEM is required to fulfill this integral part of the UW Bothell experience.

FLEXIBILITY + INTERCHANGEABILITY

Research labs as described by focus groups perform two functions: faculty research spaces to attract high quality faculty who further the mission with great research; and space within these labs for faculty to reinforce curriculum by providing undergraduate research opportunities. Project labs are also critical as they provide spaces for student research and Capstone project development. These spaces could be a similar size to the research labs, but provide more space for team-based research and individual storage, as well as greater density of students.

Shared shops for large equipment (or items that require additional power, water, air, gas, etc.) are critical for the research and project labs to function and be versatile. Some functions that might occur in these spaces are material testing labs, surplus space for computers to run interrupted, thermal fluids storage, hoods for soldering, or etching of circuit boards. Faculty research space is a critical component of the STEM programs, as it fosters the growth and development of student research. Faculty research also helps grow the equipment and skill set for student research. Spaces that accommodate faculty research also need to be large enough to accommodate up to 12 undergraduate student researchers.

EXPERIENTIAL LEARNING LABS - SPACE ASSUMPTIONS

At UW Bothell the line between instructional space and lab research spaces is very difficult to draw. In some instances, computer class labs for instance, may be opened after class time and become student project space. Dedicated space for undergraduate research is a dire need for the STEM programs. The experiential learning labs would be classified as Open Laboratories in the FEPG in that they have specialized equipment that is used by particular disciplines in a room that is not regularly scheduled. For experiential learning labs associated with faculty + undergraduate research, 425 ASF/station is dedicated to wet and dry labs and 200 ASF/station is dedicated to computational labs. For experiential learning labs for project and capstone focus, 35 ASF/station is dedicated to computational labs, 40 ASF/station for dry labs, and 60 ASF/station for wet labs.

The FEPG assumptions for research laboratories was also embraced, including the following:

- Provide flexibility in expansion capability, ability to convert space from one activity to another, and ability to adapt to new technology.
- Enhance communication through spatial requirements
- Ensure safety through code compliance/regulatory guidelines/EH&S standards

EXPERIENTIAL LEARNING LABS - BENEFITS

Research opportunities for students help to prepare them for careers in their fields and provide perspective on practical and applicable experience. Undergraduate research usually involves some training time; so, typically, it is beneficial to have the same student working on research for at least a year commitment. Experiential Learning Labs have the following potential benefits for instructors and students:

1. Undergraduates often gain an increased willingness to try new things, struggle, collaborate, and develop self-direction and the desire to seek out resources from each other.
2. Brainstorming, research, tinkering, exploring and building on ideas often result in learning that is generative for both undergraduates and faculty.
3. With undergraduate research and making, there can be an increased opportunity for reflection and a deeper individual appreciation for how they are learning.
4. Faculty connect with students on a deeper level. By getting to know students, faculty can reinforce their individual strengths.
5. Engaged faculty and undergraduate research experience can inspire educators to change their own teaching methods, offer more hands-on opportunities, and create a more student directed curriculum.
UW Bothell has the following goals for these types of spaces:

- Make research mission more visible - research on display
- Develop research labs that contain the flexibility to allow space for faculty’s student researchers
- Embrace the fact that some research happens off-campus
- Recognize that non-bench sciences need research space that may contain a desk, storage, whiteboards, and technology connections
- Consider for small group gatherings in non-bench space that could facilitate instructor-student meetings
- Create semi-private space: explore space dividers that are more of a furniture solution with assigned lockable storage and whiteboard and possibly power
- Include casework that can be modified to accommodate future growth

Experiential learning labs would have a range of equipment and services to ensure cross-disciplinarity through both programmed and un-programmed spaces. The diagrams below depict how experiential learning labs could be organized on a module to allow for versatility.

**Incorporating a Flexible Concept:**

**Lab Module**

- A common module that can accommodate Research Labs, Capstone Project Space, or Class Labs
- Space that allows expansion and contraction depending on class size and user needs
- Mechanical and electrical infrastructure coordinated to provide adaptability over time

![4-module wet lab diagram](image1)

![8-module wet lab diagram](image2)
Computational labs should be set up to support collaboration and creativity. They should be similar to professional work environments with space for doing individual and group work (Usually, there are two to four students). A diversity of spaces and layouts would be important, and ideally larger spaces would be zoned to allow for dynamic and organic occupation by students and faculty.
MENTOR [PROPOSED OFFICES]

With a student population that has nearly doubled since 2009, UW Bothell has hired (and continues to hire) new faculty and staff in an effort to maintain pedagogical goals and quality, as well as to facilitate the increased demand. The growth in STEM will need to be supported with the addition of great tenure, lecture, and part-time track faculty.

In an effort to maximize academic space, UW Bothell has elected to experiment with a variety of options for faculty and staff. Hoteling-style stations and smaller single offices are being tried in an effort to redistribute area towards a common space used for informal and formal meet-ups between faculty and students.

The mentor spaces would be classified as Academic Offices in the FEPG standards. The UW Bothell standard is 120 ASF per person regardless of the role of the faculty member, so this was used as the basis for the development of square footages.

Full-time faculty and staff that spend longer hours in their offices are allocated 120 square feet. In the new model, 80 sf of that space is allocated to an individual office and the remaining 40 sf distributed to common space within the office suite. A shared work room, and conference room space make up this redistributed office space. Part-time staff and faculty are allocated a hoteling-style desk with storage in an open setting.

The diagrams below depict how offices could be organized in the new facility.
COLLABORATE  [PROPOSED SEMINAR ROOM + BREAKOUT SPACES]

In all fields today, third spaces are critical to student learning. Having spaces available for student-to-student, student-to-faculty, and faculty-to-faculty interactions can be easy to overlook, but certainly Discovery Hall’s spaces are well used. These are spaces where extended conversations can happen after class and impromptu meetings, tutoring sessions, or even big discoveries can take place. The diagrams below depict how these collaboration spaces may be configured.

This program also includes a STEM Advising Center, which will allow the graduate and undergraduate advising to be collocated together for comprehensive support for students. In addition, as a commuter school with little student housing, it must be acknowledged that spaces “to be” after and between classes are critical to meeting student needs. A mixture of space is critical as people are different and seek out spaces with different acoustic and visual privacy. A balance of open and closed spaces for private work or group work should be considered.

*Every space is an opportunity to learn, but spaces require a variety of acoustic and visual separation for different tasks*

<table>
<thead>
<tr>
<th>public</th>
<th>communal</th>
<th>intimate</th>
<th>private</th>
</tr>
</thead>
<tbody>
<tr>
<td>lobby</td>
<td>seminar spaces</td>
<td>group work</td>
<td>private spaces</td>
</tr>
</tbody>
</table>

Collaboration space for student group work adjacent to faculty offices

Various types of collaboration space for student group, semi-private study, and acoustically separated spaces meet-up.
3.0 PROGRAM ANALYSIS

INTERACT
classrooms and instructional teaching labs with a 68% efficiency ratio

INNOVATE
experiential learning labs and support/collaborative shops. Wet labs have a 60% efficiency ratio, dry labs have a 62% efficiency ratio, and computational labs have a 68% efficiency ratio

MENTOR
faculty offices and single touchdown desk space. Office suites and hoteling stations have a 68% efficiency ratio

COLLABORATE
seminar rooms, graduate student shared space, breakout space, cafe, STEM advising center. All other collaborate spaces reflect 68% efficiency ratio except for those spaces located in corridors where the efficiency ratio is 85%

<table>
<thead>
<tr>
<th>Description</th>
<th>% of overall program</th>
<th>% of overall cost</th>
<th>TOTAL FTE SUPPORTED BY TYPE OF SPACE</th>
<th>TOTAL GSF</th>
<th>PROJECT COST ($/GSF) FOR TYPE OF SPACE</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERACT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classrooms + Teaching Labs</td>
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<td>30%</td>
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<tr>
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</tr>
<tr>
<td>Experiential Learning Labs - Small Group</td>
<td>42%</td>
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<tr>
<td>Experiential Learning Labs - Projects</td>
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</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaborative Office - Single Offices</td>
<td>16%</td>
<td>14%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoteling / Touchdown Stations</td>
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<td></td>
<td></td>
<td>12,176</td>
<td>221</td>
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<tr>
<td>MENTOR spaces subtotal</td>
<td>1,479</td>
<td>12,397</td>
<td>821</td>
<td>10,495,069</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Collaboration Space</td>
<td>7%</td>
<td>6%</td>
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<td>5,353</td>
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<td>4,186,000</td>
</tr>
<tr>
<td>COLLABORATE spaces subtotals</td>
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<td>5,353</td>
<td>788</td>
<td>74,977,654</td>
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</tr>
</tbody>
</table>

GBF TOTAL 78,647

COST TOTAL (2019 funding) 74,977,654
3.4 SPACE REQUIREMENTS

INTRODUCTION
The design team worked with the School of STEM to conduct a space needs assessment for this project. The process identified needs to support new and expanded programs and to accommodate an additional 1,000 student FTE’s as well as systems needs to tie new construction into the campus. Input was solicited from many stakeholders. For a full description of focus groups, reference Section 2.8.

In the discussion of the preferred site, it was determined that the proposed Phase 4 building should accommodate a seamless movement between it and Discovery Hall as much as possible. Allowing the proposed building to maintain the same floor elevation as Discovery Hall would maximize the use of the existing stair landings of the hill climb and promote easy transport of materials and equipment between the two STEM buildings. Consequently, a similar floor to ceiling height, is desirable.

LANDSCAPE SYSTEMS - PROPOSED
Exterior program spaces are intended to support both the program needs of the project and the immediately surrounding campus area:

Vehicular Circulation
At the current preferred site, service and emergency access is accommodated at both the east and west edges of the building site via both existing roads and paths. It is assumed that required service access will include delivery trucks of small packages, and a drop-off zone near wheelchair accessible entrance. The location of service access is recommended to be adjacent to the appropriate interior facilities including room for garbage and recycling.

Pedestrian Circulation
Pedestrian access is currently available on the east and west edges of the preferred site and on the south side at the hill climb stair landings. Access into and through the forest grove to the north should be pursued in an informal manner to integrate the forest into the campus network, and the proposed building and its academic function into the site.

Wheelchair Access
In the new building, all entries must meet ADA accessibility requirements. The building must include disabled parking spaces, and a loading area accessible to disabled persons’ shuttle. These must be located in close proximity to the wheelchair accessible building entry.

Bicycles
The amount of bicycle parking is tied to the total building occupancy including students, faculty, paid student workers and staff at 10%; plus 5% of the maximum student classroom capacity (or 24 spaces, whichever is greater). Additionally, secured parking is required for 3% of the total building population or at the minimum 10 spaces. Based on a total occupancy of 1,102 and the maximum student class room capacity of 920, a total of 156 bicycle stalls will be required. Proposed secured bicycle parking would be 33 stalls, which can either occur within the building or as lockers on site.
3.0 PROGRAM ANALYSIS

Academic and Social Exterior Gathering Spaces
These would be spaces which support both the function of the building and the larger campus. As indicated in the program section 3.3, there are spaces inside the building to support academic and social gathering and these spaces are valuable to include at the exterior as well. Examples of these exterior spaces include outdoor convening areas, an informal class space in the forest or main entries with seating and gathering areas in close proximity to bicycle parking. These should be linked visually and spatially to interior spaces such as passive gathering places, main corridors, communal work areas, or other “third places”. Additionally, the exterior spaces should be located to allow for campus interaction and solar access wherever possible. If located within the forest area, these amenities should be designed to leverage and improve existing planted areas without detriment to the canopy, understory, or related ecological function.

It is recommended to include an exterior class area as an informal ADA accessible area with seating for a 24-person class with an area of 300 to 400 square feet. This exterior space would include seating, leaning rails and a work table. Based on focus group input, this space could include integration of educational research items such as reuse of salvaged trees as nurse logs, an identified soil filled ‘splash box’ and other yet to be identified elements.

Entries
Entry gathering areas and plazas should be designed and furnished to support the mission of the building and extend the internal activities out into the site. The size of these spaces will need to be determined in the design phase in response to detailed program needs and entry sequence. The entry sequence at the low side of the slope should take into consideration the adjacency of the stepped concrete plaza at Discovery Hall, the future access, circulation, and nodes impacted by a possible expansion of the library. An entry at this lower location could open onto the main pedestrian spine of campus and create an important connection between the open plaza and the upper, forested slope.

MECHANICAL SYSTEMS - PROPOSED

Cooling Sources
All proposed system concepts utilize the existing campus chilled water plant for the building’s cooling needs. This reflects the campus master plan. Chilled water lines and valves are already in place to receive the proposed Phase 4 building and future construction would expand upon the existing system with connection points for future growth. Chilled water coils should be sized for a minimum of 14 degree Fahrenheit delta, but ideally would be sized for an 18 degree Fahrenheit delta to maximize central plant operating efficiencies. The economizer chilled water temperature should also be reviewed with coil selections to help maximize the number of hours of year that chillers can be shut down on the campus. The estimated cooling load for this building is between 300 and 350 tons based off a GSF of approximately 78,000 square feet with approximately 42% of the area slated for experiential learning labs. This assumes code minimum insulation and glazing performance.

At the time of this predesign report, trend/log data on the existing chiller plant had been lost due to a server infrastructure issue. In order to gather accurate data, it is highly recommended that the chiller plant is monitored with trend/log data on chiller and cooling tower operation over the cooling season of 2016. Based on theoretical calculations of the campus buildings and their respected peak block loads, there is approximately only 250-300 tons of chilled water available at the central plant. After discussions with UW facilities on chiller and cooling tower staging, there is likely significant capacity available. If the plant does not have the 300-350 tons available to service this new STEM building, a chiller plant upgrade project would be required which would likely switch out an existing 300 ton chiller with a new 500 to 1,000 ton chiller (size dependent on budget available) and add associated cooling tower and pumps as required.

Heat Source
All proposed system concepts utilize, at least in part, local natural gas boilers, likely located in a roof penthouse similar to other installations at UW Bothell campus. The estimated heating load for this building is between 3,500 and 4,500 MBH would be very dependent on the reheat load associated with the lab exhaust system. This assumes code minimum insulation and glazing performance. A minimum of (3) boilers should be provided, with (1) boiler providing an N+1 redundancy function. High performing system options are noted in system concepts below.

Building Central Air Handling Units
As UW will own and operate this building for years to come, custom air handling units with long equipment life should be
considered for this project. This will give designers maximum flexibility to meet UW standards such as coil thickness, optimum maintainability, and maximum operating efficiency. It will also allow the future team to adjust equipment dimensions to fit effectively in rooftop penthouses. Air handling units should be designed around a fan array concept for redundancy and high acoustical performance. Each fan should be paired with its own associated VFD; all fans should ramp up and down together for simple control. The team should consider including a fan array and damper diagnostic package. All coils should be piped in multiple sections to allow individual branches to be isolated if necessary for repair (while maintaining the overall cooling or heating function). The estimated supply airflow is highly dependent on the system that is selected: high performance Variable Air Volume (VAV) or Dedicated Outside Air Systems (DOAS) with decoupled conditioning systems (system concepts noted in further detail below).

**Lab Exhaust System**
The design team should review systems that comply with UW Environmental Health and Safety Laboratory Safety Design Guide, ANSI Z9.5, NFPA 45, Washington State Mechanical Code and other relevant standards & codes. To help insure and maintain the highest environmental quality, a wind consultant should be brought on the project to model proposed hazardous exhaust discharge locations. This will help avoid contaminant entrainment back through operable openings and ventilation intakes on this building and adjacent buildings. This will also help to insure the indoor environmental quality maintains the highest of quality. Possible lab exhaust equipment options include: low profile exhaust fan arrays with high plume throw, plume dilution fans (strobic), and utility set fan with large vertical stacks. Discharge strategies such as variable geometry nozzle technology offer increased energy savings over traditional bypass air strategies, while still maintaining safe discharge velocities (3,000 fpm). Systems should be controlled with variable volume airflow with pressure independent terminal units at each hood and zone. Lab exhaust ductwork shall be fully welded 316 stainless steel material. The estimated lab exhaust airflow for this building is between 45,000cfm to 55,000cfm but this estimation is extremely dependent on the number of hoods utilized and the final experiential lab space design. A minimum of (3) exhaust fans should be provided, with (1) fan providing an N+1 redundancy function.

**Building Automation System (BAS)**
The proposed Phase 4 building should be provided with a central web enabled Direct Digital Control (DDC) BAS control and monitoring system based on a native BACnet architecture. The system should consist of head-end system located in this building with a DDC point server, alarm printer and user interface. The system should also integrate (control and monitoring) with the UW Bothell Campus Johnson Control System. It should be provided with data logging and trending capabilities, sufficient digital storage and processor speed for these functions. It should allow authorized Owner personnel full access to the Building Automation System through password protected portal for remote monitoring and control of connected systems. UW Bothell should consider as part of this project a campus BAS upgrade to the latest revision, which would include an energy dashboard to monitor gas, water and electricity used by the proposed building.

**Rooftop Penthouse**
All proposed system concepts utilize a rooftop penthouse(s) to protect equipment against the elements, prolonging equipment life and provide a safe, tenantable work environment for building operators. The following equipment is assumed to be enclosed in the penthouses:

- Air handling units
- Boilers
- Water heaters
- Pumps
- Controls
- Ductwork run around coils

**System Redundancy**
The following system redundancy considerations are assumed:

- Air handling units – 20% extra capacity on fans, coils & duct risers
- Hazardous lab exhaust system – 30% extra capacity on fans & duct risers with N+1 redundancy on fan equipment allows (1) fan to fail while still meeting peak airflow demand
- Makeup air lab system - 30% extra capacity on fans, coils & duct risers
• Heat Exchangers – 30% extra capacity (space on assembly only, plates added later)
• Boilers - N+1 redundancy allowing one boiler to fail while still meeting peak design load
• Pumps - N+1 redundancy allowing one pump to fail while still meeting peak design flow. Pumps shall run in parallel.

System Standby Power
The following systems should be considered on standby power:
• Lab Exhaust System
  o Minimum of 50% airflow capacity (UW standards)
• Lab Makeup Air System
  o Active (fans) or Passive (dampers)
• Split systems serving critical loads
  o Emergency electrical rooms
  o Elevator control rooms

MECHANICAL SYSTEMS OPTIONS (BASE, ALTERNATE 1, ALTERNATE 2)
Base: Code Minimum System

Cooling Source:
• Campus chilled water tie in tertiary pump assembly

Heating Source:
• Conventional 82% efficient commercial boiler array
  o 180 deg F supply water
  o 140 deg F return water

Classroom/Lecture/Office Areas/Lobbies/Hallways:
• High performing variable volume air handling units
  o Chilled water coil
  o Heating water coil
  o 100% economizer capability
• Zone level variable air volume terminal units (vav box)
  o Hot water reheat
• Overhead Distribution

Research/Lab Areas:
• Zone level fan coil units
  o Chilled water coil
  o Heating water coil
• Hazardous lab exhaust system
  o Variable volume system with zone level venturi valves
  o No heat recovery
  o Manifold all rooms together
• Makeup lab air system
  o Chilled water coil
  o Heating water coil
  o Variable volume system with zone level venturi valves
• Overhead Distribution

Energy Efficiency:
The heating, cooling, ventilation and airflow delivery methods listed in this option are appropriate for the type of occupancies expected in the proposed Phase 4 STEM building, however they represent the minimum efficiency levels in order to satisfy the requirements of the 2015 Washington State Energy Code. Of the options presented, the Baseline Code system described is expected to have the highest carbon footprint and life cycle cost. The expected increase in carbon footprint and life cycle cost are associated with a relatively modest boiler efficiency and fan power required to move heating and cooling air throughout the building.
Alternate 1: High Performing System

Cooling Source:
- Campus chilled water tie in tertiary pump assembly

Heating Source:
- High performance 92% efficient commercial condensing boiler array
  - 140 deg F supply water
  - 100 deg F return water

Classroom/Lecture/Office Areas/Lobbies/Hallways:
- Zone level passive chilled beams requiring medium temperature chilled water distribution loop.
- Perimeter hydronic convective heating element
- Dedicated outside air system
  - Chilled water coil
  - Heating water coil
  - Heat Recovery
    - Review alternate options including total enthalpy plate heat exchanger, sensible only plate heat exchanger, enthalpy wheel, heat pipe and run-around loop.
- Zone level variable air volume terminal units (vav box)
  - Hot water reheat (dehumidification function only)
- Displacement ventilation distribution at floor.

Research/Lab Areas:
- Zone level standard active chilled beams (30% airflow turndown without losing induction) requiring medium temperature chilled water distribution loop.
- Perimeter hydronic convective heating element
- Hazardous lab exhaust system
  - Variable volume system with zone level venturi valves
  - Run around loop heat recovery
    - Bypass with isolation dampers around coil is required
  - Manifold all rooms together
- Makeup lab air system
  - Chilled water coil
  - Heating water coil
  - Variable volume system with zone level venturi valves
  - Run around loop heat recovery
    - Bypass w/ isolation dampers around coil is required
- Overhead Distribution

Energy Efficiency:
The heating, cooling, ventilation and airflow delivery methods described in this option are significantly more efficient than the code baseline system and reflect a high performance design on par with LEED Silver and possibly Gold standards. Fan energy is minimized through the use of chilled beams, convective heating elements in the offices and displacement ventilation where applicable. In addition, heat recovery systems and condensing boilers are projected to significantly reduce energy use and carbon emissions due to reduced on-site natural gas consumption. It is expected that this option will have the lowest life cycle cost of the three system configurations presented.
Alternate 2: Highest Performing System

**Cooling Source:**
- Campus chilled water tie in tertiary pump assembly

**Heating Source:**
- 1st stage heating air to water heat pump integrated with building exhaust to maximize coefficient of performance
- High performance 92% efficient commercial condensing boiler array
  - 140 deg F supply water
  - 100 deg F return water

**Classroom/Lecture/Office Areas:**
- Zone level passive chilled beams requiring medium temperature chilled water distribution loop.
- Perimeter hydronic radiant heating element
- Dedicated outside air system
  - Chilled water coil
  - Heating water coil
  - Heat Recovery
    - Review high efficient alternate options including total enthalpy plate heat exchanger or enthalpy wheel.
- Zone level variable air volume terminal units (vav box)
  - Hot water reheat (dehumidification function only)
- Displacement ventilation distribution at floor.

**Lobby/Hallways Areas:**
- Radiant heating and cooling floor
  - Manifold stations with heat exchangers
  - Pex distribution in floor
- Ventilation from classroom/lecture/office dedicated outside air unit
- Zone level variable air volume terminal units (vav box)
  - Hot water reheat (dehumidification function only)

**Research/Lab Areas:**
- Zone level premium active chilled beams (70% airflow turndown without losing induction) requiring medium temperature chilled water distribution loop; Swegon or equivalent.
- Perimeter hydronic radiant heating element
- Hazardous lab exhaust system
  - Variable volume system with zone level venturi valves
  - Run around loop heat recovery
    - Bypass with isolation dampers around coil is required
  - Manifold all rooms together
- Makeup lab air system
  - Chilled water coil
  - Heating water coil
  - Variable volume system with zone level venturi valves
  - Run around loop heat recovery
    - Bypass w/ isolation dampers around coil is required
- Overhead Distribution

**Energy Efficiency:**
The heating, cooling, ventilation and airflow delivery methods described in this option provide an incremental improvement to each system in Alternate 1 and would be expected to perform at a level needed to achieve LEED Gold or Platinum Certification. Natural gas use is significantly reduced through the use of an electric air-to-water heat pump as the first stage of heating. Fan power needed to circulate heating air is reduced by specifying radiant heating solutions for perimeter spaces. In addition, low heating water temperatures are specified to further enhance boiler efficiency and increase the operating hours of the air-to-water heat pump system. Life cycle costs are expected to be the highest for this option due to the increased first cost of the systems, however it is also expected that this alternative have the lowest carbon footprint and annual energy consumption.
PLUMBING SYSTEMS - PROPOSED

**Domestic Water**

A 4 inch domestic water connection from the site water system with a 4 inch meter is estimated for the building. An additional UW Bothell water meter should be installed and connected to the campus energy dashboard for monitoring. The incoming static water pressure is approximately 78 psi. The water service should have a domestic double check valve backflow preventer exterior to the building, provided by civil. The Phase 4 building should have three wet columns consisting of capped services for future tenant build out evenly spaced across the floor plates; a 4 inch sanitary stack with 4 inch connection, a 4 inch vent stack with 3 inch stubs, and a 2 inch water line with 1.5 inch stubs. Freeze proof hose bibs should be located every 100 feet around the perimeter of the building. Water hammer arresters should be located at all banks of fixtures as well as at all locations where fast closing valves are located.

**Fire Water**

A 6 inch fire water connection from the site water system is proposed for the building. The double detector check valve backflow preventer should be located at the exterior of the building and should be provided by civil. (See Fire Protection and Safety Systems for more information). Water heater and associated equipment should require approximately 50 square feet in addition to mechanical space requirements.

**Domestic Water Heating**

Hot water for the lavatories, showers, sinks and mop sinks should be provided from a 100 gallon, gas fired condensing type water heater located in the mechanical penthouse. The domestic hot water piping should be circulated at 105 degrees F through a 1/20 hp bronze fitted in line pump. Water heater and associated equipment will require approximately 50 square feet in addition to mechanical space requirements.

**Laboratory Water Heating**

Hot water for the labs should be provided from a separate 100 gallon, gas fired condensing type water heater located in the mechanical penthouse. The lab hot water piping should be circulated at 125 degrees F through a 1/20 hp bronze fitted in line pump. Water heater and associated equipment should require approximately 50 square feet in addition to mechanical space requirements. A backflow preventer separating the lab water from the domestic water should be located upstream of the lab hot water heaters in the mechanical penthouse as well.

**Piping Insulation**

Fiberglass insulation should be provided for domestic hot and cold water piping systems. Horizontal rainwater leaders and drain bodies shall be insulated with fiberglass blanket.

**Natural Gas**

Natural gas at 2 psi supply pressure should serve the mechanical equipment and the labs. Gas piping should be Schedule 40 steel pipe, with welded and threaded fittings.

**Sanitary Sewer and Vent**

A 6 inch sanitary sewer is proposed to serve the building. Waste and vent stacks should run up the building serving the core restrooms, janitor closets, wet columns and any break areas. Waste systems should be no-hub cast iron with heavy duty couplings with separate vent lines.

**Laboratory Drainage**

If true wet labs are required to meet program needs, future laboratory areas could be located in the non-lab areas of the Discovery Building to avoid the expense of adding the necessary equipment to provide compressed air, vacuum and deionized water. The displaced dry functions would then be relocated to the Phase 4 building. The design team should consider accommodating a lab waste system to anticipate a wet lab in the future. Underground lab waste in polypropylene piping with electric resistance welded joints could be installed with future stubs located above grade.

**Storm Water**

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An 8 inch storm water service for the building should be provided and connected to the existing campus storm drain system. Separate roof drain and overflow drains should be provided for each of the roof areas. Roof drains should be collected and directed to stormwater treatment prior to routing to the existing runnel system on the north side of Discovery Hall. Overflow drainage should be routed separately and daylight near grade where it would be directed to the existing campus storm drain system. Rainwater reuse could be explored as a water saving measure.

**Plumbing Fixtures and Drains**

Plumbing fixtures and drains should be chosen for long service and water savings. Risers for the domestic hot water, domestic cold water, and sanitary waste and sanitary vent should be located within the footprint of the toilet core and would serve the fixtures at each floor. Fixtures should be flush valve type for all water closets and urinals and wall mounted. Lavatories, water closets and urinals, and electric water coolers shall be specified to be ADA compliant.

| Water Closets:   | Kohler Kingston with Sloan Royal manual flush valve (1.28 gpf) |
| Urinals:        | Kohler Bardon with Sloan Royal manual flush valve (0.125 gpf) |
| Lavatories:     | Kohler Ladena undermount with Sloan Lino hard wired hands free faucet (0.5 gpm) |
| Showers:        | Tiled in shower with Symmons Safetymix shower system (2.0 gpm) |
| Break Room Sinks: | Elkay Lustertone double bowl undermount with Chicago Faucet single lever spout and sprayer (1.5gpm), garbage disposal, and hot water dispenser |
| Hydration Stations: | Elkay EZH20 wall mounted, dual level drinking fountain with bottle filler and filter |
| Janitor Sinks:  | Stern-Williams CORLOW 24”x24”x12” service sink with Chicago Faucet wall mounted service sink faucet |

Floor drains should be located in each toilet room with two or more fixtures and floor sinks and drains should be provided in all mechanical rooms and adjacent to equipment requiring drainage. All floor sinks and drains should be automatically trap primed to maintain trap seals.

**Potential Sustainable Features**

- **Solar Hot Water System:**
  - This system should be investigated if there is sufficient hot water needs to support it. If a shower room or kitchen is anticipated, a solar system would help offset energy costs.

- **Rainwater Collection System:**
  - This system should be evaluated as a method to supply water for irrigation or toilet flushing. Up to 50% of the water utilized in a classroom building is for non-potable uses for which rainwater collection is a suitable source.

**FIRE PROTECTION AND SAFETY SYSTEMS - PROPOSED**

The design should follow nationally recognized fire protection standards and the requirements of the local building and fire codes. Means of egress should be in accordance with NFPA. Egress systems designed per NFPA 101 are generally considered to meet or exceed the requirements of the IBC. All other fire protection features, such as occupancy, fire resistive construction, building size limitations, and opening protection should be provided in accordance with the IBC and comply with local amendments.

- **Fire Protection Systems:**
  - A 6 inch fire service connection and double detector check backflow preventer should be located in the water entry room. The estimated available pressure appears sufficient to supply the sprinkler system without the use of a fire pump. This requires verification by hydraulic calculation.
  - Fire protection systems, such as fire sprinkler, fire alarm and elevator control, should be provided in accordance with referenced standards.
  - Fire sprinkler systems should be provided throughout the building in accordance with NFPA 13 and insurance company requirements. The prospective insurance company should be contacted early to determine any recommended or mandatory requirements above and beyond code. A wet-pipe system should be provided with individual floor zones and distinct water flow alarms by zone. Quick response sprinklers should be utilized throughout. All piping should be Schedule 10 with roll groove Victaulic joints for mains and Schedule 40 steel with threaded fittings for branch piping.
• One egress stair should contain a combined sprinkler valve assembly and hose valves. A 2 inch drain should be located adjacent to the riser to facilitate system testing and drainage. The other egress stairs should contain a standpipe-only riser with hose valves on each level. The entire system should be designed to NFPA standards and should be hydraulically calculated. A fire department connection and alarm bell should be provided at the building exterior.

STRUCTURAL SYSTEMS - PROPOSED

Basement
In order to minimize shoring costs and no day lit spaces, it is anticipated that the grade-level floor will step up the hillside, thereby creating two or three different basement levels. Each level will daylight to the east, either to the exterior or to an interior framed level. To achieve this, a significant amount of cut soil will be required on the site. Full height basement/retaining walls should be required as the floors step up to levels above. These walls would be 12 inches thick, with a reinforcing mat at each face.

Superstructure: Floor Construction
Two primary options are available for the framing of the floor levels:
• A structural steel frame comprised for wide-flange columns and wide-flange floor beams, supporting a composite concrete/metal floor deck. The lateral system would consist of steel braced frames and/or concrete shear walls.
• A concrete frame system comprised of cast-in-place floor beams supporting a concrete deck. The beams would be supported by full-height concrete columns. The seismic force resisting system would consist of concrete shear walls.

The system selected will be very dependent on the laboratory requirements and vibration criteria established by the University. The structural steel frame may be most cost-effective for typical classroom and office loading. However, if elevated spaces are designated as laboratories with special vibration resisting requirements, the concrete framed system would likely be required, as the additional mass and stiffness dampens vibrations more effectively.

Superstructure: Roof Construction
All sloped roofs (greater than 1 inch/foot) should consist of wide-flange steel beams supported by wide-flange steel girders and steel columns. Typical roof sheathing shall be 1.5 inch Type “B” metal deck. Flat roofs used to support mechanical equipment, either interior (penthouse) or exterior would be framed similar to the floor construction below.

ELECTRICAL SYSTEMS - PROPOSED

Introduction
With an emphasis on electrical engineering for a major piece of the program, careful consideration should be given to electrical equipment, electrical room sizing, and voltage required for future experiential learning lab equipment. The building will be fed from a new PSE transformer located just north of the building. Final electrical loads and size of the building will need to be further developed, but the overall load based on current program needs is anticipated to be approximately 1500 KVA based on 78,000 SF at 15-20VA/SF and should include 25% slope. A new 2500 amp, 480Y/277 volt service should be proposed for the building depending on load studies to be developed. Service should terminate in a new switchboard, which would feed separate lighting, HVAC, and plug load panels in the facility. All equipment should be Eaton per the UW Bothell standard and be provided with metering for main loads and all branch loads. Feeders should be provided to panel risers on each floor containing plug load. Lighting panels and mechanical panels would be required. Lighting and HVAC would be generally served at 277/480 volt and plug loads at 120/208 volt. All feeders should be copper per UW Bothell Standard. Dry type transformers shall meet new 2016DOE standards.

Surge Protection
Surge protection should be provided at the service entrance, with all branch panels serving sensitive equipment, and emergency panels. All receptacles shall be specification grade. Plug load controls should be provided for at least 50% of the building and should be green receptacles. STEM equipment labs would need to be provided with dedicated panel and emergency panel shutdown. A main electric room would be required for the new building to house the service. Branch electric rooms should be on each floor (likely 2 per floor) to keep 120 volt branch circuits to a maximum of 150 feet per UW standards.
Emergency Service
A new emergency service would be required and should be served from a new diesel engine generator located on the site just northeast of the building in a Nema 3R Quiet Site 2 enclosure with 48-hour dual wall base tank. The size would be approximately 300 KW, though this is dependent on load studies to be developed, and would need to be sized to serve emergency and optional loads. The loads included should be emergency lighting, elevator, lab exhaust, critical lab refrigeration and experiment receptacles, communication rooms receptacles and cooling, and life safety systems.

Automatic Transfer Switches should be provided for the emergency and optional equipment systems. These shall be Russelectric type and be provided with internal metering. A selective coordination study would be required for the emergency system per NEC 700 and 701. This would result in several panels being equipped with electronic trip circuit breakers. The UW and UW Bothell do not allow fuses or fused panels. The UW and UW Bothell also prefer the use of breaker time current curves for coordination in lieu of manufacturer's standard tables. In addition, an Arc Flash Study should be provided and any panels should be labeled with the results.

The lighting system shall consist of Planled Tunable Daylight fixtures in all classrooms, STEM areas, and offices. All other areas shall be lit with decorative or utility LED fixtures. The entire building would be outfitted with LED lighting and tunable to be considered for other areas with the staff. Exterior fixtures shall match the AAL Miter camps standard and will be either LED or match existing induction lamps. Due to energy code requirements a networked, digital, automatic lighting control system should have throughout. Classrooms and individual offices should be provided with room controllers with occupancy sensors, photo sensors and plug load control relays or the provided Planled lighting control system. The system should be networked together using a main controller or relay in the electric room. The system should incorporate the Planled tunable lighting control with wall controller with color temperature read out.

Communication System
A new main distribution frame (MDF) will be required in the building, as well as a system of intermediate distribution frame (IDF) on each floor. IDF’s shall keep all runs under 280 feet. A riser system of 3-4” conduits should be provided from the MDF to IDF’s and shall include copper a single mode fiber cabling. New cabling should be Category 5E cabling to standard drops and green Category 6A to wireless drops. The system should be installed in accordance with EIA/TIA 568 standards. Wireless drops would also be installed throughout the facility but terminated in the closets to be removed and in areas to be remodeled. A complete new wireless cabling system should be provided at locations directed by the Aruba Wi-Fi designer. All cabling should be routed in minimum 1 inch minimum conduits to a cable tray and through 4” sleeves to a MDF and IDF rooms (no open cable). A new Simplex clock system should be provided. A master controller should be located in the main electric room and new synchronous analog clocks in all areas per the program.

An emergency responder system shall be provided for the facility if required by the Fire Marshall. The system should ideally connect to the system in the Activities and Recreation Center building and be provided to meet current International Fire Code.

AV systems shall be provided in all classroom and STEM spaces per UW Bothell standards and include digital video switching system, audio system with wireless miscellaneous and connection to the fire alarm system. All controls should be through touchscreen is control panels located in the instructor podium or on the front wall. Any meeting and conference room should be provided with AV systems to connect monitors to source devices. System should be Crestron DM or equal to match UW AV standards. System should include touchscreen control, HDMI over UTP, sound amplification, wireless mic, USB, and assisted listening systems all connected to the lighting control system where possible. If powered blinds are provided, the system should also connect to and control blinds.

Cable television system should be provided where dictated by the program. The system should originate from the single mode fiber and be distributed through converters and amplifiers via coaxial cable.

Electronic Safety and Security Systems
The fire alarm system should be Simplex 4100 with voice alarm per the UW Bothell standard. The panel should be located in the main electric room and network to the campus via the single mode fiber loop. The existing monitoring panel will be upgraded to current fiber networking card and processor. The system should include all requirements of the City of Bothell Fire Marshal and shall include at a minimum corridor smoke detection, room detection where required, voice alarm throughout for fire and emergency broadcast, and visual notification. Annunciation and remote voice control should be provided at the main entrance.
Card access system will be provided throughout the facility. The system should be Software House as installed by RFI to match the campus standard. Main system controller will be located in the main electric room and connected to ethernet for remote control.

Card readers and electric locks to match the campus standard. The campus head end software will be upgraded to the current revision of Software House.

Video surveillance is currently not planned for the facility but additional Category 5E drops should be provided to allow it as a future addition.

### 3.5 Future Requirements

Some upcoming future projects are: a library extension (planned adjacent to the Crescent Path and across from the proposed site), student housing which will create more emphasis on a student-activated campus with more opportunities for students to gather and study, and a future Cascadia College building (planned just north of this project on the northern edge of the forest grove).

This Phase 4 STEM building is part of a larger build-out plan identified in the Campus 2011 master plan. The implications for future requirements include capital funding, infrastructure, and capacity needs. Rapid growth increase in student population, careful consideration of the master plan, with near future expansion projects in mind, would contribute to more thoughtful and efficient design for both the proposed Phase 4 project as well as other campus developments.

As noted in Section 2, the campus houses both UW Bothell and Cascadia College. Through the two entities are funded separately by the state legislature and the timeline of their capital projects do not always align, they will continue to share the cost of infrastructure, so development of this and future buildings will be reliant on joint capital infrastructure funding.

The construction of this Phase 4 building will require the addition of both vehicle and bicycle parking based on a percentage of total building occupancy. Future academic and residential buildings will expand the need for both types of parking. On the preferred site for the phase 4 STEM building, the steep slope will play a factor in siting the building, as well as required bicycle parking. The recommendation for bike parking would be to locate it at the top and bottom of the slope adjacent to building entry courts. This project should strive to accommodate this need without interrupting circulation and campus character.

The campus will continue to be developed to meet ultimate student FTE goals and needs. Siting and design of this building, and future buildings to meet these capacity goals should be seamless to promote improved circulation and interconnection between academic and student functions. Adjacent uses and shared open space should be thoughtfully aligned as buildings are added within the boundaries of the campus to support campus life and identity. Within this context, service and loading for each building should be strategically placed to allow for ease of access without diminishing the entry sequence and character of each building, as each is experienced on all sides by members of the campus community.

### 3.6 Codes and Regulation

All construction will comply with the 2015 International Building Code as adopted by the State of Washington and City of Bothell, as well as its reference documentation.

- 2009 International Building Code (IBC)
- 2009 International Mechanical Code (IMC)
- 2009 Uniform Plumbing Code (UPC)

State and local building codes

- 2012 International Building Code – Chapter 51-50 WAC, with the exception of Administration described in Chapter 1, part 2. For the City of Bothell. Construction administration is governed by the Construction Administration Code as described in Chapter 20.02 BMC.
- Access for mobility impaired persons Chapters 19.27 RCW and 70.92 RCW
- 2012 International Mechanical Code – Chapter 51-52 WAC
3.0 PROGRAM ANALYSIS

- National Fuel Gas Code (NFPA 54) – Chapter 51-52 WAC
- Liquefied Petroleum Gas Code (NFPA 58) – Chapter 51-52 WAC
- 2012 International Fuel Gas Code – Chapter 51-52 WAC
- 2012 Uniform Plumbing Code – Chapters 51-56 and 51-57 WAC
- 1997 Uniform Housing Code
- 2012 International Fire Code
- Energy codes (Chapter 39.35 RCW)

Environmental regulations, including the Growth Management Act and local, state and federal laws and regulations (such as shoreline and wetlands)

City of Bothell
- Pedestrian and bicycle access: All development within the district shall include provisions for pedestrian and bicycle access in accordance with the adopted pedestrian and bicycle facilities plan within the Imagine Bothell... Comprehensive Plan. Special consideration shall be given to developing a complete non-motor vehicle traffic network, including connections to a trail system along North Creek and access to such system.

MEP
- 2015 International Mechanical Code (IMC) with State Amendments
- 2015 Uniform Plumbing Code (UPC) with State Amendments
- 2015 International Fire Code (IFC) with State Amendment
- 2015 Washington State Energy Code, (WAC 51-11, WSEC)
- Washington State Ventilation and Indoor Air Quality Code, WA 51-13 (VIAQ)

Bothell is within the Southwest Snohomish Urban Growth area and this helps fulfill goals in the state Growth Management Act. Environmental considerations for the development of this building will go through the process as outlined by state and municipal guidelines, including satisfaction of requirements for geologically hazardous areas, significant tree retention, and stormwater management.

This project site is located upland of a section North Creek that includes wetlands, and that is governed by the Shoreline Master Plan.

This project site lies outside of the buffer zone and critical area for the wetland and the creek, but the following policies may apply.

- Wetland policies NE-P28 through NE-P30 in the adopted Imagine Bothell...Comprehensive Plan may be applicable to this project.
- Local ordinances or special comprehensive plan requirements

City of Bothell Municipal Code Requirements: The UW Bothell campus is within the Downtown Subarea of Bothell, and is regulated by special sub-area zoning specific to this zoning classification. The campus is designated as its own land-use type, and development within it is guided by a separate Planned Unit Development (agreement) between the University of Washington at Bothell, Cascadia Community College, and the City of Bothell. The PUD is the principal guiding entitlement document for development within the campus, and requires an addendum for each new project built within the campus.

The maximum allowable building height on this part of campus is 65 feet.

