CPS
Cambridge Public Schools

The Department of
Human Service Programs
Cambridge, Massachusetts

FEASIBILITY STUDY VOLUME 1

JOHN M. TOBIN MONTESSORI SCHOOL

VASSAL LANE UPPER SCHOOL

DHSP PRESCHOOL & COMMUNITY AFTER SCHOOL

PERKINS EASTMAN

JUNE 26, 2020

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acknowledgments

On behalf of the Perkins Eastman Team, we would like to acknowledge and thank the administration and staff of the entities listed below, the leadership team listed on the opposite page, as well as the schools' parents and faculty, and the Cambridge citizens and neighborhood community. These voices helped shape the project goals and greatly assisted in the development of the Preferred Option.

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Tobin Montessori School

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Vassal Lane Upper School

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Food Service Consultant - Crabtree McGrath

Hazardous Materials Consultant - Fuss & O'Neil

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Environmental / Geotechnical Engineer- CDM Smith Inc.

Stormwater Engineer - Stantec / Kleinfelder

Property Surveyor - SMC| Survey Mapping & Consultants

1.0

EXECUTIVE SUMMARY

Green Ivy Montessori School Battery Park: New York

1.0 Three School Programs and a Neighborhood Playground Woven Together for Learning and Community Benefit

The City of Cambridge in collaboration with the Cambridge Public Schools (CPS) and the Department of Human Service Programs (DHSP) has begun the process of renewing the Tobin School site. Currently the existing site houses two school programs: the Tobin Montessori and Vassal Lane Upper School. The Tobin Montessori program consist of a JK to 5th grade lower school program and the Vassal Lane program has a 6th to 8th grade upper school program. These existing school programs are being reprogrammed and redesigned to support the City's vision for the education of the children of Cambridge. This includes the introduction of a public preschool and enhance the opportunities for community recreation provided by Father Callanan Playground which shares the site.

CPS's vision is to provide rigorous, joyful, and culturally responsive learning for personalized support that builds postsecondary success. The engaged community members are complemented by the City's commitment to early childhood education. As demonstrated by the Birth to 3rd Grade Partnership between CPS and the DHSP, the aspiration is to provide an accessible, aligned and coherent system of affordable high-quality education and care that begins with prenatal care and extends through 3rd grade.

These complementary visions inspire the renewal of this school with a goal of enhancing educational opportunities and achievement for children ranging in age from three (DHSP Preschool and Special Start at Tobin Montessori) to fourteen years old (Vassal Lane Upper School, eighth grade). In addition to supporting this range of ages, the new school will also expand opportunities for students learning English as a Second Language in the Sheltered English Immersion (SEI) Program and provide better environments for children learning with special needs through the Autism Spectrum Disorder (ASD) Program. Each program is designed to prepare students for success in the next step of their educational journey to high school, and ultimately, to enhance their lives as engaged citizens in the 21st Century.

The design will create high performance learning environments that are healthy, supportive and sustainable. These environments will enhance the preschool, lower, and upper school's programs and support extended learning opportunities with active community use of the site after school hours. As a center of community, the renewed site will feature a building and outdoor open space that will together create an appropriate "civic presence," symbolically representing the value that Cambridge places on education, community, sustainability, and health and wellness.

This report summarizes the conclusions of the feasibility study and describes the open process used to define the programmatic needs, establish principles and goals, and determine the best strategy to realize the City's vision.

Avenues The World School: New York

1.1 Project Summary

Project Definition

The project site, located at 197 Vassal Lane, currently houses the existing Tobin Montessori Lower School, and the Vassal Lane Upper School. When complete, the new school building will accommodate up to 979 students as follows:

336 students in the lower school (JK to 5th grade)

450 students in the upper school (6th to 8th grade, including 75 SEI students)

68 students in the (ASD) Program (including the two schools)

45 students in Special Start

80 students in the Department of Human Services Programs (DHSP) Preschool

Total: **979** Students

To provide high performance learning environments for this diversity of programs, the Preferred Option calls for the demolition of the existing school building and the construction of a new building of approximately 300,000 gross square feet.

Process

This year-long Feasibility Study began with visioning workshops in March 2019, and will be completed in March 2020. The process included the following phases of work: Visioning and Programming, Creative Analysis, Design Development Options, and the selection of a Preferred Option. The process was intensive and broadly engaging, and the resulting Preferred Option was shaped by extensive input from stakeholders and the design team.

Education programming and design experts worked collaboratively through a series of visioning sessions and focus groups meetings. These meetings were attended by the school

Image 1.1a Community Meeting

Principals, representative teachers and staff, CPS department heads and administrative personnel, and City Human Services staff to create an Educational Specification that embodies the unique educational needs that capture the mission and vision of each of the existing and proposed programs. As appropriate, school members, CPS academic, and administrative staff participated in a space needs survey to provide further input to the team. Benefiting from the City's prior two projects at the MLK Jr/Putnam Street and the King Open/Cambridge Street Upper School sites, the Educational Specifications were informed by lessons derived from the programming, use and operation of those precedent facilities.

The study team is comprised of architects, civil, traffic, geotechnical, structural, mechanical, electrical, plumbing/fire-protection engineers, and specialty experts for survey, acoustic, audiovisual, commissioning, cost estimating, embodied energy, foodservice, hazardous materials, and Net Zero energy consulting. The existing site and building were concurrently analyzed as the Educational Specifications (Vol. 2) was developed. This was done while the schools were in session to ensure that the analysis represented typical in-use patterns and conditions.

Early in the Creative Analysis process, meetings with the community began. Collectively, all of these diverse inputs and analyses informed the initial options for the project. As the process helped develop and refine the options that resulted in a preferred option, the extent and the range of stakeholder engagement. From the visioning and programming meetings with educators, administrators and City officials, to the active participation of members of the community at publicly advertised meetings held in the school auditorium - the process was open and responsive.

Ultimately, the Preferred Option that evolved from the process is a demonstration that the City seriously listened and, with the design team, responded to the input received. This Feasibility Study Report and Education Specification summarize the resources that will be made available on the site to accommodate the City's, CPS's, DHSP's and the community vision for the site.

This process of active engagement is illustrated by the numerous meetings conducted by the design team during this period, including the following:

47 Focus Groups

23 Steering and Executive Committee

6 Community (including one focus group)

11 City department

8 City Manager

8 City Council and School Committee members

5 Geotechnical / Stormwater

5 Visioning Sessions

Total: **113** Meetings

The Preferred Option: Crossroads

Crossroads is a direct result of the engagement process and strikes an effective balance between the Educational Specifications, the organizational and design principles derived from the visioning and programming process, and the traffic, open space and massing issues that derived from site analysis and significant community input.

With its compact footprint and massing, Crossroads will create an efficient, dynamic, and exciting place to learn. Each program is organized around the "Heart of the School," a Community Commons. A crossroads of circulation connect the building with the outdoor playground through the shared program spaces. This central "heart" within the building will feature the learning commons for each school, organize the dining, gyms and auditorium, and it will help build upon the already strong relationships and communication between the lower and upper schools. It will provide each school with its own distinct environments and resources tailored to their specific programs. The "Heart" will also foster the community school program and be the locus for after-hours use of the building.

From the very arrival on site, the "Heart of the School" will address one of the key design principles identified by the stakeholders: the importance of creating a clear identity and presence for each of the three major programs on site, while also addressing safety and security. Balancing these goals, the "Heart" will provide a single, secure point of entry for the lower and upper schools, while clearly defining the presence and the domain of each program.

Each program will engage the "Heart" but be provided with its own distinct and secure environment that satisfies space needs, and organizational principles. The Tobin and Special Start will occupy the entire three-story wing east of the "Heart of the School". The Children's House and Special Start will be co-located on the first floor, the Lower Elementary on the second and the Upper Elementary on the third floor.

Image 1.1b Preferred Option Site Plan

Image 1.1c Preferred Option Massing View

The western wing of the building will house the Preschool and some administrative functions of the Vassal Lane Upper School on the ground floor. The co-location of all of the programs serving the youngest children in the building on the ground floor, in both wings, will enable efficient sharing of resources and allow for the easy movement of these young students throughout the school and grounds. Upstairs in the western wing of the building, the Vassal Lane Upper School's interdisciplinary, grade level "neighborhoods" will each occupy their own floor.

Each wing will have easy and direct access to the shared spaces surrounding the "Heart of the School" (dining, the gyms and the auditorium) which will be housed in a volume directly north of the academic wings, and adjacent to the outdoor recreation and fields of Father Callanan Playground. With the most compact footprint of all the options studied, the Crossroads Option will provide a diversity of recreation, recess, physical education and active, experiential learning opportunities, including the CitySprouts garden for all grades, as well as for the community.

Sustainability/Net Zero/Resilience

Sustainability is very important to the progressive residents of Cambridge and the City's sustainability goals for this project reflect this. The primary sustainability goals for this project are –

- Net Zero Emissions
- Energy Efficiency/Net Zero Energy potential
- Site and Storm Water Control
- Integrated Parking/Traffic Management
- Indoor Environmental Quality (fresh air, thermal comfort, daylight and views)
- Sustained maintenance

To reach these goals, it is essential to have an integrated design approach that results in a truly effective high-performance building. Each phase of design presents different opportunities to achieve these goals and the design team has already begun to set the stage for Schematic Design. This is most evident in the orientation of the building on the site. The mass of the building oriented along an east-west axis enables effective sunlight control and reduces heat gain and glare within the building. This will have a positive impact on both the cooling load and the quality of the natural light in the learning environment. The Preferred Option begins to integrate site and storm water control measures into the landscape concept, and begins to locate the 1.25 million gallon stormwater storage tank that will enhance community resiliency during major storm events.

During this Feasibility Study different options were evaluated for their ability to achieve Net Zero Energy on site, or in other words, the ability to produce as much energy on the site through photovoltaic panels as would be used by the building. While the Preferred Option has laid the groundwork to achieve these goals, its more vertical massing will limit its available roof area for photovoltaic panels (PV), and thus more study in schematic design is essential to understand what can truly be achieved. A Net Zero energy project usually achieves between 70-75% better energy efficiency than a typical building designed to meet the energy code. To achieve this, design is part of the equation, but additionally, the users of the building must be engaged and aware of how they can optimally use the building to reduce energy use. This is not a burden, but an opportunity for the building to become a teaching tool that educates students and teachers on how energy and water can be conserved.

Parking & Transportation

One of the unique features of the Preferred Option that emerged from the community meetings is that all of the parking on the site and the car drop-off / pick-up will be located in an underground parking structure. This solution allows for more active use of the site for playgrounds and open space serving both the schools and the community. Bus drop-off and pick-up will occur on grade to avoid bus/car conflicts. Adequate bicycle parking and blue bike stations will be provided to encourage alternative means of arriving to the school. A bike lane will traverse the site from north to south, helping to connect to the paths at Fresh Pond and Danehy Park.

Other options studied and the ranking matrix

Crossroads, the Preferred Option, rose from an iterative design process that studied and evaluated numerous options. Many of these options were dropped from consideration early on in their development due to one or more significant shortcomings in satisfying the Educational Specifications, the principles and/or other factors. Three distinct options led off the conversation with the community, and their consideration contributed to the development of the Preferred Option:

- Renovation/Addition – This option attempted to modernize and expand the existing building. The modernization would have required significant upgrades within the existing building and the limitations imposed by the existing building would have required a large addition to the north of the building across the site
- Wings – This option would have provided some of the same organizational attributes of the Preferred Option, but would have been located on the site to the north. It featured separate entrances for each program. With a three story massing and a larger foot print than the Preferred Option, it did not provide as much open area as the Preferred Option.
- Pavilions – This option arrayed each program along a north-south “spine”, creating a variety of courtyards between pavilion-like structures housing each school. Like Wings, it featured separate entrances for each program, but its larger footprint also did not provide as much open area as the Preferred Option.

To help assess each option and identify the preferred option the following matrix was prepared to rank each option relative to a list of comparable attributes. The highest score was selected as Replacement, which evolved into the Preferred Option: Crossroads.

1.2 Design Options Matrix

This Design Options matrix was used to assist in the selection of the Preferred Option. The Educational Principles and Architectural Goals in Section 2, along with the Design Drivers of Section 3 are summarized in these measures. Each of the four options: Renovation/Addition, Wings, Pavilions, and Replacement, were ranked against the measures. A value of 0 to 3, with 3 being a best fit, was given to each measure.

Factors where all of the options performed the same are not included in the matrix. They are: Life-Long Learning, Building Design, Building Program, and Design Process. These were discussed and will come into play during the design phases.

Image 1.0d Preferred Option Massing View




	RENOVATION/ADDITION	WINGS	PAVILIONS	REPLACEMENT
Design Goals				
Resilience	0 ▼	3 ▲	2 ▬	2 ▬
Sustainability, ZNE	1 ▬	3 ▲	3 ▲	2 ▬
Education Principles				
Identity & Arrival	1 ▬	2 ▬	3 ▲	3 ▲
Heart of School	1 ▬	2 ▬	1 ▬	3 ▲
Efficient Sharing	0 ▼	2 ▬	2 ▬	3 ▲
Open Space Diversity	1 ▬	3 ▲	2 ▬	3 ▲
Direct Outdoor Access	3 ▲	2 ▬	3 ▲	2 ▬
Community Partner				
Traffic and Parking	0 ▼	2 ▬	1 ▬	3 ▲
Contiguous Open Area	1 ▬	2 ▬	1 ▬	2 ▬
Building Size/Footprint	0 ▼	2 ▬	1 ▬	3 ▲
Site Circulation	0 ▼	2 ▬	1 ▬	3 ▲
Total	8	25	20	29

1.3 Project Schedule

The design process began with the Feasibility Study in February 2019 and continued through March 2020. This Feasibility Study phase consists of conducting investigations to establish the building organization, form, program, and viability resulting in a Preferred Building Option. This document summarizes the investigations and conclusions that resulted in the Preferred Option that will be used to guide the building design and construction moving forward. Normally a 10 month process, the Feasibility Study phase for this project was extended to allow for additional community input before choosing a Preferred Option.

Design

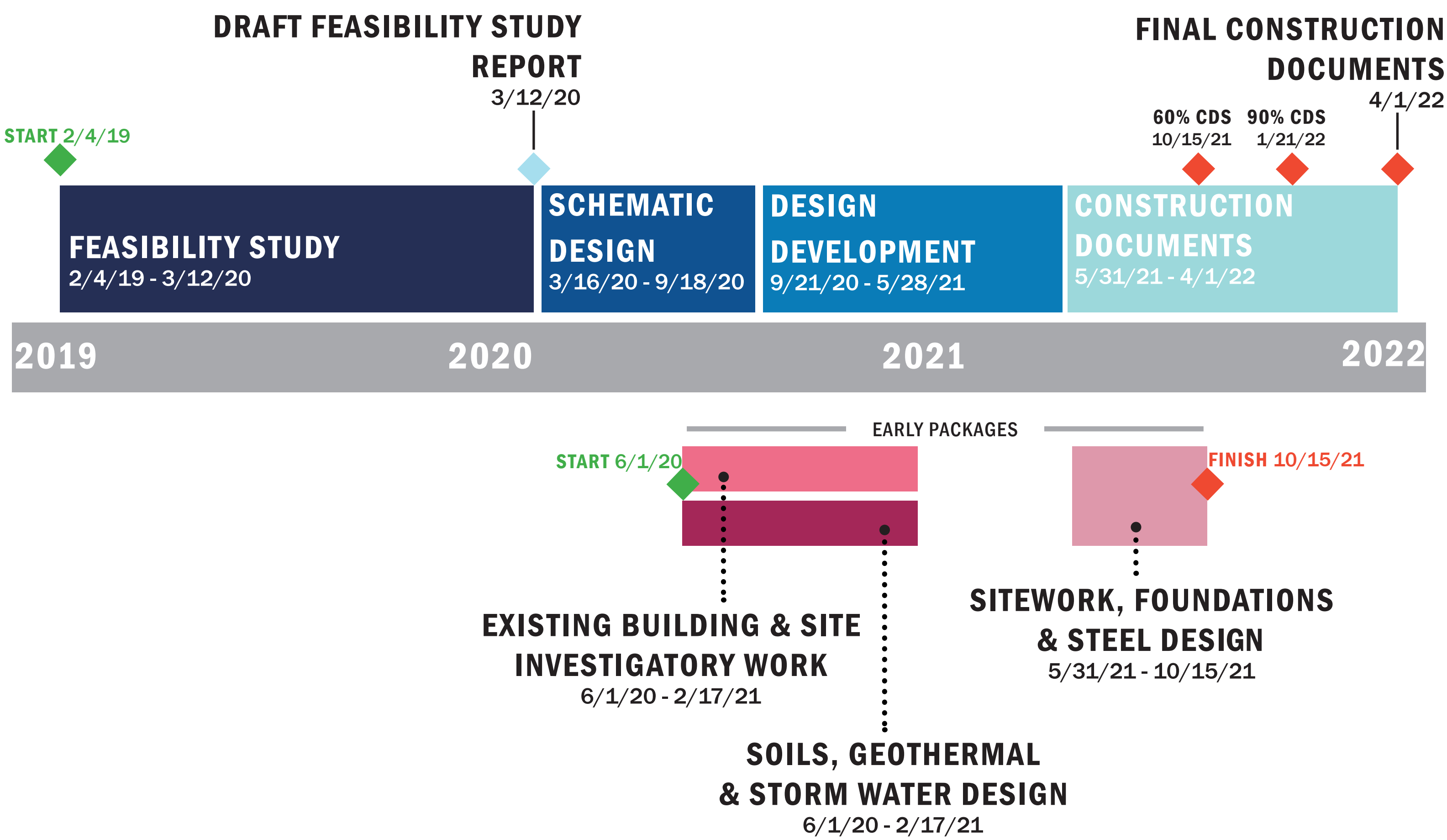
Schematic Design is the phase when the building project begins to take shape. More detailed studies, including traffic, will inform the ultimate configuration of site elements, interior layouts, building materials, and system choices. For the Tobin Montessori Vassal Lane Upper Schools project this phase is expected to take approximately 6 months, beginning in late March 2020 and finishing in September 2020, the result is a set of drawings and documents. The project will need approval from the Cambridge City Council before moving on to the next phase.

Design Development phase continues the refinement of the design. Where details are examined and products are chosen. Because of the extent of the detail, decisions can be made on how the construction budget may be spent. This phase will last approximately 8 months, from late September 2020 to June 2021.

Construction Documents is the final design phase where detailed drawings and specifications are created that can instruct the construction team on the design intent of the building. The documents are issued at a mid-point to allow for detailed review and cost estimating before a final set is issued to establish a Guaranteed Maximum Price (GMP) for construction. This phase will also take 8 months, running from June 2021 to late February 2022.

Construction

Construction is expected to last an additional two years. Teachers and administrators will move into the new school in August 2024. In order to ensure that the construction can be completed on time, three Early Packages (EP) will be issued by the design team: EP 1 is Abatement and Demolition in Fall of 2020; EP 2 is a site work package for Soils, Stormwater Tank, and Ground Source Heat Pump (GSHP) wells in early 2021; and EP 3 is for the superstructure including Foundations and Steel to be issued at the same time as the 60% Construction Documents package.


DRAFT FEASIBILITY STUDY REPORT
3/12/20
FINAL CONSTRUCTION DOCUMENTS
4/1/22
START 2/4/19
60% CDS
10/15/21
90% CDS
1/21/22
FEASIBILITY STUDY
2/4/19 - 3/12/20
SCHEMATIC DESIGN
3/16/20 - 9/18/20
DESIGN DEVELOPMENT
9/21/20 - 5/28/21
CONSTRUCTION DOCUMENTS
5/31/21 - 4/1/22
2019
2020
2021
2022
EARLY PACKAGES
START 6/1/20
FINISH 10/15/21
EXISTING BUILDING & SITE INVESTIGATORY WORK
6/1/20 - 2/17/21
SITEWORK, FOUNDATIONS & STEEL DESIGN
5/31/21 - 10/15/21
SOILS, GEOTHERMAL & STORM WATER DESIGN
6/1/20 - 2/17/21

2.0

PROJECT PRINCIPLES

2.1 VISIONING

2.2 PRINCIPLES

Princeton Day School: New Jersey

2.0 A School Designed to Enhance Educational Success for Each Stage of Development

At the outset of the project, visioning sessions with each program were attended by a variety of parents, teachers, school administrators, student support staff, and district and city-wide representatives. The attendees of each session were intentionally diverse, in order to broadly represent each of the stakeholders. The conversations that ensued explored ideas about how children learn, how teachers teach, what was unique about the school's culture, what defined their learning community, and what sustainable design means to their program and constituents.

User Group Meeting

2.1 Visioning

The Tobin Montessori Lower School

Tobin is the first and one of few public Montessori schools in the country. It serves children from diverse backgrounds, represented by the over 30 languages spoken by the students and their families. As an accredited Montessori program it follows the curricula and pedagogy of the Montessori Method, and the participants of the visioning sessions shared the following key Montessorian ideas that should inspire the design:

- Educate the Whole Child
- Attend to Individual Needs: provide opportunities for all to rise up, include marginalized voices, recognize achievements of all
- Encourage Independence
- Foster Collaboration
- Engage Nature

As a public program, in supporting these the key ideas, the school can tap additional resources that would be unusual in a private Montessori program, including Occupational and Physical Therapy, and other student support services. The school's passionate belief in the Montessori Method and its unique resources draw numerous visitors to the school each year.

As the conversation continued, each of the participants shared their individual hopes and dreams for the new building:

- It should reflect Tobin Montessori's values and approach to learning
- Every child should be able thrive and feel accepted
- It should foster independence and resilience
- It should be welcoming, and safe for students, teachers and families
- It should be joyful
- It should provide open spaces
- It should contain lots of natural light
- It should represent the future of learning and teaching

With these initial insights about the Tobin and this understanding of the group's higher order goals, this meeting and subsequent focus groups, further explored these ideas and goals. Those conversations are articulated the design and organization principles that follow in the next section.

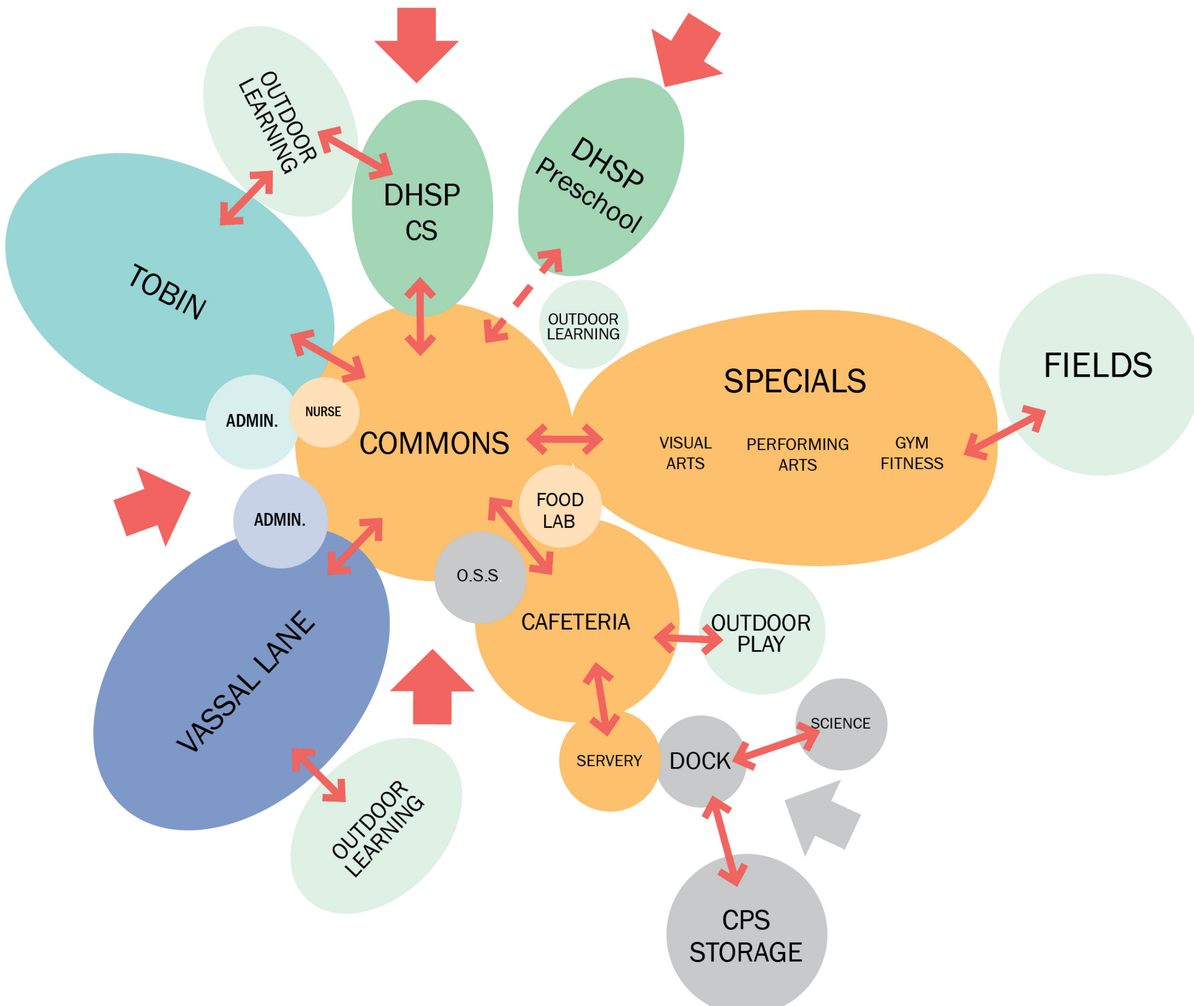
Vassal Lane Upper School (VLUS)

Created through the Innovation Agenda, upper schools are a relatively new idea in the Cambridge Public Schools. As such, Vassal Lane Upper School's (VLUS) culture is still evolving. Currently, the students and the school are very diverse. Students are urban and savvy, and aware of the world around them. They are perpetually learning, and the culture generally places great emphasis on equity and social justice.

Like the Tobin, the Vassal Lane Upper School's diverse population speaks more than 30 different languages. To serve the varied backgrounds and needs of the children and their families, the school offers three programs: General Education, Sheltered English Immersion (SEI) and a special education, Autism Spectrum Disorder (ASD) Program offered by the Office of Student Services (OSS). The school also features a co-teaching model designed to support more individualized instruction.

The environment created for the VLUS should respect and respond to the diverse and varied needs of the students, and also understand the distinct developmental needs typical of middle school age children. Middle school students are growing physically, intellectually and emotionally. They are more autonomous and independent; they are growing larger, and are more physically active; they like to socialize; and they are "creatures of technology."

Middle School students are coming to terms with their identity, and they need social/emotional support as they grow and develop. The environment should support their growth and emerging identities, such as providing



School Organization Bubble Diagram

gender-neutral bathrooms, and it should impede bullying by enabling easy formal and informal interaction with, and supervision by, adults.

As the visioning conversations continued, each of the participants shared their individual Hopes and Dreams for the new building:

- It should reflect VLUS' values and approach to learning
- It should feel their own: provide a distinct identity for VLUS
- It should be designed for the dynamic nature of middle schoolers
- It should inspire learning and teaching
- It should be welcoming, joyful, and "homey" for students, staff and families
- It should make every student feel that they matter
- It should be safe/calm/comfortable and foster community
- It should be full of sunlight and breathable air
- It should support future growth for enrollment and teaching/learning possibilities
- It should be connected to nature: bring the outside in & the inside out
- It should provide larger classrooms for larger students and to support co-teaching

With these initial insights about the VLUS and further understanding of the group's higher-order goals, this meeting and subsequent focus groups further explored these ideas and goals. Those conversations are articulated the design and organization principles that follow in the next section.

Department of Human Service Programs: Preschool and Community School

The Department of Human Service Programs (DHSP) culture is welcoming to families, and built upon kindness and inclusion. DHSP currently operates a Community School program on-site serving children ranging in age from three to eleven years old that serves as an after school enrichment opportunity. The program serves approximately 112 children that all attend the program during the day, and the majority of the children are drawn from the earlier grades, typically up to first grade. Current offerings for older children are restricted due to space limitations. The new building should increase the programming opportunities for students from grades two through five by providing additional appropriate space.

With a growing need for Preschool programming across the city, DHSP is also planning to provide a new program at the new building. DHSP's preschool programs have the State's highest quality rating and can help meet Cambridge's early childhood education needs on the site. To do so, the new program will target approximately 80 children, between 2.9 and five years old. The majority are expected to be three and four years old. Within the new building, this program should have proximity to the Children's House and Special Start to help all of the young children in the school to grow into strong members of a diverse and multi-cultural community.

As the visioning conversations continued, the DHSP participants each shared their individual hopes and dreams for the new building:

- Collaboration should be encouraged between the Tobin & DHSP to benefit the children
- The space should reflect creative, open and flexible possibilities for children to learn, grow and build community
- Provide room for senior programming
- Foster a sense of community with opportunities for collaboration
- Create a place that is inviting for young children and families as well as older teens

- Offer access to green courtyards and playgrounds
- Provide community space for engagement & activities
- Create great places outdoors as well as indoors

With these initial insights about the DHSP and this understanding of the group's higher order goals, this meeting and subsequent focus groups, further explored these ideas and goals. Those conversations are articulated in the design and organization principles that follow in the next section.

Site Amenities & Community Resources

Each of the programs housed within the building has distinctive needs for outdoor education, recreational and physical education opportunities. These range from developmentally appropriate playgrounds for the youngest DHSP and Tobin students, and a place for outdoor education like CitySprouts, to social spaces for Vassal Lane students, and athletic fields for school physical education and school and summer sports programs.

In the forums held with the community, open space was also highlighted as a critical issue for the new design. The community spoke passionately about retaining the amount of outdoor space on site. Through the conversations, the design team recognized the important role that Father Callanan Playground has played in the community, and understood the community's desire for continued access to basketball, baseball/softball and playground space for after hours use.

Another synergy arose when the community also expressed a desire to have bicycle access across the site from Concord Avenue to Vassal Lane continuing Cambridge's bicycle network and further enhancing connectivity to Fresh Pond. Students, staff and members of the community will all benefit from these amenities.

2.2 Principles

Through the visioning sessions and subsequent iterative rounds of focus groups, each program's ideas about teaching, learning, community, culture and sustainability continued to be refined and elaborated upon. These refinements are captured in the following principles. These organizational and design principles will guide the design of learning environments that are uniquely tailored to support each of the programs individually, and collectively. In addition to guiding the designers, these goals/principles can help the stakeholders assess the developing designs, ensuring that they reflect and respond to the vision established at the very beginning of the project.

Tobin Montessori Lower School

1. **The school, the neighborhood and classrooms should create a home-like ambiance for students.**

    The Tobin school should be welcoming, and reflect the principles established by the Montessori program. Natural light, finishes, and furniture will play a key role within each classroom. Age-appropriate furniture, shelving and counters provide ample opportunities for discovery and use, and help to establish the "house for children" atmosphere embodied in the Montessori principles.

2. **The design should engage the front office into a welcoming arrival.**

    The entry sequence is an important part of a student's day. The main entry should be secure, yet welcoming, and expand upon the Montessori values. The main office and reception should be at the building main entrance convenient to the Tobin's academic space. Visitors will arrive at an identifiable, secure entry sequence which will also enable staff to greet visitors in an open, and inviting public space.

3. **The school should foster community by creating academic neighborhoods.**

    Creating three distinct academic neighborhoods will help break down the scale of the school, and promote teacher collaboration. The Children's House and Special Start will share a neighborhood, creating an opportunity for a dynamic central dining area and breakout activity space for children to enjoy right outside the classrooms. The extension of learning from the classroom into the neighborhood breakout area allows for more group activity space, and shared opportunities between classrooms. The Lower and Upper Elementary neighborhood wings will also feature an open breakout space for group learning and reading, (Images 2.2a-2.2d).

Diagram Color Key:

- Lower School Classroom
- Restroom/Storage
- Resource
- Shared Support
- Circulation

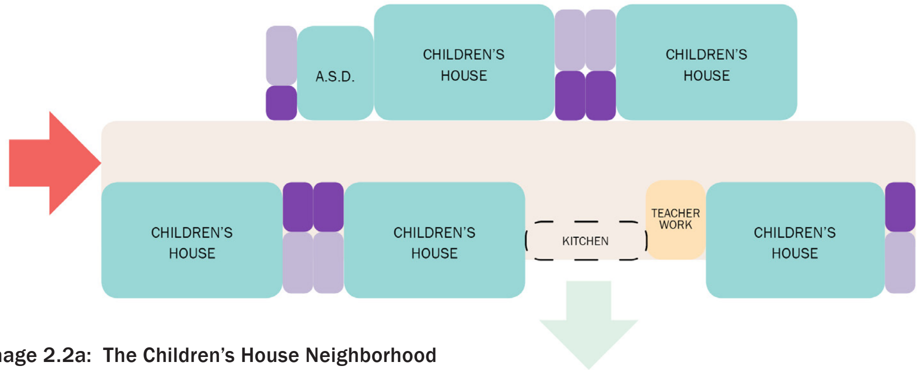


Image 2.2a: The Children's House Neighborhood

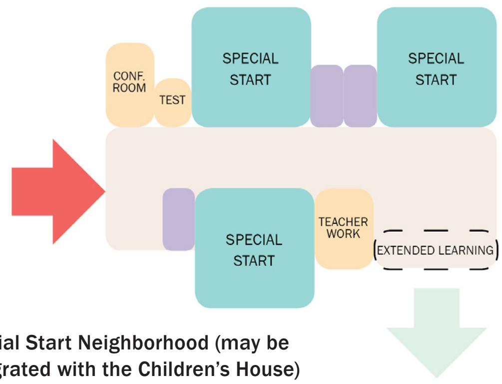


Image 2.2b: Special Start Neighborhood (may be integrated with the Children's House)

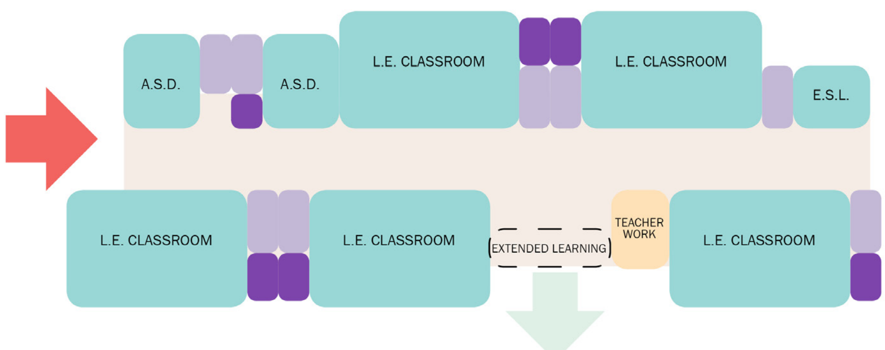


Image 2.2c: Lower Elementary Neighborhood

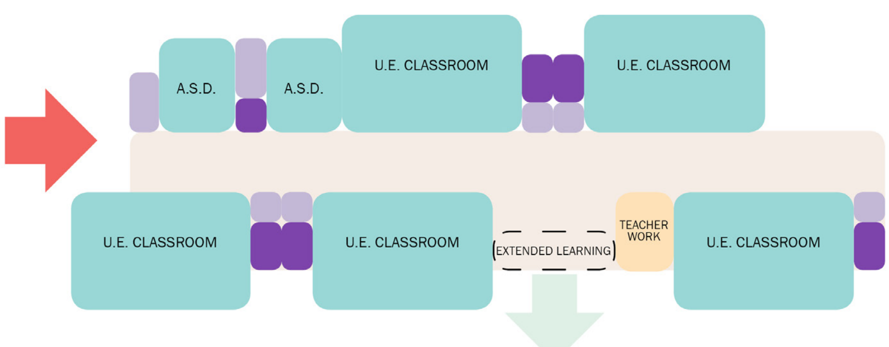


Image 2.2d: Upper Elementary Neighborhood

Vassal Lane Upper School

1. **The design should establish a strong first impression for the Upper School**.

   One of the problems with the existing facility is the location of the Vassal Lane program on the upper floor, preventing the school from having an identity within the building and at the main entrance. The design should establish an identity and first impression for the Vassal Lane Upper School upon arrival at and into the building.

2. **The design should engage the front office into a welcoming arrival.**

   The main office should be a part of the new welcoming experience for Vassal Lane. Like Tobin Montessori; the Vassal Lane main office and reception should be located at the building's entrance. This will be the first opportunity for Vassal Lane to have a ground floor presence to receive visitors and direct them to the appropriate academic neighborhoods.

3. **The school should foster community by creating academic neighborhoods.**

   Three interdisciplinary neighborhoods will help foster relationships between students and teachers and promote teacher collaboration. The neighborhoods will be organized by grade level, (sixth, seventh, eighth), and each will feature a section of the SEI program, so students from all grades can access the general classrooms. Each of the neighborhoods will also include a breakout space, overlooking outdoor views (Images 2.2e - 2.2g).

4. **Situate the specials to connect the community.**

   Centrally locating the Visual and Performing Arts should provide the two schools with direct connectivity to all the shared program spaces. Each of the three Vassal Lane neighborhoods will have convenient connections to the Visual and Performing Arts, the multipurpose gymnasium, the Learning Commons and dining. This central location for these program elements will facilitate scheduling and reduce passing time, and it will allow for convenient Community School use after hours (Image 2.2h).

5. **The design should locate the Learning Commons as the heart of the school.**

   Libraries have evolved into a center for collaboration and the creative use of technology and accordingly, the Learning Commons should become the heart of the school, connecting and centering the academic neighborhoods and the building's shared program elements. This location is both symbolic and functional as it will visually establish learning as the centerpiece of the school, and it will provide easy access, and inspire serendipitous use by students (Image 2.2h).

Diagram Color Key:

- Upper School Classroom
- Storage
- Small Group Room/ Resource
- Shared Support
- Circulation

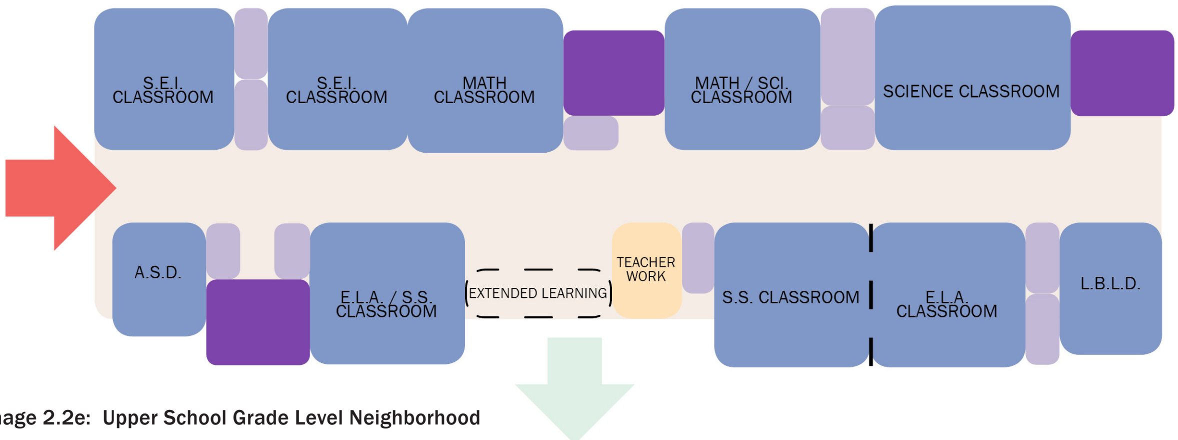


Image 2.2e: Upper School Grade Level Neighborhood

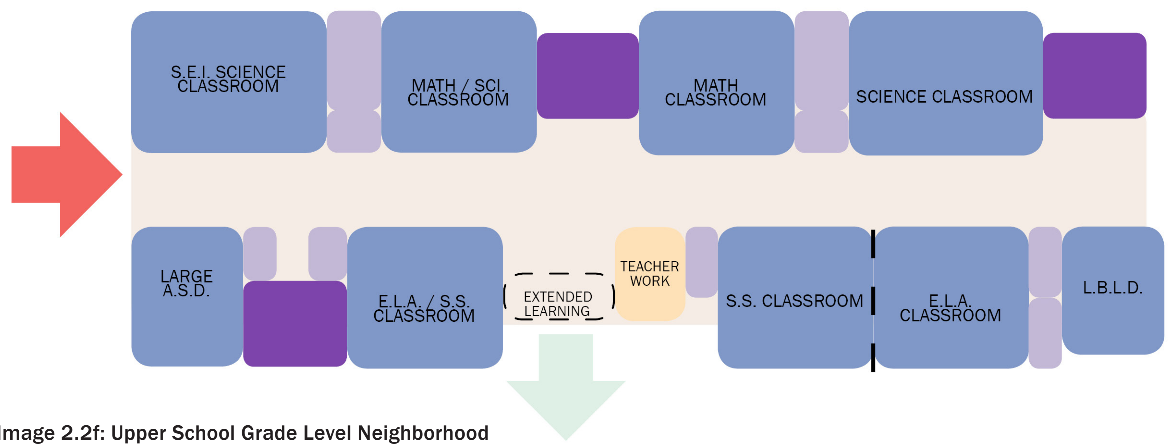


Image 2.2f: Upper School Grade Level Neighborhood

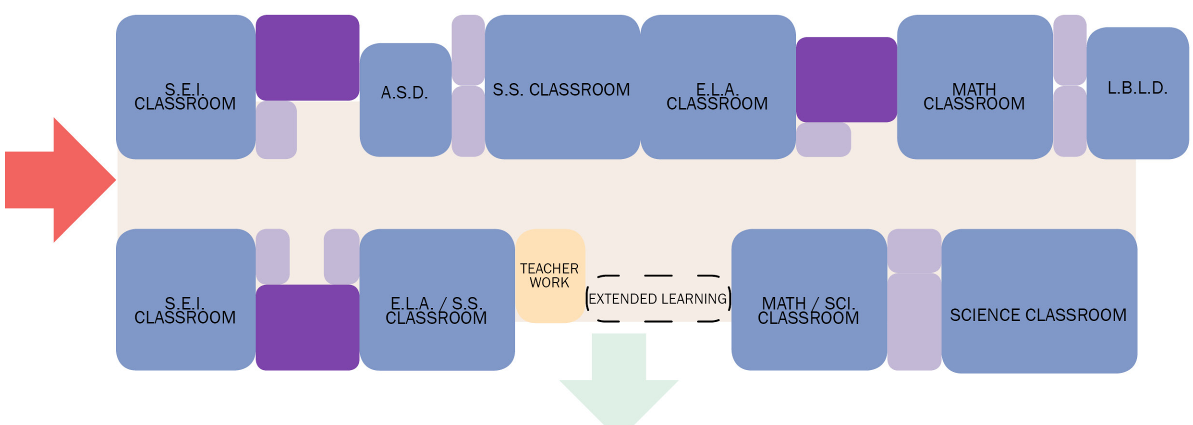


Image 2.2g: Upper School Grade Level Neighborhood

6. **Enable continued development of the Upper School program.**

   The school should allow for continued development of the Upper School Program. With the projected enrollment over the next five to ten years, the Upper School will provide flexibility for the anticipated growth. The co-teaching classroom should provide flexibility for continued development of the curriculum, pedagogy and technology.

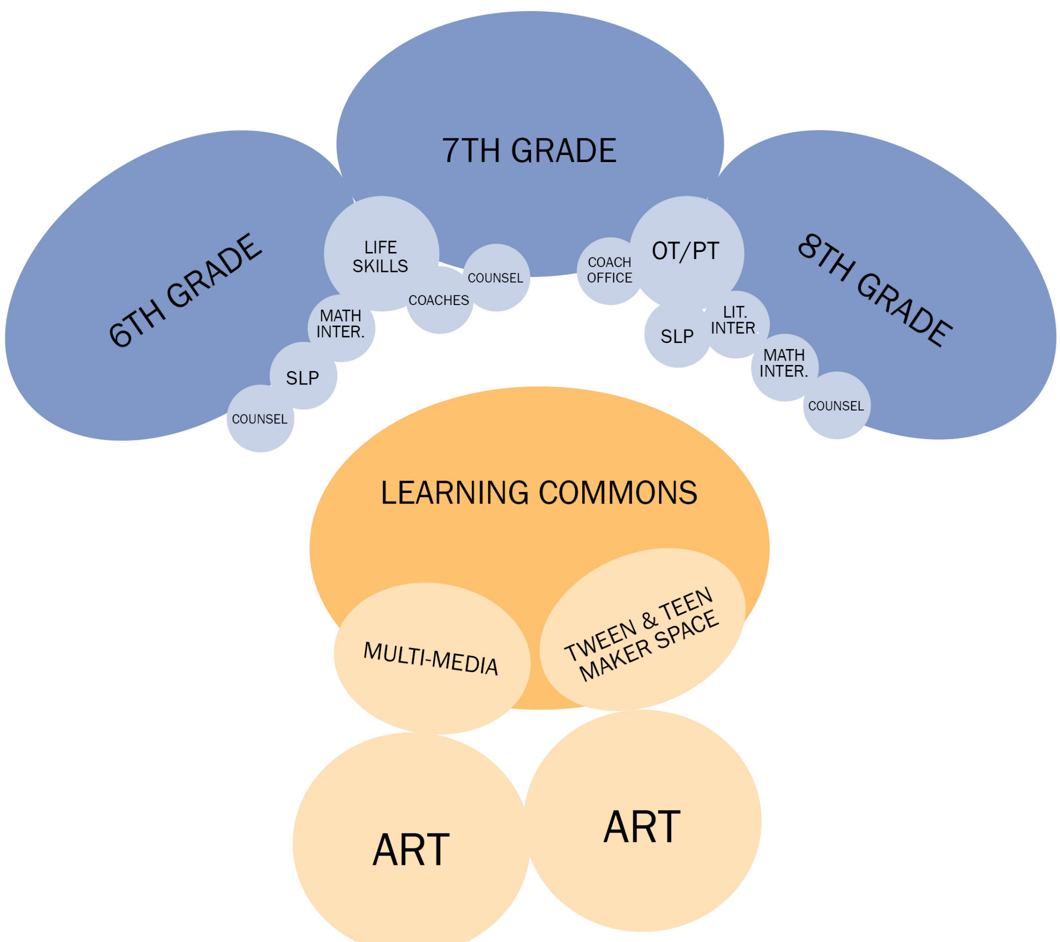


Image 2.2h: Upper School and Shared Space Affinities

Preschool

1. **Design should create a Preschool classroom neighborhood.**

   The classrooms will be gathered together to form a neighborhood centered on a shared kitchenette. This strategy will enhance collaboration and reduce movement between classrooms and the shared program, such as the Gross Motor room. The neighborhood will also provide breakout space off the kitchenette, similar to the other academic neighborhoods, with space for extended learning and view connections to the outdoors, (Image 2.2i).

2. **The design will include a welcoming and home-like setting for Preschool children.**

   The Preschool should have a separate entry from the Lower and Upper Schools, to establish an identity and facilitate secure pick up and drop off throughout the day. This additional building entrance will connect to the classroom neighborhood and provide a direct route for parents to walk their children to class without walking through the other two schools. The administrative office and reception will have the opportunity to greet visitors as they enter the building and simultaneously enhance security.

3. **The school should provide developmentally appropriate outdoor spaces.**

   The Preschool will have direct access to developmentally appropriate outdoor space within a secure play area just outside their classroom neighborhood. Similar to the Tobin Montessori, the outdoor space will include space for outdoor learning, and gardening, as well as play activity space.

4. **Pairs of classrooms will share bathrooms.**

   To allow for convenient and efficient use of facilities, classrooms and bathrooms will be paired. Bathrooms will include shared storage and changing space for students. A connecting corridor space will allow for both classrooms to share the restrooms without disturbing the one another.

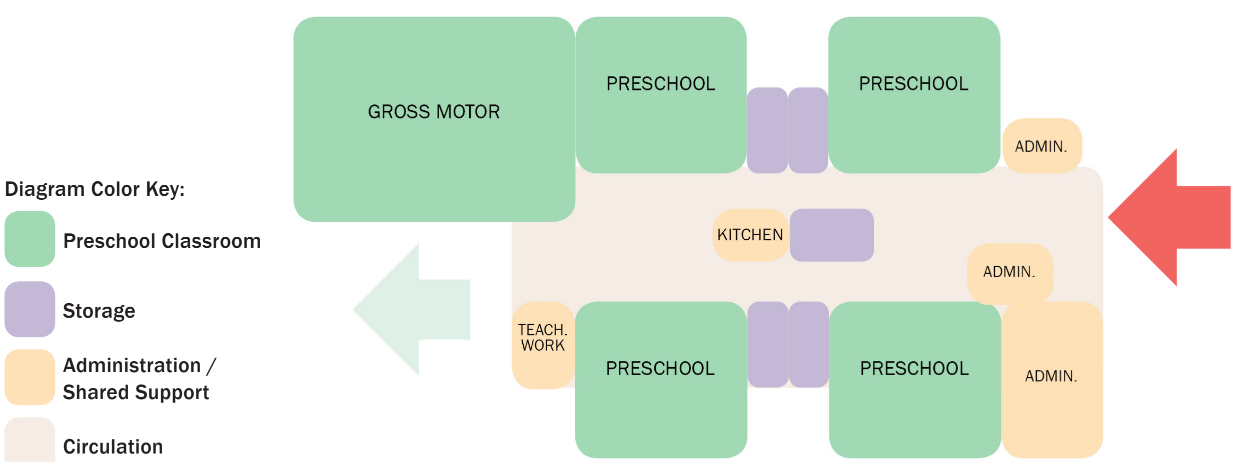


Image 2.2i: The Preschool Neighborhood

3.0

DESIGN DRIVERS

University of Pittsburgh Falk Laboratory School: Pennsylvania

3.0 A Building at the Crossroad of Education and Community

Introduction

The Preferred Option for the Tobin Montessori and Vassal Lane Upper Schools project is the outcome of evaluating and analyzing 2 development strategies: Existing Renovations with an Addition and a New Building. For the New Building approach, we explored a total of 3 options with various iterations (Renovation/ Addition, Wings, Pavilions, and Replacement). As a result, we evaluated a total of four options with iterations according to the Project Principles discussed in Section 2.0 and several other design drivers including – Project Site, Architectural Considerations and Community Impact.

