2022 APR -7 PM 3:41

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PLANNING DEPARTMENT
NEEDHAM, MA

TOWN OF NEEDHAM
MASSACHUSETTS

500 Dedham Avenue
Needham, MA 02492
781-455-7550

PLANNING BOARD

APPLICATION FOR SITE PLAN REVIEW

Project Determination: (circle one) [Major Project] Minor Project

This application must be completed, signed, and submitted with the filing fee by the applicant or his representative in accordance with the Planning Board's Rules as adopted under its jurisdiction as a Special Permit Granting Authority. Section 7.4 of the By-Laws.

Location of Property 557 Highland Avenue
Name of Applicant 557 Highland, LLC
Applicant's Address c/o The Bulfinch Companies, 116 Huntington Avenue,
Phone Number Suite 600, Boston, MA 02116

Applicant is: Owner x Tenant ____
Agent/Attorney ____ Purchaser ____

Property Owner's Name 557 Highland, LLC
Property Owner's Address c/o The Bulfinch Companies, 116 Huntington Avenue,
Telephone Number Suite 600, Boston, MA 02116

Characteristics of Property: Lot Area ____ Present Use Vacant, former car dealership
LOT AREA: 9.273 ACRES Map # __ Parcel # __ Zoning District Highway Commercial 1
PARCEL ID 1990760000300000

Description of Project for Site Plan Review under Section 7.4 of the Zoning By-Law:

Please see ~~attached~~ the filing and zoning letter filed herewith

557 Highland, LLC, by: Robert Schlager

Signature of Applicant (or representative) _____
Address if not applicant _____
Telephone # 781.707.4122
Owner's permission if other than applicant N/A

SUMMARY OF PLANNING BOARD ACTION
Received by Planning Board _____ Date April 7, 2022
Hearing Date _____ Parties of Interest Notified of Public Hearing _____
Decision Required by _____ Decision/Notices of Decision sent _____
Granted _____
Denied _____ Fee Paid _____ Fee Waived _____
Withdrawn _____
NOTE: Reports on Minor Projects must be issues within 35 days of filing date.

goulston&storrs
counsellors at law

April 5, 2022

BY HAND DELIVERY, OVERNIGHT DELIVERY & ELECTRONIC MAIL

Town of Needham Planning Board Members
Public Service Administration Building
500 Dedham Avenue
Needham, MA 02492
Attn: Lee Newman, Planning Director

Re: 557 Highland Avenue, Needham Heights, Massachusetts (the "Property")

Dear Planning Board Members:

We are counsel to 557 Highland, LLC, an affiliate of The Bulfinch Companies, Inc. (the "Applicant") in connection with the redevelopment of approximately 9.27 acres of land, bordered by Highland Avenue to the south, Interstate 95/Route 128 to the east, Gould Street to the west, and TV Place (formerly known as Permil Road), a private way, to the north. The Property is the former site of the Muzi Ford and Chevrolet automotive dealership and service centers and the Muzi car wash.

The Applicant is proposing to redevelop the Property with approximately 496,694 square feet (sq. ft.) of office, laboratory and research and development uses (the "Project"). The Project will also include construction of one-level of below grade parking under each building and a separate stand-alone parking garage as well as approximately 10,000 sq. ft. of retail and restaurant uses. The Project will include two buildings, one on the northerly portion of the Property (the "North Building") and one on the southerly portion of the Property (the "South Building"), together with a shared connector atrium (the "Atrium").

As described below, zoning allows a maximum Floor Area Ratio ("FAR") of 1.35 for the Property generating a maximum build out of 542,000 sq. ft. The Application (defined below) proposes an FAR of 1.25, based on a buildout of 506,694 sq. ft., 35,306 sq. ft. less than the maximum buildout.

The materials and studies submitted with this Application (defined below) and in the Project's MEPA Environmental Notification Form have conservatively studied and presented an analysis based on a significantly higher build out for the Property of the approximately 531,000 sq. ft. Accordingly, the traffic generation numbers in these materials and studies can be reduced by approximately 5%, yielding lesser impacts than what was studied.

Pursuant to the Massachusetts Zoning Act, G.L. c. 40A, the Needham Zoning By-Law, and the Board Rules, enclosed is an Application for Site Plan Review and issuance of Special

Permits for the Project (the "Application"). In support of the Application, the Applicant is submitting the following materials and information (*5 copies of each unless otherwise indicated*):

1. Application for Site Plan Review;

2. Plan Set titled "557 Highland Avenue Needham, MA 02494 – Needham Special Permit Package" (the "Plan Set"), prepared by Stantec Architecture and Engineering P.C. ("Stantec"), which includes the following, all dated March 30, 2022 unless noted otherwise (*1 additional 11x17 copy mailed directly and sent via electronic mail to each Planning Board member*):

    a. Proposed Site Plan

    b. Site Aerial – Proposed

    c. Street View – Proposed

    d. G-000 – Cover Sheet

    e. Civil Plan Set containing the following:

        i. Sheet C-01 – Legend and General Notes

        ii. Sheet C-02 – Overall Site Plan

        iii. Sheet C-03 – Drainage and Erosion Control Plan

        iv. Sheet C-04 – Utility Plan

        v. Sheet C-05 – Site Details

        vi. Sheet C-06 – Site Details

    f. Landscape Plan Set containing the following:

        i. Sheet L-1.0 – Site Plan

        ii. Sheet L-2.0 – Site Grading Plan

        iii. Sheet L-3.0 – Site Planting Plan

        iv. Sheet L-4.0 – Site Lighting Plan

        v. Sheet L-5.0 – Site Details #1

        vi. Sheet L-5.1 – Site Details #2

g. Architectural Plan Set containing the following:

i. Sheet G-010 – Zoning Gross Area Plans

ii. Sheet A-100G1 – Garage Level G1 – Overall Plan

iii. Sheet A-101 - Level 1 – Overall Plan

iv. Sheet A-102 Level 2 – Overall Plan

v. Sheet A-103 Level 3 – Overall Plan

vi. Sheet A-104 Level 4 – Overall Plan

vii. Sheet A-105 Level 5 – Overall Plan

viii. Sheet A-106 Level 6 – Overall Plan

ix. Sheet A-107 – Roof Plan

x. Sheet A-201 – Building Elevations – Locator Elevations

xi. Sheet A-202 – Building Elevations – North Bldg. – North

xii. Sheet A-203 – Building Elevations –North Bldg. – South & East

xiii. Sheet A-204 – Building Elevations – North Bldg. (Southwest) & South Bldg. (South)

xiv. Sheet A-205 – Building Elevations – North Bldg. (West) & South Bldg. (North & West)

xv. Sheet A-206 – Building Elevations – South Bldg. – North & East

xvi. Sheet A-211 – Building Sections – Overall

xvii. Sheet A-212 – Building Sections – North Bldg.

xviii. Sheet A-213 – Building Sections – North Bldg.

h. Architectural – Garage Plan Set containing the following:

i. Sheet AG-100.B2 – Garage Level B2

ii. Sheet AG-100.B1 – Garage Level B1

iii. Sheet AG-101 – Garage Level 1

iv. Sheet AG-102 – Garage Level 2

v. Sheet AG-103 – Garage Level 3 (Level 4-5 Sim.)

vi. Sheet AG-106 – Garage Level 6

vii. Sheet AG-211 – Garage Sections

viii. Sheet AG-212 – Garage Sections

ix. Sheet AG-301 – Elevations – North & East

x. Sheet AG-302 – Elevations – South & West

3. Transportation Impact and Access Study prepared by Vanasse Hangen Brustlin, Inc. ("VHB"), dated March 2022 (the "TIAS");

4. Stormwater Report prepared by VHB, dated March 2022 (the "Stormwater Report");

5. Fiscal Impact Analysis, prepared for the Town by the Barrett Planning Group, LLC of Plymouth, MA dated March 20, 2021, summarizing the anticipated revenues from various redevelopment scenarios of the Property and the adjacent parcels (the "Fiscal Analysis");

6. Check payable to the Town of Needham in the amount of $98,992.90, representing the filing fee for Site Plan Review and Special Permit Application, calculated at $1000 plus $0.10 per square foot in excess of 10,000 sq. ft for 506,694 sq. ft. of office/lab/research and development/retail/restaurant uses and 483,235 sq. ft. of accessory parking uses.

The Applicant hereby requests pursuant to Zoning By-Law Section 7.4.4 that the Board waive the submission by Applicant of any required information not submitted herewith.

* * *

ZONING ANALYSIS DISCUSSION:

Background and Overview:

Pursuant to the Town of Needham Zoning Map, as amended by Article 6 of the Annual Town Meeting held on May 3, 2021 (as amended, the "Zoning Map"), the Property is located within the Highway Commercial 1 District (the "HC-1 District"). The HC-1 District was established by an amendment to the Town of Needham Zoning By-Law (as amended, the "By-Law") adopted by a 168-37 vote of Town Meeting pursuant to Article 5 of the Annual Town

Meeting held on May 3, 2021. According to the Zoning Map, the Property is not located within any overlay districts.

The creation of the HC-1 District was the result of an extensive planning effort by the Town of Needham (the "Town"). The Town's Council of Economic Advisors ("CEA") began an evaluation of the Town's Industrial Zoning Districts in 2013. The CEA held public meetings with residents, neighbors, public officials, businesses, and landowners (collectively, the stakeholders) in 2014 and obtained a build-out analysis and a traffic impact report. The CEA made preliminary recommendations to the public and Select Board to upgrade the zoning adjacent to I-95/Route 128 to make these areas more economically competitive.

The Planning Board and Select Board decided to move forward with rezoning of the former Industrial-1 Zoning District circumscribed by I-95/Route 128, Highland Avenue, Gould Street, and the MBTA right of way, and occupied by the Muzi Ford and Chevrolet dealership, a car wash, and WCVB Channel 5. An Article proposing to rezone this Industrial-1 Zoning District was developed and presented to the October 2019 Special Town Meeting, where it received a majority vote but less than the required two-thirds.

In response to public concerns about density, traffic impacts, permitted and special permit uses, and environmental issues, a Town-wide community meeting was held with stakeholders in January 2020 to discuss overall land use goals for the HC-1 District. A working group, including representatives from the Planning Board, Select Board, Finance Committee, and CEA was formed. The working group then commissioned an updated traffic study of the area, to analyze the ability of the Town's traffic infrastructure to accommodate development at various densities and use profiles, as well as an updated fiscal impact analysis. From these efforts, the Planning Board drafted a revised Zoning Article to establish the HC-1 District. The revised Zoning Article reduced maximum floor area ratios and building height, increased building setback distances, required additional landscape buffering along Gould Street and Highland Avenue, increased open space requirements and established green building standards for issuance of a special permit.

In connection with the above process, the Town commissioned the Fiscal Analysis to study the potential financial benefit of such rezoning. Based on the Fiscal Analysis, a full-build out of the Property and the adjacent parcels at 1.35 FAR would yield an annual net financial benefit to the Town of approximately $8,342,400. As described above, the Project proposes a build-out of approximately 60% of the full-build out, which results in a prorated annual net financial benefit of approximately $5,000,000 to the Town from development of the Project.

The Applicant now proposes the Project to realize the goals of this re-zoning.

Proposed Project:

Use

The Property contains approximately 9.27 acres of land. It was most recently used as an automotive dealership and car wash making up a nearly entirely impervious surface which included parking for approximately 532 vehicles. As described above, the Project will remove environmentally-hazardous materials and redevelop the existing underutilized site to include approximately 496,694 square feet of office, laboratory and research and development uses. The Project will also feature approximately 10,000 square feet of retail and/or restaurant uses and accessory parking use in the form of underground parking garages and separate stand-alone parking structure. A breakdown of proposed uses and the approximate square footage of such uses is as follows:

USES	PROPOSED[1]
Office	248,347 sq. ft.
Lab/Research and Development	248,347 sq. ft.
Retail/Restaurant	10,000 sq. ft.
Accessory Parking	1,408 total parking spaces of which 343 will be located beneath the buildings, 1,021 will be located in a stand-alone parking garage, and 44 will be surface parking.

Pursuant to By-Law Section 3.2.7, professional, business, or administrative offices and laboratory uses are allowed by-right in the HC-1 District. Retail uses are also allowed by-right so long as no single retail establishment contains more than 5,750 square feet of gross floor area. Light-manufacturing uses— including manufacture of pharmaceutical, bio-pharmaceutical, medical, robotic, and micro-biotic products, which may be part of the Project tenants' laboratory uses—are allowed by right and also as an accessory use to any lab/research development use. The Applicant anticipates that light-manufacturing uses accessory to research and development uses, including the production of prototypes, may be part of the Project depending upon the ultimate tenanting of the Project.

By-Law Section 3.2.7.1(m) allows all customary and proper uses accessory to lawful principal uses. Given that the accessory parking on the Property is intended to provide parking incidental to operation of the main uses described above, such accessory use is allowed by-right.

[1] The specific square footage breakdown is subject to final tenant demands and the Applicant requests that the Board allow the allocation among the uses (and floor plans) to change from time to time without further Board review or approval as long as the Project maintains the number of parking spaces required by the approvals. The Applicant requests the ability to construct the Project in phases, including the right to obtain a final certificate of occupancy for the parking garage and/or either building prior to completion of construction of both buildings.

Formerly, the Property showed 532 lined spaces, a portion of which were used for parking for customers and employees, and the balance of which were used for parking of new and used car inventory and auto repair activities in connection with the dealership on the Property. These spaces do not include any employees or visitors for the car wash.

The Applicant anticipates that the retail space may contain a tenant in excess of approximately 6,000 sq. ft., and a restaurant of approximately 4,000 sq. ft. Accordingly, the Project will require a Special Permit for the potential occupancy of a single retail tenant in excess of 5,750 sq. ft. and a Special Permit for restaurant use.

Parking

The Applicant plans to construct a total of 1,408 parking spaces to be provided between a one-level underground parking structure beneath the buildings and a separate above-ground parking garage.[2] The following chart describes the number of parking spaces required pursuant to By-Law Section 5.1.2.

Use	**Space Required by Zoning**	**Proposed Parking Spaces**
Research facilities/laboratories	828 spaces *(1 space per 300 sq. ft.)**	
Office	828 spaces *(1 space per 300 sq. ft.)*	
Retail	20 spaces *(1 space per 300 sq. ft.)*	
Restaurant	13 spaces *(1 space per 3 seats plus 10 spaces per take-out service station)*	
Total	1,689	1,408 total parking spaces of which 343 will be located beneath the buildings, 1,021 will be located in a stand-alone parking garage, and 44 will be surface parking.
**Provided that occupancy by a single tenant of more than 50,000 sq. ft. shall require one space per 300 sq. ft. for the first 50,000 sq. ft. and 1 space per 400 sq. ft. in excess of 50,000 sq. ft. Thus, the number of required parking spaces will be reduced if a single tenant occupies all of the North Building or the South Building, or both.*		

As shown above, the Applicant proposes 1,408 parking spaces. However, the By-Law's parking requirements assume a higher employee density than is typical for lab/research &

[2] The stand-alone garage will contain two levels of underground parking as shown in the Plan Set.

development uses. The By-Law also assumes that each employee will commute alone and does not take into account the Applicant's proposed use of carpool, walking, biking, and public transit alternatives that will reduce the number of vehicles required to be parked on-site. Furthermore, the By-Law does not consider the potentially permanent changes in commuting patterns resulting from the COVID-19 pandemic, including hybrid/remote work programs. For these reasons, the Applicant's proposed number of parking spaces is more reflective of expected demand than the parking requirement under the By-Law. Therefore, the Project will require a Special Permit from the Planning Board for the difference in its proposed 1,408 spaces from the required spaces under zoning owing to these special circumstances, or for less than 1,408 total spaces, as the Planning Board may deem sufficient based on a review of the Application.[3]

The parking spaces provided will comply with all design guidelines prescribed by By-Law Section 5.1.3 as shown on the Plan Set included with the Application.

Dimensional Requirements

The following chart sets forth dimensional requirements applicable to the Project:

Item	Required	Project	Compliance with Zoning?
Minimum Lot Area	20,000 sq. ft.	403,933 sq. ft.(1)	YES
Minimum Lot Frontage	100 ft.	At least 100 ft.	YES
Maximum Floor Area Ratio	0.70 as-of-right Up to 1.35 by special permit	1.25	**YES – Special Permit Required**
Front Setback from Highland Avenue and Gould Street	15 ft.	North Building: 200 ft. South Building: 50 ft.	YES
Landscape Buffer	50 ft. along Highland Ave. and Gould Street	50 ft.	YES
Increased Height Setback	200 ft. from Highland Ave. and Gould Street	North Building: 200ft.	YES
Side/Front Setback on Rt. 95	20 ft.	20 ft.	YES
Rear Setback	20 ft. (along TV	20 ft.	YES

[3] As described below, the Planning Board is the special permit granting authority for all special permit relief for Major Projects under Section 7.4.3 of the By-Law, and accordingly may grant relief under Section 5.1.1.5 from both parking space requirements under Section 5.1.2 and parking plan.

Item	Required	Project	Compliance with Zoning?
	Place)		
Maximum Lot Coverage	65%	48%	YES
Maximum South Building Height* (within 200 ft. height limitation zone)	35 ft. as-of-right 42 ft. by special permit	42 ft.	**YES – Special Permit Required**
Maximum Building North Height* (outside 200 ft. height limitation zone)	56 ft. as-of-right 70 ft. by special permit	70 ft.	**YES – Special Permit Required**
Maximum Garage Height*	44 ft. as-of-right 55 ft. by special permit	55 ft.	**YES – Special Permit Required**
Maximum Stories* (within 200 ft. height limitation zone)	2.5 stories as-of-right Up to 3 stories by special permit	3 stories (South Building)	**YES – Special Permit Required**
Maximum Stories* (outside 200 ft. height limitation zone)	4 stories as-of-right Up to 5 stories by special permit	5 stories (North Building)	**YES – Special Permit Required**
Maximum Garage Footprint	42,000 sq. ft.	42,000 sq. ft.	YES
Minimum Open Space	25%	27.1%	YES
Maximum Uninterrupted Façade Length	200 ft.	200 ft.[(2)]	YES
Building Parapet Height	5 ft.	5 ft.	YES
**Pursuant to Section 4.11.1(e), structures erected on a building and not used for human occupancy, including mechanical equipment, may exceed the maximum building height provided that no part of such structures extends more than 15 ft. above the maximum allowable building height (e.g., 57 ft and 85 ft., respectively for each building) and such structures do not cover more than 25% of the building roof.*			

Item	Required	Project	Compliance with Zoning?
(1) The Applicant's property at 0 Gould Street containing approximately 7,127 sq. ft. is not included in calculation of lot area and other measurements. (2) As shown in the Plan Set, the façade length of the stand-alone garage will be broken up through the use of banners which will result in interruptions of the façade so as to make it less than 200 ft.			

Based on the foregoing, the Project will require Site Plan Review (described below) and Special Permits from the Planning Board as follows: (i) to allow a maximum Floor Area Ratio of 1.25; (ii) to allow a maximum height of 70 feet for the North Building; (iii) to allow a maximum of 5 stories in height for the North Building; (iv) to allow a maximum height of 42 feet for the South Building; (v) to allow a maximum of 3 stories in height for the South Building; and (vi) to allow a maximum building height of 55 feet for the above-ground parking structure.

With respect to clause (i) above, pursuant to By-Law Section 4.11.1(5) the Planning Board may allow an FAR of up to 1.35 by issuance of a Special Permit. The grant of a Special Permit pursuant to this section must consider the factors detailed further below.

With respect to clauses (ii) through (vi) above, pursuant to By-Law Section 4.11.1(1), buildings within 200 ft. of Highland Avenue and Gould Street are limited to a height of 35 ft. and 2.5 stories. The Planning Board may grant a Special Permit to increase the height of buildings within the 200 ft. height limitation zone to 42 ft. and 3 stories and may further increase the height of buildings beyond the 200 ft. height limitation zone to up to 70 ft. and 5 stories. The 200 ft. height limitation envelopes allowing for such height increases are depicted in Figure 1 and Figure 2 of By-Law Section 4.11.1(f), which provides for such figures to clarify the limits of the required setbacks and allowed envelopes. Additionally, pursuant to Section 4.11.2, the Planning Board may grant a Special Permit to increase the height of a parking structure up to 55 ft.[4]

The Project will also require a Special Permit to allow for retaining wall height greater than 4 ft. and other applicable design requirements for retaining walls pursuant to By-Law Section 6.11.5.

Major Project Site Plan Review and Special Permit:

Site Plan Review and Approval, in the form of a Planning Board Special Permit, is required for any "Major Project". Pursuant to Section 7.4.2 a "Major Project" is any project in the HC-1 District that involves the construction of 10,000 or more square feet, an increase in gross floor area of 5,000 or more square feet, or the creation of 25 or more new off-street parking

[4] In lieu of applying the height/story limitation in Section 4.11.1, the By-Law sets parking garage height at 44 ft. and allows an increase up to 55 ft. by Special Permit pursuant to Section 4.11.2(1).

spaces. The Project will exceed each of the foregoing thresholds and therefore qualifies as a Major Project subject to Site Plan Review.

Pursuant to By-Law Section 7.4.3, "the special permit granting authority for all permits the issuance of which is necessary for the construction or use of a Major Project shall be the Planning Board."

Based on the above, the Project will require Site Plan Review and Approval pursuant to By-Law Section 7.4 from the Planning Board and subject to review by the Design Review Board. Additionally, as a Major Project, the Project will require a Special Permit from the Planning Board in connection with Site Plan Review. As provided by By-Law Section 7.4.3, the Planning Board may also issue any other Special Permits required for the Project given its status as a Major Project.

Relief Requested:

Based on the foregoing analysis and in accordance with By-Law Sections 3.2.7.2, 4.11, 5.1.1.5, 6.11.5, 7.2, 7.4, 7.5 and 7.6, and such other By-Law Sections as may apply, the following items of zoning relief are requested:

1. Special Permit in accordance with By-Law Section 4.11.1(5) for an FAR of 1.25 for the Project.

2. Special Permit, in accordance with By-Law Section 4.11.1(1) for a building height of 70 feet for the North Building.

3. Special Permit, in accordance with By-Law Section 4.11.1(1) for 5 stories for the North Building.

4. Special Permit, in accordance with By-Law Section 4.11.1(1) for a building height of 42 feet for the South Building.

5. Special Permit, in accordance with By-Law Section 4.11.1(1) for 3 stories for the South Building.

6. Special Permit, in accordance with By-Law Section 3.2.7.2 (g), for restaurant use.

7. Special Permit, in accordance with By-Law Section 3.2.7.2 (d), for retail use by a single tenant of between 5,750 – 10,000 sq. ft.

8. Special Permit, in accordance with By-Law Section 4.11.2(1) for a parking garage structure height of 55 feet.

9. Site Plan Review and Approval of the Project as a Major Project in accordance with Section 7.4.

10. Special Permit, in accordance with By-Law Section 5.1.1.5, for deviation from the required parking space number under By-Law Section 5.1.2 to be provided as part of the Project.

11. Special Permit, in accordance with By-Law Section 6.11.5, for deviation from the design requirements for retaining walls.

12. Any additional Special Permits required for the permitting of the Project.

Satisfaction of Criteria for Granting Relief Requested:

In connection with granting the above-requested relief, the Planning Board must make certain findings related to the Project as set forth in the applicable Sections of the By-Law. The applicable criteria are set forth in bold below and are followed by the Applicant's description of how the Project complies or will comply with such criteria. Explanatory notes from the By-Law are provided in italics.

I. Pursuant to By-Law Section 7.6.1, the Planning Board must make the following findings and determinations when issuing a Special Permit, as delineated in By-Law Section 7.5.2.1:

Prior to granting a special permit, the Planning Board, shall make a finding and determination that the proposed use, building structure, off-street parking or loading, modification of dimensional standards, screening or landscaping, or other activity, which is the subject of the application for the special permit:

(a) Complies with such criteria or standards as may be set forth in the section of this By-Law which refers to the granting of the requested special permit;

As set forth below, the Project complies with the specific criteria and standards for the special permit relief requested herein.

(b) is consistent with: 1) the general purposes of this By-Law as set forth in subparagraph 1.1, and 2) the more specific objectives and purposes applicable to the requested special permit which may be set forth elsewhere in this By-Law, such as, but not limited to, those at the beginning of the various sections;

The Project is consistent with the general purposes of the By-Law, including the promotion of health, safety, convenience, morals, and welfare for Needham residents

because it redevelops an underutilized and environmentally compromised site into an economically viable and eco-friendly development with public amenities.

The Project will promote the welfare of the inhabitants of Needham through a significant increase in property tax revenues, providing approximately $5,000,000[5] in annual additional real estate and personal property taxes which will support the Town's educational and recreational programs, housing initiatives, community and open spaces, and other Town priorities. The Project includes traffic mitigation measures and bicycle lane improvements to lessen congestion on area streets. This is an appropriate use of the land, specifically contemplated by the recent rezoning of the area. With the requested special permits, the Project will comply with the applicable use, height, area, and building location requirements of the By-Law.

By-Law Section 1.2 requires that any building or structure erected and any use of premises established must be in conformity with the By-Law. With the requested special permits, the Project will be in conformity with the By-Law.

(c) is designed in a manner that is compatible with the existing natural features of the site and is compatible with the characteristics of the surrounding area.

The site has few natural features, as it is almost entirely covered with the foundations of the former car dealership and car wash buildings and associated impervious areas used for parking and for the display of motor vehicles for sale. The Project is compatible with the characteristics of the surrounding area. The orientation of the buildout with the parking garage located near the "rear" of the Property will result in limited visibility of the parking structures from the major surrounding roads, including Highland Avenue and Gould Street. Extensive landscaping will be provided around the entire Project site, including a circumferential walking path with exercise stations for use by tenants' employees, neighbors, and the general public.

Where the Planning Board determines that one or more of the following objectives are applicable to the particular application for a special permit, the Planning Board shall make a finding and determination that the objective will be met:

(d) the circulation patterns for motor vehicles and pedestrians which would result from the use or structure which is the subject of the special permit will not result in conditions that unnecessarily add to traffic congestion or the potential for traffic accidents on site or in the surrounding area; and

[5] As described above, this is an approximate proration based on the development scenarios for a full-buildout of the Property and the adjacent parcels described in the Fiscal Analysis and as applied to the Project, which is for approximately 60% of the full-buildout scenario.

The Transportation Impact and Access Study prepared by VHB analyzes existing traffic conditions on area roadways and at area intersections, under current conditions and as projected to exist in seven years with and without construction of the Project. The study recommends, and the Applicant has committed to implement, several measures to prevent the Project from increasing traffic congestion or the potential for traffic accidents. These measures include the grant of an easement to the Town to widen and reconfigure Gould Street at the intersection with Highland Avenue and at the intersection with the site entrance (opposite the Wingate Residences entrance), and adding sidewalks along Gould Street. The internal circulation pattern has been designed to control vehicle speeds and to reduce vehicle-pedestrian interactions by providing wide sidewalks.

(e) the proposed use, structure or activity will not constitute a demonstrable adverse impact on the surrounding area resulting from:

1) **excessive noise, level of illumination, glare, dust, smoke, or vibration which are higher than levels now experienced from uses permitted in the surrounding area,**
2) **emission or discharge of noxious or hazardous materials or substances, or**
3) **pollution of water ways or ground water.**

The proposed use, structures and activity at the Property will not have a demonstrable adverse impact on the surrounding area. Any minimal noise, illumination or glare associated with the Project will be mitigated with the design features such as landscaping and cut-off lighting, as more particularly demonstrated in the Plan Set. No noxious or hazardous substances are anticipated to be emitted as a result of the Project, and no waterways or groundwater will be polluted.