The updated PUD will inform ultimate regulatory requirements, but the project will be subject to standard municipal landscape code requirements at the very least:
The following code sections have project implications:

- 12.64.108 BMC General Campus District requirements
- 12.16 BMC Parking requirements
- 12.18.100 BMC Landscaping Adjacent to Buildings and Refuse Containers
- 12.18.030 BMC Existing Vegetation Retention: This section references significant trees and requires a tree retention plan, a tree retention bond and or other surety. Trees over 8" Diameter at breast height (DBH) that are identified for removal should be replaced at a minimum ratio of 3:1.
- 12.18.040 BMC Types of Landscaping: This may have some flexibility given the campus context.
- 12.56.100 BMC Landscape Standards
4.0 SITE ANALYSIS
### 4.1 Site Description

**Site History + Context**

The co-located campus is situated atop a 128-acre plot of picturesque land overlooking protected wetlands and the Cascades Mountains beyond. A half mile east of downtown Bothell, bordered by Beardslee Boulevard to the north, SR 522 on the south, I-405 on the east, and single and multifamily residential along the western edge of campus. Once home to a 500-acre, purebred cattle Boone-Truly Ranch, the property was sold in 1995 to the State of Washington. Of the 128 acres, 71 acres are restored wetlands, an effort that has been recognized as one of the most successful restoration projects in the state. The University reinforces the health of the wetlands with a robust and sustainable stormwater management system designed to support the full campus build-out. Treatment is provided by a three-stage water quality system consisting of a Coalescing Plate oil/water separator (CSP), a wet-vault, and a bio-filtration facility.

View corridors to the wetlands have been identified in the 2011 Master Plan to help guide future projects benefit from this natural resource. The STEM Phase 4 project site has been identified along a view corridor and is in a position to take advantage of the view looking eastward, down the hill. Additional views to the northeast through the forest grove include the campus complex and the surrounding regional landscape.

Per the 2011 Master Plan, the proposed STEM Phase 4 project is situated on a hill climb, running east to west within the Upland Academic Zone, connecting planned student housing and parking to the west with the pedestrian Crescent Path below. An existing healthy grove of trees sits north of the planned STEM Phase 4 project and has the potential to lend the proposed building a treehouse-like experience for inhabitants. The mature second growth forest grove is identified in the 2010 Master Plan as a signature defining feature of the Upland Academic Zone character and plays a role in the curriculum of Environmental Science programs. A student-faculty tree study, *Environmental Impacts Analysis for Tree Removal in the UW3 Building Project* is attached in Appendix E.
**4.0 SITE ANALYSIS**

**Natural Systems**

The 2011 Master Plan identifies the important role of the mature second growth forest as part of the defining character for the Upland Academic Zone. The plan illustrates the role of this mature grove as the center piece on the sloped site located between the Truly House and the future Library expansion. The canopy of native conifer and hardwood species are an important link to the regional identity of the campus within its larger landscape in addition to the multiplicity of ecosystem services the forest provides. The 2015 update to the Imagine Bothell Comprehensive Plan added language to the preamble that underscores the shared obligation to support the natural environment through responsible development, that celebrates and respects its picturesque setting, and identifies a commitment to the conservation of natural resources.

- The stand of trees provide ecosystem services including: climactic regulation for the building, carbon sequestration, and habitat preservation.
- Mature trees on a forested slope provide storm water mitigation, such as uptake, reducing intensity of storm events, all of which may be critical functions and tools in the mitigation strategy associated with site hydrology. Some amount of storm water can be handled on site through existing vegetation (see appendix E).
- The existing limited understory plantings currently do not provide robust habitat. In addition to visually integrating the outdoor classroom spaces into the adjacent forested slope while addressing CPTED concerns, additional planting can improve habitat for important bird and mammal species.
- Existing and potential paths through the forest exist at the scale of the pedestrian; offer alternative access points to the proposed building, and provide an immersive Pacific Northwest experience of place. These paths can align with existing and proposed building entries, and connect to possible outdoor classroom spaces. The existing paths traverse the steep slope in such a manner to make the steep grade and forest more accessible.
- Accessible to campus artwork, “The Ancestors” frames entry to the stand of trees to the north, serving as a link to our cultural resources. The potential of a path system through the forest could increase access and importance of the artwork as part of the campus experience.
- Areas disturbed as part of construction of Discovery Hall have provided open space that can be integrated into the STEM Phase 4 project and support the implementation of the Master Plan.
- Opportunity for different scaled spaces at top and bottom of slope provide different levels of visual and physical connection between adjacent entrances with Discovery Hall, and the future library expansion.
- The selective removal of trees to accommodate the design and construction of the phase 4 STEM building may strategically connect a series of formal and informal gathering spaces, including areas around building entrances, and outdoor classroom spaces.
- Views towards the building site, the forested slope, and from the building site towards the restored wetland to the east connect this site to its larger environmental context, establishing an important sense of place. Additionally, they provide a campus scale which integrates the buildings into a campus context. There are multiple locations where this occurs around and within the preferred building site. The result is a defining positive site characteristic.
- Framed views connect the building site to its campus context, as well as the surrounding environment. Views from the bottom of the hill-climb frame Discovery Hall and the future phase 4 STEM building within the forested slope, and its adjacency to the library. Framed views from the top of the hill-climb connect the site to the Truly house and provide views into the forested slope and longer views to the campus and wetlands beyond.
- The proposed site is located at the edge of the mature grove to remain, and will have some impact the southern portion of the grove, including trees of significant size, apparent health and character. Given the potential impact of the proposed building and associated construction on this significant grove, additional evaluation of existing trees, site soils and hydrology is needed. Further siting evaluation potentially reducing impact on the grove is desirable. The development of clear actions associated with tree protection during construction and potential post construction management will help ensure that the building supports the preservation of key trees.
Built Systems
Built systems such as views, corridors, nodes, and circulation are important site factors to consider in the ultimate design of the Phase 4 STEM Building.

Circulation
Circulation to this central campus location is ample, with wide, multi-use paths running north-south through the campus.

- Crescent Path: The central spine of campus is the Crescent Path, connecting the campus core to parking garages and bus stops. This spine provides emergency, and limited service vehicle access to the STEM Phase 4 site, and serves as the primary pedestrian and bicycle access. This path is the most direct link to the Sammamish River and Burke Gilman Trails. Along this route long views situate you within the campus, helping to define the campus identity, while near views frame communal spaces adjacent to each building. Gathering spaces can be designed adjacent to the Crescent Path to create more human-scale spaces and places of pause along this wide path.

- West Campus Lane: West Campus Lane provides the same level of access at the uphill side of the proposed STEM building site, adjacent to the Truly House. Where the hill climb meets this road, there are long views east: through campus to the wetlands, and into the forested hillside.

- Hill Climb: Secondary pedestrian access to the building site is via the hill climb—the east-west stairwell that runs parallel to Discovery Hall and the future STEM Phase 4 building. Storm water management features run parallel to the east-west stair corridor. This stair corridor reinforces pedestrian circulation by connecting exterior landings to 4 levels of Discovery Hall. Places of pause along this hill climb will become more important for the STEM Phase 4 building as the campus develops further, as a stair fit closely between two tall buildings is at risk of becoming a rapid through-way where students may not want to linger between classes. Utilizing this already existing connection through the proposed Phase 4 building would reinforce the north-south pedestrian connections into gathering areas in the Forest to the north.

- Foot Paths: Informal paths through the tree grove create a pedestrian-oriented experience, connecting 110th Avenue NE to the project site, parallel to West Campus Way. Improvements or expansion to these paths as part of the STEM Phase 4 building present the opportunity to integrate this new building to its environmental context in a meaningful way, and can increase pedestrian access between this building, the campus, and potential future buildings to the north.

- Perimeter Roads: Vehicular access to parking exists around the perimeter of the campus via 110th Avenue NE from the north and via Campus Way/NE 180th Street from the south. Transit routes serve bus stops at the north end of campus, but are envisioned as part of city planning initiatives to include a mid-campus stop in the future to create a more direct pedestrian link to the center of campus.

- Emergency access to the building will be via West Campus Lane on the west and Crescent Path on the east.

Site Sequence
- Building Entries: Entry into the east and west ends of the proposed STEM building (lower and upper ends of the sloped site) are a subset or extension of the entry sequence into UWB-2 and Discovery Hall, as well as the future library expansion, and any future construction to the south of the Truly House. The flatter grade at these entries permits a more generous entry to accommodate gathering space, smaller courts, bicycle parking, and emergency access. These spaces must accommodate access for loading and service without creating an eyesore or perceived conflicting uses. It is important to note that all sides of the proposed building are viewed by those using the campus and as a result, the location of service functions must be carefully inserted to minimize the visual and functional impact on the campus experience.

- Working with the Steep Site: The steep site and stepped floor plate of the proposed building should align entries and compatible uses with the adjacent Discovery Hall. Connections and common spaces should allow accessible, at grade connections through the Phase 4 STEM building and the indoor-outdoor connection associated with the Pacific Northwest. These entries should make logical connections to existing and future accessible pathways through the forested slope, addressing circulation for planned future buildings across the slope.

- Accessibility: The exterior hill climb does not provide sufficient ADA accessibility. The interior connector must provide, and should emphasize, accessibility as part of its design.

- Water Quality: As part of a storm water strategy and possible teaching tool, a green roof may be considered for
the Phase 4 STEM building. The steep site may afford an opportunity for at-grade access to the roof creating an outdoor classroom space with exceptional views. A water quality vault may be incorporated into the building for similar reasons.

Campus circulation routes in the core accommodate pedestrian, bicycle, ADA, service, and emergency access.

Campus diagram illustrates spatial relationships and circulation.
4.2 EVALUATING POTENTIAL SITES

SITE OPTIONS
When exploring site options, the primary considerations for identifying the optimal site took into considerations the adjacent infrastructure and programmatic spaces that would be shared with Discovery Hall, natural site conditions such as soil conditions, topography, and existing trees, as well as campus character and the context of the master plan and campus growth and development over time.

Campus core diagram highlights Phase 4 site options in blue and future planned buildings and extensions per the 2011 campus master plan.
SITE OPTION 1: As Identified in the 2011 Master Plan

Assumptions:
- Total SF: 78,000 sf (with some basement)
- Number of floors: 5 stepped plates with floor to ceiling height to match Discovery Hall for maximum connectivity
- Height Limit: 65'-0"

Advantages:
- Site is owned by UW Bothell and is within the current Campus zoning boundary.
- Close proximity to other STEM facilities, equipment, and storage in Discovery Hall.
- Storm and utility infrastructure has been planned to receive the Phase 4 building and is available for connection.
- Requires less storm management efforts due to proximity of existing facilities.
- The site has good potential for delivery and loading access, venting, and exhausting.
- Central views over campus from the top of hill.
- Creates opportunities to connect the campus through the grove and utilize the grove in a meaningful way.

Challenges:
- Steep slope increase costs.
- Building footprint is limited by between West Campus Lane and the Crescent Path.
- Grade transition at base of hill climb and at Crescent Path will create a challenging circulation transition.
- Campus character of the forest grove is impacted if a larger footprint than that identified in the master plan is chosen, with the probable result of more mature tree loss.
- There is possibility that the Phase 4 building will be cast in shade by Discovery Hall.
SITE OPTION 2: Development Reserve Site

Assumptions:
- Total SF: 78,000 sf (without basement)
- Buildable Area: 68,550 sf
- Height Limit: 45' along property line adjacent to SF zone and 65' along Campus zone
- Number of floors: 5

Advantages:
- Site is owned by UW Bothell and is within the current Campus zoning boundary.
- Larger site allows for footprint options.
- Preservation of campus grove of mature trees that reflect campus character.
- Central views over campus from top of hill.
- The site has good potential for delivery and loading access, venting, and exhausting.
- Works with existing campus roads and creates presence along 110th Ave NE.

Challenges:
- Less connected to other STEM facilities, equipment, and storage in Discovery Hall.
- This option will require storm and utility infrastructure.
- Lacks readily accessible chilled water connection.
- Adjacent to Single Family zoning which restricts height of building due to setbacks; site is constrained by a 45' height limit within a 60' setback abutting the SF zone (65' height limit beyond the 60' setback).
- Site contains wetland to be mitigated at north end and potential wetland at south end.
- Less connected to the campus core academic buildings.
- Occupants are likely to be at the facility after hours and on the weekends. This may be disturbing to neighboring residents.
PREFERRED SITE CONCLUSION
Although Option 1 is sited on a steep slope, it presents the most conducive adjacencies to program and existing utility connections. Site Option 1 would connect into existing chilled water, sewer, storm, water, and electrical lines that were installed during the construction of Discovery Hall. Close proximity to Discovery Hall provides opportunities to maximize efficiency by locating STEM support spaces and equipment near each other. The transport of lab materials and supplies between Discovery Hall and the STEM Phase 4 building would further enhance the experience of these two buildings sharing in the proximity of each other.
4.3 SITE EVALUATION - PHYSICAL ISSUES

The proposed building site fits between West Campus Way and the Crescent Path with a footprint of approximately 70’ by 200’. It is oriented east-west, located on a hill side with approximately 40 feet of grade change within the building footprint as identified in the 2011 Master Plan. The hillside is primarily a wet condition that drains into the wetland to the east. The soil type is Class C and made up of glacial till. The site has steep grade that will require more than typical grading and drainage efforts. There are significant mature trees on the proposed site as well as to the north of the site.

SITE CONSIDERATIONS
The STEM Phase 4 project will need to respond to at least 40’ of grade change. Careful considerations regarding subgrade spaces should be analyzed to prevent undesirable spatial conditions without daylight. For example, if the proposed STEM Phase 4 project contains 5 levels of a uniform floor plate at 70’ x 200’ of academic space and the building is approximately 80’ tall at the 5th level’s roof elevation, then approximately half of the habitable building spaces will be below grade.

GEOTECHNICAL / SOILS INFORMATION
Geotechnical report information is available for several surrounding buildings, attached in Appendix C.

SITE HYDROLOGY
The documented site hydrology indicates water movement in the soils in the vicinity of the project site and the mature second growth forest. There is also evidence of a relatively high groundwater level as well as a possible artesian condition. Temporary dewatering measures will be required during construction. Additionally, the artesian flow will require a permanent, robust drainage system behind the foundations that step up the site.

Illustration of steep slope and tree canopy.
CONSTRUCTION ACCESS
Construction sequencing and access will need to be coordinated with protection of individual trees and identified groves to be retained. This can be accomplished even in tight conditions to support project objectives and regulatory requirements. The tree protection plan is a standard requirement in Bothell Municipal Code and is an effective tool to manage tree protection and site impact.

MASSING
The project aims to create efficiencies of overlapping function through maximizing the use of existing infrastructure. Careful massing considerations will affect circulation and overall site connections to other campus buildings. The new exterior stair north of Discovery Hall connects the uplands to the campus core and creates landings for Discovery Hall at 4 levels. The STEM Phase 4 project could connect in a similar elevation layout and create north-south connections from Discovery Hall to the camps grove of trees. Siting the new STEM building in proximity to the exterior stair will be a cost factor due to shoring and other temporary structure during construction. Another siting consideration will be solar access and creating day lit space along the vertical spine between STEM and Discovery Hall.

If the STEM Phase 4 project considers terracing the floor plates as it steps up the hill, then locating an elevator shaft that intersects all floors will result in an efficient service throughout the building while reinforcing overall campus connections.

The identified preferred site contains many mature trees, some tree removal will be necessary and will require a replant ratio per the City of Bothell due to tree classification as ‘significant’. Depending on how many square feet the building is to serve, there may be opportunity to retain more trees by looking at massing options with desired campus character in mind.

Illustration of Discovery Hall on the left, the hill climb exterior stair at center and the proposed siting of the Phase 4 STEM building.
4.4 SITE UTILITIES

SITE PROGRAMING
With the addition of Discovery Hall, the campus invested in a robust utility infrastructure with the Phase 4 building in mind. It is generally more cost effective to grow from south to the north, expanding from existing utility lines.

UTILITIES + INFRASTRUCTURE
Most utility lines that serve the newly built Discovery Hall were planned to extend service to the STEM Phase 4 project. Drawing from this existing infrastructure will inform the STEM Phase 4 massing.

SANITARY SEWER
The existing campus sanitary sewer (gravity) system consists of 6-inch, 8-inch and 12-inch diameter pipes, manholes, and cleanouts. The northern portion of the site discharges to the existing 60-inch diameter trunkline that bisects the site. The southern portion of the site discharges to the existing 24-inch diameter trunkline underneath SR-522. An 8-inch sanitary sewer line can be extended from in front of Discovery Hall on the east to the north under the Crescent path to serve the new building. This new sanitary sewer line will provide gravity connection points for the required services of the new building. A grease interceptor may be necessary if food preparation is included in the new building. Sanitary sewer systems will be designed to City of Bothell Design and Construction Standards. The sanitary sewer system will consist of 6-inch to 8-inch diameter PVC pipe, manholes, and cleanouts.

STORM WATER
Storm water detention is not necessary due to proximity to North Creek wetlands and the Sammamish River. The stormwater system at UWB is a split system that addresses “clean” and “dirty” stormwater separately. The collection of roof and landscape water, “clean” water, is diverted to the wetlands. “Dirty” water collected from roads and parking lots is treated via a three-stage water quality treatment system consisting of a coalescing Plate oil/water Separator (CPS), a wet-vault, and a biofiltration facility where the treated water is then dispersed to the North Creek wetlands and then to the Sammamish River. Although the stormwater system has been designed to handle the full build out of the campus, modifications will be required to support the proposed building locations in the 2011 Master Plan.

Runoff from the proposed new building will be treated at the building prior to routing it to the existing runnel located on the north side of Discovery Hall. Although roof runoff is typically considered clean water, the campus has had a bird problem on roofs which may be contributing pollution to the stormwater runoff. Treating the roof runoff will help reduce potential pollution. Runoff from areas adjacent to the building for loading/unloading and accessible parking off of West Campus Lane will also be treated before being routed to the existing West Campus Lane stormwater system.

Groundwater within the hill where the proposed building is sited will need to be addressed. Underdrains under the foundation and behind the foundation walls will be necessary to transport groundwater away from the building.

The storm drainage system design will be in accordance with the City of Bothell Surface Water Design Manual.

WATER
The existing campus domestic water system consists of 6-inch, 8-inch and 12-inch diameter pipes. The water service for the new building will be provided off the 8-inch water line in West Campus Lane. In addition to the new water lines, additional fire hydrants, fire department connections (FDC), and other appurtenances may be required to comply with City of Bothell requirements.

Water flow and system pressure will need to be confirmed with the City of Bothell water system model at each phase to ensure adequate accommodation can be made to support the build-out condition. The domestic water and fire line systems will be in accordance with the City of Bothell Design and Construction Standards. The water line will consist of 4-inch to 12-inch diameter, ductile iron, class 52 pipe. A 34-inch domestic service line and a 6-inch fire line are anticipated to serve the new building.
EXISTING CAMPUS MECHANICAL INFRASTRUCTURE

With the exception of Cascadia’s Global Learning Arts building, all existing campus mechanical systems are relatively consistent and uniform. Primary systems are outlined in diagrams within this section.

CENTRAL CHILLED WATER DISTRIBUTION

The diagram below illustrates the existing chilled water system. Direct buried chilled water supply and return piping originates as 18” piping at the Central Plant. A 16” branch of this service extends to the north edge of campus. The existing system also makes provisions for future development to the west with a 16” valved branch located immediately north of the Central Plant. Total capacity of the 18” main piping is very large. At a moderate 10 feet per second (fps) velocity, the pipe can accommodate up to 9000 gallons per minutes (gpm) in flow. At standard conditions this would permit delivery of 3800 tons of cooling. At somewhat lower velocities each 16” branch could easily handle half of this total flow, providing 1900 tons for each chilled water branch. Chilled water valve vaults are provided at the chilled water branch to each building.

CHILLED WATER PLANT DESIGN

Main piping manifolds within the plant were sized at 16” and 18” to allow for expansion. Existing capacity is provided by a 1000 ton and a 300 ton chiller piped as a primary/secondary plant. Parallel secondary pumps are sized for 1430 gpm each, allowing delivery of 2860 gpm without adding pump capacity. At standard conditions, this flow rate would provide for 1200 tons of cooling to the campus. A third parallel pump could be added to increase flow to 4290 gpm at a comparatively low cost. The additional pump would provide plant capacity of roughly 1600 tons with the addition of a third chiller or replacement of an existing chiller with a larger machine. Full build-out of the plant to the limit of the chilled water piping infrastructure would likely require replacement of one or both existing chillers and/or the expansion of the plant to provide additional chillers.

HEATING

Each building is provided with a self-contained heating hot water plant designed around the use of low temperature condensing boilers with Aerco Benchmark boilers being the typical specification.

Existing sewer line and storm water system.  
Existing chilled water and water main lines.
HVAC AIR DISTRIBUTION
Existing building HVAC (potentially excepting CCC-3) is based on conventional mixed air variable volume hot water reheat designs making use of custom housed air handlers and parallel fan power boxes for perimeter zones. Temperature controls are Johnson Controls Metasys system throughout campus.

NATURAL GAS INFRASTRUCTURE
Each building is provided with a self-contained heating hot water plant designed around the use of low temperature condensing boilers with Aerco Benchmark boilers being the typical specification. Each building is also equipped with central high efficiency gas water heaters for domestic and lab hot water services.

PROCESS AND OTHER 24/7 LOADS
The original design accommodates 24/7 building loads by using chilled water during daytime operation to cool a condenser water loop in each building. The building condenser and campus chilled water loops are isolated from each other using a heat exchanger. During night operation the central campus chilled water distribution system converts to a condenser water distribution system cooled by the plant cooling towers.

ELECTRICAL
The Phase 4 building should be served from a new PSE padmount transformer located north of the proposed building. Primary power will originate from the existing PSE padmount transformer located just NW of B3 serving Discovery Hall. Service will include trench down drive for PSE to install primary and transformer. An engine generator will be located on site for emergency power to the building.

COMMUNICATIONS
Communication for the Phase 4 building should be served from the manhole to the NW of the site. From this location two 4 inch conduits will be provided just north of the new building and a manhole installed for future extension of circuits. From there two 4 inch conduits into the building MDF. All cabling will be provided by UW IT.

ENVIRONMENTAL
The University of Washington Bothell contains 71 acres of wetland located at the east edge of campus. The University maintains a strong commitment to the wetlands and values this asset as both a visual nicety as well as a learning tool in the curriculum with hopes of establishing an Environmental Science Program. As part of the University of Washington Bothell’s commitment to the wetlands rehabilitation, a water treatment infrastructure on campus cycles dirty water through a series of cleansing processes before releasing it to the wetlands.

CIRCULATION
Using already established vehicular access roads and expanding upon pedestrian paths that align with the project goals presents an opportunity for the UW Bothell to use existing infrastructure efficiently.

Vehicular access to parking near the building will be via 110th Avenue NE from the north and Campus Way / NE 180th Street from the south. Emergency access to the building will be via West Campus Lane on the west and Crescent path on the east. The proposed building will front the Crescent Path, the main pedestrian arterial that is also designed to service fire trucks.

CONSTRUCTION STAGING
Given the potential impact of the proposed building and associated construction on this significant forest grove, additional evaluation of existing trees, site soils and hydrology should be further evaluated in the context of clear actions associated with tree protection during construction and potential post construction management will be required. Construction staging may be orchestrated to prioritize the protection of site trees, whereby construction activities are limited to a zone five to ten feet from the finished building face in order to retain trees that contribute to the unique character of the site. A tree retention plan will be required for the project, as well as a plan indicating mitigation for areas disturbed by the project. Tree replacement policies are discussed in Section 3.6. Construction parking and staging is likely to present a conflict with the campus’ desire to preserve trees. When a massing scheme is selected, the project can assess a tree retention plan.
4.0 SITE ANALYSIS

- View north of the Crescent Path and proposed site from Discovery Hall.
- Exterior stair water runnel, Discovery Hall at left and proposed building site at right of the stair.
- Approaching Crescent Path with Discovery Hall in the foreground and proposed site to the left.
- West Campus Way and vehicle access to Discovery Hall. Proposed STEM Phase 4 site beyond and to the left of Discovery Hall.
- Trail into the grove. Adjacent to proposed site.
SITE CONSIDERATIONS
Project goals related to site and the overall campus connections were identified through a series of meetings with various focus groups. Some of the major themes were saving as many trees as possible and allowing the forest grove to maintain a dense character. A bio-filtration box as part of the site for experiments and research, a green roof for testing soils and filtration system as well as other curriculum experiments, providing an unconditioned space outside for informal and formal gatherings, providing an exterior space with height for physics experiments, creating accessible routes with ADA as well as equipment and materials transportation in mind, circulation and massing of the new building with future campus expansion in mind, and bicycle parking properly sited at the low-end of the hill climb.
5.0 PROJECT BUDGET
5.1 ASSUMPTIONS

CAMPUS PERSPECTIVE
The UW Bothell/Cascadia College campus was the state’s first and only collocated baccalaureate and community college campus. Until UW Bothell Phase 3, the development on the collocated campus was under the management of General Administration. UW projects are now funded separately and under the management of UW Capital Planning and Development Office.

EFFECTIVE UTILIZATION OF SPACE
As part of the predesign effort, the current utilization of classroom, office, and STEM experiential learning lab spaces on the current campus were analyzed to ensure that all existing space was being effectively used on campus before the program for Phase 4 was developed. The resultant program that is represented in this report represents only the program spaces required to meet the growth needs for the School of STEM on campus, though the addition of classroom and office space will also fulfill some of the urgent needs of the larger campus. Reference Section 3 for more information on the analysis of program spaces.

RELATIONSHIP OF BUDGET TO SCOPE OF WORK
In the UW’s 2013-2015 Capital Budget Request to the state, the University requested $500,000 in state funding for a Predesign Study for Phase 4 of the Bothell campus. In the 2017-2019 UW Capital Plan, request for funding for the design and construction of UW Bothell Phase 4 is shown to occur in 2019-2021. In order to adjust the project and associated budget for the escalation associated with this schedule, the project cost has been escalated at an average annual inflation rate of 4.5% through the mid-point of construction. The escalation is consistent with the Office of Financial Management recommended escalation assumptions. However, due to the uncertainty associated with the significant passage of time between the development of the current target value budget and the scheduled construction, it will be important to analyze and adjust for actual escalation at the time that design and construction funds are allocated to ensure the project budget remains consistent with the project scope.

TARGET VALUE BUDGET
A preliminary target budget for UW Bothell Phase 4 was prepared by an independent professional cost estimator based on the program presented in this report. The cost estimator worked with the University and design team to visualize the cost of design, materials, effort, and risk and used a benchmarking approach, explained later in this section, to develop a target value budget in a logical and structured manner. The resultant projected total project cost is summarized in this section and Appendix D. Project Costs were based upon the progressive design-build delivery method, with appropriate levels of markups and fees beyond the construction cost incorporated by historical percentages by the UW CPD.
5.0 PROJECT BUDGET ANALYSIS

5.2 COST PLANNING VS. COST ESTIMATING

Setting a target value budget early was critical to allow the team to filter the longer list of needed program space to a program that would fit with the expectations of the University. In addition, with the assumed delivery method to be progressive design build, the type of estimate had to be carefully considered.

To begin, the team reviewed the 2008 report from OFM and Berk & Associates that provided an upper and lower boundary for square foot costs for different types of buildings (reference top chart below). The projected midpoint of construction required the estimating team to adjust for escalation to 2020, which further increased the recommended square footage costs. It was clear though, that this project didn’t fall directly into the categories, as the Phase 4 program is only 42% Experiential Learning Labs and 35% classrooms, with the rest of the spaces as offices and collaboration space. Therefore, additional research was needed to set a target budget that would represent the mix of program and the unique, intimate teaching environments that make UW Bothell a great public institution.

Instead of following a more traditional approach to estimation where an independent cost estimator provides an estimate for the design team’s proposal, a different approach based on benchmarking of similar completed projects was undertaken. The benchmarking effort was designed to allow for the design-build team to have flexibility in the development of the design, but a solid foundation of goals and priorities on which to base the ultimate design solution.

**BENCHMARKING APPROACH**

The UW Capital Planning and Development Office, UW Bothell staff and facilities representatives, the design team, and the cost estimator visited and researched several examples that represented recently constructed, state funded higher education buildings that house general STEM programs that serve pedagogically-similar (and smaller) classes in the Seattle area. It was valuable for the entire group to see how other STEM buildings are providing spaces for teaching, learning, and research and what qualities those spaces had. The estimating team then used these as a datum to reference as the design team and owner’s group jointly evaluated quality and cost expectations for the Phase 4 STEM building in light of the needs for space and the desire to provide a high quality learning environment. These benchmark projects set a standard for construction, efficiency, and quality that was then used to set a target goal for the cost of each of the spaces. In this process, a target budget was set for the shell and core, as well as the landscape and site costs. Each of the individual types of spaces was then given a target budget as it was a tenant improvement in a cold dark shell building, with all specialized systems and structural requirements represented in that TI cost per square foot of space. This matrix was then used by the team to come up with a final list of spaces that would fit within the target budget for the entire building.
DESCRIPTION OF BENCHMARKS
Three recently constructed, state funded, STEM buildings in Washington state were selected as representative of three alternative approaches to mechanical and electrical systems, exterior envelope, site conditions, structural solutions, and accommodation of STEM related programming. Design, operational, and construction cost information was gathered on these four buildings and used to assess the range of costs for each of the Uniformat categories. The following is a detailed description of the Benchmark examples. Additional information is included in Appendix D and Appendix F for each building.

BENCHMARK 1 - STEM BUILDING 1 (SLOPED SITE)
• 78,000 gsf building on a steeply sloped site
• STEM focused program including classrooms, offices, collaboration spaces, teaching labs, computer labs, & project labs
• High sustainability goals - LEED Gold with radiant heating and chilled beams as feature sustainable elements
• Exterior envelope - a combination of brick, terracotta, glazing, and board formed concrete with a high ratio of glazing to solid skin
• Completed in 2014
• State funded design and construction
• Total Project Cost: $62.8 million

BENCHMARK 2 - STEM BUILDING 2 (FLAT SITE)
• 95,000 gsf on a flat site
• STEM focused program including student services, cafe, offices, administration, classrooms, and engineering and computer related labs
• High sustainability goals - LEED Gold with high efficiency mechanical system and PV’s as feature sustainable elements
• Exterior envelope - a combination of brick, metal panel, and glazing with a high ratio of glazing to solid skin
• Under construction, projected completion 2017
• State funded design and construction
• Total project cost: $71 million

BENCHMARK 3 - STEM BUILDING 3 (FLAT SITE)
• 120,000 gsf building on a relatively flat site
• STEM focused program including classrooms, offices, research labs, teaching labs, specialty labs, planetarium/lecture hall, and an observatory tower
• High sustainability goals - LEED Silver with use of waste heat via retrofitted boiler plant as feature sustainable element
• Exterior envelope - a combination of brick, precast concrete, metal panels and glazing with a high ratio of glazing to solid skin
• Under construction, projected completion 2016
• State funded design and construction
• Total project cost: $61 million
5.0 PROJECT BUDGET ANALYSIS

The analysis to arrive at the target budget included evaluation of the structural and site systems for each building condition. There were two benchmarks that were located on flat sites, resulting in lower cost for foundations and site preparations, and only one on a steeply sloped site that had considerably more cost associated with the site and structural requirements. The site identified for Phase 4 is also a steeply sloped site, so some decisions were made on the budget to maintain higher target budget numbers for the sloped site.

Each benchmark had a commitment to sustainability that manifested itself differently. STEM BUILDING 1 included radiant heating and chilled beams, STEM BUILDING 3 included bioheat recovery, and STEM BUILDING 2 emphasized photovoltaics (PV’s) for energy savings. The team worked to assess the HVAC options for the building based on the types of spaces to be included and ensure that the future design build team would be able to develop a system that was in keeping with the sustainability and performance goals of UW Bothell. Refer to Section 3 for more information on the HVAC systems considered.

Each benchmark incorporated a variety of learning spaces including active learning classrooms as well as student research and applied learning labs. Though some were more focused on specific nursing skills or biomedical wet lab research, they were valuable comparable facilities that demonstrated different approaches to small classes and applied experiential learning. In the final target budget, the final numbers for equipment, interior construction, and interior finishes were determined based on the types of spaces that the project will be supporting and similarities between the proposed Phase 4 program and the benchmarks.

The following information was gathered and evaluated to develop the target value budget. The purple column titled PHASE 4 STEM BUILDING (SLOPED SITE) represents the target value budget for the project in Uniformat categories. Information was added to account for negotiated site services, design fees, contingencies, etc., below the subtotal for direct subcontract work to reach the total project cost at the bottom right of the chart. $950 per GSF is the proposed budget for the total project cost/GSF for this project. For additional information about the development of the target budget and the C-100 form, reference Appendix D.
All of the totals shown have been escalated to the assumed midpoint of construction. The pricing is based on the following general conditions of construction: a start date of June 2019, and a construction period of 24 months. The general contract will be progressive design-build. There will not be small business set aside requirements and the contractor will be required to pay prevailing wages. Design/Estimating contingency is assumed to be in the respective system target values and therefore, no additional percentage is included. The target value estimate includes negotiated support services, MACC risk contingency, GC fee and general conditions. The target value estimate assumes pre-construction services and WSST are included in soft costs.

The target value estimate column was reached as the Executive Committee considered what was similar to the three benchmarks and what would be relevant that would elevate the budget number above the study provided by the OFM and Berk & Associates for each space type. Ultimately, the foundations, site work, substructure, and structure for a sloped as opposed to a flat site was the biggest difference. These numbers were likely closer to the benchmark for a STEM building on a sloped site (STEM Benchmark 1) and thus those numbers are elevated above the average cost for STEM buildings for the target value budget. In addition, with a large emphasis on electrical engineering and computer science, the cost for electrical systems was kept above the average.

### Uniformat Category

<table>
<thead>
<tr>
<th></th>
<th>MACC ESTIMATE STEM BUILDING 1 (SLOPED SITE)</th>
<th>MACC ESTIMATE STEM BUILDING 2 (FLAT SITE)</th>
<th>MACC ESTIMATE STEM BUILDING 3 (FLAT SITE)</th>
<th>LOW</th>
<th>AVERAGE</th>
<th>HIGH</th>
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<tbody>
<tr>
<td>Basement Construction</td>
<td>$14.82</td>
<td>$14.82</td>
<td>$14.82</td>
<td>$1.42</td>
<td>$4.27</td>
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<tr>
<td>Superstructure</td>
<td>$91.74</td>
<td>$73.80</td>
<td>$65.24</td>
<td>$65.24</td>
<td>$76.93</td>
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<td>Exterior Enclosure</td>
<td>$76.47</td>
<td>$66.58</td>
<td>$33.80</td>
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<td>Roofing</td>
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<td>$7.04</td>
<td>$5.45</td>
<td>$5.45</td>
<td>$6.29</td>
<td>$7.04</td>
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<td>Building construction</td>
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<td>Stairs</td>
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<td>$1.87</td>
<td>$-</td>
<td>$-</td>
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<tr>
<td>Interior finishes</td>
<td>$19.87</td>
<td>$21.61</td>
<td>$15.55</td>
<td>$15.55</td>
<td>$19.01</td>
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<td>Conveying</td>
<td>$8.39</td>
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<td>HVAC</td>
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<td>$50.21</td>
<td>$47.67</td>
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<td>Fire protection</td>
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<td>$5.11</td>
<td>$4.55</td>
<td>$4.55</td>
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<tr>
<td>Electrical</td>
<td>$77.84</td>
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<td>$73.56</td>
<td>$49.68</td>
<td>$67.03</td>
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<td>Equipment</td>
<td>$20.13</td>
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<td>Site improvements</td>
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<td>$4.06</td>
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<td>Site utilities</td>
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<td>$4.02</td>
<td>$1.61</td>
<td>$1.61</td>
<td>$9.39</td>
<td>$22.53</td>
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<td>Midpoint of construction</td>
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<td>$70.60</td>
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<td>$56.97</td>
<td>$89.52</td>
<td>$127.47</td>
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<td>MACC ESTIMATE</td>
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<td>$475</td>
<td>$357</td>
<td>$561</td>
<td>$799</td>
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<tr>
<td>TCC plus Preconstruction Services</td>
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<td>$495</td>
<td>$531</td>
<td>$399</td>
<td>$627</td>
<td>$893</td>
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</table>

All of the totals shown have been escalated to the assumed midpoint of construction. The pricing is based on the following general conditions of construction: a start date of June 2019, and a construction period of 24 months. The general contract will be progressive design-build. There will not be small business set aside requirements and the contractor will be required to pay prevailing wages. Design/Estimating contingency is assumed to be in the respective system target values and therefore, no additional percentage is included. The target value estimate includes negotiated support services, MACC risk contingency, GC fee and general conditions. The target value estimate assumes pre-construction services and WSST are included in soft costs.
5.3 COST ESTIMATE • TARGET VALUE BUDGET

The UW Capital Planning and Development Office developed a Total Project Cost target value budget based on the Maximum Allowable Construction Cost (MACC) cost estimate prepared by the consultant. The state of Washington’s C100 (2014) cost estimating model was used as the basis for this budget, applying consultant and project management fees, contingencies and escalation.

A summary of projected project costs are shown below. A detailed cost budget using the OFM C-100 form is provided in Appendix D.

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
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<tr>
<td>Consultant Services</td>
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<td>Construction Contracts</td>
<td>$60,795,545</td>
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<td>Equipment</td>
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<td>Art Work</td>
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<td>Other Costs</td>
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<tr>
<td>Project Management</td>
<td>$2,929,455</td>
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<tr>
<td>Total Project Costs</td>
<td>$75,000,000</td>
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6.0 MASTER PLAN & POLICY COORDINATION
INTRODUCTION
The UW Bothell Phase 4 project is one of the building components reflected in the 2015 Campus Facilities Master Plan. No changes are proposed to the current master plan as a result of this project. The Campus Master Plan (revised 2011) indicates only one development site for UW Bothell Phase 4. The current proposal will include significant STEM teaching facilities and general classrooms and will be well suited to the currently identified site, as it will reinforce the STEM teaching facilities created in Discovery Hall during Phase 3 and allow for on-grade connections to Discovery Hall on multiple levels.

The project is consistent with the 2010 Campus Master Plan (revised 2011) and the Amendments made in 2011 to that document. This plan is also consistent with:
- City of Bothell’s Growth Management Plan
- City of Bothell’s Planned Unit of Development. North Creek Habitat Protection Area
- City of Bothell Master Plan City of Bothell 2015 Plan
- City of Bothell Shoreline Master Program Update May 2012

The illustration below from the 2010 Master Plan (revised 2011) document illustrates all the phases of the UW Bothell/Cascadia College full campus build-out for 10,000 FTE’s. As noted in Section 2, in June of 2016, UW Bothell and Cascadia College began a Master Plan update with the intent of establishing a new campus zone within the City of Bothell’s comprehensive plan and land use code. The 2016 master plan will address future growth of the collocated campus to ensure a positive future for the campus. The Phase 4 STEM Building project will be part of the master plan update.
The current Campus Master Plan (revised 2011) provides a framework for buildings, open spaces, circulation routes, and campus systems that allow future development to be implemented in a flexible way to accommodate evolving program needs and funding opportunities. While the plan identifies locations for future buildings and open spaces, they are placeholders that define intent and describe approximate footprints and building areas. Because the framework provides an enduring organizing structure for the campus and allows for variation at the project level, it is expected that actual footprints and building areas for each future project will be refined and confirmed as future facilities are constructed. Future facilities may vary somewhat from the placeholders shown in the plan.

The following planning principles were developed to guide the development of planning concepts:

- Enhancing the campus entries
- Locating parking at the edges of campus to maintain a pedestrian environment
- Creating a heart of campus
- Strengthening connections between buildings
- Continuing the campus’ commitment to sustainability
- Maintaining the feel of a small and cohesive campus
- Providing universal access
- Preserving the healthiest tree groves, and
- Strengthening connections and views to the wetlands

The following goals were developed for the 2010 Campus Master Plan (revised 2011) to support the mission of the University:

- Ensure good stewardship of the existing campus. Maintaining and protecting the value of the University’s physical resources and character, history, architecture and open space is critical.
- Changes to the campus should improve and enhance, rather than detract from, the value and quality of the campus. The 2010 Campus Master Plan (revised 2011) identifies and encourages preservation of historic resources and open space.
- Provide for the facility and infrastructure needs of the next decade.
- Provide the maximum amount of flexibility in order to best accommodate future growth and take advantage of unforeseen opportunities.
- Create an aesthetic quality appropriate to the campus as a whole and to specific areas, conserving and improving existing buildings, open spaces, and views on campus, and looking for opportunities to create additional open spaces.
- Create a safe and healthy environment, with personal and workplace safety considerations integral to planning and design of circulation elements, buildings, and open spaces.
- Value the environment and strive to promote the conservation of natural resources and goals of the Growth Management Act and Shoreline Management Act.
- Encourage efficiency and economy in University operations, with advantageous locations for facilities and advantageous adjacencies of uses.
- Recognize the importance of the surrounding communities and strive to achieve compatible working relationships with these communities to improve the quality of life and public benefits for all in the vicinity.
All regulatory requirements identified in the Campus Master Plan (revised 2011) will be adhered to. Specific elements in the Campus Master Plan (revised 2011) will also be considered in how the Phase 4 building integrates with site elements, other existing and future buildings, and key landscape plazas and outdoor gathering areas. Some of the key elements of the master plan that the Phase 4 project will need to consider are:

SITE ELEMENTS
The natural context of campus provides a strong identity for the institutions. The Campus Master Plan (revised 2011) builds on this dimension of institutional identity by both reinforcing the natural character of the landscape and providing quality places to accommodate the campus’ daily activities.

PLAZA
A new 150’ x 300’ plaza provides a central gathering space and is envisioned as a set of steps and shallow terraces to provide seating and bridge the change in topography between existing buildings UW Bothell-1, UW Bothell-2 and UW Bothell-3. The crescent-shaped pathway traverses the west edge of the plaza, providing further activity and life to it.

BUILDING ENTRY COURTS
Future buildings should be sited and designed to enhance and activate adjacent outdoor spaces. Courtyards and small plazas at building entries can provide places for both interaction and solitude and, when effectively designed, can contribute directly to intellectual pursuit and dialogue within the campus community, as well as quiet contemplation in a collegial setting. The most successful courtyards are those that have a sense of enclosure, provide a variety of seating opportunities, and incorporate quality materials.

HILL CLIMB STAIRWAYS
Proposed hill climb stairways are an integral part of the plan’s organizing concept, introducing circulation routes to access existing and proposed buildings and providing view corridors from the upland forest to the wetlands. The stairs are planned as integrated components to adjacent buildings and constructed together, allowing thoughtful coordination of stair landings with building entries and where appropriate, providing sheltered stairs within building overhangs. Accessible routes through campus will be provided via elevators in buildings, coordinated with stair landings to allow north-south movement between buildings with minimal elevation change. Hill climb stairways in the upland have the opportunity to be designed together with an adjacent stormwater feature, including integrated concrete planters with shade trees and a terraced system of progressive stormwater troughs to convey water from the stair and nearby building rooftops to the wetlands. The materials used in the stairs should correspond with adjacent buildings while providing a uniform language that reinforces their role as visible corridors that weave through and connect the campus.