Project Site

The Tobin Montessori and Vassal Lane Upper School is located east of Fresh Pond Reservation in West Cambridge. The once active clay pit for New England Brick Company is surrounded by mainly residential neighborhoods along Vassal Lane, Alpine Street, and Concord Ave (Image 3.0a). The neighbors actively visit the Father Callanan Playground towards the northern part of the site. Parallel to Concord Avenue, three baseball fields and basketball court serve as a community outdoor activity space (Image 3.0b), and a pedestrian friendly buffer from ongoing traffic, (Image 3.0c). From our site studies, we deduced the following to be our main design drivers when considering the project site:

- *Urban Design (Maintain relationship to Neighborhood)*
- *Parking and Vehicular Circulation (Relieving street parking & traffic congestion mitigation)*
- *Storm water management and Resilience (2070 100-year storm & Sea Level Rise)*


Image 3.0a


Image 3.0b


Image 3.0c


Design team meeting

Architectural Considerations

As the design process progressed, there were architectural considerations that acted as design drivers to insure that all options put forth were addressing the main architectural concerns. One was ensuring all options provided enough building area to include all the program components listed in the Educational Specifications. When satisfying the programmatic spatial requirements and adjacencies, we simultaneously focused on working with the building massing to ensure indoor to outdoor connections, and placement on site. Lastly, the City of Cambridge is actively seeking all their new projects to meet Net-Zero Emissions according to their Net Zero Action Plan. We are actively considering sustainability Net Zero Energy potential for the project, while also monitoring the project's cost. As a result, the following are our main design drivers in terms of architectural considerations:

- *Building Massing & Program Fit*
- *Sustainability Potential (Site, Water Efficiency, Materials & Resources, Indoor Environmental Quality)*
- *Net Zero Potential (Energy Use Intensity & Alternative Energy)*
- *Project Cost*


Design team meeting


Design team meeting

Community Meeting Presentation

3-D Model at Community Meeting

Landscape Breakout Group at Community Meeting

Community Impact

From the early stages of the Feasibility Study process, the involvement from the City of Cambridge and the Neighborhood were key drivers in the development of the Preferred Option. The City of Cambridge and the Design Team organized several community meetings in the span of 10 months where the Neighborhood provided important insights that influenced all 8 project options. In the course of all the community meetings and the written material submitted to the City of Cambridge, over 590 community comments were reviewed and summarized into the following main design drivers (Image 3.0d & e):

- *Continuous Open Outdoor Area: should retain or exceed the acreage from the current Father Callanan Playground and continue to be accessible to the community.*
- *Play Space Types: outdoor sport activities should remain part of the community culture for young generations to continue to enjoy. Therefore, one baseball field minimum should be retained without any overlap with another athletic field.*
- *Traffic: Vehicular access coming into the site from Concord Avenue is not preferred due to existing traffic patterns. This Feasibility Study recommends that a Traffic Impact Study be conducted during Schematic Design phase to ascertain the impact to the neighboring street network.*
- *Proposed Program & Building Size: program should be reduced to decrease population and vehicular density allowing the building program to condense and accommodate more open outdoor area.*

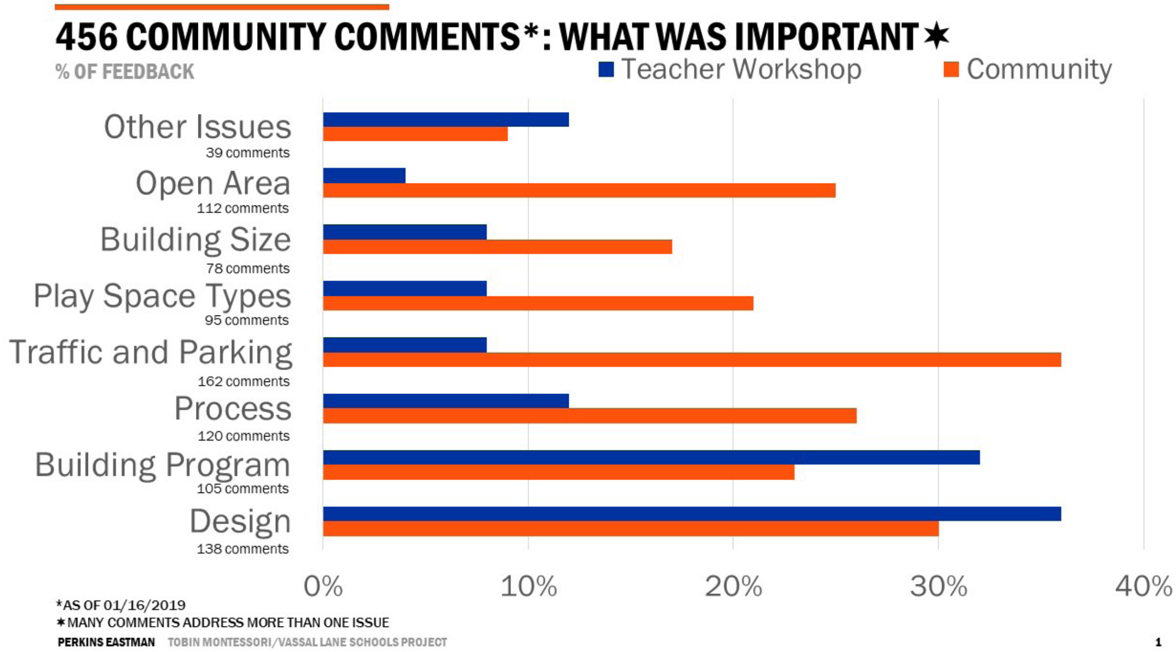


Image 3.0d

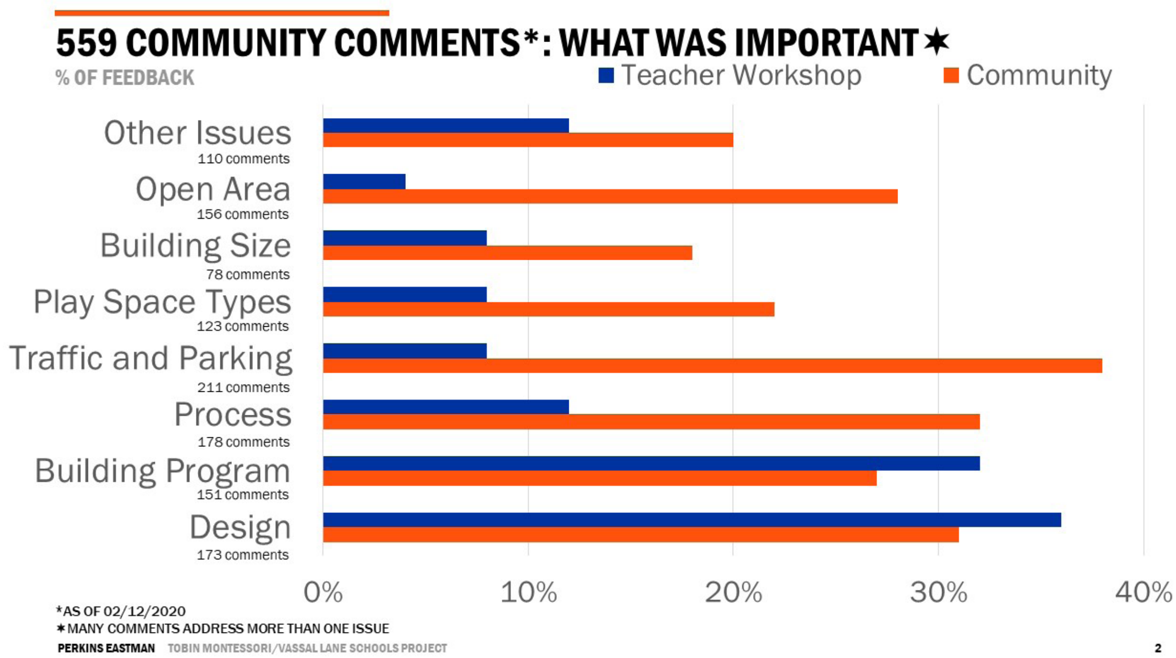


Image 3.0e

3.1 Design Narrative

Description

The basis of Crossroads partí is that the Vassal Upper School, The Tobin Montessori School and the DHSP Preschool and Community School are housed in two wings flanking a main entrance, and roughly parallel to Vassal Lane, in generally the footprint of the existing structure (see Image 3.1a). The community spaces (the cafeteria, the gym and the auditorium) are housed in a volume directly north of the academic wings, and adjacent to the outdoor recreation and fields of Father Callanan Playground (image 3.1b). The academic spaces and community spaces are arranged around the Heart of the School, a central, multi- story space that physically links many central aspects of the school (image 3.1c).

The Heart of the School is fundamentally a Community Commons, a crossroads of the many paths students will take throughout their day to and from the academic neighborhoods to all the shared spaces offered at the school. From the Heart of the School it is possible to travel in the east-west direction to two courtyards flanking it. A multitude of connections both vertically to the other floors, and also horizontally to community spaces can be made from this geographic center of the school.

Entrances and Identity

A key design principle identified with the school stakeholders is the importance of creating a clear identity and presence for each of the schools. Making distinct entrances for each of the schools was one of the ways we imagined satisfying this design parameter. As the design progressed, and encouraged by other considerations, a central, single point of entry was developed for the entire community. This being the case, a single point of entry simplifies the security sequence and gives access to the Heart of the School. Once at the Heart each program must have its own identity and entry point to remain consistent and satisfy the principle (image 3.1d).

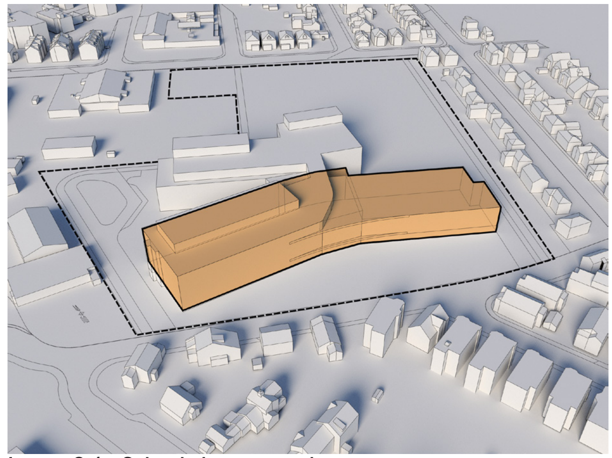


Image 3.1a School classroom wings

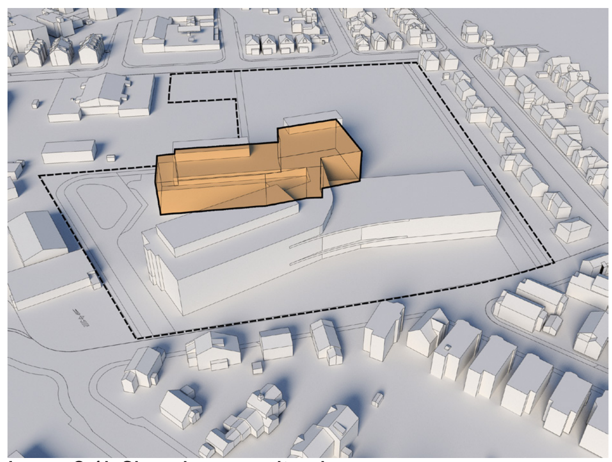


Image 3.1b Shared community wings

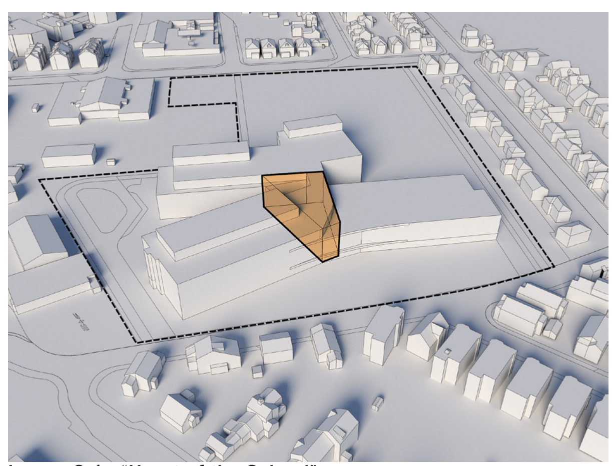


Image 3.1c “Heart of the School”

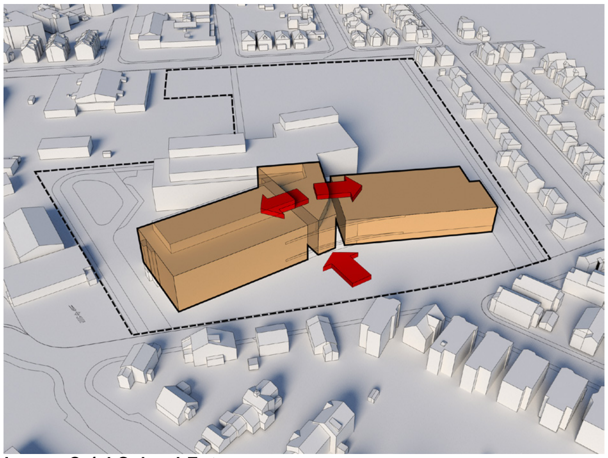


Image 3.1d School Entrance

Building Orientation and Massing

The concept of Crossroads organizes the classrooms with windows facing a north-south orientation. This orientation is ideal in that it promotes the greatest amount and control of natural light coming into the classrooms, which in turn reduces energy needed for artificial lighting and cooling. This has been shown to improve student outcomes and building performance (image 3.1e). The massing along Vassal Lane is four levels on the western side of the site (towards Fresh Pond) and three levels along the eastern side, towards the neighboring homes along Vassal Lane and Alpine Streets (image 3.1f). This deliberate design refinement promotes a school building that, while being a community civic asset, recognizes the importance of being a good neighbor.

The large volume community spaces, the gym, auditorium and cafeteria, are placed north of the academic wings, but at a significant distance from Concord Avenue. This location also relates to the planned improvements of Father Callanan Playground , placing indoor athletic facilities adjacent to outdoor recreation uses. This location limits the impact of shadows cast by the building.

Community Spaces and The Heart Of The School

The multi-story, Heart of the School is accessed by the main entrance on Vassal Lane. Continuing walking north through the Heart a secondary entrance facing Concord can be reached. All the spaces planned for after-school use by the community can be accessed directly from the Concord Avenue entrance. Internal doors separate the community spaces from the academic classroom wings of the Upper and Montessori Schools allowing flexible secure control. During the school day administrative suites on the ground floor have visual control of the Vassal Lane entrance. The Health Office has visual control of the Heart of the School and the doors leading to the courtyards. The physical education offices have visual control of the Concord Avenue entrance. An entry along the

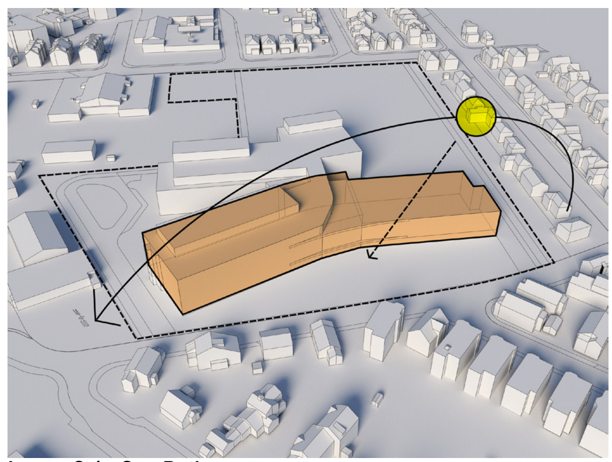


Image 3.1e Sun Path

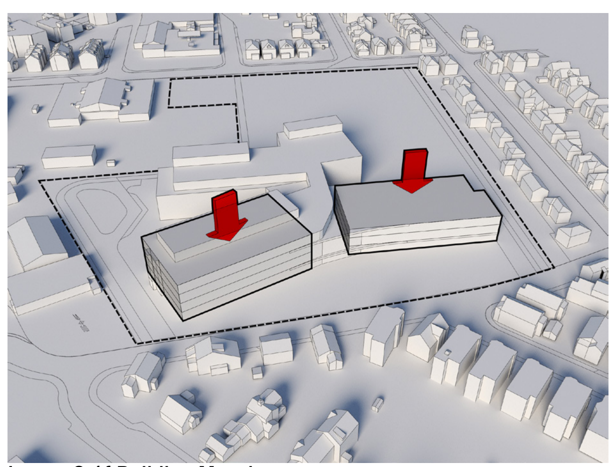


Image 3.1f Building Massing

western side of the building provides convenient access to the After-School program housed on the ground floor.

Of all the options developed, the concept of Crossroads has the most compact footprint. This is achieved by carefully stacking the program in a logical manner while minimizing walking distances between the various parts. For example, the auditorium, a program component that requires little daylight, is acoustically isolated and placed above the music program spaces on the western side of the site near the neighboring Armory. This location is optimal because it gives the auditorium a clear connection to the Heart of the School with secondary access from Concord Avenue for after-hours use. Corridors for circulation surround the auditorium and serve naturally lit and ventilated classrooms and other instructional spaces. This layout, with "dark" spaces at the core, surrounded by light spaces on the perimeter, creates a compact and efficient floor plan. Throughout the school, circulation systems are double loaded for maximum efficiency. The building enclosure is as compact as possible while providing natural light and ventilation to every classroom and instructional space.

School Administration and the Welcome Center

The concept of Crossroads locates two satellite administrative suites for both the Tobin Montessori and Vassal Lane Upper School on the ground floor flanking the main entrance. This adjacency assures that there is a clear line of sight to observe the building entrance. The administrative suite for the Preschool and shared health suite are positioned just passed the lobby entrance, flanking the Heart of the School, providing redundant, subtle security by staff. The balance of the administrative suites are distributed at other locations in the school. For Vassal Lane Upper School, there is an administrative suite on the second-floor entry, which is the Upper School's main entry point from the Heart of the School. For the Tobin Montessori School, the administrative spaces are in a suite on the ground floor adjacent to The Children's House.

Preschool

The Preschool is on the ground floor of the school's West wing along Vassal Lane (image 3.1g). It has a front door from the main lobby and the Heart of the School, and a secondary entry along the West controlled by the both the preschool and community school administrative suite. The secondary entrance allows for access from the vehicular drop off along the west side of the property. This drop off area would be available when not used by buses. From this ground floor location preschoolers have access to shared resources including the gross motor room. A contained outdoor play area is accessed directly from preschool classrooms providing a safe and secure setting for the youngest members of the school community (image 3.1h).

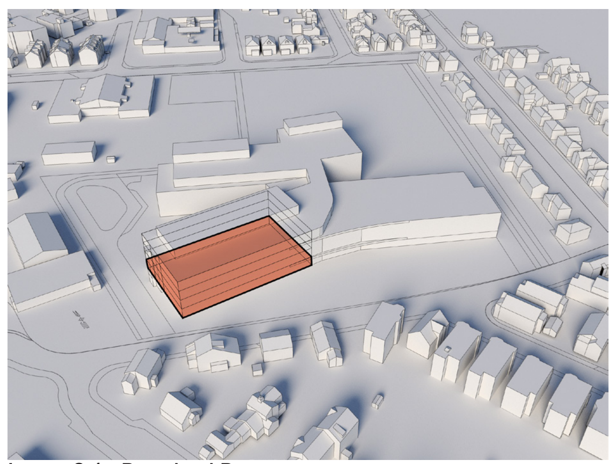


Image 3.1g Preschool Program

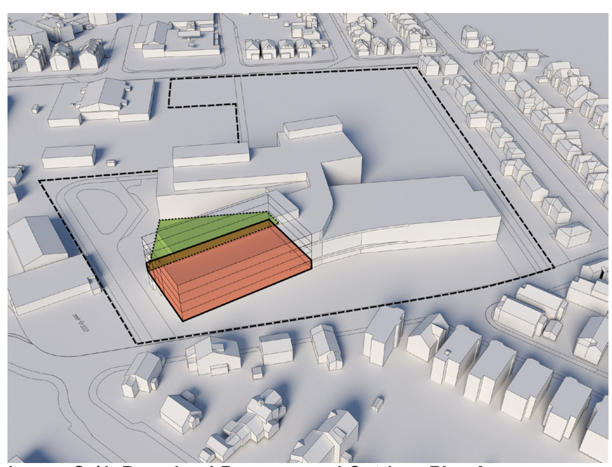


Image 3.1h Preschool Program and Outdoor Play Area

Learning Commons

One of the most important instructional spaces serving both the Montessori and Upper Schools is the Learning Commons. Replacing the library of former schools, this space will continue to house the schools' hard copy books but additionally it will offer an environment suitable for interactive learning and teaching using the latest technologies. The importance of this space is expressed by its location in Heart of the School. The Learning Commons is split between levels 2 and 3 (image 3.1i). Students from any grade only walk a short distance and up or down a maximum of one story to get from their classrooms to their respective Learning Commons. Additionally, to emphasize its importance as the Heart of the School, the Learning Commons is located to provide natural light and views to both the east and west. On one side, a multi-story view of the Heart of the School structure, and on the other, a view of the courtyard and play areas. While oriented to the east and west, these view windows will be somewhat protected by the length of the adjacent wings – something that will be studied during Schematic design. Dividing the two age groups into distinct Learning Commons areas supports opportunities for creating age appropriate spaces dedicated to each of the learning communities. In addition, through thoughtful location of a communicating stair, both spaces can still function as one when desired.

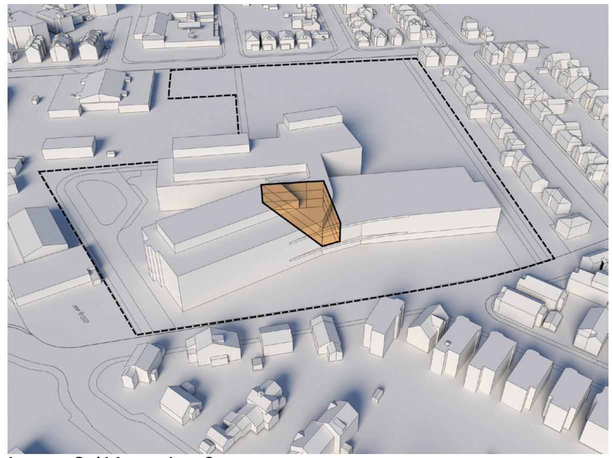


Image 3.1i Learning Commons

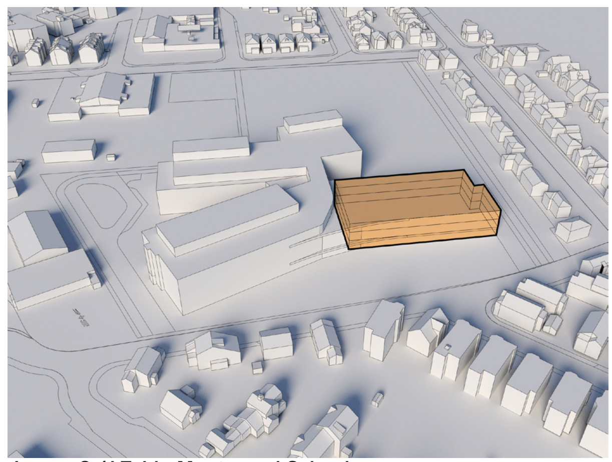


Image 3.1j Tobin Montessori School

School Organization, Tobin Montessori

The concept of Crossroads creates a compact footprint affording classrooms ample natural light while providing convenient access to teacher work and support spaces in the interior. To achieve this the Tobin Montessori was organized on three floors (image 3.1j). The five Children's House classrooms and the three Special Start classrooms are located on the first floor along with the Main Office. This first floor location provides direct access to outdoor spaces and extends the learning opportunities and instructional space to the landscape areas. Lower Elementary Grades 1 to 3 are directly above on the second floor which can be quickly accessed through the main stair in the Heart of the School, or an elevator in the Lobby. The Upper Elementary Grades 4-5 are all on the third floor of the Eastern academic wing. All three levels are connected by an internal stair that doubles as the required means of egress.

On each floor of the Tobin Montessori school there is an extended learning space that can be used for collaborative project work by small groups. The extended learning areas on each floor are strategically located to gather natural light and direct it to the internal corridor areas. This central area also promotes casual supervision from adjacent classrooms, teacher work areas and other offices which are distributed on each floor to enhance the subtle security of the school.

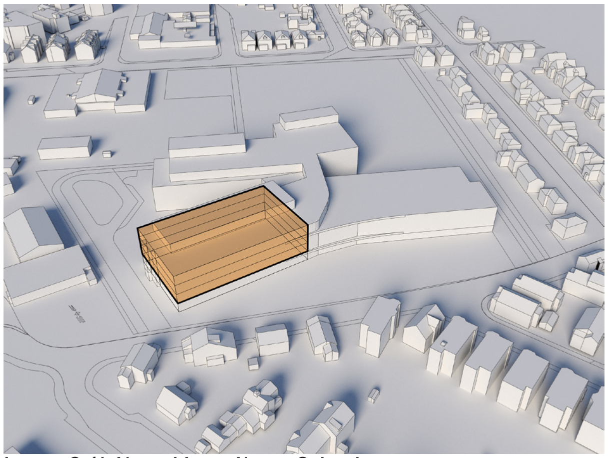


Image 3.1k Vassal Lane Upper School

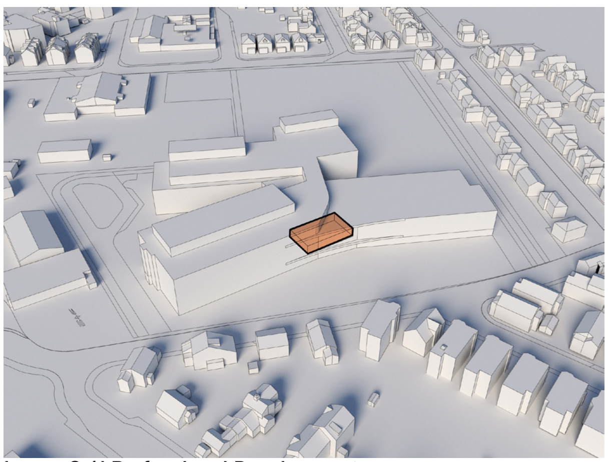


Image 3.1l Professional Development

School Organization, Vassal Lane Upper School

The Crossroads option locates the Vassal Lane Upper School on levels 2 to 4 of the west academic wing (image 3.1k) . This location is above the Preschool and directly adjacent to the Heart of the School. A stair internal to the neighborhoods links them together and provides the required means of egress. Each neighborhood is complete with teacher work and support spaces plus extended learning areas, which are strategically located to provide for natural light and ease of supervision.

A Community of Professionals

In order to allow for collaboration among teachers to foster curriculum interconnectivity and professional development, properly located support spaces are included in the design of the preferred option. The teacher workspaces become the heart of each floor within each academic wing. The Professional Development Multi-Purpose space is located at the connection between the Tobin and Vassal Schools providing equal access to all the teaching communities (image 3.1l). Teacher workspaces are also part of the Preschool learning neighborhood.

Garden, Dining and Food Lab

Just as the Learning Commons is more than a library, the vision for dining is more than a cafeteria. As an important shared teaching and learning opportunity, the food lab is centrally located, directly below the Learning Commons. Its on-grade location, with abundant natural light, also allows direct access to outdoor seating, and for students to participate in maintaining a garden appropriate for the seasons. This garden can become an outdoor classroom while at the same time providing fresh herbs to be used in the main kitchen.

Site Amenities

Both the schools and the community expressed significant interest in having active outdoor uses on site. The following are site amenities identified in the Crossroads option that will be developed at the Schematic Design stage:

Play and recreation areas for the various schools benefit from the reduced site area that was dedicated to vehicular movement and the building footprint. A variety of outdoor play and recreation spaces are imagined, including passive spaces, areas with play equipment, and active spaces for running and ball-play. The Tobin School play area is closest to the Tobin School to the east of the site. This space and equipment are shared with the community and are easily accessed from Vassal Lane and Concord Avenue. The current fields at Father Callanan Playground will be updated to provide a regulation size Youth Little League Field and a U12 Soccer field.

The landscaping of the site for the benefit of the schools and Father Callanan Playground has been carefully considered. The positive benefits for the school and neighboring community are equally important.

Access pathways on both the east side of the site, as it exists today, and the expansion and refurbishment of the multi-modal path on the west side of the site will be created addressing the goals of the Envision Cambridge Plan.

The two courtyards flanking the Heart of the School are significant features of the outdoor space and have the capacity to also function as an outdoor teaching space. The courtyards have perimeter fencing with decorative gates.

The site will become part of a larger bike network and encourage ridership. Bike routes on the site are marked, leading from all site entry points to bike parking areas located strategically near the entrances around the school. Fun sculptural bike racks are placed throughout the site to encourage bike use and create elements of interest within the landscape. Lastly, indoor bike storage will be provided for staff.

The Crossroads option earned preferred status partly due to how it organizes the parking and vehicular flow. Space is allocated below grade for the parking of approximately 150 cars: 100 parking spaces dedicated for faculty and staff, and 50 short-term drop-off parking spaces. This means that the presence of vehicles on site, excepting buses, is minimized and strategically located. A vehicular drop off lane is being created below grade to safely pick and drop off students that come by car (image 3.1m). Considerations for the ventilation of this below ground space will be advanced during Schematic Design. Additional traffic studies for the site and area are also anticipated.

Building Components

A carefully considered building envelope will have a significant impact in the energy conservation aspirations for this learning community. This includes, but is not limited to early design considerations for materials, exterior wall and roof systems, exterior window and curtainwall systems, light-shelves, shading

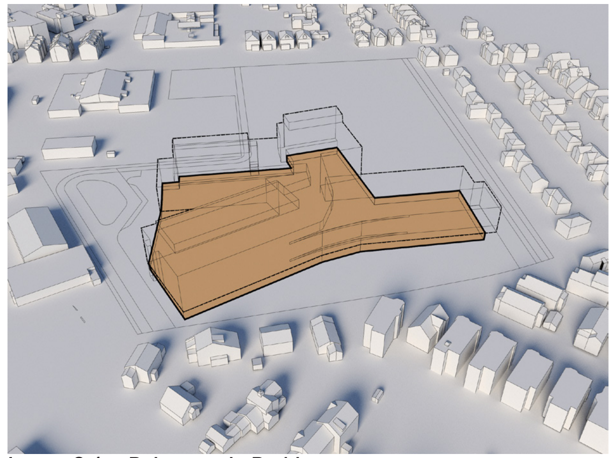


Image 3.1m Below-grade Parking

devices, skylights, and interior door and window systems. The City of Cambridge expects this building to have a minimum of a 50-year life expectancy. Different components will have different life expectancies. The building design considers energy efficiency, flexibility to meet changing curriculum needs, inherent durability, and ease of maintenance.

Energy Efficiency

In addition to optimizing the north-south orientation of classrooms, other features are employed to effectively control glare and heat gain/loss through the walls. To balance the wall to window ratio certain targets are established which, together with parametric analysis, will

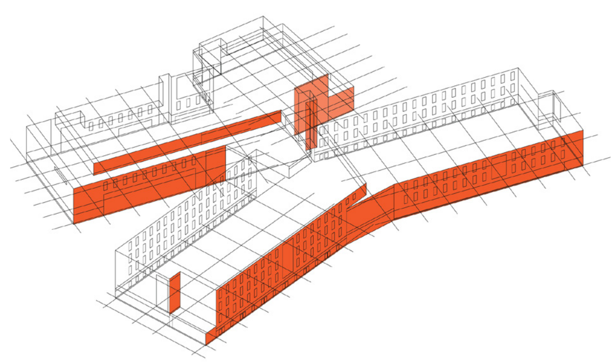


Image 3.1n

help guide the design of the façade in the next phase of Schematic design (image 3.1n):

- Overall Building: +/- 30% glazing or windows
- South/North facing façades: +/- 35% glazing or windows
- East/West façades +/- 20% glazing or windows

It is advisable that the windows and curtain wall systems be of a thermally broken type of construction within the frame. The shading coefficients and visual transmittance values of the glass will be adjusted to respond to the orientation on the building. Glazing elements facing east and west are overlaid with a vertically oriented fin shading system to minimize the impact of the sun when it is at lower angles in the sky. The exterior opaque walls have insulation (approx. R-30 for insulation only) applied to the exterior of the structure to minimize thermal bridging from inside to outside through the structure. An air/water/vapor barrier will be installed on the warm side of the insulation and the exterior cladding will be installed as a rain-screen system with an air space between the cladding and the insulation to allow any water that may migrate through the cladding to be managed and directed back to the outside before it ever has an opportunity to reach the wall.

To allow natural light to penetrate deep within the classrooms a clerestory window system will be analyzed for the exterior envelope. The system will also include a light-shelf on the inside of the south-facing classrooms with the purpose of bouncing light to the ceiling and deeper into the room. This effect is enhanced by the 14' floor-to-floor dimension of the typical floor which serves the added benefit of supporting adequate space for building systems such as ventilation ducts and sprinklers. This space allows for coordinating systems in the plenum space as well as supporting proper access for maintenance. As the energy conservation and on-site power generation opportunities are better understood, the design will explore the addition of photovoltaic panels on the exterior, south facing sunshade devices to increase on site power generation opportunities.

The roof construction also plays an important role in the energy efficiency of the building. Insulation with a target value of approximately R-40 is being examined, plus the additional value of a green roof system where they may occur. The green roof not only helps to keep the roof cool and control storm water, but it also protects the membrane from harmful UV rays of the sun which eventually cause the degradation of the roof over time. PV panels will be accommodated on ballasted roof supports as well as a canopy structure that "floats" above rooftop equipment and learning spaces.

Flexibility

The size of the classrooms has been developed to comfortably accommodate the maximum number of students allowed by contract within the City of Cambridge while providing instructional set-up flexibility within. Ample storage will be provided, as well as wall space for display and writing surfaces.

An emphasis in acoustics within and between classrooms and offices needs careful consideration through optimized wall construction and materials selection, and isolating sound within very noisy spaces such as the music rooms. Additionally, special attention to the selection of materials for the atrium space needs to be given so that the acoustics within the space are active and yet comfortable even at the busiest of times.

Some aspects of the shared spaces in the school are offered for community use after school hours. For this reason, it is necessary to engineer the security systems, lighting systems and the mechanical systems to be flexible to accommodate a variety of uses at a variety of times. The design of these spaces will be given special attention so that storage for daytime school use is separate from after school program use and transitions between uses can occur with ease.

The preferred option maximizes connectivity between indoor space and outdoor space supporting the use of outdoor spaces as learning spaces as well. Roof spaces can become integral teaching spaces in addition to the on-grade opportunities such as the garden outside the cafeteria and food lab. The roof above the Heart of the School is flanked by the Vassal Lane academic wing to the south and the Shared spaces to the north, creating a protected, three-sided courtyard, fundamentally an outdoor classroom that captures views of Fresh Pond to the west (image 3.1o).

Durability and Maintenance

Interior and exterior materials will be selected for their durability and aesthetic value. Flooring choices for public spaces are crucial for a long lasting low-maintenance school. Consideration of the benefits of a product like terrazzo outweighs the potential initial cost increase to the project. Materials such as this will be evaluated through a cost/benefit analysis, as appropriate. Other items such as finishes on railings will be selected so that the on-going need for repainting and finishing will be either eliminated or kept to a minimum.

The placement of building system components that require maintenance and controls that require monitoring will also be an important criterion as the design evolves so that filters and parts can be replaced without undue disruption and anomalies in the systems performance can be identified early. Even the type, location and lifespan of light bulbs becomes important to keep an energy efficient building performing at its peak.

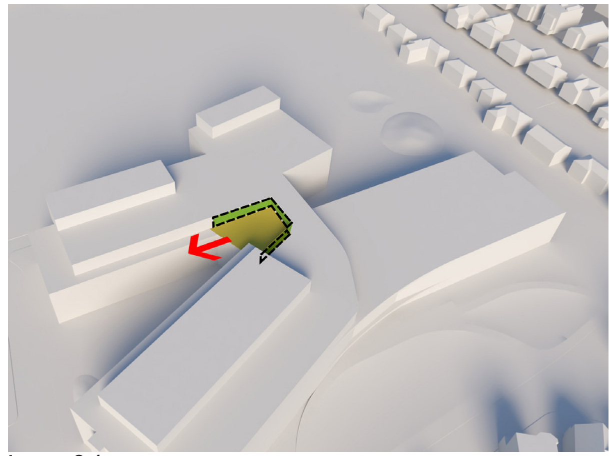


Image 3.1o

3.2 Regulatory Analysis

Zoning

The Tobin Montessori School and Vassal Lane Upper School are located in West Cambridge-Neighborhood 10. With a population of approximately eight thousand, West Cambridge is considered a relatively low-density neighborhood, according to the Cambridge Community Development Department.

The site at 197 Vassal Lane is zoned for both OS: Open Space (public parks and recreation facilities and other public facilities) and B: Residence B ("Res. B") (two family or semi-detached dwellings). The surrounding context is zoned Residence B to the north and east, and Business A to the west (Image 3.2a).

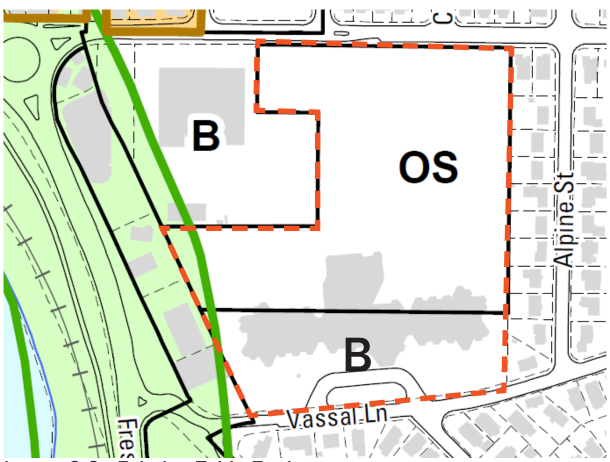


Image 3.2a Existing Tobin Zoning

The existing building is located partially within Res B. zoning and partially in OS (Image 3.2b). The proposed new building is sited relatively in the same location, with an extension to the north-east. According to 4.56b Table of Institutional Use Regulations, both portions of the site may be used for educational purposes.

The project will need to pursue variances and/or special permits for building height and maximum FAR allowed. The City of Cambridge will manage the process and determine the preferred approach for acquiring relief.

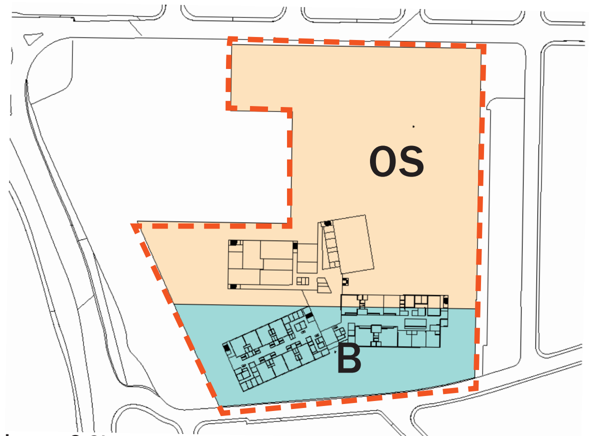


Image 3.2b Preferred Option Zoning

Article 97

Under Massachusetts State Constitution, Articles of Amendment Article XCVII, the site has 4.96 acres of Open Space protected under Commonwealth of Massachusetts Executive Office of Environmental Affairs EOEA Article 97 Land Disposition Policy of 1998 (Appendix A4.4a 1.1). The City of Cambridge is managing the process of interpreting the definition of open space, the required area, and the allowable uses of the space on this site. The design options have focused on evaluating alternative options for the configuration of the program on the site to maximize the acreage of protected open space for that configuration.

Building Code Requirements:

Building Use: Educational Group E

The new building will be fully sprinklered, three-and four-stories, and approximately 60' high, not including mechanical screening and penthouses. According to Tables 504.3 & 506.2 of the IBC, the project would likely be of Construction Type1B, 2A or 4A. The design team is exploring using Construction Type 4A, a hybrid of steel and heavy timber construction. This approach would likely require building separations and will be further explored in early schematic design.

During Schematic Design, the team will engage the code consultant, Hastings Consulting for a more through code analysis.

Residence B & Open Space

CATEGORY	REQUIRED	PROPOSED IN PROJECT	REF.	RELIEF REQUIRED
Zoning District	Res. B Residence B: two family or semi-detached dwellings OS (Open Space): Public parks and recreation facilities and other public facilities	To be determined if a change of zoning will be recommended or required		
Overlay District	None	None		
Uses	Educational	Educational	4.56	
Max. Ratio of Floor Area to Lot Area	Res. B: 0.5 OS: 0.25		Table 5-1 & Table 5-5	5.54.2 FAR shall not exceed existing FAR on lot, except Planning board may approve an increase in FAR to 1.25 for any portion of the lot located within a residential zoning district (but excluding portions of the lot located within an OS district)
Minimum Lot Area (SF)	Res.B: 6,000 SF OS: 43,560 SF	Res. B: 111,193 SF OS: 285,765 SF	Table 5-1 & Table 5-5	Complies
Minimum Front Yard (ft)	Res. B: 15' OS: 25'	29'	Table 5-1 & Table 5-5	Complies; Refer to Fig. A.
Minimum Side Yard (ft)	Res. B: 7'6" (sum of 20) OS: 15'	55'	Table 5-1 & Table 5-5	Complies; Refer to Fig. A.
Minimum Rear Yard (ft)	Res. B: 25' OS: 25'	36'	Table 5-1 & Table 5-5	Complies; Refer to Fig. A.
Maximum Building Height (ft)	Res B.: 35' OS: 35'	60'	Table 5-1 & Table 5-5	Yes; Note: excluding mechanical & penthouse
Minimum Private Open Space Ratio (%)	Res B.: 40% OS: 60%	N/A	Table 5-1 & Table 5-5	Private space provided on lot used for residential purposes
Minimum Lot Frontage	Res. B: 50' OS: 150'		Table 5-1 & Table 5-5	
Minimum # of parking spaces	3 per 2 instruction rooms or 1 per 5 seats in the main auditorium, whichever is greater. (60 instruction rooms and 525 auditorium seats)	150 (105 minimum)	6.36	Instruction: 3/2x60=90 Auditorium: 1/5 x 525=105 Minimum = 105
Compact Parking Space Dimension		7'-6" x 16'	6.40	
Regular Space Dimension		8'-6" x 18'	6.40	
Number of Long-term Bicycle Parking		18.00	6.107.2	Note: Plus bike share systems
Number of Short-term Bicycle Parking		102.00	6.107.3	

Figure A - Preferred Option: Distances from Building to Property Line.

Historic Considerations:

The building site has historical significance, as it was once an active clay pit for New England Brick Company (Image 3.2c). The City of Cambridge's history is rich with clay manufacturing. The clay pits of Cambridge helped to build factories, mills, and buildings at Harvard. Recognition of the site's historical could be integrated into the design of the building and site.

The John M. Tobin Montessori School, designed by modernist architect Pietro Belluschi, is a living example of brutalist-style architecture. Belluschi was an Italian-American architect known as one of the leaders of Modernist architecture, and he later became the dean of the MIT School of Architecture and Planning.

The building design features a unique layout of hexagonal spaces that break up the façade of the building, and help bring the building to a more residential scale. The design team recognizes the building's architectural value, as well as its inherent embodied energy & carbon. The team has developed and presented options for renovating the main portion of the existing building and adding on additional space to the north (Father Callanan Playground side).

However, the state of the current building presents challenges to its continued use:

- The classroom geometry makes layout extremely difficult,
- There are significant deficiencies in the building envelope, including water and air leakage and poor and missing insulation

New England Brick Company Brick

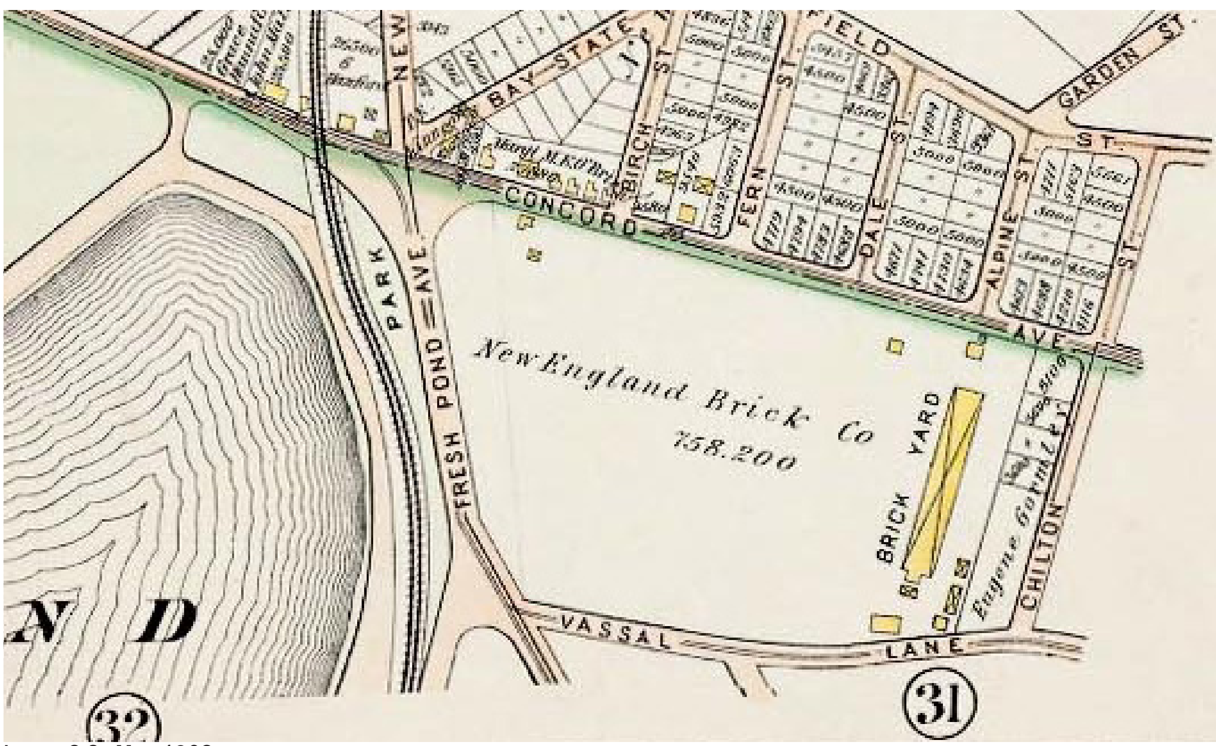


Image 3.2c Map 1903

- The building contains hazardous materials that will need to be abated using sometimes destructive methods.
- Windows are not well-configured for providing high quality, day lit learning environments.

All told, much of the existing would need to be demolished and replaced in order to keep the structural elements of the building. Even with this extensive effort, the geometry of the building will make the building inefficient, and require an increase in the size of the addition. Further, the best way to make the existing building sustainable would be to reconfigure windows for daylight and reclad the building with a thermally improved façade. Much of the quality of Belluschi's building would be lost.

Ultimately, the City of Cambridge will make a determination about the demolition of the existing John M. Tobin School building. The Historical Commission will advise the City's Building Commissioner on its review of an application for demolition. The Commission will consider the age and significance of the building. The building construction documents were issued in 1969, with occupancy beginning 1971. Buildings that are 50 years old and older must be considered for their historic value. If the building is demolished, some homage to the building's history may be appropriate in the new design.


LIBRARY

4.0

SYSTEM RECOMMENDATIONS

4.1 TRAFFIC
4.2 CIVIL
4.3 GEOTECHNICAL
4.4 STRUCTURAL
4.5 MEP & FP
4.6 FOOD SERVICE
4.7 AUDIO / VISUAL
4.8 SUSTAINABILITY AND RESILIENCY
4.9 NET ZERO EMISSIONS AND ENERGY
4.10 HAZ MAT
4.11 LANDSCAPE

Chengdu International School: China

4.0 Systems Integrated for Maximum Value and Performance

Typical school projects of this magnitude require significant coordination and integration of various engineering and design disciplines. This project has particular challenges pertaining to the site, in addition to the goal of creating a high performance building. Those are summarized below, and the following subsections go into additional detail.

Site Systems

- Site coordination is complicated by subsoil conditions. The site was used as a clay pit. Later, the quarry was filled as a municipal dump. The dump, was later filled, and the site developed by for the Father Callanan Playground and the 1970 school building. The dump materials will need to be handled as contaminated and will need to be handled with special precaution and if removed from the site, will need to be taken to restricted landfills.
  Ground water is generally high, approximately 3-4 feet below the existing surface. This causes challenges with construction, and sub-grade waterproofing. There is a geotechnical strategy being considered that creates in-places structured soil walls to allow for excavation and stop migration of contaminated ground water.
- The site is an opportunity to reduce the frequency and intensity of flooding in the neighborhood. As a result, the site will house a 1.25 million gallon stormwater tank and provide 100,000 gallons of bioretention systems to address local flooding from short duration and intense storms.
- The site spans two zoning districts, Residence B and Open Space, both with restrictions on Floor Area Ratios (FARs) and building heights.
- Envision Cambridge intends to use the site as a pathway connection between Fern Street to the north and Fresh Pond at the southwest.
- The community fields have been used for playgrounds, ball fields and a basketball court. Maximizing recreational use, and natural amenities is an important parameter.
- There are Commonwealth of Massachusetts restrictions pertaining to Article 97 Open Space

Building Systems

- The Preferred Option will overlap with the existing building.
- As the existing building sits on wood piles, those will need to be removed or avoided for foundations.
- The existing building was constructed at a time when many materials, now considered hazardous, were used as insulation, caulking, adhesives and coatings. These materials will need to be carefully disassembled, handled, and removed.
- As parking is intended to be under the building, waterproofing and foundations must be carefully designed and coordinated.
- New structural systems will be on deep foundations and will be either a base design of steel with composite slabs or an alternate hybrid steel/wood/concrete topping slab option, which would reduce the embodied carbon of the project and provide natural materials within the building.
- MEP/FP systems, integrated with architectural systems will be designed for highest performance, durability, and cost effectiveness. All will be targeted at low carbon solutions with net zero emissions as a mandate and net zero energy as a goal.

4.1 Traffic and Parking

A Transportation Assessment was conducted for the existing school. The assessment quantified and summarized existing school transportation conditions and operations to assist the design team in understanding existing school operations, identify access challenges and opportunities, and to provide guidance and input regarding the framework of future transportation conditions and operations in connection with the design and implementation of the new school project. Specifically, the following key elements of school transportation operations were observed, quantified and assessed:

- School bus staging on-site
- Parent drop-off/pick-up activities
- Pedestrian circulation
- Bicycle use and accommodation
- Parking utilization, access and egress
- Loading and service activities

The purpose of this initial effort was to better understand the demands generated by the existing school student, faculty and staff populations and to assess the ability of the existing infrastructure to accommodate those demands. This was a key exercise to clearly define the transportation infrastructure that will be needed to support the two schools, early start programs, pre-school programs, administrative space needs, and other uses defined within the site that fall outside of regular school times, including any enhancements that may be needed to the surrounding transportation infrastructure to support that plan.

4.1.1 Existing Conditions

School Site and Key Adjacent Streets

The Tobin Montessori School and the Vassal Lane Upper School are bounded by Vassal Lane to the south and by Concord Avenue to the north. The main entrance, drop-off/pick-up circle, staff parking lot, and loading bay are all accessed via Vassal Lane. The schools are accessed via walkways connecting to the staff parking lot and Vassal Lane via Concord Avenue. The schools also abut Fresh Pond Parkway (US Route 3) to the west, and Alpine Street to the east, but these two roadways do not provide direct access to the Schools.

- *Vassal Lane* is a one-lane, one-way eastbound roadway that runs along the frontage of the Schools. The posted school zone speed limit within the vicinity of the Schools is 20 mph. Sidewalks are present along both sides of the roadway, and land use is primarily residential within the vicinity of the Schools. On-street Cambridge resident parking is provided on both sides of the street.
- *Concord Ave* is an east-west, two-lane roadway that runs along the playing fields and the Cambridge Armory behind (north) the Schools. There is no posted speed limit along the roadway in the vicinity of the project area. Sidewalks are present along both sides of the roadway, and land use is primarily residential within the vicinity of the Schools.

Existing School Site Conditions

In general, the sidewalks along Vassal Lane and Concord Avenue abutting the existing Project site and in fair to good condition. Main pedestrian access to the existing Tobin Montessori School and Vassal Lane Upper School is provided off Vassal Lane in the front of the school where sidewalks are provided along the curbside drop-off loop that is served by two curb cuts on Vassal Lane for vehicular access to the Schools' main entry. Secondary access is provided in the rear of the building, which serves as a staff entry from the adjacent surface parking lot. Additionally, two pedestrian paths are provided on the site including one connecting Concord Avenue to Vassal Lane, on the east edge of the site, parallel to Alpine Street and another on the west edge of the Callanan Playground from Concord Avenue to the rear of the school building.

There is strong bicycle connectivity to surrounding residential neighborhoods. Short-term bicycle parking is provided at the main entrance to the school as well as a 19-dock Bluebikes station provided on site. There are dedicated bicycle lanes provided on Huron Avenue, Fayerweather Street and Lexington Avenue. Bicycle paths are also provided on Fern Street connecting to a series of bicycle paths within Danehy Park, on Concord Avenue, west of the Sozio Rotary, along Fresh Pond Parkway, and around the perimeter of Fresh Pond.

The Project site is served by several nearby public transportation options. Massachusetts Bay Transportation Authority (MBTA) local bus routes 72 and 75 stops along Huron Avenue approximately 0.3 miles from the site. MBTA local bus routes 78 and 74 stops along Concord Avenue approximately 0.2 miles from the site. The MBTA Red Line Alewife Station is about 1 mile away from the school site.

Roadway access to the Project site in provided by Vassal Lane. There exists a curbside drop-off loop that provides two curb cuts for entering and exiting drop-off activity to the school's main entry as well as a driveway for parking lot access and egress; all of this vehicular access and egress is provided on Vassal Lane. The curbside drop-off loop is used primarily by school buses, vans, and some supporting parent drop-off/pick-up activity. Many parents dropping-off or picking-up students frequently choose to park in the neighborhood roadways nearby the school. Additionally, many parents also either choose, or are required, to escort their child into the school and directly to their respective classroom. This is the case most notably for the youngest students enrolled in the Tobin Montessori school program.

Many students walk to and from the school from the surrounding neighborhood. Many students also arrive by parent vehicle drop-off, van, or school bus. The modes of the student trips are not consistent between the morning arrival period and the evening dismissal. Far more students walk when dismissed from school than patterns that occur during the morning arrival.

Existing School Operations

To understand operations related to site access, egress, and circulation for school buses and vans, parent pick-ups and drop-offs, walkers, bicyclists, and employees at the two Schools, along with curbside operations and on-site parking, VHB conducted observations of the school. VHB met with the Tobin Montessori School and Vassal Lane Upper School principals prior to field observations to discuss arrival and dismissal activity. During the meeting, the principals highlighted areas that require the most improvement as well as areas that function well under existing daily activity.

Currently, buses and vans use the one-way circle off Vassal Lane to drop off and pick up students. Parents are requested to park along Vassal Lane to drop off and pick up students to ensure buses and vans have enough space to maneuver the circle, although some parents do choose to use the circle anyway. No drop-offs or pick-ups occur along Concord Avenue. Students who walk to school utilize the walkways as well as the sidewalks along Vassal Lane and adjacent neighborhood streets. Bicycle parking, as well as Blue Bikes, are provided at the main entrance.

Additionally, the principals outlined the following student and staff profiles:

Tobin Montessori School

- There are approximately 320 students ages 3 – 11 years old in Pre-K – Grade 5.
- Students begin to arrive at 7:15, when breakfast is provided by the school. The school day begins at 7:55 AM and ends at 1:55 PM.
- There are approximately 70 staff.
- Staff begin to arrive before 7:00 AM, but most arrive between 7:10 and 7:30. Most staff leave after the school day ends and their bus duties are finished.
- Afterschool program (through Cambridge Department of Human Service Programs (DHSP)) runs Monday – Friday from 1:55 PM to 6:00 PM.

- As required for students 3 years old only, but apparent for students 4 and older as well, there are many parents who bring their students to school in cars, park, and then walk their students into the school. At dismissal, parents wait for their students in the lobby.

Vassal Lane Upper School

- There are approximately 295 students ages 11 – 14 years old in Grades 6 – 8.
- Students begin to arrive at 8:15 AM, when breakfast is provided by the school. The school day begins at 8:55 AM and ends at 2:55 PM.
- There are approximately 53 staff.
- Most staff arrive between 8:15 and 8:30. Most staff leave after the school day ends and their bus duties are finished.
- Afterschool activities take place Tuesday – Thursday from 2:55 PM to 4:30 PM.
- Students are not typically accompanied by parents into the school; vehicle congestion is therefore much lower compared to the Tobin Montessori School.

Each school has its unique challenges reflective of the range of student age groups. The principals noted the heaviest congestion occurs during arrival and dismissal of Tobin Montessori School students due to the larger volume of parent vehicles transporting younger students, and three additional buses serving those students.