As referenced in the foregoing criteria, certain Sections of the By-Law prescribe additional criteria to be considered for particular Special Permit relief. Such criteria, and how the Project complies or will comply with such criteria, are provided below:

1. **Special Permit criteria for relief for FAR of 1.25, pursuant to By-Law Section 4.11.1(5):**

In granting such special permit, the Planning Board shall consider the following factors:

(i) the ability of the existing or proposed infrastructure to adequately service the proposed facility without negatively impacting existing uses or infrastructure, including but not limited to, water supply, drainage, sewage, natural gas, and electric services;

As set forth in the Stormwater Report, the TIAS and based on our engineer's independent review of the infrastructure, the existing or proposed infrastructure

can adequately service the Project without negatively impacting existing uses or infrastructure, including but not limited to, water supply, drainage, sewage, natural gas, and electric services.

(ii) impact on traffic conditions at the site, on adjacent streets, and in nearby neighborhoods, including, but not limited to, the adequacy of the roads and intersections to safely and effectively provide access and egress;

As set forth in the TIAS, the Project will include off-site mitigation that will counterbalance the intersection capacity impacts of the additional Project-generated trips added to the roadway network. The applicant will grant an easement to the Town which will expand the cross-section of Gould Street, as recommended by the Town's traffic consultant during the rezoning of the Site in 2020. The Project will also include a robust Traffic Demand Management (TDM) program to incentivize reduced single occupant driving and increase use of alternative forms of transportation.

(iii) the Environmental impacts of the proposal; and

Regarding direct Environmental Impacts, the Applicant is committed to taking all feasible steps to reduce carbon emissions and minimize energy usage. Energy modeling will evaluate several emissions mitigation measures including hybrid electric/gas heating with electric heating being the first to operate whenever capacity allows, high efficiency glycol heat recovery loop, reduced laboratory exhaust through exhaust monitoring, electric water heating, and more. The Project will also be studying options to include photovoltaic solar panels at the roof of the parking garage and roof of the North & South Buildings. In addition to these emission reduction strategies, the Project will utilize the LEED v4 BD+C rating system for the Core and Shell building components to incorporate other sustainability strategies. The current goal is to achieve LEED Silver Certified with higher targets being evaluated.

In addition, the Project has utilized the MEPA Environmental Justice tool, which demonstrates that this Project is not within 1-mile of any Environmental Justice community. The Project will not exceed any air quality thresholds or cause impacts outside of the 1-mile radius and therefore will not negatively impact such communities.

Regarding future impacts due to Sea Level Rise/Storm Surge and other climate change considerations, the Project is not exposed to Sea Level Rise/Storm Surge or Extreme Precipitation-Riverine Flooding. Although the Property has a high risk of Extreme Precipitation-Urban Flooding and a high risk of Extreme Heat, the Project will combat these risks by including measures to reduce the threat of

urban flooding from extreme precipitation and developing appropriate strategies for a changing climate in the near term, as well as planning for a longer-term adaptation strategy over the course of the Project's life span.

No part of the Property has a historic structure, or a structure within a historic district listed in the State Register of Historic Places or the Inventory of Historic and Archaeological Assets of the Commonwealth.

(iv) the fiscal implications of the proposal to the Town

Based on the Fiscal Analysis, a full-build out of the Property and the adjacent parcels at 1.35 FAR would yield a net annual financial benefit to the Town of approximately $8,342,400. As described above, the Project proposes a build-out of approximately 60% of the full-build out, which results in a prorated net annual financial benefit of approximately $5,000,000 to the Town from development of the Project, plus personal property taxes which would also generate significant additional revenue.

(v) In granting a special permit, the Planning Board shall also consider any proposed mitigation measures and whether the proposed project's benefits to the Town outweigh the costs and adverse impacts, if any, to the Town.

The Project will include significant mitigation as described above and below. In addition, based on the Fiscal Analysis, the Project is anticipated to provide a net annual financial benefit to the Town of approximately $5,000,000, plus personal property taxes which would also generate significant additional revenue.

2. Pursuant to By-Law Section 4.11.3, in addition to the foregoing criteria, the Planning Board must consider the below design guidelines when issuing a Special Permit for relief under By-Law Section 3.2.7.2 and/or Section 4.11:

(a) The proposed development should provide or contribute to providing pedestrian and neighborhood connections to surrounding properties, e.g., by creating inviting buildings or street edge, by creating shared publicly accessible green spaces, and/or by any other methods deemed appropriate by the Planning Board;

The Proposed Development will contain various pedestrian and neighborhood connections and amenities. The south end of the South Building, near the main intersection of Gould and Highland will contain the "retail zone" which will have approximately 10,000 sq. ft. of retail or restaurant use. This area is being developed with retail plaza and landscapes visible from the public streets, making it a vibrant and cohesive part of the neighborhood. A landscaped ½ mile public walking loop is

planned around the site, with various exercise areas planned at intervals on the loop, and including a pond and water feature.

(b) Any parking structure should have a scale, finish and architectural design that is compatible with the new buildings and which blunts the impact of such structures on the site and on the neighborhood;

The parking structure will be primarily constructed of structural precast concrete columns and spandrel beams with color and finish intended to coordinate with the color and finish of the lab buildings. In addition, the overall scale of the stand-alone parking structure will be broken up through the use of fabric banners hung from the upper levels, which will result in visual interruptions and a softening of the façades onto the sides most visible to the neighborhood. The parking structure will be in the northeast corner of the site, downgradient and well way from Gould Street. Its presence will be masked to the south and southwest by the North Building. The structure will also comply with the specific dimensional criteria developed for this district to integrate with the surrounding area.

(c) The proposed development should encourage creative design and mix of uses which create an appropriate aesthetic for this gateway to Needham, including but not limited to, possible use of multiple buildings to enhance the corner of Highland Avenue and Gould Street, possible development of a landscape feature or park on Gould Street or Highland Avenue, varied façade treatments, streetscape design, integrated physical design, and/or other elements deemed appropriate by the Planning Board;

The Project will include two buildings, the North Building on the northerly portion of the Property, and the South Building on the southerly portion of the Property and the shared Atrium to connect them and will help break down the scale of the overall project into smaller pieces. As noted above, the south end of the South Building, near the main intersection Gould Street and Highland Avenue is planned to contain the "retail zone" which will have approximately 10,000 sq. ft. of public retail or restaurant use. This area is being developed with retail plaza featuring soft and hardscape landscaping, outdoor seating, and a water feature at the former location of Muzi pond at the Gould Street and Highland Avenue intersection. Together the proposed R&D, Office, Lab use mixed with Retail use at the corner will create an active gateway condition visible from the public streets. A landscaped ½ mile public walking loop is planned around the site, with various exercise areas planned at intervals around the buildings, and including a pond and water feature.

(d) The proposed development should promote site features and a layout which is conducive to the uses proposed;

The building massing was designed to take advantage of unique view corridors, interesting topography, solar orientation, and comply with the zoning requirements outlined above. The building will provide flexible floorplates that are desirable for today's tenants looking for access to light and views and opportunities for shared indoor and outdoor amenities. In addition, a ½ mile fitness/walking loop rings the entire site culminating at the retail plaza at Gould & Highland providing an opportunity for internal and external users to enjoy the site.

(e) The proposed development should incorporate as many green building standards as practical, given the type of building and proposed uses;

The Project is committed to taking all feasible steps to reduce carbon emissions and minimize energy usage. Energy modeling will evaluate several emissions mitigation measures including hybrid electric/gas heating with electric heating being the first to operate whenever capacity allows; high efficiency glycol heat recovery loop; high efficiency chilled water plant; reduced laboratory exhaust through exhaust monitoring; electric water heating; improved envelope insulation and infiltration without thermal bridging; and high-performance lighting and controls.

In addition to emission reduction strategies, the Project will utilize the LEED v4 BD+C rating system for the core and shell building components to incorporate other sustainability strategies such as: green vehicle parking; open space; rainwater management; heat island reduction; construction and demolition waste management; and building product disclosure and optimization. The current goal is to achieve LEED Silver Certified with higher targets being evaluated. In addition, the Project will be Energy Star rated and certified as a WELL Building.

The WELL Building Standard takes a holistic approach to health in the built environment addressing behavior, operations and design. WELL is a performance-based system for measuring, certifying, and monitoring features of the built environment that impact human health and well-being, through air, water, nourishment, light, fitness, comfort and mind. WELL is grounded in a body of medical research that explores the connection between the buildings where we spend more than 90 percent of our time, and the health and wellness impacts on us as occupants. WELL Certified™ spaces can help create a built environment that improves the nutrition, fitness, mood, sleep patterns and performance of its occupants.

(f) The proposed development should be designed and conditioned to reduce or mitigate adverse impacts on adjacent properties or the surrounding area such as those resulting from excessive traffic congestion or excessive demand for parking; and

The Project will include off-site mitigation that will counterbalance the intersection capacity impacts of the additional Project-generated trips added to the roadway network. The car wash previously reported 1,360 peak vehicle trips to the car wash during the winter months, or roughly 600 vehicles daily during peak periods. The car wash coupled with Muzi employees, visitors, new and used car sales, parts distribution, etc., yielded an additional 600 single occupancy vehicles such that there will be little, if any, increase in traffic from the Project. Nevertheless, as recommended by GPI, the Applicant will grant an easement to the Town to expand the cross-section of Gould Street, as recommended by the Town's traffic consultant during the rezoning of the Site in 2020. The Project will also look to augment the Town's rezoning concept with dedicated bicycle lanes on Gould Street that connect the Project and its future pedestrian and open space amenities to the bicycle lane network along Highland Avenue. As set forth above, the Project will also include a robust TDM program to incentivize reduced single occupant driving and increase use of alternative forms of transportation. Based on the TIAS, the roadway network as improved through the Project's proposed transportation mitigation, can safely and adequately handle the trips associated with the Project.

(g) The proposed development shall include participation in a transportation demand management program to be approved by the Planning Board as a traffic mitigation measure, including but not limited to, membership and participation in an integrated or coordinated shuttle program.

As set forth above, the Project will also include a robust TDM program to incentivize reduced single occupant driving and increase use of alternative forms of transportation. The Applicant will explore and look to implement shuttle connectivity through its future proactive involvement in the Route 128 Business Council to improve public transportation access and accessibility to the Property.

3. <u>Pursuant to By-Law Section 6.11.5, the Planning board must consider the specific criteria given below when issuing a Special Permit for relief from retaining wall requirements in By-Law 6.11:</u>

(a) That the retaining wall will not cause an increase of water flow off the property;

The 4-6 foot high retaining wall proposed along the eastern property boundary will be located along the side of the proposed fire lane/fitness path and adjacent to the I-95/Route 128 off ramp. The retaining wall will direct stormwater discharge toward the site's proposed drainage system and not to the MassDOT's ROW. This is a significant improvement over existing conditions, under which sheet drainage discharges untreated runoff off to adjacent properties and roadways.

(b) That the requested retaining wall will not adversely impact adjacent property or the public;

The requested retaining walls will face the Exit 35C ramp from I-95/Route 128 to Highland Avenue. As such, it will have little, if any, impact on adjacent property or the public. Additionally, the retaining wall has a low profile and there is a wide vegetated shoulder from the roadway before the wall.

(c) That the report of the Design Review Board has been received and considered.

We anticipate that any comments from the Design Review Board will continue to be considered and incorporated into the Project.

II. Special Permit in accordance with By-Law Section 5.1.1.5 waiving adherence to the required number of parking spaces and/or parking design requirements:

Such a special permit waiving strict adherence to the minimum number of required parking spaces may be granted only after it is demonstrated by an applicant that either:

(i) special circumstances in a particular use of structure does not warrant the minimum number of spaces required under Section 5.1.2; or

The By-Law's required parking ratios assume a higher employee density than is typical for lab/research & development uses. The By-Law also assumes that each office employee will commute alone, by motor vehicle. By contrast, the Applicant is committed to a transportation demand management program to encourage the use of carpool, walking, biking, and public transit alternatives to single occupancy vehicle trips. Also, the By-Law's parking ratio does not consider the potentially permanent changes in commuting patterns resulting from the COVID-19 pandemic, including hybrid/remote work programs. For these reasons, the minimum number of spaces that would be required under the By-Law is not warranted for the Project

(ii) the extent of existing building coverage on a particular lot is such that in laying out parking spaces in accordance with the design requirements of Subsection 5.1.3, the requirement for minimum number of spaces under Section 5.1.2 cannot be met.

As noted above, the proposed quantity of parking spaces is sufficient to satisfy the anticipated parking demand for the Project.

In reviewing a request for a special permit under this Section 5.1.1.5, the Planning Board shall consider the following:

(a) The issuance of a special permit will not be detrimental to the Town or to the general character and visual appearance of the surrounding neighborhood and abutting uses, and is consistent with the intent of this Zoning By-Law;

The Project redevelops an underutilized site into an economically viable development with public amenities. The addition of the Project will be a source of employment for Needham residents, will generate significant additional tax revenues for the Town, introduces uses, including retail/restaurant uses which will contribute to making the Project a vibrant and cohesive part of the neighborhood and will be designed to enhance the aesthetic of a prominent entry to Needham.

(b) In the case of waiving strict adherence to the requirements of Section 5.1.2 under subparagraph (i) above, the special permit shall define the conditions of the use of structure so as to preclude changes that would alter the special circumstances contributing to the reduced parking need or demand;

The Applicant anticipates working with the Board to incorporate appropriate conditions regarding such changes.

(c) [Not Applicable]

(d) Provisions to demonstrate the ability to provide for additional parking consistent with Section 5.1.2 and/or parking designed in accordance with the particular requirements of Section 5.1.3; and

As noted above, the proposed quantity of parking spaces is sufficient to satisfy the anticipated parking demand for the Project.

(e) The granting of a special permit under this Section shall not exempt a structure, use or lot from future compliance with the provisions of Section 5.1.2 and/or 5.1.3.

The special permit decision will not so exempt the structure, use, or lot.

III. Site Plan Review and Special Permit for Major Project

In conducting the Site Plan Review, the Planning Board shall consider the following matters:

(a) Protection of adjoining premises against seriously detrimental uses by provision for surface water drainage, sound and sight buffers and preservation of views, light, and air;

The Project maintains a significant landscape buffer between the proposed structures and Highland Avenue and Gould Street, which themselves provide a buffer for residential and other properties nearby. The buffer includes landscaped berms planted with shade trees and conifers. The buildings are far enough from the property lines so there will no shade cast towards any residential properties beyond the property boundary. Except for a small surface parking lot next to Gould Street, all parking will be contained below the buildings or within the parking garage. Service and loading areas are located within the buildings. A tree-lined fitness path is proposed around the site perimeter.

As detailed in the Stormwater Report, stormwater will be contained within the project boundary and catch basins with sumps and hoods, oil/water separators, rain gardens, and vegetated swales to improve storm water quality discharges, are provided. Stormwater will be infiltrated to mitigate storm water volumes. The retention pond is incorporated into the pedestrian and fitness path loop around the development.

(b) Convenience and safety of vehicular and pedestrian movement within the site and on adjacent streets, the location of driveway openings in relation to traffic or to adjacent streets and, when necessary, compliance with other regulations for the handicapped, minors and the elderly;

The parking garages and other parking areas proposed to be created will contain enough parking to accommodate all vehicles on the Property and the parking spaces provided will comply with the design criteria set forth in By-Law Section 5.1.3. The Project will provide a primary entrance on Gould Street, across from the existing curb cut for the Wingate senior housing community via a signalized intersection. An internal drive loop will mitigate traffic queuing in and out of the property. There will be a secondary entrance/exit from the parking garage to TV Place. The Applicant will grant an easement to the Town to allow for the proposed transportation mitigation, including the widening of Gould Street to better handle traffic movements and volume. Internal sidewalks and a bike lane connected to Gould Street will encourage multimodal transportation opportunities. Bicycle storage for short-term and long-term use is incorporated into the project design. Handicapped parking will be provided in compliance with applicable requirements. All access walks and paths are designed with slopes of less than 5%, so no ramps will be needed. Crosswalks are proposed at the Gould Street signalized intersection.

(c) Adequacy of the arrangement of parking and loading spaces in relation to the proposed uses of the premises;

Parking and loading spaces have been adequately arranged in relation to the proposed uses on the Property, and in compliance with parking plan and design requirements under By-Law Section 5.1.3. Structured parking is provided under the buildings, and

in a parking garage. A small surface parking area will provide handicapped parking near the primary building entrances, and parking for adjacent retail and/or restaurant space. Loading areas are included in each section of the buildings.

(d) Adequacy of the methods of disposal of refuse and other wastes resulting from the uses permitted on the site;

Adequate methods for disposal of refuse and waste will be provided by the Project. Solid waste and refuse will be disposed of in compliance with all applicable rules and regulations. The wastewater system will be connected to the municipal sewer system. Tenants will be required to comply with all regulations applicable to the handling and disposal of wastes.

(e) Relationship of structures and open spaces to the natural landscape, existing buildings and other community assets in the area and compliance with other requirements of this By-Law; and

The Project will comply with the setback and landscape buffer requirements of the By-Law that were specifically developed to create an appropriate relationship between the Project and the surrounding area. A curvilinear walking/jogging and bike path is proposed along the perimeter of the Property, to be available for use by the general public. Fitness stations will be provided along the path.

(f) Mitigation of adverse impacts on the Town's resources including the effect on the Town's water supply and distribution system, sewer collection and treatment, fire protection, and streets; and may require when acting as the Special Permit Granting Authority or recommend in the case of minor projects, when the Board of Appeals is acting as the Special Permit Granting Authority, such appropriate conditions, limitations, and safeguards necessary to assure the project meets the criteria of a through f.

The Project will not have any adverse impact on the Town's water supply and distribution system, sewer collection and treatment, fire protection, or streets. The Project will not have any adverse impact on the Town's water or wastewater infrastructure. Sufficient pump stations provide support for the area. The proposed buildings will be fully accessible for the Town's firefighting apparatus.

As detailed above and in the materials submitted herewith, the Project satisfies each of the applicable criteria for the requested relief.

As required by G.L. 40A and the By-Law, the Applicant has submitted a copy of these applications to the Town Clerk.

We appreciate your attention to this matter. The Applicant and the entire Project team look forward to meeting with you and discussing the Project on June 7, 2022 or any earlier date that is convenient for the Board.

Very truly yours,

Timothy W. Sullivan
Attorney for Applicant

Enclosures

Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210-1723

Transmittal

To:	Lee Newman	From:	Thomas Urtz
Company:	Town of Needham Planning Board	☐	For Your Information
Address:	Public Service Admin Building 500 Dedham Avenue Needham, MA 02492	☒	For Your Approval
		☐	For Your Review
		☐	As Requested
Phone:			
Date:	April 5, 2022		
Project/File:	218421343		
Delivery:	Hand		

Reference: 557 Highland Avenue - Special Permit Submission

Item	Doc Date	Description
Cover Letter	04/05/2022	Cover Letter/SP Application
Plan Set	03/30/2022	557 Highland Avenue Special Permit Package – Drawing Set Containing Renderings, Proposed Site Plan, Civil, Landscape and Architectural Drawings
TIA	March 2022	557 Highland Avenue – Traffic Impact Study
TIA Appendix	March 2022	557 Highland Avenue – Traffic Impact Study Appendix
Stormwater Report	March 2022	557 Highland Avenue – Stormwater Management Report
Fiscal Impact Analysis	March 20, 2021	Fiscal Impact Analysis by the Barrett Planning Group
Check	4/5/2022	Check payable to the Town of Needham

As requested, please find seven copies of the fore listed documentation which is being submitted to the Town of Needham Planning Department for Special Permit Application, plus applicable submission fee.

Respectfully,

STANTEC ARCHITECTURE AND ENGINEERING P.C.

Thomas Urtz AIA
Senior Associate
Phone: 857-210-2615
thomas.urtz@stantec.com

557 Highland Ave
Needham, MA 02494

Needham Special Permit Package

03/30/2022

Bulfinch

Stantec

Proposed

Site Plan

Aerial – Looking North

Aerial – Looking West

Aerial – Looking South

Aerial – West Entry Drive

Site Aerial - Proposed

Gould Street – Looking North-East

Fitness Loop – Looking South

Street View - Proposed

Bulfinch

Stantec

557 HIGHLAND AVE

NEEDHAM, MA 02494

PROJECT TEAM

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DRAWING INDEX-SUBMISSION MATRIX

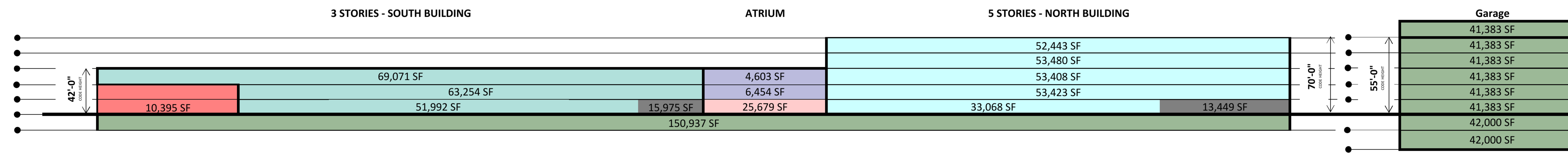
DRAWING NUMBER	DRAWING NAME
GENERAL	
G-000	COVER SHEET
G-010	ZONING GROSS AREA PLANS
CIVIL	
C-01	LEGEND AND GENERAL NOTES
C-02	OVERALL SITE PLAN
C-03	DRAINAGE AND EROSION CONTROL PLAN
C-04	UTILITY PLAN
C-05	SITE DETAILS
C-06	SITE DETAILS
LANDSCAPE	
L-1.0	SITE LAYOUT & MATERIALS PLAN
L-2.0	SITE GRADING PLAN
L-3.0	SITE PLANTING PLAN
L-4.0	SITE LIGHTING PLAN
L-5.0	SITE DETAILS 1
L-5.1	SITE DETAILS II
ARCHITECTURAL	
A-100G1	GARAGE LEVEL G1 - OVERALL PLAN
A-101	LEVEL 1 - OVERALL PLAN
A-102	LEVEL 2 - OVERALL PLAN
A-103	LEVEL 3 - OVERALL PLAN
A-104	LEVEL 4 - OVERALL PLAN
A-105	LEVEL 5 - OVERALL PLAN
A-106	LEVEL 6 - OVERALL PLAN

DRAWING INDEX-SUBMISSION MATRIX

DRAWING NUMBER	DRAWING NAME
A-107	ROOF PLAN
A-201	BUILDING ELEVATIONS - LOCATOR ELEVATIONS
A-202	BUILDING ELEVATIONS - NORTH BLDG - NORTH
A-203	BUILDING ELEVATIONS - NORTH BLDG - SOUTH & EAST
A-204	BUILDING ELEVATIONS - NORTH BLDG (SOUTHWEST) & SOUTH BLDG (SOUTH)
A-205	BUILDING ELEVATIONS - NORTH BLDG (WEST) & SOUTH BLDG (NORTH & WEST)
A-206	BUILDING ELEVATIONS - SOUTH BLDG - NORTH & EAST
A-211	BUILDING SECTIONS - OVERALL
A-212	BUILDING SECTIONS - NORTH BLDG
A-213	BUILDING SECTIONS - NORTH BLDG
ARCHITECTURAL - GARAGE	
AG-100.B2	GARAGE LEVEL B2
AG-100.B1	GARAGE LEVEL B1
AG-101	GARAGE LEVEL 1
AG-102	GARAGE LEVEL 2
AG-103	GARAGE LEVEL 3 (LEVEL 4-5 SIM.)
AG-106	GARAGE LEVEL 6
AG-211	GARAGE SECTIONS
AG-212	GARAGE SECTIONS
AG-301	ELEVATIONS
AG-302	ELEVATIONS

218421343
SPECIAL PERMIT SET - 03/30/2022

Project Stats: Highland Ave
Date: 3/30/2022
Stantec DRAFT



	GROUND FLOOR	
	Program	SF
A1	Retail	10,395 SF
A2	Amenity	25,679 SF
A3	Office/Lab	430,139 SF
A4	Tenant Bridge	11,057 SF
A5	BOH	29,424 SF
A6	PARKING & GARAGE (TOTAL)	483,235 SF
A7	**Total FAR SF (A1 + A2 + A3 + A4 + A5)**	**506,694 SF**

Garage	
Program	SF
Garage	**332,298 SF**

Parking Space Totals

Building Parking Count (Below Grade)					
Level	**Standard**	**Parallel**	**Compact**	**ADA - VAN**	**ADA**
Level G1	200	8	127	2	6
Total by Type	**200**	**8**	**127**	**2**	6
Total Parking		**343**			
% Compact		**37%**			

Garage Parking Count				
Level	**Standard**	**Compact**	**ADA - VAN**	**ADA**
Level B2	71	55	0	3
Level B1	70	58	0	3
Level 1	64	58	3	1
Level 2	70	58	0	3
Level 3	71	58	0	2
Level 4	71	58	0	2
Level 5	71	58	0	2
Roof	71	38	0	2
Total by Type	**559**	**441**	**3**	**18**
Total Parking	**1021**			
% Compact	**43%**			