OUTDOOR RECREATION SPACES
The Campus Master Plan (revised 2011) features a flat, grassy space adjacent to the Truly House in the upland housing zone for informal use such as student social events, small group studying and meetings, pick-up sports and Frisbee playing. There is currently only one space available for these unstructured activities, north of the Library, which has been expanded to more than one acre with the completion of the lawn associated with the Global Learning and Arts Building. A multi-purpose sports field is located on the east side of Campus Way NE, south of the north garage. The campus contains sports fields; soccer, football, softball and other sports. Another open grassy area is planned south of the sports field for other informal uses or events. This grassy area will also serve as a replacement bioswale, since a similar storm drainage facility nearby will be replaced with a new building.

SERVICE ACCESS
The Campus Master Plan (revised 2011) provides clear service access routes to loading facilities for each building and a Corp Yard with a raised loading dock for centralized receiving. For some buildings the service area may simply include a trash enclosure or dedicated area for service vehicles; other buildings with large daily deliveries may require a more robust loading dock. Connected buildings may choose to dedicate their service areas for particular functions, such as separating deliveries from waste and recycling.

While West Campus Lane is primarily a pedestrian street, it will accommodate small delivery vehicles and waste and recycling pick-up for several buildings. The Promenade and the crescent-shaped path are also primarily pedestrian, but will accommodate service vehicles when the surrounding service routes cannot provide access.
6.2 OTHER SIGNIFICANT STATE POLICIES

The UW Bothell Phase 4 project complies with and/or supports important state policies on growth management, energy conservation, and the environment.

CLEAN AIR ACT OF 1991
The University of Washington’s response to the Clean Air Act of 1991 is illustrated on a campus wide basis by capital improvements to the existing power plant and the University’s U-Pass program, which has resulted in a campus wide reduction in the number of single occupancy vehicle commuters. Measures to encourage commuting by non-automobiles are incorporated in each capital project through such measures as provisions for bicycle racks and safety improvements. Design standards for emissions and indoor air quality will be implemented in the building design stages as part of a comprehensive LEED strategy.

GROWTH MANAGEMENT ACT OF 1990
The Growth Strategies legislation requires state agencies to comply with local land use regulations adopted pursuant to the Growth Management Act, which the University of Washington Bothell acknowledges through the development of the Campus Facilities Master Plan. This project will comply with any Master Use Permit requirements as well as any adjustments to the PUD for campus.

GOVERNOR’S EXECUTIVE ORDER 90-94 FOR PROTECTION OF WETLANDS
The University has surveyed the wetland areas on campus as required by the Growth Management Act and Governor’s Executive Order. Surveys were prepared for use during capital project planning to ensure that wetland resources remain protected. No wetlands or other environmentally sensitive areas will be affected by this project. The project carefully considered stormwater management to control water movement downslope to the area identified as a wetland on campus.

GOVERNOR’S EXECUTIVE ORDER 05-05 ARCHAEOLOGICAL AND CULTURAL RESOURCES
The University will comply with requirements of the Governor’s Executive Order and consult with the Department of Archaeology and Historic Preservation (DAHP) to review the project as required for state funded projects.

CLEAN WATER ACT
The University is incorporating storm water, drainage and erosion control plan requirements into its construction documents for all major capital projects. National Pollution Discharge Elimination System (NPDES) permit requirements will be implemented through the installation and maintenance of drainage utility systems for each capital project.

HAZARDOUS SUBSTANCES
Prior to occupancy, the University prepares an inventory of all hazardous substances to be utilized in the facility; a chemical hygiene plan is prepared for all employees.

STATE ENVIRONMENTAL POLICY ACT (SEPA)
As the Lead Agency, the University of Washington will ensure compliance with the State Environmental Policy Act RCW 34.21C, WAC 197-11 and WAC 478 for all capital projects.

SUSTAINABLE DESIGN
Effective July 24, 2005, Washington State Senate Bill 5509 requires major facility projects for all state agencies, institutions of higher education, and other entities receiving state funding to meet at least the LEED Silver Standard in design, construction, maintenance, and commissioning to the extent appropriate.

CHAPTER 39.35 RCW ENERGY CONSERVATION IN DESIGN OF PUBLIC FACILITIES
In conformance with this statute, during the design phase of the proposed project, reviews and studies conforming to the guidelines developed in RCW 39.35.050 will be prepared.
7.0 FACILITY OPERATIONS & MAINTENANCE REQUIREMENTS
To develop these operating budget costs and impacts, the current operational costs for the most recent STEM Building on campus, Discovery Hall, were collected and updated for the specific uses and operation of the proposed Phase 4 project. A summary of this budget is included below and a more detailed look at the Ongoing Building Costs is included in Appendix F in the Life Cycle Cost Model format.

### Ongoing Building Costs

<table>
<thead>
<tr>
<th>New Building Operating Costs</th>
<th>Known Cost / GSF / 2021</th>
</tr>
</thead>
<tbody>
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<td>Energy (Electricity, Natural Gas)</td>
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</tr>
<tr>
<td>Janitorial Services</td>
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<tr>
<td>Utilities (Water, Sewer, &amp; Garbage)</td>
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<td>Grounds</td>
<td>$-</td>
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<tr>
<td>Pest Control</td>
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<td>Security</td>
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<td>Maintenance and Repair</td>
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<td>Management</td>
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<td>Road Clearance</td>
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<td>Additional Parking</td>
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<td>Other</td>
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</tr>
<tr>
<td><strong>Total Operating Costs</strong></td>
<td><strong>$17.84</strong></td>
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</table>
7.2 OPERATIONS AND MAINTENANCE COSTS

The Phase 4 building will receive the University’s normal level of campus operations and maintenance. In addition, energy management systems and electrical power supply will be designed in conformance to the UW FSDG, which describes energy efficient systems. Although new buildings tend to have increased energy demands and operation costs due to more sophisticated technology, increased energy demand is anticipated to be offset by energy conservation measures to be incorporated into the design. However, campus operations and maintenance costs continue to increase yearly with inflation. The UW Bothell Phase 4 building will be designed to achieve LEED Silver Certification consistent with state policy. That being said, UW has a multi-year history of achieving LEED Gold certification on major capital projects and it is a recommended target and strong aspiration that the Phase 4 building reach LEED Gold as well. Energy conservation measures such as high performing mechanical systems, stormwater strategies, and green roof elements will be considered and the priorities are laid out in more detail in Appendix E and H.

It is assumed that in-house staff will be operating the building HVAC and electrical systems, with some involvement of outside vendors for the maintenance of key complex HVAC systems if those become part of the project. The projected staff required to operate the building include the following:

- Per APPA national averages, 2.1 FTE custodial staff for a total of 78,000 GSF.
- Per APPA national averages, 1.1 FTE maintenance staff for a total of 78,000 GSF.
- 1.0 FTE Campus Security Officer based on 72,000 GSF per Campus Security Officer. The cost for this FTE includes $70,000/year (= Annual Salary $47,148 at top step + 3% COLA + 39.4% current benefits rate for FY2016) and $2,500 Initial/one-time cost for outfitting 1.0-FTE Security Officer (for uniform items, radio, misc. office supplies, etc.)

7.3 OPERATIONS AND MAINTENANCE FUNDING

Campus operations and maintenance costs for a future building will be funded from the University’s existing allocation. New staff will not be required to maintain and service the new building. Costs on a per square foot basis will be within industry ranges and the overall net impact to the campus facility operating budget will be funded through tuition fees generated by the associated enrollment growth of the campus.
8.0 PROJECT DRAWINGS & DIAGRAMS
8.1 PROJECT DRAWINGS AND DIAGRAMS

BUILDING MASSING CONSIDERATIONS
The Predesign effort considered massing issues on the preferred site location. The preferred site is bound between the pedestrian Crescent Path to the east, West Campus Lane to the west, the mature forest grove to the north, and the exterior stair to the south. Per the 2010 Campus Master Plan (revised 2011), the proposed Phase 4 STEM building is depicted as a 70’x200’ footprint. Although there is capacity to test these boundaries, it is not without consequences on immediate adjacent site characteristics. For example, if the massing of the STEM Phase 4 building approaches closer than 20 feet towards the exterior stair at the south then shoring at that cut will be required. If the building moves to the north then additional trees will need to be eliminated.
Some Massing Considerations that were Identified in the Predesign Phase:

- Visual and physical porosity through the building
- Internal vertical pedestrian access
- Rooftop program for both academic purposes as well as informal gathering
- STEM programmatic adjacencies in the Discovery Hall
- The pedestrian experience at the Crescent Path; creating informal gathering space between the edge of the Crescent Path and the proposed Phase 4 STEM building
- It is recommended that a minimum of a 10’ setback from West Campus Lane be maintained and a 15’+ setback is preferable
- It is recommended that a 20’ minimum setback from the exterior stair be maintained in an effort to avoid shoring requirements
Finished floor elevations in the proposed Phase 4 STEM building should match those in Discovery Hall to facilitate smooth transport of sensitive materials and equipment between the two STEM facilities of Discovery Hall and the proposed Phase 4 project.

When exploring massing options during the next design phase, it is recommended that special attention be paid to activating the space along the exterior edge of the building, both to the south between exterior stair and the proposed Phase 4 building as well as to the north, between the Phase 4 building and future development north of the forest grove beyond. Treating the southern edge will require additional solar studies but a snapshot of solar conditions are illustrated on the following page, representing a general massing scheme. Explorations that include at grade opportunities, above grade or roof top opportunities, as well as carved space from the massing in an effort to create a series of thoughtful experiential outdoor spaces is recommended.

Stepping the floor plates up the hill with the grade will lend more day lit spaces as well as reduce shoring requirements. It is suggested that footings deeper than 20 feet may trigger shoring requirements. One consideration that may be further explored is reallocate otherwise subgrade massing along the along the edge of West Campus Lane, creating presence along the inner campus path in the upper academic zone.

All massing schemes on the proposed site will require a multifaceted design approach that will take into account the site’s unique characteristics; mature forest grove, steep grade, existing infrastructure, and existing and future circulation, solar exposure, and the relationship to Discovery Hall.
Solar Study: Equinox sun path and shadows

Solar Study: Summer solstice sun path and shadows

Solar Study: Winter solstice sun path and shadows
APPENDIX A

PREDESIGN CHECKLIST
The Predesign checklist should be completed by the agency and submitted to OFM with the Predesign. Are the following in the Predesign? If not, the item should be noted “not applicable.” Suggestion: Put boxes instead of checks. The intent is for the agency to use a checklist and check of items as they are completed.

| ☑ Executive Summary |
| ☑ Project Analysis |
| ☑ Discussion of operational needs |
| ☑ Discussion of alternatives |
| ☑ Summary of LCCA results using the LCCT |
| ☑ Discussion of selected alternative |
| ☑ Identification of issues |
| ☑ Prior planning and history |
| ☑ Stakeholders |
| ☑ Project description |
| ☑ Implementation approach |
| ☑ Project management |
| ☑ Schedule |
| ☑ Program Analysis |
| ☑ Assumptions |
| ☑ Functions and FTEs |
| ☑ Spatial relationships between the facility and site |
| ☑ Interrelationships and adjacencies of functions |
| ☑ Major equipment |
| ☑ Special systems such as environmental, information technology, etc. |
| ☑ Future needs and flexibility |
| ☑ Sustainability, energy use and greenhouse gas emission reduction |
| ☑ Applicable codes and regulations |
| ☑ Site Analysis |
| ☑ Potential sites |
| ☑ Building footprint |
| ☑ Site considerations such as physical, regulatory and access issues |
| ☑ Acquisition process |
| ☑ Project Budget Analysis |
| ☑ Assumptions |
| ☑ Detailed estimates |
| ☑ Funding sources |
| ☑ Project cost estimate |
| ☑ Funding methods |
| ☑ Sign-off by agency |
| ☑ Master Plan and Policy Coordination |
| ☑ Impacts to existing plans |
| ☑ Adherence to significant state policies |
APPENDIX A PREDESIGN CHECKLIST

☑ Facility Operations and Maintenance Requirements
  ☑ Assumptions
  ☑ Operating costs in table form
  ☑ Staffing plan (capital and operating)

☑ Project Drawings/Diagrams
  ☑ Site plans
  ☑ Building plans
  ☑ Building volumes
  ☑ Elevations

☑ Appendix
  ☑ Predesign checklist
  ☑ Project budget unit cost detail
  ☑ Sustainable design charrette summary
  ☑ Copy of policies adopted in accordance with RCW 70.235.020 on the state’s limits on the emissions of greenhouse gases
  ☑ A letter from DAHP on the impact of potential sites on cultural resources
  ☑ Additional information as needed

N/A Executive report from the life cycle cost analysis
PROGRAM SUMMARY

INTERACT (584 seats; 27,682 GSF)
- (4) 1,050 SF classrooms for 30 students
- (3) 1,680 SF classrooms for 48 students
- (2) 2,500 SF classrooms for 100 students
- (2) 1,680 SF computer teaching lab for 48 students
- (1) 1,080 SF thermal fluid dynamics teaching lab for 24 students

INNOVATE (296 seats; 33,214 GSF)
- (1) 4,800 SF CSS + E&M computational experiential learning lab modules for 24 seats
- (1) 2,975 SF CSS + E&M dry experiential learning lab modules for 7 seats
- (1) 2,550 SF CSS + E&M wet experiential learning lab modules for 6 seats
- (1) 5,425 SF STEM computational experiential learning lab modules for 151 seats
- (1) 3,880 SF STEM dry experiential learning lab modules for 77 seats
- (1) 1,800 SF STEM wet experiential learning lab modules for 30 seats

MENTOR (72 seats; 12,397 GSF)
- (6) 8,280 SF total collaborative office suite with shared space for 12 persons /each space
- (3) 150 SF total touchdown station for 3 person

COLLABORATE (5,353 GSF)
- (2) 240 SF seminar conference room, general use, STEM-focus for 12 persons/each space
- (2) 150 SF grad student hoteling with storage for 3 persons
- (1) 875 SF entry/gathering space for 24 persons
- (1) 1,600 SF grad and undergraduate STEM advising center for 20 persons
- (1) 700 SF corridor breakout and gathering space

Total Proposed Phase 4 STEM Building: 78,647 GSF
### B. INTERACT: 30-PERSON CLASSROOM

**General Description**

The desired attributes of each type of space was gathered through a series of focus group sessions with various STEM groups. These attributes of academic spaces are described in a general room data sheet that begins to inform initial costs and size of a building. These classrooms should allow for active learning or with moveable furniture for multiple configurations. Given the higher level of movement that occurs in active learning classrooms, providing storage space (baskets under chairs or coat racks) for bags and coats off the floor will help keep aisles clear. It was requested in multiple focus group sessions that projector screen should not obstruct whiteboard space and that whiteboard surface should be considered for a projector surface if possible.

**Room Type**

<table>
<thead>
<tr>
<th>Room Type</th>
<th>30 person Active Classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of these spaces</td>
<td>4</td>
</tr>
<tr>
<td>Room size</td>
<td>1,050 sf</td>
</tr>
<tr>
<td>Level of technological standard</td>
<td>A-</td>
</tr>
<tr>
<td>Height requirements</td>
<td>10'-0&quot; minimum</td>
</tr>
<tr>
<td>Adjacency Requirements</td>
<td>none</td>
</tr>
<tr>
<td>Windows</td>
<td>desired natural light</td>
</tr>
<tr>
<td>Daylight Control</td>
<td>manual shades</td>
</tr>
<tr>
<td>Lighting</td>
<td>To be determined.</td>
</tr>
</tbody>
</table>

**Utility Requirements**

**Electrical**

Wall mounted duplex outlets and USB ports for power of devices, floor boxes or overhead power to be considered

**Data / Telecom**

Technology package to include sound system, video capture, projection system, wifi repeaters for internet access

**Audio-Visual**

Portable projectors, ceiling mounted projectors, or individual monitors to be considered. Microphones, video recording capabilities

**HVAC / controls**

Comfort heating, cooling, and ventilation. No occupant adjustment.

**Equipment**

**Fixed**

Projection screen or whiteboard with digital projector, white boards along perimeter, storage, instructor station/computer

**Movable**

Podium with AV controls, tables, chairs, storage for instruction demonstrations/props. Ability for students to share content with class, classroom storage.

**Other**

Coat racks or under table storage for loose items
Incorporating a Flexible Concept:
General Classroom

- Common structural module that allows similar ‘shells’ to be outfitted for future space conversions
- Common furniture in all layouts highlights flexibility
- Non-directional room orientation allows pedagogical options
- Electrical infrastructures to support variety of uses and technology
- Unobstructed writable surface
B. INTERACT: 48-PERSON CLASSROOM

General Description
The desired attributes of each type of space was gathered through a series of focus group sessions with various STEM groups. These attributes of academic spaces are described in a general room data sheet that begins to inform initial costs and size of a building. These classrooms should allow for active learning or with moveable furniture for multiple configurations. Given the higher level of movement that occurs in active learning classrooms, providing storage space (baskets under chairs or coat racks) for bags and coats off the floor will help keep aisles clear. It was requested in multiple focus group sessions that projector screen should not obstruct whiteboard space and that whiteboard surface should be considered for a projector surface if possible.

<table>
<thead>
<tr>
<th>Room Type</th>
<th>48 person Active Classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of these spaces</td>
<td>3</td>
</tr>
<tr>
<td>Room size</td>
<td>1,680 sf</td>
</tr>
<tr>
<td>Level of technological standard</td>
<td>A-</td>
</tr>
<tr>
<td>Height requirements</td>
<td>10'-0&quot; minimum</td>
</tr>
<tr>
<td>Adjacency Requirements</td>
<td>none</td>
</tr>
<tr>
<td>Windows</td>
<td>desired natural light</td>
</tr>
<tr>
<td>Daylight Control</td>
<td>manual shades</td>
</tr>
<tr>
<td>Lighting</td>
<td>To be determined.</td>
</tr>
</tbody>
</table>

Utility Requirements

Electrical
Wall mounted duplex outlets and USB ports for power of devices, floor boxes or overhead power to be considered.

Data / Telecom
Technology package to include sound system, video capture, projection system, wifi repeaters for internet access.

Audio-Visual
Portable projectors, ceiling mounted projectors, or individual monitors to be considered. Microphones, video-recording capabilities.

HVAC / controls
Comfort heating, cooling, and ventilation. No occupant adjustment.

Equipment

Fixed
Projection screen or whiteboard with digital projector, white boards along perimeter, storage, instructor station/computer

Movable
Podium with AV controls, tables, chairs, storage for instruction demonstrations/props. Ability for students to share content with class, classroom storage.

Other
Coat racks or under table storage for loose items.
Incorporating a Flexible Concept:
General Classroom

- Common structural module that allows similar ‘shells’ to be outfitted for future space conversions
- Common furniture in all layouts highlights flexibility
- Non-directional room orientation allows pedagogical options
- Electrical infrastructures to support variety of uses and technology
- Unobstructed writable surface
## B. INTERACT: 100-PERSON CLASSROOM

### General Description
The desired attributes of each type of space was gathered through a series of focus group sessions with various STEM groups. These attributes of academic spaces are described in a general room data sheet that begins to inform initial costs and size of a building. Given the higher level of movement that occurs in active learning classrooms, providing specific space (baskets under chairs or coat racks) for bags and coats off the floor will help keep aisles clear. It was requested in multiple focus group sessions that projector screen should not obstruct whiteboard space and that whiteboard surface should be considered for a projector surface if possible.

### Room Type
- **100 person Active Classroom**

### Number of these spaces
- 2

### Room size
- 2,500 sf

### Level of technological standard
- A-

### Height requirements
- 10'-0" minimum if level floor; higher if 6'-8" tiers used

### Adjacency Requirements
- none

### Windows
- desired natural light

### Daylight Control
- manual shades

### Lighting
- To be determined.

### Utility Requirements

#### Electrical
- Wall mounted duplex outlets and USB ports for power of devices, floor boxes or overhead power to be considered.

#### Data / Telecom
- Technology package to include sound system, video capture, projection system, wifi repeaters for internet access.

#### Audio-Visual
- Portable projectors, ceiling mounted projectors, or individual monitors to be considered.

#### HVAC / controls
- Comfort heating, cooling, and ventilation. No occupant adjustment.

#### Equipment

##### Fixed
- Projection screen or whiteboard with digital projector, white boards along perimeter, storage, instructor station/computer, ability for students to share content with class, classroom storage.

##### Movable
- Podium with AV controls, tables, chairs, storage for instruction demonstrations and props.

##### Other
- Coat racks or under table storage for loose items. A flat floor is preferable as it was noted to provide flexibility in the space for movement as well as for future re-purpose, can be used for events and Capstone Project display.
APPENDIX B PROGRAM ANALYSIS

whiteboard
surface for projection
monitor
## B. INTERACT: COMPUTER TEACHING LAB

### General Description

The desired attributes of each type of space was gathered through a series of focus group sessions with various STEM groups. These attributes of academic spaces are described in a general room data sheet that begins to inform initial costs and size of a building. A student focus group suggested these classrooms be multipurpose computer labs that provide access to software across departments and programs for an interdisciplinary experience.

<table>
<thead>
<tr>
<th>Room Type</th>
<th>48 station computer teaching lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of these spaces</td>
<td>2</td>
</tr>
<tr>
<td>Room size</td>
<td>1,680 sf</td>
</tr>
<tr>
<td>Level of technological standard</td>
<td>A-</td>
</tr>
<tr>
<td>Height requirements</td>
<td>10'-0&quot; minimum</td>
</tr>
<tr>
<td>Adjacency Requirements</td>
<td>AV closet and technology support</td>
</tr>
<tr>
<td>Windows</td>
<td>Desired natural light</td>
</tr>
<tr>
<td>Daylight Control</td>
<td>Manual shades</td>
</tr>
<tr>
<td>Lighting</td>
<td>Daylight and occupancy sensors</td>
</tr>
</tbody>
</table>

### Utility Requirements

**Electrical**

Wall mounted duplex outlets and USB ports for power of devices, floor boxes or overhead power to be considered

**Data / Telecom**

Technology package to include sound system, video capture, projection system, wifi repeaters for internet access

**Audio-Visual**

Portable projectors, ceiling mounted projectors, or individual monitors to be considered

**HVAC / controls**

Comfort heating, cooling, and ventilation. No occupant adjustment.

**Equipment**

**Fixed**

Projection screen, white boards, storage, instructor station/computer, ability for students to share content with class at group table, classroom storage

**Movable**

Podium with AV controls, tables, chairs, storage for instruction demonstrations/props. Configured for group work and content sharing/reviewing.

**Other Considerations**

Same size module as 48-seat classroom
B. INTERACT: THERMAL FLUID DYNAMICS TEACHING LAB

General Description
The desired attributes of each type of space was gathered through a series of focus group sessions with various STEM groups. These attributes of academic spaces are described in a general room data sheet that begins to inform initial costs and size of a building. The teaching lab for thermal dynamic thermals requires 4 sinks, floor drain, sufficient power access for students, and a flexible podium. Whiteboards should be considered for all cabinetry surfaces. It was requested a number of times that projector screen should not obstruct whiteboard space and that whiteboard surface should be considered for a projector surface if possible.

<table>
<thead>
<tr>
<th>Room Type</th>
<th>24 seat thermal fluid dynamics teaching lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of these spaces</td>
<td>1</td>
</tr>
<tr>
<td>Room size</td>
<td>1,080 sf</td>
</tr>
<tr>
<td>Level of technological standard</td>
<td>A-</td>
</tr>
<tr>
<td>Height requirements</td>
<td>10'-0&quot; minimum</td>
</tr>
<tr>
<td>Adjacency Requirements</td>
<td>AV closet and technology support</td>
</tr>
<tr>
<td>Windows</td>
<td>desired natural light</td>
</tr>
<tr>
<td>Daylight Control</td>
<td>manual shades</td>
</tr>
<tr>
<td>Lighting</td>
<td>daylight and occupancy sensors</td>
</tr>
</tbody>
</table>

Utility Requirements

Electrical
Floor boxes at center of room or overhead power. Raceway at perimeter

Data / Telecom
Technology package to include sound system, video capture, projection system, wifi repeaters for internet access

Audio-Visual
Portable projectors, ceiling mounted projectors, or individual monitors to be considered

HVAC / controls
Comfort heating, cooling, and ventilation. No occupant adjustment. Ventilation for engine testing.

Plumbing
Lab hot water, lab cold water, and lab waste plumbed to each lab sink. Natural gas and vacuum plumbed to each lab bench. Floor drains as needed throughout space plumbed to lab waste

Equipment

Fixed
Lab benches, adjustable shelving at perimeter with whiteboard surface, white boards at perimeter of room, emergency eye wash and shower, projection system, storage, instructor station/computer

Movable
Cylinder gases; inert and flammable, moveable stools and chairs, podium, storage for instruction demonstrations/props

Other
Ventilation and vibration and noise control, open spaces for experiments
APPENDIX B

PROGRAM ANALYSIS

PODIUM

STORAGE

40’ (4 modules)

30’

1 module

40’ (4 modules)

whiteboard

surface for projection
B. INNOVATE: COMPUTATIONAL EXPERIENTIAL LEARNING LAB

General Description
Experiential learning labs and support spaces allow STEM students the opportunity to apply the theoretical studies in a practical settings. At UW Bothell, it is an integral part of STEM curriculum that students engage in an experiential research experience. Undergraduate and graduate students learn by connecting classroom theory and community-based experience through the completion of an academic project. Project options consist of internships, research with faculty, individual projects, or group projects. Currently the research that occurs on campus is limited due to critical space deficiencies. Experiential research that supports Engineering and Computer Science programs is required to fulfill this integral part of the UW Bothell experience.

Computational experiential labs could be configured on a 30’X40’ module. This module would allow for transition during growth and provide space that is convertible to a teaching lab, or an experiential learning lab shared among 4 faculty members with student researchers, an image processing lab, or a computer lab devoted to engineering and math. This space is allocated to include shared equipment and supply rooms as necessary. These spaces require consideration for robotics, electrical engineering programs, and server rooms.

<table>
<thead>
<tr>
<th>Room Type</th>
<th>Computational Learning Lab; dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of these spaces</td>
<td>Total 10,225 net sf; space for 176 students/faculty</td>
</tr>
<tr>
<td>Room size</td>
<td>A-</td>
</tr>
<tr>
<td>Level of technological standard</td>
<td>10'-0&quot; minimum</td>
</tr>
<tr>
<td>Height requirements</td>
<td>AV closet and technology support. Adjacent to faculty offices</td>
</tr>
<tr>
<td>Adjacency Requirements</td>
<td>Desired natural light</td>
</tr>
<tr>
<td>Windows</td>
<td>Manual shades</td>
</tr>
<tr>
<td>Daylight Control</td>
<td>Daylight and occupancy sensors</td>
</tr>
<tr>
<td>Lighting</td>
<td></td>
</tr>
</tbody>
</table>

Utility Requirements

- **Electrical**
  - Overhead power and raceway-combination electrical/data with 120V duplexes at 24” o.c. with wireless network capacity

- **Audio-Visual**
  - Portable projector, ceiling mounter projector, or monitors to be considered

- **HVAC / controls**
  - Comfort heating, cooling, and ventilation. No occupant adjustment.

- **Plumbing**
  - Whiteboards, projection screen should be provided.

- **Equipment**
  - Storage units for project storage, community table and individual moveable tables and work stations should be provided.
APPENDIX B  PROGRAM ANALYSIS

Layout Option 1

Layout Option 2

Layout Option: Flexible Modules Expanded to 8 modules.

1 module

80' (8 modules)

whiteboard

surface for projection
## B. INNOVATE: DRY EXPERIENTIAL LEARNING LAB

### General Description
Experiential learning labs and support spaces allows STEM students the opportunity to apply the theoretical studies they've learning in a practical setting. At UW Bothell, it is an integral part of STEM curriculum that students engage in an authentic research experience. Undergraduate and graduate students learn by connecting classroom theory and community-based experience through the completion of an academic project. Project options consist of internships, research with faculty, individual projects, or group projects. Currently the research that occurs on campus is limited due to critical space deficiencies. Research that supports Computer Science and Engineering programs is required to fulfill this integral part of the UW Bothell experience.

Spaces could be arranged to facilitate flexibility for future growth considerations. A lab module that when ganged together allows for expansion and contraction based on the institution’s needs. Shared lab space accommodates student research as led by faculty. Specifically, dry lab modules could accommodate flexibility to convert the space into experiential labs, a computer lab devoted to engineering and math, or an image processing lab. The size of the space is determined by the number of faculty and student researchers. Shared equipment and supply rooms are accommodated as necessary. Some required considerations for these spaces include robotics, electrical engineering programs, and server rooms.

<table>
<thead>
<tr>
<th>Room Type</th>
<th>Experiential Learning Lab; dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of these spaces</td>
<td>Total 6,775 net sf; space for 84 students/faculty</td>
</tr>
<tr>
<td>Room size</td>
<td>A- 10'-0&quot; minimum</td>
</tr>
<tr>
<td>Level of technological standard</td>
<td>AV closet and technology support. Access to emergency eyewash and shower stations. Adjacent to faculty offices, loading and storage for large equipment.</td>
</tr>
<tr>
<td>Height requirements</td>
<td>Daylight and occupancy sensors</td>
</tr>
<tr>
<td>Adjacency Requirements</td>
<td>Desired natural light Manual shades</td>
</tr>
<tr>
<td>Windows</td>
<td>Daylight Control Lighting</td>
</tr>
<tr>
<td>Daylight Control</td>
<td>Manual shades</td>
</tr>
<tr>
<td>Lighting</td>
<td>Daylight Control Lighting</td>
</tr>
<tr>
<td>Utility Requirements</td>
<td>Overhead power and raceway-combination electrical/data with 120V duplexes at 24” o.c. with wireless network capacity</td>
</tr>
<tr>
<td>Electrical</td>
<td>Portable projector, ceiling mounter projector, or monitors to be considered</td>
</tr>
<tr>
<td>Floor boxes</td>
<td>Comfort heating, cooling, and ventilation. No occupant adjustment. Welding exhaust if applicable.</td>
</tr>
<tr>
<td>Data / Telecom</td>
<td>Lab hot water, lab cold water, and lab waste, and natural gas plumbed to each lab sink along perimeter.</td>
</tr>
<tr>
<td>Audio-Visual</td>
<td>Soldering stations, power lab equipment, whiteboards, projection screen,</td>
</tr>
<tr>
<td>HVAC / controls</td>
<td>Oscilloscopes, computers, additional Electrical Engineering equipment,</td>
</tr>
<tr>
<td>Plumbing</td>
<td>Storage units for project storage, community table and individual moveable tables and work stations.</td>
</tr>
</tbody>
</table>
APPENDIX B PROGRAM ANALYSIS

Layout Option 1

Layout Option: Flexible Modules Expanded to 8 modules.

- whiteboard
- surface for projection
## B. INNOVATE: WET EXPERIENTIAL LEARNING LAB

### General Description
Experiential learning labs and support spaces allows STEM students the opportunity to apply the theoretical studies they've learning in a practical setting. At UW Bothell, it is an integral part of STEM curriculum that students engage in an authentic research experience. Undergraduate and graduate students learn by connecting classroom theory and community-based experience through the completion of an academic project. Project options consist of internships, research with faculty, individual projects, or group projects. Currently the research that occurs on campus is limited due to critical space deficiencies. Research that supports Computer Science and Engineering programs is required to fulfill this integral part of the UW Bothell experience.

Spaces could be set up to work on the 30’x40’ Space convertible to teaching lab and could be a shared faculty lab for 4 faculty with one student working. This specifically could be set up for research and include students. Could also include image processing lab. Could include a computer lab devoted to engineering and math. These are generated by faculty numbers (also generated from the FTE). This would include shared equipment and supply rooms as necessary. These spaces require consideration for robotics, electrical engineering programs, and server rooms.

<table>
<thead>
<tr>
<th>Room Type</th>
<th>Experiential Learning Lab; wet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of these spaces</td>
<td>Total 4,350 sf; space for 36 students/faculty</td>
</tr>
<tr>
<td>Room size</td>
<td>10’-0” minimum</td>
</tr>
<tr>
<td>Level of technological standard</td>
<td>A-</td>
</tr>
<tr>
<td>Height requirements</td>
<td>AV closet and technology support. Access to emergency eyewash and shower stations. Adjacent to faculty offices, loading and storage for large equipment.</td>
</tr>
<tr>
<td>Adjacency Requirements</td>
<td>Desired natural light</td>
</tr>
<tr>
<td>Windows</td>
<td>Manual shades</td>
</tr>
<tr>
<td>Daylight Control</td>
<td>Daylight and occupancy sensors</td>
</tr>
<tr>
<td>Lighting</td>
<td>Overhead power and raceway-combination electrical/data with 120V duplexes at 24” o.c. with wireless network capacity</td>
</tr>
</tbody>
</table>

### Utility Requirements

#### Electrical
- Portable projector, ceiling mounter projector, or monitors to be considered
- Four chemical fume hoods, accommodation of laminar flow hoods/biosafety cabinets. Considerations for exhaust for engine testing, snorkel exhaust, accommodation for welding and wood shop activities. Comfort heating, cooling, ventilation. No occupant adjustment.

#### Floor boxes
- Lab hot water, lab cold water, and lab waste, natural gas, lab air and vacuum plumbed to each lab sink along perimeter: (4) lab sinks and (4) cup sinks.
- Floor drains as needed throughout space plumbed to lab waste.

#### Equipment
- Fixed
- Movable
- Acid/chemical storage, cylinder restraint, whiteboards, projection screen,
- Laminar flow hoods, microscopes, stereoscopes, tensile testing equipment, wood shop equipment, metal shop equipment, lathe, additional Engineering equipment, Storage units for project storage, community table and individual moveable tables and work stations.
APPENDIX B  PROGRAM ANALYSIS

Layout Option 1

Layout Option: Flexible Modules Expanded to 8 modules.

- orange: whiteboard
- blue: surface for projection
### General Description

Offices are arranged with some shared space allocated to conference rooms and work rooms. Office suite should be large enough to allow students to gather for group collaboration or use conference rooms.

<table>
<thead>
<tr>
<th>Room Type</th>
<th>Single office suite with shared support space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of these spaces</td>
<td>6</td>
</tr>
<tr>
<td>Room size</td>
<td>Total 8,280 net sf; space for 12 faculty (69 seats total)</td>
</tr>
<tr>
<td>Level of technological standard</td>
<td>A-</td>
</tr>
<tr>
<td>Height requirements</td>
<td>10'-0&quot; minimum</td>
</tr>
<tr>
<td>Adjacency Requirements</td>
<td>None</td>
</tr>
</tbody>
</table>

| Windows                            | Desired natural light                         |
| Daylight Control                   | Manual shades                                 |
| Lighting                           | Daylight and occupancy sensors               |

**Utility Requirements**

| Electrical                         | Electrical/data with 120V duplexes at 24" o.c. with wireless network capacity. |
| Floor boxes                        | Other items to be determined.                |
| Audio-Visual                        |                                                |
| HVAC / controls                    |                                                |

**Plumbing**

| Equipment                          | Whiteboards, and other items to be determined. |
| Fixed                              |                                                |
| Movable                            | Storage units, community table and individual moveable tables and work stations should be provided. |
Office Module with Identified Area Redistributed to Common Shared Space.
### General Description
80 sf/officer and 40 sf allocated to community space and conference rooms

<table>
<thead>
<tr>
<th>Room Type</th>
<th>graduate and undergraduate advising center</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of these spaces</td>
<td>1</td>
</tr>
<tr>
<td>Room size</td>
<td>Total 1,600 net sf; 20 stations</td>
</tr>
<tr>
<td>Level of technological standard</td>
<td>A-</td>
</tr>
<tr>
<td>Height requirements</td>
<td>10'-0&quot; minimum</td>
</tr>
<tr>
<td>Adjacency Requirements</td>
<td>None</td>
</tr>
<tr>
<td>Windows</td>
<td>Desired natural light</td>
</tr>
<tr>
<td>Daylight Control</td>
<td>Manual shades</td>
</tr>
<tr>
<td>Lighting</td>
<td>Daylight and occupancy sensors</td>
</tr>
</tbody>
</table>

#### Utility Requirements

<table>
<thead>
<tr>
<th>Electrical</th>
<th>Electrical/data with 120V duplexes at 24&quot; o.c. with wireless network capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor boxes</td>
<td>To be determined.</td>
</tr>
<tr>
<td>Data / Telecom</td>
<td>Access to natural ventilation option. Comfort heating, cooling, and ventilation.</td>
</tr>
<tr>
<td>Audio-Visual</td>
<td>Occupant adjustment.</td>
</tr>
<tr>
<td>HVAC / controls</td>
<td></td>
</tr>
</tbody>
</table>

#### Plumbing

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Projector screen or large monitor in conference room or shared spaces, other items to be determined.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed</td>
<td>Storage units, tables and chairs, other items to be determined.</td>
</tr>
<tr>
<td>Movable</td>
<td></td>
</tr>
</tbody>
</table>
Advising Center Based on Office Module with Identified Area Redistributed to Common Shared Space
### B. MENTOR: HOTELING STATION

**General Description**
Touchdown stations for part-time faculty and staff. To maximize flexibility, the same model is used for graduate students in mechanical and electrical engineering.

<table>
<thead>
<tr>
<th>Room Type</th>
<th>Hoteling station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of these spaces</td>
<td></td>
</tr>
<tr>
<td>Room size</td>
<td>50 sf/station net; space for 3 faculty</td>
</tr>
<tr>
<td>Level of technological standard</td>
<td>A-</td>
</tr>
<tr>
<td>Height requirements</td>
<td>10'-0&quot; minimum</td>
</tr>
<tr>
<td>Adjacency Requirements</td>
<td>None</td>
</tr>
<tr>
<td>Windows</td>
<td>Desired natural light</td>
</tr>
<tr>
<td>Daylight Control</td>
<td>Manual shades</td>
</tr>
<tr>
<td>Lighting</td>
<td>Daylight and occupancy sensors</td>
</tr>
<tr>
<td>Utility Requirements</td>
<td></td>
</tr>
<tr>
<td>Electrical/data</td>
<td>120V duplexes at 24&quot; o.c. with wireless network capacity.</td>
</tr>
<tr>
<td>Floor boxes</td>
<td>To be determined.</td>
</tr>
<tr>
<td>Data / Telecom</td>
<td></td>
</tr>
<tr>
<td>HVAC / controls</td>
<td></td>
</tr>
<tr>
<td>Plumbing</td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td></td>
</tr>
<tr>
<td>Fixed</td>
<td></td>
</tr>
<tr>
<td>Movable</td>
<td>Whiteboards, other items to be determined.</td>
</tr>
<tr>
<td></td>
<td>Storage units should be provided at work stations.</td>
</tr>
</tbody>
</table>
B. COLLABORATION: SEMINAR ROOM

General Description
STEM seminar rooms would provide space for graduate and upper divisional course as well as provide informal meeting spaces for students to gather, faculty meetings, or for community business members to meet with students.

<table>
<thead>
<tr>
<th>Room Type</th>
<th>Seminar room</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of these spaces</td>
<td>2</td>
</tr>
<tr>
<td>Room size</td>
<td>480 sf; space for 12 students/faculty in each space</td>
</tr>
<tr>
<td>Level of technological standard</td>
<td>A-</td>
</tr>
<tr>
<td>Height requirements</td>
<td>10'-0&quot; minimum</td>
</tr>
<tr>
<td>Adjacency Requirements</td>
<td>None</td>
</tr>
<tr>
<td>Windows</td>
<td>Desired natural light</td>
</tr>
<tr>
<td>Daylight Control</td>
<td>Manual shades</td>
</tr>
<tr>
<td>Lighting</td>
<td>Daylight and occupancy sensors</td>
</tr>
</tbody>
</table>

Utility Requirements
Electrical
- Electrical/data with 120V duplexes at 24" o.c. with wireless network capacity.

Floor boxes
- To be determined.

Data / Telecom
- To be determined.

Audio-Visual

HVAC / controls
- No occupant adjustment.

Plumbing

Equipment
Fixed
- Whiteboards, projector screen or large monitor, other tbc items.

Movable
- Storage units, tables and chairs, other items to be determined.
### B. COLLABORATION: GRADUATE STUDENT HOTELING WITH STORAGE

**General Description**
Touchdown stations for graduate students in mechanical and electrical engineering. To maximize flexibility, the same model is used for part-time faculty and staff.

<table>
<thead>
<tr>
<th>Room Type</th>
<th>graduate student hoteling station with storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of these spaces</td>
<td>2</td>
</tr>
<tr>
<td>Room size</td>
<td><strong>50 sf/station</strong> (150 net sf); 3 stations</td>
</tr>
<tr>
<td>Level of technological standard</td>
<td>A-</td>
</tr>
<tr>
<td>Height requirements</td>
<td>10'-0&quot; minimum</td>
</tr>
<tr>
<td>Adjacency Requirements</td>
<td>Desired natural light</td>
</tr>
<tr>
<td>Windows</td>
<td>Manual shades</td>
</tr>
<tr>
<td>Daylight Control</td>
<td>Daylight and occupancy sensors</td>
</tr>
<tr>
<td>Lighting</td>
<td></td>
</tr>
</tbody>
</table>

**Utility Requirements**

| Electrical                   | Electrical/data with 120V duplexes at 24" o.c. with wireless network capacity. |
| Floor boxes                  | To be determined.                                                                 |
| Data / Telecom               | Access to natural ventilation option. Comfort heating, cooling and ventilation. |
| Audio-Visual                 | Occupant adjustment.                                                              |
| HVAC / controls              |                                               |
| Plumbing                     |                                               |

**Equipment**

| Fixed                         | Whiteboards, other items to be determined.                                           |
| Movable                       | Storage units, tables and chairs.                                                     |
B. **COLLABORATION: ENTRY / GATHERING SPACE**

**General Description**
This space should consider a variety of furniture types and be flexible and easily accessible for in between class study and group work.