DHSP Programs / Arrival and Departure Patterns

- *Early Arrival* – starting at 7:15 for the Tobin Montessori School and 8:15 for Vassal Lane Upper School each morning, 40 minutes prior to the start of the school day (during which time breakfast is available)
- *After-School Program* – After-school activities are provided for Tobin Montessori School, along with other students at nearby schools. There are 125 students currently enrolled, and daily attendance averages to about 80 students. There are about 12 – 17 staff that typically work for the program. The program starts at the end of the school day at 1:55, and students are typically picked up by parents from 4 – 6:00 PM. Parents must accompany students out of the school for pick-ups.
- *Summer Camp Program* – During summer break, a day camp is provided for students including 125 students who are currently enrolled. The program runs from 8:00 AM to 5:30 PM. Staffing is similar to that of the After-School Program. About 4 times each week, students participate in field trips off-site, requiring up to 4 buses each trip. Parents must accompany students into and out of the school for pick-ups and drop-offs. Several other programs are offered in the school during the summer as well.

Site Observations and Data Collection

VHB conducted field observations and data collection on Tuesday, March 5, 2019 during school day arrival, dismissal, and after school dismissal to observe the concerns discussed with the Schools' principals, to quantify the volume of activity during the busiest times of the day, to quantify where the activity takes place, to assess parking demand and supply in the staff parking lot, and to document other noteworthy transportation/access/circulation activity. The field work helped form a picture of daily arrival and dismissal activity at the Tobin Montessori School and the Vassal Lane Upper School to provide a basis for the development of conceptual design alternatives.

During field observations, all pedestrian, bicycle, bus, van, and private car activity occurring at the curbside within the circle and along Vassal Lane was documented. "Drop-offs" and "pick-ups" were observed when parents did not get out of their cars and let their students walk in alone. This activity was distinguished from parents who parked their cars and walked their students into the school due to the greater traffic impact associated with the latter activity.

Field observations began prior to the arrival of the earliest Tobin Montessori School students at 7:15 AM, and lasted through late arrivals after the school day began at 7:55 AM. Observations for the Vassal Lane Upper School began soon after to capture early arrivals and ended after the school day began at 8:55 AM. Afternoon observations began prior to the arrival of the majority of parents picking up students at the Tobin Montessori School, and lasted through school dismissal at 1:55 PM for late pick-ups. Observations for the Vassal Lane Upper School began soon after and lasted through school dismissal at 2:55 PM. VHB staff remained on site to observe the Vassal Lane Upper School late bus dismissal, which occurred at 4:15 PM. Weather conditions were clear and cold with moderate snow banks along Vassal Lane from a recent storm, but travel conditions were good.

The cold, inclement weather in March, was not conducive for bicyclists, therefore additional, supplemental observations specifically related to bicycle operations were conducted on Wednesday, May 8, 2019 from 7:00 AM to 9:30 AM. It was assumed the reverse bicycle activity would occur during afternoon dismissal.

A more detailed assessment of transportation demands generated by the Tobin Montessori School and Vassal Lane Upper School, including an overview of findings from the arrival and dismissal observations is summarized in the Appendix of this Feasibility Study. Image 4.1a provides a summary of existing school transportation infrastructure accommodation.

4.1.2 Proposed Design

The next step in this evaluation process will focus on an in-depth analysis of future impacts of the Project. An evaluation of future anticipated school demands and associated infrastructure considerations will be undertaken to support the continued design evolution of the selected preferred design scheme. The Project is being designed to support increased student and staff populations, as well the accommodation of new programs that are not currently offered at this location. The generation of new trips associated with this anticipated program will be evaluated to understand the following:

- What specific accommodations are required on site to support school bus and van drop-off, parent drop-off, staff parking, pedestrian and bicyclist needs, and loading/service operations.
- What actions may need to be considered to ensure that quantified impacts to area roadways and intersections are identified and remedied.

Some changes to the surrounding transportation infrastructure may be required, such as signal timing adjustments, modified directionality of nearby one-way streets, new signage installation and new pavement marking installation might be necessary to better manage the future project impacts. In addition, the sizing and location of supporting on-site transportation infrastructure – most notably bus loading and parent pick-up/drop-off will continue to be reviewed in concert with evolution of the new building design. The overriding goal of this effort is to develop a transportation plan that accomplishes the following:

- Significantly reduces the reliance of nearby residential streets to support parent drop-off/pick-up activities.
- Provides a surface school bus and van drop-off solution that can appropriately accommodate anticipated demand, and has a geometric configuration that promotes safe and efficient access by these vehicles.
- Supports strong pedestrian and bicycle accommodation and connectivity between the adjacent residential neighborhoods, the new school, and open space.
- Provides appropriate staff parking.
- Allows for efficient loading/service that is segregated from student arrival zones.
- Maximizes opportunity to maintain quality open space for recreational uses that support both the school and the community

Image 4.1a provides a summary of the anticipated transportation infrastructure needs of the new school based upon the changes in program that are expected to be accommodated into the future.

4.1.3 Traffic Impact Study

The City of Cambridge Public School (CPS) Department, will also be required to prepare and submit a Traffic Impact Study (TIS) in advance of the proposed project's approval by the Planning Board. This effort will first require the development of a scope of work that will need to be submitted to and approved by the City of Cambridge Traffic, Parking and Transportation (TP&T) Department prior to conducting that effort. Typically, that scope would be inclusive of the following preliminary elements:

- Review of the project program and site plan and a brief project description and overview, including the proposed development size and parking requirements.
- A brief description of the existing school operations.
- A trip generation analysis for proposed project uses in accordance with City of Cambridge guidelines.
- Trip distribution and assignment of project trips in accordance with City of Cambridge guidelines.
- Based on the trip distribution and assignment, study area intersections would be proposed for the supporting analysis.
- Identify likely project parking needs as required by City of Cambridge.
- Assemble available traffic, bicycle & pedestrian data from other studies in the area

Once the scope of the TIS Scope has been finalized by the TP&T, The TIS analysis and report would be prepared and would include the following key components, which would be performed in accordance to the TIS guidelines provided by TP&T:

- Existing Transportation Data:
    - Obtain existing geometric inventory for roadways and intersections as well as parking, transit and land uses within the study area based on the City TIS guidelines.
    - Perform queue counts by lane for each approach at signalized intersections.
    - Conduct traffic counts in accordance with TIS Guidelines, including peak hour Turning Movement Counts (TMCs), 48-hour Automatic Traffic Recorder (ATR) counts and 12-hour Pedestrian counts
    - Using the information gathered, develop separate turning movement networks for vehicles, pedestrians and bicycles.
    - Summarize MassDOT crash data in accordance with the TIS guidelines for the most recently available 3-year period.
    - Assemble the most recent AM, PM and daily boarding and alighting information available from the MBTA for stops and stations within ½ mile of the project site. In addition, document transit routes, schedules and headways.
- Project Impacts: Revise the project trip generation and distribution as required to address TP&T input and responses.
- Background Projects: Review the background projects identified by TP&T and quantify the number of trips associated with each development to be added in to the future analysis scenarios.
- Intersection Capacity Analysis: Using Synchro software, prepare and document the intersection capacity analysis for each of the study area intersection. The analysis will be prepared for the weekday morning, afternoon school dismissal, and evening peak hours for the following conditions:
    - Existing Conditions (2020) - Based on existing traffic counts
    - Full-Build Conditions (2020) - Existing plus the Project
    - Future Conditions (2025) - Existing Conditions plus the Project plus other area project trips, plus percent background growth determined by TP&T for five years.

- Queue Analysis: Provide average queue analysis results by lane group for all signalized intersections for all analysis conditions.
- Residential Street Impacts: Analyze the increase of traffic on residential streets within the study area for all analysis conditions.
- Parking: Prepare parking demand calculations consistent with approved vehicle trip generation and modal split assumptions.
- Transit: Provide a transit analysis (for local bus and transit routes) of peak service headways, capacity, and demand for existing, build, and build with mitigation conditions.
- Pedestrians: Evaluate pedestrian access to/from the site along principal access routes. Pedestrian level of service (PLOS) calculations will also be conducted for the study area intersections for the analysis conditions listed above.
- Bicycles: Evaluate bicycle access to/from the site and bicycle parking in the vicinity of the site. Potential bike/vehicle conflicts will be identified for the analysis conditions listed above.
- Mitigation: Identify potential mitigation for adverse impacts identified through the above analyses. Develop conceptual mitigation strategies, conceptual intersection improvements, evaluate roadway improvements or circulation changes to protect the neighborhood, and TDM programs, etc.
- Planning Board Criteria: Conduct the analyses required to complete the Planning Board Criteria Analysis for inclusion in the TIS document.

The development of the TIS will include several meetings with the City and the neighborhood to help explain impacts, the intention of key Project design elements, and any required off-site mitigation and improvement actions. This process will be required by TP&T prior to their review of the TIS and future Certification of that analysis and report. TIS Certification is required prior to the commencement of Planning Board presentations in support of the Project.

Image 4.1.a: Existing School Transportation Conditions and Future Infrastructure Program Requirements

	Infrastructure Type	Existing Condition	Incremental Change	Proposed Condition
Morning Peak Period	Parent Drop-Off/Pick-Up	13 vehicles	10 Additional Spaces	23 vehicles
	Parent Drop-Off/Pick-Up (Short-Term Parking)	25 vehicles	14 Additional Spaces	39 vehicles
	School Bus Staging	2 Buses	No Expected Increases	2 Buses
	Van Staging	2 Vans	No Expected Increases	2 Vans
Afternoon Peak Period	Parent Drop-Off/Pick-Up	20 vehicles	6 Additional Spaces	26 vehicles
	Parent Drop-Off/Pick-Up (Short-Term Parking)	20 vehicles	6 Additional Spaces	26 vehicles
	School Bus Staging	6 Buses	No Expected Increases	6 Buses
	Van Staging	3 Vans	No Expected Increases	3 Vans
Pedestrian Amenities		Pedestrians dispersed throughout and from the neighborhood during arrival/dismissal times	No Change	Suggest maintaining similar pedestrian circulation and accommodating pedestrians in a safe environment separate from vehicular activity
Staff Parking		Approximately 80 Vehicles Parked	20 Additional Vehicles Parked	100 Parking Spaces to Serve Staff
Loading & Service		1 Bay / informal truck parking area	1-2 Loading Bays and 1 Trash Compactor Bay *truck turns and overhead clearance for tractor trailers and dumpster removal need to be studied*	2-3 Total Bays

4.2 Civil

Image 4.2a: Aerial Locus (Google Imagery)

Site Utility and Stormwater Narrative

Project Overview

The School is located at 197 Vassal Lane within the Fresh Pond area of Cambridge. The parcel is approximately 9.1 acres and includes the School building, an existing parking lot, and a drop-off driveway along Vassal Lane (Image 4.2a). Father Callanan Playground is in the northern portion of the parcel along Concord Ave. The parcel is bounded by Vassal Lane to the south, residential houses on Alpine Street to the east of Concord Ave to the north, and commercial properties on Fresh Pond Parkway and the Armory along Concord Ave to the west.

Excluding pavement, the existing subsurface soil profile consists of a layers of topsoil, granular fill, waste fill, clay and silt, glacial till, and weathered rock. Thicknesses vary across the site. Depth to bedrock varies between 30 to 93 feet below ground surface (bgs). The majority of the site was a former clay pit, that was later filled with soil and waste material. The seasonal high water table of approximately 3 feet bgs, the presence of the contaminated waste material, and the surrounding remnants of the clay pit walls create subsurface conditions that are not suitable for significant infiltration

According to the preferred option, the proposed school building will be constructed in the same location as the existing building along Vassal Lane. Parking for the site will be shifted into a new underground parking garage that will span the entire footprint of the proposed building. The drop-off area will be located to the west of the proposed building with access from Vassal Lane. The Tobin fields will be replaced. A bike path is proposed to the west of the building connecting from Concord Avenue to Vassal Lane.

SITE UTILITIES

Stormwater Management

Existing Stormwater Management

The southern portion of the existing site, including the existing school building roof, parking lots, and driveways, are collected into a closed drainage system and directed to one of several drain lines in Vassal Lane. Currently, it does not appear as if there are stormwater quantity mitigation measures or quality improvements located within the Tobin School site drainage systems. Refer to Image 4.2c and Appendix Volume 4a for more information on the existing drainage.

The eastern portion of the site runoff is directed to the 54-inch trunk line in the center of Vassal Street. The roof runoff is piped to a 20-inch drain which discharges to a 36-inch drain in Vassal Lane and bypasses to the 54-inch. Both the 54-inch, the 36-inch, and an additional 36-inch drain combine at a drainage vault to the southwest of the existing school. Stormwater runoff in the northern portion within Father Callanan Playground are collected in a series of underdrains and 12-inch pipes that discharge into a 48-inch drainage line in Concord Avenue. Refer to Image 4.2b and Appendix Volume 4a for more information on existing drainage.

The Vassal Lane and Concord Avenue drainage systems combine at the intersection of Fresh Pond Parkway and Concord Avenue. Stormwater continues through a series of box culverts before discharging to the Alewife Stormwater Wetland behind Cambridge Park Drive and a drainage outfall to the Alewife Brook.

Proposed Neighborhood Stormwater Storage Project

The City of Cambridge has identified the Tobin School site as a preferred location for neighborhood stormwater storage to help mitigate projected flooding conditions identified using the Cambridge Flood Viewer. The Tobin design team initially learned about the stormwater storage tank in the project's Request for Proposals; however, at that time it was identified as a 1-million-gallon tank. During design team meetings in 2019, Stantec clarified that the tank should be 1.25-million-gallons.
As detailed in the memorandum prepared by Stantec, dated Feb 25, 2020, stormwater from the drainage mains in Vassal Lane and Concord Avenue will be diverted through weir structures in large storm events and flow by gravity to the 1.25-million-gallon stormwater storage tank (refer to Appendix 4a for the Stantec memorandum). Once the storm has passed, the tank will be emptied out and stormwater will be pumped through a force main to a discharge in Vassal Lane.

The stubs from the storm drain infrastructure in both Vassal Lane and Concord Avenue have already been constructed. The gravity main from Concord Avenue will be a 36-inch service and the gravity service from Vassal Lane will be a 42-inch service. The tank, pump station, supporting infrastructure, gravity mains, and force main will be designed by Stantec however, the stormwater storage project will be closely coordinated with the Tobin School project and integrated into the design documents.

As discussed in the Stantec Memorandum, provided in Section 4a, the preferred tank size and location is 140-ft long by 60-ft wide by 20-ft deep and located to the west of the proposed school building beneath the bus turnaround. The 1.25 MG stormwater storage tank will include a dewatering pump station that consists of two (2) 20-HP submersible pumps operating in a duty-standby configuration. Electrical equipment to support the tank operation includes a control panel, transformer, circuit breaker, automatic transfer switch, and generator. The generator type will be determined, but may be natural gas and would require a natural gas meter. The equipment is estimated to require a space of 15-ft wide by 30-ft long and can be housed in an outdoor fenced electrical area or electrical room.

The tank will require drive-up access to the tank for operation and maintenance. Maintenance of the tank generally consists of exercising the pumps, removing the pumps for inspection and refurbishing, tank washdown and removal of debris that accumulates in the tank.
The minimum operation and maintenance

requirements for the tank includes:

- Access points for the tank and pump station:
  - Required at a minimum above each pump, one above the sump location(s), and a minimum of one at the upstream end of the tank for manned entry to assist with tank cleaning.
  - Increasing the width of the tank may require more access points to facilitate cleaning due to the increased quantity of intermediate column supports required.
  - Must be accessible at all times and cannot be buried or placed in an area where vehicles are parked on them.
- It is expected that the tank will need to be cleaned every 24 months. More frequent cleaning may be required depending on the use of the tank. The duration of the tank cleaning is typically 3 to 5 days.
- The pumps will need to be removed from the wet well by a small crane truck every 3 months for preventive maintenance. This maintenance will need to be performed during regular working hours M-F, 7:00am-3:00pm.
- Authorized DPW personnel will need unrestricted access to the control panel at all times.

Image 4.2b: Cambridge GIS - Sewer and Drain at Project Site

- The pump station and all controls need to be connected to the DPW's telemetry system.
- If emergency repairs are needed, they will need to be completed immediately and cannot be scheduled around events at the school.

In addition to the stormwater storage tank, the City has also identified an area of surface flooding near the intersection of Vassal Lane and Standish Street that occurs in high-intensity storm events. The City is proposing to integrate a surface stormwater feature on the Tobin School site to help improve the flooding condition on Vassal Lane. During design team meetings in 2019, Stantec identified the need to have approximately 100,000 gallons (13,370 cubic feet) of storage in order to help alleviate the surface flooding. To align with this need, the project team has identified a space in front of the proposed building along Vassal Lane where stormwater can be directed from Vassal Lane.

Nitsch is proposing two bioretention basins that are hydraulically connected but separated by a pedestrian walkway. Stormwater runoff will enter the bioretention basins through curb openings and swales along Vassal Lane. The bioretention basins will total approximately 6,500 square feet and will have approximately 1.5 feet of maximum ponding depth which is less than the required 100,000 gallons of storage. The bioretention basins will also include subsurface storage to enhance the available volume for storage and meet the 100,000 gallon storage target. The bioretention basin and subsurface storage will be lined due to the high water table and contaminated soils. Overflow from the bioretention basins will be conveyed to the stormwater storage tank.

Proposed On-Site Stormwater Management

The City of Cambridge typically has two primary stormwater design requirements under the DPW's Stormwater Control Permit. Projects need to reduce the proposed development peak flow rate from the 25-year storm event to be less than or equal to the peak flow from the 2-year storm event under existing conditions and the total phosphorus loading from the site needs to be reduced by 65% in the proposed condition.

The City has indicated that because the improvements from the stormwater storage tank and the surface/subsurface bioretention system would provide more benefits to the neighborhood than the typical required peak rate mitigation, additional peak rate mitigation measures are not necessary. However, the project will be required to meet the phosphorus reduction requirement, which generally means collecting and treating the first inch of stormwater runoff generated over impervious and pervious surfaces.

The proposed site design results in a net decrease in impervious cover that results in a slight reduction in the phosphorus loading. Although phosphorus loading is being reduced by the change in land cover, additional treatment is required in order to meet the 65% reduction requirement. Because the subsurface conditions are not suitable for infiltration, the project intends to meet the phosphorus reduction requirement by using a combination of green roof, porous pavement, bioretention, StormTech Isolator Rows, and proprietary stormwater treatment devices. For the purposes of this feasibility study, Nitsch is assuming that 10% of the proposed roof can be used as a green roof. The location of the stormwater treatment facilities is provided in Concept Utility Plan, see Appendix 4a.

As shown in the Conceptual Utility Plan, several proposed landscaped areas have been identified for use as bioretention basins. Stormwater from the adjacent surfaces will runoff overland to the bioretention basins to be treated. A portion of the roof runoff will be directed to a bioretention basin to the northeast of the proposed building. The bioretention basins includes a minimum 24-inch specialized soil media filter to provide solids and nutrient pollutant removal and will be lined to provide separation from groundwater and prevent infiltration. The bioretention basins will have 6" perforated PVC underdrains that will discharge to an onsite closed drainage system

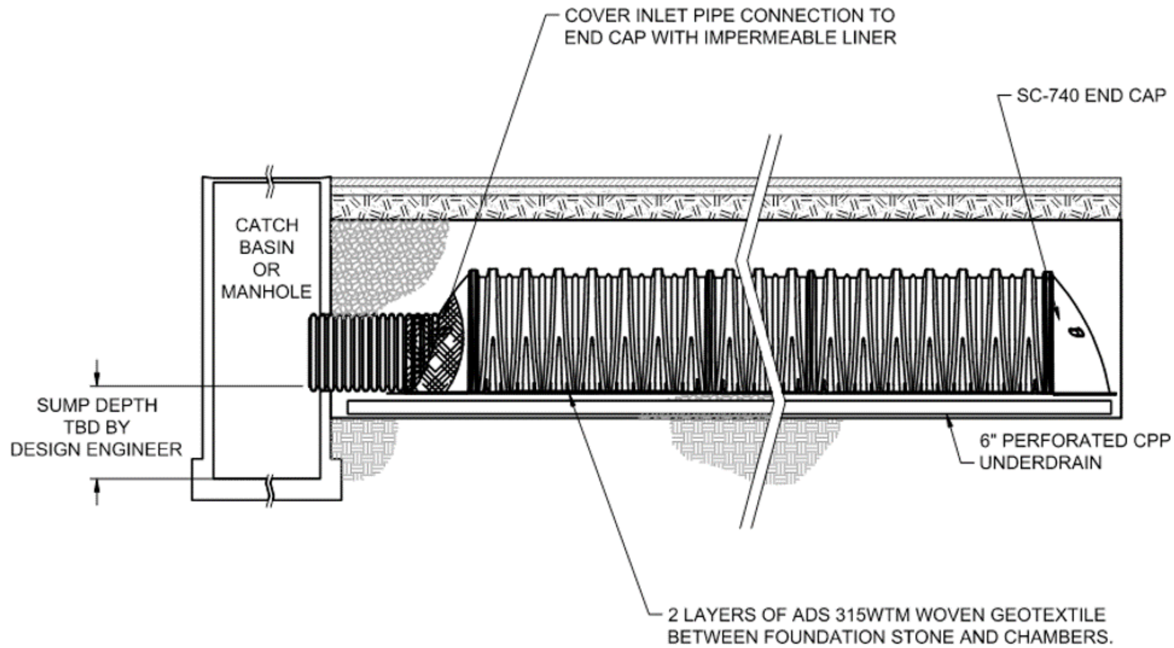


Image 4.2c: Sample StormTech Isolator Row Detail (for pricing purposes)

that will connect to the City of Cambridge drainage system in either Vassal lane or Concord Avenue. The bioretention basins may need to be lined because of the elevation of groundwater.

The proposed bike path and perimeter around the basketball court are proposed to be constructed from porous asphalt. The porous asphalt will consist of an 18-inch bank-run gravel filter course and 8-inch crushed stone reservoir section to provide phosphorus removal. The reservoir course will have a 4-inch perforated underdrains that will connect to the onsite closed drainage system that will connect to the City of Cambridge drainage system in either Vassal lane or Concord Avenue. The porous asphalt will treat stormwater runoff from itself and from the adjacent areas that slope to it. The porous pavement section may need to be lined.

For areas of the site where stormwater runoff cannot be captured by a bioretention basin or porous pavement, structural best management practices (BMPs) are proposed. Nitsch is proposing the use of StormTech Isolator Rows (Image 4.2c) and Stormceptor water quality treatment units. The use of Isolator Rows is preferred because they provide a higher level of phosphorus removal but in areas of the site where space is limited, Stormceptors will be used. For purposes of pricing, we are assuming the Stormceptor STC-900 unit will be used. Discharge from these BMPs will be directed to the onsite closed drainage system that will connect to the City of Cambridge drainage system in either Vassal lane or Concord Avenue. Refer to the Conceptual Utility Plan for the locations of these BMPs.

All systems, including bioretention, porous pavement, and isolator rows will likely need to be lined to provide separation between the systems and the groundwater/underlying fill. Infiltration is not feasible because of the high groundwater table and contaminated soils.

Sanitary Sewer

The existing 8-inch sanitary sewer service for the Tobin School exits he south face of the building and connects to the 18-inch sewer main in Vassal Lane (Image 4.2b). The municipal sewer and drain infrastructure in Concord Ave and Vassal Lane were reconstructed within the last five years and are in good condition. Cambridge DPW reported that there are no known issues with the sewer capacity in Concord Ave and Vassal Lane. The City prepared models during the reconstruction process to review capacity. There was infiltration/inflow removal and the system capacity was increased at that time.

The City of Cambridge indicated that the sewer mains in both Concord Avenue and Vassal Lane are in good condition and the project could connect to either system. Because the proposed building is going to be located along Vassal Lane, the sanitary sewer services are proposed to connect to the main in Vassal. Nitsch is anticipating three sanitary sewer service from the building, one from each wing of the building. The cafeteria is located in the northwest corner of the building and will require its own service that will be directed to an external grease trap. Nitsch is anticipating the need for at least two connections the from the site into the main in Vassal Lane.

The City of Cambridge indicated that they are open to allowing the project to reuse some of the existing connections from the site to the main. If the project determines this approach is feasible and desired, the City will require video scoping of the services from the point where they will be reused to the main. This approach may be desirable to avoid constructing utility crossings with the drain mains in Vassal Lane. The design team will need to continue to coordinate with the City to confirm the preferred connection location and capacity of the municipal systems.

The proposed building use (for Title V calculation purposes) will remain the same in the existing and proposed conditions. In the existing conditions, there are 618 students and 212 while the proposed school is being designed for 975 students and 265 staff. Nitsch calculated the existing and proposed sewer flows for the school using Title V calculations (Table 1). The proposed project will increase sewer use by 4,100 gallons per day (GPD).

As design progresses, the project team will need to continue to confirm the proposed population of the school and impacts on the sewer flow generation. If sewer flow is increased by more than 15,000 gallons per day, infiltration and inflow (I/I) calculations will be required for mitigation with the Cambridge Department of Public Works.

	Student Count	Staff Count	Use	Flow Generation per Person (GPD/.person)	Total Flow Generation (gpd)
Existing	618	212	Elementary School with Cafeteria and Showers	10	8,300
Proposed	975	265	Elementary School with Cafeteria and Showers	10	12,400
Increase	357	53	-	-	4,100

Domestic Water and Fire Protection

The domestic water service for the existing school is 8-inch and is fed from the 12-inch main in Concord Avenue (Image 4.2d and Appendix 4a Survey). A 6-inch hydrant service branches off the 8-inch domestic. Nitsch Engineering assumes the fire protection system for the existing school building is also serviced from the 8-inch water service. Note that there is also an existing 8-inch water main in Vassal Lane that does not appear to supply the existing school building.

Nitsch Engineering proposes to connect to the existing 8-inch water main Vassal Lane although this will need to be reviewed by the City of Cambridge to confirm the capacity of the existing main is appropriate. The proposed building has a water room located at the northwest corner of the building. The project currently plans to connect a domestic water and fire protection service to the 8-inch main at the southwest corner of the site. The water services will run underneath the drop off area to the west of the school and connect to the water room.

As the design progresses, Nitsch Engineering will coordinate with the MEP Engineers and the Cambridge Water Department. The Cambridge Water Department will need to review and approve water plot plans.

Gas Service

The School is currently serviced by a gas line (size unknown) that connects to the existing 4-inch gas main located in Vassal Lane (Appendix 4a – Survey). The existing gas line connects to the School building in the vicinity of the intersection of Vassal Lane and Standish Street. There is no gas service proposed for the new school building; however, the stormwater tank pump house may require a natural gas service for its backup generator. The generator will be located to the west of the proposed building. If a gas service is need, it will likely connect to the 4-inch gas main in Vassal Lane.

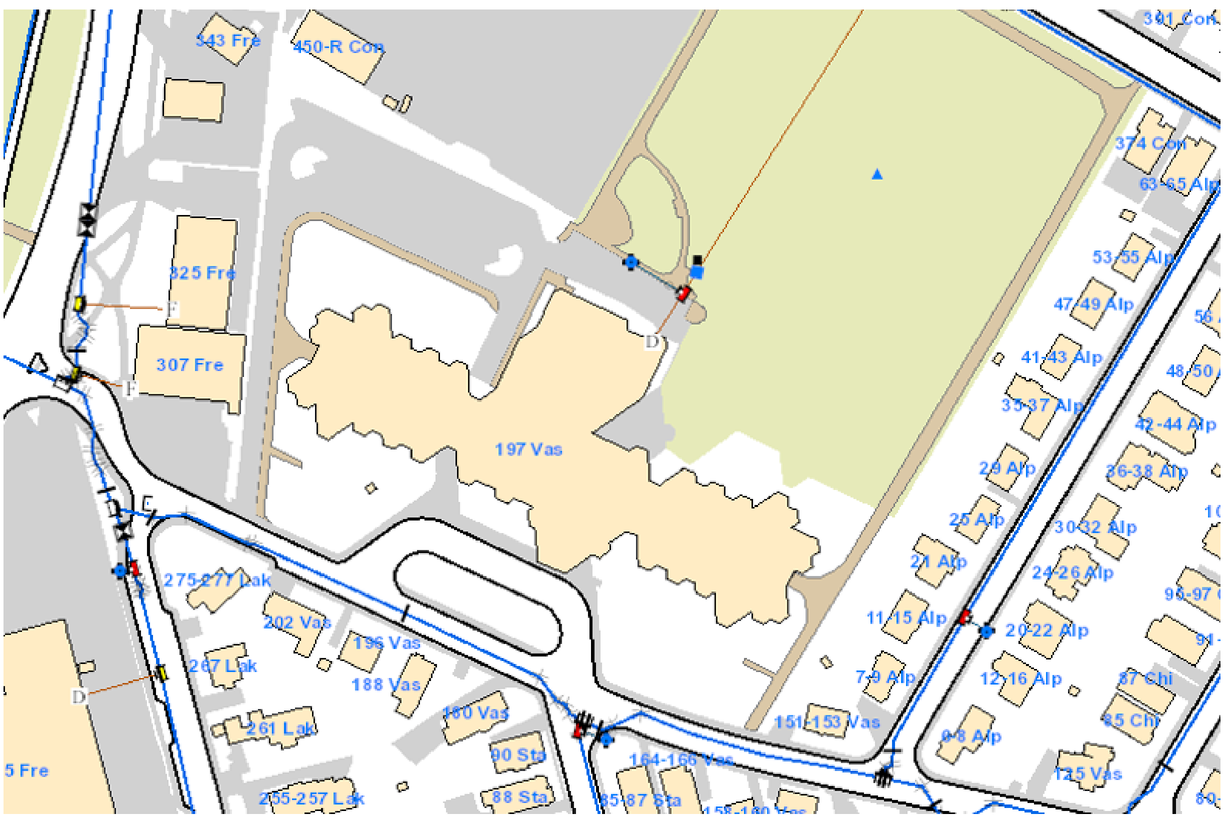


Image 4.2d: Cambridge GIS Water System Distribution Map

Site Electrical

The School is currently serviced by multiple electrical services (size unknown) from Vassal Lane. At the westernmost driveway, which serves as access to the parking lot, an underground electrical service extends from a manhole in Vassal Lane into another manhole in the parking lot, before connecting into the western side of the existing school building. Along the eastern parcel boundary, overhead wires extend into the site from the overhead wires located along the south side of Vassal Lane. This electrical connection appears to service lighting located behind the school building. Refer to Appendix 4a – Survey for additional information.

The MEP Engineer has indicated the utility companies have determined there is adequate capacity to connect the electrical service for the project to either Vassal Lane or Concord Avenue. Because the building is located along Vassal Lane, the electrical will most likely connect to the existing infrastructure in Vassal. The electrical room for the proposed building is located in the northwest corner of the building.

The electrical service is proposed to enter the southwest corner of the site underground and run underneath the drop off area to the northwest corner of the building.

PERMITTING CONSIDERATIONS

Surface Water Supply Protection (310 CMR 22.20)

The Massachusetts Department of Environmental Protection (DEP) ensures the protection of surface waters used as sources of drinking water supply from contamination by regulating land use and activities within critical areas of surface water sources and tributaries and associated surface water bodies to these surface water sources.

Massachusetts GIS indicates that the site is within a Surface Water Protection Zone A and Zone C (Image 4.2e) and an Outstanding Resource Water Area (Image 4.2f) due to its proximity to the Fresh Pond. However,

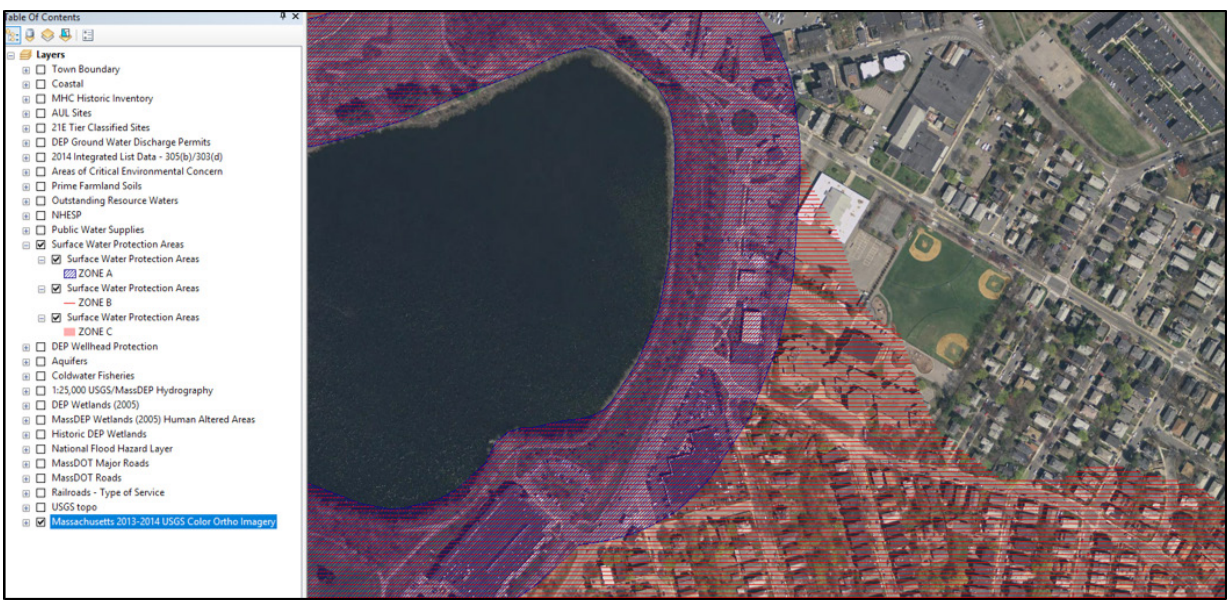


Image 4.2e: MassGIS Surface Water Protection

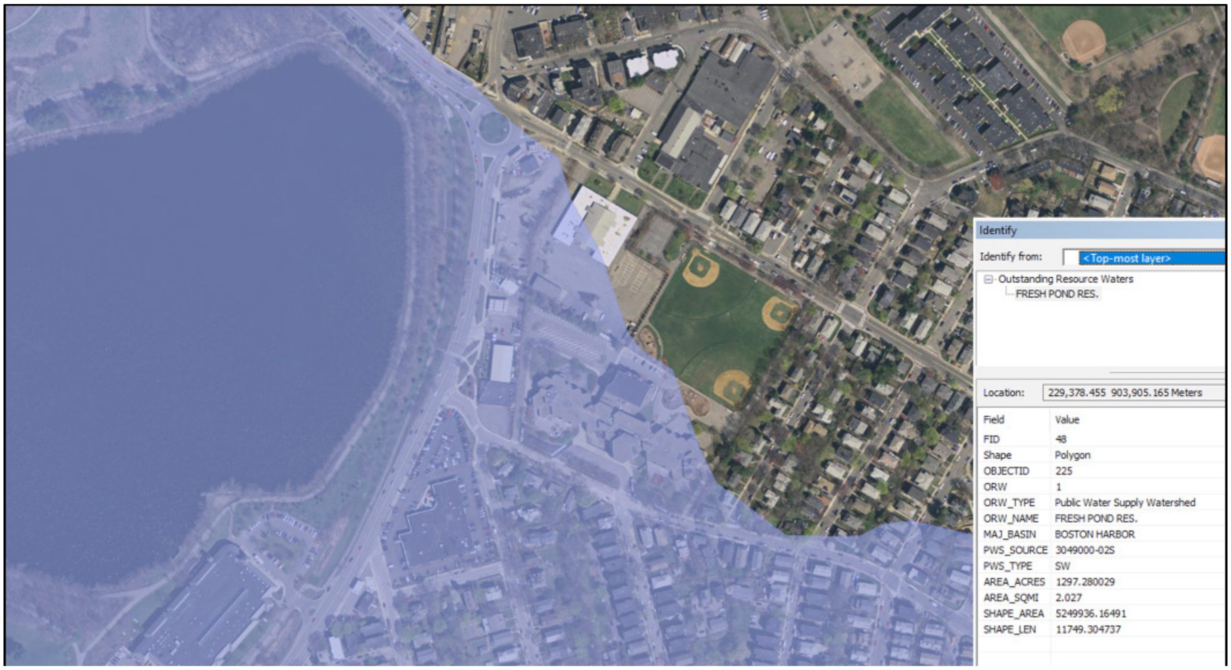


Image 4.2f: MassGIS Outstanding Water Resource Area

based on the site survey and Cambridge GIS information, the majority site runoff is collected in a closed drainage system that discharges to the Alewife Brook, rather than overland to Fresh Pond. Additional coordination with the City of Cambridge will be needed to confirm if the Surface Water Protection Zones and Outstanding Resource Water designation are applicable to the site.

Nitsch Engineering will coordinate with the Cambridge Department of Public Works and/or the Watershed Management Division of the Cambridge Water Department to determine if the Surface Water Protection and the Outstanding Resource Water classifications are applicable. Because the stormwater approach to provide phosphorus treatment requires significant stormwater improvements already, this classification is not anticipated to significantly affect the stormwater design. However, it may require the project to undergo an additional review by the City.

FEMA Floodplain

Based on the Flood Insurance Rate Map (FIRM), Community Panel Number 25017C 0419E, dated June 4, 2010, it appears that portions of the project site falls within a shaded Zone X. Zone X is described as areas of 0.2% annual chance of flood; areas of 1% annual chance flood with average depths of less than one (1) foot or with the drainage areas less than one (1) square miles; and areas protected by levees from 1% annual chance of flood.

Cambridge Flood Viewer v2.1

The Tobin School site was identified as an area of concern in the Cambridge Flood Viewer 2.1 mapping study.

Nitsch Engineering reviewed The City of Cambridge Flood Viewer in January 2020 and it indicated that the present day 100-year flood elevation is 22.8 feet while the anticipated 2070, 100-year flood elevation is 22.6 feet (Sea Level Rise/Storm Surge) and 23.7 feet (Precipitation) (Image 4.2g).

The City has indicated that the project should be designed to avoid damage in the 2070 10-year storm (Elevation 22.1) and recover from the 2070 100-yr storm event (Elevation 23.7). This means that, at a minimum, all electrical

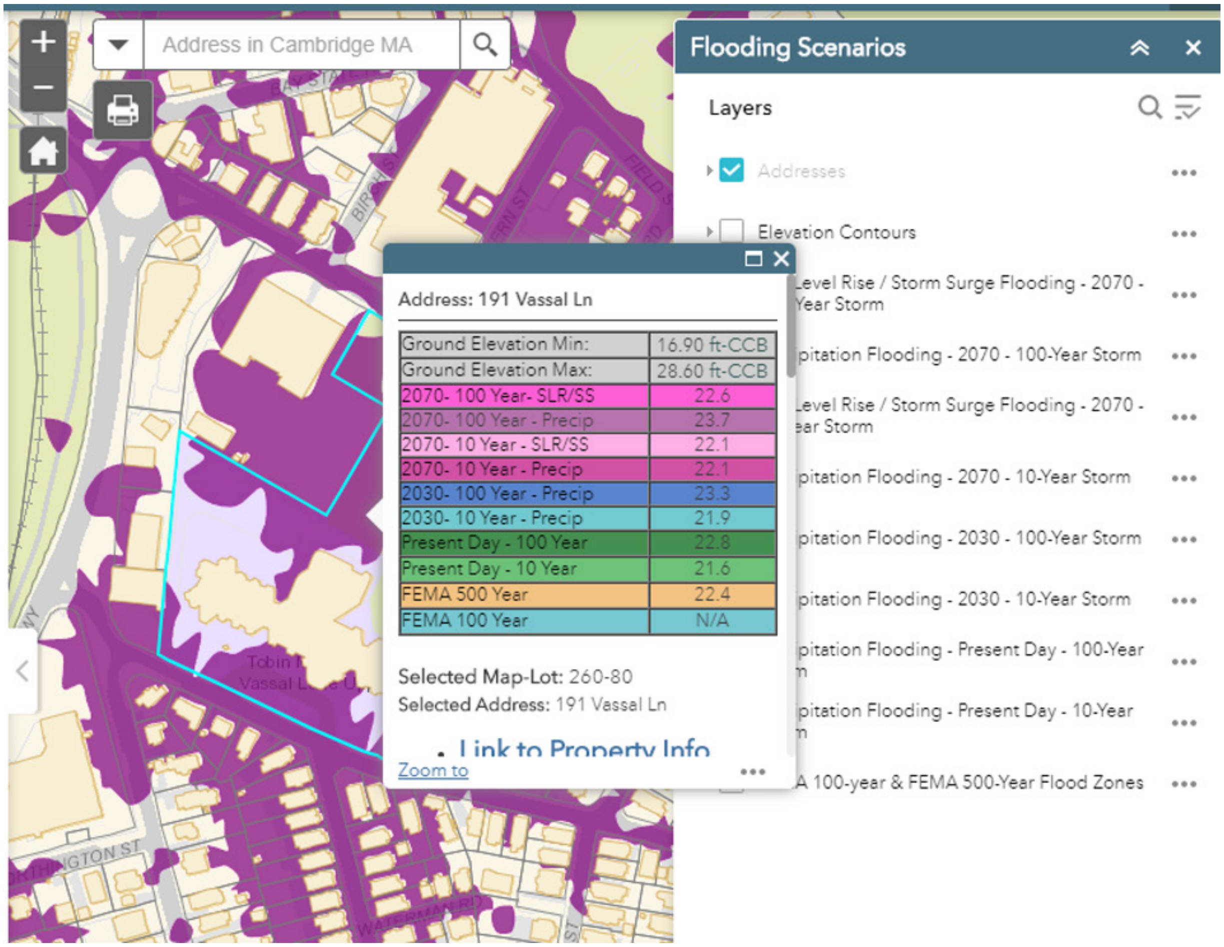


Image 4.2g: Cambridge Flood Viewer, January 2020

equipment should be at or above elevation 23.7 although the project team should consider if this approach is adequate or if the entire building should be raised to elevation 23.7. The City has indicated this decision should be basin on review of the level of acceptance for the first floor of the building to flood, development of an evacuation plan, and consideration of the school as a community shelter or warming center for the community in the event of a disaster.

City of Cambridge Stormwater Control Permit

The project is required to obtain a Stormwater Control Permit because it currently exceeds the following standards, as outlined in Section 3.1 of the Wastewater and Stormwater Management Guidance document:

- The project will disturb one (1) or more acres of land;
- The project will exceed 50,000 square feet of Gross Floor Area;
- The project parcel(s) equals or exceeds one (1) acre in size; and

• A Special Permit is required for the project by the Planning Board.

The City of Cambridge requires the peak flow rate associated with the 25-year storm from proposed developments not to exceed the peak flow rate associated with the 2-year storm under existing conditions and 65% of phosphorus is removed from stormwater generated by proposed site redevelopment on an annual basis. As noted previously, the City has indicated that the benefits to the neighborhood and the drainage system from the stormwater storage tank and bioretention surface/subsurface systems will be greater than the typical requirements for peak rate reduction on the project site.

EPA NPDES Construction General Permit

Construction activities that disturb more than one (1) acre are regulated under the United States Environmental Protection Agency's (EPA) National Pollution Discharge Elimination System (NPDES) Construction General Permit (CGP) Program. In Massachusetts, the EPA issues a NPDES CGP to owners and operators of regulated construction sites. Regulated projects are required to develop and implement stormwater pollution prevention plans in order to obtain permit coverage. The project is anticipated to disturb more than one (1) acre and is anticipated to require this permit.

Dewatering Permitting Considerations

If the proposed project requires perimeter foundation drains and underslab drainage to be installed under the lower levels of the proposed building, note that the City of Cambridge does not allow collected groundwater (from underslab drainage and/or perimeter drainage systems) to be discharged to its municipal storm water system. Therefore, any groundwater that is collected in these types of systems will need to be discharged on-site and not allowed to find its way to the municipal storm drains. Since the soil and groundwater conditions are not suitable for infiltration, rainwater harvesting and reuse will be evaluated to meet this requirement.

Per guidance from CDM Smith, dewatering will likely be necessary for deep excavations. Based on groundwater quality that was evaluated during site investigations in 2017 and 2018 (see Volume 5, Geotech Report), an active remediation system for groundwater collected as part of a dewatering program would be required prior to discharge to the local stormwater system or the local stormwater combined sewer system. If local stormwater discharge is feasible, then an USEPA NPDES Remediation General Permit would be required. If local stormwater/combined sewer overflow discharge is feasible, then a Massachusetts Water Resource Authority (MWRA) Construction Dewatering Permit would be required.

4.3 Geotechnical and Site Environmental

This narrative was prepared by CDM Smith on behalf of the City of Cambridge for the Feasibility Study for the Replacement of the Tobin Montessori Vassal Lane School. This narrative provides information regarding the feasibility of the new school based on the geotechnical and environmental issues associated with the site and previous and ongoing studies associated with the geotechnical engineering and environmental issues associated with the site redevelopment. CDM Smith has also developed volume estimates for the volumes of impacted soils that may need to be removed for the construction of the parking area below the building and other areas that will be located in areas that contain impacted materials. In addition, CDM Smith has performed lab studies to look at the feasibility of solidification and/or stabilization of the impacted materials on-site. This narrative is a current summary of these issues as understood at the time of this submittal. Additional details and information are contained in previous CDM Smith reports and bench scale studies are ongoing.

4.3.2 Reference Documents

CDM Smith used the following reference documents in developing this narrative:

1. Replacement Plan Revised, prepared by Perkins Eastman, dated January 30, 2020.
2. Proposed Storage Tank Location, Replacement Revised, prepared by Perkins Eastman, dated January 30, 2020.
3. Tobin Stormwater Tank Conceptual Design Parameters and Location Analysis, prepared by Stantec, dated February 25, 2020 (Appendix A5.1)
4. Proposed Storage Tank Locations drawing A-1, prepared by Stantec, dated June 12, 2019.
5. John M. Tobin School, Cambridge Mass. drawings, S-2, S-3, and S-6, prepared by LeMessurier Associates, dated October 25, 1968, revised January 20, 1969.
6. Bottom of Waste and Bottom of Clay Contour Plans, prepared by CDM Smith, dated March 2019.
7. Top of Bedrock Elevations Plan, prepared by CDM Smith, dated March 2019.
8. Existing Conditions Survey, prepared by Survey and Mapping Consultants, dated October 2, 2017.
9. Horizontal Edge of Waste Figure 2, prepared by CDM Smith, dated April 2018.

4.3.3 Existing Site and Subsurface Conditions

Site Description

The John M. Tobin School site is located at 197 Vassal Lane in Cambridge, Massachusetts. The site is located within a mixed residential and commercial area and is bounded by Vassal Lane to the south, Concord Avenue to the north, residences along Alpine Street to the east, and a gas station, commercial properties and the Cambridge Armory to the west. The site has an overall area of about 9 acres and is relatively flat with the ground surface ranging from approximately elevation (El.) 20 to El. 23.

The existing John M. Tobin School is located on the south side of the site and consists of a three-story concrete structure constructed in the early 1970's. The building has an approximate footprint of 59,000 square feet. North of the existing school is the Callanan playground and field complex, which extends to Concord Avenue.

According to available drawings, the existing building is supported on a combination of concrete piles and timber piles. The top of pile cap elevations ranges from approximately El. 14.0 to El. 29.3.

Based on the site history, the site was previously used to mine clay for brick making. After mining activities ceased, the remnant clay pit was used as an uncontrolled waste pit (1930's through the 1950's) prior to development of the current school and recreational field. Due to the presence of the waste materials beneath the Tobin School property, a sub-slab depressurization and venting system was installed in the early 1990's at the school to prevent the migration of landfill gas and any volatile organic vapors from migrating into the school building indoor air.

4.3.4 Subsurface Explorations

As summarized below, several subsurface explorations have been performed at the site. Many of these explorations were performed for environmental purposes and provide only limited information for geotechnical engineering and design purposes. Additional subsurface explorations will be required to advance the geotechnical design of the project.

New England Test Boring Corp. – November 1966 and January 1968

New England Test Boring Corporation conducted subsurface investigations during October to November 1966 and January 1968 consisting of 24 test borings drilled to depths ranging from 25.5 to 97 feet. Monitoring wells were installed at two test boring locations.

Camp Dresser & McKee (CDM) – September 1997 to April 1998

CDM conducted subsurface explorations between September 1997 and April 1998 to perform environmental characterization of the fill beneath the school grounds and playing fields.

Clean Harbors Environmental Services, Inc. – March 2000 and February 2001

Clean Harbors Environmental Services, Inc. conducted subsurface explorations at the adjacent National Guard Armory property consisting of seven Geoprobe borings (B-1, B-4, B-6, and CHI-4 through CHI-7) in March 2000 and consisting of eleven test hollow-stem auger borings (B-13 through B-18, and CHI-8 through CHI-12) in February 2001. The Geoprobe borings were advanced to depths ranging from 12 to 20 feet, and hollow-stem auger borings were advanced to depths ranging from 8 to 22 feet. Groundwater monitoring wells were installed at nine locations for the environmental characterization of groundwater.

CDM Smith Phase 1 Explorations – July to August 2017

CDM Smith conducted a Phase 1 subsurface exploration program consisting of 15 test borings (CDM-1 through CDM-15) between July 17 and August 9, 2017. The borings were advanced to depths ranging from 40 to 94 feet. Continuous split-spoon sampling was typically conducted through the top 30 feet or until natural soil was encountered, and then at 5-foot intervals thereafter. Rock coring was conducted at five test boring locations. Five (5) borings (CDM-3, CDM-4, CDM-7, CDM-9, CDM-14) were completed as groundwater monitoring wells.

CDM Smith Phase 1 Test Pits – December 2017

CDM Smith conducted a Phase 1 test pit program consisting of two test pit excavations (TP101 and TP-102) on December 28, 2017. The test pits were excavated to depths between 12 to 13.5 feet.

CDM Smith Phase 2 Explorations – January to February 2018

CDM Smith conducted a Phase 2 subsurface exploration program consisting of 22 test borings (CDM-101A, CDM-101B, CDM-102A, and CDM-102B through CDM-120) between January 22 and February 2, 2018. The borings were advanced to depths ranging from 5 to 36 feet. Continuous split-spoon sampling was conducted generally from ground surface until termination in all borings.

CDM Smith Phase 2 Test Pits – February 2018

CDM Smith conducted a Phase 2 test pit program consisting of three (3) test pits (TP-201, TP203, and TP-204). The test pits were excavated to depths between 16 and 22 feet.

4.3.5 Subsurface Conditions

The subsurface conditions encountered in the subsurface explorations are described below, beginning at the ground surface and proceeding downward.

4.3.5.1 Soil and Rock

Pavement

A 4- to 6-inch-thick layer of asphalt or concrete pavement was encountered at the ground surface at five Phase 1 test boring locations and ten Phase 2 test boring locations.

Topsoil

A 3- to 12-inch-thick layer of Topsoil was encountered at the ground surface at 8 Phase 1 test boring locations, 9 Phase 2 test boring locations, one previous test boring, and at all test pit locations. The Topsoil typically consisted of light to dark brown, fine SAND and SILT, trace to no fine gravel.

Granular Fill

An approximately 1.2- to 11.5-foot-thick layer of Granular Fill was encountered at the ground surface or beneath the Pavement or Topsoil at all CDM Smith test boring and test pit locations, and at 16 previous test borings. The Granular Fill typically consisted of very loose to very dense, dark to light brown, gray, tan, or black, fine to coarse SAND with varying amounts of gravel and silt.

Waste Fill

An approximately 2- to 30-foot-thick layer of Waste Fill was encountered below the Granular Fill at all locations; except for the 2000 Geoprobe locations and three 2001 test boring locations, where it was encountered at the ground surface. The Waste Fill typically consisted of very loose to very dense, dark brown to brown, light gray to gray, or black, fine to coarse SAND, with varying amounts of gravel, silt, brick, concrete, coal, ash, cinders, slag, metal, glass, wood, leaves, granite blocks, and other miscellaneous and deleterious material.

Organic Soil

An approximately 0.3- to 5-foot-thick layer of Organic Soil was encountered below the Waste Fill at a total of ten test boring locations. This Organic Soil typically consisted of moist to wet, loose to medium dense or stiff, black, slightly Organic to Organic, fine to medium SAND and SILT or CLAY & SILT, trace fine sand.

Clay and Silt

Clay and Silt (i.e. Boston Blue Clay) was encountered below the Granular Fill, Waste Fill or Organic Soil. Where fully penetrated, the layer ranged between 6.5 to 75 feet thick. The layer typically consisted of very soft to hard, dark to light brown, or light gray to olive gray to greenish gray, CLAY & SILT with varying amounts of sand and gravel.

Glacial Till

Glacial Till was encountered beneath the Clay and Silt at 27 test boring locations. Where fully penetrated, the layer ranged from about 0.5

to 12.5 feet thick. The layer typically consisted of medium dense to very dense, light gray to greenish gray, fine to coarse SAND with varying amounts of gravel and silt.

Weathered Rock

Weathered Rock was encountered below the Clay and Silt or Glacial Till stratum. This layer typically consisted of moist, gray, fine to coarse GRAVEL and fine to coarse SAND, some silt, with gravel inclusions resembling broken Argillite.

Bedrock

Bedrock consisting of hard, extremely fractured to sound, moderately weathered to fresh, gray, ARGILLITE was encountered depths ranging from about 29.6 to 92.5 feet. Preliminary Geotechnical Design Recommendations

4.3.6 Foundation Design

4.3.6.1 General

The underlying fill, waste fill, and organic soil layers are unsuitable for supporting the proposed building and excavation and replacement of these unsuitable soils is not considered feasible for supporting the building loads. However, solidification of the waste materials below the slabs are potentially feasible, as discussed later in this section. It is assumed that the proposed building columns and perimeter walls will need to be supported on a deep foundation that derives its support in the weathered rock or bedrock.

4.3.6.2 Piles

Driven concrete piles, steel H-piles, or concrete filled steel pipe piles are all suitable pile types for this project. Steel piles may penetrate further into the bedrock to achieve their design capacity and are expected to be more expensive than concrete piles. Typical pile types and allowable design capacities are provided below:

- 14-inch square Pre-stressed Concrete (6,000 pounds per square inch [psi] concrete): 100 to 120 tons
- 16-inch square Pre-stressed Concrete (6,000 psi concrete): 180 to 200 tons
- HP14x117 (50 kilopound per square inch [ksi] steel, 1/16-inch corrosion allowance): 180 to 200 tons

Only one (1) pile type should be used throughout the project. The piles should include tip protection (typically a 1.5-inch-thick steel plate or “stinger” for concrete piles, or a cast steel tip for H-piles) to reduce the risk of damage to the piles from potential obstructions in the fill and waste fill, boulders in the glacial till, and from driving into bedrock.