Site Totals

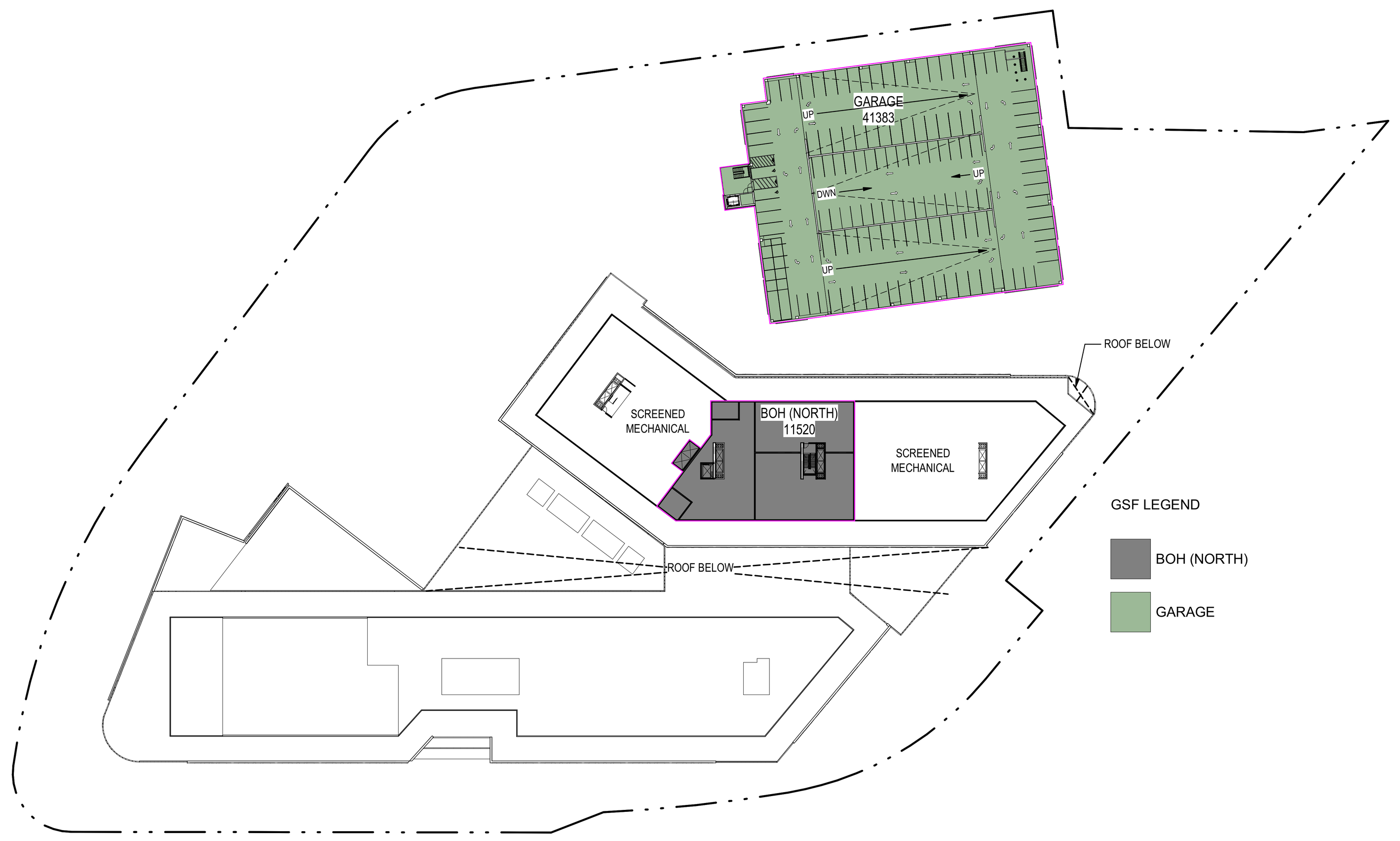
	Program		
			Proposed
P1	**Total FAR SF** (Office + Garage)		**506,694 SF**
P2	**Total Office/Lab SF** (A3 + A4)		**441,196 SF**
P3	Site Parking and Drive Aisles		51,598 SF
P4	Total Lot Coverage (P7 - P4)		252,681 SF
P5	Total Open Space		151,252 SF
P6	Parking Spaces Required at 1/300sf		1689.0
P7	**TOTAL SITE SF**		**403,933 SF**
	SITE FAR		**1.25**

	Site Parking Totals	
		Proposed
SP1	Surface Parking	44
SP2	Office/Lab Building	343
SP3	Garage	1021
SP4	**Total Parking** (SP1 + SP2 + SP3)	**1408**

BUILDINGS A&B (GROSS - OFFICE ONLY)		
BUILDING	GSF (SF)	Comments
LEVEL G1		
PARKING	150937	EXCLUDED
	150937	
LEVEL 1		
ATRIUM	25679	
BOH (NORTH)	13449	
BOH (SOUTH)	15975	
RETAIL	10395	
TENANT - NORTH	33068	
TENANT - SOUTH	51992	
	150558	
LEVEL 2		
TENANT - BRIDGE	6454	
TENANT - NORTH	53423	
TENANT - SOUTH	63254	
	123131	
LEVEL 3		
TENANT - BRIDGE	4603	
TENANT - NORTH	53408	
TENANT - SOUTH	69071	
	127082	
LEVEL 4		
BOH (SOUTH)	11045	EXCLUDED
TENANT - NORTH	53480	
	64525	
LEVEL 5		
TENANT - NORTH	52443	
	52443	
PENTHOUSE - NORTH		
BOH (NORTH)	11520	EXCLUDED
	11520	

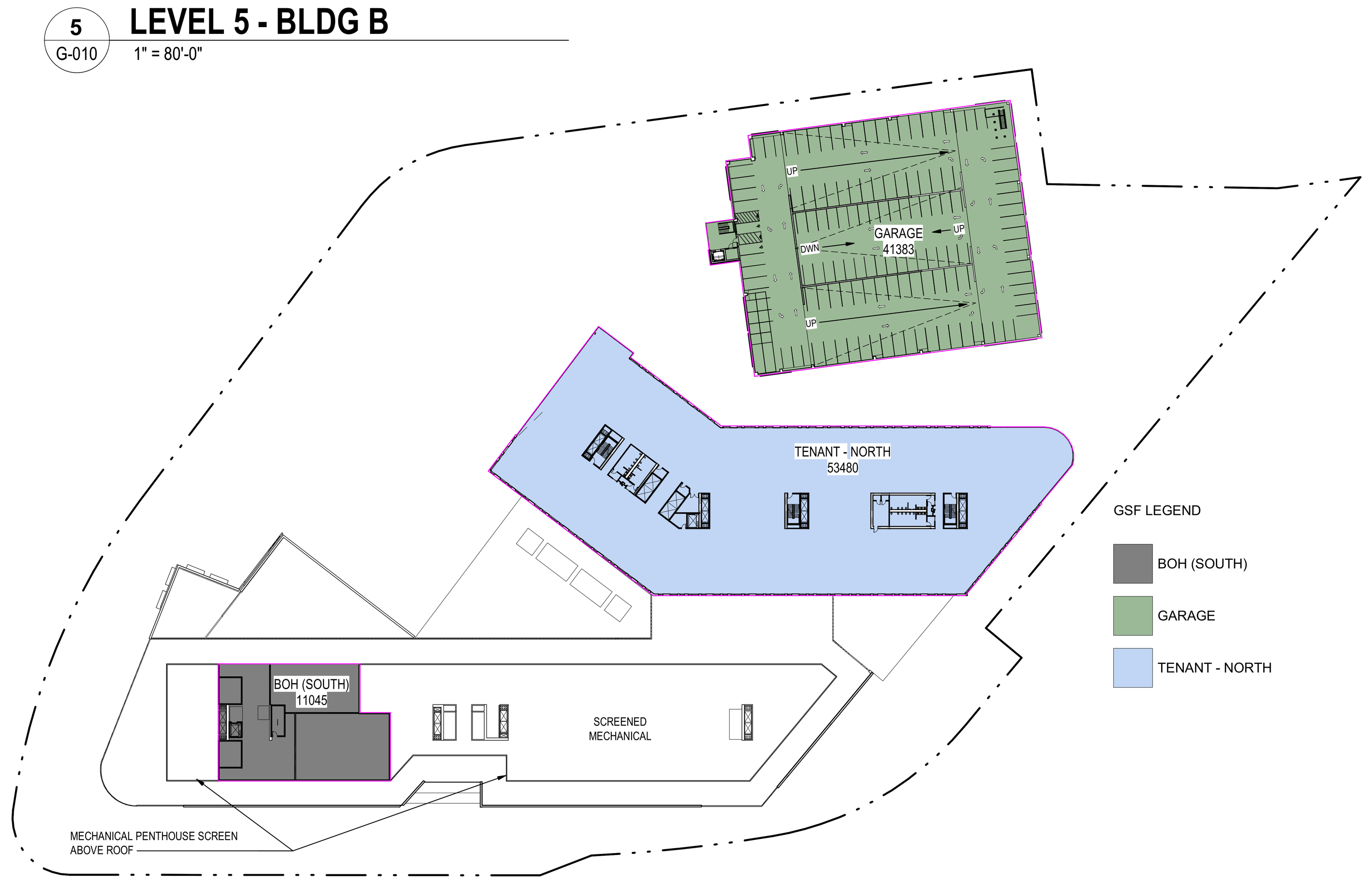
BUILDINGS A&B (GROSS - GARAGE ONLY)		
BUILDING	GSF (SF)	Comments
LEVEL G2		
GARAGE	42000	EXCLUDED
	42000	
LEVEL G1		
GARAGE	42000	EXCLUDED
	42000	
LEVEL 1		
GARAGE	41383	
	41383	
LEVEL 2		
GARAGE	41383	
	41383	
LEVEL 3		
GARAGE	41383	
	41383	
LEVEL 4		
GARAGE	41383	
	41383	
LEVEL 5		
GARAGE	41383	
	41383	
PENTHOUSE - NORTH		
GARAGE	41383	
	41383	
TOTAL	332296	

GENERAL NOTE: ALL AREAS ARE IN PROGRESS AND SHOULD NOT BE CONSIDERED FINAL.



6 G-010 **GSF - ROOF**
1" = 80'-0"

5 G-010 **LEVEL 5 - BLDG B**
1" = 80'-0"



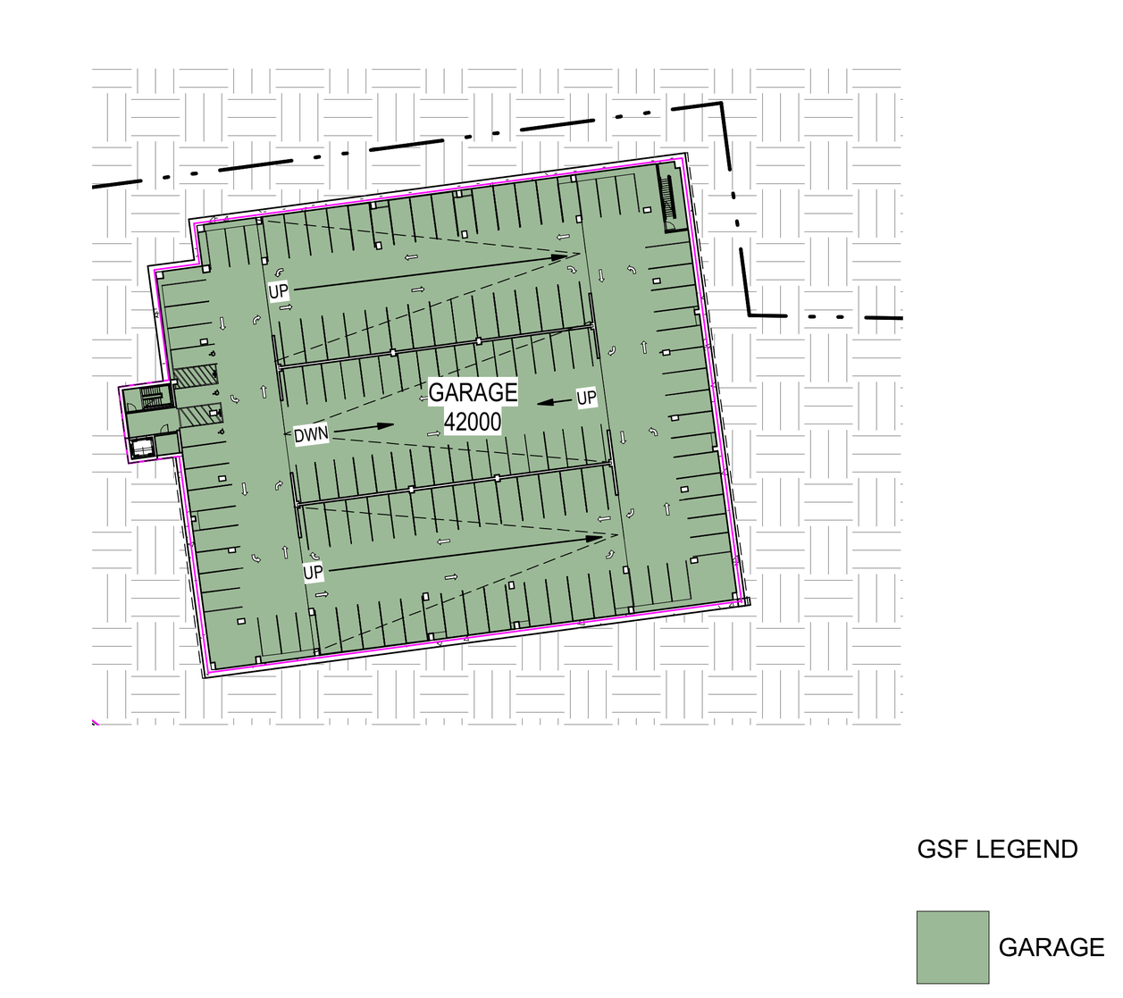
4 G-010 **GSF - LEVEL 4**
1" = 80'-0"

2 G-010 **GSF - LEVEL 2**
1" = 80'-0"

G1 G-010 **GSF - LEVEL G1**
1" = 80'-0"

3 G-010 **GSF - LEVEL 3**
1" = 80'-0"

1 G-010 **GSF - LEVEL 1**
1" = 80'-0"



G2 G-010 **GSF - LEVEL G2**
1" = 80'-0"

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Issued/Revision	By	Appd	YYYY.MM.DD
SPECIAL PERMIT PACKAGE			2022.03.30

Permit/Seal

REGISTERED ARCHITECT BARTON D NELSON No. 951652 BOSTON, MA COMMONWEALTH OF MASSACHUSETTS

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1" = 80'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
ZONING GROSS AREA PLANS

Revision:
Drawing No.
G-010

Legend

Exist. / Prop.

- PROPERTY LINE
- PROJECT LIMIT LINE
- RIGHT-OF-WAY/PROPERTY LINE
- EASEMENT
- BUILDING SETBACK
- PARKING SETBACK
- BASELINE
- CONSTRUCTION LAYOUT
- ZONING LINE
- TOWN LINE
- LIMIT OF DISTURBANCE
- WETLAND LINE WITH FLAG
- FLOODPLAIN
- BORDERING LAND SUBJECT TO FLOODING
- WETLAND BUFFER ZONE
- NO DISTURB ZONE
- 200' RIVERFRONT AREA
- GRAVEL ROAD
- EDGE OF PAVEMENT
- BITUMINOUS BERM
- BITUMINOUS CURB
- CONCRETE CURB
- CURB AND GUTTER
- EXTRUDED CONCRETE CURB
- MONOLITHIC CONCRETE CURB
- PRECAST CONC. CURB
- SLOPED GRAN. EDGING
- VERT. GRAN. CURB
- LIMIT OF CURB TYPE
- SAWCUT
- BUILDING
- BUILDING ENTRANCE
- LOADING DOCK
- BOLLARD
- DUMPSTER PAD
- SIGN
- DOUBLE SIGN
- STEEL GUARDRAIL
- WOOD GUARDRAIL
- PATH
- TREE LINE
- WIRE FENCE
- FENCE
- STOCKADE FENCE
- STONE WALL
- RETAINING WALL
- STREAM / POND / WATER COURSE
- DETENTION BASIN
- HAY BALES
- SILT FENCE
- SILT SOCK / STRAW WATTLE
- MINOR CONTOUR
- MAJOR CONTOUR
- PARKING COUNT
- COMPACT PARKING STALLS
- DOUBLE YELLOW LINE
- STOP LINE
- CROSSWALK
- ACCESSIBLE CURB RAMP
- ACCESSIBLE PARKING
- VAN-ACCESSIBLE PARKING
- CONCRETE
- HEAVY DUTY PAVEMENT
- BUILDINGS
- RIPRAP
- CONSTRUCTION EXIT
- TOP OF CURB ELEVATION
- BOTTOM OF CURB ELEVATION
- SPOT ELEVATION
- TOP & BOTTOM OF WALL ELEVATION
- BORING LOCATION
- TEST PIT LOCATION
- MONITORING WELL
- UNDERDRAIN
- DRAIN
- ROOF DRAIN
- SEWER
- FORCE MAIN
- OVERHEAD WIRE
- WATER
- FIRE PROTECTION
- DOMESTIC WATER
- GAS
- ELECTRIC
- STEAM
- TELEPHONE
- FIRE ALARM
- CABLE TV
- CATCH BASIN CONCENTRIC
- CATCH BASIN ECCENTRIC
- DOUBLE CATCH BASIN CONCENTRIC
- DOUBLE CATCH BASIN ECCENTRIC
- GUTTER INLET
- DRAIN MANHOLE CONCENTRIC
- DRAIN MANHOLE ECCENTRIC
- TRENCH DRAIN
- PLUG OR CAP
- CLEANOUT
- FLARED END SECTION
- HEADWALL
- SEWER MANHOLE CONCENTRIC
- SEWER MANHOLE ECCENTRIC
- CURB STOP & BOX
- WATER VALVE & BOX
- TAPPING SLEEVE, VALVE & BOX
- FIRE DEPARTMENT CONNECTION
- FIRE HYDRANT
- WATER METER
- POST INDICATOR VALVE
- WATER WELL
- GAS GATE
- GAS METER
- ELECTRIC MANHOLE
- ELECTRIC METER
- LIGHT POLE
- TELEPHONE MANHOLE
- TRANSFORMER PAD
- UTILITY POLE
- GUY POLE
- GUY WIRE & ANCHOR
- HAND HOLE
- PULL BOX
- MATCHLINE

Abbreviations

General

ABAN	ABANDON
ACR	ACCESSIBLE CURB RAMP
ADJ	ADJUST
APPROX	APPROXIMATE
BIT	BITUMINOUS
BS	BOTTOM OF SLOPE
BWLL	BROKEN WHITE LANE LINE
CONC	CONCRETE
DYCL	DOUBLE YELLOW CENTER LINE
EL	ELEVATION
ELEV	ELEVATION
EX	EXISTING
FDN	FOUNDATION
FFE	FIRST FLOOR ELEVATION
GRAN	GRANITE
GTD	GRADE TO DRAIN
LA	LANDSCAPE AREA
LOD	LIMIT OF DISTURBANCE
MAX	MAXIMUM
MIN	MINIMUM
NIC	NOT IN CONTRACT
NTS	NOT TO SCALE
PERF	PERFORATED
PROP	PROPOSED
REM	REMOVE
RET	RETAIN
R&D	REMOVE AND DISPOSE
R&R	REMOVE AND RESET
SWEL	SOLID WHITE EDGE LINE
SWLL	SOLID WHITE LANE LINE
TS	TOP OF SLOPE
TYP	TYPICAL

Utility

CB	CATCH BASIN
CMP	CORRUGATED METAL PIPE
CO	CLEANOUT
DCB	DOUBLE CATCH BASIN
DMH	DRAIN MANHOLE
CIP	CAST IRON PIPE
COND	CONDUIT
DIP	DUCTILE IRON PIPE
FES	FLARED END SECTION
FM	FORCE MAIN
F&G	FRAME AND GRATE
F&C	FRAME AND COVER
GI	GUTTER INLET
GT	GREASE TRAP
HDPE	HIGH DENSITY POLYETHYLENE PIPE
HH	HANDHOLE
HW	HEADWALL
HYD	HYDRANT
INV	INVERT ELEVATION
I=	INVERT ELEVATION
LP	LIGHT POLE
MES	METAL END SECTION
PIV	POST INDICATOR VALVE
PWW	PAVED WATER WAY
PVC	POLYVINYLCHLORIDE PIPE
RCP	REINFORCED CONCRETE PIPE
R=	RIM ELEVATION
RIM=	RIM ELEVATION
SMH	SEWER MANHOLE
TSV	TAPPING SLEEVE, VALVE AND BOX
UG	UNDERGROUND
UP	UTILITY POLE

Notes

General

1. CONTRACTOR SHALL NOTIFY "DIG-SAFE" (1-888-344-7233) AT LEAST 72 HOURS BEFORE EXCAVATING.
2. CONTRACTOR SHALL BE RESPONSIBLE FOR SITE SECURITY AND JOB SAFETY. CONSTRUCTION ACTIVITIES SHALL BE IN ACCORDANCE WITH OSHA STANDARDS AND LOCAL REQUIREMENTS.
3. ACCESSIBLE ROUTES, PARKING SPACES, RAMPS, SIDEWALKS AND WALKWAYS SHALL BE CONSTRUCTED IN CONFORMANCE WITH THE FEDERAL AMERICANS WITH DISABILITIES ACT AND WITH STATE AND LOCAL LAWS AND REGULATIONS (WHICHEVER ARE MORE STRINGENT).
4. AREAS DISTURBED DURING CONSTRUCTION AND NOT RESTORED WITH IMPERVIOUS SURFACES (BUILDINGS, PAVEMENTS, WALKS, ETC.) SHALL RECEIVE 6 INCHES LOAM AND SEED.
5. WITHIN THE LIMITS OF THE BUILDING FOOTPRINT, THE SITE CONTRACTOR SHALL PERFORM EARTHWORK OPERATIONS REQUIRED UP TO SUBGRADE ELEVATIONS.
6. WORK WITHIN THE LOCAL RIGHTS-OF-WAY SHALL CONFORM TO LOCAL MUNICIPAL STANDARDS. WORK WITHIN STATE RIGHTS-OF-WAY SHALL CONFORM TO THE LATEST EDITION OF THE STATE HIGHWAY DEPARTMENTS STANDARD SPECIFICATIONS FOR HIGHWAYS AND BRIDGES.
7. UPON AWARD OF CONTRACT, CONTRACTOR SHALL MAKE NECESSARY CONSTRUCTION NOTIFICATIONS AND APPLY FOR AND OBTAIN NECESSARY PERMITS, PAY FEES, AND POST BONDS ASSOCIATED WITH THE WORK INDICATED ON THE DRAWINGS, IN THE SPECIFICATIONS, AND IN THE CONTRACT DOCUMENTS. DO NOT CLOSE OR OBSTRUCT ROADWAYS, SIDEWALKS, AND FIRE HYDRANTS, WITHOUT APPROPRIATE PERMITS.
8. TRAFFIC SIGNAGE AND PAVEMENT MARKINGS SHALL CONFORM TO THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES.
9. AREAS OUTSIDE THE LIMITS OF PROPOSED WORK DISTURBED BY THE CONTRACTOR'S OPERATIONS SHALL BE RESTORED BY THE CONTRACTOR TO THEIR ORIGINAL CONDITION AT THE CONTRACTOR'S EXPENSE.
10. IN THE EVENT THAT SUSPECTED CONTAMINATED SOIL, GROUNDWATER, AND OTHER MEDIA ARE ENCOUNTERED DURING EXCAVATION AND CONSTRUCTION ACTIVITIES BASED ON VISUAL, OLFACTORY, OR OTHER EVIDENCE, THE CONTRACTOR SHALL STOP WORK IN THE VICINITY OF THE SUSPECT MATERIAL TO AVOID FURTHER SPREADING OF THE MATERIAL, AND SHALL NOTIFY THE OWNER IMMEDIATELY SO THAT THE APPROPRIATE TESTING AND SUBSEQUENT ACTION CAN BE TAKEN.
11. CONTRACTOR SHALL PREVENT DUST, SEDIMENT, AND DEBRIS FROM EXITING THE SITE AND SHALL BE RESPONSIBLE FOR CLEANUP, REPAIRS AND CORRECTIVE ACTION IF SUCH OCCURS.
12. DAMAGE RESULTING FROM CONSTRUCTION LOADS SHALL BE REPAIRED BY THE CONTRACTOR AT NO ADDITIONAL COST TO OWNER.
13. CONTRACTOR SHALL CONTROL STORMWATER RUNOFF DURING CONSTRUCTION TO PREVENT ADVERSE IMPACTS TO OFF SITE AREAS, AND SHALL BE RESPONSIBLE TO REPAIR RESULTING DAMAGES, IF ANY, AT NO COST TO OWNER.
14. THIS PROJECT DISTURBS MORE THAN ONE ACRE OF LAND AND FALLS WITHIN THE NPDES CONSTRUCTION GENERAL PERMIT (CGP) PROGRAM AND EPA JURISDICTION. PRIOR TO THE START OF CONSTRUCTION CONTRACTOR IS TO FILE A CGP NOTICE OF INTENT WITH THE EPA AND PREPARE A STORMWATER POLLUTION PREVENTION PLAN IN ACCORDANCE WITH THE NPDES REGULATIONS. CONTRACTOR SHALL CONFIRM THE OWNER HAS ALSO FILED A NOTICE OF INTENT WITH THE EPA.

Utilities

1. THE LOCATIONS, SIZES, AND TYPES OF EXISTING UTILITIES ARE SHOWN AS AN APPROXIMATE REPRESENTATION ONLY. THE OWNER OR ITS REPRESENTATIVE(S) HAVE NOT INDEPENDENTLY VERIFIED THIS INFORMATION AS SHOWN ON THE PLANS. THE UTILITY INFORMATION SHOWN DOES NOT GUARANTEE THE ACTUAL EXISTENCE, SERVICEABILITY, OR OTHER DATA CONCERNING THE UTILITIES, NOR DOES IT GUARANTEE AGAINST THE POSSIBILITY THAT ADDITIONAL UTILITIES MAY BE PRESENT THAT ARE NOT SHOWN ON THE PLANS. PRIOR TO ORDERING MATERIALS AND BEGINNING CONSTRUCTION, THE CONTRACTOR SHALL VERIFY AND DETERMINE THE EXACT LOCATIONS, SIZES, AND ELEVATIONS OF THE POINTS OF CONNECTIONS TO EXISTING UTILITIES AND, SHALL CONFIRM THAT THERE ARE NO INTERFERENCES WITH EXISTING UTILITIES AND THE PROPOSED UTILITY ROUTES, INCLUDING ROUTES WITHIN THE PUBLIC RIGHTS OF WAY.
2. WHERE AN EXISTING UTILITY IS FOUND TO CONFLICT WITH THE PROPOSED WORK, OR EXISTING CONDITIONS DIFFER FROM THOSE SHOWN SUCH THAT THE WORK CANNOT BE COMPLETED AS INTENDED, THE LOCATION, ELEVATION, AND SIZE OF THE UTILITY SHALL BE ACCURATELY DETERMINED WITHOUT DELAY BY THE CONTRACTOR, AND THE INFORMATION FURNISHED IN WRITING TO THE OWNER'S REPRESENTATIVE FOR THE RESOLUTION OF THE CONFLICT AND CONTRACTOR'S FAILURE TO NOTIFY PRIOR TO PERFORMING ADDITIONAL WORK RELEASES OWNER FROM OBLIGATIONS FOR ADDITIONAL PAYMENTS WHICH OTHERWISE MAY BE WARRANTED TO RESOLVE THE CONFLICT.
3. SET CATCH BASIN RIMS, AND INVERTS OF SEWERS, DRAINS, AND DITCHES IN ACCORDANCE WITH ELEVATIONS ON THE GRADING AND UTILITY PLANS.
4. RIM ELEVATIONS FOR DRAIN AND SEWER MANHOLES, WATER VALVE COVERS, GAS GATES, ELECTRIC AND TELEPHONE PULL BOXES, AND MANHOLES, AND OTHER SUCH ITEMS, ARE APPROXIMATE AND SHALL BE SET/RESET AS FOLLOWS:
   - A. PAVEMENTS AND CONCRETE SURFACES: FLUSH
   - B. ALL SURFACES ALONG ACCESSIBLE ROUTES: FLUSH
   - C. LANDSCAPE, LOAM AND SEED, AND OTHER EARTH SURFACE AREAS: ONE INCH ABOVE SURROUNDING AREA AND TAPER EARTH TO THE RIM ELEVATION.
5. THE LOCATION, SIZE, DEPTH, AND SPECIFICATIONS FOR CONSTRUCTION OF PROPOSED PRIVATE UTILITY SERVICES SHALL BE INSTALLED ACCORDING TO THE REQUIREMENTS PROVIDED BY, AND APPROVED BY, THE RESPECTIVE UTILITY COMPANY (GAS, TELEPHONE, ELECTRIC, FIRE ALARM, ETC.). FINAL DESIGN LOADS AND LOCATIONS TO BE COORDINATED WITH OWNER AND ARCHITECT.
6. CONTRACTOR SHALL MAKE ARRANGEMENTS FOR AND SHALL BE RESPONSIBLE FOR PAYING FEES FOR POLE RELOCATION AND FOR THE ALTERATION AND ADJUSTMENT OF GAS, ELECTRIC, TELEPHONE, FIRE ALARM, AND ANY OTHER PRIVATE UTILITIES, WHETHER WORK IS PERFORMED BY CONTRACTOR OR BY THE UTILITIES COMPANY.
7. UTILITY PIPE MATERIALS SHALL BE AS FOLLOWS, UNLESS OTHERWISE NOTED ON THE PLAN:
   - A. WATER PIPES SHALL BE CLASS 52 CEMENT LINED DUCTILE IRON (CLDI).
   - B. SANITARY SEWER PIPES SHALL BE SDR 35 POLYVINYL CHLORIDE (PVC).
   - C. STORM DRAINAGE PIPES SHALL BE HIGH DENSITY POLYETHYLENE (HDPE).
   - D. PIPE INSTALLATION AND MATERIALS SHALL COMPLY WITH THE STATE PLUMBING CODE WHERE APPLICABLE. CONTRACTOR SHALL COORDINATE WITH LOCAL PLUMBING INSPECTOR PRIOR TO BEGINNING WORK.
8. CONTRACTOR SHALL COORDINATE WITH ELECTRICAL CONTRACTOR AND SHALL FURNISH EXCAVATION, INSTALLATION, AND BACKFILL OF ELECTRICAL FURNISHED SITEWORK RELATED ITEMS SUCH AS PULL BOXES, CONDUITS, DUCT BANKS, LIGHT POLE BASES, AND CONCRETE PADS. SITE CONTRACTOR SHALL FURNISH CONCRETE ENCASEMENT OF DUCT BANKS IF REQUIRED BY THE UTILITY COMPANY AND AS INDICATED ON THE DRAWINGS.
9. CONTRACTOR SHALL EXCAVATE AND BACKFILL TRENCHES FOR GAS IN ACCORDANCE WITH GAS COMPANY'S REQUIREMENTS.
10. ALL DRAINAGE AND SANITARY STRUCTURE INTERIOR DIAMETERS (4' MIN.) SHALL BE DETERMINED BY THE MANUFACTURER BASED ON THE PIPE CONFIGURATIONS SHOWN ON THESE PLANS AND LOCAL MUNICIPAL STANDARDS. FOR MANHOLES THAT ARE 20 FEET IN DEPTH AND GREATER, THE MINIMUM DIAMETER SHALL BE 5 FEET.