<table>
<thead>
<tr>
<th>Room Type</th>
<th>Entry / Gathering space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of these spaces</td>
<td>1</td>
</tr>
<tr>
<td>Room size</td>
<td>875 net sf; 24 seats</td>
</tr>
<tr>
<td>Level of technological standard</td>
<td>A-</td>
</tr>
<tr>
<td>Height requirements</td>
<td>10'-0&quot; minimum</td>
</tr>
<tr>
<td>Adjacency Requirements</td>
<td>None</td>
</tr>
<tr>
<td>Windows</td>
<td>Desired natural light</td>
</tr>
<tr>
<td>Daylight Control</td>
<td>Manual shades</td>
</tr>
<tr>
<td>Lighting</td>
<td>Daylight and occupancy sensors</td>
</tr>
</tbody>
</table>

**Utility Requirements**

<table>
<thead>
<tr>
<th>Electrical</th>
<th>Electrical/data with 120V duplexes at 24&quot; o.c. with wireless network capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor boxes</td>
<td></td>
</tr>
<tr>
<td>Data / Telecom</td>
<td></td>
</tr>
<tr>
<td>Audio-Visual</td>
<td>To be determined.</td>
</tr>
</tbody>
</table>

**Plumbing**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Whiteboards, other tbc items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed</td>
<td>These spaces should contain a variety of furniture options: lounge, booth, study space with single desks and community tables, other items to be determined.</td>
</tr>
<tr>
<td>Movable</td>
<td></td>
</tr>
</tbody>
</table>
## B. Collaboration: Breakout Spaces in Corridors

### General Description

<table>
<thead>
<tr>
<th>Room Type</th>
<th>breakout space in corridors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of these spaces</td>
<td>2</td>
</tr>
<tr>
<td>Room size</td>
<td>700 net sf; 24 seats</td>
</tr>
<tr>
<td>Level of technological standard</td>
<td>A-</td>
</tr>
<tr>
<td>Height requirements</td>
<td>10'-0&quot; minimum</td>
</tr>
<tr>
<td>Adjacency Requirements</td>
<td>None</td>
</tr>
<tr>
<td>Windows</td>
<td>Desired natural light</td>
</tr>
<tr>
<td>Daylight Control</td>
<td>Manual shades</td>
</tr>
<tr>
<td>Lighting</td>
<td>Daylight and occupancy sensors</td>
</tr>
</tbody>
</table>

### Utility Requirements

<table>
<thead>
<tr>
<th>Electrical</th>
<th>Electrical/data with 120V duplexes at 24&quot; o.c. with wireless network capacity.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor boxes</td>
<td>To be determined.</td>
</tr>
</tbody>
</table>
| Data / Telecom                | Access to natural ventilation option. Comfort heating, cooling and ventilation. Occu
| Audio-Visual                  | tant adjustment.                                                               |
| HVAC / controls               |                                                                |

### Plumbing

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Whiteboards, other items to be determined.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed</td>
<td>Variety of furniture options; lounge, booth, study space with single desks and community tables, other items to be determined.</td>
</tr>
</tbody>
</table>
APPENDIX C
SITE ANALYSIS
C.1 ADDITIONAL SITE SECTIONS AT PREFERRED SITE

10' Minimum Setback From West Campus Lane
Section diagrams depicting proposed Phase 4 building site (Option 1 per section 4) exterior stair, steep slope, Discovery Hall and Phase 4 building relationship.
C.2 PRELIMINARY GEOTECHNICAL REPORT

Geotechnical Engineering Services

Phase 4 STEM Building
University of Washington
Bothell, Washington

for
The University of Washington

May 24, 2016

GeoEngineers

8410 154th Avenue NE
Redmond, Washington 98052
425.861.6000
Geotechnical Engineering Services

Phase 4 STEM Building
University of Washington
Bothell, Washington

File No. 0183-120-00

May 24, 2016

Prepared for:

University of Washington
University Facilities Building
Box 3522205
Seattle, Washington 98195-2205

Attention: Jeannie Natta

Prepared by:

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Principal

Disclaimer: Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.
EXECUTIVE SUMMARY

This report contains the results of our geotechnical engineering services for use in the design of the proposed Phase 4 STEM (UWB4) Building at the University of Washington in Bothell, Washington. The project consists of constructing a new four-story building with a mechanical penthouse. The UWB4 building will be stepped up the hill slope and will be located north of the existing UWB3 building (Discovery Hall) and west of the library.

Subsurface Conditions

Preliminary subsurface conditions were evaluated by drilling three borings in the proposed UWB4 building footprint.

Soils

The near surface native soils generally consist of the following:

- Topsoil: Topsoil was observed from 6 to 12 inches thick.
- Fill: Approximately 7 feet of fill generally consisting of loose to medium dense silty sand with variable gravel and organic matter was encountered in boring GEI-3 that was drilled at the bottom of the hill slope.
- Weathered Glacial Till: Weathered glacial till was observed in the upper 12½ feet of each boring, except where fill or topsoil exists. Weathered glacial till is typically medium dense to dense silty sand with variable gravel.
- Glacial Till: Relatively unweathered glacial till was observed below the weathered till in all three borings. The unweathered till extended to depths explored of 26½ to 31½ feet below the existing ground surface. Glacial till typically consists of dense to very dense silty sand with variable gravel and cobble content.

Groundwater

Perched groundwater was observed in boring GEI-2 at depths of about 10 and 25 feet, and should be expected within permeable layers within the native glacial deposits and at the contact with the overlying fill during wet weather. A monitoring well was installed in boring GEI-2, but no groundwater was measured in this boring following completion. No significant groundwater was observed during drilling for the UWB4 building.

Earthquake Engineering

In accordance with the 2012 International Building Code (IBC), the site is classified as Site Class C.

Structural Fill

On-site weathered till and glacial till soils should be suitable for use as structural fill in areas outside of the building footprint provided the work is accomplished during the normally dry season (June through September) and that the soil can be properly moisture conditioned and compacted.
The contractor should plan to import gravel borrow for use as structural fill under the entire building footprint and within a 1H:1V (horizontal to vertical) influence zone projected down from the edges of the foundations. Imported gravel borrow should be used as structural fill during the wet season (October through May) and in wet weather.

**Excavation Considerations**

Excavations for the building could require cuts up to 15 feet deep. These cuts can be made as temporary open cut slopes or using temporary shoring, depending on site constraints. Temporary unsupported cut slopes more than 4 feet high may be inclined at 1½H:1V maximum steepness in the fill and weathered till, and 1H:1V in the dense to very dense glacial till. Temporary shoring such as soldier pile and lagging walls or soil nail walls may also be used to support temporary cut slopes for the project.

**Temporary Dewatering**

Temporary dewatering may be required to deal with perched water and/or surface water entering excavations, and for excavation of the UWB4 lower level. Perched or surface water entering excavations can likely be addressed by drainage ditches and sump pumps.

**Shallow Foundations**

The building can be supported on conventional spread and mat footings bearing on undisturbed native soils or on structural fill extending to undisturbed native soils. We recommend a preliminary allowable bearing pressure of 8,000 pounds per square foot (psf) for shallow foundations bearing on the dense to very dense glacially consolidated soils. Foundations will generally need to extend about 7½ to 10 feet below the existing ground surface to achieve 8,000 psf design bearing pressure. Foundations supported on structural fill consisting of imported gravel borrow and overlying medium dense to very dense glacial soils or foundations supported on undisturbed medium dense to dense native glacial soils may be designed using an allowable bearing pressure of 4,000 psf. These allowable soil bearing pressure apply to the total of dead and long-term live loads and may be increased by up to one-third for wind or seismic loads. These allowable soil bearing pressures are net values.

Lateral foundation loads may be resisted by passive resistance on the sides of the footings and by friction on the base of the footings. For footings supported and surrounded by either medium dense to dense glacially consolidated soil or compacted structural fill, a coefficient of friction of 0.4 and a passive resistance of 350 pounds per cubic foot (pcf) may be used.

Perimeter footing drains should be included in the design of the building.

**Slab-on-Grade Floors**

A subgrade modulus of 150 pounds per cubic-inch (pci) may be used for design of the slabs-on-grade at the site. Concrete slabs-on-grade should be supported on a 6-inch-thick capillary break layer overlain by a vapor retarder. A suitable vapor barrier should be installed below the floor slabs. On-grade floor slabs for lower levels cut into the hill slope should be designed with a perforated pipe underdrain system.
Below-Grade Walls and Retaining Walls

Below-grade walls should be provided with a free draining drainage layer and footing drain pipes. For below-grade walls constructed either neat against the dense native soils, or backfilled with compacted structural fill, we recommend the following equivalent fluid weights for walls having horizontal backfill:

- allowable passive – 350 pcf
- active – 35 pcf
- at rest – 55 pcf

Drainage Considerations

Drainage should be provided behind below-grade walls and retaining walls, footing drains should be designed around the perimeter of the building, and underslab drainage should be provided below the UWB4 floor slabs. A more robust underslab drainage system may be needed for the lower level to prevent the buildup of hydrostatic uplift pressures, if more extensive groundwater is observed during construction. The lower level of the adjacent UW3 Building encountered more groundwater than what we observed in boring GEI-3 for the UW4 Building.

Pavements

New hot-mix asphalt (HMA) pavement sections around the building should consist of at least 3 inches HMA over 4 inches of base course in car parking areas and 4 inches HMA over 6 inches of base course in areas exposed to truck traffic or heavy traffic volumes. A subbase layer consisting of at least 12 inches of imported gravel borrow should underlie the pavement sections for driveways and parking areas where medium dense to very dense native soils are not present.
**INTRODUCTION**

This report presents the results of our geotechnical engineering services for the proposed University of Washington Bothell Phase 4 (UWB4) STEM Building project in Bothell, Washington. The location of the site and general configuration of the proposed building is shown on the Vicinity Map and Site Plan, Figures 1 and 2, respectively.

The Phase 4 project includes the construction of a new four-level Phase 4 STEM building (UWB4) with a mechanical penthouse. The building will be stepped up the hill slope and will be located north of the existing UWB3 building (Discovery Hall) and west of the library. The floor levels are not known at this time. Cuts on the order of 10 to 15 feet may be required to accomplish planned lower floor levels cut into the hill slope. The floor level at the west end of the building may be near existing grade along West Campus Lane. The planned building section is shown in Cross Section A-A’, Figure 3.

**Scope of Services**

The purpose of our geotechnical engineering services is to evaluate soil and groundwater conditions as a basis for developing preliminary design criteria for the geotechnical aspects of the proposed UWB4 STEM building and associated site improvements. Our services were performed in general accordance with scope of services outlined in our Agreement for Professional Services dated March 7, 2016.

**FIELD EXPLORATIONS AND LABORATORY TESTING**

**Field Explorations**

The subsurface soil and groundwater conditions were evaluated by reviewing existing geotechnical information and drilling three geotechnical borings (GEI-1 through GEI-3). The borings were completed to depths ranging from 26½ to 31½ feet below the ground surface. The borings were completed on March 3, 2016, using a rubber track-mounted, continuous-flight, hollow-stem auger drilling equipment. A 2-inch-diameter monitoring well was installed in boring GEI-2 to observe groundwater conditions. The approximate locations of the explorations are shown on Figure 2. Descriptions of the field exploration program and the boring logs are presented in Appendix A.

**Laboratory Testing**

Soil samples were obtained during the exploration program and taken to our laboratory for further evaluation. Selected samples were tested for the determination of moisture content, fines content (material passing the U.S. No. 200 sieve), and sieve analysis tests. A description of the laboratory testing and the test results are presented in Appendix B.
Previous Studies
GeoEngineers previously conducted geotechnical and geologic services for design and construction of the existing UWB/CCC Co-located Campus including existing buildings and site work, as well as the adjacent UW3 Building to the south, the parking lot to the west, and the Library Building to the east. The results of our previous geotechnical services are summarized in the following documents:


The approximate locations of relevant explorations completed for the studies listed above are shown on the Site Plan, Figure 2. Logs of the relevant explorations are also included in Appendix C.

SITE DESCRIPTION

Site Geology
Our review of the geologic map for the area (Minard 1985) and our previous geotechnical reports for the campus indicates that the proposed building site is underlain by dense to very dense glacial till at relatively shallow depths. Dense to very dense native glacial till was observed in all of the explorations completed at the site.

Glacial till commonly consists of a very compact, poorly sorted, non-stratified mixture of clay, silt, sand, gravel and cobbles. Glacial till commonly appears gray or blue on a fresh surface, while weathered glacial till may be brown to yellow in color. Till may include cobbles and large boulders.

Transitional bed deposits are also mapped in the project vicinity, but were not observed in the explorations completed at the site. Transitional bed deposits are glacially consolidated sedimentary deposits commonly consisting of interbedded stiff to hard clay, silt, and sand. Transitional bed deposits were observed at the lowest floor level for the UW3 Building to the south.
Surface Conditions

The proposed UWB4 building is planned north of the UWB3 building, east of West Campus Lane, west of the library building, and will be stepped westward up the slope. The ground surface in the footprint of the proposed UWB4 building slopes downhill from approximate Elevation 121 feet near the west end of the building to about Elevation 80 feet near the east end. Vegetation generally consists of tall grass, shrubs and scattered large conifer trees. The east end of the building footprint is occupied by landscaping and near the concrete walkway (Crescent Walk). The west end of the building footprint is adjacent to West Campus Lane and has a few underground utilities. Numerous underground utilities located at the north end of the UWB3 Building are adjacent to the planned south side of the UWB4 Building footprint.

Subsurface Conditions

In general, four soil units were encountered in the explorations: topsoil, fill, weathered and unweathered glacial till. The following sections describe subsurface conditions observed for the UWB4 building.

Soil Conditions

Topsoil. Topsoil consisting of loose, dark brown, sandy silt and silty sand and roots was observed in borings GEI-1 through GEI-3, and typically ranged from 6 to 12 inches in thickness.

Fill. Fill consisting of loose to medium dense silty sand with gravel and organic debris was observed in boring GEI-3 to depths up to 7½ feet below the existing ground surface.

Weathered Till. Weathered till was observed below the topsoil or fill in the borings. The weathered till extends about 12 feet deep and consists of medium dense to dense silty sand with varying gravel and cobble content.

Glacial Till. Dense to very dense relatively unweathered glacial till was observed below the weathered till in the borings completed for the building. The glacial till generally consists of silty sand with variable gravel and cobbles. The glacial till was observed below the weathered till and extended to depths from 26½ to 31½ feet below the existing ground surface. Glacial till typically consists of dense to very dense silty sand with gravel and occasional cobbles and boulders.

Groundwater Conditions. Perched groundwater was observed in boring GEI-2 at depths of about 10 feet and 25 feet, and should be expected within permeable layers within the native glacial deposits and at the contact with the overlying fill during wet weather. A monitoring well was installed in boring GEI-2, but no groundwater was measured in this boring following completion. No significant groundwater was observed during drilling for the UWB4 building.

Groundwater observations represent conditions observed during drilling and at the time of readings and may not represent the groundwater conditions throughout the year. We anticipate that perched groundwater will exist at the contact between the glacial till and the overlying looser weathered till soils, and within more permeable layers within the native glacial soils. Groundwater seepage is expected to fluctuate as a result of season, precipitation, and other factors. More significant groundwater was observed during excavation for the lower floor level of the UWB3 building to the south, although the observed water was handled during construction with sumps and pumps.
CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our field exploration program, laboratory testing, and engineering analysis, we conclude that development of the site can be accomplished as proposed and that shallow foundation support will be suitable for the planned UWB4 building. A summary of primary geotechnical considerations for the site development and preliminary design of the proposed building is provided in the subsequent sections.

Earthquake Engineering

We evaluated the site for seismic hazards including liquefaction, lateral spreading, fault rupture and earthquake induced landsliding. Our evaluation indicates that the site does not have liquefiable soils present and therefore also has no risk of liquefaction induced lateral spreading. In addition the site has a low risk of fault rupture and earthquake induced landsliding.

2012 IBC Seismic Design Information

For the site, we recommend the International Building Code (IBC) 2012 parameters for Site Class, short period spectral response acceleration ($S_S$), 1-second period spectral response acceleration ($S_1$), and Seismic Coefficients $F_A$ and $F_V$ presented in Table 1.

<table>
<thead>
<tr>
<th>TABLE 1. IBC SEISMIC PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2009 IBC Parameter</strong></td>
</tr>
<tr>
<td>Site Class</td>
</tr>
<tr>
<td>Short Period Spectral Response Acceleration, $S_S$ (percent g)</td>
</tr>
<tr>
<td>1-Second Period Spectral Response Acceleration, $S_1$ (percent g)</td>
</tr>
<tr>
<td>Seismic Coefficient, $F_A$</td>
</tr>
<tr>
<td>Seismic Coefficient, $F_V$</td>
</tr>
</tbody>
</table>

Liquefaction Potential

Liquefaction is a phenomenon where soils experience a rapid loss of internal strength as a consequence of strong ground shaking. Ground settlement, lateral spreading and/or sand boils may result from soil liquefaction. Structures supported on liquefied soils could suffer foundation settlement or lateral movement that could be severely damaging to the structures.

Conditions favorable to liquefaction occur in loose to medium dense, clean to moderately silty sand, which is below the groundwater level. Based on our evaluation of the subsurface conditions observed in the explorations completed at the site, it is our opinion that potentially liquefiable soils are not present below the site.

Ground Rupture

Ground rupture from lateral spreading is associated with liquefaction. Lateral spreading involves lateral displacements of large volumes of liquefied soil, and can occur on near-level ground as blocks of surface soils displace relative to adjacent blocks. In our opinion, ground rupture resulting from lateral spreading at the site is unlikely because potentially liquefiable soils are not present at the site as discussed above.
Because of the thickness of the Quaternary sediments below the site, which are commonly more than 1,000 feet thick, the potential for surface fault rupture is considered remote.

**Landslides**

Because dense to very dense glacial till deposits occur at shallow depths, it is our opinion that landsliding as a result of strong ground shaking is unlikely at this site.

**Earthwork**

Based on the subsurface soil conditions encountered in the borings, we expect that the soils at the site may be excavated using conventional heavy duty construction equipment. The materials we encountered are generally loose to medium dense to depths of about 7½ feet where topsoil, fill and weathered till soils were encountered. Below the medium dense weathered till deposits the native soils are generally dense to very dense silty sand with gravel and occasional cobbles and boulders. Materials within the deeper portions of excavations will require a large excavator to accomplish the excavations. Glacial deposits in the area commonly contain boulders that may be encountered during excavation, as observed in boring GEI-2. Accordingly, the contractor should be prepared to deal with boulders, if encountered.

The fill, weathered till and glacial till contain a high percentage of fines (material passing the U.S. standard No. 200 sieve) that are extremely moisture-sensitive and susceptible to disturbance, especially when wet. Ideally, earthwork should be undertaken during extended periods of dry weather when the surficial soils will be less susceptible to disturbance and provide better support for construction equipment. Dry weather construction (typically June through September) will help reduce earthwork costs. If earthwork will occur between October and May, we suggest that a contingency be included in the project schedule and budget to account for increased earthwork difficulties.

Trafficability on the site is not expected to be difficult during dry weather conditions. However, the fill and native soils will be susceptible to disturbance from construction equipment during wet weather conditions. Even in the summer months pumping and rutting of the exposed native soils under equipment loads will occur.

**Clearing and Site Preparation**

All existing utilities should be removed from the building footprint and rerouted if needed. Existing utility trench backfill under the building footprint should be removed and replaced with structural fill. An existing north-south groundwater interceptor trench exists in the native vegetation upslope of the rockery for the Crescent Walk. The location of the pipe and trench should be determined.

All areas to receive fill, structures or pavements should be cleared of vegetation and stripped of topsoil. Clearing should consist of removal of all trees, brush and other vegetation within the designated clearing limits. The topsoil materials could be separated and stockpiled for use in areas to be landscaped. Debris should be removed from the site, but organic materials could be chipped/composted and also reused in landscape areas, if desired. We anticipate that the depth of stripping will generally be about 6 to 12 inches in the footprint for the UWB4 building. Stripping depths may be greater in some areas, particularly where trees and large vegetation have been removed. Actual stripping depths should be determined based on field observations at the time of construction. The organic soils can be stockpiled and used later for landscaping purposes or may be spread over disturbed areas following completion of grading.
out, the organic strippings should be in a layer less than 1 foot thick, should not be placed on slopes greater than 3H:1V and should be track-rolled to a uniformly compacted condition. Materials that cannot be used for landscaping or protection of disturbed areas should be removed from the project site.

Grubbing of the project should consist of removing and disposal of stumps, roots larger than 1-inch-diameter, and matted roots from the designated grubbing areas. Grubbed materials should be completely removed from the project site. All depressions made during the grubbing activities to remove stumps and other materials, should be completely backfilled with properly placed and compacted structural fill.

Care must be taken to minimize softening of the subgrade soils during stripping operations. Areas of the exposed subgrade which become disturbed should be compacted to a firm, non-yielding condition, if practical, prior to placing any structural fill necessary to achieve design grades. If this is not practical because the material is too wet, the disturbed material must be aerated and recompacted or excavated and replaced with structural fill.

Subgrade Preparation

Prior to placing new fills, pavement base course materials or gravel below on-grade floor slabs, subgrade areas should be proof rolled to locate any soft or pumping soils. Prior to proof rolling, all unsuitable soils should be removed from below building and pavement areas. Proof rolling can be completed using a piece of heavy tire-mounted equipment such as a loaded dump truck. During wet weather, the exposed subgrade areas should be probed to determine the extent of soft soils. If soft or pumping soils are observed, they should be removed and replaced with structural fill.

We recommend that UWB4 building concrete slabs-on-grade be supported on at least 6 inches of capillary break gravel overlying properly compacted imported structural fill or approved native soil subgrade. Recommendations for subgrade preparation under building foundations including overexcavation of fill soils is provided in the foundation support section of this report.

If deep pockets of soft or pumping soils are encountered below floor slabs or outside the building footprint, it may be possible to limit the depth of overexcavation by placing a woven geotextile fabric such as Mirafi 500X (or similar material) on the overexcavated subgrade prior to placing structural fill. The geotextile will provide additional support by bridging over the soft material and will help reduce fines contamination into the structural fill. This may be performed under pavement and building floor slab areas depending on actual conditions observed during construction, but it should not occur under future building foundations.

After completing the proof rolling, the subgrade areas should be recompacted to a firm and unyielding condition, if possible. The achievable degree of compaction will depend on when construction is performed. If the work is performed during dry weather conditions, we recommend that all subgrade areas be recompacted to at least 95 percent of the maximum dry density (MDD) in accordance with the American Society for Testing and Materials (ASTM) D 1557 test procedure (modified Proctor). If the work is performed during wet weather conditions, it may not be possible to recompact the subgrade to 95 percent of the MDD. In this case, we recommend that the subgrade be compacted to the extent possible without causing undue weaving or pumping of the subgrade soils.
Subgrade disturbance or deterioration could occur if the subgrade is wet and cannot be dried. If the subgrade deteriorates during proof rolling or compaction, it may become necessary to modify the proof rolling or compaction criteria or methods.

**Subgrade Protection**

Site soils contain significant fines content (silt/clay) and will be highly sensitive and susceptible to moisture and equipment loads. The contractor should take necessary measures to prevent site subgrade soils from becoming disturbed or unstable. Construction traffic during the wet season should be restricted to specific areas of the site, preferably areas that are surfaced with crushed rock materials not susceptible to wet weather disturbance.

**Structural Fill**

All fill, whether on-site or imported soil, supporting floor slabs, pavement areas, foundations, or placed against retaining walls or in utility trenches should meet the criteria for structural fill presented below. The suitability of soil for use as structural fill depends on its gradation and moisture content.

**Materials**

Materials to be placed below the building footprint, to backfill below structures, below-grade walls, utility trenches, and paved areas are classified as structural fill for the purpose of this report. Structural fill material quality varies depending upon its use as described below:

1. Structural fill placed below the building foundations (designed for 4,000 pounds per square foot [psf] bearing or less), within the building footprint, behind below-grade walls, and within the 1H:1V zone of influence of the building footprint should consist of imported gravel borrow as described in Section 9-03.14(1) of the 2016 Washington State Department of Transportation (WSDOT) Standard Specifications, with the additional restriction that the fines content be limited to no more than 5 percent.

2. Structural fill placed to construct embankment, roadway, and parking areas, to backfill utility trenches, and for general site grading may consist of on-site weathered till and glacial till soils or suitable fill soils provided that the soils are properly conditioned within 2 percent of the optimum moisture content for the required compaction. If needed during dry weather, imported soil should meet the criteria for select borrow as described in Section 9-03.14(2) of the 2014 WSDOT Standard Specifications. On-site soils and imported select borrow will be suitable for use as structural fill during dry weather conditions only and only if properly moisture conditioned and compacted. If structural fill is placed during wet weather and/or the wet season (October through May) the structural fill should consist of imported gravel borrow as described in Section 9-03.14(1) of the 2016 WSDOT Standard Specifications, with the additional restriction that the fines content be limited to no more than 5 percent. For planning purposes we recommend that gravel borrow be used throughout the project during wet weather conditions and from October through May.

3. Structural fill placed immediately outside below-grade walls (drainage zone) or around footing drains should consist of washed 3/8 inch to No. 8 pea gravel per section 9-03.1(4)C Grading No. 8, or conform to Section 9-03.12(4) of the 2016 WSDOT Standard Specifications, as shown on Figure 4.

4. Structural fill placed as crushed surfacing base course below pavements should conform to Section 9-03.9(3) of the 2016 WSDOT Standard Specifications.
5. Structural fill placed as capillary break below slabs should consist of 1½-inch minus clean crushed gravel with negligible sand or silt in conformance with Section 9-03.1(4)C, Grading No. 67 of the 2016 WSDOT Standard Specifications, as shown on Figure 4.

**Reuse of On-site Native Soils**
Imported gravel borrow should be used for backfill within the UWB4 building footprint and within the building influence zone. The on-site weathered till and glacial till soils are expected to be suitable for use as structural fill in areas outside of the building footprint in areas requiring compaction to at least 95 percent of MDD (per ASTM D 1557) provided the work is accomplished during the normally dry season (July through September) and that the soil can be properly moisture conditioned to achieve the specified compaction criteria. Laboratory tests indicate that the moisture content of on-site soils within anticipated areas of cut ranges between about 8 to 15 percent. The optimum moisture content to achieve adequate compaction for the glacial till soils likely ranges from 7 to 9 percent; therefore, the contractor should be prepared to dry the on-site soils as necessary during the dry season.

It will be necessary to import gravel borrow to achieve adequate compaction for support of pavement and other areas outside of the building footprint during wet weather construction. For planning purposes the project should include importing all structural fill for wet weather construction where compaction to at least 90 percent of MDD is required. The use of existing on-site glacial soils as structural fill during wet weather should be planned only for areas requiring compaction to 90 percent of MDD, as long as the soils are properly protected, properly moisture conditioned for specified compaction, and not placed during periods of precipitation. The contractor should plan to cover all stockpiles with plastic sheeting if to be used as structural fill. The reuse of on-site soils is highly dependent on the skill of the contractor, schedule, and the weather, and we will work with the design team to maximize the reuse of on-site soils during the wet and dry seasons.

**Fill Placement and Compaction Criteria**
Structural fill should be mechanically compacted to a firm, non-yielding condition. Structural fill should be placed in loose lifts not exceeding 12 inches in thickness when using heavy compactors, and 6 inches when using hand operated compactors. The actual thickness will be dependent on the structural fill material used and the type and size of compaction equipment. Each lift should be moisture conditioned to within 2 percent of the optimum moisture content and compacted to the specified density before placing subsequent lifts. Compaction of all structural fill at the site should be in accordance with the ASTM D 1557 test method. Structural fill should be compacted to the following criteria:

1. Structural fill placed below floor slabs, foundations, and against foundations should be compacted to at least 95 percent of the MDD, including all backfill for utility trenches in these areas.

2. Structural fill placed behind below-grade walls should be compacted to between 90 to 92 percent of the MDD. Care should be taken when compacting fill near the face of below-grade walls to avoid over-compaction and hence overstressing the walls. Hand operated compactors should be used within 5 feet behind the wall. Wall backfill placed within the building footprint and under floor slabs should be compacted to between 90 to 92 percent of the MDD within 5 feet of the walls and to at least 95 percent of the MDD beyond 5 feet of the walls. The upper 3 feet of fill below floor slab subgrade should also be compacted to at least 95 percent of the MDD. The contractor should keep all heavy construction equipment away from the top of retaining walls a distance equal to half the height of the wall, or at least 5 feet, whichever is greater.
3. Structural fill in new pavement and hardscape areas, including utility trench backfill, should be compacted to at least 90 percent of the MDD, except that the upper 2 feet of fill below final subgrade should be compacted to at least 95 percent of the MDD, as shown on Figure 5.

4. Structural fill placed as crushed rock base course below pavements should be compacted to 95 percent of the MDD.

5. Non-structural fill, such as fill placed in landscape areas, should be compacted to at least 90 percent of the MDD.

Weather Considerations
Disturbance of near surface soils should be expected if earthwork is completed during periods of wet weather. During dry weather the soils will: (1) be less susceptible to disturbance, (2) provide better support for construction equipment, and (3) be more likely to meet the required compaction and subgrade preparation criteria.

The wet weather season generally begins in October and continues through May in western Washington; however, periods of wet weather may occur during any month of the year. For earthwork activities during wet weather, we recommend that the following steps be taken:

- The ground surface in and around the work area should be sloped so that surface water is directed away from the work area. The ground surface should be graded so that areas of ponded water do not develop. Measures should be taken by the contractor to prevent surface water from collecting in excavations and trenches. Measures should be implemented to remove surface water from the work area.

- Earthwork activities should not take place during periods of moderate to heavy precipitation.

- Slopes with exposed soils should be covered with plastic sheeting.

- The contractor should take necessary measures to prevent on-site soils and soils to be used as fill from becoming wet or unstable. These measures may include the use of plastic sheeting, sumps with pumps, and grading. The site soils should not be left uncompacted and exposed to moisture. Sealing the surficial soils by rolling with a smooth-drum roller prior to periods of precipitation will help reduce the extent that these soils become wet or unstable.

- The contractor should cover all soil stockpiles that will be used as structural fill with plastic sheeting.

- Construction traffic should be restricted to specific areas of the site, preferably areas that are surfaced with working pad materials not susceptible to wet weather disturbance.

- Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practical.

Routing of equipment on the native soils during the wet weather months will be difficult and the subgrade will likely become highly disturbed and rutted. In addition, a significant amount of mud can be produced by routing equipment directly on the glacial soils in wet weather. Therefore, to protect the subgrade soils and to provide an adequate wet weather working surface for the contractor’s equipment and labor, we recommend that the contractor protect exposed subgrade soils with crushed gravel or ATB.
Permanent Cut and Fill Slopes

We recommend that permanent slopes be constructed at inclinations of 2H:1V or flatter. Fill slopes should be blended into existing slopes with smooth transitions. To achieve uniform compaction, we recommend that fill slopes be overbuilt slightly and subsequently cut back to expose well-compacted fill.

All fill placed on existing slopes, including structural fill placed under the building, should be benched or keyed into the slope in accordance with Section 2-03.3(14) of the 2016 WSDOT Standard Specifications.

To reduce erosion, newly constructed slopes should be planted or hydroleed shortly after completion of grading. Until the vegetation is established, some sloughing and raveling of the slopes should be expected. This may necessitate localized repairs and reseeding. Temporary covering, such as clear heavy plastic sheeting, jute fabric, or erosion control blankets (such as American Excelsior Curlex 1 or North American Green SC150) could be used to protect the slopes during periods of rainfall.

Utility Trenches

Trench excavation, pipe bedding, and trench backfilling should be completed using the general procedures described in the 2016 WSDOT Standard Specifications or other suitable procedures specified by the project civil engineer. The native glacial deposits and fill soils encountered at the site are generally of low corrosivity based on our experience in the Puget Sound area and on the campus.

Utility trench backfill should consist of structural fill and should be placed in lifts of 12 inches or less (loose thickness) when using heavy compactors such that adequate compaction can be achieved throughout the lift. The loose lift thickness should not exceed 6 inches when using hand operated equipment. Each lift must be compacted prior to placing the subsequent lift. Prior to compaction, the backfill should be moisture conditioned to within 2 percent of the optimum moisture content. The backfill should be compacted in accordance with the criteria discussed above. Figure 5 illustrates recommended trench compaction criteria under pavement and non-structural areas.

Erosion and Sediment Control

In our opinion, the erosion potential of the on-site soils is low to moderate. Construction activities including stripping and grading will expose soils to the erosional effects of wind and water. The amount and potential impacts of erosion are partly related to the time of year that construction actually occurs. Wet weather construction will increase the amount and extent of erosion and potential sedimentation.

Erosion and sedimentation control measures may be implemented by using a combination of interceptor swales, straw bale barriers, silt fences and straw mulch for temporary erosion protection of exposed soils. All disturbed areas should be finish graded and seeded as soon as practicable to reduce the risk of erosion. Erosion and sedimentation control measures should be installed and maintained in accordance with the requirements of the City of Bothell.

Excavation Considerations

Excavations are planned for the UWB4 building and for underground utilities. Cuts up to 15 feet deep may be required for the UWB4 building. Based on current design concepts, the UWB4 building will have three to four levels with concrete slabs-on-grade constructed by stepping up the slope from the lower level at the east end of the building to the second level at the west end of the building. Planned finish floor elevations
have not been determined at this time. We anticipate additional excavation ranging from about 3 to 5 feet below finish floor will be required for building foundations. A majority of the excavations can likely be made as temporary open cut slopes depending on site constraints. However, general recommendations for temporary soldier pile and tieback wall, and temporary soil nail wall shoring systems are included in the following sections.

The contractor performing the work has the primary responsibility for protection of workmen and adjacent improvements. In our opinion, the contractor will be in the best position to observe subsurface conditions continuously throughout the construction process and to respond to variable soil and groundwater conditions. Therefore, the contractor should have the primary responsibility for deciding whether or not to use open cut slopes for much of the excavations rather than some form of temporary excavation support, and for establishing the safe inclination of the cut slope. Acceptable slope inclinations for utilities and ancillary excavations should be determined during construction. Because of the diversity of construction techniques and available shoring systems, the design of temporary shoring is most appropriately left up to the contractor proposing to complete the installation. Temporary cut slopes and shoring must comply with the provisions of Title 296 WAC, Part N, “Excavation, Trenching and Shoring.”

The excavations will be completed primarily in medium dense to dense weathered till or dense to very dense glacial till deposits. The following sub-sections summarize our general excavation recommendations.

**Temporary Cut Slopes**

For planning purposes, temporary unsupported cut slopes more than 4 feet high may be inclined at 1H:1V maximum steepness within the dense to very dense glacial till deposits and 1.5H:1V maximum steepness in the fill and medium dense weathered till soils. If conditions allow, temporary cuts made in the dense to very dense till may be included to ¾H:1V, based on observations made during construction by the geotechnical engineer and if groundwater seepage is not encountered. If significant seepage is present on the cut face then the cut slopes may have to be flattened. However, temporary cuts should be discussed with the geotechnical engineer during final design development to evaluate suitable cut slope inclinations for the various portions of the excavation. The contractor should scale slopes cut at 1H:1V or steeper to remove loose materials and cobbles.

The above guidelines assume that surface loads such as traffic, construction equipment, stockpiles or building supplies will be kept away from the top of the cut slopes a sufficient distance so that the stability of the excavation is not affected. We recommend that this distance be at least 5 feet from the top of the cut for temporary cuts made at 1H:1V or flatter, and no closer than a distance equal to one half the height of the slope for cuts made steeper than 1H:1V.

Temporary cut slopes should be planned such that they do not encroach on a 1H:1V influence line projected down from the edges of nearby or planned foundation elements. New footings planned at or near existing grades and in temporary cut slope areas for the lower level should extend through wall backfill and be embedded in native soils.

Water that enters the excavation must be collected and routed away from prepared subgrade areas. We expect that this may be accomplished by installing a system of drainage ditches and sumps along the toe of the cut slopes. Some sloughing and raveling of the cut slopes should be expected. Temporary covering, such as heavy plastic sheeting with appropriate ballast, should be used to protect these slopes.
during periods of wet weather. Surface water runoff from above cut slopes should be prevented from flowing over the slope face by using berms, drainage ditches, swales or other appropriate methods.

If temporary cut slopes experience excessive sloughing or raveling during construction, it may become necessary to modify the cut slopes to maintain safe working conditions. Slopes experiencing problems can be flattened, regraded to add intermediate slope benches, or additional dewatering can be provided if the poor slope performance is related to groundwater seepage.

Soldier Pile and Tieback Walls

Soldier pile walls consist of steel beams that are concreted into drilled vertical holes located along the wall alignment, typically about 8 feet on center. After excavation to specified elevations, tiebacks are installed, if necessary. Once the tiebacks are installed, the pullout capacity of each tieback is tested, and the tieback is locked off to the soldier pile at or near the design tieback load. Tiebacks typically consist of steel strands or bars that are installed into pre-drilled holes and then either tremie or pressure grouted. Timber lagging is typically installed behind the flanges of the steel beams to retain the soil located between the soldier piles. Geotechnical design recommendations for each of these components of the soldier pile and tieback wall system are presented in the following sections.

Soldier Piles

We recommend that soldier pile walls be designed using the preliminary earth pressure diagrams presented in Figure 6. The earth pressures presented in Figure 6 are for full-height cantilever soldier pile walls and for full-height soldier pile walls with a single or multiple levels of tiebacks. The earth pressures presented in Figure 6 represent the estimated loads that will be applied to the wall system for various wall heights.

The earth pressures presented in Figure 6 include the loading from traffic surcharge. Other surcharge loads such as cranes, construction equipment, or construction staging areas should be considered on a case-by-case basis, as shown on Figure 7. No seismic pressures have been included in Figure 6 since the walls will be temporary.

We recommend that the embedded portion of the soldier piles be at least 2 feet in diameter and extend a minimum distance of 10 feet below the base of the excavation to resist “kick-out.” The axial capacity of the soldier piles must resist the downward component of the anchor loads and other vertical loads, as appropriate. We recommend using an allowable end bearing value of 40 kips per square foot (ksf) for piles supported on the glacially consolidated soils. The allowable end bearing value should be applied to the base area of the drilled hole into which the soldier pile is concreted. This value includes a factor of safety of about 2.5. The allowable end bearing value assumes that the shaft bottom is cleaned out immediately prior to concrete placement. If necessary, an allowable pile skin friction of 1.5 ksf may be used on the embedded portion of the soldier piles to resist the vertical loads.

Lagging

We recommend that the temporary timber lagging be sized using the procedures outlined in the Federal Highway Administration’s Geotechnical Engineering Circular No. 4. The site soils are best described as competent soils. Table 2 presents recommended lagging thicknesses (roughcut) as a function of soldier pile clear span and depth.
### Table 2. Recommended Lagging Thickness

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>5 feet</th>
<th>6 feet</th>
<th>7 feet</th>
<th>8 feet</th>
<th>9 feet</th>
<th>10 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 25</td>
<td>2 inches</td>
<td>3 inches</td>
<td>3 inches</td>
<td>3 inches</td>
<td>4 inches</td>
<td>4 inches</td>
</tr>
<tr>
<td>25 to 100</td>
<td>3 inches</td>
<td>3 inches</td>
<td>3 inches</td>
<td>4 inches</td>
<td>4 inches</td>
<td>5 inches</td>
</tr>
</tbody>
</table>

Lagging should be installed promptly after excavation, especially in areas where perched groundwater is present or where clean sand and gravel soils are present and caving soils conditions are likely. The workmanship associated with lagging installation is important for maintaining the integrity of the excavation.

The space behind the lagging should be filled with soil as soon as practicable. Placement of this material will help reduce the risk of voids developing behind the wall and damage to existing improvements located behind the wall.

Material used as backfill in voids located behind the lagging should not cause buildup of hydrostatic pressure behind the wall. Lean concrete or controlled density fill (CDF) are suitable options for use as backfill behind the walls. Lean concrete or CDF will reduce the volume of voids present behind the wall. Based on our experience, the voids between each lean concrete or CDF lift are sufficient for preventing the buildup of hydrostatic pressure behind the wall.

**Tiebacks**

Tieback anchors can be used for wall heights where cantilever soldier pile walls are not cost-effective. Tieback anchors should extend far enough behind the wall to develop anchorage beyond the “no-load” zone and within a stable soil mass. The anchors should be inclined downward at 15 to 25 degrees below the horizontal. Corrosion protection will not be required for the temporary tiebacks.

Centralizers should be used to keep the tieback in the center of the hole during grouting. Structural grout or concrete should be used to fill the bond zone of the tiebacks. A bond breaker, such as plastic sheathing, should be placed around the portion of the tieback located within the no-load zone if the shoring contractor plans to grout both the bond zone and unbonded zone of the tiebacks in a single stage. If the shoring contractor does not plan to use a bond breaker to isolate the no-load zone, GeoEngineers should be contacted to provide recommendations.

Loose soil and slough should be removed from the holes drilled for tieback anchors prior to installing the tieback. The contractor should take necessary precautions to minimize loss of ground and prevent disturbance to previously installed anchors and existing improvements in the site vicinity. Holes drilled for tiebacks should be grouted/filled promptly to reduce the potential for loss of ground.

Tieback anchors should develop anchorage in the glacial till deposits. We recommend that spacing between tiebacks be at least 3 times the diameter of the anchor hole to minimize group interaction. We recommend a preliminary design load transfer value between the anchor and soil of 4 kips per foot for glacially consolidated soils and 1.5 kips per foot for fill soil. Higher adhesion values may be developed, depending on the anchor installation technique. The contractor should be given the opportunity to use higher adhesion values by conducting performance tests prior to the start of installing the production tieback anchors.
The tieback anchors should be verification- and proof-tested to confirm that the tiebacks have adequate pullout capacity. The pullout resistance of tiebacks should be designed using a factor of safety of 2. The pullout resistance should be verified by completing at least two successful verification tests in each soil type and a minimum of four total tests for the project. Each tieback should be proof-tested to 133 percent of the design load. Verification and proof tests should be completed as described in Appendix D, Ground Anchor Load Tests.

The tieback layout and inclination should be checked to confirm that the tiebacks do not interfere with adjacent buried utilities.

Drainage
A suitable drainage system should be installed to prevent the buildup of hydrostatic groundwater pressures behind the soldier pile and lagging wall. It may be necessary to cut weep holes through the lagging in wet areas. Seepage flows at the bottom of the excavation should be contained and controlled. Drainage should be provided for permanent below-grade walls as described below in the “Drainage Considerations” section of this report.

Construction Considerations
Temporary casing or drilling fluid may be required to install the soldier piles and possibly the tiebacks where:

- Loose fill is present;
- The native soils do not have adequate cementation or cohesion to prevent caving or raveling; and/or
- Perched groundwater is present.

GeoEngineers should be allowed to observe and document the installation and testing of the shoring to verify conformance with the design assumptions and recommendations.

Soil Nail Walls
Temporary soil nail walls were used during construction of the lower level of the UWB3 building. The soil nail wall system consists of drilling and grouting rows of steel bars or “nails” behind the excavation face as it is excavated and then covering the face with reinforced shotcrete. The placement of soil nails reinforces the soils located behind the excavation face and increases the soil’s ability to resist a mass of soil from sliding into the excavation. GeoEngineers should prepare the soil nail design or should be allowed to review the design-build soil nail design to estimate shoring wall deflections and to provide recommendations for additional deflection control measures, as appropriate.

Soil nail walls are typically constructed using the following sequence:

1. Excavate the soil at the wall face to between 1 and 3 feet below the row of soil nails to be installed. Depending upon the soil conditions at the wall face, the excavation may be completed with a vertical cut or with berms (native or fill).
2. Drill, install and grout soil nails.
3. Excavate berm, if present, located within about 3 feet below the elevation of the soil nail.
4. Place drainage strips, steel wire mesh and/or reinforcing bars in front of excavated soil.
5. Install shotcrete and place steel plates and nuts over soil nails.