The pile caps be tied together for seismic design, if the structure is assigned to Seismic Design Category C, D, E, or F. This can be accomplished with grade beams or an appropriately designed floor slab. This requirement can also be achieved by using oversized pile caps that can develop the required restraint by passive pressure against the soil.

4.3.6.3 Lowest Level Floor Slab

The bottom level of the proposed building will likely be located below the permanent groundwater table. Thus, the bottom level slab will need to consist of a waterproof structural slab designed to resist hydrostatic uplift, or an underdrain system will need to be installed that relieves hydrostatic uplift. Since the bottom level slab will be located within groundwater that is impacted, an underdrain system that discharges effluent into city drains would require permits and likely periodic testing of effluent. The control of groundwater is also possible using a barrier wall or cut off wall around the site. The barrier could be built as a soil cement wall that extends down into the clay layer below the site. This would serve to control groundwater inflows both during construction and to limit groundwater inflow into an underdrain system. This determination can be made during schematic design.

4.3.6.4 Foundation Waterproofing

Foundation waterproofing should be performed in accordance with Section 1805 of the International Building Code, 2015 edition (IBC 2015) and include the following elements:

- Membrane waterproofing beneath the bottom level floor slab and on the outside face of the foundation walls up to finish exterior grade.
- Waterstops at all penetrations through the bottom level slab, foundation walls, and all construction joints.

	Preliminary Values
Total Unit Weight of Soil	125 pcf
Buoyant Unit Weight of Soil	62.6 pcf
Coefficient of Active Earth Pressure, Ka	0.31
Coefficient of At-Rest Earth Pressure, Ko	0.47
Coefficient of Passive Earth Pressure, Kp	3.25
Lateral Surcharge from Vertical Loads	150 psf

- Waterproofing and structural design for hydrostatic uplift of any pits or vaults that extend below the mat, including membrane seals around elevator piston shafts.

4.3.6.5 Hydrostatic Pressure

For schematic design, we recommend a groundwater level at El. 20 for computing hydrostatic pressure.

4.3.6.6 Lateral Earth Pressures

Preliminary values for computing lateral earth pressures against buried structures are provided below. The top 4 feet of soil should be neglected when computing passive resistance.

4.3.6.7 Seismic Design

For preliminary seismic design, we recommend the site be classified as Site Class D. We recommend using the earthquake design factors for the City of Cambridge (per the Massachusetts amendments to Chapter 16 of the IBC) and the amplification factors (Fa and Fv) for Site Class D.

The soils at the site are not considered susceptible to liquefaction.

4.3.6.8 Seismic Pressure

For computing seismic forces against buried structures, we recommend a seismic pressure distribution equal to 15.9H for computing the seismic forces, where the seismic pressure is in pounds per square foot (psf), H is the height of the buried structure in feet, and the pressure is distributed as an inverted triangle over the height of the structure.

4.3.7 Environmental Conditions

4.3.7.1 Data Summary for Soil

Phase 1 (July-September 2017) and Phase 2 (January-February 2018) environmental field investigations were conducted to evaluate the overall extent of waste/fill materials and to determine the concentrations of contaminants in subsurface soils and fill and waste materials.

During the Phase 1 subsurface exploration program, environmental soil samples were collected at select intervals at all Phase 1 test boring locations (CDM-1 through CDM-15) and sent to Alpha Analytical in Westborough, Massachusetts for laboratory testing. No analytical soil samples were collected during the Phase 2 subsurface exploration program. During the Phase 1 drilling program, laboratory analytical samples were collected at all 15 soil boring locations in the shallow soil (approx. 0-3 feet below ground surface [bgs]), fill/waste materials (approx. 3-30 feet bgs) and from the shallow clay directly beneath the waste materials. All soil samples were analyzed for the following parameters:

- Volatile organic compounds (VOCs) (including 1,4-dioxane) using United States Environmental Protection Agency (USEPA)

Method 8260C,

- Semi-volatile organic compounds (SVOCs) using USEPA Method 8270D,
- Massachusetts Contingency Plan (MCP) 14 Metals using USEPA Method 6010C/7471B,
- Polychlorinated biphenyls (PCBs) using USEPA Method 8082A, and
- Massachusetts Department of Environmental Protection (MassDEP) Extractable Petroleum Hydrocarbon (EPH) Method carbon ranges.

Duplicate samples were collected for quality assurance/quality control purposes. Excess soil generated during drilling and drilling fluids were containerized into 55-gallon drums, temporarily stored on-site and later transported offsite for disposal.

The subsurface soils at the Tobin School are categorized under the Massachusetts Continency Plan as S-1 (from 0-15 feet bgs), S-1/S-2 (315 feet bgs) and S-3 (>15 feet bgs). Several metals were detected above their respective soil standards. Arsenic was detected in sample CDM-9 (14-16 feet bgs) at a concentration of 64.4 mg/kg exceeding the S-2 standard (20 mg/kg) and S-3 standard (50 mg/kg). Zinc was detected in sample CDM-7 (6-8 feet bgs) at a concentration of 18,500 mg/kg exceeding the S-1 standard (1,000 mg/kg) and S-2 standard (3,000 mg/kg). Zinc was detected in sample CDM-9 (14-16 feet bgs) at a concentration of 1,590 mg/kg exceeding the S-1 standard of 1,000 mg/kg. Zinc was also detected in sample CDM-14 (20-22 feet bgs) at a concentration of 18,500 mg/kg exceeding the S-3 standard of 5,000 mg/kg.

Lead was detected in sample CDM-1 (8-10 feet bgs) at a concentration of 417 mg/kg and was also detected in sample CDM-11 (2-4 feet bgs) at a concentration of 550 mg/kg, exceeding the S-1 standard of 200 mg/kg. Lead was detected in sample CDM-1 (24-28 feet bgs), CDM-7 (68 feet bgs), CDM-7 (16-18 feet bgs), CDM-8 (6-8 feet bgs), CDM-9 (14-16 feet bgs), CDM-13 (812 feet bgs) and CDM-14 (8-10 feet bgs) with concentrations ranging from 816 to 5200 mg/kg, exceeding the applicable S-2 and S-3 standard of 800 mg/kg. Due to the elevated concentrations of lead, toxicity characteristic leaching procedure (TCLP) analysis was completed at locations where the analysis criteria were triggered. At soil sample locations CDM-1 (24-28 feet bgs), CDM-7 (6-8 feet bgs), CDM-8 (8-10 feet bgs), CDM-9 (14-16 feet bgs), and CDM-11 (2-4 feet bgs), leachable lead was detected with concentrations ranging from 7.62 mg/L (CDM-11) to 138 mg/L (CDM-1), exceeding the TCLP USEPA hazardous waste limit of 5 mg/L.

SVOCs were also measured above applicable soil standards in several samples. Benzo(a)pyrene was detected in sample CDM-1 (8-10 feet bgs) at a concentration of 2.5 mg/kg, exceeding the S-1 standard of 2 mg/kg. Benzo(a)pyrene was detected in sample CDM-4 (8-10 feet bgs), CDM-8 (8-10 feet bgs), CDM-9 (14-16 feet bgs) and CDM-14 (8-10 feet bgs) with concentrations ranging from 13 to 17 mg/kg, exceeding the applicable S-2 standard of 7 mg/kg. Benzo(a)anthracene was detected in sample CDM-4 (8-10 feet bgs) at a concentration of 28 mg/kg and was also detected in sample CDM-8 (8-10 feet bgs) at a concentration of 17 mg/kg, exceeding the S-1 standard of 7 mg/kg. Dibenzo(a,h)anthracene was detected in sample CDM-8 (8-10 feet bgs) at a concentration of 1.5 mg/kg and was also detected in sample CDM-9 (14-16 feet bgs) at a concentration of 1.7 mg/kg, exceeding the S-1 standard of 0.7 mg/kg. Indeno(1,2,3-cd)perylene was detected in sample CDM-4 (8-10 feet bgs) at a concentration of 8.5 mg/kg, exceeding the S-1 standard of 7.0 mg/kg. EPH compound C11-C22 aromatic was detected in sample CDM-7 (6-8 feet bgs) at a concentration of 1,060 mg/kg, exceeding the S-2/GW-1 standard of 1,000 mg/kg. EPH compound C19-C36 aliphatic was detected in sample CDM-7 (6-8 feet bgs) at a concentration of 3,060 mg/kg, exceeding the S-1 standard of 3,000 mg/kg.

Overall, fill and waste materials contain elevated concentrations of heavy metals (lead, zinc, arsenic), EPH compounds and SVOCs. Some samples exceeded the regulatory limit for TCLP lead indicating that without treatment, this material would be considered a hazardous waste if excavated for disposal. This material could be treated in-situ and disposed of as a non-hazardous waste. Other heavy metals, VOC, SVOC and EPH compounds were detected, however, all detections were below applicable standards. PCB compounds were not found above the laboratory method detection limit at any sampling locations.

4.3.7.2 Data Summary for Groundwater

Groundwater sampling was conducted in August 2017 and March 2018 at the five (5) well couplets (MW-3S/3D, MW-4S/4D, MW-7S/7D, MW-9S/9D, & MW-14S/14D) to determine the chemical quality of the groundwater at the site with respect to MassDEP groundwater standards and to evaluate potential discharge options associated with dewatering of the site during excavation/construction. Sampling and testing occurred in two phases to evaluate seasonal variability of concentrations. Groundwater sampling was performed by CDM Smith representatives between August 16 and August 17, 2018 for Phase 1 and on March 1, 2018 for Phase 2. The laboratory reports were provided in the July 2018 Memorandum.

Groundwater sampling was conducted using low flow groundwater sampling procedures in accordance with USEPA low flow guidance document (Revised September 19, 2017). The static depth to water and depth to the well bottom were recorded prior to sampling. An adjustable rate peristaltic pump was used to purge each well and collect the samples. While purging, field parameters including conductivity, specific conductance, pH, temperature, dissolved oxygen (DO), and oxidation-reduction potential (ORP) were measured and recorded.

Groundwater samples were analyzed for the following parameters:

- Volatile Organic Compounds (VOCs) (8260/5053),
- Semivolatile Organics (SVOCs) (8270D/SIM),
- Polychlorinated Biphenyls (PBCs) (8082),
- MCP Extractable Petroleum Hydrocarbons (EPHs), Carbon-ranges only (EPH-04-1.1),
- MCP 14 Total Metals (6010C/7471B) – Phase 1, and
- MCP 14 Dissolved Metals (6010C/7471B) - Phase 2.

Groundwater at the site is categorized as GW-1 only in the far western portion of the site (area of MW-7S/7D) due to the Zone A surface water protection zone for the Fresh Pond Reservoir. Groundwater is categorized as GW-2 for any location within 30 feet of the school building where the water table depth is less than 15 feet bgs (MW-9S/9D and MW-14S/14D). Groundwater at the entire site is categorized as GW-3 due to the potential for discharge to the Fresh Pond Reservoir, located to the west and downgradient of the Tobin School property. Due to the total metal exceedances at select well locations during Phase 1, samples were collected for dissolved metals during Phase 2. During the August 2017 monitoring round, total barium was detected at a concentration of 3,660 ug/L and 2,060 ug/L in the samples collected from MW-7S and MW-7D, respectively, exceeding the applicable GW-1 standard of 2,000 ug/L. In March 2018, dissolved barium was detected greater than the GW-1 standard in the sample collected from MW-7D (2,140 microgram per liter [ug/L]) and was below the GW-1 standard of 2,000 ug/L in the sample collected from MW-7S (526 ug/L). The total and dissolved barium concentrations at MW-7D are consistent (2,060 ug/L vs 2,140 ug/L, respectively) suggesting that the elevated barium concentrations are not related to the presence of suspended solids from the groundwater sample. The dissolved barium concentration at MW7S is one-order of magnitude lower than the total barium concentration from August 2017 suggesting that suspended solids from the August 2017 groundwater sample may have contributed to elevated total barium concentration and GW-1 exceedance (August 2017). Dissolved barium was also detected at the remaining groundwater monitoring well sampling locations with concentrations ranging from 49 to 1,150 ug/L which is consistent or slightly lower that the August 2017 total barium results.

During the August 2017 monitoring round, total lead was detected greater than the GW-3 standard of 10 ug/L in samples collected from MW-3D (67 ug/L), MW-4D (31 ug/L), MW-9S (26 ug/L), MW-9D (11 ug/L) and MW-14S (65 ug/L). In March 2018, dissolved lead was detected greater than the GW-3 standard of 10 ug/L in the samples collected from MW-4D (77 ug/L) and MW-9S (54 ug/L). Lead was reported below the laboratory method detection limit of 10 ug/L at the remaining groundwater monitoring well sample locations which suggests that these previous detections and GW-3 exceedances appear to have been related to the presence of suspended solids in the groundwater sample. The dissolved lead concentrations and associated GW-3 exceedances at MW-4D and MW-7D are slightly lower than the total lead concentrations from the August 2017 monitoring round but do not appear to be related to the presence of suspended solids from the groundwater sample.

During the August 2017 monitoring round, total arsenic was detected at groundwater monitoring wells MW-3S, MW-4S/4D, MW-9S/9D and MW-14S with concentrations ranging 6-28 ug/L, all below the applicable GW-3 standard of 900 ug/L. During the March 2018 monitoring round, dissolved arsenic was detected in the groundwater samples collected from MW-3D (6.6 ug/L), MW-9D (40.2 ug/L) and MW-14S (5.5 ug/L), all below the applicable GW-3 standard of 900 ug/L. The March 2018 dissolved arsenic detections are consistent with August 2017 total arsenic concentrations at MW-3D, MW-9D and MW-14S. During the August 2017 monitoring, total zinc was detected in the groundwater samples collected from MW-3D (54 ug/L) and MW-14S (234 ug/L), below the applicable GW-3 standard of 900 ug/L. During the March 2018 round, dissolved zinc was reported below the laboratory method detection limit of 50 ug/L at MW-3D and MW-14S. Dissolved zinc was detected in the sample collected from MW-7S (60 ug/L) below the GW-1 standard of 5,000 ug/L and GW-3 standard of 900 ug/L. Dissolved zinc was also detected in the sample collected from MW-9S at a concentration of 224 ug/L which is below the GW-3 standard. The presence of elevated concentrations of heavy metals in soil and groundwater such as barium and lead appear to be attributed to the interaction of buried waste material and groundwater at the site.

In both the August 2017 and March 2018 monitoring rounds, other VOC and SVOC compounds were detected at all groundwater well locations, however, the concentrations were reported below applicable standards. In the sample collected from MW-9D during the March 2018 round, methyl-tert-butyl-ether and tertiary-amyl methyl ether were detected consistent with the August 2017 concentrations and well below applicable GW-2 and GW-3 standards. Benzene was detected in the sample collected from MW-14D (6.7 ug/L), however the concentration is well below GW-2 and GW-3 standards. Numerous SVOCs compounds, primarily PAHs, were detected at all groundwater monitoring wells but were below the applicable standards in both sampling rounds. During both the August 2017 and March 2018 round, 1,4-dioxane was detected in the sample collected from MW-9D (0.198 ug/L and 0.158 ug/L, respectively), however, the detected concentrations are well below the applicable GW-2 and GW-3 standard. PCBs were below the laboratory method detection limit in samples collected from all groundwater monitoring wells. In August 2017 and March 2018, select VOC, SVOC compounds were detected in groundwater samples collected from the two (2) well couplets as noted above (MW-7S/7D and MW-9S/9D) located approximately within 30 feet of the building, however, none of the detections exceeded applicable GW-2 standards.

4.3.7.3 Data Summary for Soil Gas

On August 16-17, 2017, CDM Smith installed/sampled a total of 28 landfill gas probe locations and screened the 10 newly installed groundwater wells for the presence of landfill gas (see Image 4.3a). For all landfill gas sampling locations, concentrations of methane (CH_4), carbon dioxide (CO_2), oxygen (O_2), Lower Explosive Limit (LEL) and atmospheric pressure were obtained using a Landtec GEM 2000 Gas Analyzer. VOC concentrations were obtained using a PID. Hydrogen sulfide (H_2S) concentrations were obtained using an Interscan Gas Analyzer. Landfill gas sampling locations were purged for 10 minutes with the Landtec Gas Analyzer prior to collection of final readings. Due to the elevated concentrations of methane observed at SGP-27, SGP-28 and groundwater monitoring wells MW-3S/3D and MW-4S/4D during the August 2017 sampling event, CDM Smith returned to the Tobin School on October 2, 2017 to screen on-site utilities adjacent the recreational fields and to complete sub-slab and indoor air sampling at the Tobin School.

Due to the history of the landfilling operations at the Tobin School property, landfill gas migration investigations were completed to determine the nature and extent of landfill gas in the shallow and deeper sub-surface and to confirm there was no gas migration offsite beyond the property boundary. A total of 28 landfill gas probes were installed in August 2017 with a majority of the gas probes installed around the perimeter of the site at the property boundary. Methane was not detected at any of the perimeter landfill gas probes except at SGP-27 which is located at the Armory property boundary, where the initial methane (as an indicator of landfill gas) concentration was detected at 2.9 percent (58 percent LEL) and the final methane concentration was detected at 2.8 percent (56 percent LEL). This is not an unexpected finding since it is believed that the waste material extends underneath the Armory property. One landfill gas probe was installed in the center of the recreational fields (SGP-28) to evaluate shallow sub-surface landfill gas conditions in the center of the recreational field. At landfill gas probe, SGP-28, methane was initially detected at 63.8 percent (1,276 percent LEL) and the final concentration was detected at 50.2 percent (1,004 percent LEL). These LEL readings are considered very high and comparable to what may be observed at a municipal solid waste landfill. Carbon dioxide was detected at all landfill gas probes with concentrations ranging from 0.5 to 5.4 percent. Oxygen concentrations ranged from 0.9 to 20.3 percent at all landfill gas probe locations. VOC concentrations were non-detect (0.0 ppm) at all landfill gas probe locations except SGP-26 where the initial VOC concentration was detected at 111.7 parts per million volume (ppmv) and the final VOC concentration was detected at 58.8 ppmv. Hydrogen sulfide was not detected at any landfill gas probe location.

The ten (10) groundwater monitoring wells installed during Phase 1 were also screened for the presence of landfill gas during the August 2017 landfill gas sampling event. Methane was detected at groundwater monitoring wells MW-3S, MW-3D, MW-4S, MW-4D, MW-7S and MW14D. Methane was initially detected at MW-3S at a concentration of 13.5 percent (270 percent LEL) and the final methane concentration was detected at 13.4 percent (268 percent LEL). Methane was initially detected at MW-3D at a concentration of 1.9 percent (38 percent LEL) and the final methane concentration was detected at 0.8 percent (16 percent LEL). Methane was initially detected at MW-4S at a concentration of 73 percent (1,460 percent LEL) and the final methane concentration was detected at 71.6 percent (1,432 percent LEL). Methane was initially detected at MW-4D at a concentration of 0.6 percent (12 percent LEL) and the final methane concentration was detected at 0.3 percent (6 percent LEL). Methane was initially detected at MW-7S at a concentration of 2.4 percent (48 percent LEL) and the final concentration was detected 2.3 percent (46 percent LEL). Methane was initially detected at MW-14D at a concentration of 0.4 percent (8 percent LEL) and the final methane concentration was detected at 0.3 percent (6 percent LEL).

Due to the elevated landfill gas readings across the site, a supplemental gas investigation was completed by CDM Smith on October 2, 2017. During the October 2, 2017 sampling, CDM Smith re-screened the 10 groundwater monitoring wells for the presence of landfill gas. Results were similar to the August 2017 monitoring. The most significant difference between the two rounds was that methane was detected at MW-9S with elevated concentrations in October 2017, whereas, it was not detected in August 2017. Methane was detected at MW-9S at an initial concentration of 22.8 percent (456 percent LEL) and the final methane concentration was detected at 23.9 percent (478 percent LEL). Simultaneously on October 2, 2017, CDM Smith collected sub-slab and indoor air samples inside the Tobin School to confirm there was no indoor air quality problems inside the school. The conclusion of the Tobin School assessment was that the sub-slab monitoring results showed low levels of contaminants below MassDEP thresholds. The indoor air (within the crawl spaces) did show some commonly found constituents in indoor air, however, they do not appear to be attributed to the underlying waste material. A summary of the results of the Tobin School subslab and air sampling was included in a separate memorandum.

In addition to the screening of the groundwater monitoring wells for landfill gas, 30-minute grab soil vapor samples were collected from groundwater monitoring well MW-4S and MW9S where the highest concentrations of methane were observed and were analyzed for VOCs, fixed gases (methane, carbon dioxide, carbon monoxide, nitrogen and oxygen), sulfide analysis and mercaptans. Overall, there were some VOC detections, however, none of the concentrations exceeded MassDEP sub-slab soil gas screening criteria. Fixed gas concentrations were consistent with concentrations observed when collecting field analyzed gas samples using the Landtec GEM 2000. Sulfide and mercaptan compounds including hydrogen sulfide, methyl mercaptans, dimethyl sulfate and carbon disulfide were detected in the soil vapor samples collected from MW-4S and 9S with concentrations ranging from 4.43 to 6.38 ug/m^3.

Due to the elevated methane concentrations within the subsurface of the recreational fields, deeper landfill gas probes were attempted along the eastern property line to confirm there was no gas migration beyond the eastern property line, however, due to subsurface conditions, continuous refusal was encountered at multiple locations and the gas probes could not be installed below 5 feet bgs. Due to the clean corridor of no waste between the recreational fields and the eastern property line and no observed gas detections from the August 2017 gas sampling, it does not appear gas is migrating towards the eastern property line.

A total of twenty-six (26) utility locations on the Tobin School property and adjacent to the Tobin School property boundary (catch basins, manholes, electrical boxes) as shown on Image 4.3a were screened for the presence of landfill gas on October 2, 2017. Methane was only detected in the water meter pit manhole located directly north of recreational fields. Methane was detected in the water meter pit manhole initially at 296 percent LEL of methane and at 16 percent LEL of methane after venting with the manhole cover off. Under the MCP, an LEL reading greater than 10 percent LEL in a utility is a 2-hour reporting condition. Since the LEL of methane results were greater than 10 percent LEL in the Water Meter Pit Manhole, the results were reported to MassDEP Bureau of Waste Site Cleanup (BWSC) by Kathleen Murphy, LSP, (CDM Smith). A release tracking number (RTN) was assigned by MassDEP (RTN 3-34521). As a mitigation measure, the City of Cambridge determined that the water vault was no longer in use and backfilled the manhole with flowable fill on October 18, 2017 and re-screened the manhole with a 4-gas meter which resulted with an LEL of reading of 0.0 percent.

CDM Smith completed confirmation methane screening of utilities adjacent to the abandoned water meter pit and on Concord Avenue on November 30, 2017. During the supplemental screening event, methane was not detected at any of the utility locations. Since the water meter pit was abandoned and methane was not detected during the supplemental screening, CDM Smith submitted an Immediate Response Action (IRA) Completion Report to MassDEP on December 7, 2017 closing out RTN 3-34521 linking it to the overall RTN for the Tobin School property (3-01658).

During the Phase 1 and Phase 2 Test Pit programs, multi-gas monitors were placed approximately 20 feet at different directions from each test pit to monitor ambient air for oxygen, carbon monoxide, hydrogen sulfide and LEL. During both phases of test pits, there were no detections of any gases and oxygen concentration remained at approximately 20.9 percent. A photoionization detector (PID) was also used during test pitting to determine the presence of VOCs in ambient air, and values ranged from non-detectable to 8.2 parts per million (ppm).

4.3.8 Bench Scale Testing Summary

CDM Smith has prepared this summary detailing the activities and results of the Geotechnical Investigation and Bench Scale Testing for the In-Situ Solidification/Stabilization (ISS) of the onsite waste materials for the construction of the new Tobin Montessori Vassal Lane School.

4.3.8.1 Scope of Work and Bench Scale Testing Goals

The scope of work for the bench scale testing consisted of three main tasks:

1. Collect representative soil and groundwater samples for ISS bench scale testing;
2. Perform a laboratory bench scale ISS test program using typical Solidification/Stabilization (S/S) reagents, mix dosages, mixing procedures and perform physical and analytical testing of S/S treated specimens.
3. Prepare a written summary of the field investigation and bench scale testing conducted. The results will be used to evaluate and estimate costs for carrying out various alternatives for the design and construction of the new Tobin School.

Goals for the bench scale testing were to perform additional characterization of the impacted materials on site and then mix specimens of these materials with various bulking agents and additives and the underlying clay to improve the physical characteristics of these materials. The anticipated goals of the bench scale testing were as follows:

1. Identify locally available, cost effective reagents that can be used for the soil mixing.
2. Conduct compatibility testing with the reagents identified above, to ensure they are compatible with the site groundwater.
3. Characterize the physical and analytical characteristics of the composite waste fill material prior to conducting mixing.
4. Characterize the compressive and/or shear strength of the S/S treated samples using handheld index testing equipment such as a pocket penetrometer. Additionally, select specimens will be tested for Unconfined Compression Strength (UCS) by ASTM method D2166. A UCS value of 100 psi is deemed desirable for future site uses.
5. Characterize the hydraulic conductivity of S/S treated specimens and identify samples with a hydraulic conductivity equal to or less than 1E-06 centimeters per second (cm/s).
6. Characterize the leachability of the S/S treated specimens for the contaminants of concern identified during the initial analytical characterization of the composite samples. Testing included a combination of toxicity characteristic leaching procedure (TCLP), synthetic precipitation leaching procedure (SPLP), and dynamic leaching testing depending upon strength and conductivity testing results.

4.3.8.2 Geotechnical Field Program Summary

CDM Smith conducted the following tasks during the field program:

- Geotechnical Field Investigation – drilling and sample collection of the physical and analytical samples needed for the bench scale testing.

    - A subsurface exploration program was conducted to collect a sufficient volume of soil for physical and analytical samples needed for the bench scale testing. The subsurface exploration program targeted the location of three previously drilled locations (CDM-1, CDM-7, and CDM-9). Site groundwater was collected during the investigation to use in the ISS mixes to better simulate full-scale site conditions.

- Bench Scale Testing – characterization of the waste composite samples, reagent evaluation, and S/S mixing of the impacted soils with various reagents to produce samples to compare with the Site regulatory criteria.

- S/S Sample Evaluation – S/S mixed batches cured for 28 days and were subjected to chemical and geotechnical properties testing to evaluate performance.

4.3.8.3 Bench Scale Study Summary

The Tobin School bench scale study was designed to evaluate the mixing of contaminated soils with a series of reagents to achieve a product that meets the geotechnical performance criteria necessary to support structural design of the new Tobin School. CDM Smith evaluated Portland Cement, Cement Kiln Dust, and Fly Ash as potential S/S additives. Based on the results of the screening, Portland Cement and Fly Ash were selected as reagents for S/S additives.

S/S mixing was performed at the CDM Smith Geotechnical Laboratory in Chelmsford, Massachusetts. Prior to S/S mixing, composite samples were prepared from the material collected during the subsurface investigations that were representative of anticipated subsurface conditions at the site for in-situ mixing. Composite 1 represents a soil-waste column consisting of the smallest thickness of Waste Fill observed (9-feet) overlying 5-feet of Clay and Silt. Composite 2 represents the largest thickness of waste fill observed (34-feet) overlying 5-feet of Clay and Silt. Composite 3 represents the average thickness of Waste Fill observed (16-feet) overlying 3-feet of Clay and Silt and, also included a sand bulking material.

The reagents were added to the composites and samples of the S/S mixes were cast into 2inch by 4-inch cylinder molds and allowed to cure for 7, 14, and 28 days prior to physical and analytical testing. S/S mixes were prepared for Composite 1, 2, and 3 using the percentages of reagents described below for Case A, B, and C:

1. <u>Case A:</u> Portland Cement (Type I/II) with bentonite: 15 percent PC + 5 percent bentonite, 20 percent PC + 5 percent bentonite, and 25 percent PC + 5 percent bentonite.

2. <u>Case B:</u> Portland Cement (Type I/II): 5 percent, 10 percent, 15 percent, 20 percent, and 25 percent.

3. <u>Case C:</u> Portland Cement (Type I/II) with fly ash: 3 percent PC + 2 percent fly ash, 5 percent PC + 5 percent fly ash, and 5 percent PC + 10 percent fly ash.

4.3.8.4 Physical Testing

Samples collected during the geotechnical investigation were transported to the CDM Smith Geotechnical Laboratory in Chelmsford, Massachusetts and submitted for preliminary geotechnical index testing. The following laboratory tests were performed as part of the preliminary sample characterization:

- Grain Size no Hydrometer (ASTM D6913 and ASTM D1140) – 4 tests

- Grain Size with Hydrometer (ASTM D7928 and ASTM D1140) – 3 tests

- Moisture Content (ASTM D2216) – 7 tests
- USCS Classification (ASTM D2488) – 7 tests
- Density and Dry Density (ASTM D7263) – 4 tests
- Specific Gravity (ASTM D854) – 4 tests

4.3.8.5 Analytical Testing

Unmixed samples from the field investigation and samples of Composite 1, 2, and 3 were submitted to Alpha Analytical in Westborough, Massachusetts for analytical characterization. The following laboratory tests were performed as part of the characterization:

- Volatile organic compounds (VOCs) using USEPA Method 8260C – 5 tests,
- Semi-volatile organic compounds (SVOCs) using USEPA Method 8270D – 4 tests,
- (MCP) 14 Metals using USEPA Method 6010C/7471B – 4 tests,
- Toxicity Characteristic Leaching Procedure (TCLP) for Lead – Method SW846 – 4 tests,
- Polychlorinated biphenyls (PCBs) using USEPA Method 8082A – 4 tests, and
- Massachusetts Department of Environmental Protection (MassDEP) Extractable Petroleum Hydrocarbons – 4 tests.

4.3.8.6 Physical Testing

The following physical tests were performed on S/S treated specimens:

- Unconfined Compression Test (ASTM D2166) – A total of 99 tests; 33 conducted after 7 days of curing, 33 conducted after 14 days of curing, and 33 conducted after 28 days of curing.
- Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084) – A total of 33 tests were conducted on S/S specimens after 7 days of curing.

4.3.8.7 Analytical Testing

Analytical testing was performed to evaluate lead leachability of the S/S samples via TCLP methods to verify stabilized material can meet the regulatory performance criteria of the site for the following analytes:

- TCLP lead – 6 tests,
- Semi-Dynamic Leaching (SDL) test for lead– 6 tests, and
- Synthetic precipitate leaching procedure (SLPL) for lead –6 tests.

The TCLP samples were sent to Alpha Analytical located in Westborough, Massachusetts for analytical testing. The SPLP and SDL testing took place in the CDM Smith Laboratory located in Denver, Colorado.

4.3.8.8 Summary of Laboratory Results

Preliminary Composite Sample Characterization Results: Physical Test Results

Laboratory test results for the preliminary composite sample characterization are described in the following subsections.

Grain Size Analyses

The grain size distributions were measured using sieve analyses with and without hydrometers in accordance with ASTM D6913, ASTM D7928, and ASTM D1140. In the test boring samples (SSTB-1, SSTB-7, and SSTB-9), the waste fill material ranged in sand content from 27.4 percent to 49.2 percent, fines content from 18 percent to 59.3 percent, and gravel content from 13.3 percent to 32.8 percent. Due to the variability in grain size distribution, a composite of the waste fill samples was created and analyzed for grain size distribution.

The composite waste fill sample sand content was 53.5 percent, fines content was 27.5 percent, and gravel content was 19.0 percent. Composite-1 through Composite-3 samples ranged in sand content from 39.8 percent to 47.7 percent, fines content from 34.4 percent to 57.8 percent, and gravel content from 1.9 percent to 6.0 percent.

Moisture Content

Moisture contents were measured in accordance with ASTM D2216. Moisture contents for the test boring samples (SSTB-1, SSTB-7, and SSTB-9) ranged from 24.2 percent to 73.0 percent. Moisture content for the composite waste fill sample was 29.0 percent. Moisture contents for Composite-1 through Composite 3 samples ranged from 34.4 percent to 57.8 percent.

Density and Dry Density

Densities and dry densities were measured in accordance with ASTM D7263. The densities and dry densities measured for the test boring samples (SSTB-1, SSTB-7, SSTB-9) ranged from 85.5 pounds per cubic foot (pcf) to 115.1 pcf and from 55.2 pcf to 82.5 pcf, respectively. The density and dry density for the composite Waste Fill sample was 70.6 pcf and 91.0 pcf, respectively. Densities and dry densities were not measured on samples Composite-1 through Composite-3.

Specific Gravity

The specific gravities were measured in accordance with ASTM D854. Specific gravity was measured for composite samples only. The specific gravity of the composite Waste Fill sample was 2.61. The specific gravities measured for Composite-1 through Composite-3 ranged from 2.49 to 2.64.

Analytical Test Results

A summary of the analytical test results will be provided at a later date after full completion of the SDL and TCLP testing.

Groundwater Wet Chemistry Characterization Results

A summary of the wet chemistry characterization results will be provided at a later date after full completion of the SDL and TCLP testing.

4.3.8.9 Solidified Composite Sample Results

Unconfined Compression Strength

Unconfined Compressive Strength tests were performed in accordance with ASTM D1633. Testing was performed on samples after 7, 14, and 28 days of curing. The results from the laboratory tests for each case are summarized in the following subsections.

Case A – Portland Cement and Bentonite

- Compressive strengths after 7 days of curing ranged from 88.6 psi (C2-B5PC20) to 527.7 psi (C3-B5PC25).
- Compressive strengths after 14 days of curing ranged from 124.7 psi (C2-B5PC20) to 637.9 psi (C3-B5PC25).
- Compressive strengths after 28 days of curing ranged from 126.3 psi (C1-B5P20) to 834.0 psi (C3-B5PC25).
- All composites and mixes reached the desired 100 psi compressive strength after 14 and 28 days. The majority of samples met the desired 100 psi compressive strength criteria after 7 days except for one sample, Composite 2 mixed with 5 percent bentonite and 20 percent Portland Cement.

Case B – Portland Cement

- Compressive strengths after 7 days of curing ranged from 39.6 psi (C3-PC5) to 945.0 psi

(C3-PC25).

- Compressive strengths after 14 days of curing ranged from 56.3 psi (C3-PC5) to 1136.5 psi (C3-PC25).
- Compressive strengths after 28 days of curing ranged from 60.0 psi (C3-PC5) to 1157.2 psi (C3-PC25).
- All cylinders mixed with 5 percent Portland Cement were below the desired 100 psi strength. Composite-1 and Composite-2 cylinders mixed with 10 percent Portland Cement were below the desired 100 psi strength after curing for 7 and 14 days but met the criteria after 28-days of curing. Composite-3 mixed with 10 percent Portland cement met the desired 100 psi criteria after 7, 14, and 28 days.
- All cylinders mixed with 15, 20, and 25 percent Portland Cement met the desired 100 psi criteria after 7, 14, and 28 days.

Case C – Portland Cement and Fly Ash

- Compressive strengths after 7 days of curing ranged from 12.0 psi (C2-PC2FA3) to 48.2 psi (C2-PC5FA5).
- Compressive strengths after 14 days of curing ranged from 14.9 psi (C2-PC2FA3) to 67.3 psi (C1-PC5FA5).
- Compressive strengths after 28 days of curing ranged from 13.0 psi (C1-PC2FA3) to 90.9 psi (C1-PC5FA10).
- None of the samples mixed with Portland Cement and Fly Ash were able to achieve the desired 100 psi strength, even after 28 days of curing.

4.3.8.10 Hydraulic Conductivity

Hydraulic conductivity tests were performed in accordance with ASTM D5084. The hydraulic conductivity measured in the lab ranged from 8.40E-08 cm/s (C3B5PC15) to 1.19E-06 cm/s (C3-PC2FA3). All samples indicated that the required hydraulic conductivity of 1.0E-06 cm/s or less was achieved.

4.3.8.11 Leachability and Analytical Characterization

A summary of the leachability and analytical characterization test results will be provided at a later date after full completion of the SDL and TCLP testing.

4.3.9 Environmental Implications for Design and Construction

4.3.9.1 Removal and Disposal of Soil/Waste Materials

Based on the results of the soil/waste fill concentrations, excavated fill/waste material would need to go either to an out-of-state facility or to an in-state landfill for disposal. In order to obtain a clean closure with no deed restrictions, i.e., AUL, on the school property, the entire limits of the waste material would need to be removed. Complete removal of the waste material on the school property is not possible given the depth of the waste at the property line with the abutting Armory facility and the potential to impact the existing Armory structure. In addition, removal of waste along the remaining property lines may impact abutting properties. At this time, full removal of the waste material is not recommended. Based on the soil sampling results some material will need to be treated for TCLP-lead prior to excavation and offsite disposal. The material will then need to be re-tested for TCLP-lead to document that it passes the regulatory limits.

As discussed elsewhere in this section, ISS is considered a viable option for the waste/soil material. Some material will need to be removed due to the underground parking garage, utilities and the underground storm water storage tank. Remaining material in the vicinity of the school and utilities could be treated in place. This will provide structural support as well as mitigate the environmental concerns such as methane and mobilization of lead.

Removal of the waste material will present challenges including the depth of material requiring removal (up to 32 feet bgs), dewatering during removal, control of landfill gases during removal, and proximity of nearby residents. It is anticipated that waste material not required for excavation and offsite disposal as part of the construction of the new school and related appurtenances will remain on-site. Material in proximity to the school, utilities and the stormwater tank will be treated in-situ using stabilization technologies. It is anticipated that material beneath the existing athletic fields will not be removed or stabilized since it will remain beneath the new athletic fields. The existing three feet of clean cover material will continue to be required in this area. The options for leaving some waste material in place would require an AUL.

4.3.9.2 Dewatering Groundwater Treatment and Discharge

The water table depth from ground surface ranged from approximately 6 to 9 feet bgs based on the August and October 2017 and March 2018 water level gauging data. The maximum depth of waste encountered within the footprint of the recreational fields is 32 feet bgs, therefore, dewatering for removal of the waste would require an extensive effort due to the shallow water table and depth of waste.

Some dewatering will still likely be necessary during foundation excavation and construction. The amount of water that will need to be treated could be reduced through the use of in-situ solidification of waste material around the excavation footprint by creating a barrier wall. Based on the August 2017 and March 2018 groundwater sampling results, an active remediation system for groundwater collected as part of a dewatering program would be required prior to discharge to the local stormwater system. If local stormwater discharge is feasible, then an USEPA National Pollutant Discharge Elimination System (NPDES) Remediation General Permit would be required. If discharge to the storm drain is not permitted or feasible discharge to the sanitary sewer may be allowed by the Massachusetts Water Resource Authority (MWRA). Generally, the MWRA prohibits the discharge of construction site dewatering except in combined sewer areas, however, they will review cases individually. An MWRA Construction Dewatering Permit would be required in this case.

4.3.9.3 Landfill Gas Control

Elevated concentrations of landfill gas exist beneath the Tobin School property. Landfill gas concentrations were detected in excess of 1000 percent LEL of methane at some locations. Due to the elevated concentrations of landfill gas in the shallow and deeper sub-surface strata, active landfill gas controls would be required to ensure the safety of the contractors and nearby residents, minimize gas migration during excavation, and to suppress excessive landfill gas odors.

Based on the soil vapor sample results (sulfide and VOC detections) and observations during drilling and test pit excavations, there is potential for excessive odors migrating in the ambient air during construction/excavation. Landfill gas migration controls required to control landfill gas and odors could consist of an active gas trench system (under vacuum) installed into the shallow waste across the recreational fields. Odor control foams or similar means may also be required to control odor if waste material is exposed in open excavation.

4.3.10 Preliminary Construction Considerations

4.3.10.1 Removal of Existing Foundations and Buried Structures

Existing foundations and buried structures that are located outside the footprint of the new construction may be abandoned in place, provided they do not interfere with construction of the new building or installation of new utilities. Foundations and buried structures within the footprint of the new building or that interfere with construction should be removed and replaced with compacted granular fill or flowable fill.

Existing piles should only be removed when they interfere with the new work. The existing piles located within the footprint of the new building that do not interfere with the new piles should be cut so that the tops of the cut piles are at least 2 feet below the bottom of the proposed construction. It may be possible to remove timber piles that interfere with the installation of new piles. However, it will likely not be practical to try to remove concrete piles that interfere with new piles. Thus, new piles will likely need to be designed so that they avoid the existing concrete piles.

4.3.10.2 Pile Installation

Driving displacement piles (piles with large cross-sectional areas such as concrete piles and concrete-filled pipe piles) can cause the ground surface and nearby structures and utilities to heave. Heave can be reduced by pre-augering prior to installing the piles. However, even with the pre-augering, the ground surface, including pavement and utilities, could heave 1 to 3 inches depending on the spacing and density of the piles. Pre-augering is not necessary if steel H-piles are selected.

Pre-augering will generate excess soil that will need to be disposed of.

Driving of piles will cause vibrations that may be felt in adjacent buildings. Pre-augering will reduce the vibrations.

Pile tip protection (typically a 1.5-inch-thick steel plate or H-pile stinger for concrete piles, or a cast steel tip for H-piles) should be provided to reduce the risk of damage to the piles from potential obstructions and from driving into bedrock.

A contingency should be included for concrete piles that are damaged or broken during driving. Based on previous projects, we recommend budgeting for up to 10 percent pile breakage. The potential for breakage can be reduced by installing a steel H-pile stinger at the tip of each of the concrete piles. The addition of stingers will increase the cost of each concrete pile by about $500; however, the percentage of broken concrete piles should be reduced resulting in less construction delays and the need to redesign the pile caps.

4.3.10.3 Pile Load Test

In accordance with Building Code requirements, at least one pile must be subjected to a static load test to at least 200 percent of the design load to verify its axial compression capacity. Alternatively, a minimum of three dynamic load tests of instrumented driven piles carried to 250 percent of the design load may be performed.

Because of the variable depth to the bearing layer, we recommend that at least 6 dynamic load tests be performed across the footprint of the building. Dynamic load testing is generally less expensive than static load testing and can be completed in less time. However, the use of dynamic testing will require that the piles be driven harder, which could result in a greater potential for pile damage.

4.3.10.4 Excavations and Excavation Support

We anticipate that the excavated material will consist mostly of existing building foundations, fill, and waste fill. Excavations that extend below the groundwater table and adjacent to surrounding properties and infrastructure will be required for demolition and removal of the existing structure and construction of the project. It is unlikely that there is sufficient space around the site to slope the excavations without bracing; and any excavations that extend below the groundwater table should be braced. Therefore, an excavation support system will be required for this project. Based on preliminary test results, it appears that waste material could be solidified in-place and could perform several useful functions including acting as temporary earth support, a barrier to ground water flow and reduce the need for ground water controls.

4.3.10.5 Ground Improvement for Waste Stabilization

Ground improvement methods (i.e., deep soil mixing, jet grouting, etc.) may be used as a method of waste stabilization in lieu of waste removal, to improve the engineering properties of any waste left in place for foundation support of the new structure, as a groundwater cut-off where existing waste/contaminated groundwater at adjacent sites will not be removed (e.g., the Armory), and as a means of excavation support.

4.3.10.6 Dewatering and Groundwater Cutoff

The groundwater level should be lowered and maintained to at least 2 feet below the bottom of excavation during foundation construction. Dewatering wells, well points, or a series of filtered sumps extending below the excavation bottom will be required to maintain the groundwater level below the bottom of the excavation. Dewatering activities can stop only when the building has sufficient weight and strength to withstand the hydrostatic pressure. As discussed above a groundwater barrier could also be used to limit the volume of groundwater to be removed and treated and mitigate future impacts.

Dewatering activities may lower surrounding groundwater levels beyond the limits of the excavation, which may cause settlement of the surrounding ground surface and impact nearby buildings and infrastructure. To reduce the potential for lowering the surrounding groundwater levels, the excavation support system should extend at least 5 feet into an impervious soil layer to act as a groundwater cutoff. Dewatering effluent will need to be discharged under an applicable permit as discussed in Section 4.3.9.2. Pretreatment and periodic chemical testing of the dewatering effluent will be required as part of the process for obtaining the permits.

4.3.10.7 Protection and Monitoring of Adjacent Structures

The contractor should be required to perform pre- and post-construction condition surveys of structures within 100 feet of the site. The surveys should document existing visible damage or signs of distress outside the buildings, and readily accessible areas of the building interiors. The surveys should be provided to the respective property owners.

Adjacent buildings should be monitored for vibrations during construction with seismographs placed inside or adjacent to the buildings. We recommend that the peak particle velocity not exceed 0.5 inches per second for continuous vibrations (such as jack hammering, hoe ramming, or pile driving).

Survey points should be installed at selected locations on excavation support systems, and their horizontal and vertical positions should be established before the start of construction. The survey points should be monitored for vertical and horizontal movements on a weekly basis through construction. More frequent monitoring should be performed for adjacent structures during installation of the excavation support system and while excavating below the foundation elevation of the adjacent structures.

Crack gages should be installed at representative cracks observed in the adjacent structures during the pre-construction condition surveys. The crack gages should be monitored on a weekly basis during construction.

Temporary groundwater observation wells should be installed inside and outside the excavation to monitor groundwater levels during dewatering activities. The groundwater levels should be monitored daily beginning at least two weeks before the start of dewatering and throughout dewatering.

Settlement and heave of adjacent structures such as sidewalks, buildings, utilities etc. should be monitored during pile driving. In addition, newly driven piles that are adjacent to piles being driven should also be monitored for settlement and heave.

4.3.10.8 Additional Monitoring

Additional monitoring such as noise, dust, and landfill gas (methane, hydrogen sulfide) monitoring may be required during construction.

4.3.10.9 Construction Monitoring

In accordance with the Building Code, full-time observations and documentation are required during installation of the foundations. These observations should be made by a registered design professional or their representative to meet the requirements of the foundation completion letter referred to in Section 1701.1.1 subsection 5 of the IBC 2015 (Massachusetts amendments).
2.2

4.4 Structural

Introduction

Foley Buhl Roberts & Associates, Inc. (FBRA) is collaborating with *Perkins Eastman (PE)* in the development of design options for the Tobin Montessori and Vassal Lane Upper Schools project in Cambridge, Massachusetts.

The purpose of this narrative is to summarize the basis of the structural design, describe the primary structural systems and provide preliminary structural quantities to be used in the preparation of the Conceptual Design cost estimate. Outline Structural Specifications have also been included. Proposed new construction will be designed and constructed under the provisions of the Massachusetts State Building Code (780 CMR - 9th Edition, based on the 2015 IBC). This Structural Narrative should be used in conjunction with the Conceptual Design Architectural documents and those of the other disciplines, as well as the FBRA *Existing Conditions Structural Report* dated March 29, 2019.

Design Options

A number of design options have been studied in recent months; including the following:

Option 1 (Renovation/Addition): Option 1 re-uses the classroom bar of the existing building, but demolishes the Gymnasium/Locker Room wing on the north side of the classroom bar (at the expansion joint), to accommodate the construction of a new, structurally separated, two and three-story addition. Playing fields are located along the east side of the site (Alpine Street).

Option 1A (Replacement v3 - Crossroads): Option 1A demolishes the existing building and constructs a new, three and four-story building over portions of the original building footprint. The Vassal Lane School and the Preschool are located at the west end of the classroom bar; the Tobin Montessori School is located at the east end. Shared spaces would are located to the north of the classroom bar, connected by a central “Heart of School” space. Playing fields are located to the north of the new building, along the east side of the site (Alpine Street).

Option 2 (Wings): Option 2 demolishes the existing building and constructs a new, two and three-story building to the north, in the area currently occupied by playing fields. Playing fields are located to the south of the new building, along Vassal Lane.

Option 3 (Pavilions): Option 3 demolishes the existing building and constructs a new, three-story building that overlaps a portion of the original building footprint and extends further to the north. Playing fields are located at the southwest corner of the site.

All options include a Mechanical Penthouse and a below grade parking level for 150 cars. The completed facility will not be designated as a FEMA Emergency Shelter.

The City of Cambridge has chosen Option 1A (Replacement v3 - Crossroads) as the Preferred Option. Structural comments and information that follow in this narrative relate to the **Crossroads** option.

General Structural Description (Base Scheme)

The proposed, new school (Crossroads option) will be constructed on the site of the existing building. The Tobin School Wing and the Vassal Lane School will flank a central “Heart of School” space to the southeast and southwest, respectively. Shared spaces (Auditorium, Large and Small Gymnasiums, Dining, etc.) are located to the north of this space. The building will be three and four-stories high, with a basement parking/storage level below the entire building footprint, and below the west plaza/playground area. A 1.25M gallon storm water storage tank may be located below the parking level of the Tobin Wing or below the bus drop-off area on the west side.

New construction will be steel framed, for reasons of economy, performance, flexibility and speed of construction. Typical floor construction (including Mechanical Penthouse floors) will be a concrete slab on composite steel deck, supported by composite, structural steel beams and girders. Roofs are typically flat; the pitch to drains will be achieved by the use of tapered insulation. Roofs will be framed with steel roof deck supported by structural steel beams and girders. A concrete slab on composite steel floor deck (similar to typical floor construction) will be provided below individual rooftop mechanical units, for acoustic purposes. Screens (visual and acoustic) surrounding individual rooftop mechanical units will be structured with horizontal and vertical, galvanized HSS (tube) steel members, braced down to the main roof structure. The Gymnasium roofs will be framed with acoustical steel deck, supported by structural steel purlins, which span to steel trusses. The Auditorium roof will be similarly structured, with standard, non-acoustical roof deck. The typical roof structure will be designed to support a green or blue roof system and photovoltaic (PV) panels. A concrete slab on composite steel floor deck (similar to typical floor construction) will be provided below all green roof areas (approximately 8,000 square feet) and at the outdoor classroom.

New, steel framed construction is assumed to be Type 1B (Noncombustible, Protected); Type 2A construction may be allowed by code; further review is necessary. Typical steel floor and roof members (beams, columns and bracing) and steel roof deck (except where the height exceeds 20 feet) require fire protection.

Typical floor and roof steel framing will be surface prepped and be left unpainted, except exposed steel in the Gymnasium, which will receive one shop coat of primer, compatible with the finish paint.

Typical columns will be wide flange sections or hollow steel tubes (HSS). Lateral stability for wind and seismic loads will be provided by steel bracing (various configurations) in each direction.

A pile foundation will be required for all new construction, similar to the existing building. Lowest level slab construction will be a structural concrete slab on grade. Existing foundations will be removed where they overlap with new construction. Existing utilities will be removed and relocated, as required to accommodate the new construction. Temporary lateral earth support and dewatering will be required during construction.

Exterior walls will be a combination of architectural panels and masonry veneer, with a light gauge metal framed backup wall.

An alternate (hybrid) superstructure scheme, utilizing structural steel, glued laminated timber (GLT) and cross laminated timber (CLT) members is also under consideration. A description of this alternate structural scheme is provided in a later section of this narrative.

Basis of Structural Design (Base Scheme and Alternate Scheme)

Codes and Design Standards:

Building Code:	Massachusetts Building Code - Ninth Edition (2015 IBC with Massachusetts Amendments).
Concrete:	ACI 318 and ACI 301; listed standards, latest editions.
Masonry:	ACI 530/530.1, latest edition.
Structural Steel:	AISC "Specification for Structural Steel Buildings" and AISC "Code of Standard Practice".
Glulam Construction:	AITC; listed standards, latest editions.

(Alternate Superstructure Scheme)

Steel Deck:	Steel Deck Institute (SDI); listed standards, latest editions.

Design Loads/Parameters:

Live Loads:

Auditorium (Fixed Seating):	60 PSF
Classrooms (with partition allowance):	65 PSF
Corridors:	100 PSF
Flexible, Open Plan Areas (Including the Gymnasium):	100 PSF
Stairs:	100 PSF
Mechanical Equipment Rooms and Penthouses:	150 PSF
Plaza/Playground (West Side):	300 PSF (Fire Trucks)

Snow Loads (Cambridge):

Basic Ground Snow Load:	40 PSF
Flat Roof Design Snow Load:	31 PSF (Plus drifting snow)

Wind Loads (Cambridge):

Basic Wind Speed (Ultimate):	139 MPH

Seismic Parameters:

Short Period Spectral Response Acceleration (S_s):	0.216
1.0 Sec. Spectral Response Acceleration (S_1):	0.069
Seismic Occupancy Category	III
Seismic Design Category:	B (Assumed)
Site Class:	D (Assumed)
Structural System:	Building Frame System
Lateral Load Resisting System:	Concentrically Braced Frames
	(*Not Specifically Detailed for Seismic Resistance)*
Response Modification Factor (R):	3.0
System Overstrength Factor (Ω_0):	3.0
Deflection Amplification Factor (Cd):	3.0

Foundations:
New construction will be supported on a pile foundation. The most appropriate type of pile and the design pile capacity will be determined by the project Geotechnical Engineer (CDM Smith) and the Construction Manager (W. T. Rich). The design high water elevation will also be determined by the Geotechnical Engineer. End bearing, steel H-Piles with an allowable capacity of 100 Tons have been assumed in this narrative. The design water table elevation has been assumed to be at the existing grade.

Construction Classification:
New construction will be classified as Type 1B (Noncombustible, Protected), pending confirmation by the Design Team. Type 2A construction may be allowed by code; further review is necessary. Typical steel floor and roof members (beams, columns and bracing) and steel roof deck (except where the height exceeds 20 feet) require applied fire protection. All steel framed construction is considered to be *restrained.* No fire walls are required.

Sustainable Design Considerations:
Sustainable design considerations will be incorporated into the building design. Goals of zero - emissions and zero - net energy have been established. A goal of LEED Gold has been established. Refer to Section 4.8 Sustainability and Resiliency for further information.