Layout and Materials

1. DIMENSIONS ARE FROM THE FACE OF CURB, FACE OF BUILDING, FACE OF WALL, AND CENTER LINE OF PAVEMENT MARKINGS, UNLESS OTHERWISE NOTED.
2. CURB RADII ARE 3 FEET UNLESS OTHERWISE NOTED.
3. CURBING SHALL BE VERTICAL GRANITE WITHIN THE SITE UNLESS OTHERWISE INDICATED ON THE PLANS.
4. SEE ARCHITECTURAL DRAWINGS FOR EXACT BUILDING DIMENSIONS AND DETAILS CONTIGUOUS TO THE BUILDING, INCLUDING SIDEWALKS, RAMPS, BUILDING ENTRANCES, STAIRWAYS, UTILITY PENETRATIONS, CONCRETE DOOR PADS, COMPACTOR PAD, LOADING DOCKS, BOLLARDS, ETC.
5. PROPOSED BOUNDS AND ANY EXISTING PROPERTY LINE MONUMENTATION DISTURBED DURING CONSTRUCTION SHALL BE SET OR RESET BY A PROFESSIONAL LAND SURVEYOR.
6. PRIOR TO START OF CONSTRUCTION, CONTRACTOR SHALL VERIFY EXISTING PAVEMENT ELEVATIONS AT INTERFACE WITH PROPOSED PAVEMENTS, AND EXISTING GROUND ELEVATIONS ADJACENT TO DRAINAGE OUTLETS TO ASSURE PROPER TRANSITIONS BETWEEN EXISTING AND PROPOSED FACILITIES.

Demolition

1. PROJECT PRESENTED HEREIN IS THE ADAPTIVE REUSE OF AN EXISTING SITE. TO THE EXTENT REQUIRED TO BUILD THE PROJECT, CONTRACTOR SHALL REMOVE AND DISPOSE OF EXISTING MANMADE SURFACE FEATURES WITHIN THE LIMIT OF WORK INCLUDING BUILDINGS, STRUCTURES, PAVEMENTS, SLABS, CURBING, FENCES, UTILITY POLES, SIGNS, ETC. UNLESS INDICATED OTHERWISE ON THE DRAWINGS. REMOVE AND DISPOSE OF EXISTING UTILITIES, FOUNDATIONS, AND UNSUITABLE MATERIAL BENEATH AND FOR A DISTANCE OF TEN (10) FEET BEYOND THE PROPOSED BUILDING FOOTPRINT INCLUDING EXTERIOR COLUMNS.
2. EXISTING UTILITIES SHALL BE TERMINATED, UNLESS OTHERWISE NOTED, IN CONFORMANCE WITH LOCAL, STATE AND INDIVIDUAL UTILITY COMPANY STANDARD SPECIFICATIONS AND DETAILS. THE CONTRACTOR SHALL COORDINATE UTILITY SERVICE DISCONNECTS WITH THE UTILITY REPRESENTATIVES.
3. CONTRACTOR SHALL DISPOSE OF DEMOLITION DEBRIS IN ACCORDANCE WITH APPLICABLE FEDERAL, STATE AND LOCAL REGULATIONS, ORDINANCES AND STATUTES.
4 THE DEMOLITION LIMITS DEPICTED IN THE PLANS IS INTENDED TO AID THE CONTRACTOR DURING THE BIDDING AND CONSTRUCTION PROCESS AND IS NOT INTENDED TO DEPICT EACH AND EVERY ELEMENT OF DEMOLITION. THE CONTRACTOR IS RESPONSIBLE FOR IDENTIFYING THE DETAILED SCOPE OF DEMOLITION BEFORE SUBMITTING ITS BID/PROPOSAL TO PERFORM THE WORK AND SHALL MAKE NO CLAIMS AND SEEK NO ADDITIONAL COMPENSATION FOR CHANGED CONDITIONS OR UNFORESEEN OR LATENT SITE CONDITIONS RELATED TO ANY CONDITIONS DISCOVERED DURING EXECUTION OF THE WORK.
5. UNLESS OTHERWISE SPECIFICALLY PROVIDED ON THE PLANS OR IN THE SPECIFICATIONS, THE ENGINEER HAS NOT PREPARED DESIGNS FOR AND SHALL HAVE NO RESPONSIBILITY FOR THE PRESENCE, DISCOVERY, REMOVAL, ABATEMENT OR DISPOSAL OF HAZARDOUS MATERIALS, TOXIC WASTES OR POLLUTANTS AT THE PROJECT SITE. THE ENGINEER SHALL NOT BE RESPONSIBLE FOR ANY CLAIMS OF LOSS, DAMAGE, EXPENSE, DELAY, INJURY OR DEATH ARISING FROM THE PRESENCE OF HAZARDOUS MATERIAL AND CONTRACTOR SHALL INDEMNIFY AND HOLD HARMLESS THE ENGINEER FROM ANY CLAIMS MADE IN CONNECTION THEREWITH. MOREOVER, THE ENGINEER SHALL HAVE NO ADMINISTRATIVE OBLIGATIONS OF ANY TYPE WITH REGARD TO ANY CONTRACTOR AMENDMENT INVOLVING THE ISSUES OF PRESENCE, DISCOVERY, REMOVAL, ABATEMENT OR DISPOSAL OF ASBESTOS OR OTHER HAZARDOUS MATERIALS.

Erosion Control

1. PRIOR TO STARTING ANY OTHER WORK ON THE SITE, THE CONTRACTOR SHALL NOTIFY APPROPRIATE AGENCIES AND SHALL INSTALL EROSION CONTROL MEASURES AS SHOWN ON THE PLANS AND AS IDENTIFIED IN FEDERAL, STATE, AND LOCAL APPROVAL DOCUMENTS PERTAINING TO THIS PROJECT.
2. CONTRACTOR SHALL INSPECT AND MAINTAIN EROSION CONTROL MEASURES ON A WEEKLY BASIS (MINIMUM) OR AS REQUIRED PER THE STORMWATER POLLUTION PREVENTION PLAN (SWPPP). THE CONTRACTOR SHALL ADDRESS DEFICIENCIES AND MAINTENANCE ITEMS WITHIN TWENTY-FOUR HOURS OF INSPECTION. CONTRACTOR SHALL PROPERLY DISPOSE OF SEDIMENT SUCH THAT IT DOES NOT ENCUMBER OTHER DRAINAGE STRUCTURES AND PROTECTED AREAS.
3. CONTRACTOR SHALL BE FULLY RESPONSIBLE TO CONTROL CONSTRUCTION SUCH THAT SEDIMENTATION SHALL NOT AFFECT REGULATORY PROTECTED AREAS, WHETHER SUCH SEDIMENTATION IS CAUSED BY WATER, WIND, OR DIRECT DEPOSIT.
4. CONTRACTOR SHALL PERFORM CONSTRUCTION SEQUENCING SUCH THAT EARTH MATERIALS ARE EXPOSED FOR A MINIMUM OF TIME BEFORE THEY ARE COVERED, SEEDED, OR OTHERWISE STABILIZED TO PREVENT EROSION.
5. UPON COMPLETION OF CONSTRUCTION AND ESTABLISHMENT OF PERMANENT GROUND COVER, CONTRACTOR SHALL REMOVE AND DISPOSE OF EROSION CONTROL MEASURES AND CLEAN SEDIMENT AND DEBRIS FROM ENTIRE DRAINAGE AND SEWER SYSTEMS.

Existing Conditions Information

1. BASE PLAN: THE PROPERTY LINES AND EXISTING CONDITIONS ARE SHOWN BASED ON "ALTA/NSPS LAND TITLE SURVEY 557 HIGHLAND AVENUE", PREPARED BY FELDMAN LAND SURVEYORS, DATED 12/09/2021.
2. TOPOGRAPHY: ELEVATIONS ARE BASED ON NAVD88.
3. GEOTECHNICAL DATA INCLUDING TEST PIT AND BORING LOCATIONS AND ELEVATIONS WERE OBTAINED FROM A MEMO ENTITLED "PRELIMINARY EVALUATION OF SOIL HYDRAULIC CONDUCTIVITY", PREPARED BY MCPHAIL ASSOCIATES, DATED MARCH 18, 2022.

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2. CONTRACTOR SHALL NOT RELY SOLELY ON ELECTRONIC VERSIONS OF PLANS, SPECIFICATIONS, AND DATA FILES THAT ARE OBTAINED FROM THE DESIGNERS, BUT SHALL VERIFY LOCATION OF PROJECT FEATURES IN ACCORDANCE WITH THE PAPER COPIES OF THE PLANS AND SPECIFICATIONS THAT ARE SUPPLIED AS PART OF THE CONTRACT DOCUMENTS.
3. SYMBOLS AND LEGENDS OF PROJECT FEATURES ARE GRAPHIC REPRESENTATIONS AND ARE NOT NECESSARILY SCALED TO THEIR ACTUAL DIMENSIONS OR LOCATIONS ON THE DRAWINGS. THE CONTRACTOR SHALL REFER TO THE DETAIL SHEET DIMENSIONS, MANUFACTURERS' LITERATURE, SHOP DRAWINGS AND FIELD MEASUREMENTS OF SUPPLIED PRODUCTS FOR LAYOUT OF THE PROJECT FEATURES.

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SPECIAL PERMIT PACKAGE — 2022.03.30
Issued/Revision — By — Appd — YYYY.MM.DD

Permit/Seal
COMMONWEALTH OF MASSACHUSETTS — NICHOLAS J. SKOLY CIVIL No. 52677 — REGISTERED PROFESSIONAL ENGINEER

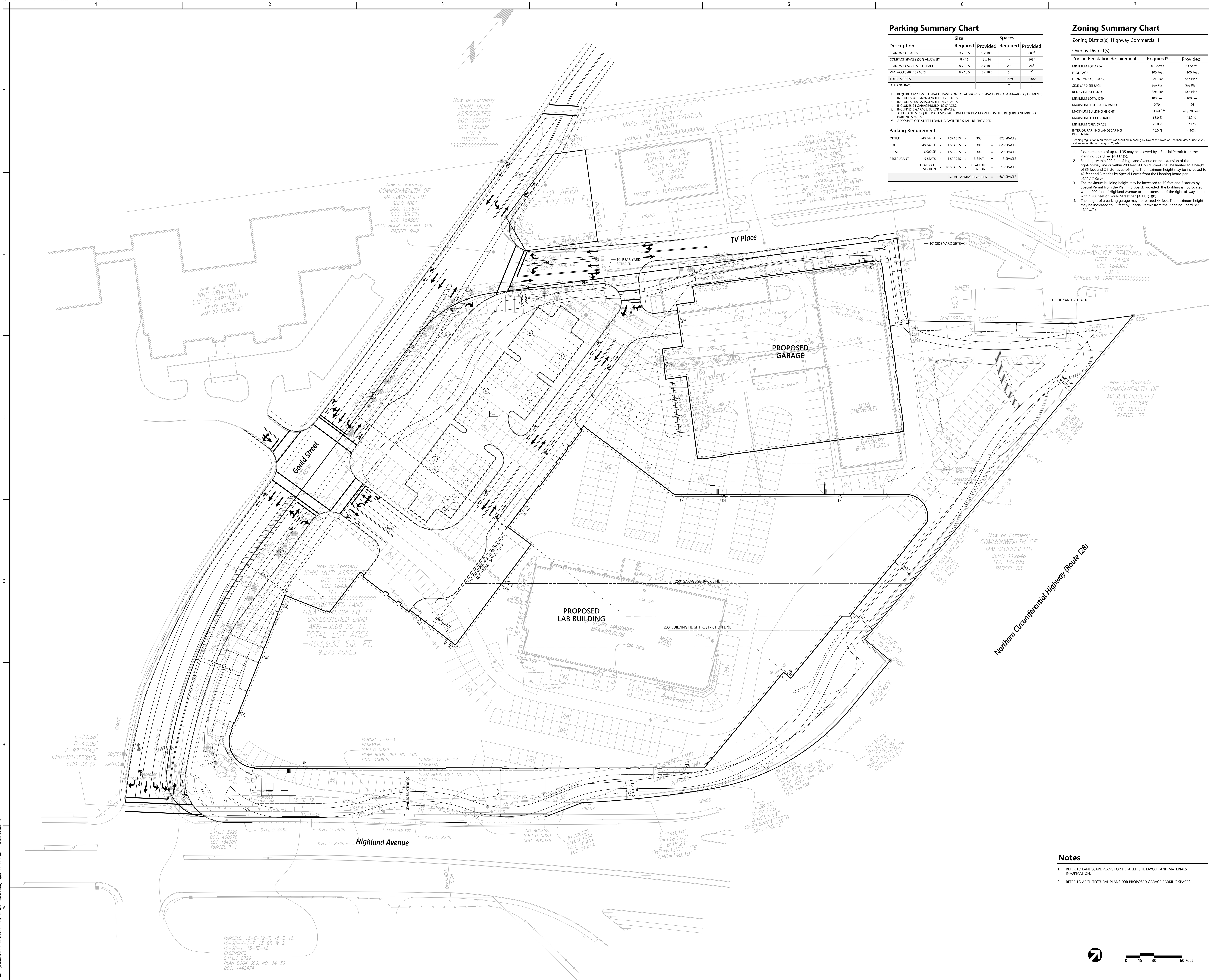
Client/Project
Bulfinch
557 Highland Ave

Project No.: 15216.00
File Name: N/A
Scale:

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
LEGEND AND GENERAL NOTES

Revision:
Drawing No.
C-01



Parking Summary Chart

Description	Size Required	Size Provided	Spaces Required	Spaces Provided
STANDARD SPACES	9 x 18.5	9 x 18.5	-	809[2]
COMPACT SPACES (50% ALLOWED)	8 x 16	8 x 16	-	568[3]
STANDARD ACCESSIBLE SPACES	8 x 18.5	8 x 18.5	20[1]	24[4]
VAN ACCESSIBLE SPACES	8 x 18.5	8 x 18.5	5[1]	7[5]
TOTAL SPACES			1,689	1,408[6]
LOADING BAYS			**	5

1. REQUIRED ACCESSIBLE SPACES BASED ON TOTAL PROVIDED SPACES PER ADA/MAAB REQUIREMENTS.
2. INCLUDES 767 GARAGE/BUILDING SPACES.
3. INCLUDES 568 GARAGE/BUILDING SPACES.
4. INCLUDES 24 GARAGE/BUILDING SPACES.
5. INCLUDES 5 GARAGE/BUILDING SPACES.
6. APPLICANT IS REQUESTING A SPECIAL PERMIT FOR DEVIATION FROM THE REQUIRED NUMBER OF PARKING SPACES.

** ADEQUATE OFF-STREET LOADING FACILITIES SHALL BE PROVIDED.

Parking Requirements:

OFFICE	248,347 SF	x	1 SPACES	/	300	=	828 SPACES
R&D	248,347 SF	x	1 SPACES	/	300	=	828 SPACES
RETAIL	6,000 SF	x	1 SPACES	/	300	=	20 SPACES
RESTAURANT	9 SEATS	x	1 SPACES	/	3 SEAT	=	3 SPACES
	1 TAKEOUT STATION	x	10 SPACES	/	1 TAKEOUT STATION	=	10 SPACES
					TOTAL PARKING REQUIRED	=	1,689 SPACES

Zoning Summary Chart

Zoning District(s): Highway Commercial 1

Overlay District(s):

Zoning Regulation Requirements	Required*	Provided
MINIMUM LOT AREA	0.5 Acres	9.3 Acres
FRONTAGE	100 Feet	> 100 Feet
FRONT YARD SETBACK	See Plan	See Plan
SIDE YARD SETBACK	See Plan	See Plan
REAR YARD SETBACK	See Plan	See Plan
MINIMUM LOT WIDTH	100 Feet	> 100 Feet
MAXIMUM FLOOR AREA RATIO	0.70 [1]	1.26
MAXIMUM BUILDING HEIGHT	56 Feet [2,3,4]	42 / 70 Feet
MAXIMUM LOT COVERAGE	65.0 %	48.0 %
MINIMUM OPEN SPACE	25.0 %	27.1 %
INTERIOR PARKING LANDSCAPING PERCENTAGE	10.0 %	> 10%

* Zoning regulation requirements as specified in Zoning By-Law of the Town of Needham dated June, 2020, and amended through August 21, 2021.

1. Floor area ratio of up to 1.35 may be allowed by a Special Permit from the Planning Board per §4.11.1(5).
2. Buildings within 200 feet of Highland Avenue or the extension of the right-of-way line or within 200 feet of Gould Street shall be limited to a height of 35 feet and 2.5 stories as-of-right. The maximum height may be increased to 42 feet and 3 stories by Special Permit from the Planning Board per §4.11.1(1)(a,b).
3. The maximum building height may be increased to 70 feet and 5 stories by Special Permit from the Planning Board, provided the building is not located within 200 feet of Highland Avenue or the extension of the right-of-way line or within 200 feet of Gould Street per §4.11.1(1)(b).
4. The height of a parking garage may not exceed 44 feet. The maximum height may be increased to 55 feet by Special Permit from the Planning Board per §4.11.2(1).

Notes

1. REFER TO LANDSCAPE PLANS FOR DETAILED SITE LAYOUT AND MATERIALS INFORMATION.
2. REFER TO ARCHITECTURAL PLANS FOR PROPOSED GARAGE PARKING SPACES.

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston, 02210-1723
Tel: (617) 234-3100 • www.stantec.com

Consultant
vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

Issued/Revision	By	Appd	YYYY.MM.DD
SPECIAL PERMIT PACKAGE			2022.03.30

Permit/Seal

COMMONWEALTH OF MASSACHUSETTS
NICHOLAS J. SKOLY
CIVIL
No. 52677
REGISTERED PROFESSIONAL ENGINEER

Client/Project

Bulfinch

557 Highland Ave

Project No.: 15216.00

File Name: N/A

Scale: 1" = 30'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

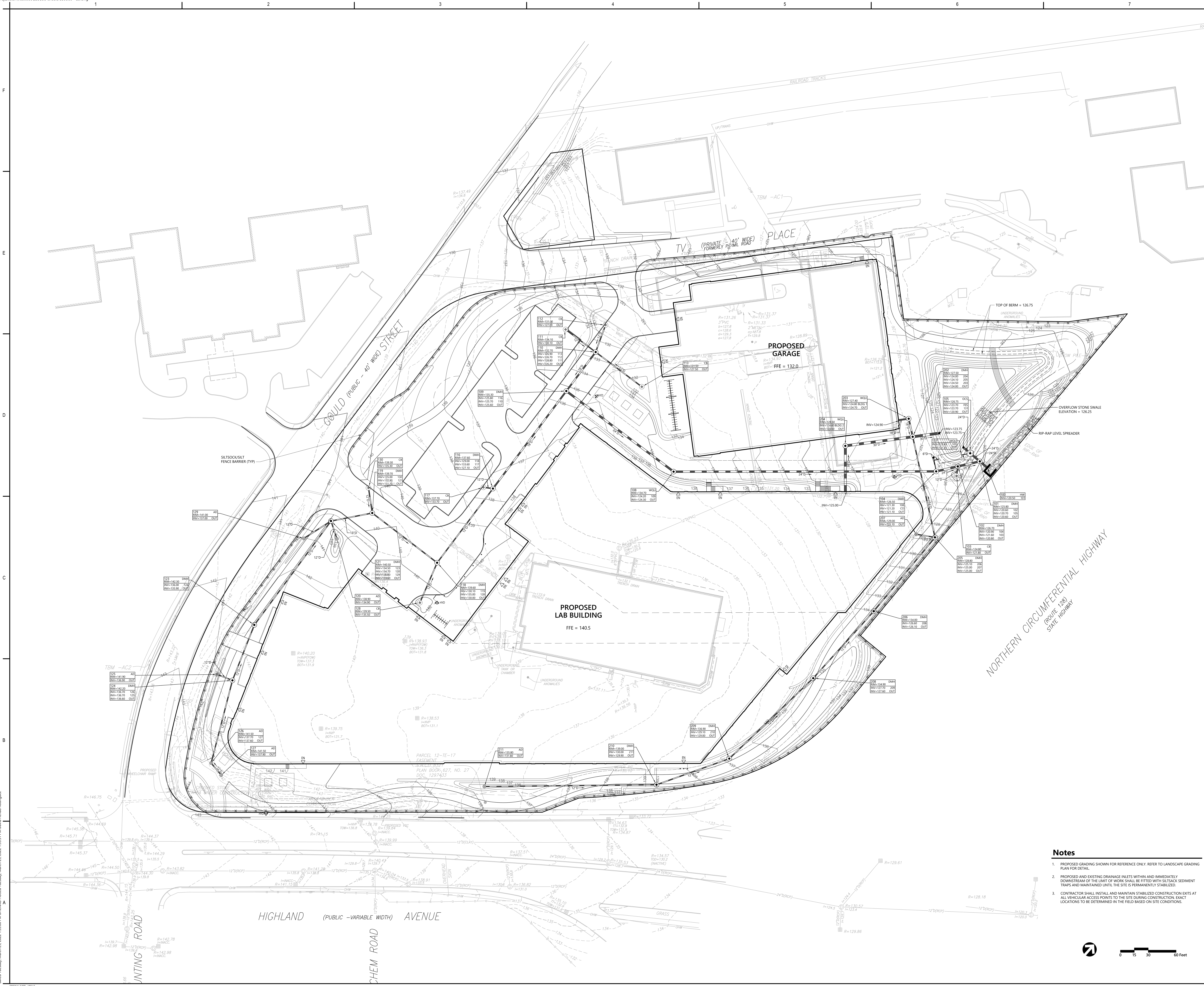
Title

OVERALL SITE PLAN

Revision:

Drawing No.

C-02



Notes

1. PROPOSED GRADING SHOWN FOR REFERENCE ONLY. REFER TO LANDSCAPE GRADING PLAN FOR DETAIL.
2. PROPOSED AND EXISTING DRAINAGE INLETS WITHIN AND IMMEDIATELY DOWNSTREAM OF THE LIMIT OF WORK SHALL BE FITTED WITH SILTSACK SEDIMENT TRAPS AND MAINTAINED UNTIL THE SITE IS PERMANENTLY STABILIZED.
3. CONTRACTOR SHALL INSTALL AND MAINTAIN STABILIZED CONSTRUCTION EXITS AT ALL VEHICULAR ACCESS POINTS TO THE SITE DURING CONSTRUCTION. EXACT LOCATIONS TO BE DETERMINED IN THE FIELD BASED ON SITE CONDITIONS.