6. Complete nail pullout capacity testing on approximately one out of every 20 nails in an installed row.

7. Repeat steps 2 through 7 for each row of nails located below the completed row.

Soil nails typically consist of #6 to #12 threaded steel bars (¾- to 1½-inch diameter). The steel bars are placed in 4- to 12-inch-diameter holes drilled at angles typically ranging from 10 to 25 degrees below horizontal. Centralizers are used to center the steel bars in the holes. Once the steel bars are installed, the holes are grouted using cement grout or concrete. Post-grout tubes can be installed with the steel bars to increase the bond strength between the grout and the soil. Post-grouting consists of injected grout under high pressure through holes placed in the post-grout tube one to two days after initial grout placement.

The soils typically are required to have an adequate standup time (to allow placement of the steel wire mesh and/or reinforcing bars to be installed and the shotcrete to be placed). Soils that have short standup times are problematic for soil nailing.

Preliminary Design Recommendations

We recommend the following for preliminary design purposes:

- Vertical elements at approximately 6 feet on center.

- A soil nail grid pattern of about 6 feet by 6 feet. A tighter grid pattern may be necessary where construction-related surcharges are anticipated.

- A soil nail length ranging up to the wall height (but not less than 10 feet), inclined at about 15 to 20 degrees from the horizontal.

- A preliminary allowable load transfer value of 1.5 kip per foot for fill and medium dense weathered till soils and 4 kips per foot for the glacial till soils for 6- to 12-inch-diameter nails.

- Strips of drainage material installed behind the shotcrete to relieve hydrostatic pressures. Additional drainage provisions may be necessary if significant groundwater is encountered during the excavation.

The fill at the site, where present, will affect the soil nail design. Typically, the soil nail spacing is tighter or the soil nails are longer, or both, where fill or looser native soils are present compared to where dense to very dense glacial till (sand with gravel soils) are present.

Difficulties associated with face stability and standup time may be experienced during construction in the site soils. The fill soils and medium dense weathered till may have shorter standup times. Some sloughing may occur, especially in the fill, which may result in requiring increased shotcrete volumes.

Contractors experienced in the soil nailing method should be able to mitigate significant spalling and raveling conditions. Contractors should also be prepared to use techniques to address problems that occur because of caving soils. The contractor should be made responsible for the safety of the shoring system.

Testing of selected soil nails should be completed as described in Appendix E, Ground Anchor Load Tests.
Drainage

A suitable drainage system should be installed to prevent the buildup of hydrostatic groundwater pressures behind the soil nail walls. Drainage behind soil nail walls typically consists of prefabricated geocomposite drainage strips, such as AmerDrain® 500, installed vertically between the soil nails. The drainage strips are typically a minimum of 16 inches wide and extend the entire height of the wall. Horizontal drainage strips may also be used in areas where perched groundwater is observed, at cold joints in permanent top-down basement wall construction, or for other reasons. We recommend that drainage strips be connected to a tightline pipe installed along the base of the wall and routed to a suitable discharge point as described in the “Drainage Considerations” section of this report.

Temporary Dewatering

Perched groundwater was observed during drilling for the UWB4 building at various elevations; however, the regional groundwater table is well below the building site. A monitoring well was installed in boring GEI-2, but no groundwater was measured in this boring. Perched groundwater seepage was observed in boring GEI-2 at depths of about 10 and 25 feet below the ground surface. Although the floor elevations of the UWB4 building have not been determined at this time, the contractor should plan for some form of groundwater control at the base of the excavation.

The existing UWB3 building was constructed without any special temporary dewatering systems and the contractor was able to control groundwater seepage with sump pumps and ditches; however, a permanent underdrain system was installed below the lower level of the building. The existing south parking garage on the campus as well as the lower level of the UWB3 building were constructed by dewatering the excavation using the permanent underslab drainage system, which consisted of a network of interceptor trenches with drain pipes and backfilled with pea gravel. Groundwater collected in the underslab drainage system was drained by gravity to a nearby catch basin. A similar system may be suitable for the UWB4 building excavation, if conditions are warranted. Refer to the Slab-on-Grade Floors section of this report for additional discussion regarding the lower level underdrain system.

The temporary dewatering system should be designed to maintain the groundwater level at least 3 feet below the foundation subgrade elevation until such time that the engineer determines that the permanent underslab drainage system is completely constructed, all foundations and underground utilities are installed, and the permanent underslab drainage system is functioning properly. We recommend that well points, if used, be turned off after the permanent drainage and underslab drainage systems have been installed and prior to placing concrete slabs-on-grade to ensure that they function as intended.

In our opinion, the contractor should be responsible for designing and installing the appropriate dewatering system needed to complete the work. Appropriate discharge points should be designated by the contractor. Also, the contractor will need to obtain the necessary discharge permits from the regulatory agencies. We recommend the details of the dewatering system be reviewed by GeoEngineers prior to construction. This will allow us to evaluate if the designs are consistent with the intent of our recommendations, and to provide supplemental recommendations in a timely manner.

Other dewatering issues which must be addressed include disposal of water and backup power. We anticipate that water removed from excavations will be diverted into the existing storm sewer system. A permit will be required to do this. Water sampling prior to and during dewatering will also be required as a part of the permit.
We recommend that a separate line item be included for dewatering in the construction bid documents. This will allow an evaluation of the proposed dewatering scheme separate from the rest of the bid. The following sections discuss well points and sump pumping, two dewatering methods that are anticipated to be the most cost effective for dewatering the lower level of the UWB4 building excavation, if significant groundwater seepage is encountered.

**Well Points**

Well points are effective for dewatering all types of soils, whether pumping small amounts of water from silt or large quantities of water from sand and gravel. The volume of water generated by a well point system is typically less than the volume generated by a corresponding system of pumped wells because the well points are generally completed at a shallower depth. Because of the shallower completion depth, the volume of aquifer that contributes water to a well point system is less than for a comparable deep well system.

Well point systems are most suitable for dewatering shallow excavations where the water table must be lowered no more than about 15 feet below ground surface. Multiple well point stages are generally required for greater depths because of the physical limitations of suction lift. Dewatering can be accomplished at depths greater than 15 feet where the excavation can be open cut to permit installation of the well point system below the original grade. This technique increases the depth to which the water table can be lowered with well points.

The well points will likely need to be installed on 4- to 10-foot centers to be effective and as close as possible to the edge of the excavations. The well point screens should be filter packed with graded sand, or sand and fine gravel to improve pumping efficiency and minimize the discharge of turbid water.

**Sump Pumping**

This dewatering method involves removing water that has seeped into an excavation by pumping from a sump that has been excavated at one or more locations in an excavation. Drainage ditches that lead to the sump are typically excavated along the excavation sidewalls at the base of an excavation. The excavation for the sump and discharge drainage ditches should be backfilled with gravel or crushed rock to reduce the amount of erosion and associated sediment in the water pumped from the sump. In our experience, a slotted casing or perforated 55-gallon drum that is installed in the sump backfill provides a suitable housing for a submersible pump. The contractor may also elect to construct the permanent underslab drainage system during the excavation process in order to help dewater the excavation. The drainage systems should be modified as needed based on excavation conditions.

**Shallow Foundations**

We recommend that the proposed UWB4 building be supported on shallow spread footings founded on the dense to very dense/hard glacial till soils encountered in our borings or on properly compacted structural fill extending down to the dense to very dense/hard glacially consolidated soils. The following recommendations for the building foundations are based on the subsurface conditions observed in the borings and the site survey.
Foundation Design

We recommend an allowable bearing pressure of 8,000 psf for shallow spread footings and mat foundations bearing on undisturbed very dense/hard glacially consolidated soils. Foundations supported on structural fill overlying medium dense to dense glacial soils or foundations supported on medium dense to dense native glacial soils may be designed using an allowable bearing pressure of 4,000 psf. These allowable soil bearing pressures apply to the total of dead and long-term live loads and may be increased by up to one-third for wind or seismic loads. These allowable soil bearing pressures are net values. Table 3 summarizes the minimum embedment depth below existing grade for an allowable bearing pressure of 8,000 psf on native soil.

**TABLE 3. MINIMUM FOUNDATION EMBEDMENT FOR BEARING SOIL**

<table>
<thead>
<tr>
<th>Boring Number</th>
<th>8,000 psf Bearing Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Approximate Depth (feet)</td>
</tr>
<tr>
<td>GEI-1</td>
<td>2½</td>
</tr>
<tr>
<td>GEI-2</td>
<td>10</td>
</tr>
<tr>
<td>GEI-3</td>
<td>7½</td>
</tr>
</tbody>
</table>

The design frost depth for the Puget Sound area is 12 inches; therefore, we recommend that exterior footings for the building be founded at least 18 inches below lowest adjacent finished grade. Interior footings should be founded at least 12 inches below bottom of slab or adjacent finished grade. Continuous wall footings and individual column footings should have minimum widths of 24 inches.

All footings near below-grade walls should be embedded to a depth that is at least below a 1H:1V line projected up from the bottom of the closest section of wall, otherwise the below-grade walls need to be designed for lateral loads from the footings. In addition, new footings planned for the first and second floor levels and in temporary cut slope areas for the lower and first floor levels, respectively, should extend through wall backfill and be embedded in native soils, unless designed to be supported on structural fill.

The soils encountered in boring GEI-3 indicate the presence of loose to medium dense fill material extending up to 7½ feet deep. Existing fill material should be removed from below building foundations and be replaced with structural fill. Loose or disturbed soils not removed from below footings may result in settlement and potential damage to the foundations.

Foundation Settlement

We estimate that the post-construction settlement of footings founded as recommended above will be less than 1 inch. Differential settlement between comparably loaded column footings or along a 25-foot section of continuous wall footing should be less than ½ inch. We expect most of the footing settlements will occur as loads are applied. Loose or disturbed soils not removed from footing excavations prior to placing concrete will result in additional settlement.

Lateral Resistance

Lateral loads can be resisted by passive resistance on the sides of the footings and by friction on the base of the footings. Passive resistance should be evaluated using an equivalent fluid density of 350 pounds per cubic foot (pcf) where footings are poured neat against native soil or are surrounded by structural fill.
compacted to at least 95 percent of MDD, as recommended. Resistance to passive pressure should be calculated from the bottom of adjacent floor slabs and paving or below a depth of 1 foot where the adjacent area is unpaved, as appropriate. Frictional resistance can be evaluated using 0.4 for the coefficient of base friction against footings. The above values incorporate a factor of safety of about 1.5.

If soils adjacent to footings are disturbed during construction, the disturbed soils must be recompacted, otherwise the lateral passive resistance value must be reduced.

**Footing Drains**

We recommend that perimeter footing drains be installed around the building. The perimeter drains should be installed at the base of the exterior footings. The perimeter drains should be provided with cleanouts and should consist of at least 4-inch-diameter perforated pipe placed on a 3-inch bed of, and surrounded by, 6 inches of drainage material enclosed in a non-woven geotextile fabric such as Mirafi 140N (or approved equivalent) to prevent fine soil from migrating into the drain material. We recommend that the drainpipe consist of either heavy-wall solid pipe (SDR-35 PVC, or equal) or rigid corrugated smooth interior polyethylene pipe (ADS N-12, or equal). We recommend against using flexible tubing for footing drainpipes. The drainage material should consist of pea gravel or “Gravel Backfill for Drains” per WSDOT standard specifications Section 9-03.12(4), as shown on Figure 4. The perimeter drains should be sloped to drain by gravity, if practicable, to a suitable discharge point, preferably a storm drain. We recommend that the cleanouts be covered, and be placed in flush mounted utility boxes. Water collected in roof downspout lines must not be routed to the footing drain lines.

**Construction Considerations**

Immediately prior to placing concrete, all debris and loose soils that accumulated in the footing excavations during forming and steel placement must be removed. Debris or loose soils not removed from the footing excavations will result in increased settlement.

If wet weather construction is planned, we recommend that all footing subgrades be protected using a lean concrete mud mat. The mud mat should be placed the same day that the footing subgrade is excavated and approved for foundation support.

We recommend that all completed footing excavations be observed by a representative of our firm prior to placing mud mat, reinforcing steel, and structural concrete. Our representative will confirm that the bearing surface has been prepared in a manner consistent with our recommendations and that the subsurface conditions are as expected.

**Slab-On-Grade Floors**

Slab-on-grade floors can be supported on the native medium dense to very dense/very stiff to hard native soils encountered in our borings or on properly compacted structural fill extending down to the soils. A subgrade modulus of 150 pounds per cubic inch (pci) may be used for design of the slabs-on-grade at the site. We recommend that an appropriate capillary break and vapor retarder be installed below the floor slab to reduce the risk of moisture migration through the floor slab. This is especially important since zones of groundwater seepage may be present at the planned floor slab level in more permeable layers within the native soil or in looser soils on top of the native soil.
We recommend that concrete slabs-on-grade be constructed on a gravel layer to provide uniform support and drainage, and to act as a capillary break. The gravel layer below slabs-on-grade should consist of 6 inches of clean crushed gravel, with a maximum particle size of 1½-inch and negligible sand or silt, such as WSDOT Standard Specification section 9-03.1(4)C, AASHTO Grading No. 67, as shown on Figure 4. If prevention of moisture migration through the slab is essential, such as where carpet or floor coverings are used, a vapor retarder such as heavy plastic sheeting or Moist-Stop should be installed between the slab and the gravel layer. We recommend that the plastic sheet be placed over the capillary break layer. The contractor should be made responsible for maintaining the integrity of the vapor barrier during construction. It may also be prudent to apply a sealer to the slab to further retard the migration of moisture through the floor.

**Underslab Drainage**

Groundwater could accumulate below the slab-on-grade floor(s) because the building will be cut into the hill slope where multiple zones of shallow perched groundwater seepage exists. To help mitigate this condition, we recommend that the building slabs-on-grade be provided with underslab drainage to collect and discharge groundwater from below the slab. This can be accomplished by installing a 4-inch-diameter, heavy-wall perforated collector pipe in a shallow trench placed below the capillary break gravel layer. The trench should measure about 1-foot wide by 1.5 feet deep and should be backfilled with clean pea gravel. The top of the underslab drainage system trenches should coincide with the base of the capillary break layer.

We recommend installing a single under drain collector pipe below the long axis of each slab-on-grade floor level and connect each end of the drain pipe into the perimeter footing drain pipe. If connected to the footing drain system, the invert of the under drain pipe should be higher than the invert of the footing drain pipe where they meet.

The collector pipe should be sloped to drain and discharge into the storm water collection system to convey the water off site. The pipe should also incorporate cleanouts, if possible. The cleanouts could be extended through the foundation walls to be accessible from the outside, or could be placed in flush-mounted access boxes cast into the floor slabs.

The drainage pipe should be either machine-slotted or perforated. The slots should be a maximum of ½-inch wide with four slots per inch and extend over the lower 60-degree perimeter of the pipe. Perforated pipe should have two rows of ½-inch holes spaced 120 degrees apart and at 4 inches on-center. The underslab drainage system trenches should be backfilled with pea gravel or “Gravel Backfill for Drains” per WSDOT standard specifications Section 9-03.12(4). The drainage material should be wrapped with non-woven geotextile fabric such as Mirafi 140N (or approved equivalent) to prevent fine soil from migrating into the drain material.

**Lower Level**

Depending of the final lower level design elevation, if significant groundwater is encountered for the UWB4 lower level, the design team may consider a system similar to the permanent ground water collection system installed for the lower level of the UWB3 building. For the UWB3 building, a system of underdrain pipes were installed below the slab.
As a minimum, we recommend that the entire lower level floor slab be underlain by a drainage blanket to intercept groundwater and to dissipate artesian and hydrostatic pressures from under the floor slab. The drainage blanket should be at least 12 inches thick and consist of clean crushed gravel, with a maximum particle size of 1½-inch and negligible sand or silt, such as WSDOT Standard Specification section 9-03.1(4)C, AASHTO Grading No. 67. The drainage blanket should be placed on undisturbed, very dense glacial till.

We recommend that perforated underslab drainage pipes be installed longitudinally on roughly 20-foot centers under the entire lower level floor slab and drainage blanket. The underdrain pipes should be installed between column footings and tie into a collector pipe along the east side of the lower level, if appropriate. If beneficial to the contractor to aid in the dewatering of the excavation, we recommend placing the pipes in trenches that extend about 3 feet below the bottom of adjacent wall and spread footing excavations. The trenches must not compromise the stability of the footings. The underslab drainage pipes should be placed within the backfill material, about 3 inches from the bottom of the drainage layer or trench, and should be sloped at a minimum of 0.25 percent. It may be necessary to modify or the underslab drainage system depending on the actual field conditions.

Below-Grade Walls and Retaining Walls

Permanent Walls Cast Against Temporary Shoring

Permanent below-grade walls constructed adjacent to temporary shoring walls should be designed for the same earth pressures (including surcharge pressures where applicable) as the adjacent temporary walls, and should also include a seismic load acting over the height of the wall equal to 8H psf, where H is the height of the wall in feet. Other surcharge loads, such as from foundations, construction equipment, or construction staging areas, should be considered on a case-by-case basis, as shown on Figure 7. We can provide the lateral pressures from these surcharge loads as the design progresses.

The soil pressures recommended above assume that wall drains will be installed to prevent the buildup of hydrostatic pressure behind the walls, as described in “Excavation Considerations”, and tied to permanent drains to remove water to suitable discharge points as described in “Drainage Considerations”.

Other Cast-In-Place Walls

Lateral earth pressures for design of below-grade walls and retaining structures should be evaluated using an equivalent fluid density of 35 pcf provided that the walls will not be restrained against rotation when backfill is placed. If the walls will be restrained from rotation, we recommend using an equivalent fluid density of 55 pcf. Walls are assumed to be restrained if top movement during backfilling is less than H/1000, where H is the wall height. These lateral soil pressures assume that the ground surface behind the wall is horizontal. If the ground surface within five feet of the wall rises at an inclination of 2H:1V or steeper, the walls should be designed for lateral pressures based on equivalent fluid densities of 50 and 80 pcf, respectively, for unrestrained and restrained conditions. These lateral soil pressures do not include the effects of surcharges such as floor loads, traffic loads or other surface loading. Surcharge effects should be included as appropriate. Below-grade walls for the building should also include seismic earth pressures. Seismic earth pressures should be determined using a rectangular distribution of 8H in psf, where H is the wall height.
If vehicles can approach the tops of exterior walls to within ½ the height of the wall, a traffic surcharge should be added to the wall pressure. For car parking areas, the traffic surcharge can be approximated by the equivalent weight of an additional 1 foot of soil backfill (125 psf) behind the wall. For delivery truck parking areas and access driveway areas, the traffic surcharge can be approximated by the equivalent weight of an additional 2 feet (250 psf) of soil backfill behind the wall. Other surcharge loads, such as from foundations, construction equipment, or construction staging areas, should be considered on a case-by-case basis, as shown on Figure 7. Positive drainage should be provided behind below-grade walls and retaining structures as discussed in “Drainage Considerations”.

These recommendations are based on the assumption that all retaining walls will be provided with adequate drainage. The values for soil bearing, frictional resistance and passive resistance presented above for foundation design are applicable to retaining wall design. Walls located in level ground areas should be founded at a depth of 18 inches below the adjacent grade.

**Wall Drainage**

**Permanent Walls Cast Against Temporary Shoring**

Drainage behind the permanent below-grade walls cast against temporary shoring is typically provided by strips of drainage material attached to the lagging between the soldier piles and behind the shotcrete facing for soil nail walls. The drainage material strips should be connected to weep pipes that extend through the exterior building wall at the footing elevation. The weep pipes should be connected to the perimeter foundation drains described above in the “Footing Drains” section.

Prefabricated geocomposite drainage material, such as AmerDrain® 500, should be installed vertically between soldier piles for soldier pile walls and behind the shotcrete facing for soil nail walls. For soldier pile shoring walls, the drainage material should be installed on the excavation side of the lagging, with the geotextile fabric adjacent to the lagging.

Full wall face coverage is preferable for minimizing spotting and leaking at the face of the permanent wall. However, the use of drainage strips, typically a minimum of 16 inches wide, placed between the soldier piles and behind the shotcrete facing for soil nail walls is generally sufficient for the structural integrity of the wall. If full wall face coverage is planned for soil nail walls, it is typically placed between the temporary and permanent walls. The drainage strips or full wall face coverage should extend the entire height of the wall. If drainage strips are used, additional drainage strips may be necessary in wet areas. Although the use of full wall face coverage will reduce spotting or leaking at the face of the permanent wall, there is still a potential for seepage. If this is a concern, waterproofing should be specified.

**Other Cast-In-Place Walls**

Positive drainage should be provided behind cast-in-place retaining walls by using free draining wall drainage material with perforated pipes to discharge the collected water, as shown in Figure 4. Wall drainage material may consist of washed % of inch to No. 8 pea gravel per WSDOT 9.03.1(4)C, AASHTO Grading No. 8, or clean gravel (gravel backfill for drains per WSDOT Standard Specification Section 9-03.12(4)) surrounded with a non-woven geotextile fabric such as Mirafi 140N (or approved equivalent). The zone of wall drainage material should be 2 feet wide and should extend from the base of the wall to within 2 feet of the ground surface. The wall drainage material should be covered with the geotextile fabric and 2 feet of less permeable material, such as the on-site silty sand that is properly moisture conditioned and compacted.
A 4-inch-diameter perforated drain pipe should be installed within the free-draining material at the base of each wall. We recommend using either heavy-wall solid pipe (SDR-35 PVC) or rigid corrugated polyethylene pipe (ADS N-12, or equal). We recommend against using flexible tubing for the wall drain pipe. The footing drain recommended above in the “Footing Drains” section can be incorporated into the bottom of the drainage zone and used for this purpose.

The pipes should be laid with minimum slopes of one-quarter percent and discharge into the storm water collection system to convey the water off site. The pipe installations should include a cleanout riser with cover located at the upper end of each pipe run. The cleanouts could be placed in flush mounted access boxes. Collected downspout water should be routed to appropriate discharge points in separate pipe systems.

**Waterproofing**

The recommendations in this section are provided to reduce the potential for buildup of hydrostatic pressures behind below grade walls and hydrostatic uplift forces below the building slab. If no special waterproofing measures are taken, leaks or seepage may occur in localized areas of the below-grade portion of the building, even if the recommended wall drainage and below-slab drainage provisions are constructed. If leaks or seepage is undesirable, below-grade waterproofing should be specified. A waterproofing consultant should be contracted to provide recommendations for below-grade waterproofing for this project.

**Other Considerations**

Exterior retaining systems used to achieve grade transitions or for landscaping, can be constructed using traditional structural systems such as reinforced concrete, concrete masonry unit (CMU) blocks, or rockeries. Alternatively, retaining walls can consist of reinforced soil and block facing structures. We can provide additional design recommendations for reinforced soil and block facing structures, if requested.

**Surface Water Drainage Considerations**

We anticipate shallow groundwater seepage may enter deep excavations depending on the time of year construction takes place, especially in the winter months. However, we expect that this seepage water can be handled by digging interceptor trenches in the excavations and pumping from sumps. The seepage water if not intercepted and removed from the excavations will make it difficult to place and compact structural fill and may destabilize cut slopes.

All paved and landscaped areas should be graded so that surface drainage is directed away from the building to appropriate catch basins.

Water collected in roof downspout lines must not be routed to the footing drain lines or subsurface drain lines. Collected downspout water should be routed to appropriate discharge points in separate pipe systems.

**Infiltration Considerations**

Sieve analyses were performed on selected soil samples collected from the borings that were completed as part of this study. The soil samples typically consisted of native weathered or relatively unweathered glacial till. The design infiltration value described below is based on the results of the grain size analyses,

Based on our analysis, it is our opinion that the on-site soils have a very low infiltration capacity. The majority of the soils across the site contain significant fines, which limits the infiltration capacity. The results of the sieve analyses indicated that the fines content (material passing the U.S. No. 200 sieve) typically ranges from 20 to 46 percent. Due to the density, high fines content, and relative impermeability of the glacial till infiltration should be assumed to be negligible when designing infiltration systems. We recommend a preliminary infiltration rate of not more than 0.1 inches per hour be used for design of the infiltration facilities.

**Elevator Jack Shafts**

Elevator jack shafts may be required below the elevator foundations for the UWB4 building. Temporary casing or drilling fluid will be required to install the elevator jack shafts since groundwater is present at deeper depths and the native soils do not have adequate cementation or cohesion to prevent caving or raveling, especially where sand and gravel layers exist. The contractor should also be prepared for possible artesian head conditions when installing the jack shafts.

**Pavement Recommendations**

The following paragraphs outline the recommended preliminary pavement sections for new asphalt concrete pavement. The design criteria are based on traffic information provided during the original campus design, our field observations and explorations, laboratory test results, and our professional judgment. The design pavement sections provided below were generated using the 1993 AASHTO “Guide for Design of Pavement Structures.” If design traffic loads are substantially different than the original campus design information, then these recommendations may need to be revised.

**Subgrade Preparation**

We recommend the subgrade soils in new pavement areas be prepared and evaluated as described in the “Earthwork” section of this report. We recommend placing an imported gravel borrow subbase layer below the pavement sections described below. If the subgrade soils are loose or soft, it may be necessary to excavate localized areas and replace them with additional gravel borrow or gravel base material. Pavement subgrade conditions should be observed and proof-rolled during construction and prior to placing the subbase materials in order to evaluate the presence of unsuitable subgrade soils and the need for over-excavation and placement of a geotextile separator.

**Pavement Design Criteria**

Traffic loading information used for the original campus design included:

- average Daily Traffic (ADT) volume of 21,000 automobiles and 1,152 buses for Campus Lane and 433 automobiles for driveways and parking lots;
- growth factor of 2 percent per year;
- 2 percent of the ADT consisting of trucks; and
- 20-year design life.
In our pavement design analyses, we assumed the following:

- For the new pavement design option, CBR for subgrade soil of 14, which corresponds to an approximate resilient subgrade modulus (Mr) value of 12 kips per square inch (ksi).
- Average equivalent single axle load (ESAL) of 1.0 and 1.6 for trucks and buses, respectively, based on information presented in the 1995 WSDOT Pavement Guide.
- Initial serviceability of 4.2.
- Terminal serviceability of 2.0.
- Reliability of 90 percent.
- Overall standard deviation of 0.44.

**New Asphalt Concrete Pavements**

Using the input parameters described above and the methodology presented in the AASHTO Guide, we recommend the HMA pavement sections presented in Table 4.

**TABLE 4. PAVEMENT SECTION RECOMMENDATIONS**

<table>
<thead>
<tr>
<th>Material</th>
<th>Pavement Section Thickness (inches)</th>
<th>Driveways and Parking Lots</th>
<th>Automobiles Only</th>
<th>Automobile and Truck Loading</th>
<th>WSDOT² Standard Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMA¹ (Class ½-inch)</td>
<td>2</td>
<td></td>
<td>3</td>
<td></td>
<td>5-04</td>
</tr>
<tr>
<td>Crushed Surfacing Base Course</td>
<td>4</td>
<td></td>
<td>6</td>
<td></td>
<td>9-03.9(3)</td>
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<tr>
<td>Subbase</td>
<td>6</td>
<td></td>
<td>6</td>
<td></td>
<td>9-03.14(1)</td>
</tr>
</tbody>
</table>

Notes:

¹ HMA = Hot Mix Asphalt
² Washington State Department of Transportation, 2016, Standard Specifications for Road, Bridge and Municipal Construction.

Where slow traffic is expected (less than 10 miles per hour), we recommend that the performance grade binder consist of PG-70-22. For pavements where the traffic speeds exceed 10 miles per hour, we recommend that the performance grade binder consist of PG 64-22. Base material should consist of base course as described in section 9-03.9(3) of the 2016 WSDOT Standard Specifications. The uppermost 2 inches of the base material should consist of top course as described in section 9-03.9(3). Top course is typically not used where ATB will be placed directly over the base material.

The base course should be compacted to at least 95 percent of the MDD (ASTM D 1557). We recommend that a proof-roll of the compacted base course be observed by a representative from our firm prior to paving. Soft or yielding areas observed during proof-rolling may require over-excavation and replacement with compacted structural fill.

The pavement sections recommended above are based on our experience. Thicker asphalt sections may be needed based on the actual subgrade conditions, traffic data and intended use.
Asphalt-Treated Base

If pavements are to be constructed during the wet seasons, consideration may be given to covering the areas to be paved with ATB for protection. Light-duty pavement areas should be surfaced with 3 inches of ATB, and heavy-duty pavement areas should be surfaced with 6 inches of ATB. Prior to placement of the final pavement sections, we recommend that areas of ATB pavement failure be removed and the subgrade repaired. If ATB is used and is serviceable when final pavements are constructed, the crushed surfacing base course can be eliminated, and the design Portland cement concrete or asphalt concrete pavement thickness can be placed directly over the ATB.

Portland Cement Concrete Pavements

We expect that portland cement concrete (PCC) pavements may be used for sidewalks and pedestrian access ways. We recommend that PCC pavements be underlain by a minimum thickness of 4 inches of base course, conforming to Section 9-03.9(3) of the 2016 WSDOT Standard Specifications, to provide uniform support and a working surface. PCC pavements may be designed using a subgrade modulus of 100 pci for the modulus of subgrade reaction.

Recommended Additional Geotechnical Services

Throughout this report, recommendations are provided where we consider additional geotechnical services to be appropriate. These additional services are summarized below:

- GeoEngineers should be retained to provide a final geotechnical engineering report containing design recommendations for the project once the final building layout and floor elevations have been determined.
- GeoEngineers should be retained to review the project plans and specifications when complete to confirm that our design recommendations have been implemented as intended.
- During construction, GeoEngineers should observe and evaluate the suitability of the foundation subgrades, observe removal of unsuitable soils, evaluate the suitability of floor slab and pavement subgrades, observe installation of subsurface drainage measures including footing and underslab drains, observe and test structural backfill, and provide a summary letter of our construction observation services. The purposes of GeoEngineers construction phase services are to confirm that the subsurface conditions are consistent with those observed in the explorations and other reasons described in Appendix E, Report Limitations and Guidelines for Use.

LIMITATIONS

We have prepared this report for use by the University of Washington and members of the project team for use in design of this project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.
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Please refer to Appendix E titled Report Limitations and Guidelines for Use for additional information pertaining to use of this report.

REFERENCES


## D.1 Cost Summary (C-100 Form)

A cost summary for the project was prepared by the Capital Planning and Development Office per the OFM C-100 format. Below is the project summary and assumptions. The detailed cost summary is included on the following page.

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<td><strong>Total Project Escalated</strong></td>
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## Cost Estimate Summary

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D.2 CASH FLOW SCHEDULE

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**UW/B4 Cash Flow Schedule**

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**Construction Months**

| Gross Value | $60,561,003 | | | | | | | | | | | | | | |

**Other Costs**

| Equipment | $1,044,382 | | | | | | | | | | | | | | |
| Artwork   | $217,677 | | | | | | | | | | | | | | |
| Project Administration | $2,931,042 | | | | | | | | | | | | | | |
| Other Costs | $2,281,005 | | | | | | | | | | | | | | |

**Cumulative Total**

| Cumulative Total | $74,993,671 | | | | | | | | | | | | | | |
D.3 Schedule

- **UW Building Project 1**: 297 days, Start: 10/22/15, End: 1/5/16
- **Design Build Selection**: 21 days, Start: 8/28/18, End: 9/16/18
- **RFQ**: 10 days, Start: 8/27/18, End: 8/31/18
- **Confirmation**: 8 wks, Start: 10/11/18, End: 11/15/18
- **Review**: 16 wks, Start: 10/30/18, End: 1/12/19
- **Completion of Design**: 50%, Start: 12/4/19, End: 12/18/19
- **BIM Issue**: 53 wks, Start: 7/24/19, End: 6/23/20
- **Permitting**: 54 days, Start: 4/22/20, End: 6/16/20
- **Tenant Occupancy**: 50 days, Start: 5/25/21, End: 6/7/21

---

**Project Timeline**

- **Pre-Design**
  - **Building Project 1**: 297 days, Start: 10/22/15, End: 1/5/16
- **Design Build Selection**: 21 days, Start: 8/28/18, End: 9/16/18
- **RFQ**: 10 days, Start: 8/27/18, End: 8/31/18
- **Confirmation**: 8 wks, Start: 10/11/18, End: 11/15/18
- **Review**: 16 wks, Start: 10/30/18, End: 1/12/19
- **Completion of Design**: 50%, Start: 12/4/19, End: 12/18/19
- **BIM Issue**: 53 wks, Start: 7/24/19, End: 6/23/20
- **Permitting**: 54 days, Start: 4/22/20, End: 6/16/20
- **Tenant Occupancy**: 50 days, Start: 5/25/21, End: 6/7/21

---

**Timeline Details**

- **Building Project 1**: 297 days, Start: 10/22/15, End: 1/5/16
- **Design Build Selection**: 21 days, Start: 8/28/18, End: 9/16/18
- **RFQ**: 10 days, Start: 8/27/18, End: 8/31/18
- **Confirmation**: 8 wks, Start: 10/11/18, End: 11/15/18
- **Review**: 16 wks, Start: 10/30/18, End: 1/12/19
- **Completion of Design**: 50%, Start: 12/4/19, End: 12/18/19
- **BIM Issue**: 53 wks, Start: 7/24/19, End: 6/23/20
- **Permitting**: 54 days, Start: 4/22/20, End: 6/16/20
- **Tenant Occupancy**: 50 days, Start: 5/25/21, End: 6/7/21

---

**Project Budget Analysis**

- **Pre-Design**
  - **Building Project 1**: $20 M, Start: 10/22/15, End: 1/5/16
- **Design Build Selection**: $2 M, Start: 8/28/18, End: 9/16/18
- **RFQ**: $0.5 M, Start: 8/27/18, End: 8/31/18
- **Confirmation**: $0.2 M, Start: 10/11/18, End: 11/15/18
- **Review**: $0.1 M, Start: 10/30/18, End: 1/12/19
- **Completion of Design**: $0.05 M, Start: 12/4/19, End: 12/18/19
- **BIM Issue**: $0.02 M, Start: 7/24/19, End: 6/23/20
- **Permitting**: $0.01 M, Start: 4/22/20, End: 6/16/20
- **Tenant Occupancy**: $0.005 M, Start: 5/25/21, End: 6/7/21

---

**Conclusion**

The project timeline and budget analysis are critical for ensuring that the project is completed within the established time frame and budget. The detailed review process and the confirmation stage play a vital role in ensuring that the project meets the required standards. The completion of design and the BIM issue stages will require careful planning to ensure smooth transition to the next phase. The permitting and tenant occupancy stages are crucial for the successful completion of the project. The detailed budget analysis helps in identifying potential cost overruns and in making necessary adjustments to stay within the budget.
D.2 TARGET VALUE BUDGET

As described in Section 5, a target value budget was developed in lieu of a traditional cost estimate. Project budgets are difficult to establish in predesigns, as much of the design work lays ahead. Instead of asking the design team to propose specific solutions for exterior envelope, systems, massing, and interior construction, the Project Team, including UW Bothell and UW CPD representatives, worked together to develop the project scope, identify the appropriate site, and set quality and performance levels. The group then visited, researched, and assessed several possible benchmark projects at comparable facilities to establish a low, average, and high target for the budget. The independent cost estimator developed Uniformat estimates for these benchmarks from which decisions could be made about what appropriate target budgets were for each Uniformat section. These targets were not set based on specific design solutions for each building subsystem, but on assumed ranges for quality and performance gathered from the example benchmark projects.

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<td>$ 1.61</td>
<td>$ 3.38</td>
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<td>$ 22.53</td>
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<td>Site utilities</td>
<td>$ 122.22</td>
<td>$ 70.60</td>
<td>$ 70.60</td>
<td>$ 89.32</td>
<td>$ 127.47</td>
<td>$ 127.47</td>
<td>$ 1,165</td>
<td>$ 1,215</td>
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<td>Escalation, per annum</td>
<td>$ 376</td>
<td>$ 475</td>
<td>$ 475</td>
<td>$ 561</td>
<td>$ 799</td>
<td>$ 799</td>
<td>$ 543</td>
<td>$ 543</td>
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<tr>
<td>Maximum Allowable Construction Cost (MACC)</td>
<td>$ 857</td>
<td>$ 531</td>
<td>$ 399</td>
<td>$ 827</td>
<td>$ 893</td>
<td>$ 643</td>
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<tr>
<td>TCC plus Preconstruction Services</td>
<td>$ 857</td>
<td>$ 531</td>
<td>$ 399</td>
<td>$ 827</td>
<td>$ 893</td>
<td>$ 643</td>
<td></td>
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</table>

Reference Appendix D and the C-100 form for more detail on project cost.
DESCRIPTION OF BENCHMARKS

As described in Section 5, for the purposes of developing a target value budget, three recently constructed, state funded, local STEM buildings were selected as representative of three alternative approaches to mechanical and electrical systems, exterior envelope, site conditions, structural solutions, and accommodation of STEM related programming. Design, operational, and construction cost information was gathered on these four buildings and used to assess the range of costs for each of the Uniformat categories. Section 5 describes these benchmarks without noting their location. A more detailed description is included here to highlight some of the characteristics of each facility and how they relate to the Phase 4 project target budget.

BENCHMARK 1 - STEM BUILDING 1 (SLOPED SITE)
Discovery Hall, University of Washington, Bothell Campus

This is a 78,000 gsf building on a steeply sloped site adjacent to the proposed Phase 4 building site. Discovery Hall was partially state funded, with additional funding added by UW Bothell to complete the project in 2014. The total project cost for Discovery Hall was $62.8 million. The building houses a variety of STEM focused program including classrooms, offices, collaboration spaces, teaching labs, computer labs, & project labs. UW Bothell’s commitment to sustainability was showcased in this building with a LEED Gold design including radiant heating and chilled beams as feature sustainable elements, as well as dashboards to help users understand energy use on campus and in the building itself. The building has a high ratio of glazing to solid skin in the exterior envelope made up of a combination of brick, terra-cotta, glazing, and board formed concrete.

Its value as a benchmark was in its almost identical site and structure, as well as the similarity in program. The site for Discovery Hall and the proposed site for Phase 4 are both steeply sloped with very wet conditions and many significant trees. The type of structure required to step the building down the hillside will be very similar to the type of structure required for Phase 4. The site preparations and shoring will also be very similar. In addition to similarities in site, the building has similar STEM program spaces. Though Discovery Hall has more traditional teaching labs than the smaller experiential learning labs that will be in Phase 4, the proportion of space that will require special HVAC for lab exhaust is similar relative to the proportion of offices and classrooms. The amount of daylight and views in the building work very well for the programs and bring light into all the spaces. UW Bothell would strive to provide a similar access to daylight and views in the Phase 4 building. The Bothell campus has a tradition of brick buildings will as much glazing as possible, and this building fits well into that context. The cost for the exterior skin in board-formed concrete and terra-cotta was higher than the target for the Phase 4 building, but the target budget allows for the design team to make choices that will fit into the context of the campus.
University Center Building, WSU North Puget Sound Everett
This is a 95,000 gsf on a flat site at a branch campus of WSU in Everett. WSU North Puget Sound at Everett has a similar focus on science, technology, engineering, and mathematics, as well as an interest in aligning the programs with the regional and local industry needs. During the 2015 legislative session, WSU secured $54.6 million to begin construction on the four-story building. The total project cost is projected to be higher than the $55 million state funding and completion is projected for 2017. The building will house STEM focused program including student services, offices, administration, classrooms, and engineering and computer related labs. The project had a similar design build delivery method to the Phase 4 building. From the very beginning, there was a commitment to sustainability and providing a high performance building. The LEED goal was to exceed the state requirement for LEED Silver, with an assumption that LEED Gold would be attainable, and the goals included a high efficiency mechanical system and PV’s as feature sustainable elements. In addition, the building will have a high ratio of glazing to solid skin in the exterior envelope made up of brick, metal panel, and curtainwall. The structure was concrete which was a comparable likely system for Phase 4 as well.

This building’s value as a benchmark was in its similarity to the Phase 4 program and approach to combining STEM programs and academic spaces such as classrooms, student services, and office spaces. Also, the project’s commitment to high performance was similar to the desires of the UW Bothell facilities and administration. At WSU NPSE, the building operations and maintenance of the environmental control systems were to be engineered and designed for long term operations efficiency and cost performance. Also, the engineering and design of the Building Envelope, Lighting, other end use systems, and HVAC were to emphasize cost effective on-going Building Operations, Maintenance and Energy Performance. The benchmark costs and investment in the ELCCA process on this project were a good example of best value decisions and were valuable comparisons to the other projects. The project also had a commitment to photovoltaics as part of the high performance system. This was different than the other benchmarks, and it was valuable to include the cost for these elements as part of the average of the benchmark costs to ensure that the Phase 4 Design build team would have sufficient budget to explore alternative methods of reaching sustainability and performance goals.
BENCHMARK 4 - STEM BUILDING 3 (FLAT SITE)
Science Phase II Building, Central Washington University

This is a 120,000 gsf building on a flat site located on Central Washington University’s campus in Ellensburg, Washington. The Science Phase II project will house the Geographical Sciences and Physics Department and is scheduled to open in Fall 2016. The facility includes an 80-seat lecture hall and planetarium, an observatory tower, and specialty labs such as optics and laser labs, an ice core lab and an acoustic lab with an anechoic chamber.

The $64 million project was funded by the state legislature while the school continues fundraising efforts for equipment. In addition to construction funds, which were allocated by the state Legislature, an additional $6.2 million was earmarked to connect the facility to campus utilities. This connection will heat the 120,000 square foot building with waste heat and without increasing CWU’s gas energy consumption. The Science Phase II project will be LEED Silver certified and will achieve high sustainability goals including use of the waste heat via retrofitted boiler plant as feature sustainable element. This building has an exterior envelope consisting of brick, precast concrete, metal panels and glazing with a high ratio of glazing to solid skin.

This building’s value as a benchmark was in its similarity to the Phase 4 program and approach to combining STEM programs and academic spaces such as classrooms, student services, and office spaces. Though this project was slightly less ambitious in terms of sustainability goals, it reached LEED Silver and had a very different element highlighted. The benchmark numbers for this building were adjusted because of its location in Ellensburg instead of the Seattle area. It was a valuable benchmark as a peer institution that has a similar STEM program.
### D.3 COST BY PROGRAM TYPE

The target value budget and cost/gsf was then further analyzed to separate costs for the core and shell of the building from the interior construction and systems required for each type of program space. As the types of program spaces were determined through involvement with focus groups and UW Bothell administration, further information was incorporated to help develop the final breakdown of spaces to be housed in the building.

The design team developed a spreadsheet that could be used to input and adjust the number and type of spaces, square footage for each space based on type of use and occupation, FTE supported by each individual space for the School of STEM as a whole, as well as the individual divisions within the school (BIO, PSD, M+E, and CSS), and then the cost by individual seats provided and gsf based on each type of space. The following is a condensed version of the spreadsheet that incorporates HECB standards for Utilization of classrooms and labs as well as UW Bothell standards for the student to faculty ratios.