Structural Systems Description and Estimated Quantities (Base Scheme)

A Substructure

A10 Foundations (Refer to CDM Smith Preliminary Letters/Memorandums):

1. Groundwater was encountered 3.0 to 12.0 feet below the existing grade. Groundwater control will be an issue during construction; temporary dewatering will be required. The Geotechnical Engineer has proposed that a barrier/containment wall be constructed around the entire new building, extending to the clay layer. The wall will serve to minimize dewatering during construction (following the initial dewatering of the foundation excavation) and to block the flow of groundwater around the building, once it is in service. The design groundwater elevation has not been determined at this time. A design groundwater elevation matching the existing grade has been assumed in this narrative.

2. New construction will be supported on a deep pile foundation; the recommended type of pile and the design load capacity has not been determined at this time. End bearing steel H-Piles with a 100 Ton capacity have been assumed in this narrative.

3. Lowest level (basement) floor construction will be a structural concrete slab on grade. Parking for approximately 150 cars and district-wide storage space will be provided below the building. The basement level will extend below an outdoor plaza/playground area, located on the west side of the building, between the Vassal Wing and the Auditorium/Dining wing to the north. The subgrade parking level slab will be fully waterproofed, with an underslab drainage system below. Basement foundation walls will be fully waterproofed and a perimeter foundation drainage system will be provided. At the (east) Tobin Wing, a 1.25 million gallon, reinforced concrete storm water storage tank may be constructed below the parking level. Alternately, the tank may be located on the west side of the site, below the bus drop-off area. In that event, the aforementioned barrier/containment wall would extend around the tank as well.

4. The site is assumed to be Site Class D, for seismic design. Liquefaction is assumed to not be an issue (Assumptions to be confirmed by the Geotechnical Engineer).

5. The anticipated settlement for new construction should be limited to 1” total and ½” differential.

6. Temporary lateral earth support will be required during construction. The aforementioned barrier/containment wall will be constructed by augering through the fill to the clay layer below, and injecting low strength grout (300 psi+/-); essentially reinforcing the material. The wall will be six to eight feet in thickness, and will be designed to cut off the flow of groundwater towards the building; both during construction and in service (low leachability). The barrier/containment wall will be designed to provide temporary lateral earth support during construction; accordingly, a separate, temporary Support of Excavation (SOE) wall will not be required.

7. A pre-construction survey along with vibration monitoring during construction is recommended.

8. Existing foundations and utilities within the footprint of the new building will be removed, as required to accommodate the new construction. Foundation elements to be removed would include

structural slabs, pile caps, grade beams, etc. All wood piles within the new building footprint will be removed. Wood piles outside of the new building footprint will be cut down to at least two (2) feet below the finished grade and be left in place. High capacity (steel or precast) piles which do not interfere with new foundation construction will be cut down at least two (2) feet below the Basement slab elevation and be left in place. Where high capacity piles interfere with new foundation construction, removal of the piles or special foundation design to accommodate the piles will be required. Refer to the original Structural Drawings for additional foundation information. Refer to the site survey drawings for the locations of existing utilities.

- Typical, average perimeter grade beams: 2'-4" wide by 42" deep, with top, bottom, and face longitudinal reinforcing bars and closed stirrups (90.0+/- plf), spanning to pile caps. The outside and inside surfaces of perimeter grade beams will receive rigid insulation and membrane waterproofing. The bottom of all perimeter grade beams will be a minimum of 4'- 6" below the exterior finish grade for frost protection (most grade beams are located at the basement level). The top of grade beam will typically be constructed flush with the top of pile cap.

- Typical interior piles (100 Ton pile capacity and 900+/- SF Tributary Area):

- 4 - story areas: **5 piles**

  - 3 - story areas: **4 piles**

  - West plaza/playground area: **4 piles**

- Typical perimeter piles (100 Ton pile capacity and 450+/- SF Tributary Area):

  - Auditorium and Gymnasium: **2 piles**

  - 4 - story areas: **3 piles**

  - 3 - story areas: **2 piles**

The above estimates assume that the storm water storage tank will be located *outside* of the building footprint.

- Typical intermediate slab support piles: *one (1), 100 Ton pile per 900± square feet* of the lowest level floor slab (basement level). Intermediate slab support piles do not need to be designed for tension/uplift (buoyancy forces), as an underslab drainage system will be provided.

- Typical pile caps quantities:

PC-1: *60 sf formwork, 2.0 cu. yd. concrete, 90 lbs. reinforcing*

PC-2: *90 sf formwork, 5.0 cu. yd. concrete, 280 lbs. reinforcing*

PC-3: *105 sf formwork, 6.0 cu. yd. concrete, 380 lbs. reinforcing*

PC-4: *115 sf formwork, 7.0 cu. yd. concrete, 350 lbs. reinforcing*

PC-5: *125 sf formwork; 8.0 cu. yd. concrete, 400 lbs. reinforcing*

- Typical piers/pilasters at interior/perimeter columns: *24 inches by 24 inches, reinforced concrete with 50 plf reinforcing.*

- Typical interior grade beams interconnecting piers/pile caps in lateral bracing bays: *2'-0" wide by 3'-6" deep with 90 plf reinforcing. Provide threaded bar terminators at each end of each grade beam. Assume one (1), 30+/-*

feet long grade beam required for every 2,700 square feet of lowest floor area.

- Anchor Bolts: *Anchor bolts at column base plates shall conform to ASTM F1554 - Grade 36 and shall be headed type. There will be a minimum of four (4), ¾" diameter anchor bolts at all columns; additional bolts and/or larger diameter bolts will be required at bracing locations.*

A1020 Special Foundations

- Elevator pits: Elevator pit construction will consist of 12" thick, reinforced concrete walls and a 24" thick, reinforced concrete foundation mat (supported by piles), with an integral sump pit. Waterstops will be provided at all construction joints and all interior surfaces of the elevator pit will be waterproofed. Elevator shaft walls will be 100% solid grouted, reinforced CMU construction (8" thick).

A1030 Lowest Level Slabs

- Lowest level floor construction (parking level) will typically be an average, 12" thick, reinforced concrete structural slab on grade with 7.0 psf reinforcing, supported by interior pile caps at columns (plus a single pile at mid-bay), and by reinforced concrete grade beams at the building perimeter. Locally thicken the structural slab to 18" deep at each intermediate slab support pile and at perimeter grade beams. The parking level slab will be given a light broom finish. The need for a vapor mitigation system or an engineered barrier is under review; a waterproofing membrane will be required below the slab, wrapping interior and perimeter grade beams and returning up the outside face of the basement foundation walls.

- The storm water storage tank slab will be a precast, reinforced concrete structure or a cast-in-place reinforced concrete structure, if located in the drop-off area. If located below the basement parking level in the Tobin Wing, the tank will be cast-in-place concrete construction (integrated with the building foundations). Additional piles will be needed to support the weight of the tank structure and its contents (each location). Due to the proposed barrier/containment wall, design of the tank for buoyant (uplift) forces will not be required.

- Temporary dewatering will be required to construct the basement parking level and the storm water storage tank. Refer to previous comments in Section 4.4 relating to construction dewatering.

A20 Below Grade Construction (Parking Level)
A2020 Foundation Walls

- Basement foundation walls at the parking level will be 22" thick, reinforced concrete construction, with a 12" wide masonry shelf and reinforcing each face (5.0 psf), supported on piles with a continuous pile cap/grade beam. All basement foundation walls will be fully waterproofed and bentonite waterstops will be provided at all horizontal and vertical construction joints.

- Foundation walls at the storm water storage tank will be 18" thick, reinforced concrete construction, with reinforcing each face (6.0 psf), supported on the tank bottom slab/mat. All basement tank walls will be fully waterproofed and bentonite waterstops will be provided at all horizontal and vertical construction joints.

B Shell

B10 Superstructure

Structural Bays/Spans: Typical structural bay size/configuration has not yet been determined; however, it is anticipated that rectangular structural bays will average approximately 900 square feet in area. Long span construction over the Gymnasium and Auditorium spaces varies.

Story Heights: The preliminary story height for the upper levels and the basement parking level is expected to be 14'- 0" minimum.

Steel Framing Connections: Type 2 simple framing connections (shear only); double clip angles typically.

Columns: Typical columns will be wide flange steel sections or steel tubes (HSS).

Lateral Force Resisting System: Lateral (wind and seismic) forces will be resisted by steel bracing, for reasons of economy, stiffness, reduced structural depth and smaller column sizes. Bracing members will be square or rectangular HSS sections. Brace configurations may include chevrons, inverted chevrons ("V"), or single diagonals in short bays, as required by structural and architectural considerations.

Expansion (Seismic) Joints: Considering the massing of the Crossroads option, it is likely that three (3) internal expansion/seismic joints will be required.

Fire Protection: As previously noted, new construction is classified at Type 1B Construction (Noncombustible, Protected). Type 2A construction may be allowed by code; further review is necessary. Typical steel floor and roof members (beams, columns and bracing) and steel roof deck (except where the height exceeds 20 feet) require fire protection. All steel framed construction is considered to be *restrained.* The new building will be fully sprinklered.

B1010 Floor Construction (First through Fourth Floors)

Upper Floor Construction (including Mechanical Penthouses) consists of a 4½" (minimum) thick, normal weight concrete topping slab with welded wire fabric, on 2" deep, 18 gauge galvanized steel composite steel floor deck (6½" minimum total slab thickness), supported by composite steel beams and girders. Slabs on steel deck will be placed at the required elevation, adding concrete to compensate for the deflection of the (unshored) steel framing (approximately ¾" average, additional concrete in each structural bay). Composite action between the steel beams/girders and the concrete slab on steel deck will be achieved by field welding ¾" diameter, 5" long headed shear connectors to the top flanges. Depressions (approximately 8" deep) will be necessary at coolers in the Kitchen. Elsewhere, depressions will be required at entrance mats, Toilet Rooms, and at the Gymnasium floor. Floor finishing will be coordinated with flooring requirements.

- Welded wire fabric for slabs on composite steel deck: *6x6-W2.9xW2.9.*
- The estimated total weight of structural steel for the structured floor levels of the new construction (including beams, columns, bracing, plates, angles, miscellaneous frames, connections, etc., but excluding entry canopies, loose lintels, PV frames, trellises, etc.) is as follows:

Estimated Weight of Structural Steel: 16.5 PSF

First floor construction at the plaza/playground area on west side of the building consists of an 18" thick, reinforced concrete, two-way structural slab, supported by reinforced concrete columns (with four (4) piles at each column) in the basement. The slab will be fully waterproofed and drained, designed for approximately 2.5 feet of soil and a 300 psf live load (fire trucks).

Estimated Weight of Reinforcing Steel: 9.0 psf

B1020 Roof Construction

Typical Roof Construction consists of a 3" deep, 18 gauge, Type WR, galvanized steel roof deck, supported by wide flange steel beams and girders. As noise and vibration will be a concern where roof top mechanical equipment is located, these sections of the roof will be framed with a 4" (minimum) deep, regular weight concrete topping slab on a 3" deep, 18 gauge, composite type galvanized steel floor deck (7" minimum total slab thickness), supported by composite, wide flange steel beams and girders. Composite action between the steel beams/girders and the concrete slab on steel deck will be achieved by field welding ¾" diameter, 5½" long headed shear connectors to the top flanges. Roof drainage will be achieved by the use of tapered insulation (steel will not be pitched). A concrete slab on composite steel floor deck (similar to typical floor construction) will be provided at all green roof areas (approximately 8,000 square feet) and at the outdoor classroom.

Gymnasium and Auditorium Roof Construction consists of a 3" deep, 18/20 gauge, galvanized, cellular acoustic deck, spanning to structural steel beams. Steel beams span to steel trusses. Trusses clear span the Large Gymnasium floor below and are supported by 14" deep wide flange steel columns. Note that the Large Gymnasium trusses will also support the Small Gymnasium floor above; accordingly, cellular acoustic composite floor deck will be required in that area. Steel framing for the Gymnasium roof will be Architecturally Exposed Structural Steel (A.E.S.S.). The Auditorium roof will be similarly structured (but not A.E.S.S.), with standard, 3" deep. non-acoustic roof deck (except over the Stage).

- Welded wire fabric for slabs on composite steel deck: *6x6-W2.9xW2.9.*

- The estimated total weight of structural steel for the various roof areas of the new building (including beams, columns, trusses, bracing, plates, angles, miscellaneous frames, connections, etc., but excluding equipment screens, loose lintels, entry canopies, PV frames, trellises, etc.) is as follows:

Estimated Weight of Structural Steel: 15.75 PSF

B20 Exterior Enclosure

B2010 Exterior Walls

Exterior walls will be a combination of architectural panels and masonry veneer, with a light gauge metal framed backup wall. In areas where a light gauge metal framed backup wall system is utilized behind a masonry veneer, framing should be 16 gauge minimum studs, designed for an H/600 deflection limitation (H/360 elsewhere). Vertical slip joints will be provided in the light gauge metal framed backup wall system at each level. Ties to the masonry veneer will be installed at 16" o.c. horizontally and vertically. The estimated structural steel weights noted previously include allowances for horizontal girts, relieving angles, hangers, bracing, etc., as may be required to support and brace the exterior wall system.

Alternate (Hybrid) Superstructure Scheme

An alternate structural system, consisting of structural steel and glued laminated timber (GLT) and cross laminated timber (CLT) members/elements (at the Second Floor and above) is also under consideration. The structural aspects of the hybrid alternate are summarized below.

1. Foundations would be similar to those in the Base Scheme (Structural Steel), except as noted below.

2. Basement floor construction would be similar to the Base Scheme.

3. First Floor construction in the building and at the plaza/playground area would be similar to the Base Scheme.

4. The Construction Type permitted by the Code and fire rating requirements would need to be further evaluated; fire walls (located at building expansion joints) would likely be necessary.

5. Structural Bays: Compared to the Base Scheme, structural bays should be reduced in area (to approximately 750 square feet), to allow for reasonable depth GLT members. Rectangular structural bays are recommended, with steel girders spanning in the long dimension, supporting shorter, GLT beams.

6. Story heights would remain the same as in the Base Scheme.

7. Steel columns (wide flange or HSS (tube) sections would support steel girders.

8. Lateral force resisting system: Lateral forces (wind and seismic loading) would be resisted by steel bracing in each direction or by cross laminated timber (CLT) shear wall panels.

9. Expansion/seismic joint locations would be similar to those required for the Base Scheme.

10. Floor construction: Typical upper floor construction (Second Floor and above) would consist of a 3" thick, normal weight concrete topping slab (reinforced with welded wire fabric) on a 3-ply (4⅛" thick) southern pine CLT deck, supported by southern pine GLT beams. Provide a ¾" plywood subfloor and a "RIM" roll-out isolation mat (by Kinetics or equal) where noise transmission is a critical issue for the spaces below. Typical GLT beams, spaced at 6+/- feet o.c. and spanning 25+/- feet, would be 8.5" x 24.75" deep. Typical supporting steel girders, spanning 30+/- feet would be W24x94 (interior) or W24x68 (perimeter).

11. Roof construction: Typical roof construction would consist of a 3-ply (4⅛" thick) southern pine CLT deck, supported by southern pine GLT beams. Typical GLT beams, spaced at 7.5+/- feet o.c. and spanning 25+/- feet, would be 6.75" x 19.25" deep. Typical supporting steel girders, spanning 30+/- feet would be W21x62 (interior) or W21x44 (perimeter). Roof/floor construction over the Gymnasiums would be similar, with GLT/CLT construction supported by hybrid trusses (wood top chords and verticals, with steel bottom chords and diagonals). Auditorium roof construction would be steel framed, similar to the Base Scheme (not fully exposed, hung catwalks, etc.). Roof construction at green roofs, below rooftop mechanical units, at the outdoor classroom, etc. would be similar to the typical floor construction described above. Roofs are typically flat; the pitch to drains would be achieved by the use of tapered insulation.

12. **Estimated Steel Weight:** The estimated weight of structural steel for the hybrid alternate (including girders, columns, bracing, plates,

angles, miscellaneous frames, connections, etc., but excluding equipment screens, loose lintels, entry canopies, PV frames, trellises, etc.) is as follows:

Floors (Second Floor and above):	**9.0 PSF**
Roofs:	**8.0 PSF**

13. Exterior walls would be similar to the Base Scheme.
14. The structural dead load of the alternate scheme is approximately 1/3 less than the steel framed structure of the Base Scheme; accordingly, foundation loads would decrease by approximately 7/5%; however, note there would be additional foundation points/pile caps required due to the smaller structural bay.

Outline Structural Specification

Concrete:

- All concrete shall be normal weight, 4,000 psi at 28 days, except exterior (exposed) concrete (paving) which shall be normal weight, 4,500 psi.
- Portland Cement: ASTM C150, Type I or II.
- Fly Ash: ASTM C618, Class F. Replacement of cement content with fly ash is limited to 20% (by weight). Fly ash is not permitted in exterior, exposed concrete, or in concrete for slabs on grade and slabs on composite steel deck.
- All concrete shall be proportioned with 3/4" maximum aggregate, ASTM C 33, except 3/8" maximum aggregate shall be used at toppings less than 2" thick (e.g. metal pan stairs).
- All reinforcing shall be ASTM A 615 deformed bars, Grade 60.
- All welded wire fabric shall conform to ASTM A 185.
- Reinforcing bars, steel wire, welded wire fabric, and miscellaneous steel accessories shall contain a minimum of 25% (combined) post-industrial/post-consumer recycled content (the percentage of recycled content is based on the weight of the component materials). Certification of recycled content shall be in accordance with Submittal Requirements.
- Concrete products manufactured within 500 miles (by air) of the project site shall be documented in accordance with Submittal Requirements.
- Cure all concrete by moisture retention methods, approved by Architect; curing compounds shall not be used.

Reinforced Concrete Masonry (Elevator Shaft):

- Masonry construction (elevator shaft) shall conform to ACI 530/ ASCE 5/TMS 402 "Building Code Requirements for Masonry Structures", latest edition.
- Masonry strength, f'm shall not be less than 1350 psi.
- Requirements for load bearing block strength shall be as required for specified masonry strength (f'm) but shall not be less than 2000 psi on the net area of the block.

- Grout shall conform to ASTM C476, Type Fine, and shall be of strength required for specified masonry strength (f'm) but not less than 3000 psi.
- Mortar for reinforced masonry shall conform to ASTM C 270 Type S and shall be of strength required for specified masonry strength (f'm) but not less than 1800 psi.
- Reinforcing bars shall conform to ASTM A 615 Grade 60 deformed bars. Lap all continuous bars 48 diameters.
- Joint reinforcing shall be 9 gauge ladder type conforming to ASTM A 82. Provide prefabricated corners and tees. Walls shall be reinforced horizontally with joint reinforcing at 16 inches on centers unless otherwise noted.
- Reinforcing bar, steel wire, welded wire fabric, and miscellaneous steel accessories shall contain a minimum of 25% (combined) post-industrial/post-consumer recycled content (the percentage of recycled content is based on the weight of the component materials). Certification of recycled content shall be in accordance with Submittal Requirements.
- Masonry products manufactured within 500 miles (by air) of the project site shall be documented in accordance with Submittal Requirements.
- Elevator shaft walls shall be 100% solid grouted (all cores).

Structural Steel:

- Structural steel shapes shall conform to ASTM A 992, Fy = 50 ksi.
- Steel tubes (HSS) shall conform to ASTM A 500, Grade B, Fy=46 ksi.
- Structural steel plates and bars shall conform to ASTM A 36, Fy = 36 ksi.
- Steel members shall contain a minimum of 25% (combined) post-industrial/post-consumer recycled content (the percentage of recycled content is based on the weight of the component materials). Certification of recycled content shall be in accordance with the Submittal Requirements.
- Steel manufactured within 500 miles (by air) of the project site shall be documented in accordance with the Submittal Requirements.
- Anchor Bolts: Anchor bolts at column base plates shall conform to ASTM F1554 – Grade 36 and shall be headed type. Provide a minimum of four (4), ¾" diameter anchor bolts at all columns; additional bolts and/or larger diameter/longer bolts will be required at bracing locations.
- Bolted connections shall be ASTM A 325, Type N (bearing) bolts, except slip-critical bolts shall be used at lateral brace beam connections.
- Shop and field welding shall be AWS D1.1 E70XX electrodes.
- Shear connectors shall be ¾" diameter, 5" or 5½" long, headed Nelson studs conforming to ASTM A 108.
- Surface treatment for typical structural steel: SSPC Surface Preparation No. 3 (Power Tool

Cleaning). Structural steel shall be left unpainted. .

- Structural steel for the Gymnasium roofs shall be Architecturally Exposed Structural Steel (A.E.S.S.) and shall meet the requirements of Section 10 of the AISC manual.
- Surface treatment for Architecturally Exposed Structural Steel: SSPC Surface Preparation No. 6 (Commercial Blast Cleaning). Exposed structural steel shall be primed with a premium architectural primer, compatible with the finish paint.
- All exterior, exposed structural steel shall be hot-dip galvanized (e.g. brick relieving angles (as applicable) and steel rooftop equipment supports).

Steel Deck:

- Typical steel roof deck shall be 3" deep, 18 gauge, Type DR, conforming to ASTM A 653, Grade 33 (minimum), galvanized in accordance with ASTM A 653, coating class G-60. Exposed steel roof deck in the Large and Small Gymnasiums shall be 3" deep (18/20 gauge) cellular acoustic deck (cellular acoustic composite steel floor deck at the Small Gymnasium floor area), and shall have a factory applied primer on the exposed bottom surface.
- Steel floor deck shall be 2" deep, 18 gauge, composite type, conforming to ASTM A 653, Grade 33, galvanized in accordance with ASTM A 653, coating class G-60.
- All steel floor deck and roof deck accessories (pour stops, finish strips, closures, etc.) shall be the same finish as the deck; 18 gauge minimum.
- Steel deck shall contain a minimum of 25% (combined) post-industrial/ post-consumer recycled content (the percentage of recycled content is based on the weight of the component materials). Certification of recycled content shall be in accordance with the Submittal Requirements.
- Steel deck manufactured within 500 miles (by air) of the project site shall be documented in accordance with the Submittal Requirements.
- Provide 14 gauge sump pans at all roof drains.

Glued Laminated Wood Construction (Alternate Superstructure):

- Glued laminated timber (GLT) and cross laminated timber (CLT) decking shall conform to the latest edition of the American Institute of Timber Construction (AITC) Manual. Materials, manufacture and quality control shall be in conformance with the latest AITC standards.

4.5 Mechanical, Electrical, Plumbing and Fire Protection

SITE UTILITIES

Electric Power:

The primary electrical power for the new electrical service will be from an overhead high voltage pole line provided by Eversource on Vassal Lane. At the utility pole, the high voltage supply will be routed underground to an Eversource transformer vault located near the kitchen area inside the new building. The new building will be served by two (2) 2000 kVA, 6000A, 480/277V, 3Ø, 4 Wire electrical service. From the transformers a 6000A, 3Ø, 4 Wire bus duct will provide power to a 6000A, 480/277V, 3Ø, 4 Wire Main Switchboard.

Telecommunications:

The telecommunications service entrance (a.k.a. "demarc") will be located on the ground floor level, central to the overall building architectural footprint. The service entrance room will be outfitted with grounding and plywood backboards for mounting of entrance cable protection, cabinets, etc. Four (4) 4-inch conduits will be provided from the pole line on Vassal Lane to the building demarc for telecommunications site utility services inclusive of internet and phone service providers (i.e. Verizon, Comcast, etc.), City of Cambridge network, and any interbuilding cables. It is anticipated this will be a mix of copper and fiber optic cables, each suitably sized to support the respective services for the building's user community with spare capacity for future growth. From the building demarc, the site telecommunications services will be extended to the Main Distribution Frame (MDF) for connection to the building telecommunications equipment and network.

MECHANICAL, ELECTRICAL, PLUMBING AND FIRE PROTECTION

The following sections identify the mechanical, electrical, plumbing and fire protection systems proposed for installation in the Tobin Montessori Vassal Lane School. The proposed systems will meet the requirements of all applicable codes along with the City of Cambridge's desire to minimize energy consumption to reach a goal of creating a net positive energy building. Proposed systems will prioritize the use of energy efficient features to achieve ultra-low energy performance.

MECHANICAL SYSTEMS

Codes and Standards:

Heating, ventilating, and air conditioning (HVAC) systems design for the building will be in accordance with the Massachusetts State Building Code (780 CMR), referenced International Mechanical Code, 2018 International Energy Conservation Code, and other applicable Codes as adopted and amended by the Commonwealth of Massachusetts.

As appropriate, standards, guidelines, and recommendations pertaining to energy efficiency, environmental quality, and building performance, such as those developed by ASHRAE, USGBC, and the USDOE, will be applied to the selection and design of the HVAC systems for the building.

Outdoor Design Conditions:

Summer: 91°F DB/73°F WB

Winter: 0°F DB

Indoor Design Conditions:

Cooling: 75°F DB/50% RH

Heating: 70°F DB

HVAC System Options:

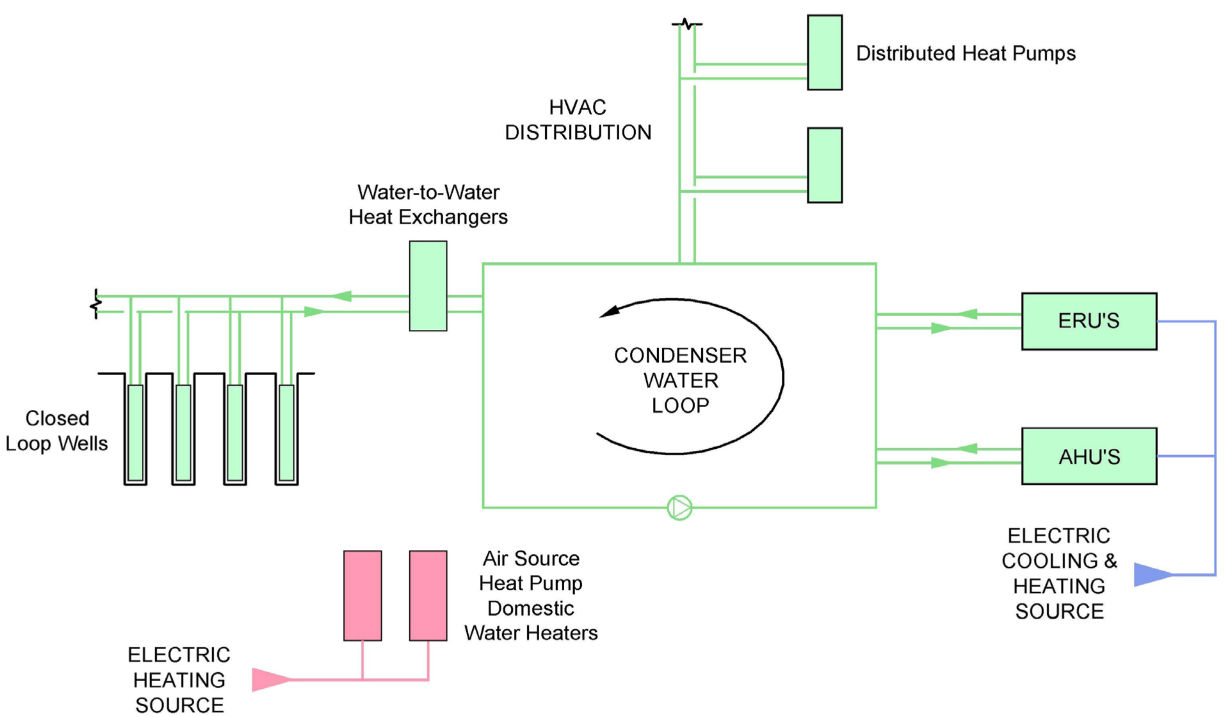
Three (3) options have been analyzed for consideration for the heating and cooling system for the building.

Option #1: Ground-Source Geothermal Heat Pumps

A ground-source geothermal heat pump system will provide primary heating and cooling capacity for the building. It is currently estimated that two hundred (200) wells will be required to meet the heating and cooling load requirements. The estimated well field size is based on an anticipated capacity of 2.5 tons per well.

The geothermal well field system will be closed loop type, circulating a 20% propylene glycol/ water antifreeze solution from the heat pumps through a network of pipes buried below grade. The wells shall be spaced approximately 20 feet on-center. The installation of a test well and live thermal testing will determine actual site characteristics such that the quantity of wells can be confirmed or adjusted.

The geothermal well field system pumps will distribute source water from the well field to plate and frame heat exchangers located in a first floor mechanical room. Two (2) main load side system pumps will be provided to distribute condenser water throughout the building from the mechanical room to distributed water to air heat pumps throughout the building. The pumps will operate in lead/standby, each with a flow capacity of 100% of the peak flow requirement. The estimated size of each pump is 400 GPM. Variable frequency drives will be provided for condenser water flow modulation. Other condenser water system components will include a tangential air separator, expansion tank, chemical pot feeder, and ancillary components.



Option #1

Option #2: Variable Refrigerant Flow (VRF) Air Source Heat Pumps

Primary heating and cooling will be provided by variable refrigerant flow (VRF) systems which will use air source heat pumps with variable speed compressors to deliver precise refrigerant flow to meet individual space heating and cooling loads. The systems will consist of distributed indoor terminal fan coil units connected via refrigerant piping to roof mounted heat pump units. The systems will have the ability to simultaneously heat/cool and transfer energy via the refrigerant system to/from different spaces with the balance of energy rejected/absorbed at the heat pumps via the ambient air.

Ceiling cassette type VRF fan coil units will be provided for the classrooms. Ducted concealed type VRF fan coil units will be provided for corridors and other learning spaces.

Total VRF system capacity is estimated to be 450-480 Tons.

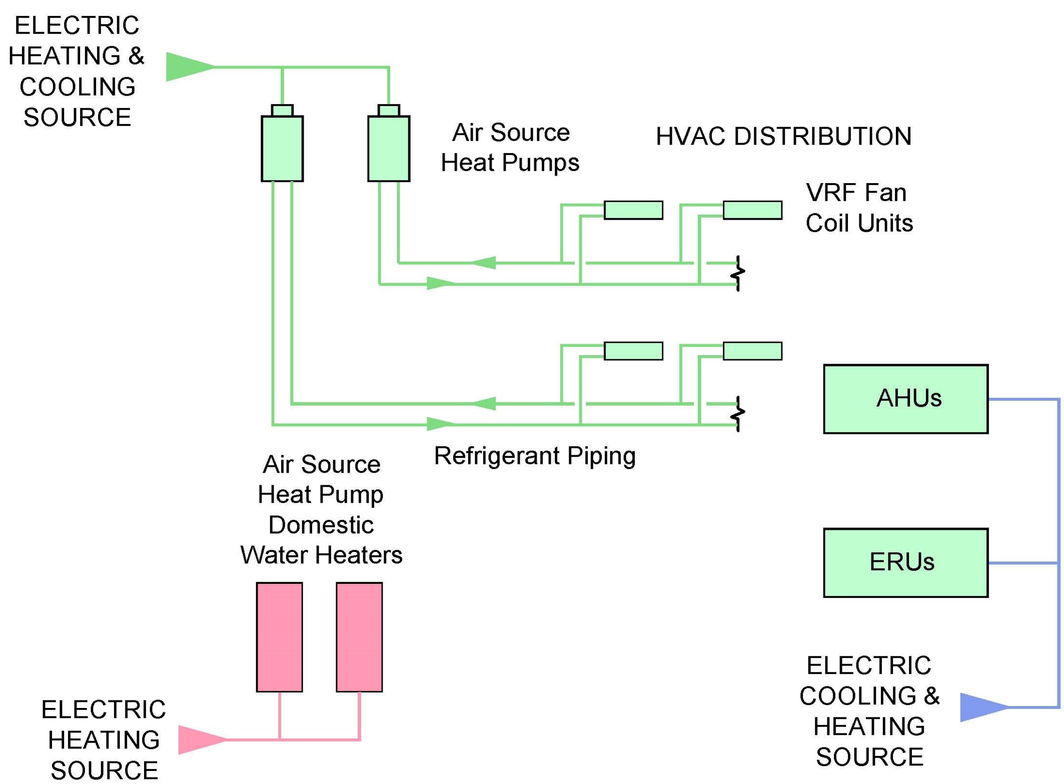
Refrigerant tubing will be distributed throughout the building from outdoor condensing units to VRF fan coil units.

Supplemental electric heating will be provided for heating only areas (storage rooms, mechanical rooms, etc.) and at building entries.

Option #3: Ground-Source Geothermal Heat Pump and Variable Refrigerant Flow (VRF) Air Source Heat Pump Hybrid

A ground-source geothermal heat pump system will provide primary heating and cooling capacity for the gymnasium, auditorium, cafeteria and general circulation spaces. It is currently estimated that fifty to sixty (50-60) wells will be required to meet the heating and cooling load requirements. The estimated well field size is based on an anticipated capacity of 2.5 tons per well.

The geothermal well field system will be closed loop type, circulating a 20% propylene glycol/ water antifreeze solution from the heat pumps



Option #2

through a network of pipes buried below grade. The wells shall be spaced approximately 20 feet on-center. The installation of a test well and live thermal testing will determine actual site characteristics such that the quantity of wells can be confirmed or adjusted.

The geothermal well field system pumps will distribute source water from the well field to plate and frame heat exchangers located in a first floor mechanical room. Two (2) main load side system pumps will be provided to distribute condenser water throughout the building from the mechanical room to distributed water to air heat pumps throughout the building. The pumps will operate in lead/standby, each with a flow capacity of 100% of the peak flow requirement. The estimated size of each pump is 150 GPM. Variable frequency drives will be provided for condenser water flow modulation. Other condenser water system components will include a tangential air separator, expansion tank, chemical pot feeder, and ancillary components.

A variable refrigerant flow (VRF) system will provide primary heating and cooling capacity for the academic and office spaces. The VRF system will use air source heat pumps with variable speed compressors to deliver precise refrigerant flow to meet individual space heating and cooling loads. The systems will consist of distributed indoor terminal fan coil units connected via refrigerant piping to roof mounted heat pump units. The systems will have the ability to simultaneously heat/cool and transfer energy via the refrigerant system to/from different spaces with the balance of energy rejected/absorbed at the heat pumps via the ambient air.

Ceiling cassette type VRF fan coil units will be provided for the classrooms. Ducted concealed type VRF fan coil units will be provided for corridors and other learning spaces.

Total VRF system capacity is estimated to be 300–330 Tons.

Refrigerant tubing will be distributed throughout the building from outdoor condensing units to VRF fan coil units.

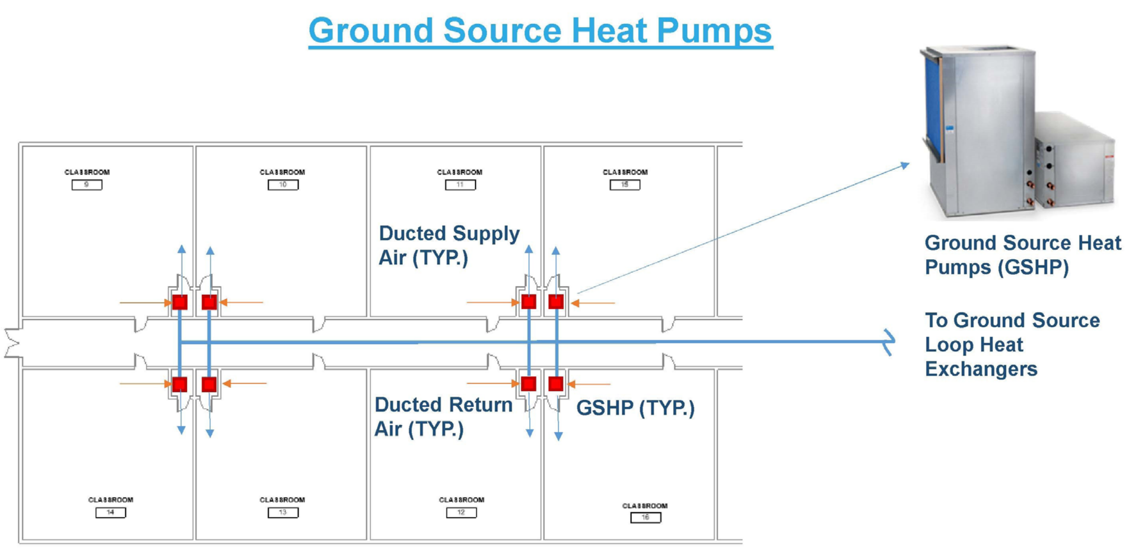
Supplemental electric heating will be provided for heating only areas (storage rooms, mechanical rooms, etc.) and at building entries.

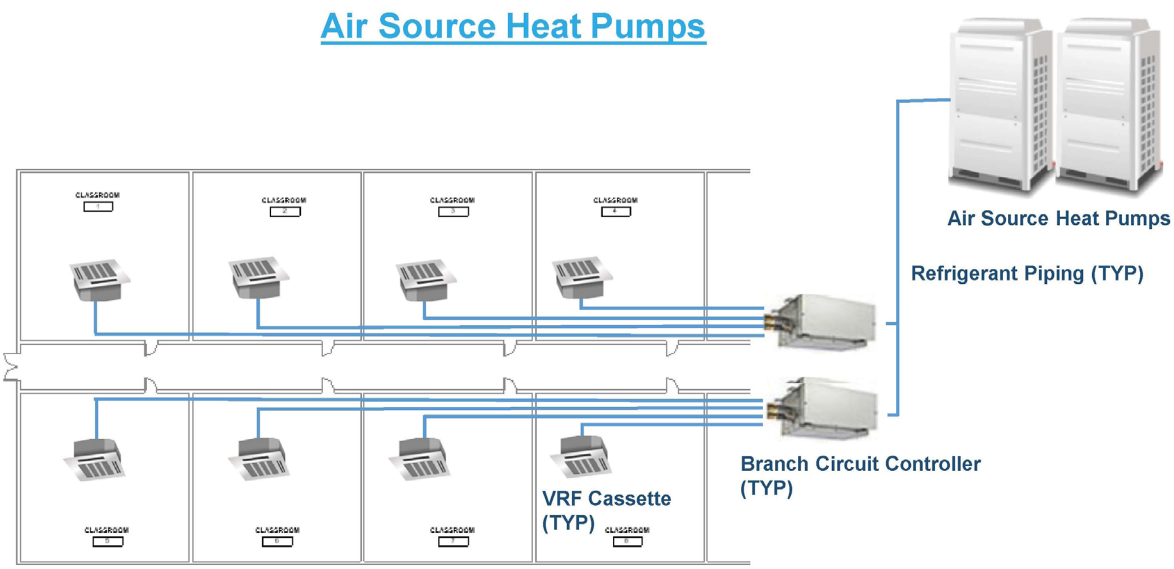
Refer to Option #1 and Option #2 above for system diagrams.

Typical classroom system diagrams:

Proposed HVAC System

HVAC system option #3 - Ground-Source Geothermal Heat Pump and Variable Refrigerant Flow (VRF) Air Source Heat Pump Hybrid is currently being proposed for the building. This





option provides high efficiency HVAC equipment and provides a significant reduction to the amount of area on the building site required for the geothermal well field.

Piping Systems:

Condenser water will be distributed throughout the building from the mechanical room to distributed water to air heat pumps throughout the building. Piping 2 inches and smaller will be Type L copper with cast brass or wrought copper solder joint fittings. Piping 2½ inch and larger shall be schedule 40 steel with butt-welded fittings. All piping will be insulated with fiberglass pipe insulation with vapor barrier jacket.

Piping distribution systems will be designed to minimize the required pump energy.

Refrigerant tubing will be distributed throughout the building from outdoor condensing units to VRF fan coil units. Refrigerant piping shall be Type L ACR refrigerant grade copper tubing with insulation with vapor barrier jacket.

Air Handling Systems:

General:

Minimum outside air ventilation rates for all air handling units will be determined in accordance with the above-referenced International Mechanical Code and ASHRAE Standard.

In accordance with the International Energy Conservation Code, the air handling unit equipment described will be designed with air-side economizer capabilities to automatically increase quantities of outside air supplied to the building when outdoor temperature and humidity conditions are favorable in order to reduce or eliminate mechanical cooling requirements.

Primary acoustic treatment for air handling unit noise control will be provided by a combination of sound attenuators and double-wall ductwork.

100% outside air (DOAS) energy recovery units will provide mechanical ventilation for the academic areas, office areas, and general circulation areas.

Independent air handling units will provide heating, ventilation, and air conditioning for the gymnasium, auditorium and cafeteria.

Preliminary air handling unit information is as follows.

AIR HANDLING UNIT	AREA SERVED		REMARKS
AHU-1	Dining and Kitchen Areas	12,000	Variable air volume, mixed air, heat pump, airside economizer, interlock with kitchen hoods, 40 tons
AHU-2	Auditorium	14,000	Single zone variable air volume, heat pump, airside economizer, carbon dioxide demand control ventilation, 40 tons
AHU-3	Large & Small Gymnasium	10,000	Single zone variable air volume, heat pump, airside economizer, carbon dioxide demand control ventilation, 25 tons
AHU-4	Learning Commons	12,000	Variable air volume, heat pump, airside economizer, 40 tons
ERU-1	Auditorium Support Areas	2,000	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 5 tons
ERU-2	Visual Arts/Performing Arts	8,000	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-3	Vassal School Ventilation	9,000	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-4	Vassal School Ventilation	9,000	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-5	Vassal School Ventilation	9,000	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-6	Vassal School Ventilation	9,000	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-7	Tobin School Ventilation	9,000	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-8	Tobin School Ventilation	9,000	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-9	Tobin School Ventilation	9,000	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-10	Tobin School Ventilation	9,000	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons

Kitchen exhaust hoods and exhaust hood fans will employ controls that vary the fan speed in response to heat and smoke production under the hoods.

The kitchen system will include variable air volume exhaust and make-up air strategies that respond to actual kitchen and food preparation activities.

Ductwork:

All ductwork shall be fabricated, sealed, installed, and supported in accordance with SMACNA HVAC Duct Construction Standards. Ductwork shall have a 2-inch (minimum) pressure class rating and sealed in accordance with seal Class A. Ductwork shall be galvanized steel.

Kitchen hood exhaust ductwork will be welded 18-gauge stainless steel or 16-gauge steel; dishwashing exhaust ductwork will be aluminum. Grease hood exhaust ductwork will be fire-rated as required by Code.

Ductwork will be designed to minimize the required fan energy.

Duct Insulation:

Ductwork insulation for ducts that are concealed above ceilings or in duct chases shall be 1½ inch thick, ¾-pound density, fiberglass all-service duct wrap with factory laminated reinforced foil/craft (FSK) vapor retarder facing.

The following ductwork shall be covered:

- All supply air ductwork.
- All outside air ductwork.
- All ductwork located within ten (10) feet of a connection to the building exterior.

Miscellaneous Systems and Equipment:

Miscellaneous Cooling Systems:

Dedicated cooling systems will be provided at the main tel/data room, tel/data closets, and elevator machine rooms. These will consist of packaged high-efficiency “mini-split” type air conditioning systems.

Parking Garage Ventilation System:

Exhaust fans will provide ventilation for the parking garage. The fans will be equipped with variable frequency drive to allow the system to modulate from minimum airflow to maximum airflow. A carbon dioxide and nitrogen dioxide gas detection system will be interlocked with the garage exhaust fans to increase/decrease fan speed as required to maintain the proper air quality within the parking garage.

Kitchen Equipment Heat Recovery System:

The main kitchen refrigeration equipment will be provided with heat recovery capability. The recovered heat will be utilized to preheat domestic hot water.

Building Automation System:

The HVAC automatic temperature control and energy management system will be direct digital control (DDC) type with electric actuation. The system will be designed to allow for flexibility in scheduling of building occupancies. The system will be designed to be integrated into the existing district-wide energy management system. Specific control and energy management approaches will be coordinated with the owner as the design progresses.

A building dashboard with public display flat screen monitor will be provided. Dashboard graphics to display sustainable building features, building energy systems, metering data, etc.

An IAQ sampling system shall monitor the air quality within each normally occupied space of the building.

PLUMBING SYSTEMS

Codes and Standards:

The plumbing system will be designed in accordance with the Massachusetts Fuel Gas and Plumbing, 248 CMR, as adopted by the Massachusetts Plumbing Board.

As appropriate, standards, guidelines, and recommendations pertaining to energy efficiency, environmental quality, and building performance, such as those developed by ASHRAE, USGBC, CHPS, and the USDOE, will be applied to the selection and design of the Plumbing systems for the building.

Domestic Water:

A new municipal water service will be provided to serve the building. A dedicated 6-inch domestic water service will enter the new water service room. The domestic water system will connect to the water service ten (10) feet beyond the building exterior wall. An approved water meter and a duplex backflow preventer will be provided on the domestic water service.

Domestic cold water will be provided to all domestic plumbing fixtures including lavatories, janitors' closets, drinking fountains, HVAC equipment, and exterior hose bibs. All domestic water piped to HVAC equipment will be provided with a reduced pressure backflow prevention device. Backflow preventers will be provided on the cold water and hot water supplies to the lab classroom sinks.

Domestic hot water will be generated by air source heat pump water heaters provided with auxiliary storage. Preliminary water heater sizing results in an air source water heater Model CXA-25 with 2,500 gallons of water storage as manufactured by Colmac. Hot water will be generated to 140° F and piped through a master thermostatic mixing valve to temper the hot water to 120° F for distribution to the domestic plumbing fixtures. 140° F water will be directly piped to the kitchen to supply the pot sinks, pre-rinse sinks and dishwashers. Hot water to the lab classrooms will be maintained after the dedicated hot water backflow preventer with the use of temperature

CxA Modular Series

Air Source Heat Pumps

COLMAC WATERHEAT

Standard Features

- ECM axial fan (plenum fan optional)
- 10 and 15 hp models fit through standard 36" door
- Slide-out tray for servicing refrigeration components
- Industrial PLC controls with touchscreen
- Electronic expansion valve
- 304L stainless steel frame and enclosure
- Double wall 316L stainless steel condenser for potable water heating
- Integrated stainless steel circulator pump
- 140°F - 160°F output temperatures

maintenance tape. Waste heat from the kitchen refrigeration equipment will be used to pre-heat the domestic cold water supply to the domestic water heater.

Domestic hot water recirculation and 140° F hot water circulation will be piped back to the water heaters and will be used to maintain domestic hot water temperatures close to points of use in the domestic system.

<u>Plumbing Fixtures:</u>

Plumbing fixtures in public toilet rooms will consist of high-efficiency wall-mounted water closets with dual-flush manual flush valves, low consumption washout urinals, vitreous china wall-hung lavatories with manual metering faucets. Showers will be molded acrylic with pressure balancing mixing valves. Janitors closets will be provided with floor mounted terrazzo mop basins. Dual height stainless steel drinking fountains with integral bottle fillers and chillers will be provided. Floor drains and hose bibs will be included at all public and student toilet rooms. Exterior hose bibs with integral vacuum breakers will be provided along the exterior of the building. Emergency shower and eyewash fixtures will be provided with point-of-use thermostatic mixing valves. Emergency fixtures will be located in all lab classrooms, the Nurses room and the lower level mechanical room.

Plumbing fixtures shall be ADA compliant in all areas requiring barrier free access. Child height fixtures will be provided to serve the preschool.

<u>Sanitary System</u>

The sanitary waste stacks within the building will collect waste from the domestic plumbing fixtures. Waste collected from the domestic plumbing fixtures located in the first floor and above will exit the building by gravity. A duplex sewage ejector will be provided to serve the lower level plumbing fixtures and will discharge to the municipal sanitary sewer outside the foundation wall. The lab classroom sinks will be provided with point-of-use pH neutralization chip tanks.

Solids interceptors will be provided at the art room and pottery sinks. A sand and oil interceptor will be provided to serve the drains in the lower level parking.

Interior grease interceptors will be provided to collect grease laden waste generated from the kitchen. The waste stream from the outlet of the interior interceptors will be piped independently to an exterior grease interceptor located below grade on the site. The outlet of the exterior interceptor will be piped to the municipal sanitary sewer.

Heat-trace and insulation will be provided on all sanitary waste and vent piping subject to freezing conditions located at the below-grade parking level.

The sanitary drain system will connect to the municipal sanitary sewer and will extend ten (10) feet beyond the building exterior wall. Multiple sanitary sewers exiting the building will be provided.

<u>Storm Drainage</u>

Conventional roof drains will be provided for all flat roof sections. The roof storm drainage will be routed internally through the building and exit the building by gravity. The storm drain will connect to the on-site municipal storm sewer and will extend ten (10) feet beyond the building exterior wall. The secondary overflow roof drain system will consist of scuppers and will discharge directly from the roof level to grade.

Heat-trace and insulation will be provided on all storm piping subject to freezing conditions located at the below-grade parking level.

A blue-roof is proposed for installation which will include the use of control-flow roof drains to restrict the flow of rain water into the municipal storm sewer. The roof assembly will be coordinated with the structural engineer, architect and shall meet the requirements of the Massachusetts Plumbing Board.

A storm water re-use system is proposed for installation. Storm water collected from the building roof will be piped to a 20,000-gallon exterior storage tank. Duplex pumps will be placed in the exterior tank which will pump storm water into the building. A dedicated storm water piping system will be installed to provide water to all water closets and urinals located in the building along with a feed for site irrigation. Filters and UV sterilizers will be provided in the building mechanical room to treat the water prior to use. The re-use water will be continuously run through a separate 1,000-gallon interior storage tank to prevent stagnation of the treated water. Water distributed through the building will be provided with a dye-injection to alert the user the water is not potable. An expansion tank and 3-way valve will be provided which will allow the system to be back-fed with municipal water in the event the storm water storage tank runs low. A booster pump system will be provided to pressurize the reuse system.

FIRE PROTECTION SYSTEMS

Codes and Standards:

The fire protection systems will be designed and installed as required by the Massachusetts State Building Code, 780 CMR (9th Edition).

Sprinkler/Standpipe Systems

A new 8-inch fire protection main will be connected to the municipal water service. The fire service will connect to the water service ten (10) feet beyond the building exterior wall. A new dedicated double check valve assembly will be provided. The new fire protection main will be installed below grade and will enter the building in the fire service room.

The wet pipe fire protection systems will be classified as Light Hazard in all toilet rooms, administration areas, classrooms and other areas of similar occupancy and will be provided with a density of 0.10 gpm per square foot over 1,500 square feet of design area. The sprinkler system will be classified Ordinary Hazard Group I coverage in mechanical rooms, storage rooms, library stack areas and kitchen service areas and will be provided with a density of 0.15 gpm per square foot over 1,500 square feet of design area. The sprinkler system will have multiple zones on each floor of the school. A dry sprinkler system will be provided to serve the unheated below-grade parking area and will be provided with a density of 0.15 gpm per square foot over 1,950 square feet of design area. The dry-pipe valve will be provided with a nitrogen generator. The new sprinkler system will be installed in conformance with NFPA 13, Installation of Sprinkler Systems.

An Inergen clean-agent suppression system will be provided to serve the main telecommunications (MDF) room. The system will include the inergen cylinders, gas discharge manifold, control panel, manual release station, heat and smoke detectors and all associated alarms and wiring. A pre-action sprinkler system shall also be included to protect the MDF room.

A manual-wet standpipe system will be provided with 2 ½” hose valves in each of the required egress stairwells at the primary landing. The standpipe system will also be located at the auditorium stage as required by the Massachusetts State Building Code. The 1 ½” fire hose valves will be located at each side of the stage and will be provided with enough hose to provide fire protection coverage of the stage area. Standpipes will be designed in conformance with NFPA 14, Installation of Standpipes and Hose Systems.

Two hydrant flow tests we performed on July 22, 2019 by the City of Cambridge Water Department. The test performed on Concord Ave and Corporal Burns Road resulted in a static pressure of 64 psi and a residual pressure of 62 psi while flowing 1,250 gpm. The test performed on Lakeview Ave and Standish Street resulted in a static pressure of 64 psi and a residual pressure of 61 psi while flowing 1,275 gpm. The results of these tests will be used for the hydraulic analysis of the proposed fire protection system.

If it is determined a fire pump is required to serve the automatic sprinkler system, a motor-driven fire pump complying with NFPA 20 - Standard for the Installation of Stationary Pumps for Fire Protection will be provided. The system will consist of a fire pump, jockey pump, controllers, automatic transfer switch and all associated piping and alarms.

ELECTRICAL SYSTEMS

Codes and Standards:

Electrical and Telecommunications systems design for the building will be in accordance with the Massachusetts State Building Code, 780 CMR (9th Edition), Massachusetts Electrical Code (527 CMR), Massachusetts Stretch Energy Code, and other applicable Codes as adopted and amended by the Commonwealth of Massachusetts.

As appropriate, standards, guidelines, and recommendations pertaining to energy efficiency, environmental quality, and building performance, such as those developed by ASHRAE, USGBC, and the USDOE, will be applied to the selection and design of the electrical systems for the building.

Power Distribution:

The estimated electrical service size for the new building is 6000A, 480Y/277V, 3Ø, 4 Wire. The main service will configured as twin 3000 ampere services, fed from two (2) utility-owned transformers. The transformers will be located in a 3-hour rated utility transformer vault construction to Eversource standards. From the transformers a 6000A, 3Ø, 4 Wire bus duct will provide power to a 6000A, 480/277V, 3Ø, 4 Wire Main Switchboard located in the new main electrical room. The new main electrical room will be located adjacent to the transformer vault near the kitchen area and will be sized to accommodate electrical distribution equipment including two (2) 3000 ampere, 480/277 volt switchboards. The room will also contain the main solar AC switchboard and 480/277-volt distribution panelboards and three-phase dry-type transformers, which will provide 120/208-volt distribution for the local area and various associated spaces. Refer to SKE1 for a proposed layout of the transformer vault and main electric room.

Satellite electrical rooms will be located in the auditorium wing, gym wing, Tobin Montessori School wing and Vassal Lane School wing. Each satellite electrical room will accommodate 480/277 volt panelboards, and three-phase dry-type transformers to provide 120/208-volt power to local electrical consuming loads. The rooms will also contain equipment part of the electrical infrastructure supporting the roof solar system. Refer to SKE2 for proposed layout of typical satellite electrical room. Control panels and motor starters for HVAC equipment will be wall mounted in various mechanical spaces, or will be unit-mounted for rooftop equipment.