0 15 30 60 Feet

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SPECIAL PERMIT PACKAGE			2022.03.30

Permit/Seal

COMMONWEALTH OF MASSACHUSETTS
NICHOLAS J. SKOLY
CIVIL
No. 52677
REGISTERED PROFESSIONAL ENGINEER

Client/Project
Bulfinch
557 Highland Ave

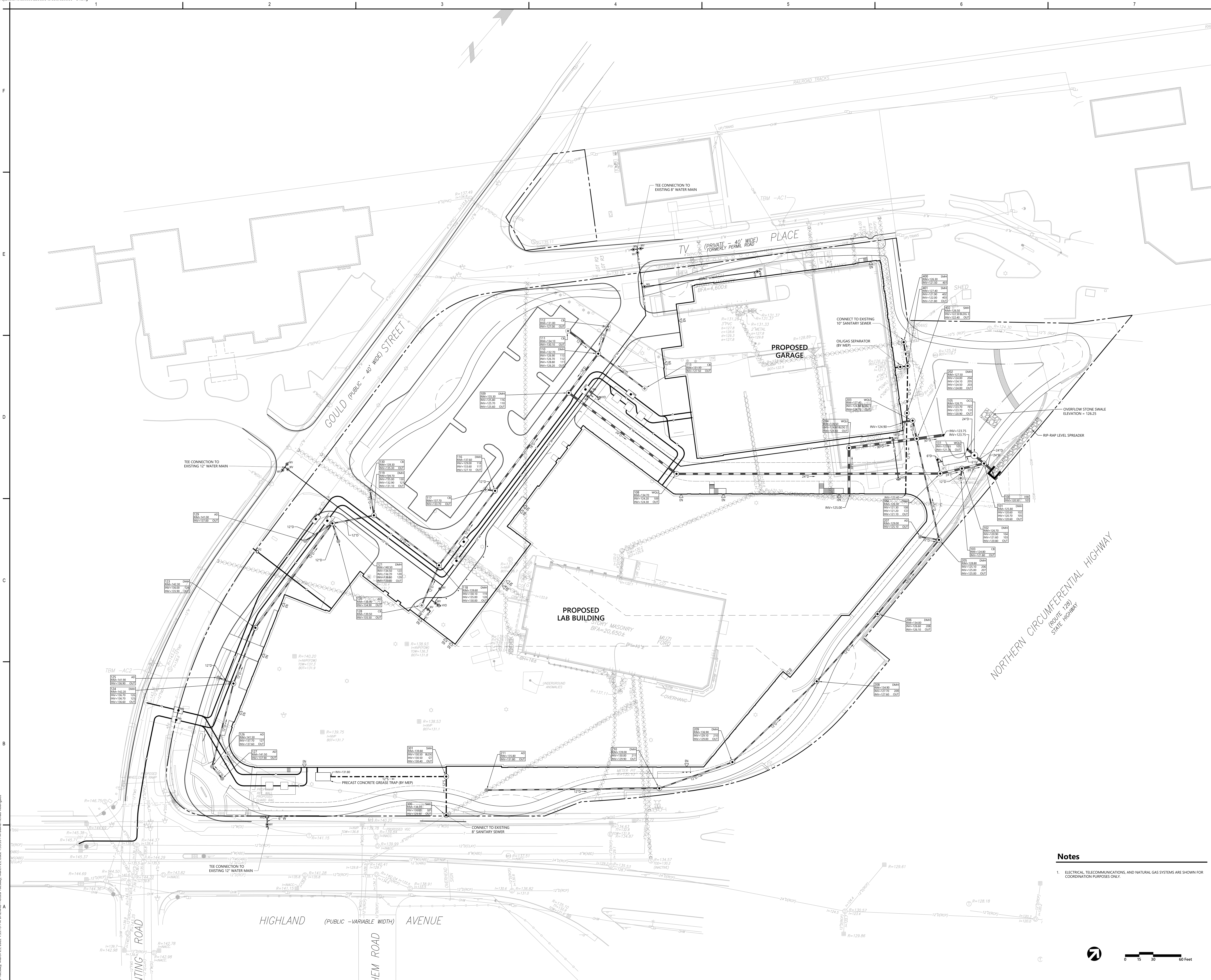
Project No.: 15216.00
File Name: N/A
Scale: 1" = 30'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
DRAINAGE AND EROSION CONTROL PLAN

Revision:

Drawing No.
C-03



Notes

1. ELECTRICAL, TELECOMMUNICATIONS, AND NATURAL GAS SYSTEMS ARE SHOWN FOR COORDINATION PURPOSES ONLY.

Saved Tuesday, March 29, 2022 1:33:13 PM DHENAO Plotted Tuesday, March 29, 2022 1:55:53 PM David Henao Rodriguez

ORIGINAL SHEET - ARCH E

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Issued/Revision	By	Appd	YYYY.MM.DD
SPECIAL PERMIT PACKAGE			2022.03.30

Permit/Seal

COMMONWEALTH OF MASSACHUSETTS
NICHOLAS J. SKOLY
CIVIL
No. 52677
REGISTERED PROFESSIONAL ENGINEER

Client/Project
Bulfinch
557 Highland Ave

Project No.: 15216.00
File Name: N/A
Scale: 1" = 30'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
UTILITY PLAN

Revision:

Drawing No.
C-04

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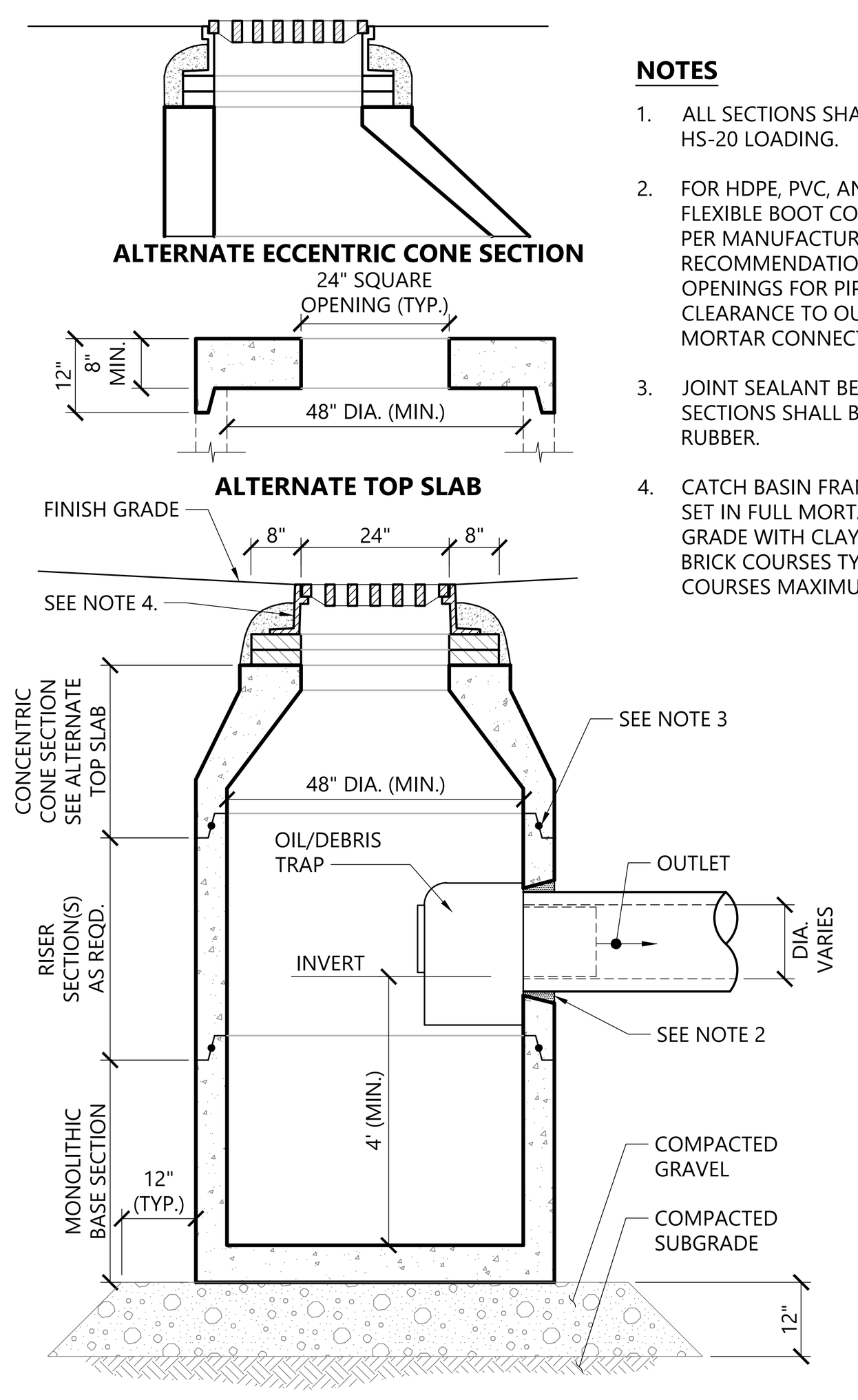


ALTERNATE ECCENTRIC CONE SECTION
24" SQUARE OPENING (TYP.)
48" DIA. (MIN.)
ALTERNATE TOP SLAB
FINISH GRADE
SEE NOTE 4.
24"
8"
CONCENTRIC CONE SECTION SEE ALTERNATE TOP SLAB
SEE NOTE 3
48" DIA. (MIN.)
OIL/DEBRIS TRAP
OUTLET
INVERT
DIA. VARIES
RISER SECTION(S) AS REQ'D.
SEE NOTE 2
4' (MIN.)
MONOLITHIC BASE SECTION
12" (TYP.)
COMPACTED GRAVEL
COMPACTED SUBGRADE

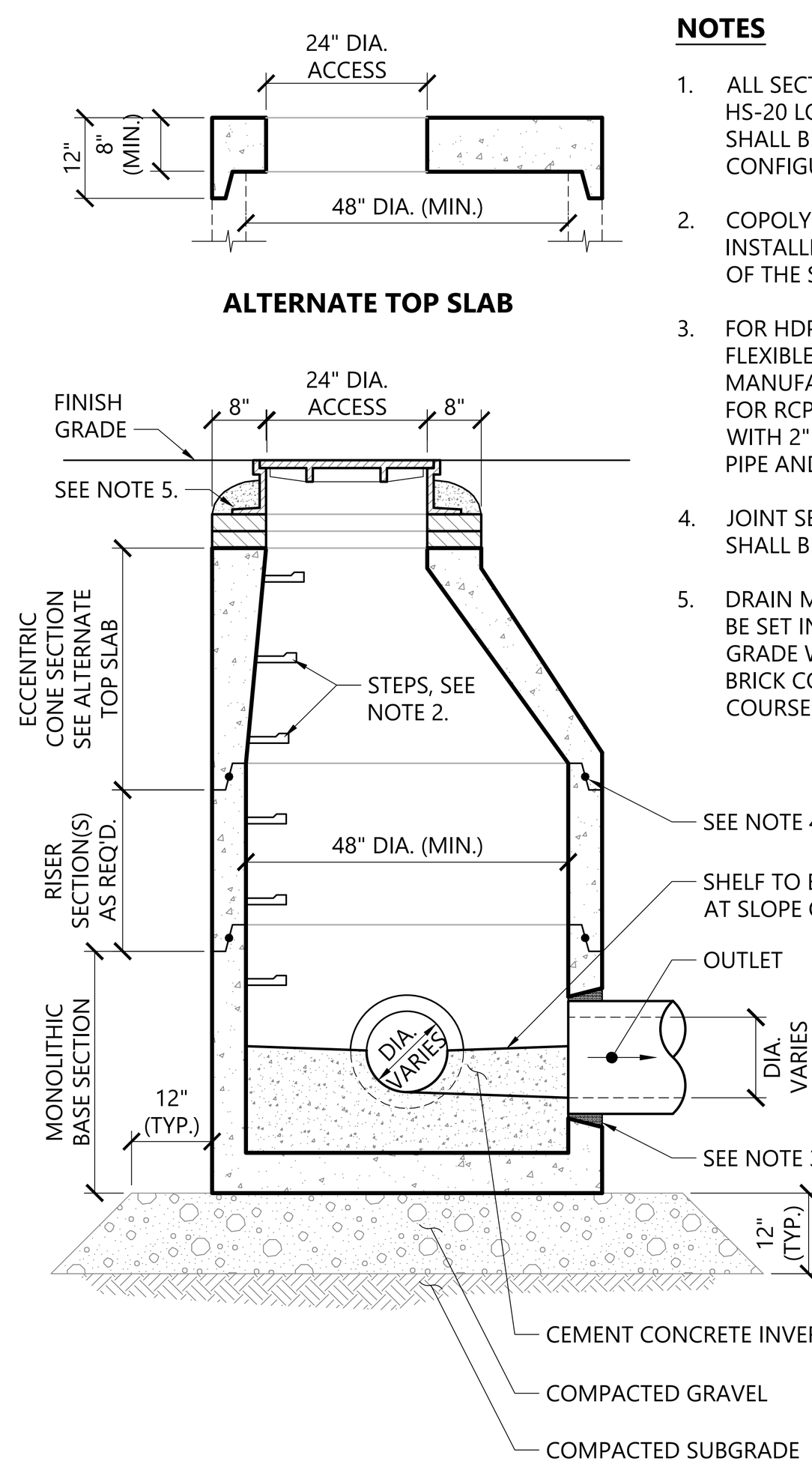
NOTES

1. ALL SECTIONS SHALL BE DESIGNED FOR HS-20 LOADING.
2. FOR HDPE, PVC, AND DI PIPE, PROVIDE FLEXIBLE BOOT CONNECTION INSTALLED PER MANUFACTURER'S RECOMMENDATIONS. FOR RCP, PROVIDE OPENINGS FOR PIPES WITH 2" MAX. CLEARANCE TO OUTSIDE OF PIPE AND MORTAR CONNECTIONS.
3. JOINT SEALANT BETWEEN PRECAST SECTIONS SHALL BE PREFORMED BUTYL RUBBER.
4. CATCH BASIN FRAME AND GRATE SHALL BE SET IN FULL MORTAR BED. ADJUST TO GRADE WITH CLAY BRICK AND MORTAR (2 BRICK COURSES TYPICALLY, 5 BRICK COURSES MAXIMUM).

Catch Basin (CB) With Oil/Debris Trap

3/21

N.T.S. Source: VHB LD_101



24" DIA. ACCESS
12"
8" (MIN.)
48" DIA. (MIN.)
ALTERNATE TOP SLAB
FINISH GRADE
24" DIA. ACCESS
8"
SEE NOTE 5.
ECCENTRIC CONE SECTION SEE ALTERNATE TOP SLAB
STEPS, SEE NOTE 2.
48" DIA. (MIN.)
RISER SECTION(S) AS REQ'D.
SEE NOTE 4.
SHELF TO BE CONCRETE FORMED AT SLOPE OF 1" PER FOOT.
OUTLET
DIA. VARIES
MONOLITHIC BASE SECTION
12" (TYP.)
SEE NOTE 3.
CEMENT CONCRETE INVERT
COMPACTED GRAVEL
COMPACTED SUBGRADE

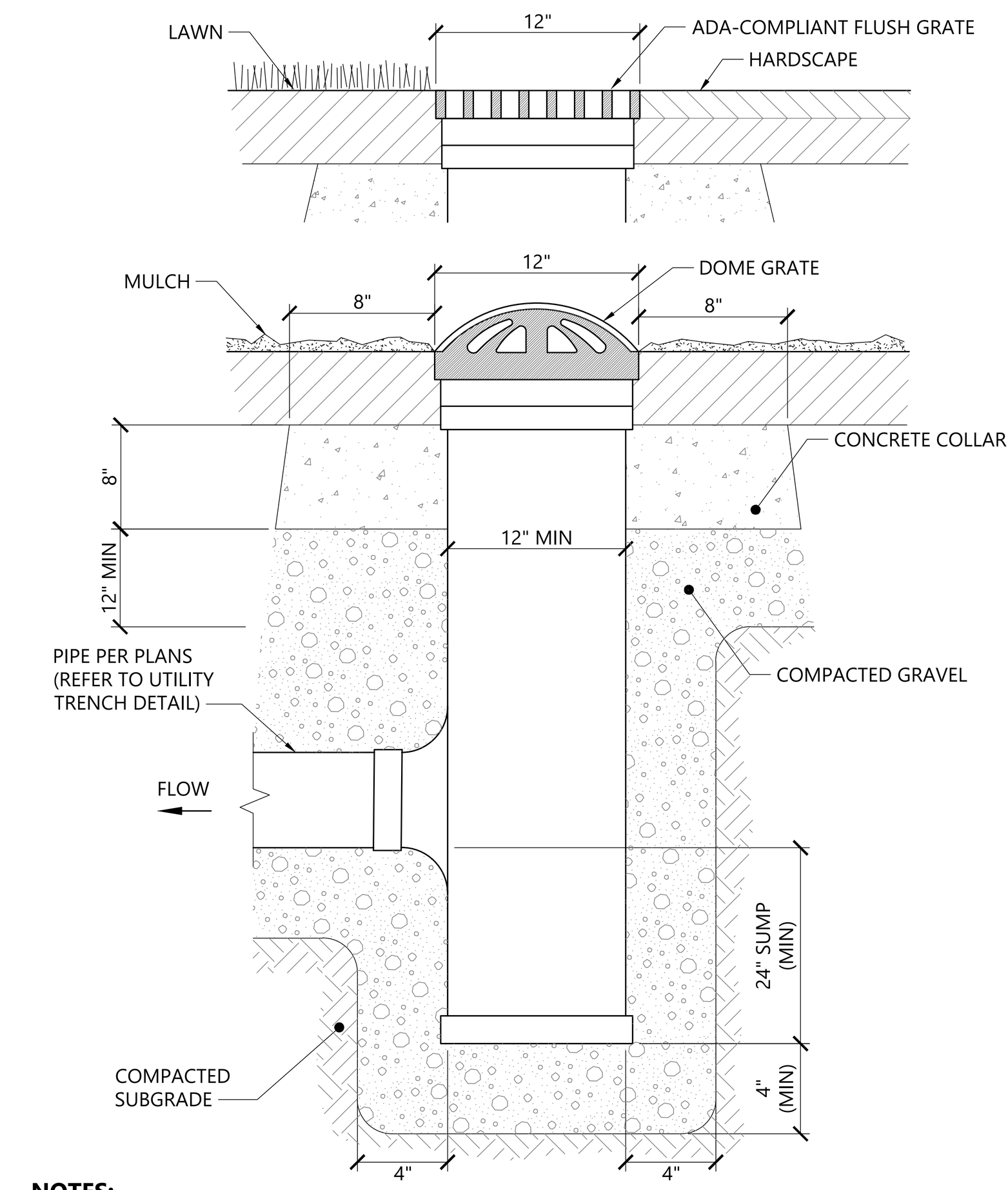
NOTES

1. ALL SECTIONS SHALL BE DESIGNED FOR HS-20 LOADING. DIAMETER OF STRUCTURES SHALL BE COORDINATED WITH PIPE CONFIGURATIONS.
2. COPOLYMER MANHOLE STEPS SHALL BE INSTALLED AT 12" O.C. FOR THE FULL DEPTH OF THE STRUCTURE.
3. FOR HDPE, PVC, AND DI PIPE, PROVIDE FLEXIBLE BOOT CONNECTION INSTALLED PER MANUFACTURER'S RECOMMENDATIONS. FOR RCP, PROVIDE OPENINGS FOR PIPES WITH 2" MAX. CLEARANCE TO OUTSIDE OF PIPE AND MORTAR CONNECTIONS.
4. JOINT SEALANT BETWEEN PRECAST SECTIONS SHALL BE PREFORMED BUTYL RUBBER.
5. DRAIN MANHOLE FRAME AND COVER SHALL BE SET IN FULL MORTAR BED. ADJUST TO GRADE WITH CLAY BRICK AND MORTAR (2 BRICK COURSES TYPICALLY, 5 BRICK COURSES MAXIMUM)

Drain Manhole (DMH)

11/19

N.T.S. Source: VHB LD_115



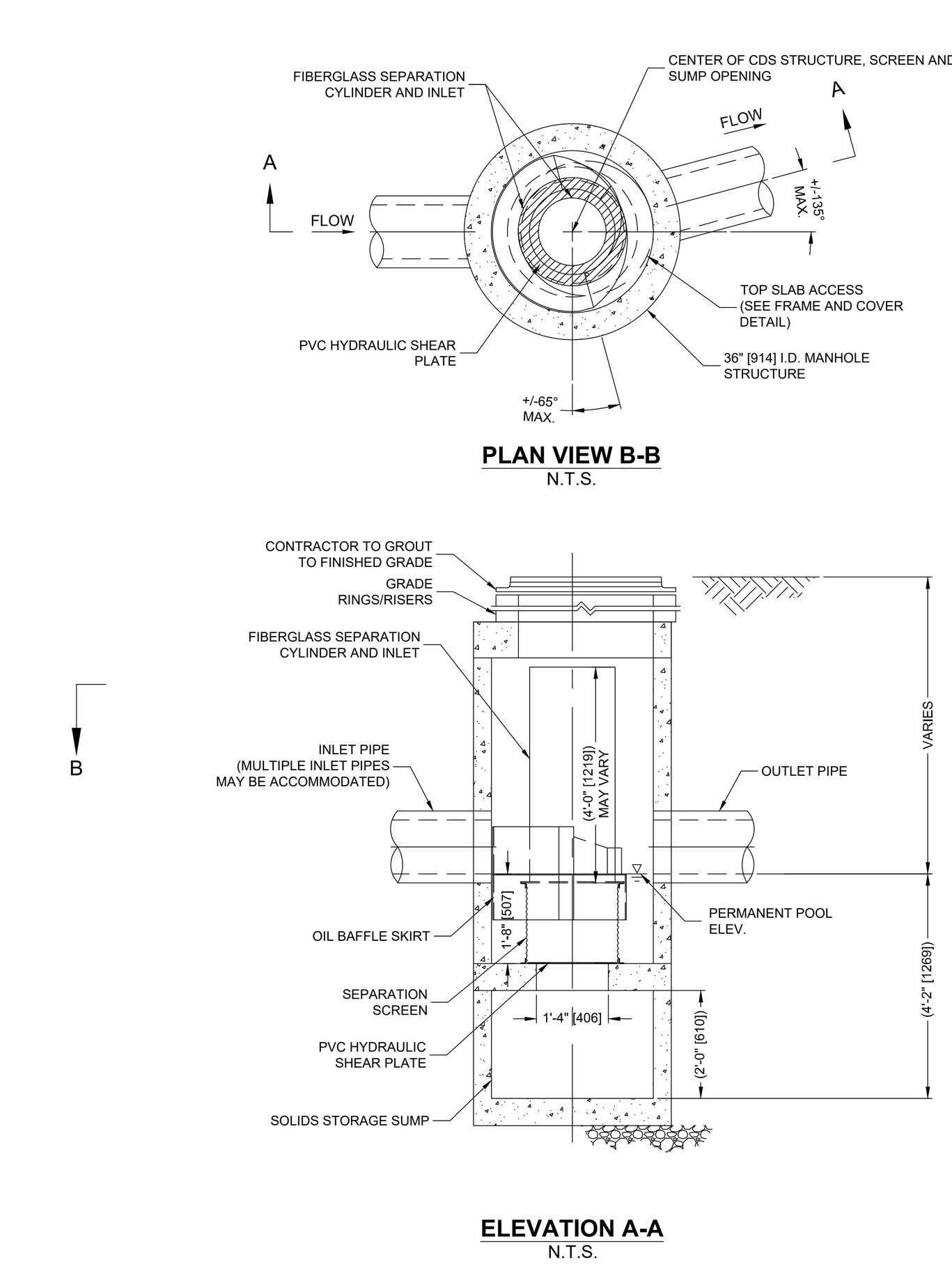
NOTES:

1. AREA DRAINS SHALL BE NYLOPLAST 12" DIAMETER DRAIN BASIN, OR APPROVED EQUAL.
2. GRATES SHALL BE NYLOPLAST 12" PEDESTRIAN MODEL 1299CGP OR 12" DOME GRATE MODEL 1299CGD (OR APPROVED EQUAL).

Area Drain (AD) Type 1

12/19

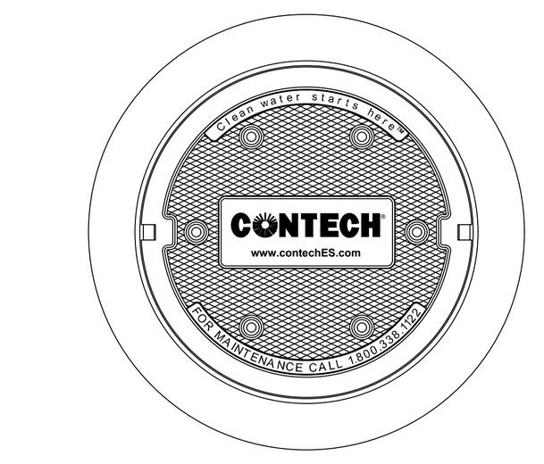
N.T.S. Source: VHB LD_193



CDS1515-3-C DESIGN NOTES

CDS1515-3-C RATED TREATMENT CAPACITY IS 1.0 CFS, OR PER LOCAL REGULATIONS.

THE STANDARD CDS1515-3-C CONFIGURATION IS SHOWN.



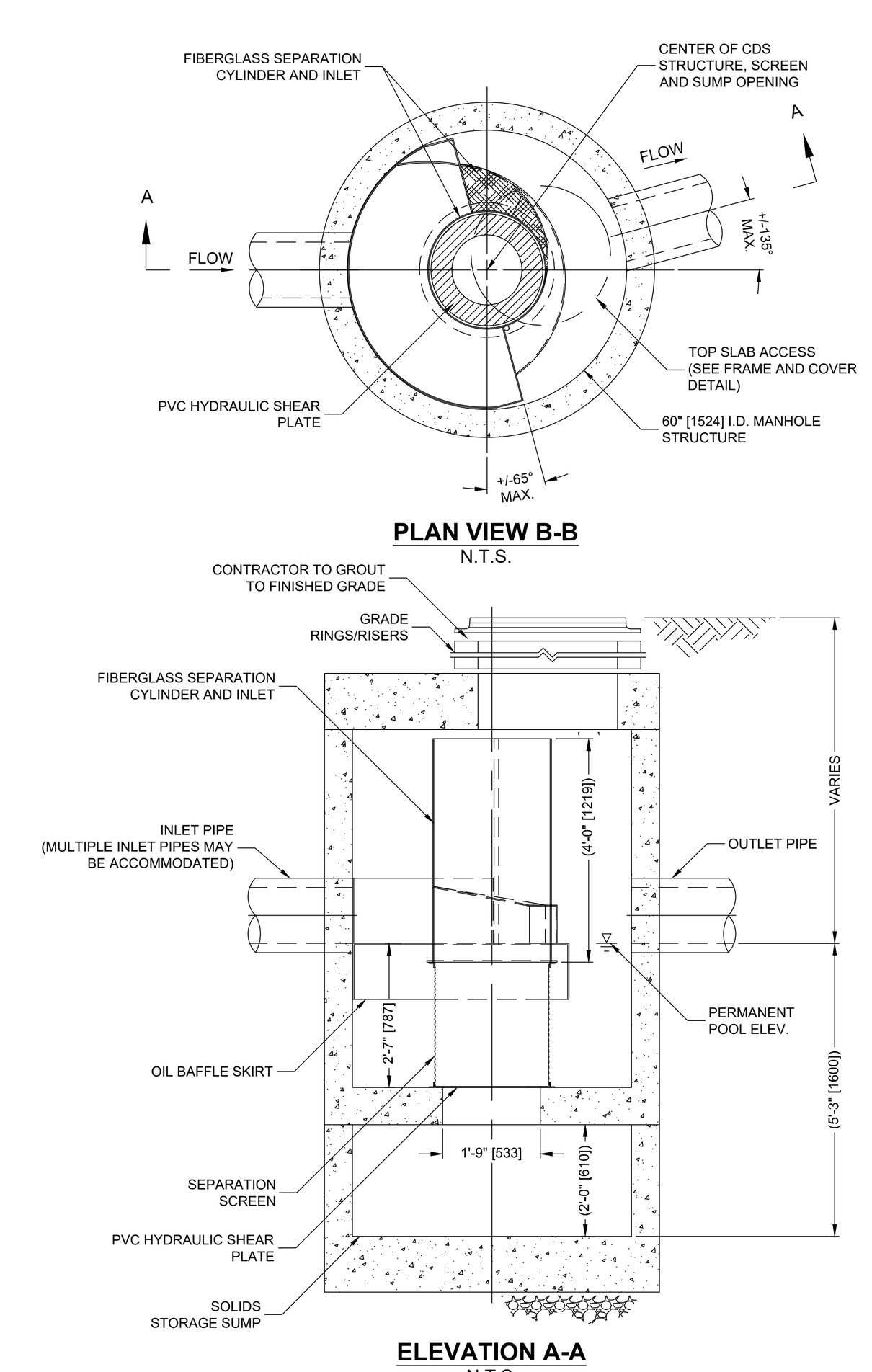
FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO..
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

WQU-203 (CDS1515-3)

N.T.S. Source: Contech

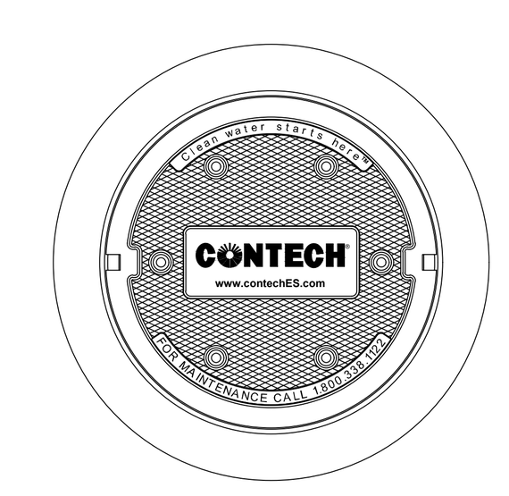


CDS2020-5-C DESIGN NOTES

CDS2020-5-C RATED TREATMENT CAPACITY IS 2.2 CFS, OR PER LOCAL REGULATIONS.