<table>
<thead>
<tr>
<th>Description</th>
<th>% of overall program</th>
<th>% of overall cost</th>
<th>TOTAL FTE SUPPORTED BY TYPE OF SPACE</th>
<th>TOTAL GSF</th>
<th>PROJECT COST ($/Gsf) FOR TYPE OF SPACE</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERACT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classrooms + Teaching Labs</td>
<td>35%</td>
<td>30%</td>
<td>1,016</td>
<td>27,682</td>
<td>$ 808</td>
<td>$ 22,127,388</td>
</tr>
<tr>
<td>INTERACT space subtotal</td>
<td>1,016</td>
<td>27,682</td>
<td>$ 808</td>
<td>$ 22,127,388</td>
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<tr>
<td>INNOVATE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiential Learning Labs - Small Group</td>
<td>42%</td>
<td>51%</td>
<td>406</td>
<td>33,214</td>
<td>$ 1,396</td>
<td>$ 38,169,207</td>
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<tr>
<td>Experiential Learning Labs - Projects</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>INNOVATE spaces subtotal</td>
<td>406</td>
<td>33,214</td>
<td>$ 1,396</td>
<td>$ 38,169,207</td>
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<tr>
<td>MENTOR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaborative Office - Single Offices</td>
<td>16%</td>
<td>14%</td>
<td>1,479</td>
<td>12,397</td>
<td>$ 821</td>
<td>$ 10,495,059</td>
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<td>Hoteling / Touchdown Stations</td>
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<tr>
<td>MENTOR spaces subtotal</td>
<td>1,479</td>
<td>12,397</td>
<td>$ 821</td>
<td>$ 10,495,059</td>
<td></td>
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<tr>
<td>COLLABORATE</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Student Collaboration Space</td>
<td>7%</td>
<td>6%</td>
<td>591</td>
<td>5,353</td>
<td>$ 782</td>
<td>$ 4,186,000</td>
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<tr>
<td>COLLABORATE spaces subtotals</td>
<td>591</td>
<td>5,353</td>
<td>$ 782</td>
<td>$ 4,186,000</td>
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<td></td>
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<tr>
<td><strong>TOTAL</strong></td>
<td></td>
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<td>GSF TOTAL</td>
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<td></td>
<td>78,647</td>
<td>$74,977,654</td>
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<td>COST TOTAL (2019 funding)</td>
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</table>

Using the target budget and the breakdown of these budgets by space type and the other variables, the project team was able to adjust the program spaces to ensure that the program included met the stated objectives for FTE to be supported by the new spaces. Using this tool, total project cost was easily calculated for each space type and compared with peer institutions and state studies such as the one conducted by OFM and Berk & Associates in 2008 to ensure the project was not significantly beyond the range of costs for higher education buildings in the Seattle area and elsewhere in the state of Washington.
Interdepartmental Correspondence

April 15, 2016

TO: Paul Jenny, Senior Vice President, Planning and Management

FROM: Steve Tatge, Executive Director, Major Capital Projects
       Jeannie Natta, Project Manager, Major Projects Group

SUBJECT: UW Bothell Phase 4, Project #205294

The Project Agreement for the UW Bothell Phase 4 predesign project is attached for your signature.

The Project Agreement defines the scope, budget, schedule, objectives, and overall approach for the work to be completed for this project. It should be the single point of reference on the project for scope, budget, schedule, and organization.

The Project Agreement has gone through a review process and prepared for your signature. Please sign and return to Capital Planning & Development, UW Box 352205, attn.: Allison Hughes.

If you have any questions, please feel free to call me at 206-724-5304. Thank you.
Project Agreement

Project Name: UW Bothell Phase 4  
Project Number: 205294  
Department (s): UW Bothell and Capital Planning and Development  
Facility Number: TBD  
Program: Pre-design for an academic building serving science, technology, engineering and mathematics (STEM) programs as well as other high demand programs and general use classrooms.

Prepared By

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<thead>
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Project Agreement Version Control

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<th>Author</th>
<th>Change Description</th>
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TABLE OF CONTENTS

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1 PROJECT AGREEMENT PURPOSE

The project agreement defines the scope, objectives, and overall approach for the work to be completed. It is a critical element for initiating, planning, executing, controlling, and assessing the project. It should be the single point of reference on the project for project scope, budget, schedule, and organization. It states what will be delivered according to the budget, time constraints, risks, and standards agreed upon for this project.

2 PROJECT EXECUTIVE SUMMARY

This project is the next step in the State of Washington’s commitment, dating back to 1989, to provide access to education by establishing and funding additional campuses. The new building will complete 90% of the UW Bothell's goal of 5000 full time equivalent (FTE) capacity build-out on the 10,000 FTE UVW Bothell/Cascadia College collocated campus.

Continuing impacts of regional population growth and shifting workforce models have resulted in increased demands on the state for access to higher education and for a workforce that holds bachelor and graduate degrees in science, technology, engineering and mathematics (STEM). The Phase 4 project will address forecasted growth need of 1,000 new FTE students in the School of STEM by 2020. The predesign study for Phase 4 will be submitted to the Washington State Office of Financial Management on July 1, 2015, with a request for funding. The targeted budget is $58 million.

3 PROJECT SCOPE

3.1 Project Description and Program

Science, technology, engineering, and mathematics (STEM) are increasingly important areas of study and research in our State and region. To help meet this demand UW Bothell proposes to increase its teaching and research program and construct a new facility to provide more access to students. The new proposed Phase 4 facility will focus on expanding engineering and computer science degree programs. The facility will contribute to meeting the following growth demands projected by 2020.

- Accommodate 1,000 new full-time equivalent (FTE) students in the School of STEM and
- Increase graduation in the School of STEM by 500 FTE, of which 300 FTE will be engineering and computer science majors.
The conceptual program for the Phase 4 facility project will provide teaching, learning, research, and faculty office space for the School of STEM. Other STEM related programs may use the facility when space is available. This new facility will include general classrooms, undergraduate research space, computer class labs, and engineering labs specific to computer sciences and engineering fields.

In addition to identifying the most effective use of the new STEM building, the design team will review existing space used by STEM programs and gather information in focus groups about all STEM related programs. The goal of this assessment is to ensure the design of new facility efficiently and effectively meets the academic growth plan for the campus.

The proposed STEM building has a close programmatic relationship with Discovery Hall. The UW Bothell master plan identified the adjacent site for a future building. This site is the preferred preliminary project site because of the utility infrastructure installed during the construction of Discovery Hall. This infrastructure includes: extensions and connections necessary to all utilities; provisions for routing storm water drainage around building; equipment and installation cost of 1000 ton chiller; construction of vehicular and pedestrian circulation necessary for building: two code-required fire lanes (east and west of the building) that serve delivery/service vehicles and pedestrian use; hill-climb stairs and ramped pathways provide necessary building and campus access. The two buildings will share the exterior stair, a path leading to upper campus. Please see appendix 1 for a site plan. The predesign will test fit the project on the preliminary site.

Campus master plan concepts, such as, landscaping (hard and soft) site circulation, building entries, building massing, daylight, existing trees, site lighting, bike storage, topography, adjacencies to other buildings, loading dock services will be developed as part of the predesign effort.

### 3.2 Project Exclusions

None identified. The predesign effort will develop the project scope, budget and schedule to determine and identify any project exclusions that may arise from the effort.

### 3.3 Key Departmental Responsibilities

<table>
<thead>
<tr>
<th>Departmental Task</th>
<th>Owner/Prime</th>
<th>Due Date/Sequence</th>
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<tr>
<td>Identify programs to be included in the facility</td>
<td>UW Bothell Project Executive committee</td>
<td>March 2016</td>
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3.4 Project Schedule

<table>
<thead>
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<th>Milestones</th>
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<th>Finish Date</th>
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<td>Predesign Initial Draft</td>
<td>February 3, 2016</td>
<td>April 6, 2016</td>
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<tr>
<td>Initial Draft Predesign Review</td>
<td>April 7, 2016</td>
<td>April 20, 2016</td>
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<tr>
<td>Final Draft Predesign</td>
<td>April 21, 2016</td>
<td>June 2, 2016</td>
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<tr>
<td>OFM Project Proposals Identified</td>
<td>May 16, 2016</td>
<td>May 16, 2016</td>
</tr>
<tr>
<td>Draft Predesign to CDP for Review</td>
<td>June 1, 2016</td>
<td>June 1, 2016</td>
</tr>
<tr>
<td>Publish Final Predesign</td>
<td>June 17, 2016</td>
<td>June 30, 2016</td>
</tr>
<tr>
<td>Final Predesign Studies to OFM</td>
<td>July 1, 2016</td>
<td>July 1, 2016</td>
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</table>

3.5 Project Budget

The State of Washington provided $500,000 for the predesign phase.

4 PROJECT CONDITIONS

4.1 Project Risks

<table>
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<tr>
<th>#</th>
<th>Risk Area</th>
<th>Potential</th>
<th>Risk Owner</th>
<th>Project Impact-Mitigation Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The project overview to the State of Washington indicates the proposed project will provide an 115,000 GSF building for an estimated project cost of $58,000,000. At $500/GSF the cost appears low for a building with teaching laboratories.</td>
<td>High</td>
<td>UW Bothell, Project design team</td>
<td>The design team will work to identify a program and project that fits within the estimated budget. The team will work with an estimating team, involving an independent estimator and a contractor. The project team will also identify ways the building may be scaled, if the project funding is less than expected.</td>
</tr>
<tr>
<td></td>
<td>Additional campus parking will be needed as a condition by the City</td>
<td>High</td>
<td>UW Bothell</td>
<td>UW Bothell and Cascadia College are conducting a preliminary parking plan study to help guide the campus</td>
</tr>
</tbody>
</table>
4.2 Project Issues

The UW One Capital Plan identifies this project as potentially being a $75 million and 105,000 GSF building. Based upon earlier information presented the legislature for a $58 million, 115,000 GSF facility. The predesign will test the desired student outcomes with the program, building size and costs to develop a preferred conceptual plan. The goal is to achieve the desired student accommodation and graduation goals within a total project cost of $58 million.

Defining the need, intent, purpose and program within the proposed project budget is essential to the success of the predesign report.

5 PROJECT TEAM ORGANIZATION

<table>
<thead>
<tr>
<th>Project Team Role</th>
<th>Project Team Member(s)</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responsible Party</td>
<td>Wolf Yeigh, UW Bothell Chancellor</td>
<td>Overseer the project executive committee and lead the effort to meet the target budget, scope and schedule. He will resolve project issues not decided by the project executive committee.</td>
</tr>
<tr>
<td>Executive Committee</td>
<td>Ana Karman, Vice Chancellor for Administration, Planning and Finance at UW Bothell</td>
<td>Ensure the Building Committee's input stays within the project requirements and provide direction to the group when issues are not resolved.</td>
</tr>
<tr>
<td></td>
<td>Amy Van Dyke, Director of Physical Planning and Space Management, UW Bothell</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elaine Scott, Dean, School of Science, Technology, Engineering, and Math, Engineering and Mathematics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Warren Buck, Professor &amp; Chancellor Emeritus, School of STEM, Physical Science Division</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rebecca Barnes, University Architect, University of Washington</td>
<td></td>
</tr>
</tbody>
</table>
## Project Agreement

**Project Agreement Project No. 204763**

**University of Washington**

<table>
<thead>
<tr>
<th>Project Committee</th>
<th>Jon Lebo, Director Major Projects, UW Capital Planning and Development</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mike McCormick, Associate Vice President, UW Capital Planning &amp; Development</td>
</tr>
<tr>
<td>Warrick Buck, Professor &amp; Chancellor Emeritus, School of STEM, Physical Science Division (Co-Chair)</td>
<td></td>
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<tr>
<td>Amy Van Dyke Director of Physical Planning and Space Management, UW Bothell (Co-Chair)</td>
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</tr>
<tr>
<td>Arnie Berger, Associate Professor, School of STEM Engineering and Mathematics Division</td>
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<tr>
<td>Christy Cherrier, Science Lab Manager, School of STEM</td>
<td></td>
</tr>
<tr>
<td>Grace Lasker, Senior Lecturer, School of Nursing and Health Studies</td>
<td></td>
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<tr>
<td>Joe Shalley, Assistant Vice Chancellor for Information Technologies</td>
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<tr>
<td>David Stokes, Associate Professor, Interdisciplinary Arts and Sciences</td>
<td></td>
</tr>
<tr>
<td>Christian Cuellar, ASUWB Sophomore Senator</td>
<td></td>
</tr>
<tr>
<td>Rebecca Barnes, University Architect, University of Washington Jon Eggert, Construction Project Manager, ex-officio</td>
<td></td>
</tr>
</tbody>
</table>

**Project Manager**

| Jeannie Natta, Project Manager, UW Capital Planning and Development |

Manage predesign to ensure the work is delivered consistent with scope and budget parameters set forth by UWB Administration in coordination with UW Planning and Management, and the Office of the University Architect, and consistent with state and...
6. APPROVALS

Signatures below authorize the final approval for a predesign study of the UW Bothell Phase 4 facility project.

Approved by

Gerald J. Baldsat
Interim Provost and Executive Vice President

Wolf Yeigh, Chancellor, UW Bothell

Paul Jenny, Senior Vice President

Electronically Approved by

☐ Ana Karaman, Vice Chancellor for Administration and Planning, Chancellor's office UW Bothell

☒ Mike McCormick, Associate Vice President Capital Planning & Development

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7. APPENDICES

Appendix 1: Site Plan (attached)
APPENDIX D  PROJECT BUDGET ANALYSIS

CPO Document Approval - Document Details

Online Document Approval

UW Bothell Phase 4
Predesign for an academic building serving science, technology, engineering and mathematics (STEM) programs as well as other high demand programs and general use classrooms.

Document Status: Approved

Author: shugheo5
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COMMENTS

APPROVAL LOG
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Mar 31 2016 8:58AM: karaman - Approved
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Apr 8 2016 10:47AM: Document Approved


192  The Miller Hull Partnership | UW BOTHELL SCIENCE TECHNOLOGY ENGINEERING AND MATHEMATICS
APPENDIX E
SUSTAINABILITY & ENERGY ANALYSIS
**E.1 SUSTAINABILITY & LEED**

**INTRODUCTION**
The project will achieve at least Gold certification from the U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) program. In an effort to establish design direction and to confirm this project is meeting UW Bothell sustainability targets, this section outlines strategies that reflect a variety of paths consistent with LEED Gold (version 4) objectives and provides a variety of paths that the design team could choose to pursue in an effort to achieve Gold LEED certification.

Additional elements and strategies this project will use to enhance sustainability are as follows:

- Maximize the program space within the building to minimize the need for future construction.
- Develop the landscape and building in such a way that the two work together, share systems, and complement each other spatially and functionally.
- Integrate material and system designs to create energy- and resource-efficient solutions for the entire project.
- Specify building materials that reduce the negative environmental impact of the project—this includes responsibly harvested and certified wood and low-toxic paints, finishes and adhesives.
- Use durable materials and systems that reinforce the high quality UW architectural and urban design standards, and the building’s connection to place on the campus.
- Consider the use of recycled, local, or sustainable materials during the design phase.
- Recycle construction debris wherever feasible.
- Building dashboards - Johnson Controls & Lucid

**UW BOTHELL + CASCADIA COLLEGE CAMPUS - JOINT SUSTAINABILITY INITIATIVES**

- The Sarah Simonds Green Conservatory opened in 2013, serving as a working educational center, adjacent to the wetlands.
- The UW Bothell Wetlands Game was published on Facebook in Autumn 2011, with a percentage of proceeds designated for real-world wetland restoration projects.
- The campus completed $2.2 million in energy saving projects in 2011, reducing its carbon footprint and energy costs. The projects were supported by $745,000 in state grant funding.
- The campus completed $2.2 million in energy saving projects in 2011, reducing its carbon footprint by 922 tons. New online utility dashboards were created in 2011 to monitor this progress.
- The campus received a $550,000 grant in 2014 to install solar panels, as part of a collaborative project with Cascadia Community College.
- The campus completed a $2.2 million ESCO energy savings project in Autumn 2011, with anticipated energy savings of 22 percent. This will reduce UW Bothell’s carbon footprint by 922 tons. New online utility dashboards were created in 2011 to monitor this progress.
- Implemented green campus initiatives, including installation of air hand dryers in bathrooms to reduce waste and reduce costs, and modification of recycling bins to encourage greater use.
- Six electric-vehicle charging stations were installed through ChargePoint America in 2011.
- Sustainable design and universal access principles were incorporated into the design of the new Discovery Hall science and academic building. The building included community gathering spaces and energy saving features.
E.2 CLIMATE ACTION PLAN

UW CLIMATE ACTION PLAN 2009
The UW will reduce greenhouse gas emissions to meet or exceed the goals passed by the Washington State Legislature in April of 2009, requiring Washington State agencies reduce emissions 15% below 2005 levels by 2020, and 36% below 2005 levels by 2035. Climate neutrality is not specified in the state mandate. The UW, hoping to achieve neutrality by 2050, is unable to set this as the firm target date since the technologies necessary to meet it, and the federal and international policies that can support GHG neutrality, are still emerging. Indeed, accelerated interdisciplinary work at the University will play an important role in guiding the very developments that will make GHG neutrality possible.

UNIVERSITY OF WASHINGTON CLIMATE ACTION PLAN 2010 UPDATE
The University of Washington is a founding signatory to the American College & University Presidents’ Climate Commitment (ACUPCC), and is committed to developing an institutional action plan for becoming climate neutral.

In January 2009, under the auspices of the Environmental Stewardship Advisory Committee, a Climate Action Planning Oversight Team formed to coordinate the drafting of a Climate Action Plan. Teams of faculty, students, administrative leaders and staff across all three campuses worked together to develop the UW plan, which was submitted to ACUPCC on September 12, 2009. The Plan describes preliminary strategies to be explored by the UW, including our intent to work toward becoming climate-neutral. The UW Climate Action Plan sets out broad strategies—i.e. a “Plan to Plan,” that will guide us to that goal.

In order to achieve zero carbon by 2050, major investments in the University’s infrastructure are required. Analysis is currently underway on existing legacy buildings that will provide information to set broader policies where individual building projects can contribute to overall carbon reduction. Outside of major systems upgrades, the focus should be on heating and cooling buildings more efficiently and sustainably, including reducing energy demand and looking for alternative sources of energy.

This project supports the energy use and greenhouse gas emission reduction goals of the UW Climate Action Plan by proposing mechanical, electrical and lighting systems that will be high performing and high efficiency which is anticipated to help reduce the overall campus energy use.

Additionally, the UW is a global leader in environmental science research, education and technology transfer and is recognized nationally as a leader in reducing its carbon footprint, including wise use practices, energy conservation and innovative transportation alternatives. UW researchers are leading authorities on the impact of global warming and are at the forefront of developing new models that refine climate change predictions. In 2009, the UW received an A- on the College Sustainability Report Card and in 2010 received 96/100 on the Princeton Green Rating (highest of all public research universities) and ranked 4th overall on Sierra Club Magazine’s Cool Schools list (See Figure 1). UW students recently voted to create a Campus Sustainability Fund, a nearly $340K fund which will be used to finance projects that increase campus sustainability, prioritize student leadership and include outreach and education components. And the first-ever Green Awards honored noteworthy environmental efforts by students, faculty and staff.

While the primary focus of the Climate Action Plan is substantive carbon reduction, others of these goals are part of a larger, more holistic set of strategies which include:
1. Moving forward toward climate neutrality
2. Engaging faculty and students in conservation and related behavior change
3. Integrating formal and informal learning on sustainability
4. Replacing the campus power plant
5. Moving students, faculty and staff to live near the UW
6. More walking/cycling, less reliance on motorized transportation
7. Becoming energy efficient
E.3 SUSTAINABILITY PRIORITIES

FUTURE ENERGY MODELING AND PERFORMANCE ANALYSIS

This project will support the energy use and greenhouse gas emission reduction goals of the UW Climate Action Plan by encouraging the selected design build team to complete early detailed energy and water consumption analysis to validate design decisions in the Schematic Design Phase. This analysis is intended to follow the state mandated life cycle cost analysis format with consideration given to additional measures beyond those required by the state. Given the desired space types in the project, the team anticipates the following end uses to be of primary concern when striving to reduce energy consumption:

- **Space Heating** – Buildings that incorporate laboratory and classroom spaces have significantly higher outside air ventilation requirements than a typical building. As a result, a high amount of energy is spent heating this outside air to a temperature appropriate to maintain the thermal comfort of occupants. The design and construction team phase will need to explore a variety of strategies to reduce the heating energy needed in the building in an effort to lower the project Energy Use Intensity (EUI), fossil fuel use and corresponding carbon footprint.

- **Supply/Return/Exhaust Fans** – As mentioned previously, the elevated ventilation rates needed in a classroom/laboratory building have a tendency to increase heating energy consumption over a standard building. The supply, return, and exhaust fan systems are tasked with moving this air throughout the building and maintaining code-required air change rates in sensitive zones. Designing a highly efficient, flexible, and variable volume system that minimizes fan energy will be very important to achieving the desired energy goals.

- **Lighting and Process Loads** – While the heating and fan energy consumption is largely due to code required ventilation rates, the lighting and process loads within this project will be the direct result of occupant behavior. As a result, there are significant opportunities to explore that may greatly reduce the lighting and process loads in the building. Aside from using LED technology for efficient lighting (and dimming), the use of vacancy sensors, occupancy based plug load controls, high efficiency computers and lab equipment may be a way to engage the occupants in driving the performance of the building.

The systems mentioned above should be studied in the design phase using detailed energy modeling software that incorporates time of day, annual weather profiles, space usage patterns, solar exposure, and interactive effects between systems to determine the best combination of system components needed to meet the climate and cost goals of the project.
E.4 ECO-CHARETTE

This project conducted an eco-charette on March 21st, 2016. In attendance were representatives from UWB Facilities, Grounds, and faculty from ecology and sustainability-focused programs. Also in attendance were key civil, landscape, mechanical, electrical, plumbing, and architectural design team members as well as representatives from UW CPD and the Office of the University Architect. The following notes from that meeting summarize the discussion. Further articulation of goals is included in the Owner’s Project Requirements (OPR) in Appendix K.

Discussion by Discipline

1. CIVIL:
   a. The new surface parking lot under construction will have drainage considerations that will affect the proposed STEM building. Existing drainage will involve rerouting storm water and require hard system additions
   b. Civil consultants will verify sewer tie-in conditions and coordinate with John Egdorf on capacity and location of expansion
   c. There are sewer line considerations associated with labs; the design team will need to evaluate lab (if any) requirements. Civil will study the 2 existing sewer lines for possible connection to the proposed STEM building; it was noted that one of the sewer lines may involve construction within the plaza. A gravity system is important and may affect which sewer line the new building connects to
   d. Subsurface french drains will be maintained around the perimeter of the proposed STEM building
   e. Clean and dirty storm water is treated and managed separately. Currently, the dirty water is split into 4 basins and managed by separate facilities. As new buildings are added, water treatment facilities will need to be added
   f. In general, ground water is less wet northwards on the site
   g. There is mutual interest between civil and UWB faculty in the promotion of rain water gardens rather than hard surface systems.
   h. Available capacity for the proposed STEM building is noted at the Discovery Hall runnel
   i. It’s proposed to locate the transformer (if required) be on the south side of the proposed building
   j. Equipment had been added to the generator in the last 2 years. Does the consultant team have these drawings?
   k. Water boxes (repurposed cargo containers) that are elevated can help mitigate drainage issues with plantings that respond well to being wet. This could provide opportunities for research experiments in STEM curriculum and allow students to monitor and take samples for experiments in water levels and quality.
      i. This concept could take advantage of the hill side for functional elevated requirements of water boxes
      ii. Direct radiation (and the lack of) would be a consideration for siting water boxes
   l. There is interest in maintaining sample drilling wells for civil engineering students to monitor and take samples for experiments in water levels and quality.

2. ELECTRICAL
   a. Additional communication vaults may be required
   b. Maintaining electrical higher on the site (upper levels) is preferred
   c. UW typically allows a 10% margin of flexibility to accommodate growth but this project should consider at least double that.
   d. Coordinate communication services with James Evans at UWS and John Egdorf
   e. Electrical can engage PSE directly while cc’ing John Egdorf
   f. Lighting controls
      i. Plug load control – monitor this?
      ii. Office spaces regarding the plug load – would like to consider option to turn it off for the predesign
   g. Tunable white LED – new standard
   h. Match induction but LED
   i. LUX LED handrail is preferred
   j. Bollards LED at DISC are preferred
   k. Regarding lighting: Would like to explore alternatives to Lutron - not responsive. Lutron is no longer a preferred standard at UWB (this is a standard for UWS)
   l. Jeannie to connect Mike Fitzmaurice with Lyle and James and UWITm. Research generator capacity needs
3. LANDSCAPE
   a. Will Phase 4 require another generator
   b. How much ADA parking is required will depend upon the capacity of the building (size of building to be confirmed)
   c. Wheelchair access from crescent path is required from top and bottom
   d. Bike facilities: covered bicycle storage at the lower access of the building makes more sense from a circulation perspective; accessing the top of the hill is less practical
   e. North side of the proposed building should consider a trail to experience the grove as well as access the growth of the campus northwards.
   f. Capturing programming uses at the exterior of the building should be considered to avoid added program later that feels like an afterthought. Can the exterior edges of the building explore academic spaces and active learning
      o How are the spaces set up in the broader campus fabric; it’s important to consider future development as it related to circulation in this phase
      o Welcoming path is important from upslope to downslope (from surface parking and residence halls)
      o Discovery Hall has access points on every level – this is really helpful for circulation and access
   g. Volume of pedestrian traffic – is the crescent path supposed to become more prominent? This is dependent upon the future of the library and its planned addition. The crescent path currently does not connect to the library but the masterplan intends to enforce this connection in the future
   h. Existing trees
      o Pedestrian access to the north side is important but not at the expense of impacting the trees
      o Creating public space that benefits from this view would help reinforce this campus asset
      o Maintaining the larger trees on campus is critical; the forest is valuable not only to the identity of the campus but for the curriculum of some courses at the school
      o Restoration and Ecology courses have performed studies on the function and benefits of the existing trees regarding storm water mitigation and carbon sequestration. There is interest in manipulating the footprint and massing of the building in order to keep the trees. A large Western red cedar has more water storage capacity and carbon sequestration than many small replanted trees down at the wetland.
         ACTION: Warren Gold will provide Jeannie with research done on these existing trees. Jeannie to provide Warren Gold with tree survey
      o There is interest in fostering a conversation regarding campus identity, growth, and maintaining as many of the trees as possible
         There is fear that more trees will be taken down and the campus’ identity will be negatively impacted.
   i. Accessible roof garden could accommodate planted boxes for course research. Would like more significant green roof; 2 feet of soil and real trees would create a better dialogue between the grove and the building

4. PLUMBING
   a. Pressure advertised was not pressure received for Discovery Hall
   b. Is there interest in recovering gray water for internal building uses? The benefit is using the water as it becomes available whereas with irrigation, storage is of a greater consideration
   c. Crows could create problems for reuse of roof water catchment for internal building functions
   d. No fire pump in DISC – minimum for sprinkler is 7psi (has a domestic pump but not a fire pump)
   e. There is a toilet located in Cascadia 3 that uses rainwater and since 2009 it has required extra maintenance.
   f. Water tank/storage at Cascadia pumps up to the 3rd floor and is filtered and treated with chlorine (otherwise there is streaking in the toilets). John doesn’t want to discount any of these systems but would like to go through the LEED checklist and look at these one-by-one and evaluate the benefit to the maintenance involved
   g. If there is possibility of adding hazmat waste in the future, it should be noted that lab waste system is difficult to install later.
5. SUSTAINABILITY
   a. Natural gas or electric?
   b. If energy use trend data or boiler system data is available, this would help in sustainable system evaluation
   c. Detailed life cycle analysis — it would be good to know in advance if there are special systems that UWB is looking considering
   d. The STEM Phase 4 project should assume the new 2015 standards for the predesign narrative
   e. Heat pump based systems will help the carbon footprint but costs more.
   f. Rob is the best person to speak to regarding sustainability
   g. Water management should be considered so as to not create new channels in the flood plane in the wetlands - better to get the water back into the ground
   h. LEED Gold is ideal. Tyson would prefer the living building certificate
   i. All these systems would be placed on the dashboards that are served by Lucid and then transferred to Johnson.
   k. If trees must be cut, using them in a more interesting way and more integrated would lend a deeper, soulful impact on the campus and its relationship to its siting and character:
      i. Nurse logs in the grove from felled tree.
      ii. Use as beams or shingles or panel siding to incorporate in future projects. Storing the felled trees for future use.
   l. If properly sited in the building with regard to solar exposure, the classrooms and offices could possibly rely on radiant heating with operable windows for cooling
   m. Create flexibility to add solar array in the future
   n. A sustainable manager for the campus begins in June and may have ideas for incorporation in the future

6. MECHANICAL
   a. There is room for expanding the chilled water system for the proposed STEM building
   b. It’s suggested that chilled water loop expansion (additional valves, deadheads) be considered for the next phase following STEM phase 4, located at either the north or west of the proposed STEM building.
   c. John Egdorf will coordinate with Joshua Checkis (mechanical) regarding 12-month performance records for other buildings on campus. Additionally, Max Wilson (sustainability/energy) would like existing plant performance data for sustainability analysis.
   d. Discovery Hall is close to capacity regarding fume hood air exchange – anticipating future STEM growth and the repurposing of the spaces should be a high priority for the Phase 4 building.
   e. Keeping flexibility in mind for mechanical systems for labs that may not be part of the initial project for Phase 4
   f. What are the mechanical considerations for a CSE shop– how does this impact facilities
   g. Lab exhaust locations should be consideration regarding prevailing winds so as not to recharge the interior air with exhausted air
   h. A pent house is desired with a component of student access to interior mechanical rooms with a glass window for demonstration
   i. Highlighting the building’s mechanical, electrical, and civil engineering components should highlight academic curriculum.
   j. The chilled beam system is a UWB preferred system. This is probably the best and most practical system because the campus is tied to the central plant which makes geothermal impractical.
E.5 BUILDING PERFORMANCE AND SUSTAINABILITY

The Phase 4 Building should be designed to support meeting a LEED Gold minimum target. This design will exceed targets for energy savings compared to the LEED baseline. Several goals were set in the Sustainability-focused Eco-Charette held on March 21, 2016 that should be considered in the design phase following the selection of the design build team.

The building operations and maintenance of the environmental control systems shall be engineered and designed for long term operations efficiency and cost performance. Additional information related to life cycle cost analysis is included in the following section - Appendix F.
E.6 SUSTAINABILITY PRIORITIES - SITE

In the Eco-charette, a focus of the conversation was on the importance of the forested area on the site. UWB faculty and students completed an analysis of the value of the trees on site that illuminates the importance of these tree groves to the site and area. A copy of this study is included here.

Environmental Impacts Analysis for Tree Removal in the UW3 Building Project

December 2013

Warren Gold, faculty (IAS)
Elliott Church, student (Environmental Science)
Linda Cung, student (Environmental Science)
Aaron Huston, student (Environmental Studies)
Mandy Knutson, student (Environmental Studies)
Sarah Witte, student (Environmental Science)
Executive Summary:

Introduction

Methods

123 trees were identified as being targeted for removal during the UW3 building construction project based upon the March 1, 2011 construction drawings done by THA Architecture. These include trees directly in the building footprint, adjacent to the building, in the line of the new upper campus access road to the building, and on the east end where the raised island and rock wall will be removed and replaced by a plaza / walkway. There were six species of trees identified in the groups for removal: 44 Douglas-fir (Pseudostuga menziesii), 53 Western redcedar (Thuja plicata), 18 big leaf maple (Acer macrophyllum), 3 red alder (Alnus rubra), 2 paper birch (Betula papyrifera), 2 sycamore (Acer pseudoplatanus), and 1 tree that was an unknown non-native species of spruce (Picea sp.).

Data on tree physical characteristics were collected on July 3, 5, and 9, 2012. The diameter at breast height (DBH; 4.5 feet above the ground) was measured with DBH tape measures. Tree height and the lowest extent of living foliage was measured using a clinometer and a tape measure to record an observer’s distance from a particular tree and the angles of sight to (1) the top of the canopy; (2) the bottom of the canopy; and (3) the base of the tree trunk. Geometric calculations were used to estimate the height of each tree and the height extent of the live canopy.

A preliminary analysis of the “value” of these trees was conducted with the National Tree Benefit Calculator – “NTBC” (Casey Trees 2012). This modeling tool estimates the economic and functional values of various ecological functions of specific tree species based upon tree DBH. It is a simplified tool adapted from the US Forest Service iTrees street tree assessment model (“STREETS”) that was developed to analyze and manage urban forest resources. The NTBC provides estimates of the functional values for an individual tree based upon inputs of (1) climate zone; (2) tree species; (3) DBH; (4) category of general landscape context. In most cases, the model included the exact tree species we found in our study (Douglas-fir; western redcedar; big leaf maple; sycamore; red alder) but in two cases we had to utilize similar species with a closely-allied canopy morphology (for paper birch, European white birch was used; for the unknown non-native spruce, Norway spruce was used).

The functional values estimated by the NTBC model included:

(1) Stormwater benefits:

Trees are considered to provide benefits in controlling (in this case reducing) the rate of stormwater runoff. There is considerable scientific literature that demonstrates negative impacts on water quality and riparian habitats from rapid runoff of stormwater following precipitation events that are characteristic of landscapes dominated more by impervious surfaces (e.g., roads, parking lots, roofs, walkways, etc.). In contrast, trees will reduce the rate of stormwater movement off site by (A) intercepting precipitation on the tree canopy (some of which will evaporate back into the
(2) Energy benefits:

The presence of trees reduce the need for energy consumption in surrounding buildings in a myriad of ways. The NTBC model incorporates three principle bases of building energy conservation by tree presence: (A) direct shading of nearby buildings reduce summer cooling needs and nighttime heat loss from buildings during cold weather; (B) the transpiration of trees increases atmospheric humidity and thus the degree to which the air heats up on warm summer days (reduces the “urban heat island effect”); and (C) tree canopies reduce wind impact on buildings and thus decrease wintertime convective cooling from the building structure and the need for more energy input to maintain warmer interior temperatures. The model calculates energy savings in kilowatt-hours of cooling saved based upon the use of electric power in cooling and the savings of therms of additional oil and natural gas that would be needed to heat buildings without the presence of the tree.

(3) Air quality benefits:

Trees reduce air pollutants by absorbing some pollutants through their leaves, intercepting larger particulate pollutants on the surfaces of leaves and stems; reducing air temperature (which can contribute to the formation of certain pollutants such as ozone; releasing oxygen into the air that has both direct benefits and indirect benefits by diluting harmful pollutants; and finally by reducing energy generation by power plants that emit air pollutants and incur monetary costs for the energy production.

The monetary benefits of trees are calculated for selected important pollutants (ozone, volatile organic carbons – VOCs, nitrogen dioxide, sulfur dioxide, and coarse particulates). These benefits are calculated by including the effects of trees in (A) “avoiding” the production of pollutants in energy generation by reducing energy needs for buildings and (B) sequestering pollutants through stem / foliar interception or absorption (termed “deposition” by the NTBC model). Monetary values are based upon the estimated costs incurred for human health issues upon exposure to air pollutants.

(4) Carbon dioxide benefits:

Trees reduce atmospheric carbon dioxide, thus playing an important direct role in reducing atmospheric greenhouse heating. The model calculates the mass of CO$_2$ that a tree potentially reduces in the surrounding atmosphere each year by including two effects that are similar to the effects on air pollutants described above: (A) “avoiding” the production of CO$_2$ in energy generation by reducing energy needs for buildings and (B) sequestering CO$_2$ in plant parts (and subsequently throughout the soil and other ecosystem components) through photosynthetic uptake of CO$_2$ (termed “sequestration” by the NTBC model). Overall these numbers will provide a valuable way to examine the removal of trees on campus in terms of our campus carbon footprint and its impact on the President’s Climate Commitment.
(5) Monetary benefits of the major types of ecological and human societal functions provided by the tree:
Monetary values were estimated for the various benefits provided for the tree in terms of (A) stormwater benefits; (B) reduced electricity demand for building cooling; (C) reduced natural gas and oil demand for building heating; (D) overall air quality benefits (pollutant reductions and their effects on reduced human health impacts); (E) reduced CO$_2$ levels and the cost savings from reduced needs to cool buildings under climate warming scenarios; and (F) the monetary value added to property by the presence of the tree.

The NTBC model does not include a myriad of other important ecological benefits that trees provide, including wildlife structural habitat, primary production (food), invasive species control, etc.

**Results & Discussion**

*Carbon Dioxide Impacts*

Large mature trees take up significant quantities of carbon dioxide from the atmosphere. With rapidly rising global CO$_2$ levels and concern about concomitant climate change it is imperative that we maintain CO$_2$ sinks whenever possible and when not possible we should understand the magnitude of our impacts upon atmospheric CO$_2$. The NTBC model considers two ways in which the presence of trees reduces human-based increases in atmospheric CO$_2$:

1. **Sequestration**: how much CO$_2$ the trees directly take up from the atmosphere and convert to plant tissue during photosynthesis. Note that trees respire (giving off CO$_2$) at the same time they take up CO$_2$ so this sequestration value is really the net uptake rate. The model values are very general and do not take into account many significant variables that influence CO$_2$ uptake rates such as the exact amount of leaf area, exposure to sunlight, and soil conditions. Thus they should be taken as ballpark estimates rather than highly accurate representations.

2. **Avoidance**: the presence of large, mature trees can reduce the energy costs associated with heating and cooling nearby buildings. In warm periods, trees provide shade during the day reducing the energy need for cooling the building interior. During colder periods, trees provide protection and longwave re-radiation, also reducing the energy needs for climate control inside the building. Furthermore, the presence of a significant vegetative cover reduces the regional / local “urban heat island effect” – once again reducing energy needs for interior climate control. The use of energy to provide climate control entails some mode of energy production, many of which directly cause substantial CO$_2$ emissions. The estimates of energy savings and associated CO$_2$ emissions in this model come from assumptions that fossil fuels will be burned in energy generation. It could be argued that in the Pacific Northwest where much of our energy comes from hydroelectric sources, some of this avoidance cost would not apply. However, fossil fuel based power generation remains a significant component of heating most buildings.

The removal of the 123 trees for construction will reduce campus CO$_2$ sequestration capabilities by about 29,816 pounds per year (Table 1). 82% of this sequestration loss comes from the removal of the large coniferous species (western redcedar and Douglas-fir). Particularly large individual trees are high significant to CO$_2$ sequestration. The largest western redcedar and Douglas-fir individuals are each estimated to sequester 405 lbs/yr. If the avoidance of additional CO$_2$ input to the atmosphere that
results from greater energy needs is considered these 123 trees provide a total CO₂ benefit of nearly 50,000 lbs./yr.

Mitigation of tree cover loss is often accomplished by planting tree seedlings or young potted trees. The NTBC model was used to estimate the CO₂ benefits of these young potted mitigation trees (seedlings would have a much lower CO₂ function and thus would require many more trees to offset the CO₂ function loss) (Table 1). Using this analysis, it would require 9,916 mitigation trees to offset the loss in CO₂ sequestration and over 11,000 mitigation trees to offset the total loss in CO₂ function provided by the 123 trees removed in this construction project (Table 1). These values are valid estimates for trees of 1-inch DBH and as those trees grow their CO₂ function value will grow as well. Thus, if one considers over time how such trees grow, a smaller number of planted mitigation trees might be acceptable. This could be difficult to calculate, as the growth rate of these trees will be site- and weather-specific. On the other hand, this also assumes all of the planted trees will survive (a rare occurrence in a restoration planting). In the end, a mitigation planting of 10,000 trees in response to the removal of 123 trees is a ratio of 81:1 – a very high replacement ratio (5:1 or 10:1 are more common).

Table 1. Results of NTBC model for annual CO₂ benefits of trees, annual CO₂ functions of 1-inch DBH trees that are typically used in mitigation plantings, and the number of these small trees required to offset the loss of CO₂ benefits when mature trees are moved for construction.

<table>
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<th>Species</th>
<th># trees</th>
<th>Sequestered (lbs)</th>
<th>Avoided (lbs)</th>
<th>Total (lbs)</th>
<th>1-inch DBH Tree</th>
<th># 1-inch DBH potted trees to replace total CO₂ benefits</th>
<th>Avoided (lbs)</th>
<th>Total (lbs)</th>
<th># 1-inch DBH potted trees to replace total CO₂ benefits</th>
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<td>352</td>
<td>3.89</td>
<td>0.76</td>
<td>4.65</td>
<td>60</td>
<td>76</td>
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<tr>
<td>Paper birch</td>
<td>2</td>
<td>145</td>
<td>119</td>
<td>265</td>
<td>7.47</td>
<td>1.79</td>
<td>9.26</td>
<td>19</td>
<td>29</td>
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<tr>
<td>Spruce</td>
<td>1</td>
<td>186</td>
<td>125</td>
<td>311</td>
<td>2.61</td>
<td>1.32</td>
<td>3.93</td>
<td>71</td>
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<tr>
<td>Sycamore</td>
<td>2</td>
<td>282</td>
<td>85</td>
<td>368</td>
<td>9.55</td>
<td>1.51</td>
<td>11.06</td>
<td>30</td>
<td>33</td>
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<td></td>
</tr>
</tbody>
</table>

**TOTALS** 123 29,816 20,068 49,885 42.8 9.1 51.9 9,916 11,162

Another way to examine the loss in CO₂ function is to compare the magnitude in loss of function to the usual impacts of our campus. One of our campus’ largest impacts on atmospheric CO₂ would be the amount of CO₂ emitted by automobiles burning fossil fuels while being driven to campus. Thus we calculated the CO₂ impacts of a student driving to campus based upon the following assumptions:
• The student would attend classes 4 days/week for 3 academic quarters (120 days/yr)
• They would drive an average RT commute to UWB of 15 miles
• Their car would average 25 miles per gallon of gasoline
• The average passenger car emits about 20 lbs CO$_2$ per gallon of gasoline burned

These assumptions are obviously not accurate for each person but there are reasonable expectations that they could deviate both above and below the values presented here (for faculty and staff as well as students). Staff commute days per year would be much greater, but some faculty and students only come to campus for as little as two days per week. Using the above assumptions this typical driver would emit 1,440 lbs CO$_2$ per year in their commute to UWB. This means that the loss in CO$_2$ sequestration from removing these trees would be equal to about 21 students and the loss in total CO$_2$ function would be equivalent to about 35 students. This points out how important our efforts are to promote alternative transportation to campus. If we could get just 20 – 40 individuals out of their single-occupancy vehicles this would offset the loss in CO$_2$ function that our campus experienced as a result of the loss of these trees.