Dedicated power distribution systems will be provided for specific high density programs, including auditorium, gym, kitchen and similar program spaces. Dedicated panelboards serving science classrooms will be provided and will be located in protected areas adjacent to the spaces and will contain shunt trip main breakers and the science classroom will have multiple emergency push buttons that can be shut off power in case of an emergency situation.

All lighting distribution in the building will be 277-volt, and will be powered from panelboards in the electrical rooms in their respective areas.

The 120/208-volt power will be distributed for receptacle power from the transformers located in the electrical rooms in their respective areas.

The distribution of power in the building will be concealed. All cabling will be copper. For each branch circuit, type EMT conduit will be utilized from the panelboard to an area junction box and Type MC Cable will be used from the last junction box to electrical devices or lighting fixtures. Larger feeders to mechanical equipment will be EMT conduit and copper conductors. No conduits or cable will be exposed in finished areas. Columns, walls, and ceiling plenums will be used for power distribution, where possible.

At least 50% of all 125-volt 20-amp receptacles in all classrooms, offices, conference rooms, printing/copying rooms, break rooms and individual workstations will be automatically controlled per ANSI/ASHRAE/IES standards.

	Proposed Emergency Generator Loads - 1,000kW	
	Life Safety, Security, Building Preservation Heat and Student Pickup Shelter	
Item No.	Description	kW Load
	LIFE SAFETY LOADS	
1	Fire Alarm System	15.0
2	Emergency and Egress Lighting	42.0
3	Generator Support Equipment (Battery Charger, Block Heater, etc.)	8.0
4	Telecommunications Rooms (Telephone/PA systems)	20.0
	Subtotal	85.0
	LEGALLY REQUIRED LOADS	
1	ADA Door Operators	10.0
2	Elevators (40HP)	45.0
3	Smoke Dampers	1.5
4	Preaction System (Main Telecom Room)	2.0
	Subtotal	58.5
	OPTIONAL STANDBY SYSTEM LOADS	
1	Security Systems Equipment	6.0
2	Telecommunications Rooms Air Conditioning	20.0
3	Select Power and Lighting (Main Elect Room, Main Office, etc.)	30.0
4	Cafeteria (Lighting and Power)	10.0
5	Gymnasium/Locker Rooms (Lighting and Power)	30.0
6	Kitchen (Lighting, Power, Equipment)	150.0
7	Domestic Hot Water (GSHPs)	80.0
8	Building Preservation Heat: GSHPs, ASHPs, Building Controls, Cabinet Unit Heaters, Prop Unit Heaters (Common areas, Cafeteria, Gymnasium, Locker Rooms	250.0
9	AHU's (Kitchen, Cafeteria, Gym, Locker Rooms & Main Office)	200.0
10	Garage and Exterior Lighting	5.0
	Subtotal	781.0
	Total without Storm Water Tank Pump Station	924.5
	ALTERNATE - OPTIONAL STANDBY SYSTEM LOADS	
1	Storm Water Tank Pump Station (2-20HP Pumps)	50.0
	Total with Storm Water Tank Pump Station	974.5

Electrical Energy Monitoring:

Measurement devices will be installed to monitor the electrical energy use for each of the following separately:

a) Total electrical energy

b) HVAC systems

c) Interior Lighting

d) Exterior Lighting

e) General Power and Receptacle circuits.

Emergency Power:

An emergency generator sized at approximately 1,000 KW, 480Y/277volt, three-phase, four-wire will be provided. The generator will be located outside of the building. The generator will provide emergency power for code required emergency lighting and fire alarm systems. The generator will also provide standby power for building preservation heat which includes boiler(s), hot water distribution pump(s), air handling equipment and the energy management system, select kitchen equipment including the coolers and freezers and other selected electrical loads. See the Proposed Generator Loads table below. The Storm Water Tank Pump Station will be provided with a separate stand-alone natural gas generator, see the "Tobin Stormwater Tank Conceptual Design Parameters and Location Analysis" from Stantec in the Appendix.

The fuel source for the generator will be #2 biodiesel fuel, which will be stored in a skid-mounted fuel tank with a capacity large enough to provide 96 hours of generator operation. A sound attenuated weatherproof enclosure will be provided. Associated emergency power transfer switches and main emergency electrical distribution systems shall be located in a separate main emergency electrical room in accordance with 2010 NFPA 110. Refer to SKE2 for proposed layout of the main emergency electrical room. Emergency branch circuit panelboards will be located in normal power electrical closets, and distributed throughout the building as required.

Generator Alternate: Standby Power to the Storm Water Tank Pump Station

Under this alternate, in lieu of a separate natural gas generator at the storm water tank pump station, a 100amp, 480volt, three-phase feeder will be provided from the building generator to the storm water tank pump station.

Lighting

In general, the lighting design will be based on the guidelines of the Illumination Engineers Society of North America (IESNA) lighting handbook (latest version). The lighting design will use the recommendations given in this handbook and Energy Star for vertical and horizontal illuminance levels required in a given space. LPD (lighting power density) will be compliant with the Massachusetts Stretch Energy Code and IECC/ASHRAE 90.1-2013 guidelines.

Energy efficient lighting LED fixtures shall be provided throughout the building. LED lighting provides energy savings and long life with minimal maintenance. LED type lighting fixtures provide dimming capabilities.

Exit lights will be LED edge-lit exit signs in the lobby, common and corridor areas, cast aluminum in back of house areas and vandal resistant high-impact in the gymnasium, locker rooms and parking garage areas.

Lighting Control Systems

Automatic lighting control will be provided in spaces required to conform to the Energy Code adopted by the State of Massachusetts. The lighting controls will be occupancy sensors for most applications and timers in specific applications where occupancy sensors are not suitable.

Occupancy sensors will be provided to comply with current energy conservation code requirements. Vacancy sensing will be utilized in classrooms, offices, and conference spaces. Vacancy sensors require on occupant to manually turn ON the lights when light is needed. The sensor will then automatically turn lights OFF. Vacancy sensors ensure the highest level of energy savings since the lights will never automatically turn ON.

Day-lighting controls will be provided for classrooms and common spaces with natural daylight. In these spaces, lighting will be regulated so that illumination in an area will maintain a constant light level. Where there is sufficient natural light in a space, the light fixtures will remain OFF.

The lighting control system will also operate corridors and common areas using astronomical time of day programming. Lights will be switched ON and OFF based upon preset time schedules or astronomical clocks. Occupancy sensors will also be integrated into the design. After hours, the occupancy sensor will turn lights ON and OFF based on occupancy. During occupied hours, lighting levels in the corridors and common areas can be decreased when unoccupied and increased when occupied.

Exterior lighting will be designed using pole and building mounted LED fixtures, providing instant-on, low maintenance and extended life characteristics. Consideration will be given to providing fixtures with integral sensors to allow for automatic reduction of the illumination levels when parking lots and walkways are void of moving vehicles or pedestrians. Astronomical time of day programming will also be used to schedule ON/OFF of exterior fixtures.

The emergency lighting system will be incorporated as part of the normal lighting system and provided with code compliant emergency power from an emergency generator. UL listed 924 transfer devices will be included in the design to allow portions of the normal lighting systems to be powered from the generator upon the loss of utility power.

Fire Alarm:

An addressable-type fire alarm system with liquid crystal display and voice activation system will be provided. The fire alarm system will include duct-mounted smoke detectors, heat and smoke detectors, manual pull-stations and alarm speaker/strobe units. Locations for devices will be in accordance with NFPA and ADA requirements. A connection to the local authority and a central monitoring company will be provided based on the city and school district standards.

Security Systems:

A new integrated access control/intrusion detection system will be provided. The master panel shall be located either in the main distribution frame (MDF) room or an appropriate electrical room with additional subpanels strategically placed throughout the facility as required to meet manufacturer panel-to-station equipment cable distance limitations. For the purpose of operational control, alarm notification, and monitoring overall system status, the systems will connect to primary and secondary external personnel and emergency services as determined and desired by school and city stakeholders.

<u>Access Control System</u>

Main entries and other exterior portals that will be used for access to the building will be outfitted with proximity card readers and door status monitoring contacts. For exterior doors that are egress only or secured with lock-and-key, door status monitors will be provided. In addition, select interior doors will have card reader access control (e.g. IT/telecom rooms, staff-only areas, high-value equipment use and storage areas, etc.). The determination of portals managed and monitored by the access control system will be determined in consultation with school and city stakeholders during the design phase of the project.

<u>Intrusion Detection System</u>

The door monitoring contacts used by the access control system to determine door status at access controlled portals will feature a second set of connection points for use by the intrusion detection system. If there are additional portals that require monitoring that are not also connected to the access control system, those doors will have contacts provided for connection to the intrusion detection. In addition to door status monitoring, glass break and motion detection devices will be provided throughout the building to monitor areas as determined during the design phase.

Closed Circuit TV System (Surveillance)

A closed circuit television system (CCTV) will be provided for video surveillance. The existing Genetec Omnicast software platform from the existing building may be reused inclusive of necessary licenses upgrades needed to support the new cameras. New color IP based fixed field-of-view and as appropriate, pan-tilt-zoom (PTZ) cameras will be provided at building entrances, corridors, large group spaces, parking garage, parking lots and select exterior locations as determined in the design development phase of the project. Operating based on a defined coverage schedule and motion detection triggers, cameras will record and store images on a network video recorder (NVR) located in the data center (sized for minimum 30 days of storage). As required or desired, the system will have connection to police to enable remote access and monitoring.

Telecommunications System:

The telecommunications system will consist of Owner provided network equipment operating on a structured cabling information transport system (ITS), that will support the connection and operation of this Owner equipment for voice, data, multimedia, and other systems as required. Creating a complete standards compliant technology infrastructure, the ITS will consist of:

- At the logistical center of the ITS, one (1) building Main Distribution Frame (MDF)
- Multiple Intermediate Distribution Frames (IDF's) located throughout the facility.
- Intrabuilding backbone cabling comprised of optical fiber and multi-pair copper cables connecting each of the IDF's to the MDF.
- Connecting the local user community around the MDF and each IDF, category 6 outlets at each workstation with category 6 cables capable of supporting gigabit data speeds.
- Within the MDF and IDF, network racks, category 6 patch panels, fiber enclosures, and associated category 6 and optical fiber patch cables for connection of user ports to rack mounted network equipment.

The distribution of communication cables in accessible ceiling spaces will be in cable tray and J-hooks. Where installed in walls and columns, and in exposed locations, cabling shall be distributed in appropriately sized conduit. The location and configuration of voice and data outlets will be determined during the design development through input from the Architect and Owner.

Given the physical footprint, square footage, and overall layout of the planned structure, IDF's shall be placed in locations around the facility so that installed cable length from rack to workstation outlet does not exceed 295 feet (90m). It is likely that at least one (1) IDF will be required per wing and possibly within a given wing, on more than one level. The actual quantity and location of IDF's will be determined during design development once the architectural and physical attributes of the structure have been defined. In addition to racks and their associated equipment, the MDF and IDF rooms will include cable tray, backboards, grounding systems, and all necessary cable management and distribution accessories.

Supporting wireless data infrastructure, dual category 6A data outlets will be provided for wireless access points (WAP's). The exact location of these outlets will be identified through a comprehensive predictive analysis and resultant heat mapped coverage profile during the design development phase of the project.

Telephone, Public Address and Clock Systems

Voice Communications System

A telephone system will be provided for the building and will be specified to meet the district's current standards. The telephone system will be integrated with the building intercom system. Telephones for administration areas and classrooms will be specified as identified by the school district's IT department. Depending on the preferred technology embraced by the school, the system will either be a traditional analog PBX type or voice over internet protocol (VoIP) transported over the data network.

<u>Public Address System</u>

A distributed public address (PA) system will be deployed throughout the school inclusive of classrooms, staff/administration areas, hallway, auditoriums, bathrooms, gymnasiums, select exterior areas, and any other spaces determined to require PA. The system will be a zoned broadcast communications platform capable of school-wide broadcast or more selective communications to specific areas. Depending on requirements in any given area, the system will be either one-way (outbound) or two-way, providing for bidirectional communications. An intercom system control panel will be located in the main office as coordinated with Architect and Owner. Speakers will include ceiling and wall mount options, with the type determined in coordination with architect and functionality desired by the school. The PA system will integrate with the telephone system and intercom functions will be available through telephone handsets. The intercom system will include a line level input and microphone(s) for announcements.

<u>Master Clock System</u>

A wireless master clock system will be provided to the entire building. The central transmitter will be located in the MDF room and twelve-inch diameter clocks will be located in each classroom, hallways, staff/administration, and other general use areas. In spaces where greater visibility may be required (such as the gymnasium or cafeteria), fifteen-inch diameter clocks will be utilized inclusive of wire guards where necessary for protection from incidental impact. The system will derive time from the atomic clock either via connection to and through the data network or a roof mounted GPS antenna. Time will be reconciled minimum twice per day by signal from the base station, propagated out clock-to-clock through the system. In addition, a wireless tone generator can be provided in any location or classroom where class change notification is desired with such system tied into the school class scheduling software.

Audio/Visual Systems

Distribution raceways, boxes power outlets, data jacks and CATV outlets to support audio/visual systems will be provided as required. This infrastructure will be coordinated with the Architect, Owner, and A/V Design Consultant.

Special Communication Systems

<u>Elevator Lobby Communications System</u>

A two-way communication system will be provided in the elevator lobbies on each floor, required by IBC 1007.8. The communication system will be connected to the emergency power system. The communication system will communicate between each location and a unit at the fire alarm panel or other location approved by the fire department.

<u>First Responder Bidirectional Amplifier System</u>

A Fire Fighter Communication system shall be provided in areas of the structured as determined necessary by RF survey to support first responder radio coverage within the building as required by IBC 907.2.13.2.

<u>Mass Notification System</u>

If desired, a mass notification system will be deployed to provide communications to the school population over the PA systems as well as remote communications methods such as text and e-mail, to provide messaging to parents and other external groups as desired. This platform can provide a broad spectrum of message transmission ranging from urgent emergency directives to routine notifications such as general event announcements or school closings due to weather.

<u>In-Building Cellular DAS Systems</u>

If deemed necessary and desired by the school, a cellular telephone distributed antenna system (DAS) will be designed to improve communications in areas of the structure that may have poor service. The areas requiring amplification will be determined through predictive analysis of the building once the final (or near final) design is complete and available as a CAD file that can be used by the predictive modeling software tool.

4.6 Food Service

The new kitchen facility shall include all the necessary components of a full service cooking kitchen to include: a receiving area to be used as a staging point for the breakdown and distribution of delivered goods. These goods shall be distributed to refrigerated rooms for storage of refrigerated and frozen ingredients. The size if the rooms shall be sized to accommodate the needs of the facility. In addition, dry goods storage room is planned for the keeping of canned, boxed, and other non-refrigerated food items.

Food preparation shall take place on stainless steel tables of various sizes and configurations. Tables may be fashioned with sinks, drawers, shelves, and overhead pot storage hook racks. Motorized food preparation equipment such as a food slicer, food cutter, and mixer shall be provided. Sizing of this equipment will be based on the scope of food preparation and tailored to fit the designed operation.

Cooking shall take place in a common location adjacent to both food storage and preparation.

Cooking equipment shall consist of standard pieces such as convection ovens, cooking kettles, braising pans, steamers, and combination oven/steamers. Adjustments shall be made to cooking equipment to suite the specific desired menu. The facility will include the necessary ware washing equipment to clean and sanitize pots, trays, and pans.

Serving will take place on two identical separate lines organized in a linear configuration, allowing for orderly and secure serving of food. These lines also include the necessary equipment needed to provide cold side offerings such as fruit and beverages. A separate salad bar will be the focal point of the serving area.

Other support facilities located in or adjacent to the kitchen will include a staff toilet for men and women, a dedicated kitchen slop sink area with enough space for the storage of mops, buckets and detergents. Typically grouped with this equipment are employee locker accommodations for the storage of personal items such as coats, handbags, or shoes.

Equipment typically required and specifically requested include:

- 20 quart mixer, automatic food slicer, and food processor
- A small blast chiller for preparing meals to be served at a later time and to quickly chill food through the danger zone. A blast chiller increases food safety as well as improves food quality.
- Two decks of combination ovens, a braising pan, and 40 gallon kettle
- A steamer, and combination oven/steamer
- Exhaust ventilation complete with a fire suppression system and variable speed drive system to be tied in to exhaust fans and building BM system.

This facility will target Net Zero energy building. As a result, the selection of the kitchen equipment is critical to achieving the Net Zero goal. Critical features will include:

- Limiting the exhaust hood length to be as short as possible, so as not to over design the cooking systems and supporting exhaust fans.
- The use of a variable speed exhaust fan control system will be used to reduce air exhaust volumes.
- Hot food wells will be fully insulated and limited to 800w units.
- Refrigerated rooms will utilize state or the art mechanical components utilizing variable speed motors and smart controllers to limit electricity use:
    - Smart Coil defrost systems

- Variable speed motors (EC fan and condenser motors)
- Increased R-values for walk-in wall panels
- LED light fixtures

- Energy Star rated equipment will be utilized
- In addition to Energy Star, all electrical equipment will be evaluated on a total kilowatt-hours per day of consumption benchmark.
- Hot water consumption shall be limited.
- No fossil fuel combustion cooking. All cooking equipment will utilize electrical power.
- Composting of organic food waste material is integral to the foodservice operation. The kitchen will be planned so that process food waste is able to be collected and placed within transport containers that are then collected and composted off site.
- Seating area food waste will be sorted and collected for offsite composting. Waste stations will be equipped with dump sinks for the elimination of liquid waste. Recyclable material such as plastic and paper will be sorted into appropriate containers. Food waste will be sorted into a separate waste container and eventually combined with the organic kitchen waste to be collected and composed off site.

Other work in the Kitchen shall include:

- Fabricated equipment other than catalog items.
- Plumbing trim consisting of mechanical system components required for standard operation of equipment items such as faucets and waste outlets. Vacuum breakers shall be furnished for equipment where water is introduced less than 2” above flood level.
- Electrical equipment forming an integral part of equipment items such as electric motors, heating elements, controls, switches, starters, temperature regulators and internal wiring to a control panel or switch, if mounted on the equipment.
- Finished floor and walls, structural supports for all ceiling supported equipment, acoustical ceilings and related building work as set forth in the Contract Documents.
- Connecting piping, waste lines, traps and vent piping, complete with shut-off valves to all the equipment, and the rough-in for sanitary waste, domestic water, floor drains and plumbing fixtures.
- Exhaust ventilating systems complete with blowers, ductwork, hangers, access panels, and insulation between the exhaust collars and the exhaust blowers:
- External wiring, the mounting and wiring of motor starters, solenoid valves, switches and receptacles not integral with the equipment, connecting conduit, and external connections to equipment to the building electrical distribution system:
- Flooring in walk-in cooler and freezer: Kitchen flooring must be carried over and installed into the walk-in cooler and freezer.

Fabricated Equipment - Stainless Steel

- Metals shall be free from defects impairing strength, durability or appearance, made of new materials with structural properties to withstand strains and stresses to which normally subject.

- Stainless steel shall be non-magnetic corrosion resistant chromium-nickel steel, Type 302 or 304 (18-8 Alloy), polished to a Number 4 finish where exposed.

- Counters, table tops and drainboards shall be 14 gauge stainless steel, of NSF construction, with edges per Item Specifications. Metal tops shall be made of the largest pieces available and shall appear as one piece with all field and shop joints reinforced and welded, ground and polished. Short pieces of metal will not be acceptable. Counter bends shall be not less than 1/8" radius. Wherever a fixture has a waste or drain outlet, the surface shall pitch toward the outlet.

- Counters, table tops and drainboards shall be reinforced with channel or angle frame as specified in the Item Specifications. Framing shall be secured to the underside with sound deadening material sandwiched between the surfaces, weld studs, and nuts.

- CASTERS: 5" diameter polyurethane tired, swivel, plate or stem mount to suit application, 300 pound capacity, brakes only if specified, NSF approved; Component Hardware C-21-3050 (plate/no brake), C21-3051 (plate/brake) C23-3350 (stem/no brake) or C23-3351 (stem/brake), or equal.

- DRAWER PULLS: Stainless steel, full grip type with beveled edge, NSF approved for stud mounting in device, in horizontal attitude to meet NSF requirements; Component Hardware P63-1012, or equal.

- DRAWER PANS: Molded plastic or fiberglass, 20" x 20" x 5" deep, NSF approved; Component Hardware S80-2020, or equal.

- DRAWER SLIDES: Stainless steel, NSF approved, full extension, 200 pound capacity with stainless steel ball bearing wheels; Component Hardware S-52 series, or equal.

    - Drawer assemblies shall consist of a removable drawer pan set in a removable 16 gauge stainless steel channel shaped drawer support frame with gusset plate reinforced corners.

    - Support frame shall have double pan front cover consisting of boxed 18 gauge stainless steel outer shell with welded corners, flush mounted recessed stainless steel pull, 20 gauge stainless steel back shell tack welded to outer shell with fiberglass sound deadening between. Drawer shall be provided with rubber bumpers to quiet closing. Support drawer frame on full extension drawer slides.

    - Drawer shall be suspended from table in a three-sided, 16 gauge stainless steel enclosure with flanged-in bottom edges, banded lower front, flanged-out front side and top edges. All sharp corners shall be broken and any exposed exterior threads of slide mounting bolts shall be provided with solid metal acorn nuts.

    - Provide each drawer with a cylinder lock with all drawers keyed alike.

    - Component Hardware S91-0020C with thermoplastic pan and cylinder lock is considered as equivalent to the above specified construction.

- FAUCET SETS, DECK MOUNTED: Chrome plated cast bronze with 1/2" IPS eccentric flanged female inlets on 8" centers, removable cartridges, lever handles, and aerator tip on swivel nozzle or swivel gooseneck to suit the application; T&S Brass

B-0221 or B-0321, or equal by Component Hardware, Chicago, or Fisher.

- FAUCET SETS, POTWASHING SINK: Chrome plated cast bronze with removable cartridges, 3/4” passages, eccentric flanged female inlets on 8” centers with LL street EL inlets with locknuts, four prong handles, 12” swing spout; T&S Brass B-290.

- FAUCET SETS, SPLASH MOUNTED: Chrome plated cast bronze with 1/2” IPS eccentric flanged female inlets on 8” centers, removable cartridges, lever handles, and aerator tip on 12” swing spout; T&S Brass, B-0231 or equal by Component Hardware, Chicago, or Fisher. Provide each with a mounting kit.

- GUSSETS: Stainless steel, stepped side, fully closed, NSF approved, mild steel interior reinforcement, wide flange for welding to framing, set screw anchor for leg; Component Hardware A20-0206C, or equal.

- LEG AND BULLET FOOT ASSEMBLIES: Stainless steel tubing, 16 gauge, number 4 finish, adjustable bullet foot with minimum of 3” vertical travel, 2,000 pound capacity, top designed for mounting in gusset, length to suit application; Component Hardware A46-6272-C, or equal.

- LEG AND FLANGED FOOT ASSEMBLIES: Stainless steel tubing, 16 gauge, number 4 finish, adjustable bullet foot with 3-1/2” diameter flange and two holes for securing to floor, minimum of 3” vertical travel, 2,000 pound capacity, top designed for mounting in gusset, length to suit application; Component Hardware A46-4272-C, or equal.

- NUTS: Zinc plated “Pal Nuts” with integral cap and lock washer; Component Hardware Q-34-1024 or equal.

- SEALANT: Sealant for sealing equipment to walls or filling crevices between components. For interior adhesives and sealants applied within the weatherproof barrier, submit a printed statement of VOC content. All materials that are used in the building interior must not exceed the following requirements:

- GFCI RECEPTACLES: Pass & Seymour 2095W, 10kA SCCR, 20A/125VAC, White or equal

Plastic Laminate Materials

- The laminate facing shall be GP-50, .050” thick, general purpose, high pressure, decorative plastic laminate that meets or exceeds the requirements of NEMA Publication LD3-1985, and NSF Standard 35. The plastic laminate exposed surfaces shall be provided in accordance with the specified manufacturer, finish and color. Balancing sheet shall be backing grade GP-28 in matching color at semi-exposed and BK-20 unfinished where hidden.

- Plastic laminate covered surfaces shall be factory fabricated with 3/4” thick core having plastic laminate facing on both faces and all edges, laminated with waterproof glue under pressure in accordance with the plastic laminate manufacturer’s specifications.

- The core shall be medium density phenolic resin particleboard conforming to ANSI A208.1, Type 2-M-2, 45 pound per cubic foot density minimum.

- Provide veneer core plywood or solid hardwood edge banding for doors and vertical dividers or panels where hardware is attached to casework.

- Hinges shall be articulated, spring loaded type equal to Grass 1200 or Stanley, with quantity adequate to support the door without deformation

- Sinks and Sink Inserts
    - Unless otherwise specified, sinks including sink inserts built into tops of fixtures, shall be made of 14 gauge stainless steel with all vertical and horizontal corners rounded to a radius of approximately 3/4” with the intersections meeting in a spherical section. Sinks shall be integrally welded to fixture tops.
    - Sinks with two or more compartments shall have full height, 1” thick double wall partitions consisting of two pieces of stainless steel back-to-back so fabricated that each compartment will be a deep bowl with coved corners. Partitions shall be welded in place to the bottom, front and back of the sink with smooth rounded coved corners. Top edges of the partitions shall be continuously welded. The front of the sinks shall consist of a stainless steel smooth, flush apron, same gauge as the sinks. Bottom and rear of partitions shall be closed. Sink dimensions contained in Item Specifications are inside dimensions.
    - Sinks shall be provided with integral 14 gauge stainless steel drainboards when specified. Drainboards and sink basins shall be pitched toward waste outlets and shall be self-draining. The underside of all sink basins shall sound deadened. Sink units shall be provided with an integral splash at walls. Provide the necessary holes for the mounting of faucet sets.
- Undershelves
    - Undershelf in an open type table shall be 16 gauge stainless steel unless otherwise noted. Edges shall be turned down 1-1/2” and in 1/2” at 45° with corners notched out to fit legs to which shelf shall be welded from underside. Line up all edges of shelf with centerline of legs. Reinforce underside with longitudinal 14 gauge channel on the centerline.
- Wall Brackets
    - Dish tables, sinks and counters with sinks shall be securely anchored 3” off the face of the wall unless specified otherwise. Brackets shall be “Z” shaped and fabricated of 3” wide, 14 gauge stainless steel. Brackets shall be secured in a vertical attitude to the rear of equipment backsplash with weld studs, and to the wall with appropriate fasteners.
    - Counters that are specified tight-to-wall shall be secured in a hidden manner with steel clips, and the wall/fixture joint shall be sealed.
- Wall Shelves
    - Wall shelves shall be fabricated of 16 gauge stainless steel, size per Item Specifications, with back and ends raised 1-1/2”, front edges of ends angled back, all corners broken, and front turned down 1-1/2”, and in 1/2” at 45°.Shelf corners shall be welded, ground and

polished. Mount shelf 1” off face of wall with suitable fasteners on 14 gauge stainless steel flag brackets, 48” on center maximum. Flag brackets shall have a web angle of 30°, measured from horizontal.

Walk in Cooler and Freezer

- Installation - The walk-in refrigerated room shall be installed in a 7” deep ID recess (below finished floor). Recess depth allows 1” for use of leveling sand; 4” for the insulated floor panels; 2” for finished floor and setting bed that shall be carried in from the adjacent room and level to same. The finished floor and setting bed shall be furnished and installed by the General Contractor, and shall have coved joints at all walls, turned up a minimum of 3”. The unit shall be set level on a bed of clean, dry mason’s sand. Shims are not acceptable for leveling material.

- Construction - All standard construction per the manufacturer, modified to meet the specific following points:

    - Walls to be 4” thick with CFC free urethane foam insulation, UL Class 1 rated and Factory Mutual listed meeting FM Approvals Standard 4880.

    - Cam type locking devices

    - 34” x 76” minimum door clearance

    - Polished hardware (hinges and latch to match)

    - Three hinges on doors (to include one Kason 1248 spring assist hinge per door)

    - Leveraged pull handle (mechanical advantage type, Kason 1236 or equal)

    - Quarter turn inside safety release lever handle mechanism (not screw type)

    - Prewired door sections with heater wires and light fixtures and switches

    - Kason 1806 LED light fixtures

    - Dial type thermometers at doors

    - Model 200 (with two sets of dry contacts) or Modularm 75LC 200 (with two sets of dry contacts) temperature and HACCP monitoring system at doors

    - NSF construction throughout with exception of buried floor panels

    - Interior and exterior faces of doors and exposed exterior wall panels shall be provided with aluminum diamond tread plate protective material to a height of 48” above finished floor.

- Minimum materials - Interior and exterior wall surfaces shall be clad with .038” pebble finished aluminum. The ceiling shall be finished in white polyester over 24 gauge galvanized steel. Interior buried floor shall be 14 gauge galvanized steel.

- Accessories - Freezer shall be provided with an electrically heated pressure relief port. Each door shall be provided with a heated vision panel, 14-1/2” x 23”, constructed of three panels of tempered unbreakable glass, electrically heated, with sealed air spaces between. Provide matching trim strips and closure panels to adjoining surfaces, fabricated per details, made of largest pieces available to minimize number of joints, and installed in accordance with NSF Brochure 770202, Installation Manual for Walk-in Refrigerators and Freezers. Provide six total extra Kason 1806 LED light fixtures for mounting in the rooms and deliver to Electrical Contractor for field installation.

- Guarantee - The walk-in refrigerated room panels shall be guaranteed for a period of ten (10) years from the date of approved installation for defects in materials and workmanship when subjected to normal use and service; remainder of rooms for one year.

Mechanical Refrigeration System

- Furnish and install complete refrigeration systems for the walk-in refrigerated rooms in accordance with the plans. The systems shall include condensing units, evaporator coils, piping, all specified accessories, and those components required to provide complete and satisfactory systems in accordance with accepted refrigeration practice.

- The installation work shall be performed by a fully qualified refrigeration contractor employing a certified mechanic fully trained in the installation of commercial refrigeration systems. Submittal shall list the installing company and the qualified system installer.

- Piping - Furnish and install the interconnecting piping between the condensing units and their respective unit coolers. Piping shall be installed in a neat and workmanlike manner with adjustable hangers spaced at no more than ten foot intervals on horizontal runs; six foot intervals, vertical runs.

- Line sizes shall be in accordance with ASHRAE standards and best refrigeration practice to assure proper feed to evaporator, avoid excessive pressure drop, and prevent excessive amounts of lubricating oil from being trapped in any part of the system. Line sizing shall be such that it will protect the compressor from loss of lubrication at all times, prevent liquid refrigerant from entering the compressor during operating or idle time, and maintain a clean and dry system.

- Refrigeration piping shall be Type L, ACR grade, hard drawn seamless copper tubing, wrought type copper fittings, and silver soldered joints. Precharged lines are not acceptable.

- Furnish and install sleeves for refrigerant and evaporator drain piping wherever piping passes through a wall or ceiling. Sleeves shall be non-conductive gray plastic tubing, with interior dimension sized at least 1/4" larger than piping, and shall be neatly packed with brine putty after installation.

- Furnish and install condensate drain piping from the unit cooler to an open drain. Piping shall consist of not less than 7/8" Type L copper tubing, supported 36" on center maximum, in such a way that there will be 1" clearance between the wall and the tubing. Provide a union or slip fitting at the connection to the evaporator drain pan to allow easy disassembly for service and cleaning. Drain piping shall be pitched 4" to the foot and carried through the wall of the refrigerated area. It shall be trapped to prevent entry of warm air and insects to the refrigerated rooms and discharged to a floor drain with the code required air gap. The exposed drain piping shall be spray painted.

- Provide an electric drainline heater tape in the freezer, with a length equal to five wraps per foot of length of the drainline located within the freezer compartment. Wrap and secure in accordance with manufacturer's recommendations.

- Provide chrome plated escutcheon plates at all exposed points where piping penetrates the wall or ceilings.

- Insulation - Suction lines for refrigerated rooms having a temperature above freezing shall be covered with 3/4" wall thickness Armaflex insulation.

- Suction lines for refrigerated rooms having a temperature below freezing shall be covered with 1" wall thickness Armaflex insulation.

- The insulation shall be applied to these lines in accordance with manufacturer's recommendations, and as they are being installed so that insulation will not be split. All joints shall be completely sealed with overlapping, cemented material to prevent the formation of frost on the lines.

- Controls - Each evaporator shall be provided with a Smart-Vap II electronic control as manufactured by National Refrigeration. The time clock and heater contactor shall be removed from the condensing unit. No control wiring will be required from evaporator to the condensing unit.

- Refrigerant Testing - The entire system shall be pressure and leak tested at no less than 100 PSIG, cleaned and dehydrated by maintaining a vacuum of 50 microns or lower for a period of five hours. The required operating charge of refrigerant and oil, if necessary, shall be added and the entire system tested for performance. Each system shall be clearly marked as to the type refrigerant required.

- Guarantee - The equipment shall be guaranteed to maintain the specified temperatures. All mechanical refrigeration equipment shall be mechanically guaranteed for a period of one year after date of acceptance by the Owner. The emergency service shall be provided free of charge, whenever necessary on a 24 hour, seven day-per-week basis during the guarantee period.

- Any leaks that occur during the first year of operation after acceptance by the Owner, shall be repaired and the necessary refrigerant added at no expense to the Owner.

- The year's service shall be provided by the installing company, and under no circumstances will the service policy be sublet to another refrigeration contractor. The name of the installer/service agency for the guarantee period shall be located at a prominent place on the condensing units.

- The condensing units shall be provided with an additional four year parts warranty to commence upon the completion of the aforementioned guarantee, bringing the total parts warranty to five years.

- Condensing Units - The condensing units shall consist of an EC energy saving motor with variable speed controller, compressor, refrigerant condenser, liquid receiver, compressor service valves, and a dual high-low pressure control. The units shall be as manufactured by National Refrigeration.

- The condensing units shall be outdoor type. The compressor shall be serviceable semi-hermetic or scroll type per schedule, and fitted with aluminum fin and copper tube condenser, suction service valve, discharge service valve, compressor contactor, high and low pressure controls, receiver with fusible plug, liquid shut-off valve and charging port, mounted fused disconnect switch, waterproof electrical control box, discharge line vibration eliminator, weather resistant enameled galvanized steel cabinet, access guard, liquid line assembly, suction line filter and vibration eliminator, crankcase heater, and 1-1/2” high raised steel base.

- Evaporator Coils - Each evaporator shall be provided with a Smart-Vap II electronic control as manufactured by National Refrigeration. The time clock and heater contactor shall be removed from the condensing unit. No control wiring will be required from evaporator to the condensing unit.

- The freezer coil shall be provided with an automatic electric defrost system consisting of one evaporator coil as indicated in the schedule. Evaporator shall be low profile type six fins per inch complete with EC energy saving fan motors. Coil shall be NSF and UL Listed.

- The cooler coil shall be provided with one evaporator coil as indicated in the schedule. Evaporator shall be low profile type six fins per inch complete with EC energy saving fan motors. Coil shall be NSF and UL Listed.

- Furnish and install 1/4” minimum diameter stainless steel threaded mounting rods for the hanging of the evaporator coils, with stainless steel washers and nuts on the interior ends, and reinforcing angle at the exterior top of the room. Plated steel running thread is not acceptable.

Sanitation Requirements and Execution

- Equipment specified herein shall be fabricated to conform to the “Food Service Equipment Standards” of the National Sanitation Foundation prepared by the Committee on Food Service Standards, and published by the National Sanitation Foundation, Ann Arbor, Michigan. Any differences of opinion on sanitation shall be referred to the State Department of Health for a ruling.

- Equipment shall be installed in accordance with the manufacturer’s instructions and the best practices of the food service industry, with careful attention to eliminating all cracks, crevices and concealed spaces in wet areas that would be difficult to clean or keep free of vermin and soil.

4.7 Audio / Visual

General

This Feasibility Study describes the audiovisual and theatrical systems designs for the Tobin Montessori and Vassal Lane Upper Schools Project in Cambridge, MA. Included within each system description are its functional requirements and a brief discussion of the specific equipment associated with the system.

Auditorium
Audiovisual System

The auditorium audiovisual system will provide excellent speech intelligibility and music reinforcement and reproduction throughout the auditorium. The sound system will be very flexible, while at the same time easy to use for small events. There will be wired microphone inputs distributed around the stage and auditorium and several wireless microphones, including handheld and clip-on units. An automatic mixer system will allow for operator-free use of the system for basic speech reinforcement events. This is a useful option for basic announcements and simple events that require only a few microphones. Compact disc players and auxiliary inputs for portable media players will provide playback options from the stage and from the main console. Audio reproduction from the video systems will be provided. The main console will be a 24-channel digital mixing console for use with larger events and school productions. An FM-based assistive listening system will be integrated into the main system for use with listeners that have mild to moderate hearing loss.

The auditorium video system will provide high quality, accurate and highly legible video images from a variety of input sources. Sources will include portable computers plugged into floor boxes on both sides of the stage, in the control booth, network-based presentation, and a Blu-ray player. A lectern will house plug-in locations for the computers. A wide-screen format electrically operated roll-down front projection screen will be integrated into the proscenium arch or suspended above the stage. The screen will be sized so that legibility is achieved to the furthest viewer in the auditorium with typical content. The video projector will be a high-quality DLP or 3-chip LCD unit to provide appropriate contrast ratio and brightness for the ambient light conditions within the room.

The auditorium audiovisual video system will be controlled with simple and easy to use touch panel controls. The controls will be located on stage, in the control booth and on the lectern. Wireless iPad control is also an option. The control system will be integrated with the lighting system to provide a single point of control over all event related systems in the auditorium.

Several sub-systems will complement and extend the main auditorium system. A production intercom system with plug-in points on the stage and in the control booth will allow production personnel to communicate discretely during rehearsals and performances. An audio recording system will allow for audio and video recording of events in the auditorium independent of the main mixing console. A portable loudspeaker system with outlet patching will allow for the flexible placement of loudspeakers on stage and in the auditorium for use as monitors or special effects loudspeakers. A program/backstage announcement system will provide the lobby and backstage areas with an audio feed of the auditorium and give production personnel the ability to make announcements to the auditorium and backstage areas covered by the system.

Theatrical Lighting System

The Theatrical Lighting System will provide control over theatrical and house lighting fixtures in the auditorium. It will support the use of basic preset looks as for lectures and concerts as well as conventional and advanced lighting technology, such as automated and color-changing lights, for theatrical productions. The control booth will be the primary lighting control position, with additional console connection points at a tech table location at the seating area and backstage. An Ethernet-based lighting control network will provide connection points through the stage and auditorium, allowing for centralized control of LED and automated lights, color changing devices, fog machines and a wide variety of other devices. Switched electrical circuits will be distributed to all lighting positions to supply power to lighting fixtures and accessories.

The Theatrical Lighting System will consist of a main computerized lighting control console, power and control distribution devices, and control system accessories. The system will include an appropriate complement of LED lighting fixtures and accessories including ellipsoidal, wash and cyclorama type fixtures.

An architectural lighting control system will be part of the theatrical lighting system. It will include a portable touch panel, with plug-in points in the control booth and at the tech table position, fader panels in the control booth and backstage, and entry panels at auditorium and stage entry points. Each of these control locations will be able to control a variety of presets programming into the system.

The system will provide emergency lighting functionality to drive architectural fixtures to full with an emergency, power-sensing, DMX controller and emergency lighting transfer switch.

Theatrical Rigging System

The Auditorium Theatrical Rigging System will provide for the suspension and movement of scenic and lighting elements with fixed-speed motorized pipes flown over the stage. The system will also provide support for curtains and drapery masking elements.

The system will consist of approximately ten full-stage motorized battens, including four lighting battens, several fixed battens, and two full-stage bi-parting traveler tracks. The motorized battens will be controlled from a central control location. A main curtain, main valance, mid-stage traveler, upstage traveler, masking legs and borders will be fabricated from inherently flame-retardant velour. A full-stage muslin cyclorama and scrim will be installed on separate battens near the upstage wall.

Cafeteria
Audiovisual System

The Cafeteria audiovisual system will provide excellent speech intelligibility and music reproduction and reinforcement to the seating area. The sound system will be very flexible, while at the same time easy to use for small events. There will be wired microphone inputs distributed around the performance area and one or two wireless microphones, including handheld and clip-on units. An automatic mixer system will allow for operator-free use of the system for basic speech reinforcement events. This is a useful option for basic announcements and simple shows that require only a few microphones. Compact disc players and auxiliary inputs for portable media players will provide playback options from the equipment rack. There will be inputs in the Cafeteria for portable media players using both wired and Bluetooth connections. Audio reproduction from the video systems will be provided. The main loudspeaker system will be designed to fit the architecture of the room. An FM-based assistive listening system will be integrated into the main system for use with listeners that have mild to moderate hearing loss.

The Cafeteria video system will provide high quality, accurate and highly legible video images from a variety of input sources. Sources will include portable computers plugged into a wall box, network-based presentation, and a Blu-ray player. A wide-screen format electrically operated roll-down front projection screen will be integrated into the ceiling at the presentation end of the room. The screen will be sized so that legibility is achieved to the furthest viewer in the seating area with typical content. The video projector will be a high-quality DLP or 3-chip LCD unit to provide appropriate contrast ratio and brightness for the ambient light conditions within the room.

Large Gymnasium
Audiovisual System

The Gymnasium audiovisual system will provide excellent speech intelligibility and music reproduction throughout the gymnasium.
We expect that this system will be used for announcements and music playback during

classes and school assemblies. The system will be flexible while at the same time be easy to use for smaller events. There will be wired microphone inputs and a couple wireless microphones including handheld and clip-on microphones. There will be inputs in the gym for portable media players using both wired and Bluetooth connections. The system will be controlled by a touch panel system including one at the equipment rack. There will be additional protected volume controls in the gym itself. The main loudspeakers will include larger sized loudspeakers with appropriate directional control for a large reverberant space. The loudspeakers will be distributed evenly throughout the room and suspended down from the roof structure. An FM-based assisted listening system will be integrated into the system

Small Gymnasium
Audiovisual System

The Gymnasium audiovisual system will provide excellent speech intelligibility and music reproduction throughout the gymnasium. We expect that this system will be used for music playback during classes. There will be inputs in the gym for portable media players using both wired and Bluetooth connections. There will be protected volume controls in the gym itself. The main loudspeakers will include larger sized loudspeakers with appropriate directional control for a reverberant space. The loudspeakers will be distributed evenly throughout the room and suspended down from the roof structure. An FM-based assisted listening system will be integrated into the system.

Professional Development Room
Audiovisual System

The Professional Development Room will be equipped for video presentation, speech reinforcement and program playback to support training sessions. There will be video inputs at an audiovisual switcher for instructor computers, a Blu-ray player and network-based presentation devices. There will be a video projector and motorized roll-down projection screen. There will be two wireless microphones and inputs for four wired microphones connected to an automatic mixer system within a digital signal processor. There will be ceiling loudspeakers distributed through the room. A simple control panel at the front of the room will operate the system. An FM-based assisted listening system will be integrated into the system.

Atrium
Audiovisual System

The two-story atrium at the heart of school will serve as an informal gathering and presentation space for the school. It will be equipped for video presentation, speech reinforcement and program playback to support presentations, lectures, small gatherings, and community events. There will be video inputs at an audiovisual switcher for presentation computers, a Blu-ray player and network-based presentation devices. There will be a video projector and motorized roll-down projection screen. There will be two wireless microphones and inputs for more wired microphones connected to an automatic mixer system within a digital signal processor. There will be ceiling loudspeakers distributed through the space. A simple control panel will operate the system. An FM-based assisted listening system will be integrated into the system.

Classrooms
Audiovisual System

The classroom audiovisual systems will provide equipment designed to support video and audio presentation during classes. The primary display device will be either a large touch-enabled LCD monitor or wall-mounted short throw projector. There will be wired inputs to the display device for the teacher computer and an option for network-based connections to the display.

4.8 Sustainability and Resiliency

Overview

The City of Cambridge has very well developed values pertaining to sustainability and resiliency. These values have been embodied and expressed in the City's progressive initiatives. In support of these goals, the City requires the project to achieve LEED Gold certification. The design team has prepared a preliminary checklist that meets or exceeds this goals (Image 4.8e). This checklist will be further refined during design. The development of the project will support these initiatives:

- Climate Action Plan (CAP) – reducing greenhouse gas emissions related to buildings, transportation and waste.
- Envision Cambridge – addressing many of the sustainability and resilience priorities, including community connections and equitable distribution of amenity and opportunity.
- Buildings – responding to project site conditions and climate (image 4.8a-d), reducing energy use, electrifying, and supporting low/no carbon energy supply.
- Transportation – supporting pedestrian trips, personal and shared bicycles, carpooling, minimizing parking and dependence on cars, and supporting electrification.
- Stormwater Management -- including raising occupied floor elevation and critical equipment, using stormwater best management practices and, uniquely on this site, providing regional stormwater retention in the form of a 1.2+ million gallon storage tank.

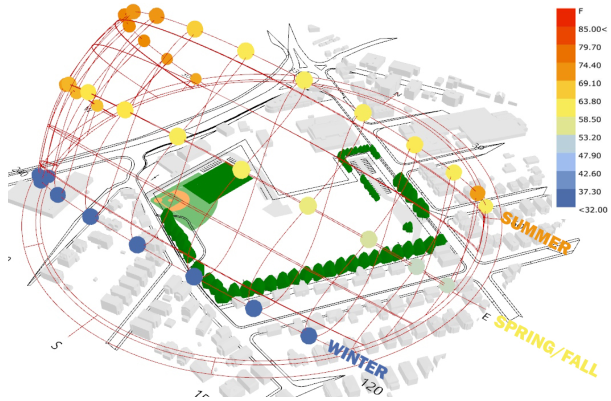


Image 4.8a: Sun Path Diagram

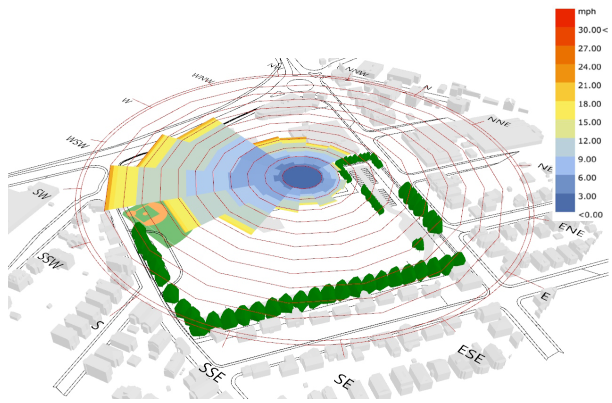


Image 4.8b: Winds Study Diagram - Warm Season (JUN - SEPT)

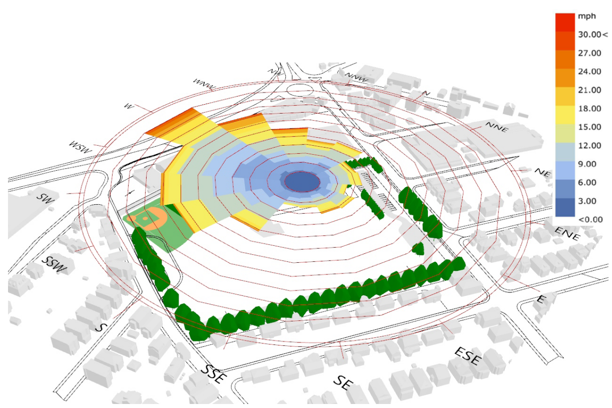


Image 4.8c: Winds Study Diagram - Cold Season (OCT - MAY)

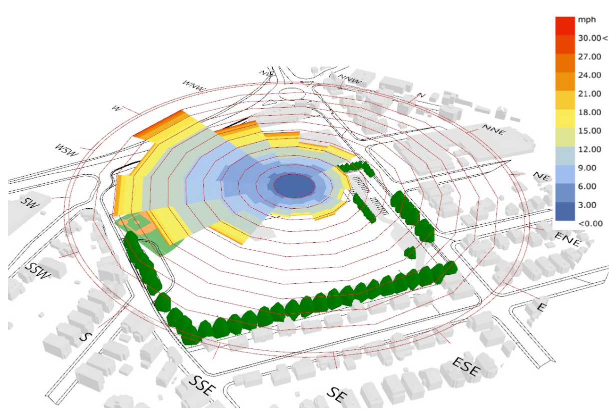


Image 4.8d: Winds Study Diagram - Yearly

LEED v4 for BD+C: Schools

Project Preliminary Checklist

Tobin Montessori & Vassal Lane Upper School

27-Feb-20

Y	?	N			
1			Credit	Integrative Process	1

9	6	15	**Location and Transportation**		15
		15	Credit	LEED for Neighborhood Development Location	15
1			Credit	Sensitive Land Protection	1
	2		Credit	High Priority Site	2
3	2		Credit	Surrounding Density and Diverse Uses	5
2	2		Credit	Access to Quality Transit	4
1			Credit	Bicycle Facilities	1
1			Credit	Reduced Parking Footprint	1
1			Credit	Green Vehicles	1

5	4	3	**Sustainable Sites**		12
Y			Prereq	Construction Activity Pollution Prevention	Required
Y			Prereq	Environmental Site Assessment	Required
1			Credit	Site Assessment	1
		2	Credit	Site Development - Protect or Restore Habitat	2
	1		Credit	Open Space	1
	3		Credit	Rainwater Management	3
2			Credit	Heat Island Reduction	2
1			Credit	Light Pollution Reduction	1
		1	Credit	Site Master Plan	1
1			Credit	Joint Use of Facilities	1

5	3	4	**Water Efficiency**		12
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
2			Credit	Outdoor Water Use Reduction	2
3	2	2	Credit	Indoor Water Use Reduction	7
		2	Credit	Cooling Tower Water Use	2
	1		Credit	Water Metering	1

27	2	2	**Energy and Atmosphere**		31
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
6			Credit	Enhanced Commissioning	6
16			Credit	Optimize Energy Performance	16
1			Credit	Advanced Energy Metering	1
		2	Credit	Demand Response	2
3			Credit	Renewable Energy Production	3
1			Credit	Enhanced Refrigerant Management	1
	2		Credit	Green Power and Carbon Offsets	2

5	3	5	**Materials and Resources**		13
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
	3	2	Credit	Building Life-Cycle Impact Reduction	5
1		1	Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
1		1	Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
1		1	Credit	Building Product Disclosure and Optimization - Material Ingredients	2
2			Credit	Construction and Demolition Waste Management	2

8	7	1	**Indoor Environmental Quality**		16
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
Y			Prereq	Minimum Acoustic Performance	Required
2			Credit	Enhanced Indoor Air Quality Strategies	2
1	1	1	Credit	Low-Emitting Materials	3
1			Credit	Construction Indoor Air Quality Management Plan	1
1	1		Credit	Indoor Air Quality Assessment	2
1			Credit	Thermal Comfort	1
1	1		Credit	Interior Lighting	2
	3		Credit	Daylight	3
1			Credit	Quality Views	1
	1		Credit	Acoustic Performance	1

6	0	0	**Innovation**		6
5			Credit	Innovation	5
1			Credit	LEED Accredited Professional	1

4	0	0	**Regional Priority**		4
1			Credit	Regional Priority: Renewable Energy Production	1
1			Credit	Regional Priority: Optimize Energy Performance	1
1			Credit	Regional Priority: Rainwater Management	1
1			Credit	Regional Priority: High Priority Site OR Indoor Water Use Reduction	1

70	25	30	**TOTALS**	Possible Points:	110

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

Image 4.8e

Image 4.8f

Healthy Indoor Environment

Providing a healthy indoor environment is an essential focus for buildings in general and especially for school buildings housing young, developing people who are most impacted by stressors (Image 4.8f). A positive healthy indoor environment will consider:

- Positive visual quality – minimizing glare, utilizing natural daylight design strategies and limiting the potential for visual noise that can distract from learning.
- Acoustical control within and between spaces – providing an aural environment that supports the exuberance of pre-K through grade 8 students, including those with particular sensorial challenges, such as those in the Autism Spectrum Disorder (ASD) program.
- Healthy Materials, minimizing volatile organic compounds (VOCs), using red list free products, and avoiding chemicals of concern to create a non-toxic environment. This is wonderfully in line with the Montessori approach to the material world.