THE STANDARD CDS2020-5-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES



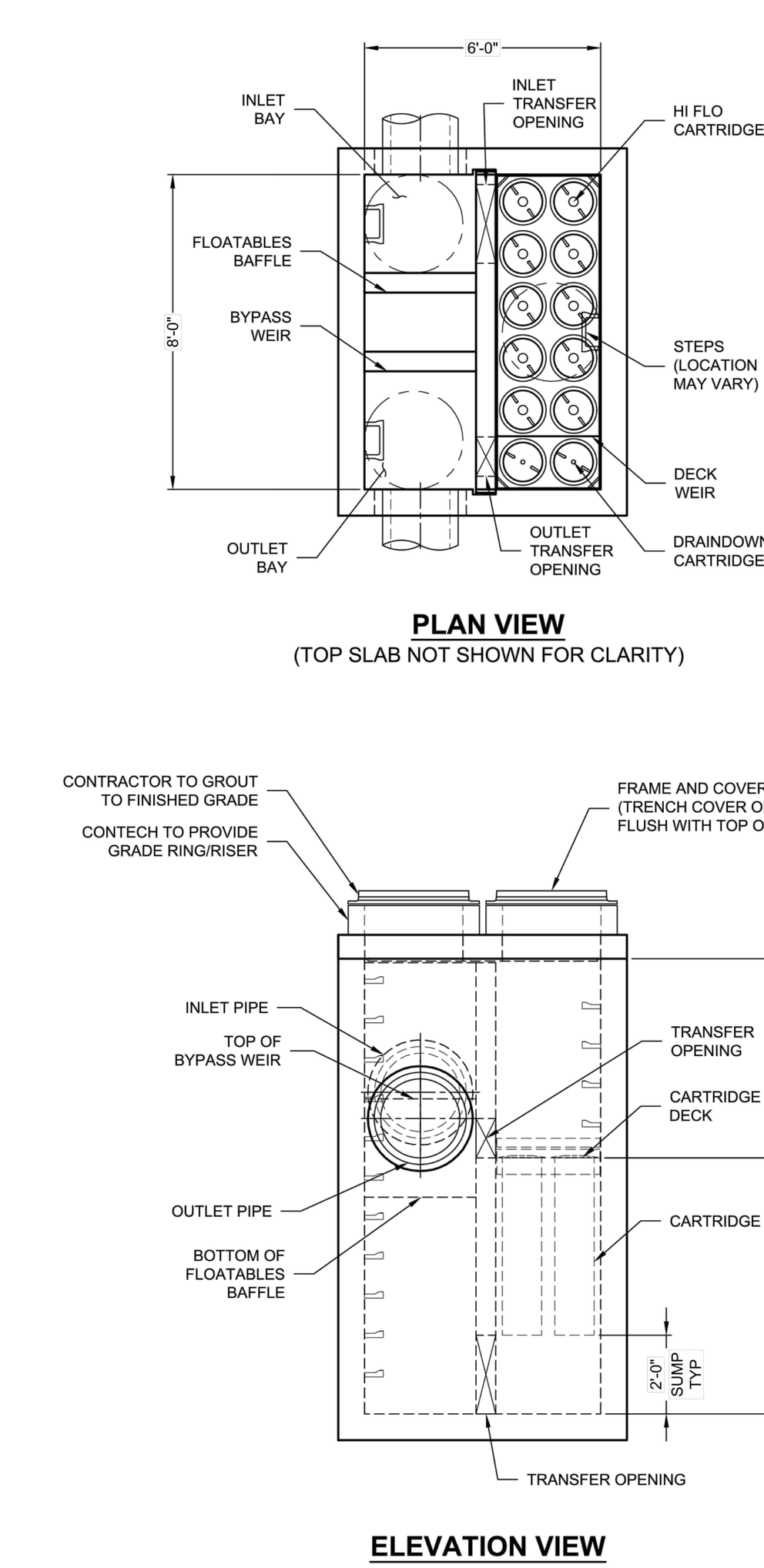
FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO..
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

WQU-204 (CD2020-5)

N.T.S. Source: Contech

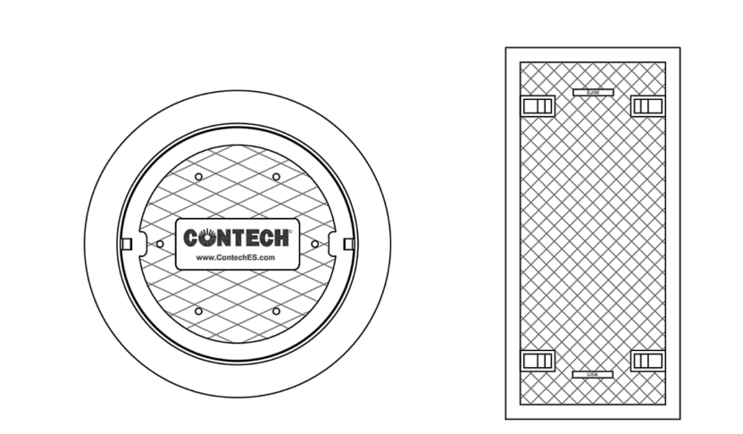


JELLYFISH DESIGN NOTES

JELLYFISH TREATMENT CAPACITY IS A FUNCTION OF THE CARTRIDGE LENGTH AND THE NUMBER OF CARTRIDGES. THE STANDARD PEAK DIVERSION STYLE WITH PRECAST TOP SLAB IS SHOWN. ALTERNATE OFFLINE VAULT AND/OR SHALLOW ORIENTATIONS ARE AVAILABLE. PEAK CONVEYANCE CAPACITY TO BE DETERMINED BY ENGINEER OF RECORD

CARTRIDGE SELECTION

CARTRIDGE LENGTH	54"	40"	27"	15"
OUTLET INVERT TO STRUCTURE INVERT (A)	6'-6"	5'-4"	4'-3"	3'-3"
FLOW RATE HI-FLO / DRAINDOWN (CFS) (PER CART)	0.178 / 0.089	0.133 / 0.067	0.089 / 0.045	0.049 / 0.025
MAX. TREATMENT (CFS)	1.96	1.47	0.98	0.54
DECK TO INSIDE TOP (MIN) (B)	5.00	4.00	4.00	4.00



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

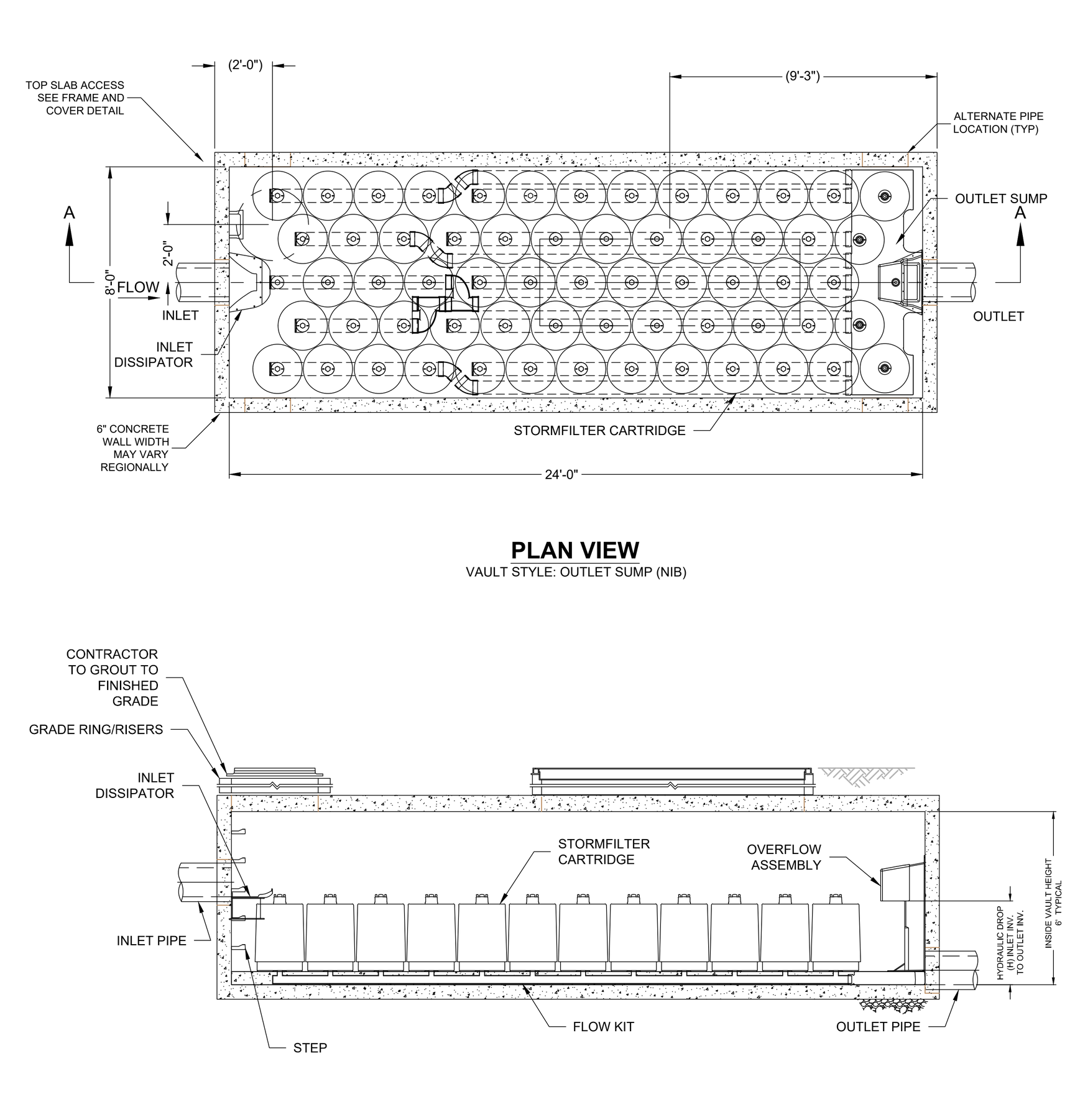
24" TRENCH COVER
(LENGTH VARIES)
N.T.S.

GENERAL NOTES:
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS REPRESENTATIVE. www.ContechES.com
3. JELLYFISH WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS-20 OR PER APPROVING JURISDICTION REQUIREMENTS, WHICHEVER IS MORE STRINGENT, ASSUMING EARTH COVER OF 0' - 10', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 LOAD RATING AND BE CAST WITH THE CONTECH LOGO.
5. STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-857, ASTM C-918, AND AASHTO LOAD FACTOR DESIGN METHOD.
6. OUTLET PIPE INVERT IS EQUAL TO THE CARTRIDGE DECK ELEVATION.
7. THE OUTLET PIPE DIAMETER FOR NEW INSTALLATIONS IS RECOMMENDED TO BE ONE PIPE SIZE LARGER THAN THE INLET PIPE AT EQUAL OR GREATER SLOPE.
8. NO PRODUCT SUBSTITUTIONS SHALL BE ACCEPTED UNLESS SUBMITTED 10 DAYS PRIOR TO PROJECT BID DATE, OR AS DIRECTED BY THE ENGINEER OF RECORD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STRUCTURE.
C. CONTRACTOR WILL INSTALL AND LEVEL THE STRUCTURE, SEALING THE JOINTS, LINE ENTRY AND EXIT POINTS (NON-SHRINK GROUT WITH APPROVED WATERSTOP OR FLEXIBLE BOOT).
D. CARTRIDGE INSTALLATION, BY CONTECH, SHALL OCCUR ONLY AFTER SITE HAS BEEN STABILIZED AND THE JELLYFISH UNIT IS CLEAN AND FREE OF DEBRIS. CONTACT CONTECH TO COORDINATE CARTRIDGE INSTALLATION WITH SITE STABILIZATION.

WQU-108 (Jellyfish JFPD0806-8-2)

N.T.S. Source: Contech



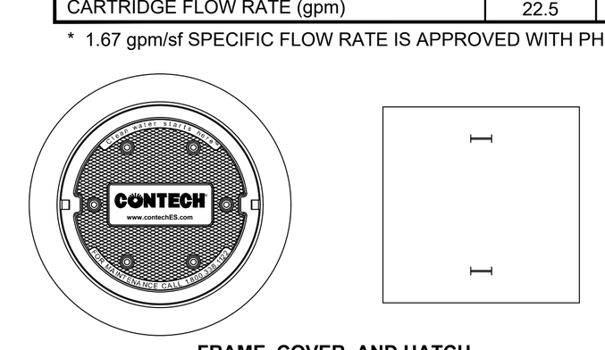
STORMFILTER DESIGN NOTES

STORMFILTER TREATMENT CAPACITY IS A FUNCTION OF THE CARTRIDGE SELECTION AND THE NUMBER OF CARTRIDGES. THE STANDARD VAULT STYLE IS SHOWN WITH THE MAXIMUM NUMBER OF CARTRIDGES (61). VAULT STYLE OPTIONS INCLUDE INLET BAY (56), INLET BAY/OUTLET BAY (51), OUTLET BAY (59), INLET BAY/FULL HEIGHT BAFFLE WALL (45), FULL HEIGHT BAFFLE WALL (54). STORMFILTER 8X24 PEAK HYDRAULIC CAPACITY IS 1.8 CFS. IF THE SITE CONDITIONS EXCEED 1.8 CFS AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

CARTRIDGE SELECTION

CARTRIDGE HEIGHT	27"			18"			LOW DROP		
RECOMMENDED HYDRAULIC DROP (H)	3.05'			2.3'			1.8'		
SPECIFIC FLOW RATE (gpm/sf)	2 gpm/sf	1.67* gpm/sf	1 gpm/sf	2 gpm/sf	1.67* gpm/sf	1 gpm/sf	2 gpm/sf	1.67* gpm/sf	1 gpm/sf
CARTRIDGE FLOW RATE (gpm)	22.5	18.79	11.25	15	12.53	7.5	10	8.35	5

* 1.67 gpm/sf SPECIFIC FLOW RATE IS APPROVED WITH PHOSPHOSORB® (PSORB) MEDIA ONLY



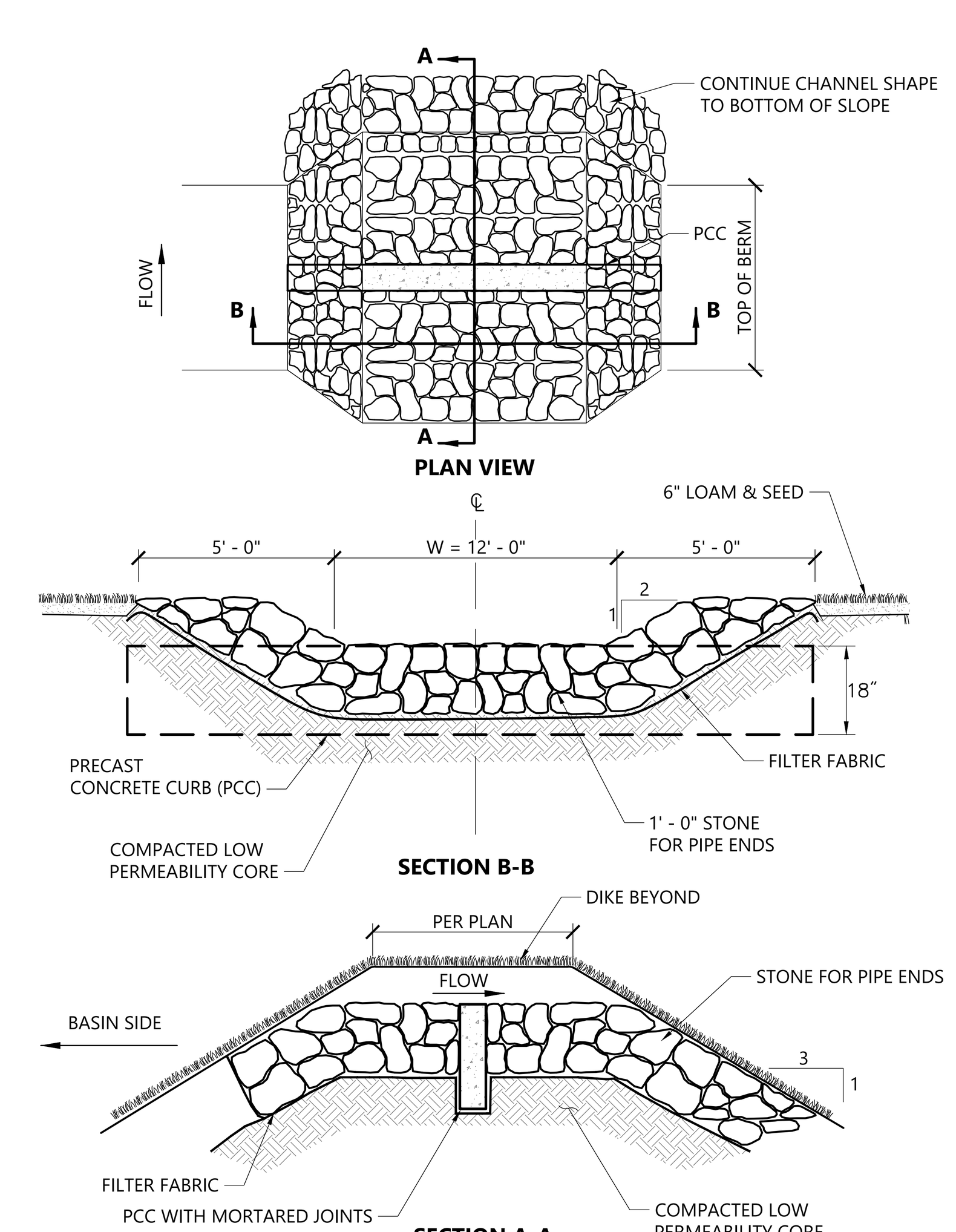
FRAME, COVER, AND HATCH
(SIZE AND CONFIGURATION VARY)
N.T.S.

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR SITE SPECIFIC DRAWINGS WITH DETAILED VAULT DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
4. STORMFILTER WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 5' AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.
6. FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. RADIAL MEDIA DEPTH SHALL BE 7-INCHES. FILTER MEDIA CONTACT TIME SHALL BE AT LEAST 38 SECONDS.
7. SPECIFIC FLOW RATE IS EQUAL TO THE FILTER TREATMENT CAPACITY (gpm) DIVIDED BY THE FILTER CONTACT SURFACE AREA (sq ft).
8. STORMFILTER STRUCTURE SHALL BE PRECAST CONFORMING TO ASTM C-857 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMFILTER VAULT (LIFTING CLUTCHES PROVIDED).
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL VAULT SECTIONS AND ASSEMBLE VAULT.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH OUTLET PIPE INVERT WITH OUTLET BAY FLOOR.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.

WQU-131 (StormFilter SF0824 with 57-18" Cartridges)

N.T.S. Source: Contech

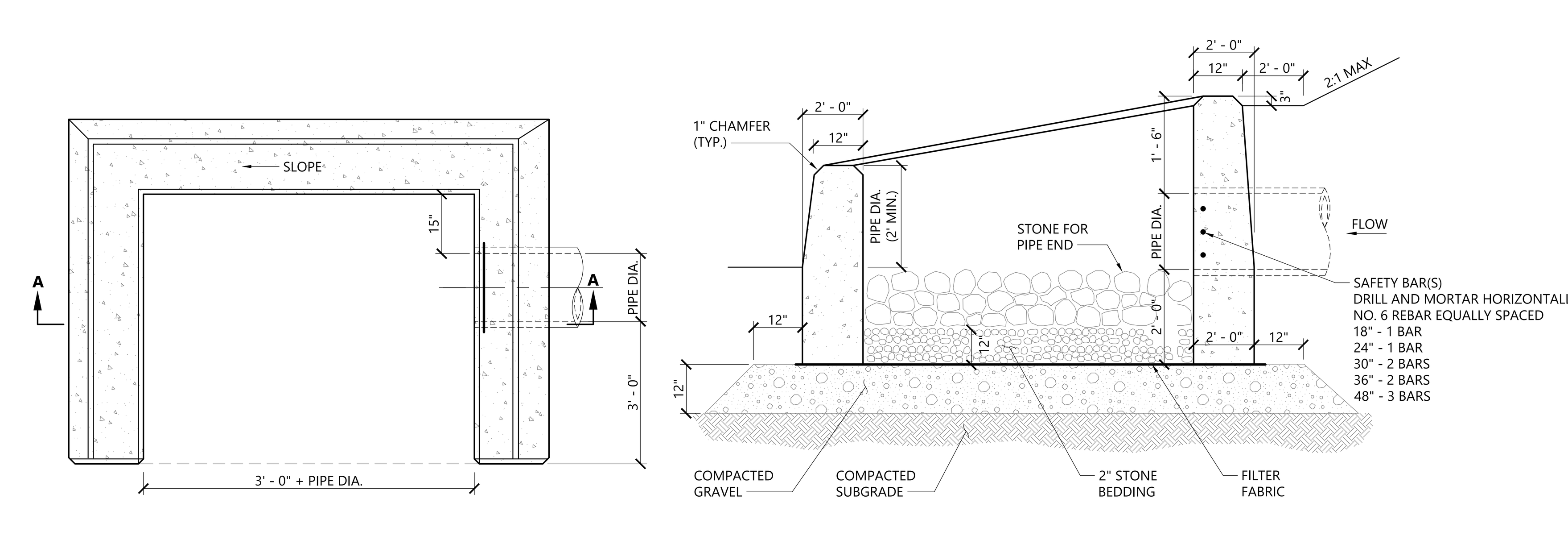


CONTINUE CHANNEL SHAPE TO BOTTOM OF SLOPE
FLOW
PCC
TOP OF BERM
PLAN VIEW
6" LOAM & SEED
5' - 0"
W = 12' - 0"
18"
FILTER FABRIC
PRECAST CONCRETE CURB (PCC)
1' - 0" STONE FOR PIPE ENDS
COMPACTED LOW PERMEABILITY CORE
SECTION B-B
DIKE BEYOND
PER PLAN
STONE FOR PIPE ENDS
BASIN SIDE
FILTER FABRIC
PCC WITH MORTARED JOINTS
COMPACTED LOW PERMEABILITY CORE
SECTION A-A

Overflow Stone Swale

1/16

N.T.S. Source: VHB REV LD_161



SLOPE
PIPE DIA.
3' - 0" + PIPE DIA.
PLAN VIEW
1" CHAMFER (TYP.)
2' - 0"
12"
2:1 MAX
FLOW
STONE FOR PIPE END
SAFETY BAR(S) DRILL AND MORTAR HORIZONTALLY NO. 6 REBAR EQUALLY SPACED
18" - 1 BAR
24" - 1 BAR
30" - 2 BARS
36" - 2 BARS
48" - 3 BARS
COMPACTED GRAVEL
COMPACTED SUBGRADE
2" STONE BEDDING
FILTER FABRIC
SECTION A-A

NOTES

1. SHOP DRAWINGS FOR PLACEMENT OF REINFORCING SHALL BE SUBMITTED TO THE ENGINEER BY THE CONTRACTOR.
2. CONCRETE SHALL BE 6% ±1.5% AIR ENTRAINED TYPE II CEMENT WITH MINIMUM COMPRESSIVE STRENGTH OF 4,000 PSI.
3. SAFETY BARS TO BE OMITTED WHERE INDICATED ON PLANS.
4. SAFETY BARS SHALL BE SET TO CREATE EQUAL OPENING DIMENSIONS.

Directional Headwall

10/20

N.T.S. Source: VHB LD_135

Saved Tuesday, March 29, 2022 1:40:25 PM DKECHES Plotted Tuesday, March 29, 2022 1:56:15 PM David Henao Rodriguez

ORIGINAL SHEET - ARCH D

Stantec

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Issued/Revision	By	Appd	YYYY.MM.DD
SPECIAL PERMIT PACKAGE			2022.03.30

Permit/Seal

COMMONWEALTH OF MASSACHUSETTS
NICHOLAS J. SKOLY
CIVIL
No. 52677
REGISTERED PROFESSIONAL ENGINEER

Client/Project
Bulfinch
557 Highland Ave

Project No.: 15216.00
File Name: N/A
Scale:

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

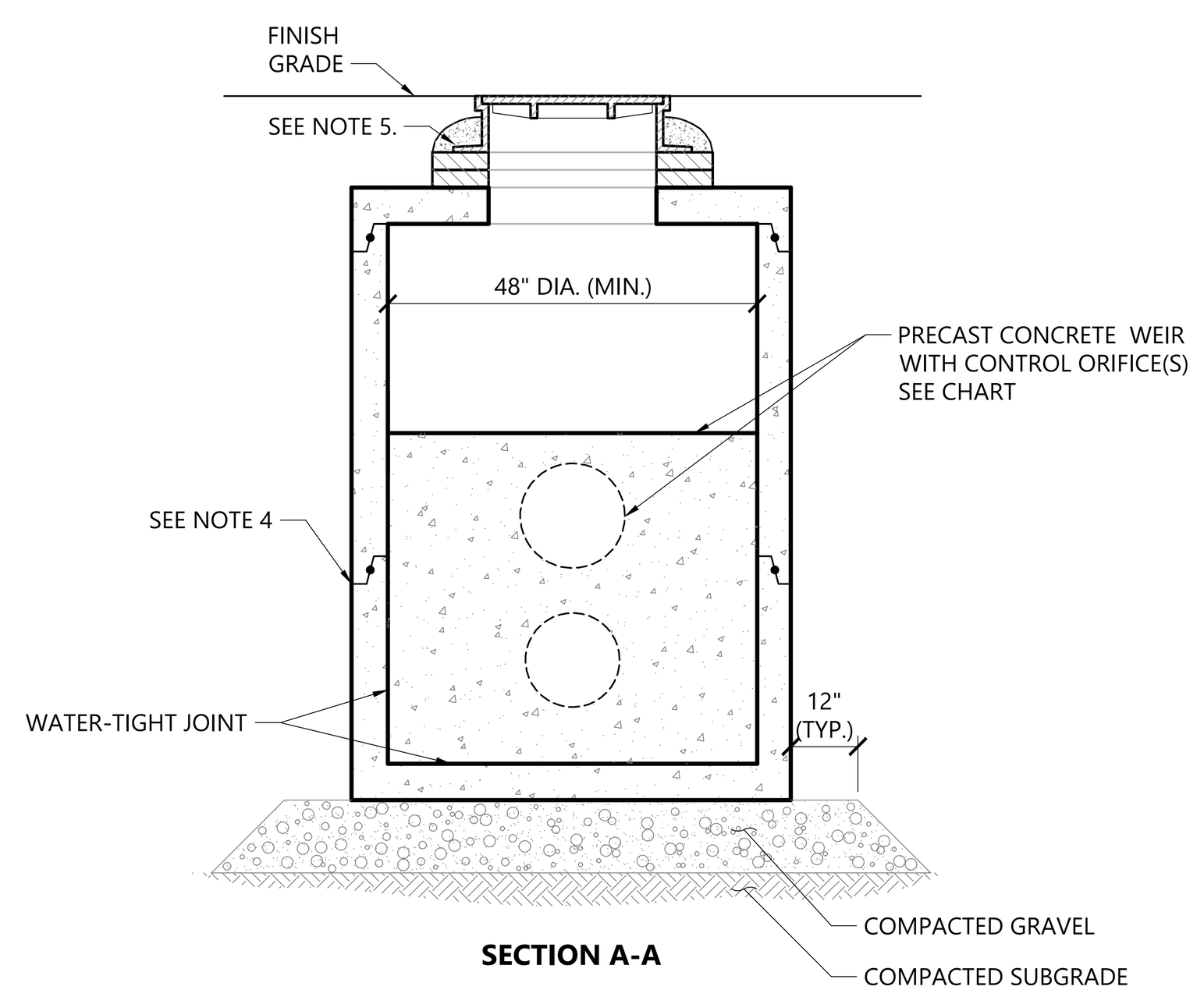
Title
Site Details

Revision:

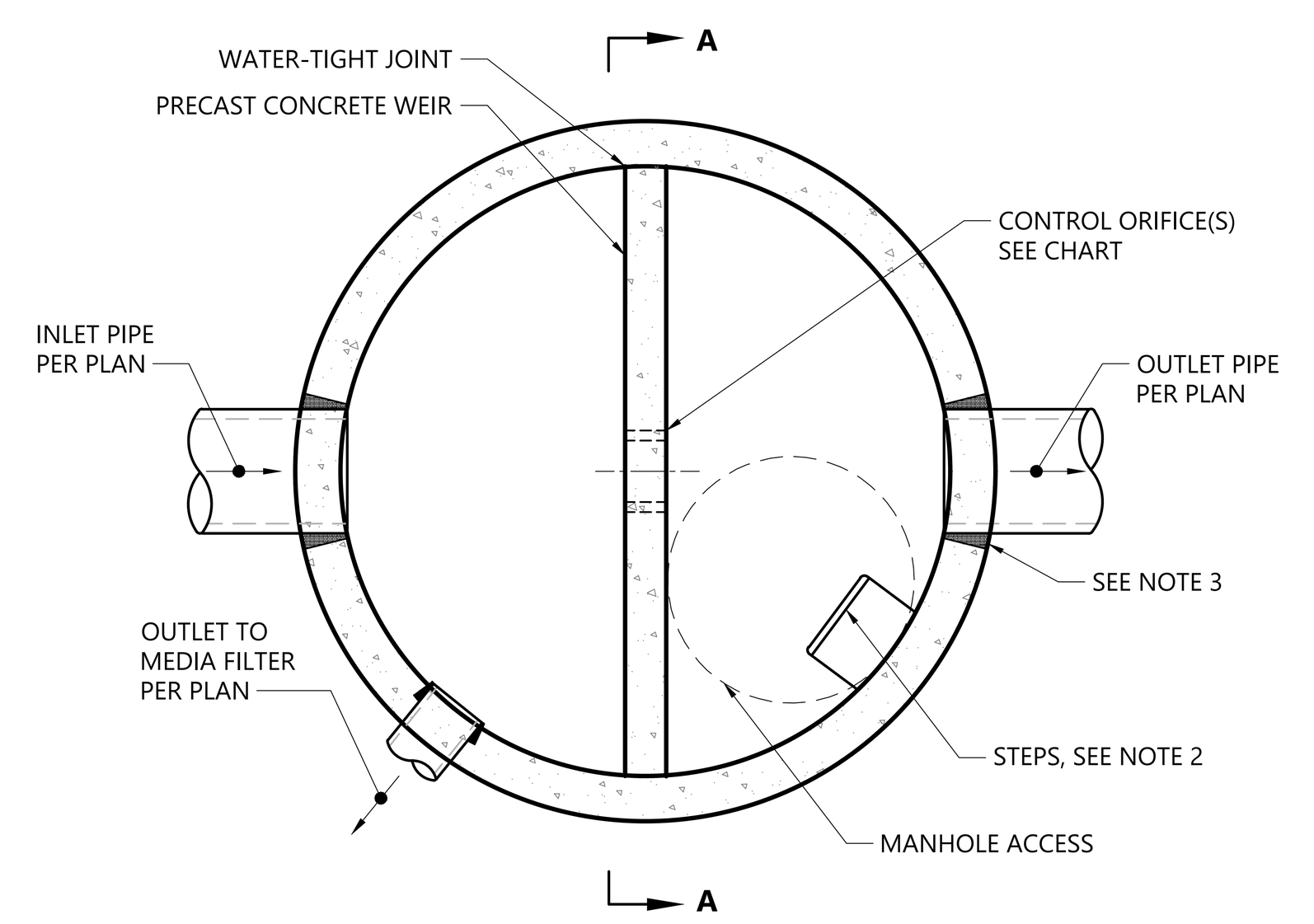
Drawing No.
C-05

OUTLET STRUCTURE CHART

DETENTION BASIN	STRUCTURE NUMBER	TOP OF WEIR ELEVATION	DIMENSIONS ORIFICE A	INVERT ORIFICE A	DIMENSIONS ORIFICE B	INVERT ORIFICE B
P1	105	125.0	N/A	N/A	N/A	N/A



SECTION A-A



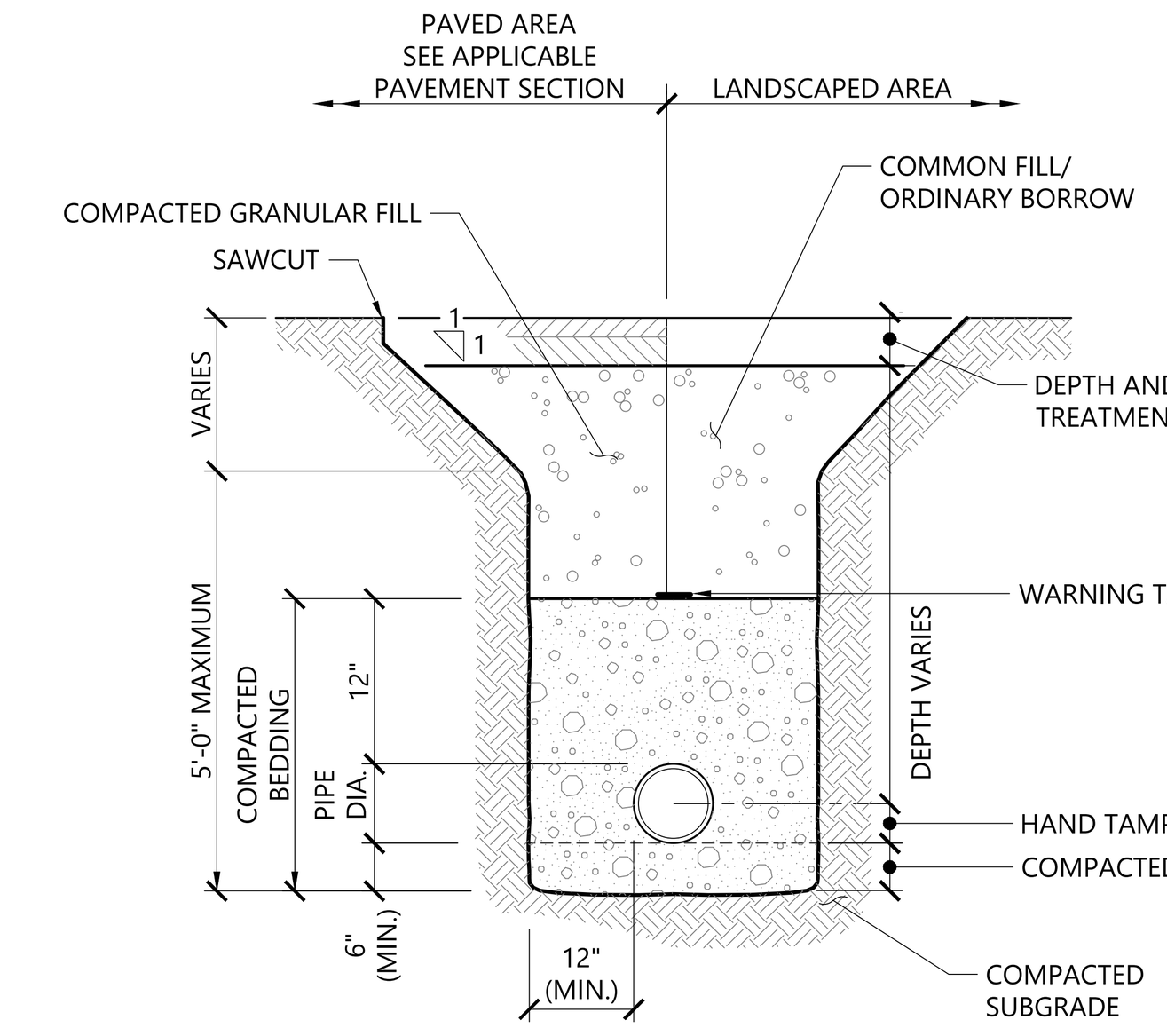
PLAN VIEW

NOTES

1. ALL SECTIONS SHALL BE DESIGNED FOR HS-20 LOADING. DIAMETER OF STRUCTURES SHALL BE COORDINATED WITH PIPE CONFIGURATIONS.
2. COPOLYMER MANHOLE STEPS SHALL BE INSTALLED AT 12" O.C. FOR THE FULL DEPTH OF THE STRUCTURE.
3. FOR HDPE, PVC, AND DI PIPE, PROVIDE FLEXIBLE BOOT CONNECTION INSTALLED PER MANUFACTURER'S RECOMMENDATIONS. FOR RCP, PROVIDE OPENINGS FOR PIPES WITH 2" MAX. CLEARANCE TO OUTSIDE OF PIPE AND MORTAR CONNECTIONS.
4. JOINT SEALANT BETWEEN PRECAST SECTIONS SHALL BE PREFORMED BUTYL RUBBER.
5. DRAIN MANHOLE FRAME AND COVER SHALL BE SET IN FULL MORTAR BED. ADJUST TO GRADE WITH CLAY BRICK AND MORTAR (2 BRICK COURSES TYPICALLY, 5 BRICK COURSES MAXIMUM)

Outlet Control Structure with Weir (OCS)

3/20
N.T.S. Source: VHB REV LD_162A

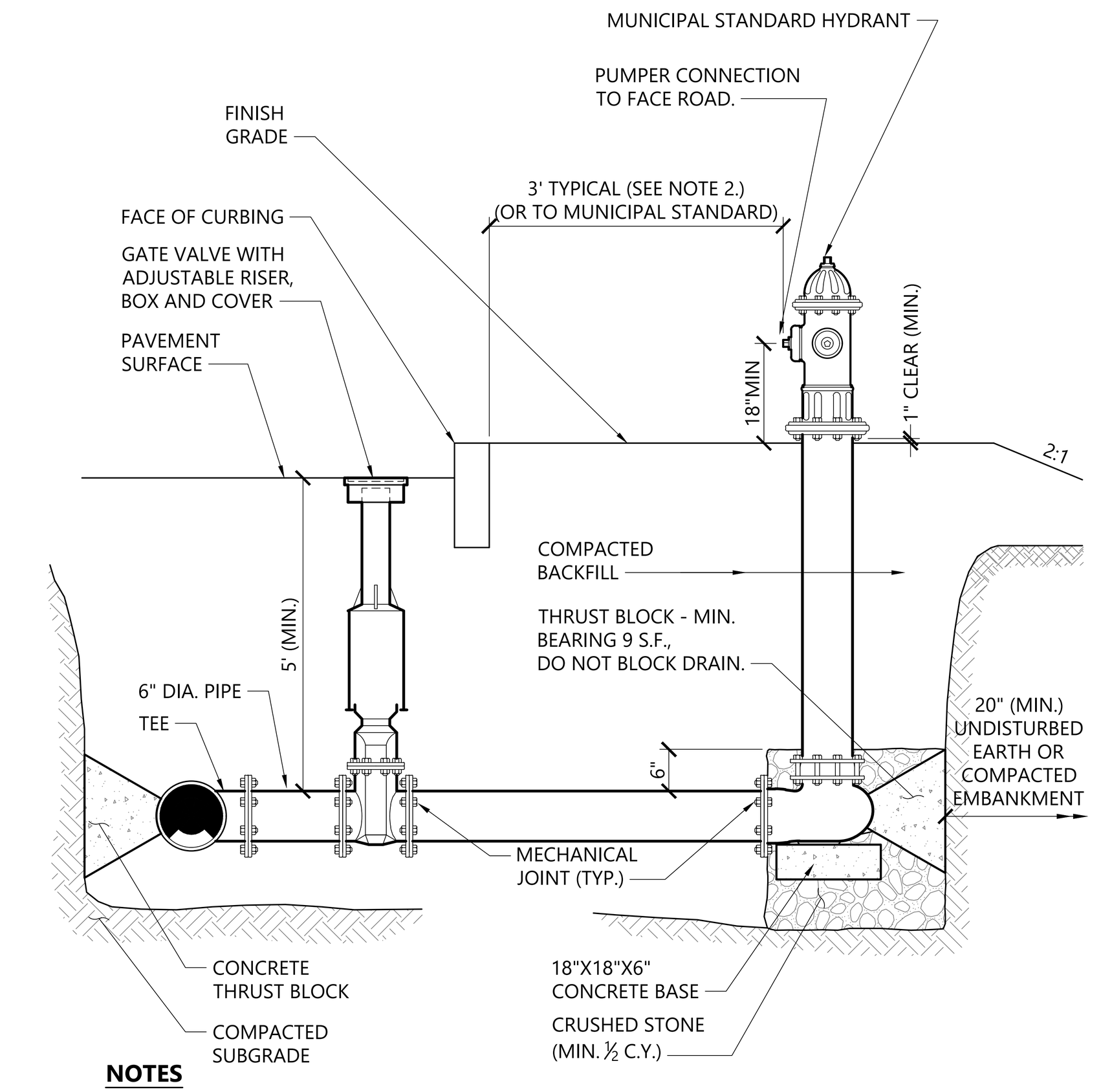


NOTES

1. WHERE UTILITY TRENCHES ARE CONSTRUCTED THROUGH DETENTION BASIN BERMS OR OTHER SUCH SPECIAL SECTIONS, PLACE TRENCH BACKFILL WITH MATERIALS SIMILAR TO THE SPECIAL SECTION REQUIREMENTS.
2. USE METALLIC TRACING/WARNING TAPE OVER ALL PIPES.
3. COMPACTED GRANULAR FILL MAY CONSIST OF GRAVEL, CRUSHED STONE, SAND, OR OTHER MATERIAL AS APPROVED BY ENGINEER.

Utility Trench

11/19
N.T.S. Source: VHB LD_300



NOTES

1. CONCRETE THRUST BLOCKS TO BE USED ONLY WHERE THEY CAN BEAR ON UNDISTURBED EARTH AS SHOWN. USE CLAMPS AND TIE RODS OR OTHER ACCEPTABLE METHOD OF JOINT RESTRAINT WHERE SOIL CONDITIONS PROHIBIT THE USE OF THRUST BLOCKS.
2. HYDRANT IN SIDEWALK AREAS TO BE LOCATED TO PROVIDE MINIMUM CLEAR SIDEWALK PASSAGE WIDTH OF 3 FEET AT HYDRANT.
3. A 36-INCH CLEAR SPACE SHALL BE MAINTAINED AROUND THE CIRCUMFERENCE OF THE HYDRANT UNLESS OTHERWISE APPROVED BY AUTHORITY HAVING JURISDICTION.

Hydrant Construction

12/19
N.T.S. Source: VHB LD_250

RESTRAINED JOINTS

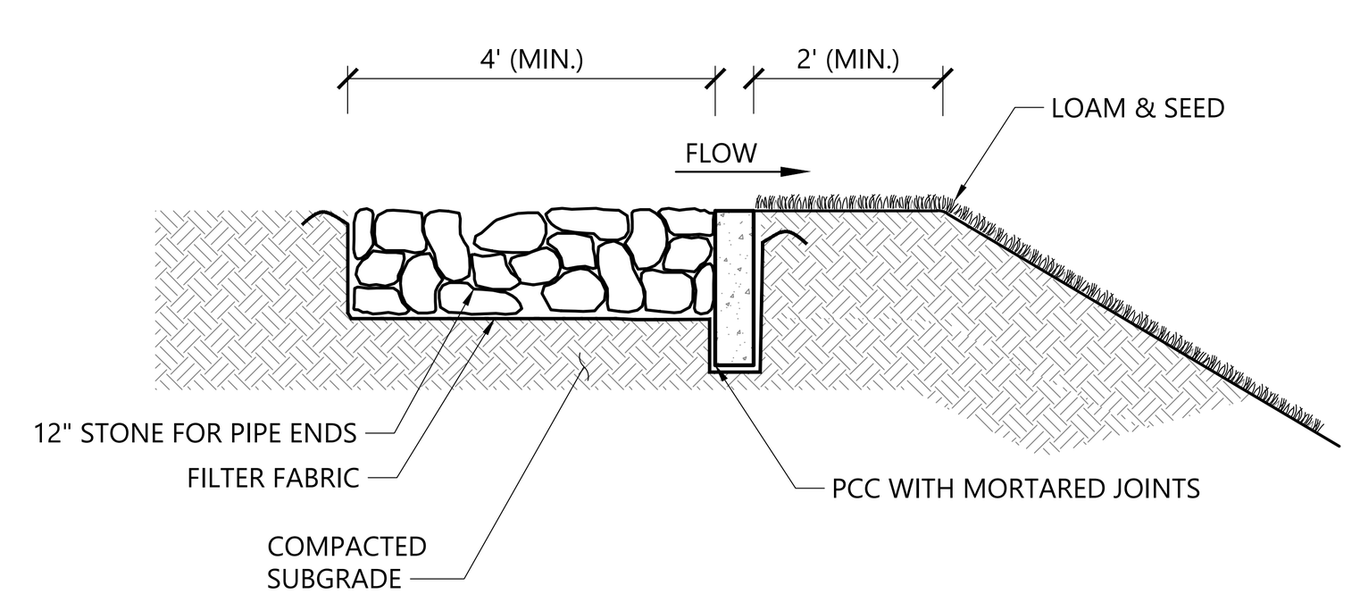
FITTINGS	NUMBER OF JOINTS TO RESTRAIN ON EITHER SIDE OF FITTING (BASED ON 18-FOOT PIPE LENGTH)
90 DEGREE BEND	3
45 DEGREE BEND	2
22-1/2 DEGREE BEND	2
TEE:	
BRANCH	3
RUN	2

NOTES

1. PIPE WITH RESTRAINED JOINTS SHALL BE INSTALLED IN ALL AREAS WHERE THE PIPE IS WITHIN FILL MATERIALS AND ALSO AT LOCATIONS SHOWN ON THE DRAWINGS. RESTRAINED JOINTS SHALL BE INSTALLED AT BENDS, REDUCERS, TEES, VALVES, DEAD ENDS, AND HYDRANTS. THE MINIMUM LENGTH OF PIPE TO BE RESTRAINED ON EITHER SIDE OF THE JOINT SHALL BE AS SHOWN ON THE TABLE ABOVE THE FITTINGS OF THE NEW PIPING SHALL BE FOR RESTRAINED JOINTS, AS MARKED ON THE DRAWINGS.
2. NO RESTRAINING IS REQUIRED IN THE DIRECTION OF THE EXISTING PIPE IF ONLY A SHORT LENGTH OF IT IS EXPOSED IN THE TRENCH FOR MAKING A CONNECTION.
3. RESTRAINED JOINT ASSEMBLIES FOR PUSH-ON PIPE AND FITTINGS SHALL BE MADE IN STRICT ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDED INSTALLATION PROCEDURES.