Note that the transportation analysis is not meant to imply that we can simply promote transportation choices to fully offset the loss of those trees. The trees provide a rich array of other important functions, some of which were analyzed and will be discussed below in coming sections.
Stormwater Benefits

As discussed previously, in an urban environment trees work to reduce stormwater runoff following precipitation events. The NTBC Models measure the stormwater benefits that urban trees provide in two ways:

a) Gallons of stormwater runoff intercepted- this is an estimate of how many gallons of stormwater runoff the tree will intercept annually through the mechanisms listed above. This is calculated using a complex interception model developed by Xiao et. al. (1998; cited in McPherson et. al. 2002).

b) Monetary value: this is an estimate of the economic value, in dollars, of the stormwater runoff reduction that the tree performs. This number is derived from the average cost to meet the minimum requirements of engineered solutions to treat and control stormwater flows as outlined by McPherson (2002).

Table 2. Results of NTBC model for stormwater interception by trees, stormwater interception of 1-inch DBH trees that are typically used in mitigation plantings, and the number of these small trees required to offset the loss of stormwater benefits when mature trees are removed for construction.

<table>
<thead>
<tr>
<th>Species</th>
<th># trees</th>
<th>Gallons intercepted</th>
<th>Monetary benefits ($)</th>
<th>Gallons intercepted</th>
<th>Monetary benefits ($)</th>
<th># potted trees to replace gallons intercepted</th>
<th># potted trees to replace monetary benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas-fir</td>
<td>44</td>
<td>3,757</td>
<td>135,339</td>
<td>22</td>
<td>0.62</td>
<td>171</td>
<td>218,289</td>
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<tr>
<td>Western redcedar</td>
<td>33</td>
<td>4,716</td>
<td>169,683</td>
<td>22</td>
<td>0.62</td>
<td>214</td>
<td>273,682</td>
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<tr>
<td>Big leaf maple</td>
<td>18</td>
<td>534</td>
<td>19,211</td>
<td>6</td>
<td>0.17</td>
<td>89</td>
<td>113,006</td>
</tr>
<tr>
<td>Red alder</td>
<td>3</td>
<td>32</td>
<td>1162</td>
<td>9</td>
<td>0.24</td>
<td>4</td>
<td>4,842</td>
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<tr>
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<td>2</td>
<td>36</td>
<td>1307</td>
<td>14</td>
<td>0.38</td>
<td>3</td>
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<td>Spruce</td>
<td>1</td>
<td>49</td>
<td>1746</td>
<td>22</td>
<td>0.62</td>
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<tr>
<td>Sycamore</td>
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<td>27</td>
<td>963</td>
<td>14</td>
<td>0.39</td>
<td>2</td>
<td>2,469</td>
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<tr>
<td><strong>TOTALS</strong></td>
<td><strong>123</strong></td>
<td><strong>9,151</strong></td>
<td><strong>329,411</strong></td>
<td><strong>109</strong></td>
<td><strong>3.0</strong></td>
<td><strong>484</strong></td>
<td><strong>618,543</strong></td>
</tr>
</tbody>
</table>

According to the NTBC models, the trees removed during construction intercepted about 9,151 gallons of stormwater runoff per year (Table 2). Western redcedars accounted for 51.5% of total gallons intercepted, while Douglas-fir and western redcedar combined accounted for 92% of total gallons intercepted. To offset the amount of stormwater intercepted on an annual basis by the 123 trees removed would require the planting of approximately four times as many 1” DBH trees typically used in mitigation plantings.

Increased stormwater runoff from the UW3 construction area as a result of the removal of trees will likely carry negative impacts for water quality, translating to negative impacts on freshwater habitat and salmon habitat. As previously mentioned, there is a wealth of scientific literature demonstrating the negative impacts on freshwater and marine habitat associated with urban stormwater runoff. In urbanized areas, impervious surfaces (asphalt, concrete, buildings) collect oil, gasoline and other contaminants associated with motor vehicle use as well as a variety of other contaminants associated with urbanized land use. When a storm event occurs, precipitation hits these impervious surfaces and runs off, collecting contaminants in the process and depositing them in waterways with negative consequences for stream dwelling organisms.
There are currently methods to clean stormwater runoff from impervious surfaces before it hits streams and rivers, such as oil and water separators, and the UWB can and does make an effort to clean up stormwater from its current paved areas before it is routed into the wetland. However, we don’t understand the scope of all human-made chemicals that are components of urban stormwater runoff and their toxicity for water dwelling organisms, such as salmon.

A recent study illustrates this reality: Scholz et al. (2011) found when investigating re-occurring Coho salmon die-offs of 60-100% in Puget Sound lowland urban streams that adult Coho are sensitive to heavy metals and petroleum hydrocarbons, which commonly originate from motor vehicles, and that there are likely as-yet unidentified toxins in urban runoff that are causing the high rate of die-offs that were observed. An increase in volume of stormwater runoff from new impervious surfaces on campus (including a new roadway) entering the campus wetlands and North Creek (assuming that the runoff from the area where construction is occurring will be managed as it has been) may result in an increase in the volume of contaminants entering the campus wetlands and North Creek, potentially including contaminants that are currently unidentified and which are not caught by the current filtration systems.

There is a potential benefit to salmon resulting from the increased volume of runoff entering North Creek, and that is an increase in water levels during periods of low water flow such as the summer drought period. However the benefit of increased stream depth is questionable if it brings with it increased levels of contaminants. Also of concern is the influx of stormwater runoff into North Creek during the wet seasons when stream flows are at their highest levels. According to the NTBC models the evergreen trees on campus, which retain their canopy year-round and perform more stormwater interception during winter months than deciduous species, account for 8,522 gallons of stormwater interception annually (93% of stormwater interception performed by the removed trees). This additional influx of stormwater into North Creek during periods of high flow will potentially contribute to more erosion of stream banks and sedimentation of the stream, which carries negative consequences for stream biodiversity.

Literature cited

Bibliography
Description of how trees reduce stormwater runoff
LIFE CYCLE COST ANALYSIS APPROACH

Analysis of life cycle cost issues is critical in any predesign effort to ensure that the project will bring the University the best value in both first cost and ongoing building costs. Though the LCCT tool provided by OFM was not utilized in this case, the predesign has included the following efforts to ensure that the team was able to evaluate systems options and make smart decisions to come to the best value target budget numbers for the project. This alternate method of incorporating Life Cycle Cost Analysis in predesign meets the intent of the minimum LCCA related to the comparison of alternative systems as described in the 2016 predesign manual.

Part 1 - Life Cycle Cost Analysis Spreadsheet
Information gathered from Target Value Budget, Benchmarking effort, C-100 form, UWB Facilities/Operations

Because the delivery method for this project will be progressive design build, the predesign has defined high level sustainability goals and targets for systems but no specific design solutions to support those goals (external skin or mechanical systems) have been selected. The purpose of a life cycle cost analysis would be to select a design that ensures that the new building provides the lowest total cost of ownership consistent with the project’s intended quality, function, and life span. This is difficult in this instance where we have developed a program, cost, and FTE count that will be supported by the building, but have intentionally not made prescriptive decisions about materials/systems, and are thus unable to include values for first cost of actual systems, first year energy consumption, energy costs, maintenance costs, or useful life of system components. We also do not have a full Uniformat estimate for a specific solution based on this approach. We have instead developed a target budget for the project using Uniformat categorization (reference Section 5 and Appendix D for more information). In addition, though program information has been developed and included, room configurations and the number of experiential learning labs and STEM focused classrooms (which may impact mechanical system scale and components) are not finalized in PreDesign. The team used the cost information and data from UWB Facilities to complete the new construction tab on the OFM lifecycle cost spreadsheet, LCCModel 2016.

Part 2 - Documentation of Systems + LCCA information for Benchmarks
Information gathered in comparison of Benchmarking, including ELCCA for STEM BUILDING 1 (SLOPED SITE) - Discovery Hall

Per the OFM description, the primary difference between the LCCT and the ELCCA is that the LCCT must quantify all costs associated with a project whereas the ELCCA includes a process focused primarily on evaluating energy using systems. The core intent of the LCCA is to compare alternative designs. We have completed an effort similar to that in our benchmarking analysis. We gathered data (organized in Uniformat categories) for three projects recently completed or under construction that received state funding: STEM BUILDING 1 (SLOPED SITE) - UW Bothell Discovery Hall, STEM BUILDING 2 (FLAT SITE) - WSU North Puget Sound Everett STEM building, and STEM BUILDING 3 (FLAT SITE) - CWU Science II Building. We evaluated the cost of the structure, stairs, interiors, systems, and equipment on these projects and used this to develop our target value budget (Reference Section 5 and Appendix D). These projects and the materials/systems that were chosen were vetted through the ELCCA requirements of the state, so we have assumed that they were chosen as a best value to provide the lowest total cost of ownership consistent with the project’s intended quality, function, and life span.

Part 3 - List of Priorities and Goals for Design-Build Team
Information gathered from Eco-Charette & systems discussions, as well as targets for LEED + energy savings from UWB

The Phase 4 project will complete a full ELCCA during the design phase once a progressive design build team has been selected. Conducting the LCCA effort will be more valuable once the team is selected as more variables and data will be available to help determine the most cost efficient design options to achieve program and sustainability goals. However, to set up the design build team with the goals and priorities established with the stakeholders and user groups in Predesign, the team created a checklist of key goals and strategies for use of LCCA in the design phases.
F.1 PART I - LIFE CYCLE COST ANALYSIS SPREADSHEET

Analysis of life cycle cost issues is critical in any predesign effort to ensure that the project will bring the University the best value in both first cost and ongoing building costs. Though the LCCT tool provided by OFM was not utilized in this case, the predesign did use the Life Cycle Cost Analysis Spreadsheet provided by the OFM. Three options were considered and documented in this spreadsheet. These alternatives, in addition to the option not to build any additional space (Alternative 1) are described in Section 2. Alternatives 2, 3, and 4 were evaluated with the spreadsheet to weigh the benefits of leasing space, acquisition/purchase of space, and new construction from a life cycle cost perspective. The following documents that analysis.

Life Cycle Cost Analysis - Project Summary

<table>
<thead>
<tr>
<th>Agency</th>
<th>360 University of Washington</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Title</td>
<td>UW Bothell Phase 4 - Academic STEM</td>
</tr>
</tbody>
</table>

| Existing Description | This is a new facility to support enrollment growth in high-demand STEM fields |

| Lease Option 1 Description | LONG TERM LEASE: 15 year average of the rents for the UW Bothell Main Street lease; OpEx for Main Street (approx $10 per SF) as well. TIs were based on the Main Street number of $150 per SF - the $85 TI allowance. |

| Lease Option 2 Description | |

| Construction Option Description | NEW CONSTRUCTION: 78,674 gsf new building to accommodate teaching, learning, undergraduate research, and office space for the School of STEM at UW Bothell. |

| Purchase Option Description | PURCHASE / RENOVATION: Acquisition cost is based on BPB estimated purchase price in late 2020 (22 M for about 49K of office space or about $450 per SF). Assumes core+shell of building accepts program requirements and is compliant with current codes and standards. |

<table>
<thead>
<tr>
<th>Lease Options Information</th>
<th>Existing Lease</th>
<th>Lease Option 1</th>
<th>Lease Option 2</th>
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<td>-</td>
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<td>$ -</td>
<td>$ 2,886,595</td>
<td>$ -</td>
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<tr>
<td>Full Service Cost/ SF [Initial Term of Lease]</td>
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<td>$ 34.80</td>
<td>$ -</td>
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<tr>
<td>Occupancy Date</td>
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<td>Project Initial Costs</td>
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<tr>
<td>RSF/Person Calculated</td>
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<td>-</td>
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<td>$ -</td>
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Financial Analysis of Options

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<td>Lease 2</td>
<td>Construction</td>
<td>Purchase</td>
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<td>Financing Means</td>
<td>Current</td>
<td>Current</td>
<td>Current</td>
<td>GO Bond</td>
<td>COP</td>
<td>COP Deferred</td>
<td>6-20</td>
<td>GO Bond</td>
<td>COP</td>
<td>COP Deferred</td>
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<td>0 Year Cumulative Cash</td>
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<td>$</td>
<td>$</td>
<td>$</td>
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<table>
<thead>
<tr>
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<th>Lease 2</th>
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<th>Purchase</th>
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<tbody>
<tr>
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<td>Current</td>
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<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
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</table>

2015, 2016, and 2017 are the year analysis period for the year 2 option using Current financing. This option becomes the best financial alternative in 2019.

<table>
<thead>
<tr>
<th>Financial Comparisons</th>
<th>Existing Lease</th>
<th>Lease 1</th>
<th>Lease 2</th>
<th>Construction</th>
<th>Purchase</th>
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</thead>
<tbody>
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<td>Current</td>
<td>Current</td>
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<td>$</td>
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</tbody>
</table>

The best NPV result for the 50 year analysis period is the construction option using GO Bond financing. This option becomes the best financial alternative in 2058.

* Defers payment on principle for 2 years while the building is being constructed. See instructions on Capitalized Interest.

Cumulative Cash - NPV of Exist, Lease, and Own Options

- No Existing Lease
- NPV New Lease Option 1
- No Lease Option 2
- NPV Construction Option - GO Bond
- Construction Option COP Not Shown
- Construction Option COP Deferred Not Shown
- Construction Option 63-20 Not Shown
- NPV Purchase Option - GO Bond
- Purchase Option COP Not Shown
- Purchase Option COP Deferred Not Shown
- Purchase Option 63-20 Not Shown
- 0 Year Analysis Period
- = 30 Year Baseline
- = 50 Year Baseline

- $500
- $450
- $400
- $350
- $300
- $250
- $200
- $150
- $100
- $50
- $0

- 2014
- 2024
- 2034
- 2044
- 2054
- 2064
- 2074

Year

Millions

The Miller Hull Partnership | UW BOTHELL SCIENCE TECHNOLOGY ENGINEERING AND MATHEMATICS
### Financial Assumptions

Analysis Period Start Date: 1/2/2019  
User Input Years of Analysis: 0

All assumptions subject to change to reflect updated costs and conditions.

<table>
<thead>
<tr>
<th></th>
<th>Lease Options</th>
<th>Construction Option</th>
<th>Purchase Option</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Inflation / Interest Rate</td>
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</tbody>
</table>

See Financial Assumptions tab for more detailed information.

COP Deferred and 63-20 Financing defer the payment on principle until construction completion.

**New Lease Assumptions**

Real Estate Transaction fees are 2.5% of the lease for the first 5 years and 1.25% for each year thereafter in the initial term of the lease.

Tenant Improvements are estimated at $65 per rentable square foot.

IT Infrastructure is typically estimated at $350 per person.

Furniture costs are typically estimated at $500 per person and do not include new workstations.

Moving, Vendor, and Supplies are typically estimated at $205 per person.

**Construction Option Assumptions**

Assumes a 2 month lease to move-in overlap period for outfitting building and relocation.

Assumes surface parking.

The floor plate of the construction option office building is 25,000 gross square feet.

The estimated total project cost for construction is $420.00 per square foot.

See the Capital Construction Defaults tab for more construction assumptions.

---

### Annual Cash Flow of Existing, New Lease, and Own Options

![Annual Cash Flow Chart](image-url)
**APPENDIX F  LIFE CYCLE COST ANALYSIS**

Alternative 2 - Lease Option

<table>
<thead>
<tr>
<th>Added Services</th>
<th>New Lease Operating Costs (Starting in current year)</th>
<th>Known Cost / SF / Year</th>
<th>Estimated Cost / SF / Year</th>
<th>Total Cost / Year</th>
<th>Cost / Month</th>
<th>Escalated to lease start date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (Electricity, Natural Gas)</td>
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<td>$1.18</td>
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<tr>
<td>Janitorial Services</td>
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<td>$ -</td>
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<tr>
<td>Pest Control</td>
<td>$0.02</td>
<td>$0.06</td>
<td>$1,544</td>
<td>$129</td>
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<tr>
<td>Security</td>
<td>$0.10</td>
<td>$0.12</td>
<td>$7,720</td>
<td>$643</td>
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<td>Maintenance and Repair</td>
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<td>$231,603</td>
<td>$19,300</td>
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<td>Management</td>
<td>$0.75</td>
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<td>$4,825</td>
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<td>Additional Parking</td>
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<td>Other</td>
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<tr>
<td><strong>Total Operating Costs</strong></td>
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<table>
<thead>
<tr>
<th>New Lease One Time Costs</th>
<th>Current Estimate</th>
<th>Calculated (for reference)</th>
<th>Per Std % $65 per SF</th>
</tr>
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<tbody>
<tr>
<td>Real Estate Transaction Fees</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
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<tr>
<td>Tenant Improvements</td>
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<td>$1,158,015</td>
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<tr>
<td>IT Infrastructure</td>
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<tr>
<td>Furniture Costs</td>
<td>$1,930,025</td>
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<td>$ -</td>
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<tr>
<td>Building Security and Access Systems</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
</tr>
<tr>
<td>Moving Vendor and Supplies</td>
<td>$77,201</td>
<td>$ -</td>
<td>$ -</td>
</tr>
<tr>
<td>Other / Incentive</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$7,411,296</td>
<td>$1,158,015</td>
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</table>

<table>
<thead>
<tr>
<th>Biennium Budget Impacts for New Lease</th>
<th>Biennium Time Period Finish</th>
<th>Existing Lease Option</th>
<th>New Lease Option 1</th>
<th>Biennium Impact:</th>
</tr>
</thead>
<tbody>
<tr>
<td>17-19 Biennium Lease Expenditure</td>
<td>7/1/2017 - 6/30/2019</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
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<tr>
<td>19-21 Biennium Lease Expenditure</td>
<td>7/1/2019 - 6/30/2021</td>
<td>$ -</td>
<td>$9,008,199</td>
<td>$9,008,199</td>
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<tr>
<td>21-23 Biennium Lease Expenditure</td>
<td>7/1/2021 - 6/30/2023</td>
<td>$ -</td>
<td>$6,387,611</td>
<td>$6,387,611</td>
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<tr>
<td>23-25 Biennium Lease Expenditure</td>
<td>7/1/2023 - 6/30/2025</td>
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<td>$6,387,611</td>
<td>$6,387,611</td>
</tr>
<tr>
<td>25-27 Biennium Lease Expenditure</td>
<td>7/1/2025 - 6/30/2027</td>
<td>$ -</td>
<td>$6,387,611</td>
<td>$6,387,611</td>
</tr>
</tbody>
</table>

**Lease Option 1 Information Sheet**

- **Requires a user input**: Green Cell = Value can be entered by user. Yellow Cell = Calculated value.

- **New Lease Option 1 Description**: LONG TERM LEASE: 15 year average of the rents for the UW Bothell Main Street lease, Dpdx for Main Street (approx $10 per SF) as well. TIs were based on the Main Street number of $150 per SF - the $85 TI allowance.
**Alternative 3 - Purchase / Renovation**

**Purchase / Renovation Information Sheet**

* Requires a user input | Green Cell = Value can be entered by user. | Yellow Cell = Calculated value.

 PURCHASE / RENOVATION: Acquisition cost is based on BPR estimated purchase price in late 2020 (22 M for about 49K of office space or about $450 per SF). Assumes core+shell of building accepts program requirements and is compliant with current codes and standards.

### Project Location
- **Bothell**
- Market Area = King-North

### Statistics
- **Gross Sq Ft**: 77,201
- **Usable Sq Ft**: 55,075
- **Space Efficiency**: 71%
- **Estimated Acres Needed**: 3.00

### Estimated MACC Cost per Sq Ft
- **$314.77**

### Estimated Total Project Costs per Sq Ft
- **$929.53**

### Escalated MACC Cost per Sq Ft
- **$365.01**

### Escalated Total Project Costs per Sq Ft
- **$1,077.90**

### Move In Date
- **1/1/2021**

### Interim Lease Information
- **Start Date**
- **Length of Lease (in months)**
- **Square Feet (holdover/temp lease)**
- **Lease Rate- Full Serviced ($/SF/Year)**
- **One Time Costs (if double move)**

### Construction Cost Estimates (See Capital Budget System For Detail)

<table>
<thead>
<tr>
<th></th>
<th>Known Costs</th>
<th>Estimated Costs</th>
<th>Cost to Use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acquisition Costs Total</strong></td>
<td>$37,740,450</td>
<td>$750,000</td>
<td>$37,740,450</td>
</tr>
</tbody>
</table>

#### A & E
- **Consultant Services**
  - A & E Fee Percentage (Defaults to Remodel): 8.82%
  - Pre-Schematic Design services: $100,000
  - Construction Documents: $2,143,282
  - Extra Services: $250,000
  - Other Services: $150,000
  - Design Services Contingency
- **Consultant Services Total**: $2,643,282

#### Construction Contracts
- **Site Work**
- **Related Project Costs**: $5,000,000
- **Facility Construction**: $19,300,250
- **MACC SubTotal**: $24,300,250

#### Construction Additional Items
- **Construction Contingency (5% default)**: $1,215,013
- **Non Taxable Items**: $-
- **Sales Tax**: $2,308,524
- **Construction Additional Items Total**: $3,523,536

#### Equipment
- **Equipment**: $2,502,940
- **Non Taxable Items**: $-
- **Sales Tax**: $86,982
- **Equipment Total**: $2,589,922

#### Art Work Total
- **Total**: $121,501

#### Other Costs
- **Total**: $1,826,428

#### Other Costs Total
- **Total**: $1,826,428

#### Project Management Total
- **Total**: $2,929,455

#### Grand Total Project Cost
- **Total**: $75,674,825
Alternative 3 - Purchase / Renovation

### Construction One Time Project Costs

<table>
<thead>
<tr>
<th>One Time Costs</th>
<th>Estimate</th>
<th>Calculated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moving Vendor and Supplies</td>
<td></td>
<td>$205 / Person in FY09</td>
</tr>
<tr>
<td>Other (not covered in construction)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$</td>
<td>$</td>
</tr>
</tbody>
</table>

### Ongoing Building Costs

<table>
<thead>
<tr>
<th>Added Services</th>
<th>New Building Operating Costs</th>
<th>Known Cost / GSF/ 2021</th>
<th>Estimated Cost / GSF/ 2021</th>
<th>Total Cost / Year</th>
<th>Cost / Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Energy (Electricity, Natural Gas)</td>
<td>$2.01 $1.18</td>
<td>$155,174 $12,931</td>
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<td></td>
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<tr>
<td>☐ Janitorial Services</td>
<td>$1.42 $1.47</td>
<td>$109,625 $9,135</td>
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<td></td>
</tr>
<tr>
<td>☐ Utilities (Water, Sewer, &amp; Garbage)</td>
<td>$0.45 $1.56</td>
<td>$34,740 $2,895</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>☐ Grounds</td>
<td>$- $50.00</td>
<td>$- $-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>☐ Pest Control</td>
<td>$0.02 $0.06</td>
<td>$1,544 $129</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>☐ Security</td>
<td>$1.14 $0.12</td>
<td>$88,009 $7,334</td>
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<td></td>
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<tr>
<td>☐ Maintenance and Repair</td>
<td>$12.21 $6.22</td>
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<tr>
<td>☐ Management</td>
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<tr>
<td>☐ Road Clearance</td>
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<td>$- $-</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>☐ Telecom</td>
<td>$- $50.00</td>
<td>$- $-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>☐ Additional Parking</td>
<td>$10.00 $-</td>
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</tr>
<tr>
<td>☐ Other</td>
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<td>$- $-</td>
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</tr>
<tr>
<td><strong>Total Operating Costs</strong></td>
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<td></td>
</tr>
</tbody>
</table>
Alternative 4 - New Construction

Construction Information Sheet

- **Requires a user input**
- **Green Cell** = Value can be entered by user.
- **Yellow Cell** = Calculated value

**Construction Project Description**
- **NEW CONSTRUCTION**: 78,674 sf new building to accommodate teaching, learning, undergraduate research, and office space for the School of STEM at UW Bothell.

**Project Location**
- Bothell Market Area = King-North

**Statistics**
- Gross Sq Ft: 78,647
- Usable Sq Ft: 52,415
- Space Efficiency: 67%
- Estimated Acres Needed: 3.00
- MACC Cost per Sq Ft: $552.00
- Estimated Total Project Costs per Sq Ft: $772.80
- Escalated MACC Cost per Sq Ft: $627.00
- Escalated Total Project Costs per Sq Ft: $896.15

**Move In Date**
- 6/1/2021

**Interim Lease Information**

<table>
<thead>
<tr>
<th>Description</th>
<th>Start Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lease Start Date</td>
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</tr>
<tr>
<td>Length of Lease (in months)</td>
<td></td>
</tr>
<tr>
<td>Square Feet (Holdover/temp lease)</td>
<td></td>
</tr>
<tr>
<td>Lease Rate - Full Serviced ($/SF/Year)</td>
<td></td>
</tr>
<tr>
<td>One Time Costs (if double move)</td>
<td></td>
</tr>
</tbody>
</table>

**Construction Cost Estimates (See Capital Budget System For Detail)**

<table>
<thead>
<tr>
<th></th>
<th>Known Costs</th>
<th>Estimated Costs</th>
<th>Cost to Use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acquisition Costs Total</strong></td>
<td>$0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Consultant Services</strong></td>
<td>$4,611,098</td>
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<td>$6,611,098</td>
</tr>
<tr>
<td>A &amp; E Fee Percentage (if services not specified)</td>
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<td>5.92% Std</td>
<td>7.34%</td>
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<tr>
<td>Pre-Schematic Design services</td>
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<tr>
<td>Construction Documents</td>
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<tr>
<td>Extra Services</td>
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<tr>
<td>Other Services</td>
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</tr>
<tr>
<td>Design Services Contingency</td>
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<td><strong>Consultant Services Total</strong></td>
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<td>$1,954,845</td>
<td>$6,611,098</td>
</tr>
<tr>
<td><strong>Construction Contracts</strong></td>
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</tr>
<tr>
<td>Site Work</td>
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</tr>
<tr>
<td>Related Project Costs</td>
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<tr>
<td><strong>MACCC SubTotal</strong></td>
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<tr>
<td>Construction Contingency (5% default)</td>
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<tr>
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<tr>
<td>Sales Tax</td>
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<tr>
<td>Equipment</td>
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<tr>
<td>Sales Tax</td>
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<tr>
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<td>$263,016</td>
<td>$246,571</td>
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<tr>
<td><strong>Other Costs</strong></td>
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<tr>
<td>Other Costs</td>
<td>$1,826,448</td>
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<td></td>
</tr>
<tr>
<td><strong>Other Costs Total</strong></td>
<td>$1,826,448</td>
<td>$1,826,448</td>
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</tr>
<tr>
<td><strong>Project Management Total</strong></td>
<td>$2,929,455</td>
<td></td>
<td>$2,929,455</td>
</tr>
<tr>
<td><strong>Grand Total Project Cost</strong></td>
<td>$74,999,837</td>
<td>$33,439,423</td>
<td>$74,999,837</td>
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</table>
Alternative 4 - New Construction

<table>
<thead>
<tr>
<th>Construction One Time Project Costs</th>
<th>Estimate</th>
<th>Calculated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moving Vendor and Supplies</td>
<td>$ -</td>
<td>$ -</td>
</tr>
<tr>
<td>Other (not covered in construction)</td>
<td>$ -</td>
<td>$ -</td>
</tr>
<tr>
<td>Total</td>
<td>$ -</td>
<td>$ -</td>
</tr>
</tbody>
</table>

$205 / Person in FY09

<table>
<thead>
<tr>
<th>Ongoing Building Costs</th>
<th>Known Cost /GSF/ 2021</th>
<th>Estimated Cost /GSF/ 2021</th>
<th>Total Cost / Year</th>
<th>Cost / Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (Electricity, Natural Gas)</td>
<td>$ 1.82</td>
<td>$ 1.18</td>
<td>$ 143,138</td>
<td>$ 11,928</td>
</tr>
<tr>
<td>Janitorial Services</td>
<td>$ 1.42</td>
<td>$ 1.47</td>
<td>$ 111,679</td>
<td>$ 9,307</td>
</tr>
<tr>
<td>Utilities (Water, Sewer, &amp; Garbage)</td>
<td>$ 0.45</td>
<td>$ 1.56</td>
<td>$ 35,381</td>
<td>$ 2,949</td>
</tr>
<tr>
<td>Grounds</td>
<td>$ -</td>
<td>$ 0.00</td>
<td>$ -</td>
<td>$ -</td>
</tr>
<tr>
<td>Pest Control</td>
<td>$ 0.02</td>
<td>$ 0.06</td>
<td>$ 1,573</td>
<td>$ 131</td>
</tr>
<tr>
<td>Security</td>
<td>$ 1.14</td>
<td>$ 0.12</td>
<td>$ 89,658</td>
<td>$ 7,471</td>
</tr>
<tr>
<td>Maintenance and Repair</td>
<td>$ 12.21</td>
<td>$ 6.22</td>
<td>$ 960,280</td>
<td>$ 80,023</td>
</tr>
<tr>
<td>Management</td>
<td>$ 0.78</td>
<td>$ 0.73</td>
<td>$ 61,345</td>
<td>$ 5,112</td>
</tr>
<tr>
<td>Road Clearance</td>
<td>$ -</td>
<td>$ 0.00</td>
<td>$ -</td>
<td>$ -</td>
</tr>
<tr>
<td>Telecom</td>
<td>$ -</td>
<td>$ 0.00</td>
<td>$ -</td>
<td>$ -</td>
</tr>
<tr>
<td>Additional Parking</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
</tr>
<tr>
<td>Other</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
</tr>
<tr>
<td>Total Operating Costs</td>
<td>$ 17.84</td>
<td>$ 11.35</td>
<td>$ 1,403,062</td>
<td>$ 116,922</td>
</tr>
</tbody>
</table>
F.2 PART 2 - BENCHMARKS - SYSTEMS ANALYSIS

The development of benchmarks is described in Section 5 and Appendix D in detail, but it is important to note here how the comparable facilities were evaluated in light of systems and life cycle cost goals.

BENCHMARK 1 - STEM BUILDING 1 (SLOPED SITE)
Discovery Hall, University of Washington, Bothell Campus
UW Bothell’s commitment to sustainability was showcased in this building with a LEED Gold design including radiant heating and chilled beams as feature sustainable elements, as well as dashboards to help users understand energy use on campus and in the building itself. The building has a high ratio of glazing to solid skin in the exterior envelope made up of a combination of brick, terracotta, glazing, and board formed concrete. Though Discovery Hall has more traditional teaching labs than the smaller experiential learning labs that will be in Phase 4, the proportion of space that will require special HVAC for lab exhaust is similar relative to the proportion of offices and classrooms. The amount of daylight and views in the building work very well for the programs and bring light into all the spaces. UW Bothell would strive to provide a similar access to daylighting and views in the Phase 4 building.

BENCHMARK 2 - STEM BUILDING 2 (FLAT SITE)
University Center Building, WSU North Puget Sound Everett
From the very beginning of the Predesign process for this building, there was a commitment to sustainability and providing a high performance building with low ongoing building costs. The LEED goal was to exceed the state requirement for LEED Silver, with an assumption that LEED Gold would be attainable, and the goals included a high efficiency mechanical system and PV’s as feature sustainable elements. The project’s commitment to high performance was similar to the desires of the UW Bothell facilities and administration. At WSU NPSE, the building operations and maintenance of the environmental control systems were to be engineered and designed for long term operations efficiency and cost performance. Also, the engineering and design of the Building Envelope, Lighting, other end use systems, and HVAC were to emphasize cost effective on-going Building Operations, Maintenance and Energy Performance. The benchmark costs and investment in the ELCCA process on this project were a good example of best value decisions and were valuable comparisons to the other projects. The project also had a commitment to photovoltaics as part of the high performance system. This was different than the other benchmarks, and it was valuable to include the cost for these elements as part of the average of the benchmark costs to ensure that the Phase 4 Design build team would have sufficient budget to explore alternative methods of reaching sustainability and performance goals.

BENCHMARK 3 - STEM BUILDING 4 (FLAT SITE)
Science II Building, Central Washington University
This connection will heat the 120,000 square foot building with waste heat and without increasing CWU’s gas energy consumption. The Science Phase II project will be LEED Silver certified and will achieve high sustainability goals including use of the waste heat via retrofitted boiler plant as feature sustainable element. This building has an exterior envelope consisting of brick, precast concrete, metal panels and glazing with a high ratio of glazing to solid skin.
F.3 PART 3 - LCCA STRATEGY CHECKLIST

This list includes specific targets for operational performance that should be considered by the successful design build team, as well as goals for efficiency and sustainability as developed by the project team or through compliance with local codes.

Performance Goals:
The building operations and maintenance of the environmental control systems shall be engineered and designed for long term operations efficiency and cost performance.

The engineering and design of the Building Envelope, Lighting, other end use systems, and HVAC shall emphasize cost effective on-going Building Operations, Maintenance and Energy Performance.

The following major goals were established in Predesign:

- The project will aim to achieve at least Gold certification from the U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) program
- Preserve existing trees where possible and incorporate felled trees into the design in a meaningful way
- Seek to reduce energy consumption with considerations for the incorporation of energy-efficient mechanical and electrical systems
- Aim to achieve UW Carbon Action Plan goals
- Maximize the program space within the building to minimize the need for future construction.
- Develop the landscape and building in such a way that the two work together, share systems, and complement each other spatially and functionally.
- Integrate material and system designs to create energy- and resource-efficient solutions for the entire project.
- Specify building materials that reduce the negative environmental impact of the project—this includes responsibly harvested and certified wood and low-toxic paints, finishes and adhesives.

The Design Process and Use of LCCA:

It is desirable for the D/B contractor selection process to include a description of the proposer’s approach to developing a high performance design that achieves the energy and sustainability targets. The team could then develop a design that fully meets requirements. The D/B contractor should complete Energy Life Cycle Cost Analysis (ELCCA) studies to inform HVAC, domestic hot water, building envelope, lighting/daylighting and environmental control systems strategies and integrated bundles strategies. These studies should include high performance alternatives identified in Section 3 Systems narratives and any identified by the proposer that would meet or exceed performance requirements. Ideally, these studies would be completed once a validated cost model for the building design has been developed, and systems are sized/scoped sufficiently to enable meaningfully contractor estimates of construction and maintenance costs and a required whole building energy simulation model can be completed.

Additional ELCCA studies may be valuable for all options the team identifies that they believe could provide better overall value to UW Bothell. This may include systems that have a lower overall LCC and/or lower first cost even if there is some sacrifice in energy performance relative to project targets. ELCCA studies shall be used during stages of the design period to support decision-making around final design details and system selection.
**Energy Performance Goals:**

- Minimum annual operational (measured) energy performance that shall be guaranteed during first [1.5 to 3.0] years of operation after building is substantially occupied are as follows:
  1. 50% reduction in energy cost relative to the ASHRAE 90.1 2007 baseline.
  2. Energy Use Index (EUI) operational target of between 65-85 kBTU/gsf-yr.
- Project shall fully meet all mandated provisions of the Washington State Energy Code, regardless of code compliance path.
- Lighting system: Design shall meet space illumination requirements per lighting design standards, with total interior lighting power a minimum of 20% lower than value computed using either TABLE C405.5.2(1) Whole Building or space-by-space values provided in TABLE C405.5.2(2) of the Washington State Energy Code.
- Building envelope: 10% better (lower) overall UAp and SHGCAP than Washington State Energy Code using the component performance building envelope option in Section C402.1.3.
- Minimum energy metering and data acquisition and reporting system requirements shall fully meet all requirements in the 2012 Seattle Energy Code, Section C409. Additional requirements that may exceed these may be found in other portions of this Standard, in which case the more stringent requirement shall apply.
- Facilities shall be designed to achieve Solar Readiness

**Water Performance Goals**

Design of systems and building shall focus on strategies to reduce use of potable water.

- Achieve the equivalent LEED v4 water efficiency credits
  1. Outdoor Water Use Reduction – 2 points (no potable water use for irrigation)
  2. Indoor Water Use Reduction – 3 point (35% reduction in potable water use for indoor fixtures)
  3. Water Metering – 1 point (meter potable and reclaimed water)
- Measurement devices with remote communication capability shall be provided to collect water consumption data for the domestic water supply to the building. Both potable and reclaimed water entering the building project shall be monitored or sub-metered. All building measurement devices, monitoring systems shall be configured to communicate water consumption data to a meter data management system. At a minimum, meters shall provide daily data and shall record hourly consumption of water. The meter data management system shall be capable of electronically storing water meter, monitoring systems, and submeter data and creating user reports showing calculated hourly, daily, monthly, and annual water consumption for each measurement device. This information should be integrated with the UW Bothell campus dashboards for student enrichment.

**LEED Goals**

Design of systems and building achieve an overall minimum Overall LEED-NC Silver Certification, using LEEDv4. In addition to LEED Credits that are required that are cited in the Owner’s Project Requirements, include the following:

- SScr6.1: Stormwater Design: Quantity Control
- SScr6.2: Stormwater Design: Quality Control
- EAcr3: Enhanced Commissioning
- Eacr5: Measurement and Verification. (see also Section 3.6 of this standard for additional requirements)
- IEQcr1: Outdoor Air Delivery Monitoring
- IEQcr1 and IEQcr2: Construction indoor air quality plan
- IEQcr7.1: Thermal Comfort – Design
- IEQcr7.2: Thermal Comfort – Verification (performance of post-occupancy activities to be included as part of required M&V activities)
- IEQcr8.2: Daylight and Views
Measurement and Verification
The D/B team should develop and implement a Building Energy Use Accountability Plan for the performance period. As part of this plan, a Measurement and Verification Plan (M&V) shall be prepared and executed during the performance period in accordance with LEEDv4.

Durability and Function
The building is a 50 year building, which refers to its design and economic life. This means that the building should remain functional and durable for at least 50 years without unforeseen cost for maintenance or repair, with a life extension beyond that time potentially requiring a significant re-investment in the facility. Given that, the primary building materials and systems need to be designed and constructed to promote a long service life.

Service Life Plan
A Service Life Plan should be used to estimate to what extent structural, building envelope and hardscape materials (not mechanical or electrical) will need to be repaired or replaced during the 50 year service life of the building.

Maintenance Plan
A Maintenance Plan should be developed for mechanical, electrical, plumbing and fire protection systems. The Maintenance Plan shall be in accordance with ANSI/ASHRAE/ACCA Standard 180 for HVAC systems. As part of following the standard, the building’s maintenance plan shall include an accounting of basic equipment information and a schedule for all preventative maintenance. The Plan shall address all elements of Section 4 of ANSI/ASHRAE/ACCA Standard 180 and shall develop required inspection and maintenance tasks similar to Section 5 of ANSI/ASHRAE/ACCA Standard 180 for electrical and plumbing systems.
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UW Climate Action Plan
IMPLEMENTATION PLAN, September 2010

I. Introduction
In September 2009, the University of Washington (UW) published the Climate Action Plan (CAP), which described the commitments being made by the UW to meet its obligations under the American College and University Presidents’ Climate Commitment (ACUPCC). The primary focus of that document was to set broad goals and strategies, providing a number of proposed actions, in order to achieve a climate-neutral university having no net greenhouse gas (GHG) emissions. The first carbon reduction target is 15% below 2000 levels by 2020. Considering that the UW is expected to add approximately 2.1 million square feet of space (an increase of 13%) and 8,200 faculty, staff and students (an increase of 11.5%) in that time, the reductions required to fully offset growth and still meet absolute reduction targets require reductions of far more than 15%.

This document was prepared to update the campus-wide actions being taken toward the CAP commitment to reduce GHG emissions. While many of the actions are in early stages and are not yet measurable, they do align with the goals and strategies outlined in CAP, including:

1. Compliance with the No-Net Carbon goal, which presents opportunities for innovation and specifically, for the University of Washington to innovate and lead
2. Ensuring that University processes (teaching, research, administrative, and outreach), and those of its vendors and suppliers, are efficient and sustainable.
3. Designing sustainability into our products (educated students and research) and services we deliver (instruction and outreach)
4. Developing new ways of doing “business” that align with University activities and strategies
5. Creating the future capacity needed to manage sustainably, including skills, values and decision making models

Additionally, the UW is a global leader in environmental science research, education and technology transfer and is recognized nationally as a leader in reducing its carbon footprint, including wise use practices, energy conservation and innovative transportation alternatives. UW researchers are leading authorities on the impact of global warming and are at the forefront of developing new models that refine climate change predictions. In 2009, the UW received an A- on the College Sustainability Report Card and in 2010 received 96/100 on the Princeton Green Rating (highest of all public research universities) and ranked 4th overall on Sierra Club Magazine’s Cool Schools list (See Figure 1). UW students recently voted to create a Campus Sustainability Fund, a nearly $340K fund which will be used to finance projects that increase campus
components. And the first-ever Green Awards honored noteworthy environmental efforts by students, faculty and staff.

While the primary focus of the Climate Action Plan is substantive carbon reduction, others of these goals are part of a larger, more holistic set of strategies which include:

1. Moving forward toward climate neutrality
2. Engaging faculty and students in conservation and related behavior change
3. Integrating formal and informal learning on sustainability
4. Replacing the campus power plant
5. Moving students, faculty and staff to live near the UW
6. More walking/cycling, less reliance on motorized transportation
7. Becoming energy efficient
II. Summary of Campus Accomplishments, Long Term and Short Term Initiatives

A. Funding

Funding strategies enable and support University program goals, including carbon reduction.

Accomplishments:

1. Funded a series of major planning studies that incorporated key CAP goals.
2. Established the student funded Campus Sustainability Fund.
3. Funded a new university architect position to support integrated capital planning.
4. Funded $100,000 for the Environmental Stewardship and Sustainability Office to support CAP implementation planning efforts.
5. Obtained $5 million DOE Smart Grid Grant with $5 million UW matching funding.

Short term (2 year) Goals:

1. Coordinate the launch of the student funded Campus Sustainability Fund within a wider funding framework for the Climate Action Plan.
2. Develop a Conservation Resource Manager Program.
3. Secure permanent funding for ESS office.
4. Fund more detailed planning studies that follow-up on a series of major planning directions, including Green Streets/Clean storm water technology, and SMART Campus.

Long-term Goals:

1. Normalize Climate Action Plan goals and initiatives into overall UW strategic planning.
2. Include ~$5,000,000 2011-13 capital budget request for development of an Energy Conservation Center.
3. Develop a strategic plan for identifying and funding energy saving projects.
4. Reorient capital funding process from building-centric to program and district-centric.
5. Retool the UW’s infrastructure for a non-carbon future.
6. Help the West of 15th neighborhood realize its full potential as eco-district for low–carbon working, living, and recreation.
7. Effectively use life-cycle cost analyses in decision-making. Create an analytical basis for higher investments in CAP reduction initiatives.

B. Academic Engagement in Climate Change

Our goal is to make the UW a sustainable and environmentally friendly institution while incubating interest and excitement for environmental studies in science, social policy, and technology for our students. Not only do attitudes and behaviors need to change, but exciting opportunities for involvement and commitment inside and outside the classroom must be planned and implemented. This will be achieved through:

1. Integrating our students, and faculty in many diverse disciplines traditionally spread across our colleges and campuses in local and campus-wide academic programs and summer research opportunities,
2. Engaging the community at large, through creating awareness,
3. Exploiting our new College of the Environment as the focal point for these activities, and
4. Building bridges of activism that connect our academic and administrative communities in common interests and challenges in the way we operate the University. Examples are as green office practices, spectrum of conservation programs, facilities evaluation and improvements, responsible housing and food service practices, and voluntary public outreach and education.