Resourceful choices

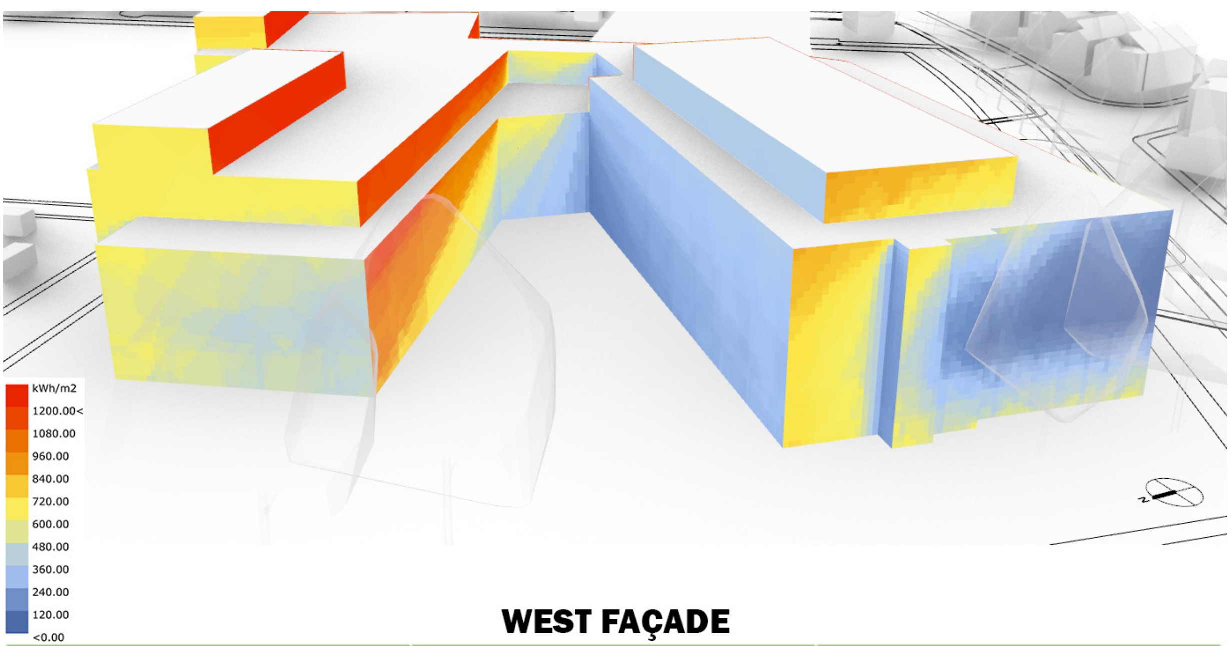
The design of interiors, the choices of materials, and the handling of waste and water are all important contributors to the ultimate resourcefulness of the project. Some aspects of resourceful design include:

- Recycled Content – utilizes less virgin material while reducing landfill impacts, with historical connections to the dump that the site is built over.
- Local/Regional content – supporting local economies, while minimizing carbon emissions associated with transportation.
- Limiting Unnecessary Finishes -- may be more durable, less expensive, and lower carbon.
- Durable Material Selection – the City's investment lasts and the indoor environment looks fresh longer.
- Water Efficient Approaches – including rainwater reuse for toilet flushing, efficient dishwashing and plumbing fixtures.
- Reducing and Managing Waste – including school/office supply recycling and controlling food waste composting waste stream.

EAST FAÇADE

SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	770,824 kWh	43.52 kWh
WARM SEASON	471,326 kWh	26.61 kWh
TOTAL YEARLY RADIATION: 1,242,150 kWh		
TOTAL YEARLY RADIATION PER SQFT: 70.13 kWh		

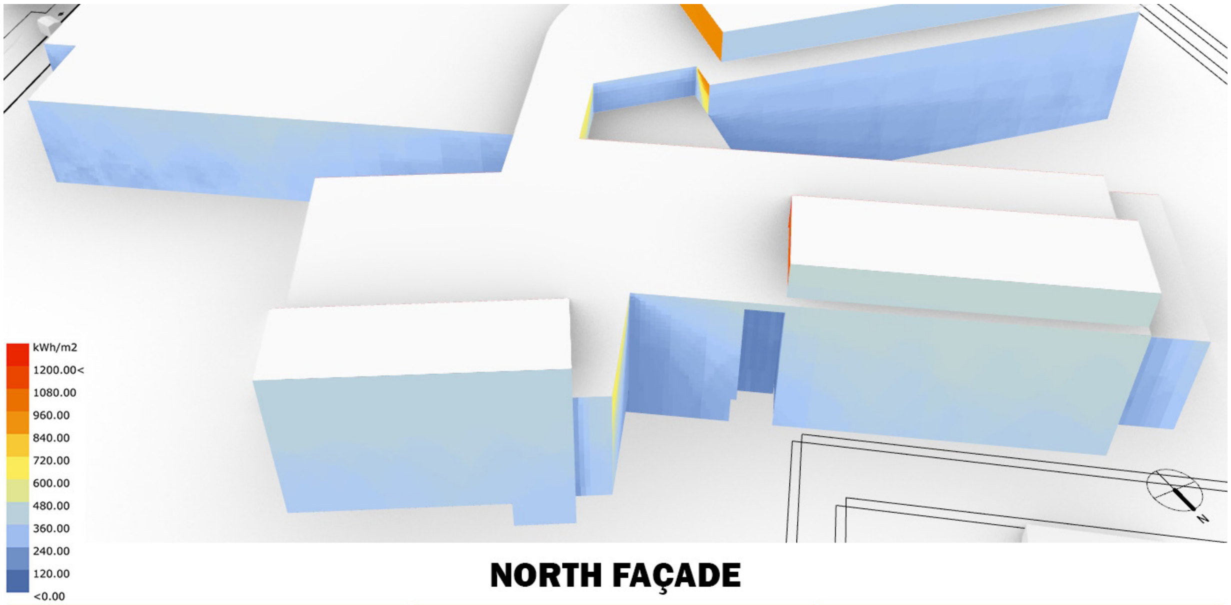
Image 4.8g



WEST FAÇADE

SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	419,350 kWh	17.64 kWh
WARM SEASON	386,758 kWh	16.26 kWh
TOTAL YEARLY RADIATION: 806,108 kWh		
TOTAL YEARLY RADIATION PER SQFT:33.9 kWh		

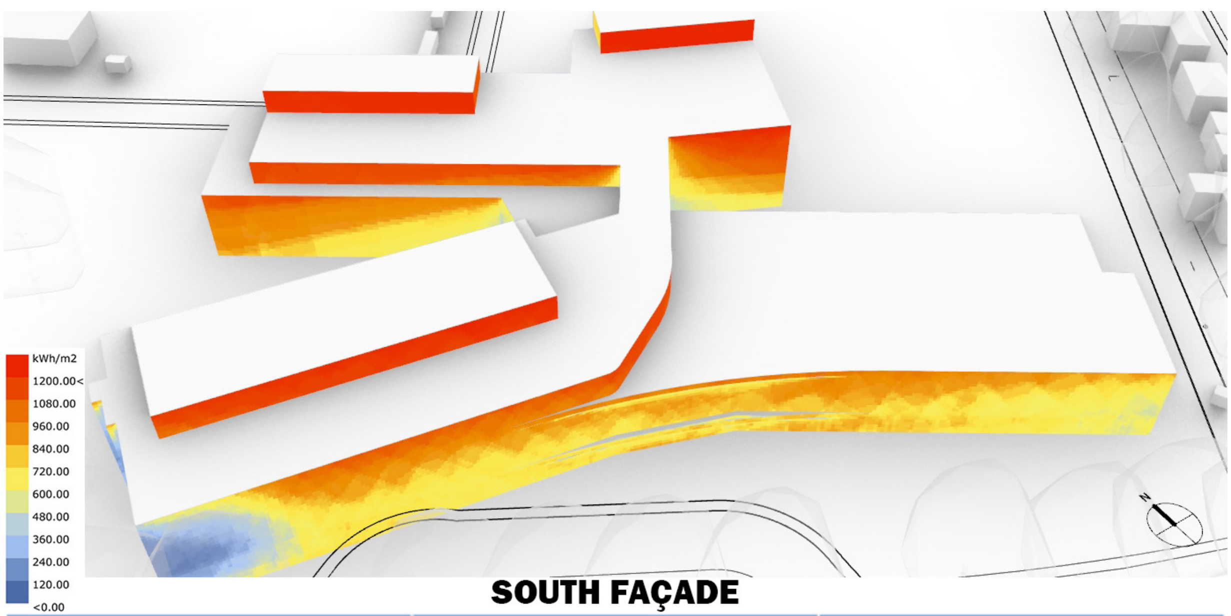
Image 4.8h



NORTH FAÇADE

SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	552,674 kWh	12.90 kWh
WARM SEASON	477,902 kWh	11.16 kWh
TOTAL YEARLY RADIATION: 1,030,576 kWh		
TOTAL YEARLY RADIATION PER SQFT: 24.06 kWh		

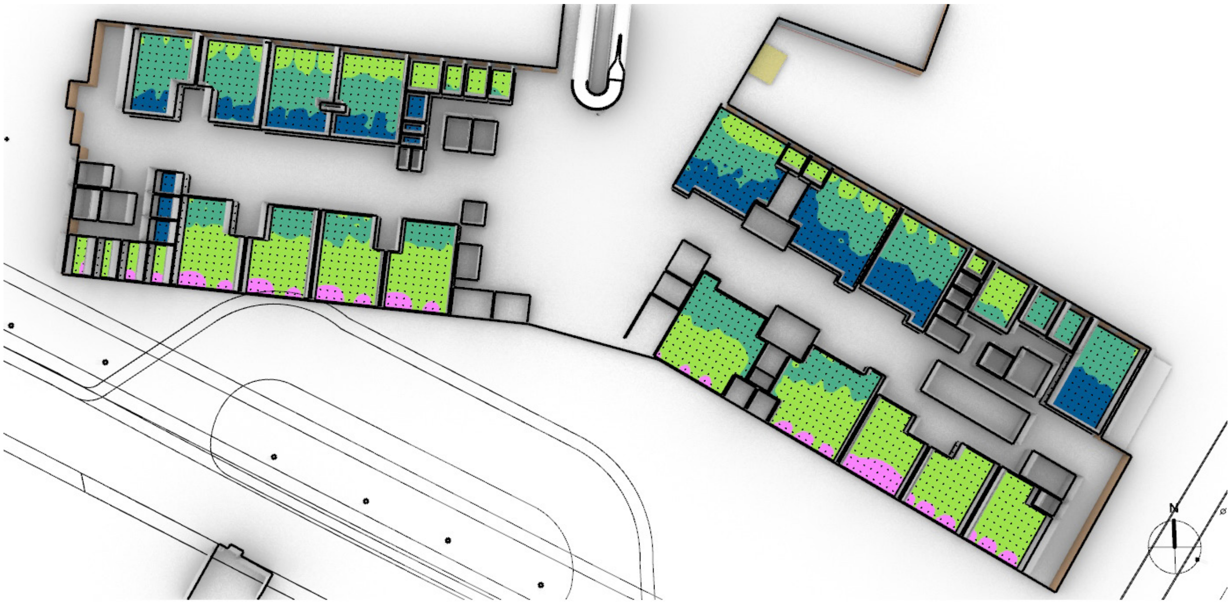
Image 4.8e



SOUTH FAÇADE

SEASON	TOTAL RADIATION	RADIATION X SQFT
COLD SEASON	1,349,200 kWh	61.98 kWh
WARM SEASON	588,786 kWh	27.05 kWh
TOTAL YEARLY RADIATION: 1,937,986 kWh		
TOTAL YEARLY RADIATION PER SQFT: 89.03 kWh		

Image 4.8j



28% **underlit** (0 lux-100 lux)

37% **autonomous** (300 lux-3000 lux)

33% **supplemental** (100 lux-300 lux)

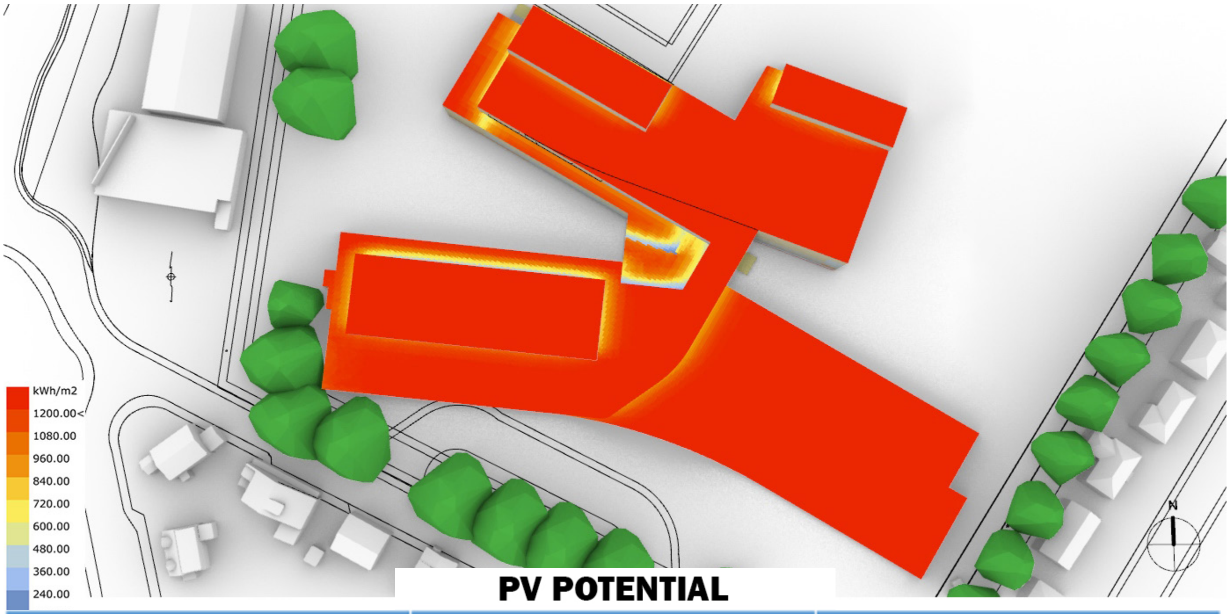
2% **excessive** (>3000 lux)

Image 4.8k: Daylight Analysis - Classroom Wing

Energy Efficiency

Energy efficient design reduces the need for the building to consume energy, lowers the carbon footprint of the building, reduces operating costs, and may, through integrative design, lower the capital costs of the building. Key aspects of energy include:

- High Performance Building Envelope -- including continuous air and vapor barrier, continuous optimized insulation, appropriately sized, located, and constructed windows, and building orientation designed to optimize solar energy (Image 4.8g - j).
- Right-sized Equipment – mechanical systems designed with clear requirements so that they are not over-sized resulting in added capital or operating costs, and appropriately sized for actual predicted use (and diversity factors).
- Advanced controls – minimizing the use of electrical lighting when there is daylight, using operable windows while turning off mechanical systems, using air movement to limit need for air conditioning.
- All Electric Systems – avoiding the reliance of on-site fossil fuel combustion and paving the way to a “green” electrical grid.
- Occupant and Operator Education – preparing the building for a smooth transition between design and occupancy, by adults and students, and operation by the City.
- Daylight Optimization – The classroom wings are oriented so that they generally get north and south daylight. This allows control of solar gain and daylight. Fenestration will be optimized during early design phases to improve indoor environmental quality while co-optimizing with energy efficiency (Image 4.8k).



PV POTENTIAL

SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	5,818,200 kWh	62.87 kWh
WARM SEASON	4,909,900 kWh	53.06 kWh
TOTAL YEARLY RADIATION: 10,728,100 kWh		
TOTAL YEARLY RADIATION PER SQFT: 115.93 kWh		

Image 4.8l

Image 4.8m

- Net Zero Emissions – fulfilling the City goal of having no emissions on site and targeting a design that approaches or meets the potential for a Net Zero Energy building that is optimally efficient and produces on site as much energy as it will use over the course of a year. Key components will be an all-electric kitchen, renewable biodiesel fueled emergency generator, and producing power with on-site photovoltaic panels (Image 4.8m). Because the building must minimize its footprint to maximize open area, Net Zero Energy will be difficult to achieve, but will still be attempted (Image 4.8l).

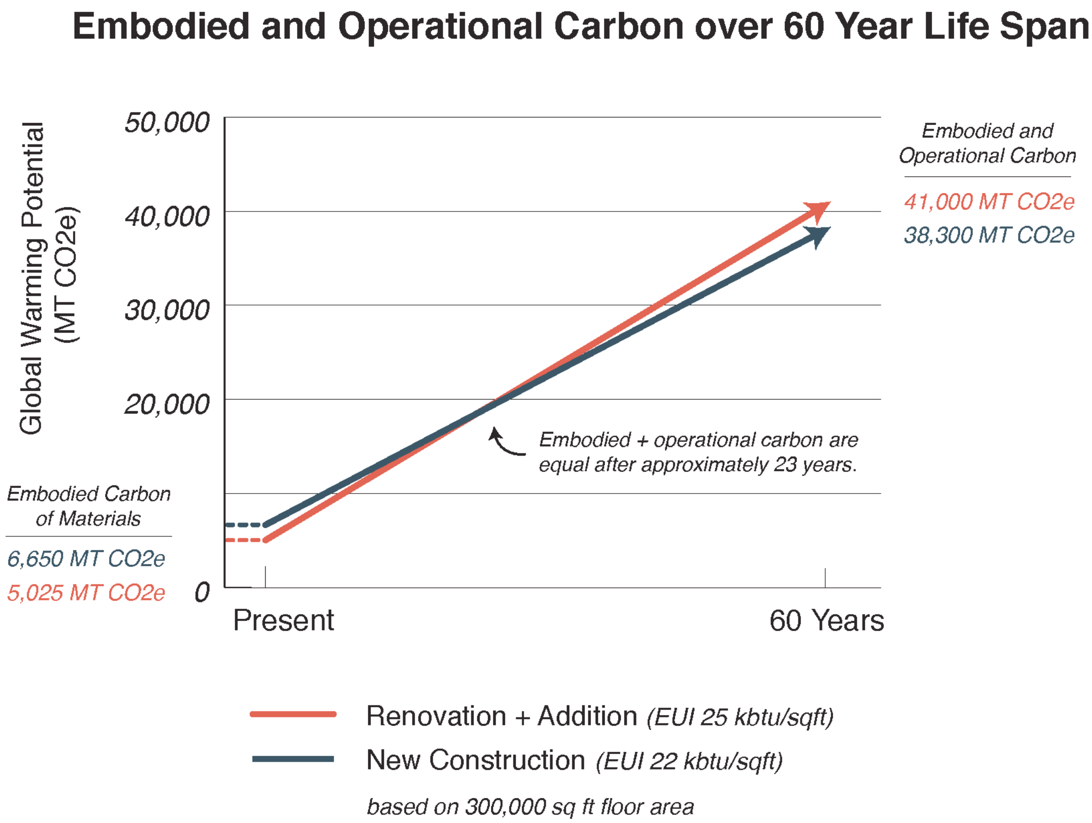


Image 4.8n

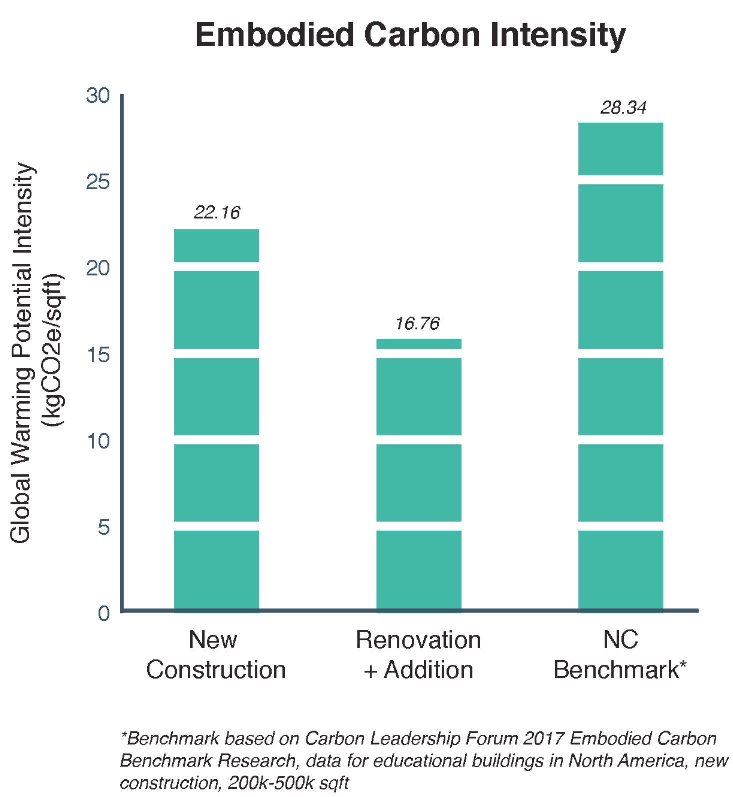


Image 4.8o

- Embodied Carbon Minimized – the building will be optimized for energy efficiency and on-site power production. The design will also consider the potential of reducing embodied carbon. A key strategy will be using mass timber (CLT or glue-lam structure) in lieu of a fully steel and concrete structure. Image 4.8n and o shows early studies of energy efficiency of a new structure plus highest possible energy efficiency, versus the existing structure plus less efficient building layout.

Image 4.8p

Teaching Sustainability

Addressing climate change through sustainability, and resilience strategies is a pressing societal challenge. Educating young students about these issues is essential, and can begin with helping to provide an appreciation of nature and being outdoors. Some elements of this may include:

- Connections to Outdoors – making wonderful outdoor spaces, built and naturalistic, easily accessible (Image 4.8p).
- Gardens and Messy Spaces – allowing exploration, discovery, and instilling a connection to nature, and providing opportunities for outdoor curriculum integration (Image 4.8q).
- Exposing systems – unfolding the functionality of systems to provide access to the workings of the building at various levels of learning (Image 4.8r).

Image 4.8q

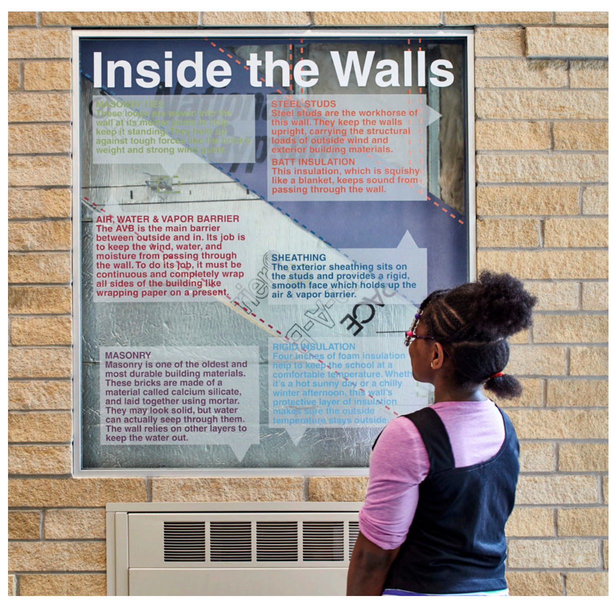


Image 4.8r

4.9 Net Zero Emissions and Energy

The City of Cambridge has committed to a goal of achieving citywide net-zero emissions by 2050. In support of that goal, the building is to be designed as a net zero energy building. In order to meet that goal the building design team will strive to design the building for low site energy use, utilize building systems that do not contribute to on-site greenhouse gas emissions and maximize on-site renewable energy generation. In addition to the emissions goal, the City requires the project to achieve LEED Gold certification as discussed in Section 4.8.

The new Tobin Montessori and Vassal Lane Upper School project will be designed for high performance and will contribute towards the City's net zero emissions goal in the following ways:

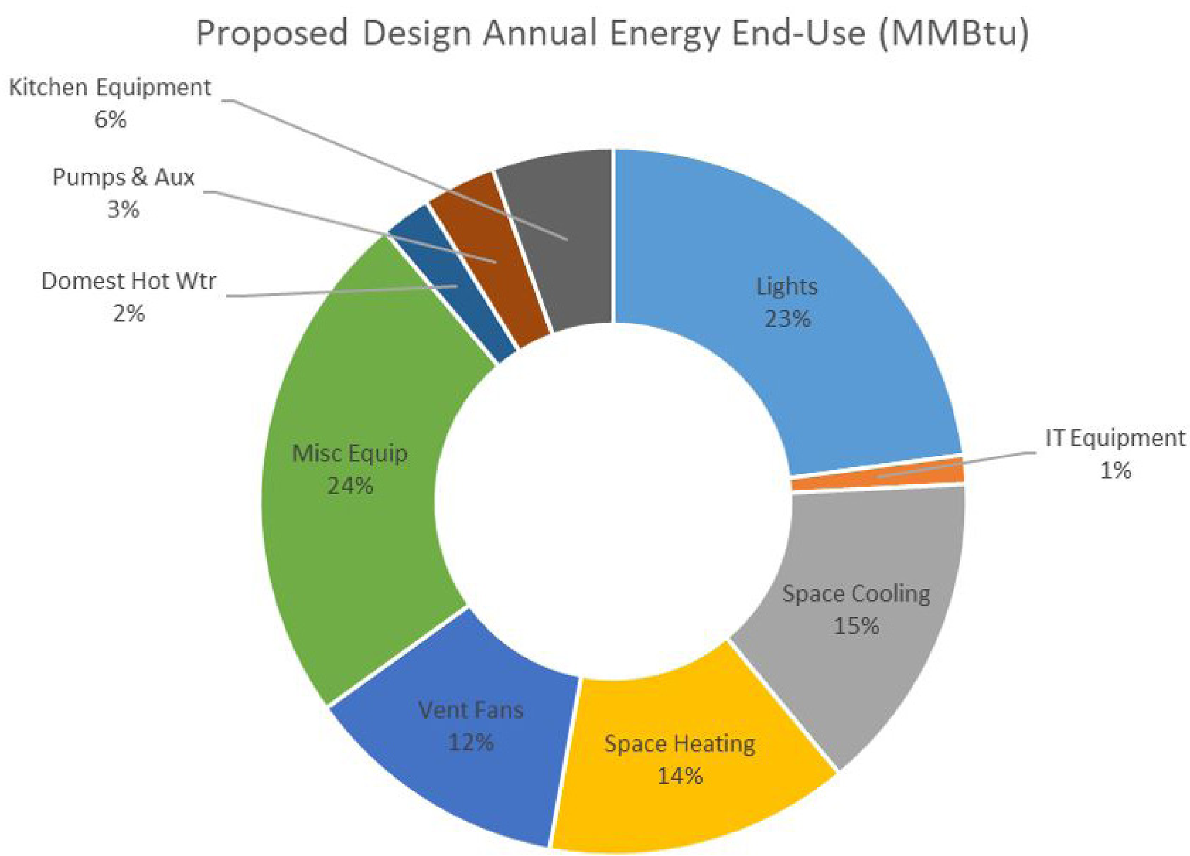
- Optimized building massing and location on the site in order to take advantage of solar orientation to maximize opportunities to provide glare-free daylighting of instructional spaces and to maximize the potential for renewable energy generation.
- A high-performance building envelope design with higher than code thermal performance and insulation R-values, close attention to elimination of thermal bridging and special care to air-barrier design to limit infiltration.
- Elimination of on-site greenhouse gas emissions through the utilization of high-efficiency all-electric HVAC systems.
- Use of energy recovery and active control strategies such as demand control ventilation to reduce HVAC energy use.
- Low energy LED lighting systems with daylight dimming and occupancy based controls.
- Low-flow plumbing fixtures and heat pump based domestic water heating systems.
- Energy recovery of kitchen refrigeration system heat rejection and recovery of heat rejection from 24/7 cooling of central IT equipment.
- Provision of energy metering to track and monitor energy use by specific end-use and to provide real-time information to building occupants on how the building is performing.
- Projected on site energy use that will be less than the minimum allowable consumption under current Massachusetts Stretch Code, resulting in an expected energy use intensity (EUI) of 26.03 kbtu/SF/year.
- Generation of on-site renewable energy that will offset approximately 34% of annual on-site energy use through roof mounted photovoltaic arrays.

The project design will incorporate all of the elements required to support the City's net zero emissions goals. Due to the project constraints it is not clear that these goals can be met with 100% on-site renewable energy. The project team has identified two different paths towards future net zero energy operations based on a high performance option and an ultra-high performance option. The ultra-high performance option maximizes energy reductions and on-site renewable energy generation with a projected energy intensity of 23.2 kbtu/SF/year and 100% on-site renewable energy generation.

Current projected energy performance based on the project energy model:

Energy Usage Summary	Electricity (kWh/yr)	Annual Cost ($/yr)	EUI (kBtu/sf/yr)	GHG Emissions (tons CO2/yr)
Proposed Design - without PV	2,411,547.48	405,139.98	26.03	1,081.17
Proposed Design – with PV	1,597,547.48	268,387.98	17.25	716.23
Ultra-High Performance Design - without PV	2,146,277.26	360,574.58	23.17	962.24
Ultra-High Performance Design - with PV	1,332,277.26	223,822.58	14.38	597.30

Projected energy end use breakdown:



Designing for net zero energy:

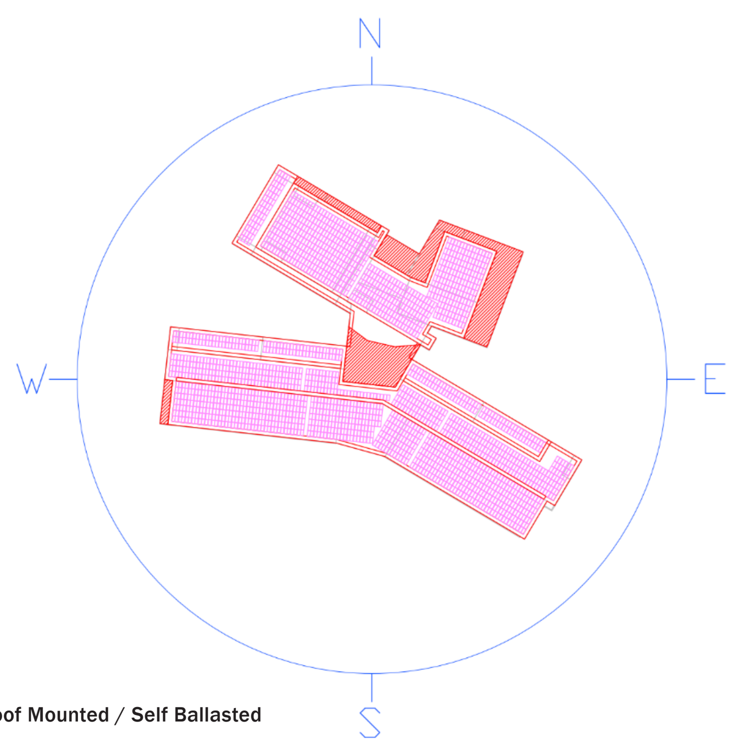
Several over-arching design objectives have guided the project team through-out the conceptual design process including:

- Optimize building orientation to provide good access to daylight.
- Ensure the building requires as little energy as possible to provide the appropriate indoor environment in support of the programmed use of the building.
- Pay attention to energy that will be used by building occupants by careful attention to plug loads.
- Utilize the most efficient all electric building systems possible given the project limits so as to reduce on-site energy use and not create on-site emissions from building operations.
- Maximize the amount of on-site renewable energy production given the project constraints.

The conceptual design process for the project included a careful balancing of the goal for net-zero energy with other important project priorities including maintaining open space, meeting the project program requirements, integration into the existing community and project budget

The need to maintain open space in particular has resulted in a compact design with all parking located in a below grade enclosed parking garage. This compact building shape and program contributes somewhat to improved energy performance but at the expense of limiting opportunities for on-site renewable energy. A further complication of the site is the high water table and existing underground contamination.

The roof area of the building is approximately 80,000 square feet which will not be adequate to achieve net zero energy operation using standard self-ballasted roof mounted photovoltaic arrays. The elimination of above grade parking further reduces opportunities for mounting PV panels on canopy structures above parking areas.



Preliminary PV Layout Roof Mounted / Self Ballasted

Building envelope performance:

The proposed building envelope design exceeds the prescriptive thermal performance requirements in current energy standards. Continuous insulation is used in lieu of cavity insulation and careful attention is given to air tightness and the elimination of thermal bridging. Glass area is limited to no more than 30% of the overall wall area and the glass areas are greater on the north and south exposures than on the east and west exposures in order to optimize access to quality daylight and minimize un-wanted solar radiation.

Energy using systems:

In support of the net zero emissions goal, options for HVAC systems that do not utilize fossil fuels are proposed for the project. Two systems are being considered along with a hybrid that is a combination of the two systems. The proposed base system is a ground-coupled geo-exchange water-to-air heat pump system (geothermal). This system has excellent energy performance and no on-site emissions but there is concern about first cost and fitting the system on the site. The second system utilizes high efficiency air-to-air heat pumps with energy recovery utilizing variable refrigerant flow (VRF) inverter driven compressors. The hybrid system utilizes the geothermal system for large assembly/public areas and the VRF system for smaller spaces such as classrooms and offices.

All of the systems being considered incorporate energy recovery and utilize dynamic control strategies such as demand control ventilation which varies the amount of ventilation air provided to spaces based on the actual occupancy and actual, real-time ventilation requirements.

Demand for hot water will be limited by the utilization of low-flow plumbing fixtures. Heat pump technology will be utilized to generate domestic hot water and take advantage of heat recovery where possible.

Interior and exterior lighting systems will utilize low energy LED lighting sources and interior lighting energy use will be limited further by dynamic controls including daylight responsive dimming controls and occupancy based sensors (occupancy or vacancy).

On Site Renewable energy

Photovoltaic panels will be the most effective means for providing on-site renewable energy at this site. The compact building shape needed to maximize open space and elimination of on-site parking means that the only viable location for mounting photovoltaic systems is the building roof. The roof area of the building is approximately 80,000 square feet which will not be adequate to achieve net zero energy operation using standard self-ballasted roof mounted photovoltaic arrays.

A conceptual layout for primarily self-ballasted roof mounted photovoltaic arrays results in a potential array size of approximately 850 kW with 2180 PV panels. The conceptual layout accounts for code required offsets and walkways but does not account for interruptions to panel placement for roof projections such as plumbing vents, exhaust fans or roof hatches. An allowance of 5% to 8% loss in panel count due to roof projections is reasonable at the feasibility phase of a project. With a 5% loss factor the annual renewable energy generation is projected to be approximately 844,000 kWh/year which drops to approximately 814,000 kWh/year with an 8% loss factor. Based on the projected annual energy needs for the project the system will offset 33.8% to 35.0% of the annual energy use.

Pathway to net zero emissions:

The base high-performance design is projected to have an energy use intensity (EUI) of 26.03 kBtu/SF/year with on-site renewable energy generation projected to offset roughly 34% of annual energy use.

In addition to the base high-performance design, an ultra-high performance design option has been developed in order to understand the pathway towards off-setting all annual energy needs on site. The ultra-high performance design maximizes every opportunity to reduce annual energy use through the incorporation of additional energy conservation measures (ECM's) not included in the base high performance design.

The ultra-high performance design will have, in addition to the high-performance features of the base high-performance design, the following energy conservations / design alterations:

- Improved whole-building lighting power density
- Enhanced solar shading on South, East and West facades
- Improved Infiltration to near Passive-House standards
- Expanded temperature control setpoints for all spaces
- Reduced static pressure on air handlers and energy recovery units
- Improved Solar Heat Gain Coefficients and Assembly U-Factors on Punched Windows and curtainwall
- Hybrid Geothermal and air-source VRF HVAC system

In order to maximize on-site renewable energy production, the PV panels in the ultra-high performance design are mounted in a continuous configuration on a structure floating above the roof. This mounting eliminates the need for offsets and walkways as well as interruptions due to mechanical equipment and other roof projections. The ultra-high performance design is projected to have an energy use intensity (EUI) of 23.2 kbtu/SF/year. In order to offset this annual energy use entirely on-site, a structurally supported array above the roof surface of approximately 100,400 square feet would be required.

Annual energy use and resultant emissions are impacted by building operations and occupant behavior and actions. Through careful attention to building operations and full engagement of building occupants and visitors in reducing their energy use it is possible that the annual energy use may ultimately be less than what is projected. This would increase the percentage of annual energy use offset by on-site renewable energy.

The MLK, Jr. School in Cambridge came on-line in 2015 and through an extended commissioning program and careful attention to building operations the annual energy needs of the building were reduced over the first few years of operation from what was initially projected. Prior to completion of construction the EUI was projected to be approximately 31.1 kbtu/SF/year. Over the first three years of operation the EUI was reduce with the EUI for 2018 reported as 22.7 kbtu/SF/year.

Operational EUI's cannot be compared directly to the projected EUI as the projection is based on typical weather data while the operational energy use is a consequence of the actual weather in any given year. Nonetheless, the reduction in EUI experienced at MLK is of such a magnitude that it is clearly not all attributable to variations in weather and a significant improvement was achieved through more diligent operation of the systems as well as occupant behavior.

The ability to achieve net zero energy on site will depend on the energy saving features that can be incorporated into the final building design, the amount of renewable energy that can be produced, the engagement of the building occupants in reducing their energy requirements and the diligence in which building operators pursue energy efficient operations. Ultimately, if full net zero energy operations cannot be achieved with on-site renewable energy generation it can be achieved with the purchase of off-site renewables or carbon offsets to make up any short-fall.

Net Zero Emissions
an all electric building

Net Zero Energy
you generate as much energy on-site (with renewable resources) as you use

4.10 Haz Mat

Scope of Work

The scope of work included a visual inspection and inventory of the following:

- Suspect Asbestos-Containing Materials (ACM);
- Suspect Lead-Based Paint (LBP) Coated Building Components;
- Suspect Polychlorinated Biphenyl (PCB)-Source Building Materials; and
- Fluorescent Light Ballasts; and
- Mercury-Containing Equipment/Materials.

Fuss & O'Neill observed all accessible areas within the Site building, including the three crawlspace areas. Intrusive or destructive investigative techniques were not performed at the Site to access and to observe concealed or inaccessible areas. Sampling of suspect hazardous building materials was not performed during this inspection.

Fuss & O'Neill also reviewed construction drawings provided by the Client to reach certain conclusions regarding current Site conditions.

Building Description

The Site building is of concrete block and structural concrete construction; it was reportedly constructed in 1968-69. Exterior finishes include concrete block, steel window frames, and a stone-ballast "rubber" roofing system. The building is heated by electric heaters located within the maintenance space at the Unit B first floor. Heated air is distributed via insulated ducts that feed the entire building. The Site building includes three sections referred to as "Units" on the provided construction drawings.

Unit A consists of the westernmost extent of the building and includes two stories and a crawlspace. Unit A is predominantly used for classroom and educational spaces. Unit A interior finishes include concrete block walls, (splined) acoustical ceiling tile, 12" x 12" floor tile, vinyl baseboard, and gypsum board soffits.

Unit B consists of the "central" portion of the building and includes three stories and a partial crawlspace. Unit B includes school offices, teacher spaces, support services, Cafeteria, Kitchen, Gymnasium, Auditorium, and mechanical spaces. Unit B interior finishes include concrete block walls, (splined) acoustical ceiling tile, 12" x 12" floor tile, vinyl baseboard, and gypsum board soffits. The Gymnasium has poured resilient flooring and a corrugated-metal roof deck (with exposed, spray-applied fireproofing).

Unit C consists of the easternmost extent of the building and includes two stories and a crawlspace. Unit C is similar to Unit A in that it is predominantly used for classroom/educational spaces and has similar interior finishes.

The joints between dissimilar materials (e.g., concrete block to structural concrete, metal door frames to concrete surround, etc.) are caulked. The joints between window/door systems and the concrete surrounds are also caulked.

HVAC ducting and plumbing lines are concealed within gypsum board soffits and within concrete block walls. Plumbing lines also run throughout the three crawlspace areas. HVAC ducts are insulated with fiberglass, and hot/cold water lines are insulated with fiberglass and mudded insulation at the fittings and elbows.

Building Construction

Utilizing the Client provided construction drawings, Fuss & O'Neill has identified several materials and conditions that should be noted. Conditions that were noted during drawing review, but no observed during the visual inspection are as follows:

- According to construction drawing review and information attained from custodial staff, most classrooms and corridors were originally carpeted. Carpeting was reportedly replaced with floor tile at some point after the mid-1980s.
- Rigid insulation is noted at the void between the exterior concrete block wall and the interior concrete block wall (Sheet A-13, Detail 2). It is likely a rigid foam or

Styrofoam insulation held in place with a mastic or glue. In addition, it is not clear whether or not a vapor or air barrier is present within the wall cavity.

- Fabric base flashing is noted at the exterior-concrete-wall-to-structural-beam joints (Sheet, A-13, Detail 2).
- Insulation is noted at the cantilevered sections (Sheet A-13, Detail 1).
- A 6-mil. vapor barrier is noted at Unit A and C crawlspaces beneath the mud slab (Sheet A-13, Detail 2).
- Dampproofing was noted (Sheet A-14, Detail 3) at the auditorium wall where concrete block extends over the structural concrete.
- A pipe trench is shown in the room across from the Auditorium (Sheet P-5, Unit B-Level 3).

Asbestos-Containing Materials (ACM)

All suspect ACM throughout the Site building are assumed to contain asbestos. Utilizing the EPA, OSHA, MADLS, and MassDEP protocols and criteria, the following materials are assumed to contain asbestos:

Interior

- 12” x 12” Floor Tile & Mastic;
- Vinyl Baseboard & Adhesive;
- Gypsum Board & Joint Compound Soffits;
- 1’ x 1’ Splined Ceiling Tile;
- Chalkboard & Adhesive;
- Top-of-Wall Joint Caulking;
- Wall-to-Column Joint Caulking;
- Sink Undercoating;
- Backsplash Adhesive Associated with Classroom Sinks;
- Classroom Bathroom Baseboard;
- Partition Wall Door Frame Caulking;
- Classroom Door Lite Glazing Compound;
- Corridor Firebreak Door Caulking;
- Corridor Firebreak Door Lite Glazing Compound;
- Ceramic Floor Tile Components;
- Quarry Tile Floor Components;
- Freezer Components;
- Cementitious Ceiling Plaster;
- Spray-Applied Fireproofing (Gymnasium);
- Poured Resilient Flooring Components (Gymnasium);
- Glue Daubs Associated with Rigid Insulation;
- Cantilevered Section Floor Insulation; and
- Crawlspace Slab Vapor Barrier.

HVAC & Plumbing

- Mudded-Fitting Insulation;
- Stick-Pin Adhesive Associated with Duct Insulation; and
- Vibration Isolators.

Exterior

- Concrete-Block-to-Beam Joint Caulking;
- Concrete-Block-to-Column Joint Caulking;
- Interior & Exterior Window Caulking;
- Window Glazing Compound (exterior windows);
- Through-Wall Flashing Fabric/Mastic;
- Louver Caulking;
- Interior & Exterior Door Caulking;
- Adhesive Associated with Rigid Insulation between Exterior & Interior Concrete Block Walls;
- Dampproofing Associated with Concrete Block and Poured Concrete Overlaps;

- Foundation Dampproofing; and
- Concealed Roofing.

Conclusions and Recommendations

Based on visual observations suspect ACM were identified at the Site.

Prior to disturbance, ACM that would likely be impacted by the proposed project must first be abated by a MADLS-licensed Asbestos Abatement Contractor. This is a requirement of MADLS, MassDEP, and EPA NESHAP regulations governing asbestos abatement.

Lead-Based Paint

Conclusions and Recommendations

Based on our visual assessment, LBP is likely present on coated building components within the Site building.

Contractors must be made aware that OSHA has not established a level of lead in a material below which OSHA Title 29 CFR, Part 1926.62 does not apply. Contractors shall comply with exposure assessment criteria, interim worker protection, and other requirements of the regulation as necessary to protect workers during any renovation and/or demolition activities that will impact LBP.

If disturbed by renovation or demolition activities, LBP-coated building components should be segregated from the general demolition waste stream for sample collection and analysis by TCLP to determine proper off-site waste disposal. If disturbed and managed off-site, non-porous LBP-coated building materials (i.e., metals) may be segregated and recycled as scrap metal. Metal LBP-coated building components cannot be subject to grinding, sawing, drilling, sanding, or torch cutting.

The building is currently characterized as a “child-occupied facility” due to the presence of the “Children’s House” within the Tobin Montessori School; therefore, it is currently subject to lead safe renovation requirements. Note that a “change in use” or building vacancy may change this characterization.

Polychlorinated Biphenyls (PCBs) Source Building Materials

Background

Sample collection and analysis of building materials for PCBs is presently not mandated by the EPA. However, significant liability risk exists for improperly disposing of PCB-containing waste materials. Recent knowledge and awareness of PCBs within matrices such as caulking, glazing compounds, paints, adhesives and ceiling tiles has become more prevalent, especially among remediation contractors, waste haulers, and disposal facilities. The EPA recommends sample collection and analysis of caulking and glazing compounds installed between 1950 and 1980 to determine PCB concentration.

The EPA requirements apply and require removal of PCBs once identified, regardless of project intent as an unauthorized use of PCBs. Once it is determined that PCBs are present and a building is to remain for re-use, the EPA still requires PCB-containing material removal. If PCBs are present at certain concentrations, additional sampling and analysis of adjacent surfaces in contact with PCB sources, or which may have been contaminated from a source of PCBs (e.g., masonry, soil), must also be performed or remediated.

EPA requirements apply only if PCBs are present in concentrations above a specified level. Presently, PCB-containing materials at concentrations greater than or equal to (≥) 50 part per million (ppm), or equivalent units of milligrams per kilogram (mg/kg), are regulated. Note materials containing ≥ 1, ppm but less than (<) 50 ppm may also be regulated unless proven to be an “Excluded PCB Product”. The definition of an Excluded PCB Product includes those products, or source of the products, containing < 50 ppm concentration PCBs that were legally manufactured, processed, distributed in commerce, or used before October 1, 1984.

Conclusions and Recommendations

Suspect PCB-containing source building materials should be presumed to contain regulated concentrations (≥ 50 ppm) of PCBs until sample analysis indicates otherwise. These materials should be removed and disposed of at an EPA-approved facility as regulated PCB Bulk Product Waste.

The extent of PCB-source building material removal is heavily dependent upon the direction of the project. Renovation may be handled using a presumptive approach. This entails addressing worker protection and disposal requirements for caulking and window glazing compound that would be impacted by the renovation work. Sample collection would not be recommended for a renovation project.

If demolition is the selected option, PCB removal and remediation becomes much more involved. Past experiences with similar building construction (MLK/Amigos Project) required removal of all porous concrete block, removal of structural concrete at the caulk line (approximately 3”), and sandblasting of all painted interior structural components. The actual approach for demolition would require additional conversations among the Owner, the Client, and Fuss & O’Neill.

Fluorescent Light Ballasts & Mercury-Containing Equipment/Materials

Conclusions and Recommendations

DEHP-containing fluorescent light ballasts and mercury-containing equipment/materials were identified in the building during this inspection.

Fluorescent light ballasts marked as “No PCBs” with date labels indicating manufacture prior to 1991 are presumed to contain DEHP. DEHP-containing ballasts must be segregated for proper packaging, transporting, and disposal as non-PCB hazardous waste. Note that disposal requirements for DEHP-containing ballasts are slightly varied, and disposal costs are slightly less, when compared to PCB-containing light ballasts.

According to the EPA, mercury-containing equipment and materials are characterized as a hazardous waste, and mercury lamps/tubes are characterized as a Universal Waste. The mercury-containing equipment/materials and fluorescent lamps/tubes identified in the proposed renovation areas must be recycled, reclaimed, or disposed of as hazardous waste or Universal Waste prior to disturbance.

4.11 Landscape

Image 4.11 a

Overall Proposed Site and Landscape Design

The Tobin Montessori-Vassal Lane Upper Schools with added Community School and Preschool require a significant amount of open space programming, and the community has historically actively used the fields at Father Callanan Playground. These uses were confirmed and requested by the community, Cambridge Public Schools Department and Cambridge Department of Health Service Programs. With limited open space in the City of Cambridge, the City is charged with looking at the project from the lens of a building within a playground. The importance of open space is outlined in *Envision Cambridge – Alewife District Plan (2018)* as well as other City of Cambridge open space and play initiatives which include specific open space objectives including expanded biking and walking paths, active and passive open space for all ages and abilities, water play and community use.

The building project will ultimately include the redevelopment of the entire property. Therefore, all play elements, courts, open space, fields, water play, paths, lighting and other amenities will be all new construction. This will provide us with the opportunity to reimagine these amenities and improve upon them for both the schools use as well as the community's use.

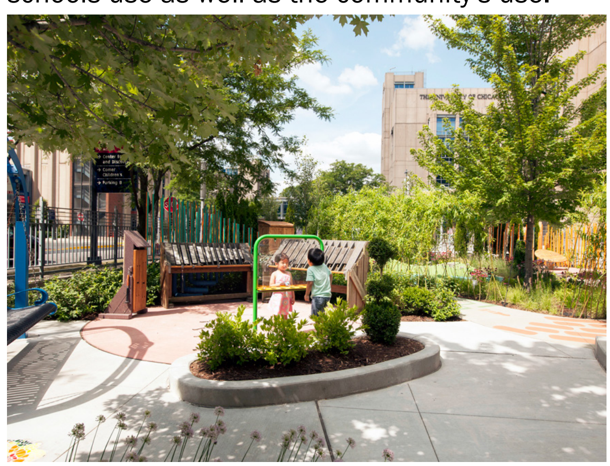


Image 4.11 b

Image 4.11 c


Image 4.11 d

Community access, through the site and to the open space elements will be a key component in the design. Access through the site meets a key objective of the intent of the *Envision Cambridge* is to "Better integrate the district with the rest of the city through new walking and biking paths, streets and open spaces." We should note here that there are also concerns regarding a clear delineation of public use versus school activities to support safety and oversight of student activities. Special consideration will be made during schematic design to provide community path network that has a physical separation from school play space during school hours yet allows for community use after hours and on weekends.

Site Amenities

Pathways for cyclists and pedestrians will be designed to provide open and safe access across the site including connectivity to main building entrances, play spaces and different parts of the neighborhood. Pathways will have lighting, wayfinding, shade, drinking fountains, bike racks, seating nooks for rest and viewing


Image 4.11 e

of open spaces and landscape. See below for further site amenities.

Play Amenities

The preferred option includes multiple structured active space and unstructured passive areas. A key objective for each space is to provide a visually connected, universally designed play areas that meet the needs of a range of age groups and abilities for both the students and the community.

Play areas will be connected by pathways and simple separation techniques including fencing, landscape and building will allow for a safe outdoor play space with age appropriate play equipment for 3-year old children, Pre-K, elementary and middle school age groups. Play space boundaries will be well delineated so that there will be passive supervision over these areas and not have incidental mixing of students and community users during school hours. Additionally, each area will have amenities including seating, tables, wayfinding, and drinking fountains in key locations for the comfort of students, staff and the community.

Play areas will include structures for active use engaging students gross motor skills and provide sensory challenges including spinning, swinging, rotating, climbing, discovery and dramatic play. These all support rich

Image 4.11 g

Image 4.11 f

experiences in cognitive, physical and social development. The emphasis of students working together to create a game, problem solve, discover all while being outdoors supports the Montessori principles.

- Pre-School/Community School Play area – This play area will incorporate freestanding play features such as musical, visual and tactile sensory play panels, swings and a functionally linked play structure which will have elements of numbers, letters, slide, mini race track, movable pieces and imaginary play area. The area will be surrounded by a trike track. Additional outdoor gardening, storage, sensory gardens and outdoor gathering/learning space will be provided. This area is approximately 12,000 sf which includes all landscape, hardscape and play space surrounded by the building walls on three sides and a fence and gate on the open side. The MA Department of Early Education and CARE (EEC) dictates 75 sf per child for early education/pre-K students. Using this formula, this area can accommodate 160 students, if calculated using every sf of space.

- Tobin Montessori Elementary School Play Area – This play area incorporates a large area of approximately 17,000 sf. Currently there is not a formula that dictates a required amount of play space for children after pre-school. The area includes City Sprouts gardens, other planting beds with trees, fencing with gates, benches, picnic tables, storage, drinking fountain, functionally linked play structure, climbing structures, swings, large rotating climbing structure, spinning structure, hard surface areas for painted games, and a messy area with a mix of traditional and natural play elements allowing students to decide how they want to play, build, and create. This area also has a water play feature which is separated by fencing allowing restricted access during the school days and easy access for the community after school, weekends and summers.

- Vassal Lane Middle School Play Area – This play area is located directly off the gymnasium so that it can also be used for PE class and is approximately 10,000sf. This area includes more fitness themed equipment, a half basketball court, benches and is enclosed with fencing. It is also directly adjacent to open lawn space which is approximately 14,000sf.

- General - It should be noted here that the middle school students will have easy access to the Tobin Montessori School Play Area with supervision if the school scheduling allows. Small and large group settings are also engrained into the landscape to create a small school feel within a larger school community. All students will have access to the recreation fields which include a multiuse field and a little league field. These areas will also have a fence and safety netting but will not be fully enclosed. Open lawn areas noted below are also a major feature that provides both structured field space and passive open space. Hard surface play areas serve multiple uses including winter activities when the other play areas cannot be used. The existing basketball court will be reconstructed including new base and pavement, seating and accessible path to not only improve the court play but also provide permeable pavement as part of the storm water management plan. All of these varied spaces will provide students and community members with a rich experience.

- Materials - Ground plane material for play areas will include a poured in place surface meeting all critical fall height safety and ADA requirements. Colors will be rich in patterns and will meet SRI values. Play equipment and site furnishings will be sturdy, durable, long-lasting materials that will be easily maintained by the City and meet all current industry safety standards. Hard court areas are bituminous paving over a gravel base and painted for basketball and other games and will meet SRI values. Pathways will be bituminous concrete and permeable in some areas to meet storm water requirements. Plazas, drop off areas and spaces at building entrances will be concrete. Walls will be cast in place or block core with stone or other veneer and stone cap. Other small walls or planter edging will be granite curb or other natural stone edge. Screen walls located near the Armory property will be a combination of masonry and green screen. Fencing for backstop and dugouts will be black chain link and will include safety netting along first and third baselines. Fences and gates for play areas will be a minimum of 42" tall steel or aluminum fence that aligns with the style and materials of the building. Garden fence and gates will be cedar posts with mesh infill. Small bridge structures hydrologically connecting bioretention areas will be precast concrete.

Gardens and Landscape

The bones of the proposed landscape is the protection and preservation of formidable existing trees around the perimeter of the site which offer immediate shade, scale, presence, buffer and atmospheric carbon sequestration. Protection will be a primary goal during construction and will require an ISA Board Certified Master Arborist with MA certification providing a tree assessment, protection measures, root and crown pruning during the entire construction phase.

Proposed shade trees that will fill in the gaps or successional planning of perimeter trees will replace those mature trees that are deemed in poor or declining health. Additionally, proposed native shade trees will be planted around the site for future shade canopy.

There will be multiple types of other gardens throughout the site for the use, enjoyment and learning of the students and the community. These include rain gardens, sensory gardens and habitat gardens. These would showcase native and adaptive plant species. Growing gardens meeting the City Sprouts program will have a primary presence for Pre-K through the Middle School use. These gardens will include various types of raised beds, work area with shade, composting, leaf litter, access to water and a storage shed.

Open space not otherwise planted with gardens or used as recreation fields will be primarily open lawn space for flexible use by all users. Recreation fields will also be planted with turf, but will require a more intense soil profile, drainage and irrigation and will require a more intense maintenance program keep it as usable as possible.

The reuse of existing topsoil or other soils on site will depend on the results of soil testing which include both a mechanical and chemical analysis. The intent would be to reuse any soils and amend them to meet the soil characteristics for healthy establishment and growth of plants. Additional imported soil to meet the quantity needed will also be tested and amended to meet the same requirements.

Green Roof

There is an 8,000sf green roof included within the building footprint will accommodate extended outdoor learning opportunities. These green roof areas will have raised garden beds filled with planting medium that can support plants of various sizes that the students can grow seasonally with a roof paver decking system around them. Trellis structures and green screens may be included for additional planting and open seating space.

Summary

The preferred option site plan provides specific information and location of materials, amenities and conceptual grading.

Image 4.11 h

5.0

OTHER DESIGN OPTIONS


Charter Oak International Academy: Connecticut Image

5.0 Comprehensive Explorations Informed the Preferred Option

There were numerous design options explored through the Feasibility Study prior to deciding the preferred option. The design team explored these options through physical block models, drawings, and 3-D massing models. Three options were presented at the November Cambridge Community meeting: Renovation / Addition, Wings, and Pavilions. Two of the three options were new construction, and one explored renovating the existing academic wings. Informed by feedback from the community meeting, and written comments received by community members, these options developed and progressed. Key comments from the community focused on: open space, traffic circulation on site and neighboring streets, building footprint, and preserving as much of Father Callanan playground as possible.

At the January Community meeting, the design team presented the developed Wings and Pavilions, but in place of the Renovation option, introduced an additional new-build option entitled Replacement. The Replacement option sought to keep the building relatively in the same location, but because the new building wasn't constrained by the inefficient layout of the existing building, the footprint was able to be greatly reduced from the Renovation / Addition option. Feedback from the January meeting, along with the design options matrix (1.2), indicated that the Replacement option most closely achieved the desired goals of the community; however, there was still a push to shrink the footprint and possibly reduce the size of the program. These factors, along with many others, led to the development of the preferred option, now known as Crossroads, as evolved from replacement.

Design Team Meeting

5.1 Renovation / Addition

The approach to the project began with analyzing the existing building: its history, environmental impacts, and its size in comparison to the projected growth of the school. Based on early discussions regarding program and enrollment, a new addition would be required to meet the schools' needs.

The existing facility is already overcrowded with students, and the inadequate conditions do not provide a constructive learning environment for students and staff. A renovation of the academic portion of the building would help significantly towards a healthier facility and a better learning environment for the students, all without demolishing the entire building. Community support for the building and its historical significance lead to the study and design of the Renovation/ Addition option.

Description – Existing Building

The area is approximately 128,170 GSF, and the building sits on the southernmost end of the site along Vassal Lane. The building height and site gestures reflect a scale appropriate to the surrounding residential neighborhood. The site elevation then drops to the full three stories on the north facing end with the gym wing and outdoor playground spaces (Image 5.1a). The building is a simple parti featuring the two academic wings in the front, a central, shared main entrance, and a shared program wing in the back facing Father Callanan Playground and the three baseball fields.

The two academic wings feature the hexagonal layout of classroom spaces that project in and

Image 5.1a Three Stories on North Facade

out of the exterior façade with bay windows and outdoor play spaces (Image 5.1b). While the building orientation is optimal for solar exposure, the size and configuration of the classrooms, as well as the size of the windows, restrict access to daylight and passive ventilation (Image 5.1c).

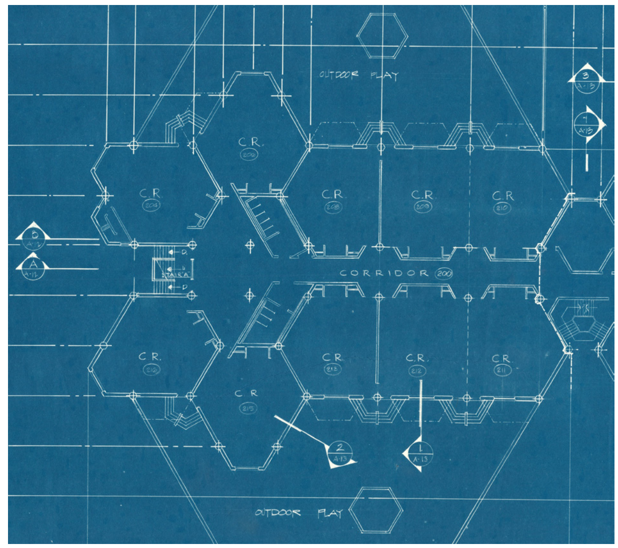


Image 5.1b Shape of Classrooms

Image 5.1c Classroom Windows

The shared main entrance is located within the center of the building, but lacks security, and allows visitors to wander through the school. Directly off the entrance is an open double-height dining hall, resulting in acoustical problems for the school (Image 5.1d). The academic wings further lack the flexibility to have both schools represented on the first floor, and therefore the Vassal Lane Upper School lacks a ground-floor presence. Teachers have

Image 5.1d Double-height Cafeteria

expressed their frustrations with this lack of identity. They have mentioned the older children being uncomfortable traveling through hallways with the younger children to get to the shared program spaces, and the classrooms not providing what is needed for the specific subject matter.

The shared program wing extends north on the site between the two academic wings. This wing includes the gymnasium, loading/delivery drop off zone, and exterior storage. This wing extends into the site and separates the staff parking and playground area. As mentioned previously, while the gyms are centrally located, traveling within the vicinity of the main entrance and past the open dining creates acoustical disruption for the neighboring classrooms. The staff and community appreciate the gym's adjacency to the outdoor baseball fields. There is also appreciation for the separation between the parking lot and the playgrounds, and the consistency of playground space and views to all three baseball fields to the north of the site. The consistency in viewing the outdoor play spaces turned out to be a significant design factor for the preferred option.

The gym wing is proposed to be demolished in the Renovation/ Addition option in order to construct a much needed, 170,210 sq. ft. addition for the shared program, new Preschool and the additional Vassal Lane classrooms.

Condition of Existing Building

The existing building is comprised of a concrete structure of columns and slabs. Exterior materials include steel window frames, a ballasted EDPM roofing system and masonry block. Retaining walls surround the half story below ground with the recessed playgrounds and outdoor classroom spaces. While visual studies found rigid insulation between the exterior and interior concrete block walls, it was not clear whether a vapor barrier exists within the cavity.

A majority of the building components are past their life expectancy; including windows, mechanical and electrical systems, and fire protection. Several of the rooftop units appear to be original equipment to the building, calculating them passed their recommended service life. The electrical systems are of similar age and in need of replacement. In addition, existing conditions investigations have found multiple areas breaking code compliance with missing fire stopping. Plumbing throughout the building will require replacement due to visible corrosion and frequent leaking. Teachers have described walking into their classroom and having to clean up water puddles, and the hallways needing multiple buckets to collect the water dripping from the ceiling. With a majority of the interior needing reconfiguration, the existing building will require significant structural upgrades to meet current seismic requirements.

A visual study of hazardous materials was conducted at the beginning of the Feasibility study. Several interior, exterior, HVAC & plumbing materials are assumed to include asbestos, PCBs, and lead paint. A more thorough sampling and testing will take place during Schematic Design. Although it is possible to renovate the existing facility and upgrade the building systems, the structural layout and configuration are a greater challenge to overcome.

Description – Renovation/ Addition

This option proposes renovating the existing two academic wings along Vassal Lane, but demolishes the existing gym wing for a large addition that extends to the north part of the site. The design was largely driven by the desire to preserve one of Belluschi's buildings.

Renovating and reorganizing the existing two wings allows for the Vassal Lane Upper School to have a presence on the first floor, and adjacency to the main entrance. Rather than having Vassal Lane stretch across the entire second floor, the school is organized with the 6th and 7th grades on the first and second floors within the southeast end of the existing building. The Tobin Montessori Lower and Upper Elementary schools are organized on the first and second floors of the southwest end. The Children's House and Special Start remain on the lower levels to make best use of the existing recessed playgrounds. The remaining Upper School 8th graders are located above the shared program spaces within the new addition. The addition runs north – south, and is located adjacent to the Armory plot, allowing the relocated sports fields to lay between the new building and the Alpine Street neighbors.

Circulation through the shared spaces also runs north – south, while the academic wings branch perpendicular in the east – west direction. The new Preschool and After school Wing stretches along Concord Avenue, allowing the entire building to surround the play fields in the center of the site. A soccer field and baseball field are located in the middle along with one of the many playgrounds dispersed throughout the site. A majority of the depressed playground spaces will remain around the existing building. The existing parking lot will be used for parent drop off, and staff have underground parking below the addition. Another new parking lot and drop off lane would be located off Concord Avenue for Preschool and After school parents (Images 5.1e – 5.1g).

The main entrance remains in the existing building, and is shared between the Lower and Upper schools. Another entry is located off the Preschool wing, at the head of the main corridor running through the addition. Administration is located adjacent to these two entrances in order to control access and better direct visitors to the appropriate school. Although the Upper and Lower School still share a front door, each school has an opportunity for a warm welcome for visitors into their respective academic wings.

Renovating the existing building expands the possibilities for a more efficient layout, a healthier building, and continuous connection

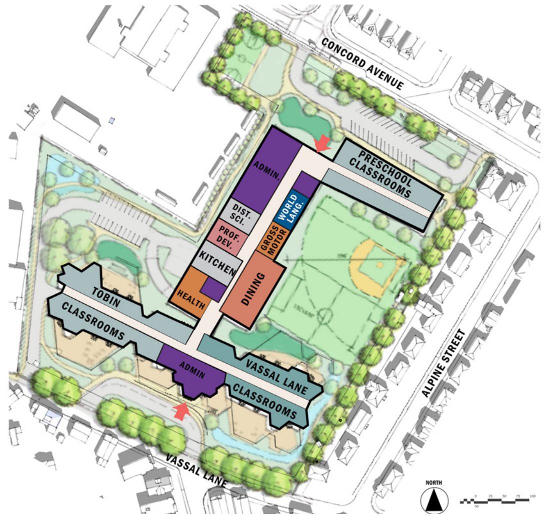


Image 5.1e: Addition / Renovation First Level

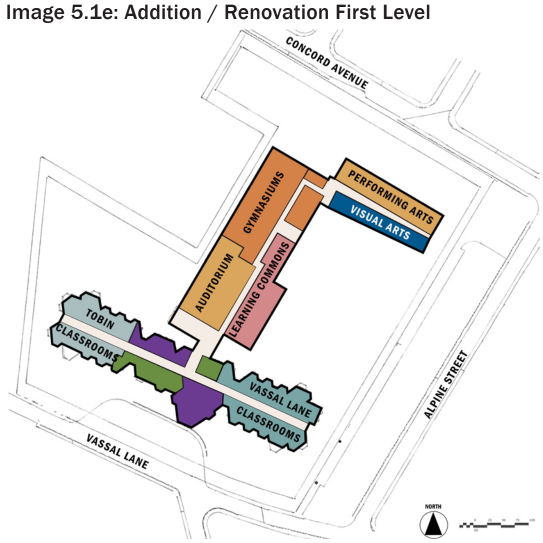


Image 5.1f: Addition / Renovation Second Level

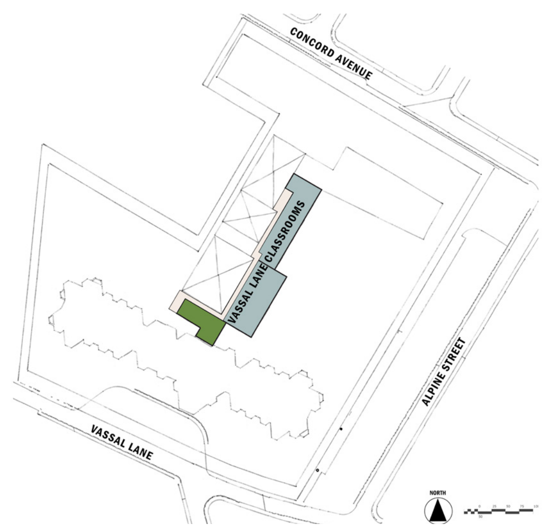


Image 5.1g: Addition / Renovation Third Level

to outdoor spaces. By renovating the interior academic wings, the classrooms can reorient with better access to daylight. Upgrading the building systems, and windows will ensure healthier learning environment. All the options will feature photovoltaics towards achieving the project's Net-Zero energy goals. Bioswales and learning gardens are dispersed throughout the site adjacent to playgrounds, allowing students to learn about the sustainable qualities of the school (Image 5.1h).

Energy and Insulation

In order to meet Net Zero goals, for both energy and carbon, a new envelope will be required, ensuring a tight thermal envelope. The new addition will also feature an underground parking garage that will require continuous insulation, and waterproofing.

The hexagonal shapes of the existing building, create many spatial inefficiencies, resulting in a large addition that creates an even greater building footprint compared to the other two options. A larger building also requires more energy to heat and cool, which challenges the net-zero energy goals. All options will require photovoltaics, but with this larger building there is an opportunity for more roof-top PV. The existing building needs to be reconfigured in order to achieve a more efficient program layout, and therefore include demolition and new material.

Resiliency is another big consideration for this project, and our site is challenged by the fact that it is in a flood plain. This option keeps many program spaces partially below grade, which is not best-practice for resilient design.

Program Fit

As mentioned, the projected enrollment and new program requirements surpass the capabilities of the existing school. The existing building has the potential to be reconfigured to better academic neighborhoods described in the Design and Architectural goals, but additional classrooms will need to be located in the new addition above the shared spaces.

Building Orientation, Natural Light, Floor to Floor Heights

The existing building is close to ideal solar orientation, although the lack of windows within the academic wings decreases the access to daylight. The configuration of the classrooms limits the amount of windows, and few corridors have outdoor views. This requires more lights to be left on for longer periods of time. The proposed addition also doesn't have a strong opportunity for proper orientation without significantly challenging the outdoor program. The addition will have ideal floor to floor height, allowing for light shelves to reflect daylight further into classrooms and shared program spaces. The orientation for the addition however is not ideal, and without proper sun-shading could create glare in classrooms.

Zoning

The existing two academic wings remain adjacent to Vassal Lane with the bus loop in front, and the service lane on the west end. The shared program bar runs north with the Preschool wing along Concord Avenue. The new addition will be a half story taller than the existing building along with a mechanical penthouse on top. With the building reaching both ends of the site, the existing park is relocated to the middle of the site between the building and Alpine neighbors. This option holds a close adjacency to both Concord Avenue and Vassal Lane in comparison to the other options explored.

Parking and Usable Open Area

Larger program requires more on-site parking. The Addition – Renovation option makes use of the existing staff lot between the existing school and the Armory plot. Additional surface parking is located north of the site off Concord Avenue (Image 5.1j). This loop provides a pick up and drop off opportunity for the Preschool parents separate from the current bus loop for the Lower and Upper School. Due to its position on site, the existing building prevents the existing bus loop from increasing in size, and therefore doesn't resolve the bus backups on Vassal Lane. A new underground parking lot is located below the addition with 100 spaces. This total

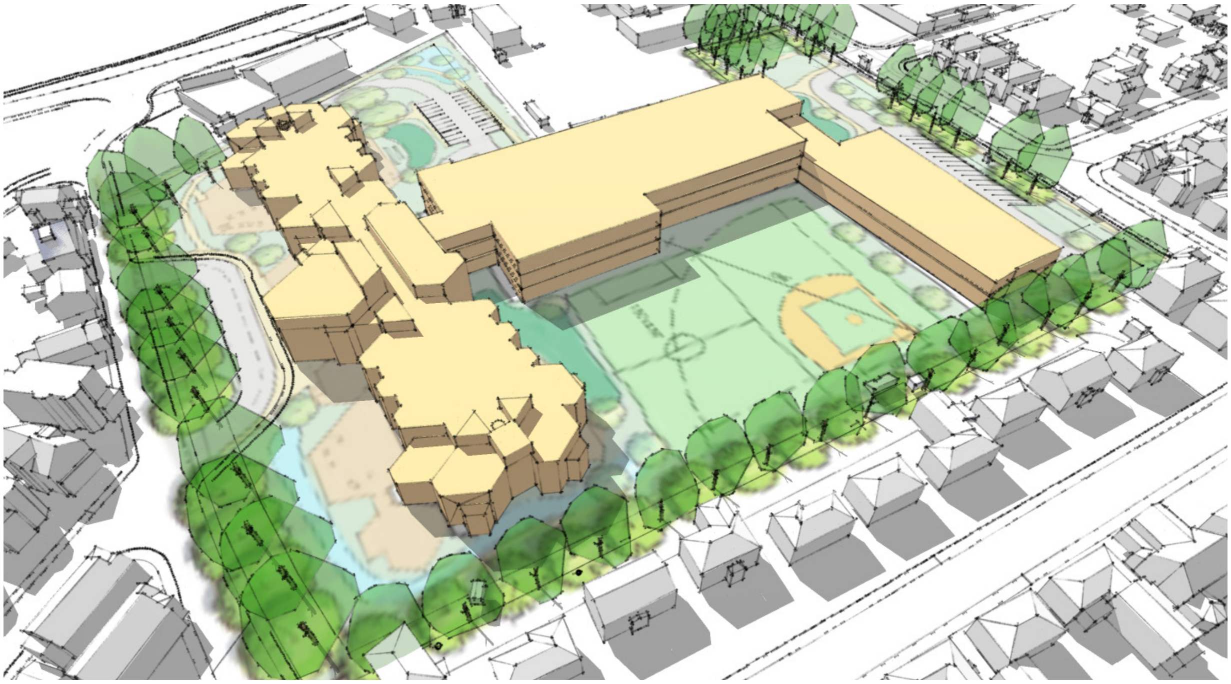


Image 5.1h: Addition / Renovation Aerial View from SE Corner

is 50 on-grade parking spots for parent drop off, and 100 below-grade spots for staff parking. The existing pedestrian routes through the site remain. Other new construction options allow for more efficient circulation options through the site, and provide a longer bus lane to bring traffic off the surrounding streets.

Addition/ Renovation Pros

1. Makes use of a portion of the existing school and preserves Pietro Belluschi's brutalist style along Vassal Lane.
2. School holds presence on both ends of the site.
3. Opportunity for on grade parking near Lower School and Preschool for parent drop off and pick up.
4. Existing service and parking lot remains behind building.
5. Large roof area for photovoltaics

Addition/ Renovation Cons

1. This design has the largest footprint out of all the options and therefore the least amount of open area.
2. The playgrounds are disconnected from each other and the sports fields, and visitors are unable to continuously see the site.
3. Renovating the existing academic wings will not result in the optimal window to wall ratio without drastically changing the façade.
4. Vehicular circulation is limited because of the existing building's location on site.
5. Soccer and baseball field overlap and cannot be used at the same time.
6. Gymnasiums are on the upper floor and do not have a direct connection to the outdoors or the playfields.
7. Auditorium is on the upper floor, making public entrances difficult to manage.
8. Visual and performing arts are above Preschool wing and are further away from the Lower and Upper school.

Image 5.1l: Addition / Renovation Site Plan

Image 5.1j: Addition / Renovation View from Concord Ave.

5.2 Wings

Description

This option proposes a new building on site, with the existing building being demolished completely. The design was driven by: swapping the building and site area, establishing a strong identity for each of the three schools, and expediting vehicular circulation through the site. The term “wings” came from the building’s three academic wings arraying out in the east/west directions, with the shared program connecting them through the site.

Three individual wings for each of the schools ensured each having a clear identity, entrance, and ground floor presence. The shared program spine begins with the main building entrance between the Preschool and Tobin Montessori Lower School, and ends with the Auditorium and entrance to the Vassal Lane Upper School. Having the entrance between the Preschool and Tobin not only breaks down the long façade between the two academic wings, but also creates a clear, identifiable main entrance. The soccer and baseball field buffer the school from the residents on Vassal Lane, while the Auditorium and Upper School wing holds presence on the more commercial Concord Avenue. A courtyard of play spaces lies between the Lower and Upper school wings. This large outdoor space features a variety of playgrounds for the various age groups, learning gardens and bioswales. Another playground on the northern corner of the Preschool wing allows younger children to be separate from the older students. Off the Preschool wing is a parent parking lot with a pick up and drop off loop separate from the buses, so parents with younger children have the opportunity to walk them into the school. A separate bus lane runs parallel with Alpine Street to drop off Lower and Upper School students (Image 5.2a – 5.2c).

The main entrance to the building is located off the Preschool parent drop off loop between the Preschool and Tobin Montessori wings. A secondary entrance is located between the Auditorium and Vassal Lane academic wing, and tertiary entrances are located at the ends of each academic wing and off the dining in the center of the building. Circulation through the central spine of the building runs parallel with

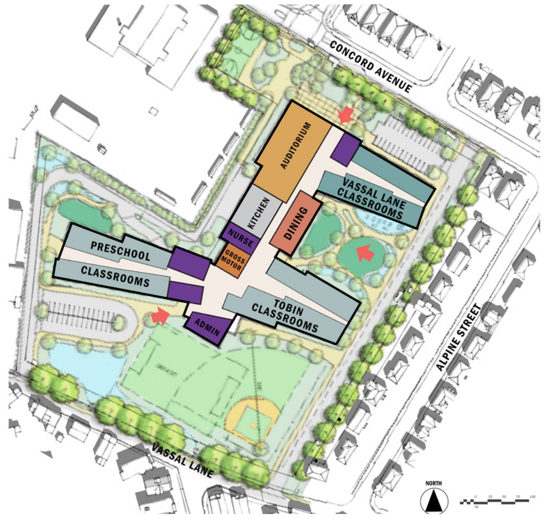


Image 5.2a: Wings First Level

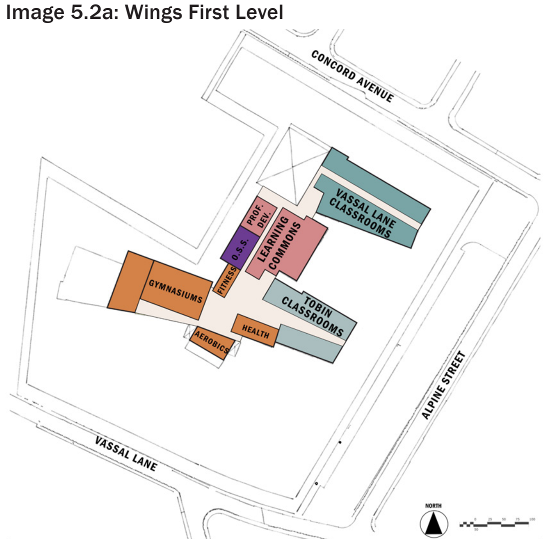


Image 5.2b: Wings Second Level

Image 5.2c: Wings Third Level

the site going north-south, while the academic wings run east-west. Administration for all three schools are located adjacent to entrances to control access and direct visitors.

With the new construction comes sustainable gestures through building orientation and connectivity to the outdoors. Classrooms can face north or south for natural light. Learning gardens are mixed in with the playgrounds off the courtyard and located near the dining spaces for direct use. Photovoltaics and roof canopies contribute to the Net Zero goals of the project. Direct connection to the outdoors is one of the fundamental principles within the Montessori program; all of the academic wings have adjacent green spaces and/or open area for outdoor activities (Image 5.2d).

Program Fit

The Wings Option provides enough building area to include all the program components listed in the Educational Specification. Classrooms are arranged into neighborhoods based on grade level as described in the Architecture Goals and Design Principles. A strong advocate for this layout is how each of the schools has a ground level presence. The existing building is unable to provide this, and therefore pushes Vassal Lane to the upper floor and prevents the school from having a clear identity.

Zoning

The Wings option improves setbacks from Vassal Lane and the surrounding residences, however the building stretches closer to Concord Avenue and into Open Space zoning. The existing playground is relocated along Vassal Lane with enough space for a baseball and soccer field. The new building would sit a half story taller than the existing building; being partially three stories with a mechanical penthouse versus the existing two and half stories above ground.

Parking vs. Usable Open Area

This option provides ample opportunity for on-site parking, pick up and drop off zones, and staff underground parking. 50 on-grade spaces are designated for parent use while walking their child into school. These are located in two lots, one off Concord Ave near the Upper School academic wing, and one off Vassal

Image 5.2d: Wings Aerial View from SE Corner


Image 5.2e: Wings from Concord Ave.

Lane near the Preschool wing. The service lane runs around the Preschool wing and branches to the loading dock and the entrance to the underground parking. The underground parking garage includes 100 spaces designated for staff. A portion of the bus lane allows for a temporary pull over space for quick pick up and drop off; allowing other traffic to continue past without clogging the lane and attempt to expedite travel time through the site. The variety of vehicular circulation options should eliminate some of the traffic build-up on perimeter streets, and keep buses and cars efficiently moving through the site.

One deficiency to this design is the amount of open area that the building and roads take up. The design requires new sports fields to overlap, and they are disconnected from the playground area. This disconnect was concerning to the community, especially for parents that have children of different ages using play spaces in different areas. The leftover open site area was another concern to the community and a huge driver towards the verticality of the preferred option (Image 5.2e).

Sustainability / Net Zero

All of the design options feature the sustainable technologies and systems that strive for Net Zero Emissions. This includes building systems, insulation, solar shading and light shelves, with rooftop photovoltaics. This option provides ample rooftop area for PV panels; either direct mounted to the roof, or canopy mounted to allow space for air handling units, rooftop classroom space, and green roof below making it easier to achieve Net Zero Energy goals. There is less site available for community outdoor recreation with the footprint and on-site vehicular circulation.

Wings Pros

1. Community use on all sides with pedestrian circulation, sports fields, and playgrounds.

Image 5.2f: Wings Site Plan

2. Opportunity for an onsite drive aisle for buses and cars that is separate from the underground parking entrance, and an opportunity for surface parking lots and service lane.
3. Service and parking entrance at site interior behind building.
4. Play fields on south side of site off of Vassal Lane, and closer to residents.
5. Large roof area for photovoltaics.
6. Classrooms appropriately face north and south for optimal daylighting.
7. Shared program spaces are within a central spine and easily accessible from all three academic wings.
8. All three schools have a ground level presence and identity off of the main entrances.

Wings Cons

1. There is a significant loss of open area due to the footprint and on-site vehicular circulation.
2. The courtyard playground is disconnected from the play fields, and parents are unable to see continuously across the playground space.
3. Gymnasiums are located on the second floor above the Preschool neighborhood, therefore disconnected from the play fields and direct outdoor access.
4. The Upper and Lower School three story academic wings are within close proximity to Alpine street neighbors.
5. Playfields are overlapping and therefore cannot be used at the same time (Image 5.2f).

Wings V2

This option evolved further after the community's comments and recommendations for a layout that provided more open area. In order to do so, the building footprint was consolidated, site vehicular circulation was minimized, and the fields were reoriented on site. To decrease the size of the building footprint, more of the program had to relocate to the third floor, leaving a majority of the building a full three stories with a mechanical penthouse above. The design goals are still achieved with the changes, however the gymnasiums remain located on the upper floors and the setback off of the Alpine neighbors decreased.

Following feedback from the community the bus lane along Alpine was removed. Additionally all surface parking was moved underground to allow for more green space. Vehicular circulation on site was reduced to a short multi-use bus lane off of Concord Avenue, and a service lane that branched to the underground parking and loading dock. Moving the surface parking underground allowed for the sports fields to separate on site to enable use at the same time. The Wings option remained inferior to the Preferred Option in the amount of open area and not having a continuity between the playground spaces and the playfields (Image 5.2g).

Image 5.2g: Wings V2 Site Plan

5.3 Pavilions

Description

This third option, Pavilions, also proposes a new building on site with complete demolition of the existing school facility. Similar to Wings, this design was driven with each school having an identity and front door on grade. This layout breaks down the academic wings into shorter and wider neighborhoods that connect to instructional and administrative program in the middle. The shorter academic wings open to the central spine of shared program, allowing for a greater setback off the east and west sides of the site. This in turn allows Pavilions to be a "better neighbor" to the surrounding residences with the shorter wings and frontage on site in comparison to the existing building. Unlike Wings, the Pavilions option has three main entrances for each of the three schools rather than being shared, and all three entrances are located adjacent to vehicular circulation on site.

The Upper School entrance is right off a surface parking lot adjacent to Concord Avenue between the academic wing and the auditorium, and a secondary entrance is located off the bus lane along Alpine street at the east end of the wing. The Preschool entrance is off a second surface parking lot near the service lane behind the school and offset from Vassal Lane. The same secondary entrance off the bus lane is available for the preschool wing as well. Finally, both Tobin Montessori entrances are located off the bus lane closest to Vassal lane. This allows parents to have a more direct route into the school. The overlapping soccer and baseball fields are located on the west end of the site in close proximity to the Preschool parking lot. Each of the three schools has their own play space adjacent to the academic wings and dining space. This allows classrooms to have direct connection to outdoor spaces, and the playground equipment can be more age appropriate. With the playgrounds being located between the bus lane and the building, the bus lane can close off during the school day for outdoor activities (Image 5.3a – 5.3c).

Similar to Wings, a bus lane runs from Concord Avenue to the north, parallel to Alpine Street, and ends on Vassal Lane. The building is

Image 5.3a: Pavilions First Level

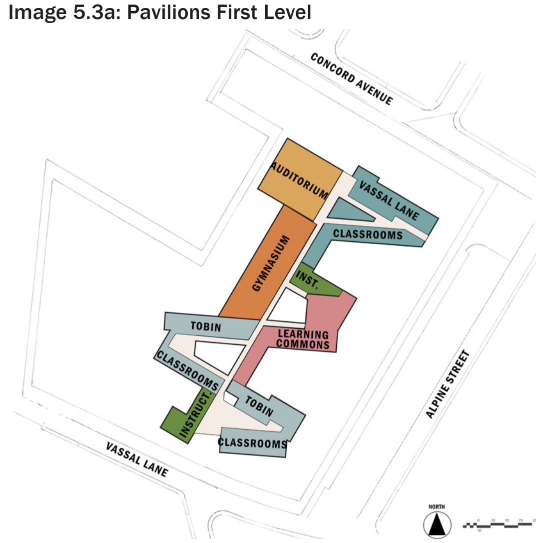


Image 5.3b: Pavilions Second Level

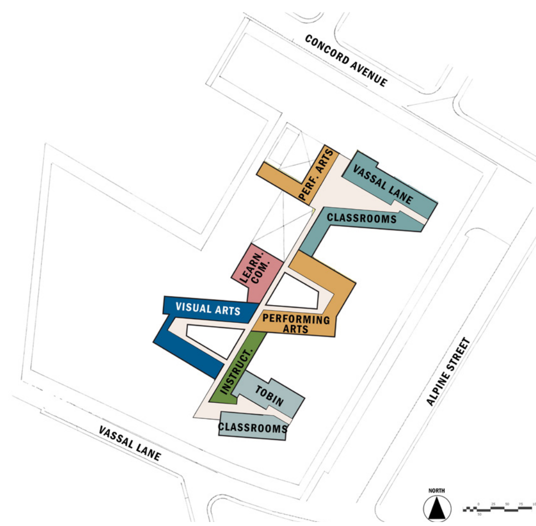


Image 5.3c: Pavilions Third Level

oriented in a similar fashion with the three wings alongside the bus lane, and the shared program spine in the middle. The three main entrances open to administration for each of the schools in order to direct visitors efficiently, and for each to have a welcoming entry into the academic neighborhoods.

Pavilions achieves similar sustainable goals to Wings with its larger footprint accommodating more rooftop photovoltaics, and the orientation of the academic neighborhoods. Classrooms can make use of the natural light, and the ground floors of each school are directly adjacent to open green space. The bioswales and learning gardens are more dispersed throughout the site around the three playground areas, fields and parking lots.

Program Fit

Pavilions achieves the design goals for program and neighborhood layouts within the building. The shorter neighborhoods allow classrooms to be closer to the central shared program spaces with less travel distances. Both the Tobin Montessori neighborhoods and the Preschool/ Afterschool neighborhoods open to rooftop courtyard spaces on the second floor. Similar to Wings, the success of this layout is driven by the identity each school is able to achieve with their main entrances and presence on the ground floor.

Zoning

While Pavilions includes better setbacks from the Alpine Street neighbors, it does have a closer presence to both Concord Avenue and Vassal Lane, in comparison to Wings and the existing building. This is in exchange for having a shorter façade frontage on both north and south ends of the site. The existing playground is relocated to the west half of the site below the Armory plot, with a baseball and soccer field. Similar to Wings, Pavilions will sit a half story taller in comparison to the existing building with a mechanical penthouse (Image 5.3d).

Parking vs. Usable Open Area

Pavilions offers the same variety of vehicular circulation as Wings with the bus lane, surface parking and underground parking. The 50 on

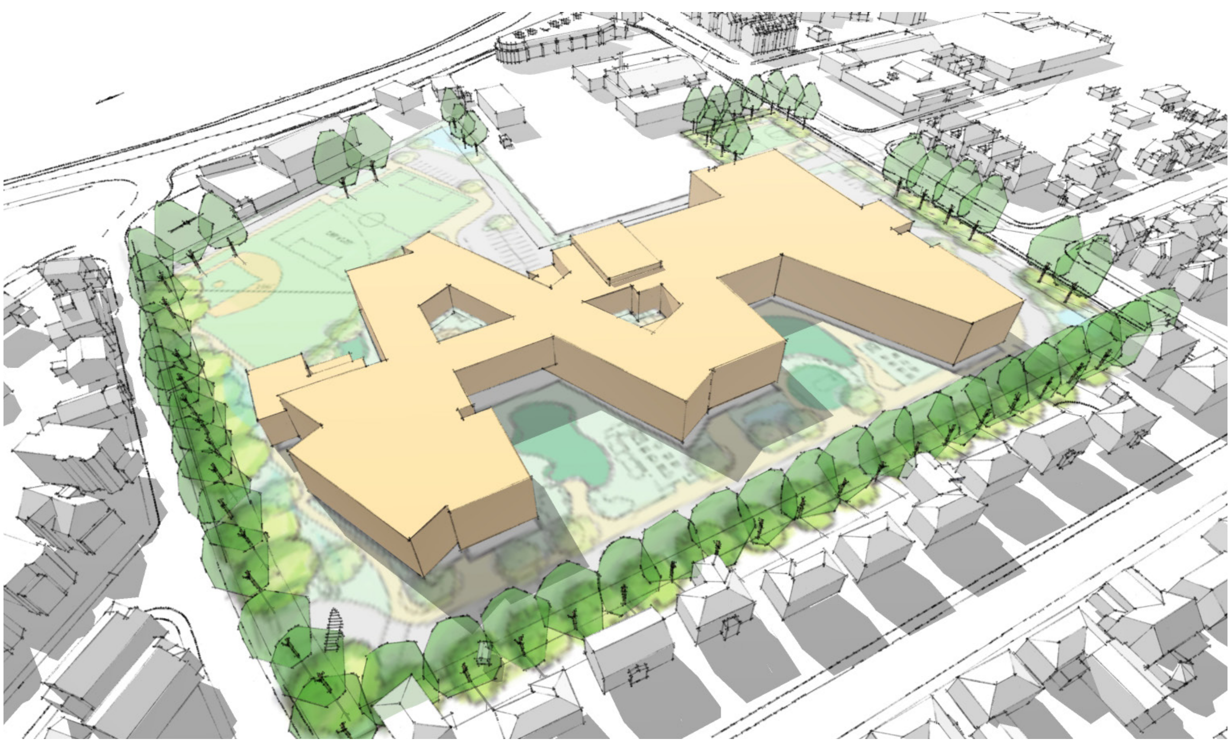


Image 5.3d: Pavilions Aerial View from SE Corner

Image 5.3e: Pavilions View from Concord Ave.

grade parking spots are located in two lots, one near the Upper School and Auditorium, and the other near the fields and the Preschool in the center of the site. As mentioned, the bus lane is located east of all three academic wings and their corresponding playgrounds, allowing it to be multiuse outdoor space during the school day. This lane also contributes to the pedestrian circulation and bike paths through the site. The service lane and entrance to the underground is completely separate from the two lots and bus lane. This allows the staff to have their own vehicular entrance to the site away from the parent drop-off and buses. This lane is located off Concord Avenue and further tucked behind the building and out of sight of children and visiting parents. The same deficiency in open area exists in this option as it does in Wings. The larger footprint covers more of the site than Wings, and therefore has even less open green space. Although the playgrounds are closer and more personalized to each school, they are isolated from one another and the sports fields making after-hours use more difficult for the community. The longer footprint did allow for a greater opportunity for outdoor roof top spaces for classrooms, and roof gardens (Image 5.3e).

Sustainability / Net Zero

As mentioned, the larger footprint provides ample space for photovoltaics and the project's Net Zero goals. The panels can be mounted to canopies above, and allow for greater rooftop space towards outdoor classrooms, gardens and air handling units. The orientation of the academic wings is a greater challenge with the building's location on site and the playgrounds in between. The playgrounds and secondary entrances to the dining spaces require a wide distance between the academic wings in order to receive natural light. This therefore prevented some interior courtyards from receiving ample light during the day. In comparison to the preferred option, Pavilions has a lack of open area and ability to manage stormwater in the appropriate locations along Vassal Lane.

Pavilions Pros

1. All three schools each have a ground level presence, identity within the building, and a main entrance.
2. Community use on three sides of the site with a multi-use bus lane and bike lane, and circulation around the playfields from the north to the southwest corner of the site.

3. More roof area for photovoltaics.

4. Service lane and underground parking entrance is tucked behind the building and completely separate from parent cars and buses.

5. Multi-use drive aisle for buses and cars that can be closed down during the school day for outdoor activities.

6. Shared program spaces are located in the middle spine of the school and easily accessible from all three schools.

7. Each school has a corresponding playground adjacent to the dining and academic wings.

Pavilions Cons

1. The playgrounds are disconnected from the playfields with the building in between, making it difficult for parents to see all children playing in the different areas on site.

2. The Upper and Lower School are closer to Concord Avenue and Vassal Lane respectively.

3. The baseball and soccer fields overlap, making them unable to be used at the same time.

4. Gymnasiums are located on the second floor of the school and do not have a direct connection to the sports fields or playgrounds.

5. The large footprint and vehicular circulation on site reduce the open area (Image 5.3f).

Pavilions V2

Pavilions evolved for reasons similar to Wings: to achieve more open area and decrease the building's presence on site. The building was mirrored in order for the playgrounds to better connect with the sports fields on the west end of the site. This mirroring allows the bus lane to also relocate to the center of the site aligning with Fern Street to the North and connecting to the underground parking entrance off Vassal Lane below. The lane would be closed to all traffic except buses allowing students and community visitors a more direct path to the sports fields. Mirroring the building also allows clear sight-lines between the fields and playground.

The smaller footprint drove the building further away from Vassal Lane, providing continuous open area and stormwater control for the neighborhood. The sports fields are able to separate, but not have as much open area around them as Wings V2 or the preferred option.

Image 5.3f: Pavilions Site Plan

Image 5.3g: Pavilions V2 Site Plan

Proper solar orientation of classrooms would prove to be more difficult to achieve with the consolidated footprint. With the building mirrored, the taller shared spaces are located closer to the Alpine Street residents. Additionally, in this layout, the Upper School wing is disconnected from the rest of the school.

Like the other version 2 options, the surface parking was moved below ground to provide more outdoor area. Ultimately, Pavilions V2 remained lower in total open area in comparison to the Preferred Option (Image 5.3g).

5.4 Replacement

Description

After investigating the Renovation/Addition option, it was determined that demolishing the existing building in its entirety would result in a more efficient and healthier school. The Replacement V1 option improved on the Renovation/Addition by replacing the existing academic wings with a new building, but otherwise keeping the "T" shape layout on site

Image 5.4a: Replacement V1 Site Plan

(Image 5.4a). This option continued to adapt and transform with the community's requests for more continuous open area and play spaces. This resulted with Replacement V2, a four story option located within a similar area on site as the existing building. True to its name, the Replacement option has a similar program parti to the original school, with the two academic wings along Vassal Lane, and the shared program in the center overlooking the site in the north. Unlike the other options, the program is consolidated to a much smaller footprint, due to adding a fourth floor to house program area.

In order to decrease the footprint, Vassal Lane Upper School (VLUS) classrooms had to move to the upper floors, making room on the first floor for the Preschool classrooms. This wing is located on the southwest corner of the site opposite the Tobin Montessori wing located on the southeast. In order to achieve a sense of identity, the VLUS main office is located adjacent to the building entrance. This will still provide an opportunity for the Upper School to have a front door presence and welcoming opportunity to visiting parents. The Tobin Montessori main office lies on the opposite side of the building entrance. Classrooms for the younger children are all located on the first floor of the academic wings so parents can walk their children directly into their classrooms. The Preschool is below VLUS, and the Community School is in its own wing to the northwest, adjacent to arts and gym areas used for the afterschool program.

The shared program wing facing the north includes the stacked gyms, dining, and auditorium adjacent to the sports fields and playgrounds. A secondary public entrance opens to these shared spaces for community use during afterschool hours. The baseball and soccer fields are located off Concord Avenue similar to the existing fields. Playgrounds lie between the fields and the building, resulting in continuous views from Callanan Playground and

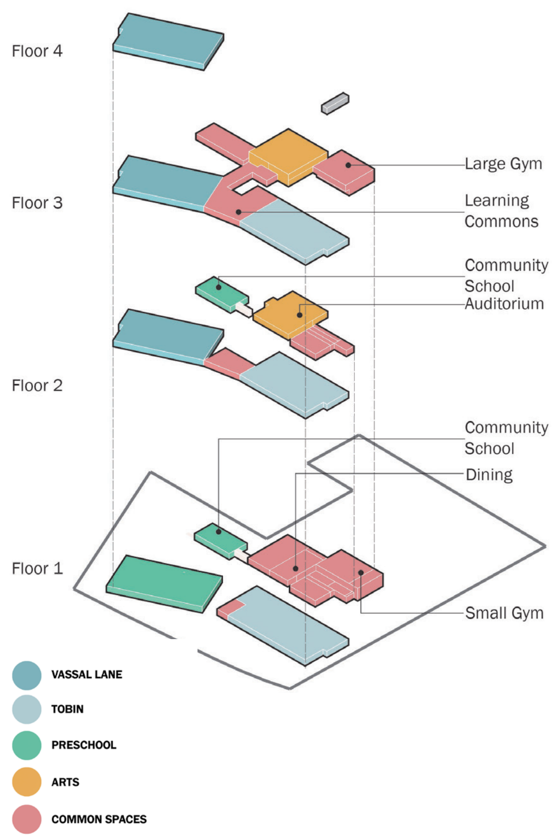


Image 5.4b: Replacement V2 Program Axon

the school. There is also a smaller protected playground for Preschool and Community School students between the west wings. In order to achieve more open area, all surface parking is relocated below ground and the existing bus loop and service lane remain on grade (Image 5.4b).

The main entrance to the building is centered between the two academic wings and opens to a central Heart of the School. All three schools have their main offices adjacent to the entrance, and all have the opportunity to welcome visitors into the heart as they travel to their destinations. The classroom neighborhoods, dining and gyms are all adjacent to the heart on the first floor. A secondary public entrance between the gym and Community School to the sports fields and playgrounds. This entrance also connects to the pedestrian circulation route from the playground and around the school. The Community School has its own entrance to the far west, off a drive loop that can be used by parents when buses are not present. The learning commons continues the heart on the third floor with outdoor views on three sides for the students to see as they pass through. The heart completes with an outdoor classroom on the fourth floor for the 8th grade classrooms to utilize.

Like the other options, this design better orients the building for daylighting and connectivity to the outdoors. In comparison to the other three options, this has the smallest footprint on site, and leaves the largest amount of open area for the community. This design would continue to evolve to the preferred option that has an even smaller footprint on site. The program stacking on four floors does bring on the challenge for photovoltaic coverage on the roof. In order to achieve Net Zero energy, either the panels will be canopy mounted and extend past the roof edge, or there will be a greater need for more photovoltaic canopies on site. By locating all the parking underground, there was more flexibility for learning gardens and bioswales around the academic wings and appropriately located along Vassal Lane.

Program Fit

The Replacement option provides enough building area to include all the program components listed in the Educational Specification, and organizes them vertically within the four floors. Through the consolidation of the building footprint, classrooms are still organized into neighborhoods that are stacked within the academic wings. Although VLUS doesn't have classrooms on the first floor, the 8th grade students now have a unique opportunity for an outdoor classroom on the building roof. The smaller footprint also required the stacking of the shared spaces. The two gyms are stacked facing the sports fields, and the Auditorium sits above the Dining and Performing arts. There is still an opportunity for a direct vertical entrance to the auditorium for the public use after hours. The success of this program layout is having the younger children on the first floor and the gym and dining directly adjacent to the fields and playgrounds.

Zoning

While this option is successful in open area and continuous outdoor connection between the playgrounds and fields, the building's proximity to Vassal Lane and Alpine Street remains a challenge. The position on site was inspired by the location of the existing school and the reuse of the service lane and bus loop. The Cambridge community encouraged the footprint to consolidate below the Armory parcel, and forced the building closer to Vassal Lane. The three story Tobin Montessori wing stretches closer to the Alpine Street neighbors than the original building. The setback off Concord Avenue remains the same with Father Callanan Playground and the sports fields in between (Image 5.4c).

Parking vs. Usable Open area

The Replacement Option evolved from improving failures of the Renovation/Addition option. One improvement relocated all surface parking below ground with the staff parking. This totals 150 parking spaces within the parking garage below ground. In order to achieve more open area, the vehicular circulation on site needed to consolidate further. The existing bus loop and service lane remains for all the traffic through the site. The service lane loops to a drop off lane near the Preschool and Community School, and branches towards the loading dock and entrance to the parking garage below. The

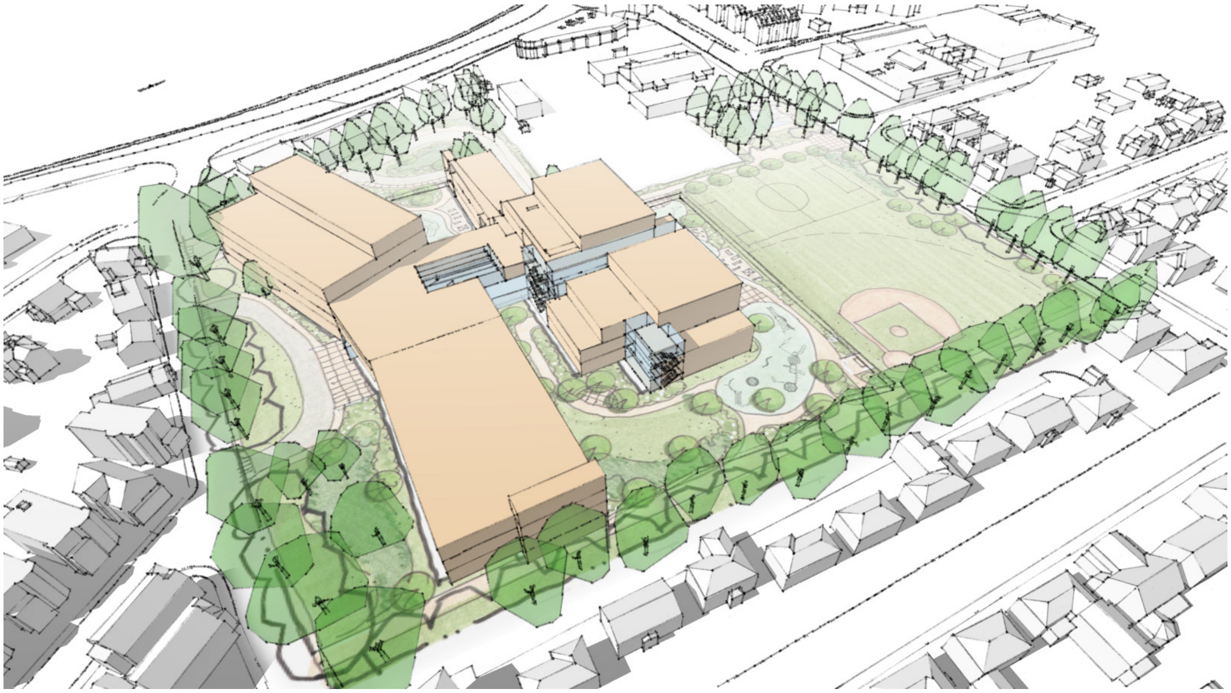


Image 5.4c

Preferred Option was able to consolidate the lanes further and omit the existing bus loop. With all the program located to the southern half of the site, the north half is left open for the sports fields, playgrounds and pedestrian circulation. This achieves the consistent views from the fields to the playgrounds requested by the community (Image 5.4d).

Sustainability / Net Zero

This option proposes to use the same sustainable technologies and systems towards Net Zero Emissions as the other three design options. The floor to floor heights will be appropriate for light shelves to bring daylight further into the classrooms. Neighborhood breakout spaces will overlook outdoor views, allowing all corridors to have a connection to the outdoors. The smaller footprint does limit the amount of space for photovoltaic panels, hindering the ability to generate enough power to be a Net Zero Energy school. As mentioned, the panels can be mounted on a canopy that extends past the rooftop footprint. Raising the canopies leaves open rooftop space for air source units and outdoor classroom space.

Replacement Pros

1. Consolidating the footprint allowed for a larger and continuous open area for the community and school.
2. The service drop off lane and parking garage entry is located behind the school.
3. All parking is located below ground leaving room for more outdoor green space, learning gardens and bioswales.
4. The academic wings and shared program are organized around a central Heart of the School.
5. The soccer and baseball fields do not overlap so both can be used simultaneously.
6. The Preschool playground is adjacent to the classrooms and can be secured within the courtyard of the building.
7. Classrooms are appropriately oriented for optimal daylighting.
8. The shared program spaces are stacked within off the Heart of the School and

Image 5.4d

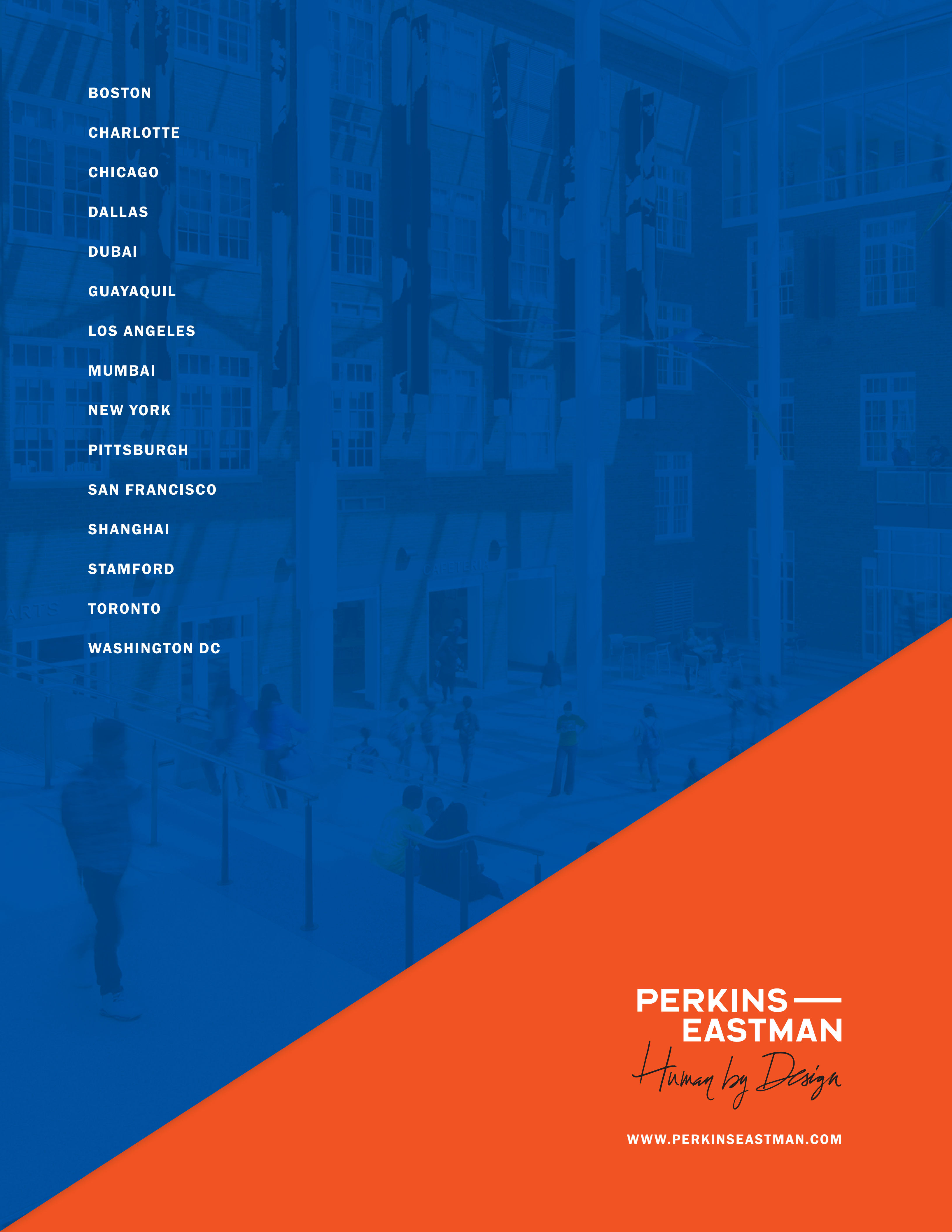
easily accessible from the academic wings.

9. All three programs have main offices and administration adjacent to the main entrance and the Heart of the School.
10. Playgrounds are adjacent to sports fields so parents can see clearly from one side of the site to the other.

Image 5.4e

Replacement Cons

1. Smaller roof area limits the space for roof mounted photovoltaic panels.
2. VLUS Classrooms are on upper floors above the Preschool wing.
3. Setbacks and footprint consolidation pushes the building closer to Vassal Lane and Alpine Street (Image 5.4e).
4. All traffic is forced to Vassal Lane.



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