There are three ways in which to academically engage students in climate change: formal learning, extracurricular/informal learning, and research.

Accomplishments

1. The UW College of the Environment was created in July 2009 in part to enable the University to provide unique, highly regarded, enhanced environmental degree programs that combine academic rigor and advanced learning methodologies. A permanent Dean has been hired and as of July 1, 2010, there are over 1400 majors in the College of the Environment (870 undergraduates, 535 graduate students) and many more majors across campus that have strong ties to sustainability and the natural and built environments.
2. Offered over 500 environmental courses annually.
3. The School of Forest Resources transformed its Paper Science and Engineering (PSE) undergraduate program into a broader Bioresource
Science and Engineering (BSE) program. The first phase of this effort will debut in Fall 2010.

4. The College of the Environment partnered with the Jessie and John Danz and Walker-Ames Lecture Funds administered by the Graduate School, the School of Public Health, the Center for Global Studies, the Jackson School of International Studies, and the UW Alumni Association (UWAA) to produce a public lecture series and a UW course that focuses on food production from the dawn of the human species through to the present from the field to the kitchen, from Seattle to the plains of Africa. (Fall Quarter 2010).

5. Co-hosting (with Oregon State University) the USGS Northwest Regional Climate Science Center. The center will support USGS workforce development through graduate student fellowships to work on regional climate research.

6. Developed new certificate programs in stream restoration, sustainable transportation, low impact development, and decision making for climate change (UW Educational Outreach).

Short-term (2 year) Goals:

1. Pursue new interdisciplinary training opportunities in climate and sustainability science, including increased support for existing and new National Science Foundation Integrative Graduate Education and Research Traineeship (NSF IGERT) programs. (e.g., Bioresource-Based Energy for Sustainable Societies program).

2. Continue planning for an undergraduate leadership minor, sponsored through the colleges of Arts & Sciences, Business, Social Work, Evans School of Public Affairs and the Law School, and designed to provide students with real world experience, as well as a sense of the kind of impact they can have in the future. This program has $2 million dollars in funding, all of which has been raised through donations.

3. Connect with and prepare incoming freshmen and transfer students via continued work with new “Learning Links” advising structure and summer orientation sessions for pre-environment students.

4. Initiate a partnership between Housing and Food Services and the College of the Environment is underway to provide regular academic programming for residents of new undergraduate housing. This is planned to debut in the fall of 2011.

5. Develop a mechanism for connecting faculty and students in research projects of mutual interest, possibly for course credits in the Program on the Environment (PoE) within its new home in the College of the Environment. This will be needed so that students with capstone projects within the PoE and/or summer funding from the Student Green Fund can be
properly supervised and evaluated by faculty, many of whom are new in environmental activism and research themselves.

6. Host Sustainability Summit (see Behavioral Change).

7. Enhance the scope of extra-curricular participatory opportunities for motivated members across our campus community through existing student-led groups. For example, in the short term we are planning to expand the UW Farm, expanding production and increasing the numbers of UW faculty, students and staff who participate in it.

8. Hire and support new faculty who focus on environmental scholarship.

**Long-term Goals:**

1. Connect with and prepare incoming freshmen and transfer students via autumn “Exploring Environmental Majors Seminar,” and events similar to Engineering’s bridge programs and “Discovery Days.”

2. Spread environmental research and scholarship across its traditional campus boundaries in fields such as law and political science, business and economics, basic science and technology, public policy, and public health and environmental safety by engaging deans and new or existing faculty in new constellations of activity.

3. Develop a tri-campus strategy for hiring, support, promotion and tenure, and merit criteria for faculty who focus on environmental scholarship, but reside in departments outside the environmental sciences.

4. Develop new or expanded course offerings that explore the environmental challenges and opportunities that exist at the boundaries between the many disciplines represented within the University.

5. Garner high-level support for broadening the scope of activities within colleges and campuses through strategic investments in environmental and climate-related hires and centers to be proposed by deans and chancellors.

**C. Encouraging Behavior Changes to Reduce Carbon Emissions**

Another important feature of creating a sustainable University is to encourage behavioral changes to reduce carbon emissions. Sustainability guidelines and education/outreach programs for faculty, staff and students need to be created and then implemented.

**Accomplishments:**

1. Created a UW Home Page featuring sustainability; launched an online sustainability pledge; and utilized social media including Facebook and Twitter as well as an e-mail newsletter.

2. Ranked #4 in Sierra Club “Cool Schools.” UW is the leading large public research university in the rankings.
3. Sponsored “Green Bag Networking Lunch” events for staff on voluntary green teams.
4. Co-hosted “Pacific Northwest Sustainability Roundtable” event with U.S. Postal Service (including Starbucks, Boeing, Costco, Nordstrom, 16 other NW companies).
6. Launched first-ever Husky Green Award to recognize efforts on UW sustainability.
7. Received A- on Sustainable Endowment Institute’s “2010 College Sustainability Report Card.”
9. Created the Husky Green Fund, a staff, faculty and alumni donor fund for sustainability.

Short term (2 year) Goals:

1. Create and implement guidelines and education/outreach program for faculty, staff and students on sustainability.
2. Engage Certificate Program in Environmental Management Keystone (masters student's final project) to explore options and research what other universities are doing, including a survey/report card to learn about best practices in schools, colleges, units.
3. Launching a network of UW sustainability coordinators.
4. Launch and manage the student-funded Campus Sustainability Fund.
5. Hold a University sustainability summit in Fall 2010.
6. Conduct behavioral audits in buildings as part of the Smart Grid Demonstration Project.
7. Create a robust set of sustainability-related metrics.
8. Create framework for and begin vetting a set of policies for UW decision makers to consider regarding CAP and sustainability, linked to Office of Planning & Budgeting activities.

Long term goals:

1. Engage students to work with UW Administration on climate reduction behaviors and strategies.
2. Develop a plan to reduce carbon emissions caused by professional travel.
3. Promote sustainable behavior as a cultural norm in Human Resource practices; new student orientation; faculty and staff; and in office and other work environments.
D. **Buildings: New Construction & Existing Buildings**

In order to achieve zero carbon by 2050, major investments in the infrastructure of the University are required. Analysis is currently underway on existing legacy buildings that will provide information to set broader policies where individual building projects can contribute to overall carbon reduction.

The largest source of Scope I & II emissions comes from the power plant, which heats the buildings on the Seattle campus (see figure 2). While replacing the Central Utility Plant is a long term goal, in the interim the focus should be on heating and cooling buildings more efficiently and sustainably, including reducing energy demand and looking for alternative sources of energy.

![Figure 2](image)

**Accomplishments:**

1. In the process of delivering 20 registered LEED® projects on all three campuses that are in various stages of design, construction and pending certification. Certified USGBC LEED projects include 7 Gold, 3 Silver, and 1 Certified. Recent renovations result in energy efficiency savings of 30% higher than the ASHRAE 90.1 standard.

2. UW Tacoma replaced an inefficient boiler with two energy efficient units to service existing facilities and the new Joy Building, and students installed a prototype Rain Garden.
3. UW Bothell purchased Midwest Independent System Operator Renewable Energy Certificate (MISO REC’s) for a total reduction of 4,324 metric tons of CO₂, in order to reduce Scope 2 emissions.

Figure 3

**UW Seattle**

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**Short term (2 year) Goals:**

1. Manage growth issues and space conservation.
2. Continue implementation of Smart Grid Demonstration Project,¹ which will enable measurement and digital communication of electrical consumption

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¹ **Smart Grid Demonstration Project**- the UW-Seattle City Light (SCL) Smart Grid Demonstration Project is one of 12 site-specific subprojects within the "Pacific Northwest Smart Grid Demonstration Project." The project was awarded an American Recovery and Reinvestment Act (ARRA) matching grant by the US Department of Energy (DOE) in November 2009. The project will enable measurement and digital communication of electrical consumption while implementing demand response strategies at various university facilities. This will facilitate the reduction of energy consumption during both peak and off-peak times. It will also deploy smart meters and related electrical infrastructure in campus buildings.
information while implementing demand response strategies at various university facilities.

3. Create a policy for high efficiency energy targets for renovations and new construction.

4. Expand Energy Audits and tune-ups for existing buildings.

5. Continue implementation Solar Photovoltaic (PV) demonstration projects, including a 35 KW roof-top solar PV project on top of the University’s central steam plant.

6. Target LEED gold (Silver minimum) for Phase 3A and 3B projects under construction/in design; continue to review ESCO opportunities for development of a geothermal central plant; and work with City of Tacoma on possible storm water collection/purification swale for the Hood Corridor pathway (UW Tacoma).

**Long term Goals:**

1. Continue the visionary exploration of development scenarios for the West Campus eco-district that aligns with 21st Century green-technology opportunities, such as analyzing alternatives and approaches for replacing the Central Utility Plant and/or exploring alternative energy sources.

2. Connect capital investments with related process improvements that innovatively and aggressively link capital and operating budgets.

3. Develop a prioritized capital investment approach for UW infrastructure as a component of UW’s One Capital Plan.

**E. Transportation/Commuting**

A major source of GHG emissions is transportation. Cutting greenhouse gas emissions will require reductions in emissions related to transportation to, from, and around campus, as well as professional travel.

**Accomplishments:**

1. Preserved 126 secure bicycle parking stalls displaced by capital projects; added 100 new secure bicycle parking stalls; completed development of secure bicycle parking prototype design; developed concept plan for Burke Gilman Trail improvements.
2. Returned to model of increasing parking rates faster than U-PASS rates in order to encourage the use of public transportation over single occupancy vehicles.

3. Updated Commuter Services (U-PASS) business plan (charting a path for continued financial viability over the next 5 years).

4. Completed pedestrian mode needs assessment and programming plan in conjunction with Feet First.

5. Entered strategic partnership with Cascade Bicycle Club, doubled the number of major cycling events each year, and implemented a regular series of cycling workshops.

6. Increased the cost for parking single occupant vehicles at UW Bothell from $380 per year to $505. Also, decreased pricing for the UWB U-Pass.

**Short-term (2 year) Goals:**

1. Encourage ownership of low-emission vehicles by individual commuters and transit agencies.

2. Establish a clearinghouse with information about greener vehicle purchase incentives and savings.

3. Expand programming, infrastructure and support for walkers and cyclists.

4. Improve off-campus parking management.

5. Identify and implement alternative funding model for U-PASS.

6. Maintain high parking rates as compared to alternatives; suppress transit rates as compared to the cost of driving; increase transit rates, as compared to active transportation.

7. Increase programming and support for ridesharing.

8. Increase use of telework and compressed work weeks; establish a telework toolkit and policy clearinghouse.

9. Prioritize use of fleet vehicles (UCAR) over use of private vehicles for business travel;

**Long Term Goals:**

Tactics to address CO2e from commuting attack one of three primary factors, vehicle emission factors, vehicle miles traveled, and transportation mode split. The University’s greatest influence and our best opportunity for substantive results over the long term lies in Transportation Mode Split (TMS). Much of our past success has come from shifting commute activity from the highest impact mode (drive alone) to lower impact modes (primarily transit). The UW’s future
success will hinge on continued incremental reductions in drive alone rates while shifting significant numbers of commuters from motorized modes (including transit) to active transportation (walking and bicycling). Another long term goal is to develop campus infrastructure to support private electric vehicle charging.

The 2005 baseline UW TMS consists of:

<table>
<thead>
<tr>
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<th>SOV</th>
<th>Transit</th>
<th>Rideshare</th>
<th>Walk</th>
<th>Bicycle</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student TMS 2005</td>
<td>13%</td>
<td>9%</td>
<td>41%</td>
<td>31%</td>
<td>1%</td>
<td>5%</td>
</tr>
<tr>
<td>Staff TMS 2005</td>
<td>5%</td>
<td>13%</td>
<td>36%</td>
<td>40%</td>
<td>1%</td>
<td>5%</td>
</tr>
<tr>
<td>Faculty TMS 2005</td>
<td>1%</td>
<td>12%</td>
<td>49%</td>
<td>11%</td>
<td>20%</td>
<td>7%</td>
</tr>
</tbody>
</table>

The UW CAP target of a 15% reduction from 2005 emission levels by 2020 has already been exceeded, with a 23% reduction from 2005 levels achieved by 2010. As a result, 2035 behavioral targets are being set to meet the University’s goal of a 30% reduction in commuting emissions by that date. To attain a 30% reduction in CO2e from commuting the UW is targeting the following 2030 TMS goals:

<table>
<thead>
<tr>
<th></th>
<th>SOV</th>
<th>Transit</th>
<th>Rideshare</th>
<th>Walk</th>
<th>Bicycle</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student TMS 2035</td>
<td>20%</td>
<td>35%</td>
<td>11%</td>
<td>30%</td>
<td>4%</td>
<td>9%</td>
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<tr>
<td>Staff TMS 2035</td>
<td>39%</td>
<td>22%</td>
<td>39%</td>
<td>21%</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>Faculty TMS 2035</td>
<td>21%</td>
<td>22%</td>
<td>39%</td>
<td>39%</td>
<td>9%</td>
<td>9%</td>
</tr>
</tbody>
</table>

F. Professional Travel

Professional travel, a significant contributor to transportation-related GHG emissions, includes air or vehicle travel to and from conferences, typically a longer distance than commuting to and from work, in addition to being less frequent. That said, such travel also plays a vital role in research, teaching, and
administrative activities at the UW. Professional travel also includes fleet and other local business transportation. Reduction targets will have to be carefully balanced against the UW’s research and educational mission. (See Figure 4).

Figure 4

**CO2 emissions - professional air travel**
(all travel reimbursed through UW accounts - the breakdown is approximate; the campuses are not tracked separately)

Accomplishments:

1. The UW fleet size has been reduced by 5.9% since September 2009 and seen a .7% increase in fuel economy, resulting in a 4.4% reduction in total fleet emissions.
2. UW Shuttle has seen a 7.6% increase in ridership.

Short-term (2 year) Goals:

1. Enhance tele/videoconference infrastructure and encourage institutional support.
2. Focus fleet purchasing on electric vehicles and partial electric vehicles; centralize management of compliance reporting for fleet and non-fleet UW
vehicles; develop minimum efficiency requirements for department-owned vehicles, prioritize shared vehicles (U-Car, D-Car) over assigned vehicles.

3. Develop efficiency and occupancy incentives tied to mileage reimbursements.

4. Encourage walking for on-campus and campus adjacent travel.

**Long term Goals:**

1. Improve monitoring of air travel emissions.
2. Develop and implement professional travel policies.
3. Purchase offsets for professionally-funded travel (air and vehicle).
4. Establish department and public bike sharing programs.

**G. Information Technology/Computing**

**Accomplishments:**

1. Completed an ESCO Project at the UW’s primary on campus data center (4545) to increase use of free cooling and to facilitate heat capture from the data center to heat the office tower of the building. The building is on track to save an estimated 4.2 million kWh of electricity, 601 kW of demand, 529 cubic feet (CCF) of water consumption, and 3,713 CCF of sewer consumption annually.
2. Completed construction of data center in UW Tower to provide opportunities for consolidation of campus computing assets from campus buildings to central conditioned computer space. Construction included installation of energy efficient lighting and lighting controls and enables the use of free cooling during the cooler months to reduce energy cost (both dollars and tons of carbon).
3. Installed Building Management Systems (BMS) in the data centers to control, monitor and measure facilities equipment operation and energy utilization.
4. Converted approximately 10% of UW-IT managed servers to virtual servers per year, and migrated older, power-hungry systems to more power-efficient hardware platforms.
5. Identified and completed evaluation of vendors who can provide a scalable and flexible approach to desktop power management.

**Short-term (2 year) Goals:**

1. Improve data center power utilization efficiency (PUE) by decreasing the ratio between total power delivered and power directed to computing work accomplished. Ideal ratio is 1.0. Current data center PUE in the UW’s primary data center is estimated at 2.0. An attractive pricing structure has been created to incentivize relocation of department server equipment into
data centers. Data center clients will be required to replace non-rated server equipment with Energy Star and EPEAT certified equipment.

2. Replace end-of-life servers managed by UW-IT with either a virtual or physical server, depending on the customer’s requirements.

3. Investigate a campus-wide approach to provide a way for systems administrators to better understand and manage power usage of desktop computers.

Long term Goals:

1. Install Building Management Systems (BMS) equipment in the remaining data centers and mission critical facilities to control, monitor and measure energy utilization.

2. Install and integrate a power monitoring system to provide metrics and opportunities to perform better power management in all data centers and mission critical facilities.

3. Achieve 50% virtualization over the next 3 years. Currently, about 20% of the servers managed by UW-IT are virtual servers.

4. Utilize a power management software solution to gather power usage statistics on desktop systems, provide reports and customization of power management per desktop and provide a simple way to better manage and reduce desktop power consumption.

H. Select Examples of Other UW Sustainability Efforts

Housing and Food Services (HFS) Accomplishments:

1. Increased the amount of total materials sent to local composting facility to over 600 tons in 2009 (increased from about 500 tons in 2008). Increased the percentage of compostable service ware in HFS restaurants from 89 to 100 percent.

2. Sent 1,100 gallons of cooking oil to be recycled for biofuels.

3. Sent 60+% of all disposables from HFS facilities to recycling or composting facilities.

4. Modified Summer Scram locations for the collection of reusable items during residence hall move-out. At the end of spring quarter 2010, 75 tons of reusable items were diverted from the waste stream.

5. Allotted about 27 percent of food expenditures toward local or sustainable products (organic, fair trade, Monterey Bay Aquarium-approved seafood, etc).
6. Initiated a logistics plan to reduce deliveries from outside vendors as well as on campus.
7. Continued to provide ongoing compost program information to other institutions.
8. Continued to collaborate with local partners such as Cedar Grove Commercial Composting and the City of Seattle in developing local programs, and with national manufacturers, such as International Paper, to develop new products.

**Short term (2 year) goals:**

1. Improve landfill avoidance from 60 to 65 percent.
2. Complete one LEED Gold-accredited Residence Hall and one LEED Silver-accredited apartment building.

**Long term goals:**

1. Improve landfill avoidance to 80 percent.
2. Complete ten additional LEED-accredited residence hall projects, adding 2,500 additional beds on campus (impact to transportation carbon).
3. Create a theme community in one residence hall focused on sustainability.
4. UW Bothell: ban all water purchased in plastic bottles.

**Paper Reduction Project**

This project was undertaken, in part, to comply with the 2009 Washington State Substitute House Bill 2287, which directed state government agencies, including the University to use 100% recycled paper and reduce paper use by 30%.

**Short-term (2 year) Goals:**

1. Make 100% Post Consumer Recycled Paper the default paper for cut sheet bond paper for copiers and printers
2. Develop and implement a paper conservation program that will reduce cut sheet bond use by 30%
3. Increase recycling of 100% of all copy and print paper
4. Encourage users to print on both sides of the page; to purchase Energy Star equipment with accountability meters; use scan-to-email.
5. Monitor quarterly progression of increase in purchase of 100% recycled paper.
III. APPENDIX

A. Carbon reduction by Scope

15% carbon reduction by 2020

<table>
<thead>
<tr>
<th>Scope 1 - direct emissions</th>
<th>2015 (emissions - MGS CO2e)</th>
<th>2015 (amount to reduce by 2020)</th>
</tr>
</thead>
<tbody>
<tr>
<td>power plant</td>
<td>82,710</td>
<td>12,405</td>
</tr>
<tr>
<td>landfill</td>
<td>12,810</td>
<td>1,920</td>
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<tr>
<td>buildings</td>
<td>6,440</td>
<td>966</td>
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<tr>
<td>vehicles</td>
<td>3,040</td>
<td>456</td>
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</table>

<table>
<thead>
<tr>
<th>Scope 2 - electricity</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>fugitive gases</td>
<td>135</td>
<td>20</td>
</tr>
<tr>
<td>central loop</td>
<td>4,674</td>
<td>701</td>
</tr>
<tr>
<td>faculty/staff commuting</td>
<td>32,710</td>
<td>4,905</td>
</tr>
<tr>
<td>student commuting</td>
<td>21,800</td>
<td>3,270</td>
</tr>
<tr>
<td>professional travel</td>
<td>18,710</td>
<td>2,805</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scope 3 - other emissions</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>off-campus medical</td>
<td>12,610</td>
<td>1,890</td>
</tr>
<tr>
<td>NSF research vessels</td>
<td>6,640</td>
<td>996</td>
</tr>
<tr>
<td>campus waste</td>
<td>(6,240)</td>
<td></td>
</tr>
<tr>
<td>forest carbon sequestration</td>
<td>(16,400)</td>
<td></td>
</tr>
</tbody>
</table>

University-wide total   188,030     159,800

SCOPE 1
- power plant 41%
- landfill 7%
- buildings 3%
- vehicles 2%
- central loop 2%
- fugitive gases <1%

SCOPE 2
- faculty and staff commuting 16%
- student commuting 11%
- professional travel 9%
- off-campus medical 6%

SCOPE 3
- NSF research vessels 3%
B. Gaining Efficiency

The following are more specific ways in which the University has become more efficient with its consumption of energy and use of natural resources. For some of these projects, it is unclear how much carbon reduction these current projects or analyses will provide, given the short time that has passed since the CAP was published. For other projects, the information provided is quite detailed and technical and thus provides further explanation and support of initiatives discussed in the document.

Facilities and New Building Construction

One of the easiest ways to reduce emissions is to make affordable housing available to faculty, staff and students closer to campus.

Savery Hall (Completed)

SUSTAINABLE FEATURES--ENERGY:

1. Through the use of demand control ventilation with CO₂ sensors, the system is able to identify the present occupant needs and adjust the ventilation accordingly.
2. High efficiency glazing on windows prevents daytime glare and reduces cooling needs.
3. Occupancy sensors reduce lighting energy throughout the building and average lighting power density of offices and other occupied spaces.
4. Increased efficiency of insulation contained in the building envelope also further serves to reduce both heating, ventilation, and cooling costs.

INNOVATIONS:

1. Mechanical equipment has improved energy efficiency beyond ASHRAE 90.1. Variable Frequency Drives (VFD) to reduce energy consumption.
2. The Variable Refrigerant Flow System transfers energy through refrigerant which results in significant fan and compressor energy savings.
3. Water use reduction of 30% in water savings achieved through the use of low flow water fixtures, toilets, and shower heads.
4. Pre-existing unusable building materials were diverted as recycled construction waste resulting in 96% construction waste recycling and 32% recycled content in building materials, low VOC material finishes, 40% of materials from within 500 miles.
Clark Hall (Completed)

**SUSTAINABLE FEATURES – ENERGY:**
1. Energy efficiency rating of 50% better than ASHRAE 90.1-2004 standard.
2. New operable energy efficient windows, ceiling fans, and skylights with rain sensors.
3. Naturally ventilated building, with no additional cooling provided in occupant use spaces and met the 2030 Challenge.

**INNOVATIONS:**
1. Recycled Building Materials of 28%, regional materials, either produced or constructed within 500 miles, of 50%, and 94% (192 tons) of the pre-existing unusable building materials were diverted as recycled construction waste.
2. Water use reduction of 38.4% was achieved through the use of low flow water fixtures, toilets, and shower heads.

Husky Union Building (Planned)

1. Green roof on the south end of the building.
2. Low flow toilet fixtures and natural ventilation in the atrium and meeting rooms.
3. Air conditioning is limited to part of the kitchen, the bowling alley to preserve the lanes, and the ballrooms and the new multipurpose room, formerly the auditorium.
4. Heating provided by the UW’s Central Cooling Water (CCW) loop.

Intramural Activities Building (Planned)

1. Potential for power producing plant to be placed on the roof.

Expanded Energy Audit for Existing Buildings (Planned)

1. Examine existing building’s systems and performance
2. Identify possible energy (electrical power and gas), resource conservation (water savings and sustainable concepts), and operation and maintenance measures
3. Quantify each measure’s potential benefit and apply measures to reduce campus energy demand and reduce carbon footprint.
IV. Glossary

ABB  
Activity Based Budgeting

CO₂  
carbon dioxide

CO₂-equivalent  
the equivalent mass of CO₂ required to have the same global warming effect as an identical mass of any other greenhouse gas

CO₂e  
CO₂-equivalent

ESAC  
University of Washington Environmental Stewardship Advisory Committee

GHG  
greenhouse gas – the two that are most abundant in the UW inventory are CO₂ and methane; 1 unit of methane has the warming potential of 23 units of CO₂

LEED  
Leadership in Energy and Environmental Design, a certification program of the U.S. Green Building Council

Offset  
a reduction of GHGs attributable to a particular project that can be sold to a party other than the owner of the project

Submetering  
measuring electric, steam or other energy use on a building-by-building basis, even when energy is supplied by a central utility plant

University Advancement  
the fundraising arm of the UW administration

UWESS  
the UW Environmental Stewardship and Sustainability Office

Virtualization  
the practice of executing computing processes that normally require different pieces of equipment on a single piece of equipment, or enabling a computing process that normally requires a specific piece of equipment to operate on multiple pieces of equipment

V. Contact Us

This document was prepared by the University of Washington Climate Action Plan Oversight Team. Please direct any related comments and questions to the UW’s Environmental Stewardship and Sustainability Office at smhelp@u.washington.edu.
APPENDIX H

POLICIES PER RWC 70.235.020 RE. STATE’S LIMIT OF GREENHOUSE GAS EMISSIONS
ADOPTED POLICIES IN ACCORDANCE WITH RCW 70.235.020

The University of Washington is a founding signatory to the American College & University Presidents’ Climate Commitment (ACUPCC), and is committed to developing an institutional action plan for becoming climate neutral.

In January 2009, under the auspices of the Environmental Stewardship Advisory Committee, a Climate Action Planning Oversight Team formed to coordinate the drafting of a Climate Action Plan. Teams of faculty, students, administrative leaders and staff across all three campuses (Seattle, Tacoma and Bothell) worked together to develop the UW plan, which was submitted to ACUPCC on September 12, 2009 and updated in 2010. The Plan describes preliminary strategies to be explored by the UW, including our intent to work toward becoming climate-neutral. The UW Climate Action Plan includes:

- Strategies for Academic Engagement in Climate Change
- University Greenhouse Gas Emissions and Emission Targets
- Strategies for Reducing University Emissions
- Looking Beyond the Inventory (land use, food and composting, reduce/reuse/recycle)
- Strategies for Financing the Climate Action Plan
- Climate Policy Development and Implementation
- Tracking Progress

One of the annually tracked sustainability metrics is greenhouse gases. Emissions are broken down by ‘scope.’ Scope 1 - emissions generated by the UW on campus (e.g. burning natural gas for heating). Scope 2 - emission produced by generating energy purchased by the UW (we purchase most of our electricity from Seattle City Light, which is carbon neutral). Scope 3 - emissions produced off campus in support of UW work (e.g. commuting and professional travel). Our goal for total emissions is a 15% reduction from 2005 levels by 2020 and a 36% reduction by 2035.
APPENDIX I

DAHP LETTER
A letter from DAHP on the impact of potential sites on cultural resources will be provided to the Office of Financial Management as soon as it is received from DAHP. The letter requesting review is provided below.

UNIVERSITY of WASHINGTON
OFFICE OF PLANNING & BUDGETING

Transmittal

Date: June 22, 2016

To: Allyson Brooks
State Historic Preservation Officer
Department of Archaeology & Historic Preservation
PO Box 48343
Olympia, WA 98504-8348

From: John Seidelmann
Director of Capital and Space Planning
University of Washington – Office of Planning and Budgeting

Subject: UW Predesign Report Submissions in Support of UW State Capital Budget Request 2017-2019

In accordance with Executive Order 05-05 directing agencies to consult with the Department of Archaeology and Historic Preservation (DAHP) on all capital construction projects to be considered for state funding, the University of Washington is hereby providing information on the following three (3) proposed projects.

These projects will follow the University’s historic resources review through the design review process and requirements set forth by Executive Order 05-05. It is anticipated that a Historic Resources Addendum would be prepared if building demolition or alteration was proposed.

The three projects are:

CAMCET – The Center for Advanced Materials & Clean Energy Technologies was created by the State of Washington in 2013 to accelerate the creation of a scalable clean energy future. Permanent operational funding was established in 2015. A new facility is needed for their operations and activities, laboratories (testbeds), collaboration spaces, teaching and offices. The center is proposed to be located in the new UW Innovation District in the west sector of campus. A specific site has not been selected.

Population Health Education Facility – The Population Health Education Facility would support flexible, active and team-based learning for pedagogical and technological needs of the University’s Health Sciences as mandated by Medicine, Nursing, Pharmacy and Dentistry accreditation boards. It would centrally locate research, academic and clinical programs. It is intended to be located in the south sector of campus near the Magnuson Health Sciences Center.

Bothell Phase 4 – To accommodate additional students in the School of Science, Technology, Engineering and Mathematics (STEM), the new University of Washington Bothell campus proposed Phase 4 facility would be for classrooms, learning labs, collaborative faculty office space, and student collaboration space. There are currently multiple on-campus site location options, which is anticipated to be selected during the Campus Master Plan update currently underway.

We would appreciate a letter from you confirming receipt of this information for OFM purposes.
APPENDIX J

OWNER’S PROJECT REQUIREMENTS
Bothell School of STEM
Owner’s Project Requirements

Predesign Draft 6/24/16

Prepared by:

UW Capital Planning and Development

For:

UW Bothell
Bothell School of STEM – Owner’s Project Requirements

Intent
The intent of this Owner’s Project Requirements (OPR) is to provide high-level guidance to the project team focused on the desired outcomes and performance of the building. It indicates where specific design standards apply but does not lock in design solutions or repeat detailed information in other documents, such as the UW Facility Services Design Guide. It merges environmental and sustainability goals into an integrated document focused on the overall results desired by the UW for all aspects of the project.

Version
An OPR is a living document that should be updated several times during an integrated design process. The following is the preferred process for developing and updating an OPR on University of Washington projects.

1. **Predesign**: The Predesign OPR is created by the University Capital Planning and Development office as an appendix to the Predesign document produced by the predesign team. It translates overall project goals, predesign analysis, and results of the predesign eco-charrette into high level owner’s requirements. The Predesign OPR is used by the selected design team as a guiding document to begin schematic design.

2. **Schematic Design**: The OPR is further developed to include more detailed requirements typically found in OPRs during schematic design in partnership with the design team but is still a representation of the University’s goals, not a design document. It should be completed prior to development of the schematic design basis of design (BOD) and expressly respond to in the BOD by the design team.

3. **Design Development**: The final version of the OPR reflects refinements in project goals as the design team develops possible design strategies, identifies issues and costs, and the University makes more detailed decisions on design direction and budget. It should be updated prior to a similar update to the BOD by the design and issuance of the 100% DD set. This version of the OPR is then used by the Commissioning Authority for the project to conduct a review of the DD set.
General Project Information
The purpose of this phase of development on the UW Bothell campus is to encourage collaborative, interdisciplinary and cross program initiatives in the School of STEM through the development of STEM academic building.

Project Description
The Bothell School of STEM will provide 78,000 square feet of space for general classrooms, computer and engineering labs, research space for capstone projects, and collaborative teaching project space to support expanded engineering and computer science degree programs. It will accommodate 1,000 new full-time equivalent (FTE) students in the School of STEM and increase graduation in the School of STEM by 500 FTE.

Site and Context
It is anticipated that the School of STEM building will be situated with its axis running parallel to the nearby Discovery Hall with a terraced floor plate up the hill. As the UW Bothell campus is adjacent to the North Creek Wetlands, the site has opportunities to benefit from view corridors to this natural resource and this location takes advantage of the view looking eastward down the hill. There is an existing central forest grove on or adjacent to the site and it is priority to preserve trees and maintain density of the forest grove. The significant grade change adjacent to the Crescent Path and adjacent to the proposed project site will require careful attention to grade transition to maintain sight lines and the connection to the path while limiting impact on the forest grove and avoiding a building entry which feels like it is set in the slope. There are also possible contaminated soils that will need remediation and evidence of potential groundwater issues, possibly from an artesian source, so a robust drainage system is required.

Existing stormwater runoff west of the proposed site in West Campus Lane is collected and treated by stormwater treatment facilities installed during the construction of West Campus Lane and Discovery Hall. Runoff from the new building will be treated at the building prior to routing it to the existing runnel located on the north side of Discovery Hall. Although roof runoff is typically considered clean water, the Campus has had a bird problem on roofs which may be contributing pollution to the stormwater runoff. Treating the roof runoff will help reduce potential pollution. Runoff from areas adjacent to the building for loading/unloading and accessible parking off of West Campus Lane will also be treated before being routed to the existing West Campus Lane stormwater system.

Although UW Bothell is a suburban campus there is reasonable bus access and amenities on campus to promote walking, biking, and alternative transportation use. The project will also add more showers and bike racks on campus.

General Operational and Occupancy Expectations
The School of STEM will have a variety of space types including general classrooms, computer and engineering labs, research space for capstone projects, and collaborative teaching project space. Occupancy will vary over time of day and year with a peak occupancy of around 1000 staff and students.

Campus operations and maintenance costs for a future building will be funded from the University’s existing allocation. New staff will not be required to hire in order to maintain and service the new building. Costs on a
per square foot basis will be within industry ranges and the overall net impact to the campus facility operating budget will be funded through tuition fees generated by the associated enrollment growth of the campus.

A Maintenance Plan should be developed for mechanical, electrical, plumbing and fire protection systems. The Maintenance Plan shall be in accordance with ANSI/ASHRAE/ACCA Standard 180 for HVAC systems. As part of following the standard, the building’s maintenance plan shall include an accounting of basic equipment information and a schedule for all preventative maintenance. The Plan shall address all elements of Section 4 of ANSI/ASHRAE/ACCA Standard 180 and shall develop required inspection and maintenance tasks similar to Section 5 of ANSI/ASHRAE/ACCA Standard 180 for electrical and plumbing systems.

**Building Life and Flexibility**

The University holds and maintains its buildings over a long time period so all projects should be designed with durability and flexibility in mind to function well for 50 to 100 years. The building operations and maintenance of the environmental control systems shall be engineered and designed for long term operations efficiency and cost performance and the engineering and design of the Building Envelope, Lighting, other end use systems, and HVAC shall emphasize cost effective on-going building operations, maintenance and energy performance.

### Project Budget

<table>
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<tr>
<th>Phase</th>
<th>Estimate</th>
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<tbody>
<tr>
<td>Predesign</td>
<td>$500,000</td>
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<tr>
<td>Design</td>
<td>$5,961,100</td>
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<td>Construction</td>
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<td>Equipment</td>
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<td>Agency</td>
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<td>Administration</td>
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<tr>
<td>Other</td>
<td>$1,826,448</td>
</tr>
<tr>
<td>Total Project Cost</td>
<td>$75,000,000</td>
</tr>
</tbody>
</table>

### Project Schedule

- The project will be delivered using the progressive design build delivery method. To maximize efficiency and take full advantage of the progressive design build delivery, it is important to maintain work flow for the design build team. Ideally the University could secure complete project funding in one biennium, but it is possible to start design in one biennium and complete the design build process in the next funding cycle. To accomplish this, the University would enter into a preliminary agreement with the design builder during the 2017-2019 biennium to complete the design development phase in July 2019. This would position the design build team to be ready to complete the design and construction during the 2019-21 biennium. Predesign 2015-2016
  - Design 2018-2020
  - Construction 2020-2021
  - Occupancy Fall 2021
Project Goals, Objectives, Performance Metrics and Standards

The UW Bothell priorities as outlined in the institution’s 21st Century Initiative include developing environmental and human sustainability as a signature initiative. Design and construction of new buildings on campus presents a prime opportunity to fulfill this priority with high-efficient, health-promoting, ecologically-contributing building design.

Goals Areas and Objectives

The following goals were established in the Predesign effort including from a sustainability charrette conducted by the design team:

<table>
<thead>
<tr>
<th>Goal Area</th>
<th>Objectives</th>
</tr>
</thead>
</table>
| Site            | - Preserve existing trees where possible and incorporate felled trees into the design in a meaningful way. Preserve the character of the forested grove.  
                  - Develop the landscape and building in such a way that the two work together, share systems, and complement each other spatially and functionally. |
| Energy and Water| - Seek to reduce energy consumption with considerations for the incorporation of energy-efficient mechanical and electrical systems  
                  - Aim to achieve UW Carbon Action Plan goals  
                  - Consider use of rainwater for flushing but evaluate maintenance concerns on current campus installation  
                  - Evaluate solar hot water and solar photovoltaic arrays for on-site renewable energy generation. Consider future solar access in building massing. |
| Materials       | - Maximize the program space within the building to minimize the need for future construction.  
                  - Integrate material and system designs to create energy- and resource-efficient solutions for the entire project.  
                  - Specify building materials that reduce the negative environmental impact of the project—this includes responsibly harvested and certified wood and low-toxic paints, finishes and adhesives.  
                  - Use durable materials and systems that reinforce the high quality UW architectural and urban design standards, and the building’s connection to place on the campus.  
                  - Consider the use of recycled, local, or sustainable materials during the design phase. Recycle construction debris wherever feasible. |

Performance Metrics and Standards

The following specific targets or requirements for the project build on the goal areas and objectives identified above.

LEED Gold

Certification as a LEED Silver building is a requirement both as University policy and because this project will receive Washington state funding. This OPR assumes the project will fall under the Version 4 of LEED. This newer version of LEED has higher baselines than version 3 (LEED 2009) and some new credits that likely mean a LEEDv4 Silver building is more equivalent to a LEEDv3 Gold building. That being said, the University has a multi-year history of achieving LEED Gold certification on major capital projects in all previous versions of LEED and the UW Bothell campus has a unique commitment to environmental and human sustainability so LEED Gold certification is strongly desired.

Required credits

The following credits are required by the University as part of any pathway to LEED Silver or Gold because of their contributions to better operating performance, to meeting the University's Climate Action Plan, and to
Bothell School of STEM – Owner’s Project Requirements

Faculty, staff, and student health and quality of life. These credits, at the required thresholds, contribute 28 points towards LEED for New Construction certification.

- Integrative Process
- Bicycle Facilities
- Light Pollution
- Site Assessment
- Outdoor Water Use Reduction (2 points)
- Indoor Water Use Reduction (3 to 4 points)
- Water Metering
- Enhanced Commissioning (all 6 points, including Building Envelope Commissioning and Monitoring Based Commissioning)
- Optimize Energy Performance (at least 10 points)
- Advanced Energy Metering
- Building Product Disclosure and Optimization – Sourcing of Raw Materials (1 points)
- Construction and Demolition Waste Management (2 points)
- Enhanced Indoor Air Quality Strategies (1 point)
- Low-emitting Materials (all 3 points)
- Construction Indoor Air Quality Management Plan
- Indoor Air Quality Assessment
- Interior Lighting (1 point)

In addition, the following prerequisites, credits, and innovation will be implemented and documented by the University for an additional 6 points.

- Surrounding Density and Diverse Uses (2 pts)
- Access to Quality Transit (at least 1 point)
- Storage and Collection of Recyclables
- Up to 2 Innovation credits for campus practices including Salmon Safe certification, Integrated Pest Management and Green Housekeeping

**Desired Credits**

In developing a LEED Gold for the School of STEM, the following credits are desired by the University in keeping with the goals above.

- Rainwater Management
- Outdoor Water Use Reduction (additional 2 points)
- Renewable Energy Production
- Building Product Disclosure and Optimization – Building Life-cycle Impact Reduction
- Building Product Disclosure and Optimization – Environmental Product Declarations, Transparency Option
- Building Product Disclosure and Optimization – Materials Ingredients, Transparency Option
- Daylighting, Quality Views, and Acoustic Performance for occupant health

**Energy Metrics**

The School of STEM project team recommend the following in terms of energy metrics and performance expectations.

Sustainability: It’s in our nature.
Minimum annual operational (measured) energy performance that shall be guaranteed during first [1.5 to 3.0] years of operation after building is substantially occupied are as follows:
1. 50% reduction in energy cost relative to the ASHRAE 90.1 2007 baseline.
2. Energy Use Index (EUI) operational target of between 25-40 kBTU/gsf-yr.

Minimum Prescriptive requirements for energy performance are:
- Project shall fully meet all mandated provisions of the Washington State Energy Code, regardless of code compliance path.
- Lighting system: Design shall meet space illumination requirements per lighting design standards, with total interior lighting power a minimum of 20% lower than value computed using either TABLE C405.5.2(1) Whole Building or space-by-space values provided in TABLE C405.5.2(2) of the Washington State Energy Code.
- Building envelope: 10% better (lower) overall UAp and SHGCAP than Washington State Energy Code using the component performance building envelope option in Section C402.1.3.
- Minimum energy metering and data acquisition and reporting system requirements shall fully meet all requirements in the 2012 Seattle Energy Code, Section C409. Additional requirements that may exceed these may be found in other portions of this Standard, in which case the more stringent requirement shall apply.
- Facilities shall be designed to achieve Solar Readiness by meeting the requirements in the 2012 Seattle Energy code, Section C410.2.

In addition, the project team should develop and implement a Building Energy Use Accountability Plan for the performance period. As part of this plan, a monitoring based commissioning plan shall be prepared and executed during the performance period in accordance with LEEDv4.

**Water Metrics**
Design of systems and building shall focus on strategies to reduce use of potable water by:
- 100% reduction in potable water use for irrigation
- 50% reduction in potable water use for flushing
- 35% reduction in building water use

In addition, measurement devices with remote communication capability shall be provided to collect water consumption data for the domestic water supply to the building. Both potable and reclaimed water entering the building project shall be monitored or sub-metered. All building measurement devices, monitoring systems shall be configured to communicate water consumption data to a meter data management system. At a minimum, meters shall provide daily data and shall record hourly consumption of water. The meter data management system shall be capable of electronically storing water meter, monitoring systems, and submeter data and creating user reports showing calculated hourly, daily, monthly, and annual water consumption for each measurement device.

**Design Process Expectations**
During predesign, the UW determined that a Life Cycle Cost Analysis as proscribed in the 2014 Predesign Guidance manual from the Washington State Office of Financial Management would not benefit the project in clarifying specific design directions given the stage of the project and it was therefore deferred to schematic design where it will be especially valuable in helping to determine the most cost efficient design options to achieve program and sustainability goals.

Sustainability: It’s in our nature.
In addition, the project team is directed to pursue the Integrative Process credit in LEEDv4 which requires a shoe box energy model and water budgeting exercise to occur before 30% design, along with development and updating of this OPR document. The IP credit and the state LCCA process should be integrated such both requirements are meet and the project team gets the best analysis to inform project decisions.

The LEED credit for a Site Assessment in schematic design is also a required credit and should be included in the schematic design scope.

The integrative design process consists of iterative cycles of large group working sessions alternating with small group or individual analysis throughout design, construction and into operations, and within the increasing constraints on the project overtime. So far, the Bothell Phase 4 has completed the initial group working session and early analysis. Schematic design should begin with another large group working session and include LCCA, energy modeling, water budgeting, and site assessment to evaluate concepts from the workshop.