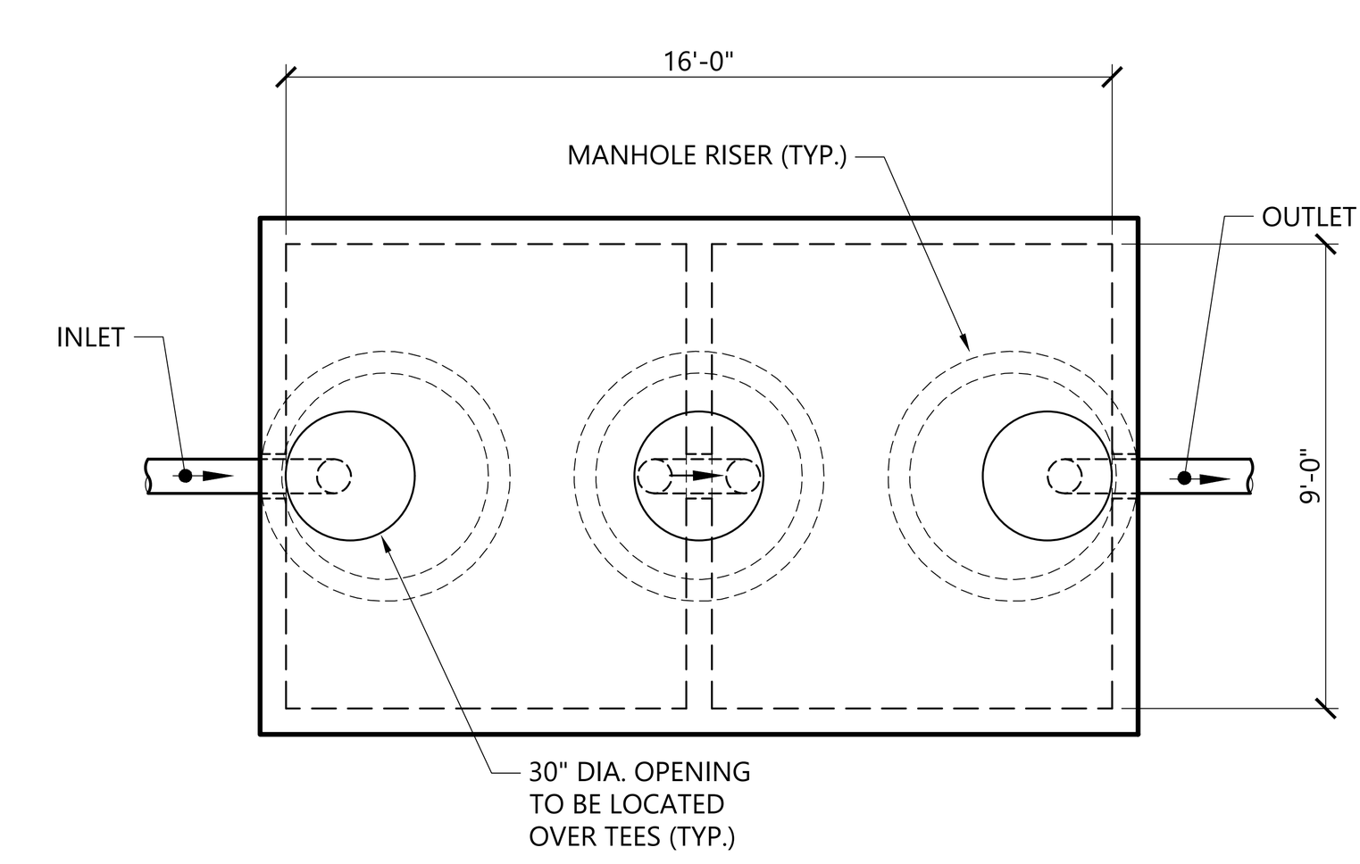
Restrained Joints for Water Pipe

3/20
N.T.S. Source: VHB LD_261

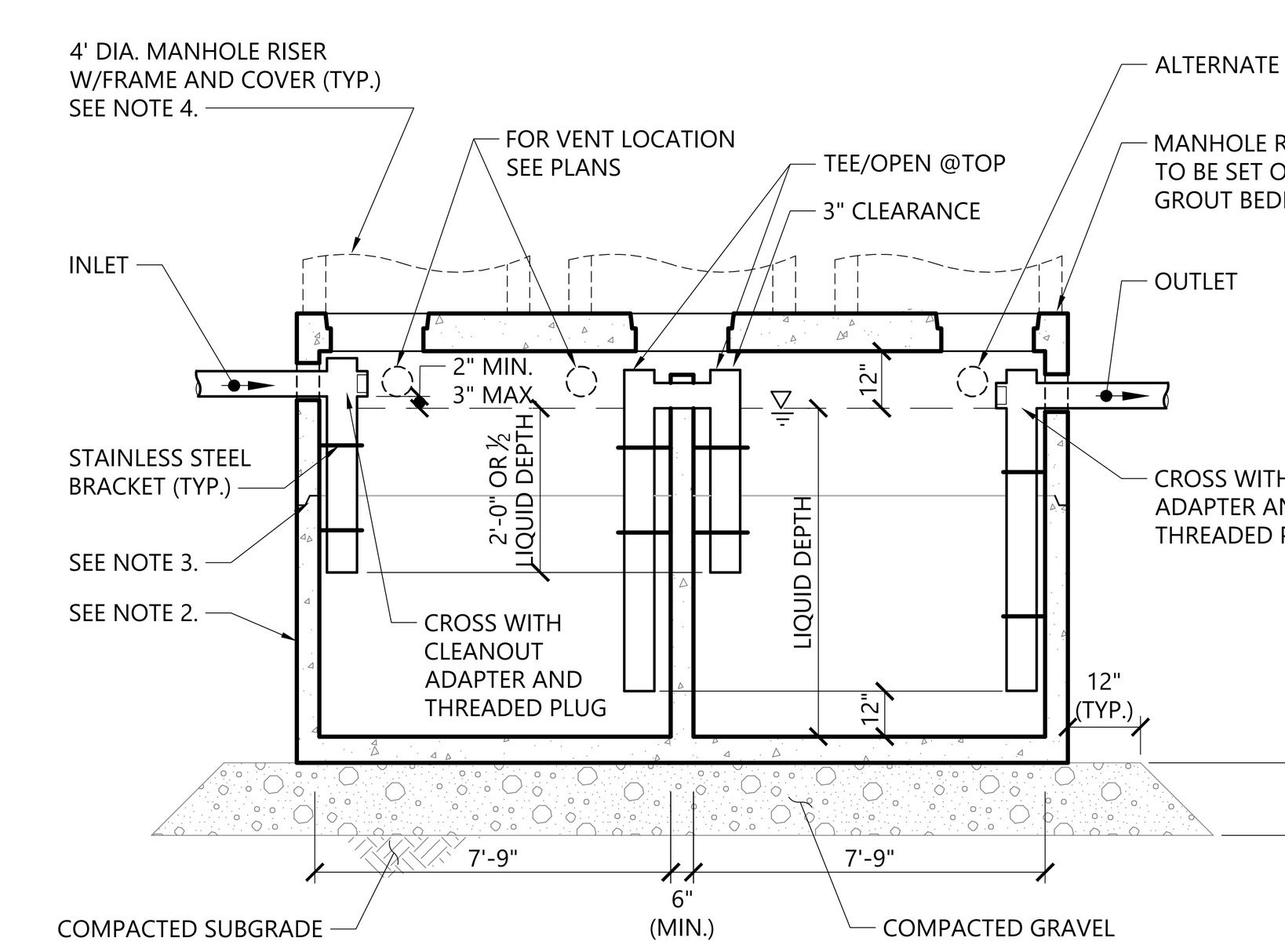


Level Spreader Section

N.T.S. Source: VHB



PLAN VIEW



SECTION

NOTES

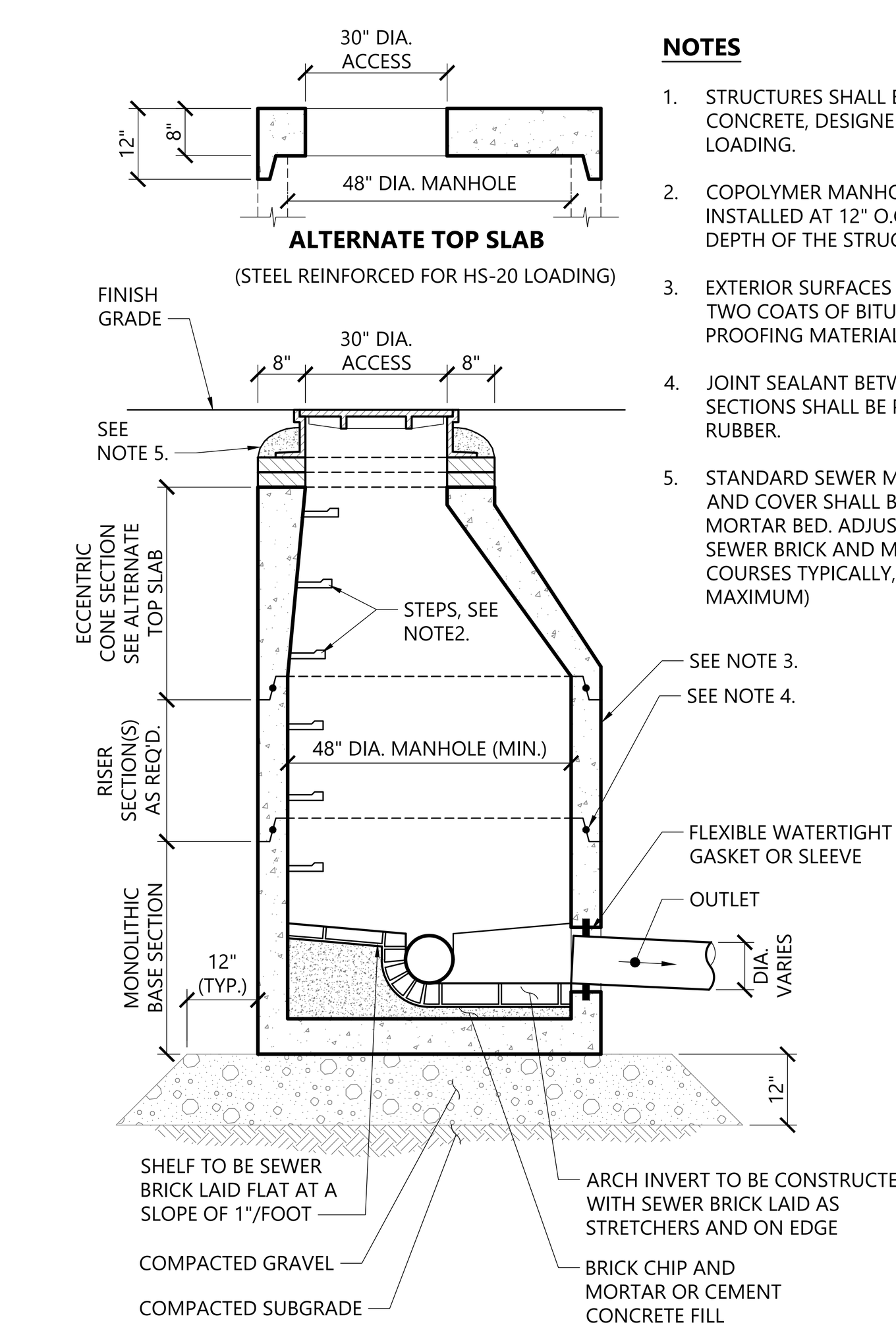
1. STRUCTURE SHALL BE DESIGNED FOR HS-20 LOADING.
2. EXTERIOR SURFACES SHALL BE GIVEN TWO COATS OF BITUMINOUS WATER-PROOFING MATERIAL.
3. JOINT SEALANT BETWEEN PRECAST SECTIONS SHALL BE PREFORMED BUTYL RUBBER.
4. STANDARD 30-INCH SEWER MANHOLE FRAME AND COVER SHALL BE LOCATED OVER CROSSES AND SET IN FULL MORTAR BED. ADJUST TO GRADE WITH SEWER BRICK AND MORTAR (2 BRICK COURSES TYPICALLY, 5 BRICK COURSES MAXIMUM)
5. PIPING SHALL BE SCH 40 PVC WITH SOLVENT WELDED JOINTS. INTERNAL PIPE DIAMETER SHALL BE SAME SIZE AS OUTLET PIPE.
6. FINAL DESIGN OF GREASE TRAP TO BE BY PLUMBING ENGINEER.
7. THE INSTALLATION OF GREASE TRAP, THE PIPING TO AND 10 FEET BEYOND IS BY PLUMBER.

GREASE TRAP

SIZE (GAL.)	LIQUID DEPTH
4,000	4'-0"
5,000	5'-0"
6,000	6'-0"
7,000	7'-0"
8,000	8'-0"
9,000	9'-0"
10,000	10'-0"

Precast Concrete Grease Trap (GT)

12/19
N.T.S. Source: VHB LD_211

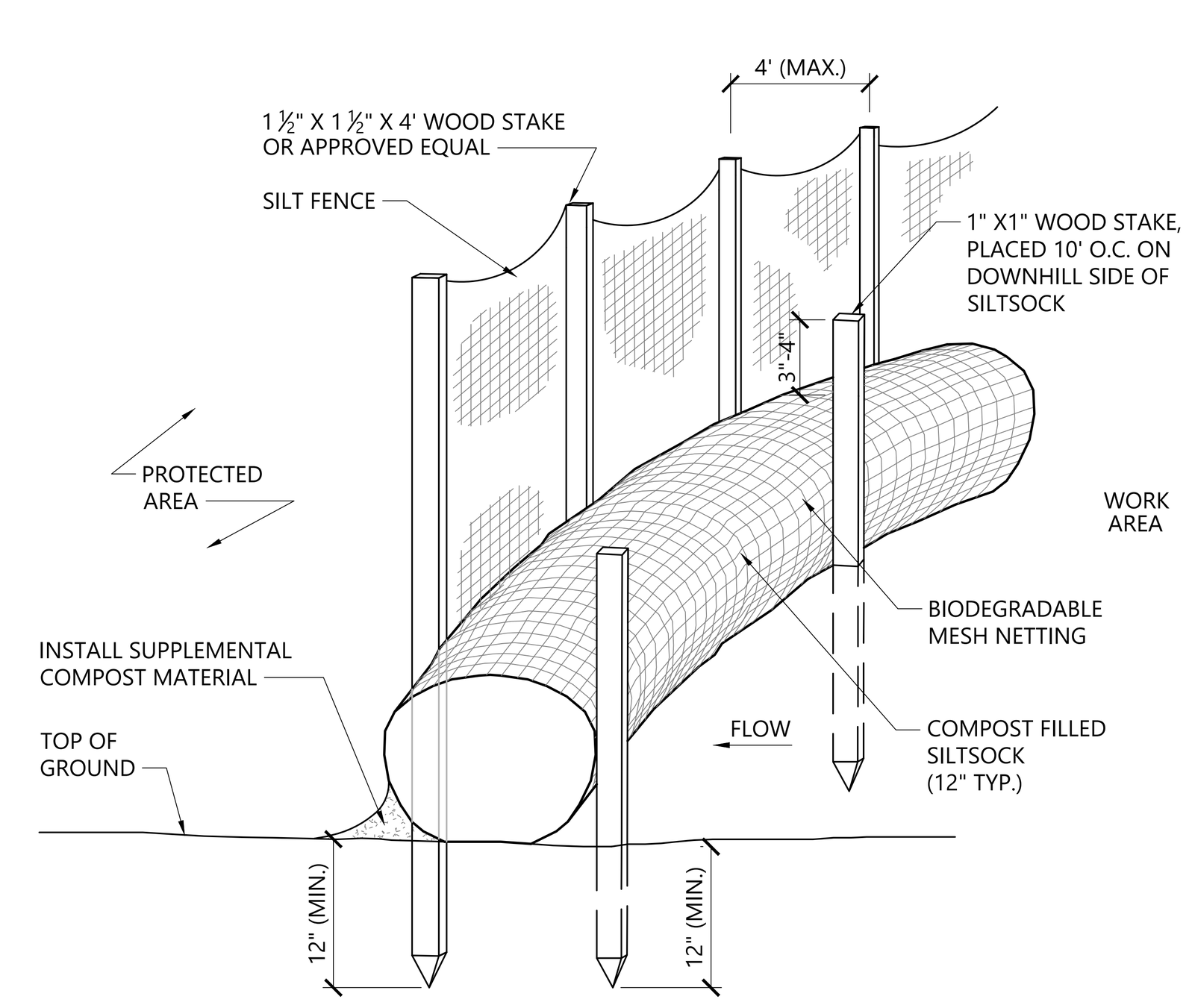


NOTES

1. STRUCTURES SHALL BE PRECAST CONCRETE, DESIGNED FOR HS-20 LOADING.
2. COPOLYMER MANHOLE STEPS SHALL BE INSTALLED AT 12" O.C. FOR THE FULL DEPTH OF THE STRUCTURE.
3. EXTERIOR SURFACES SHALL BE GIVEN TWO COATS OF BITUMINOUS WATER-PROOFING MATERIAL.
4. JOINT SEALANT BETWEEN PRECAST SECTIONS SHALL BE PREFORMED BUTYL RUBBER.
5. STANDARD SEWER MANHOLE FRAME AND COVER SHALL BE SET IN FULL MORTAR BED. ADJUST TO GRADE WITH SEWER BRICK AND MORTAR (2 BRICK COURSES TYPICALLY, 5 BRICK COURSES MAXIMUM)

Sanitary Sewer Manhole (SMH)

1/16
N.T.S. Source: VHB LD_200

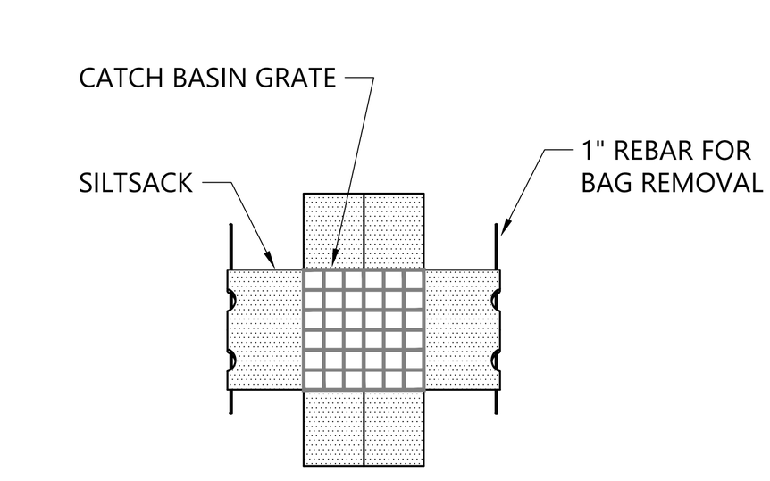


NOTES

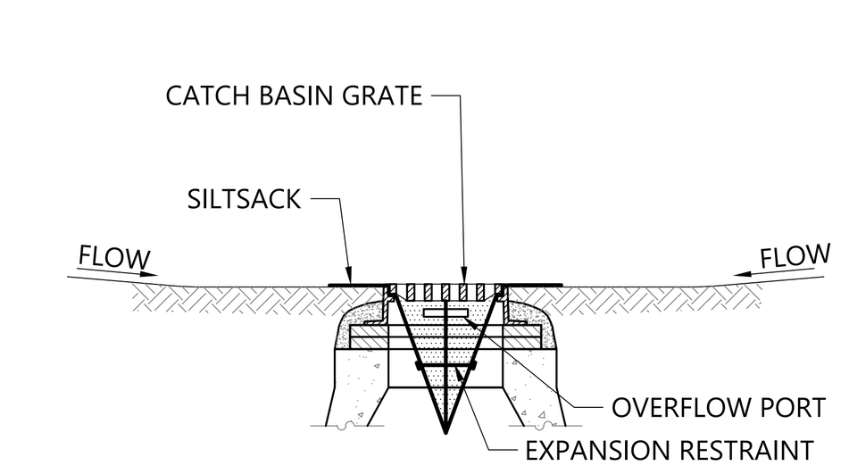
1. SILTSOCK SHALL BE FILTREXX SILTSOXX, OR APPROVED EQUAL.
2. SILTSOCKS SHALL OVERLAP A MINIMUM OF 12 INCHES.
3. SILTSOCK SHALL BE INSPECTED PERIODICALLY AND AFTER ALL STORM EVENTS, AND REPAIR OR REPLACEMENT SHALL BE PERFORMED PROMPTLY AS NEEDED.
4. UPON SITE STABILIZATION, COMPOST MATERIAL SHALL BE DISPERSED ON SITE, AS DETERMINED BY THE ENGINEER.
5. IF NON BIODEGRADABLE NETTING IS USED THE NETTING SHALL BE COLLECTED AND DISPOSED OF OFFSITE.

Siltsock / Silt Fence Barrier

10/20
N.T.S. Source: VHB LD_658-A



PLAN VIEW



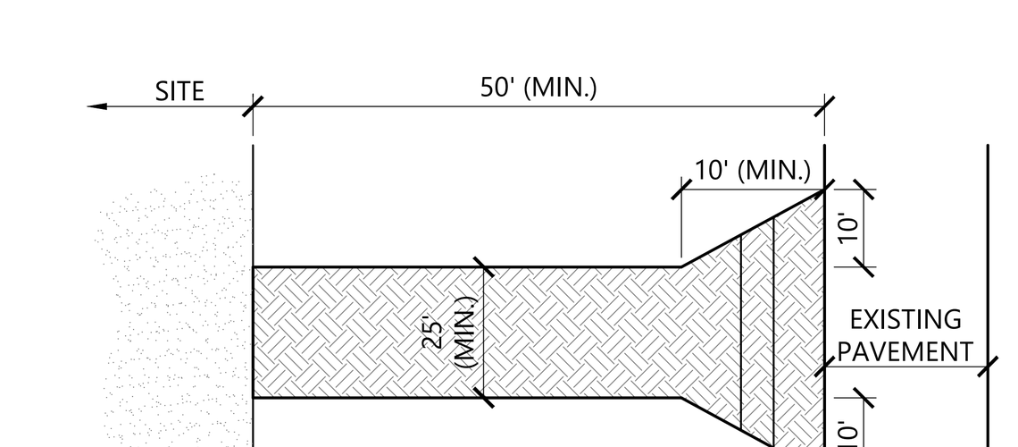
SECTION VIEW

NOTES

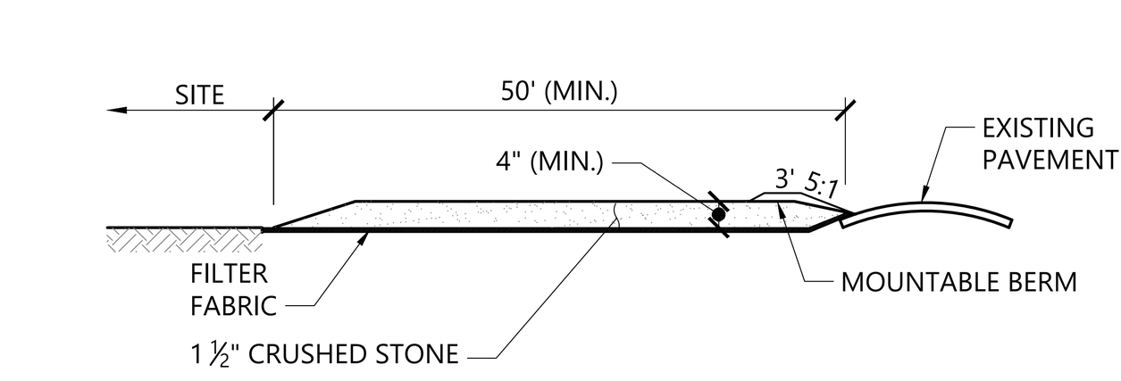
1. INSTALL SILTSACK IN ALL CATCH BASINS WHERE INDICATED ON THE PLAN BEFORE COMMENCING WORK OR IN PAVED AREAS AFTER BINDER COURSE IS PLACED AND HAY BALES HAVE BEEN REMOVED.
2. GRATE TO BE PLACED OVER SILTSACK.
3. SILTSACK SHALL BE INSPECTED PERIODICALLY AND AFTER ALL STORM EVENTS AND CLEANING OR REPLACEMENT SHALL BE PERFORMED PROMPTLY AS NEEDED. MAINTAIN UNTIL UPSTREAM AREAS HAVE BEEN PERMANENTLY STABILIZED

Siltsack Sediment Trap

1/20
N.T.S. Source: VHB LD_674



PLAN VIEW



CROSS-SECTION

NOTES

1. EXIT WIDTH SHALL BE A TWENTY-FIVE (25) FOOT MINIMUM, BUT NOT LESS THAN THE FULL WIDTH AT POINTS WHERE INGRESS OR EGRESS OCCURS.
2. THE EXIT SHALL BE MAINTAINED IN A CONDITION WHICH SHALL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHTS-OF-WAY. THIS MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE AS CONDITIONS DEMAND AND REPAIR OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT. ALL SEDIMENT SPILLED, DROPPED, WASHED OR TRACKED ONTO PUBLIC RIGHTS-OF-WAY MUST BE REMOVED IMMEDIATELY. BERM SHALL BE PERMITTED. PERIODIC INSPECTION AND MAINTENANCE SHALL BE PROVIDED AS NEEDED.
3. STABILIZED CONSTRUCTION EXIT SHALL BE REMOVED PRIOR TO FINAL FINISH MATERIALS BEING INSTALLED.

Stabilized Construction Exit

1/16
N.T.S. Source: VHB LD_682

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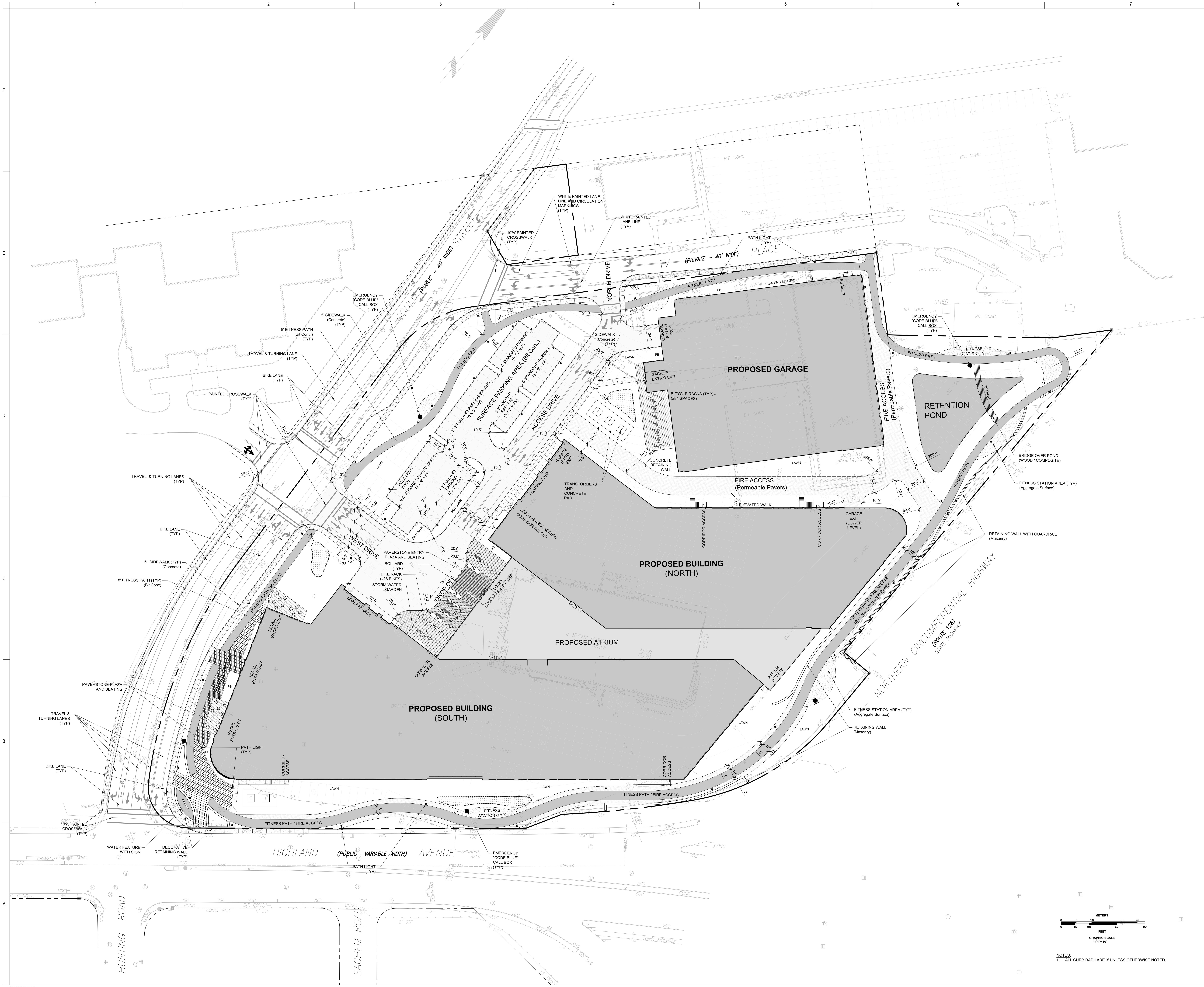
SPECIAL PERMIT PACKAGE 2022.03.30
Issued/Revision By Appd YYYY.MM.DD

Permit/Seal
COMMONWEALTH OF MASSACHUSETTS NICHOLAS J. SKOLY CIVIL No. 52677 REGISTERED PROFESSIONAL ENGINEER

Client/Project
Bulfinch
557 Highland Ave

Project No.: 15216.00
File Name: N/A
Scale:
Author Designer Checker 2022.03.30
Dwn. Dsgn. Chkd. YYYY.MM.DD
Title
Site Details
Revision:
Drawing No.
C-06



Stantec

Consultant

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Civil Engineers - Wetland Scientists
14 Spring Street
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Waltham, Massachusetts 02451-4429

Issued/Revision

Permit/Seal

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.: 218421343
File Name:
Scale: 1" = 30'-0"

Title
SITE PLAN

Revision:
Drawing No.
L-1.0

Client/Project

Bulfinch

557 HIGHLAND AVE

NEEDHAM, MA 02494

Project No.: 218421343

File Name:

Scale: 1" = 30'-0"

Dsn.	Dgn.	Chkd.	YYY.MM.DD

Title

SITE GRADING PLAN

Revision:

Drawing No.

L-2.0

Permit/Seal

Issued/Revision	By	Appd	YYYY.MM.DD
1 SPECIAL PERMIT PACKAGE			2022.03.30

Consultant

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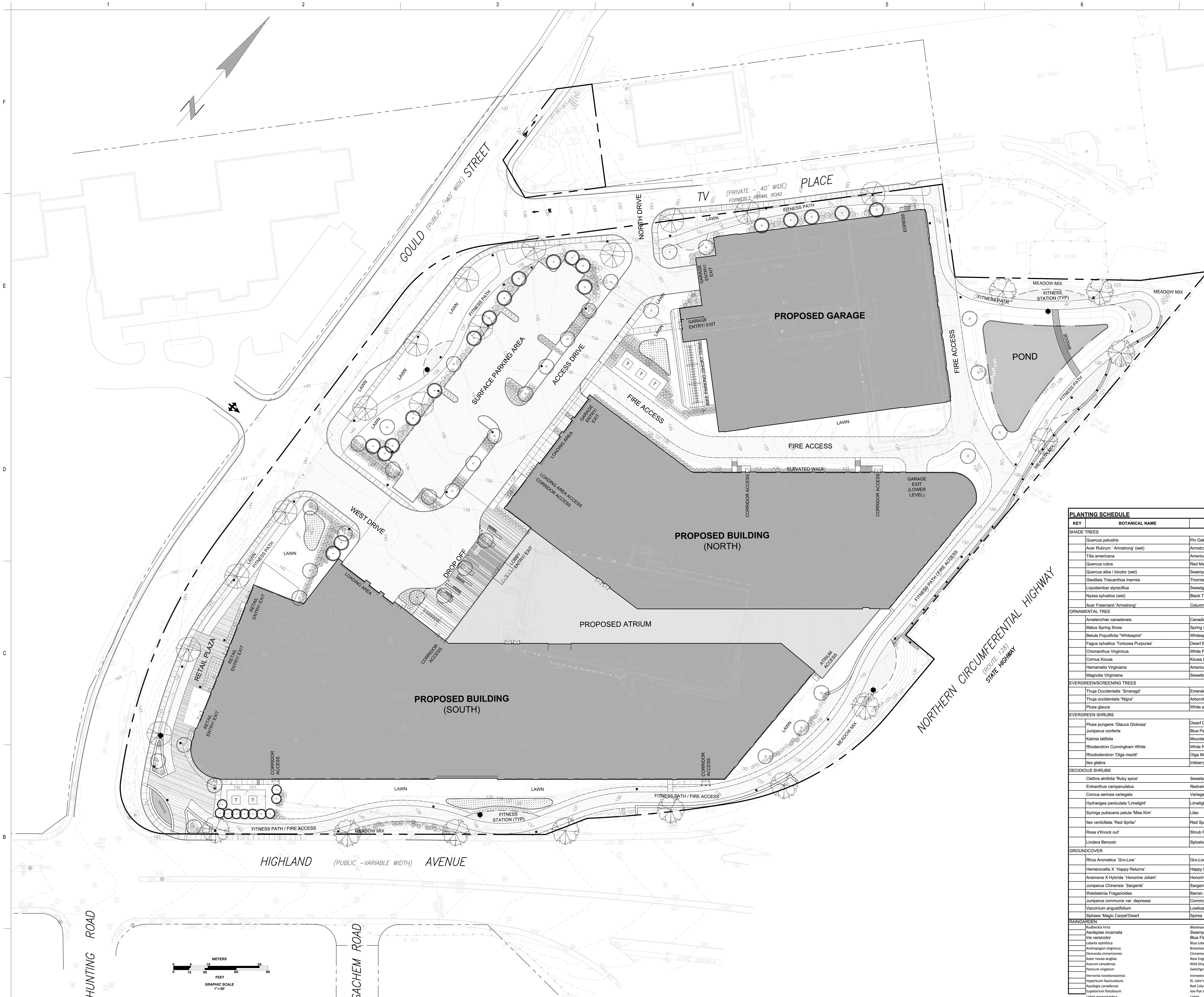

PLANT MATERIAL LEGEND:

STREET TREE / SHADE TREE (DECIDUOUS)

ORNAMENTAL TREE (DECIDUOUS)

SCREENING TREE (EVERGREEN)

EVERGREEN SHRUB

DECIDUOUS SHRUB

RAIN GARDEN AREAS

PLANTING SCHEDULE

KEY	BOTANICAL NAME	COMMON NAME	QTY	SIZE	ROOT	COMMENTS
SHADE TREES						
	Quercus palustris	Pin Oak			3.5" CAL	
	Acer Rubrum ' Armstrong' (wet)	Armstrong Red Maple			3.5" CAL	
	Tilia americana	American Linden			3.5" CAL	
	Quercus rubra	Red Maple			3.5" CAL	
	Quercus alba / bicolor (wet)	Swamp White Oak			3.5" CAL	
	Gleditsia Triacanthos Inermis	Thornless Honeylocust			3.5" CAL	
	Liquidambar styraciflua	Sweetgum			3.5" CAL	
	Nyssa sylvatica (wet)	Black Tupelo			3.5" CAL	
	Acer Freemanii 'Armstrong'	Columnar Armstrong Red Maple			3.5" CAL	
ORNAMENTAL TREE						
	Amelanchier canadensis	Canadian Serviceberry		7-8' HT		
	Malus Spring Snow	Spring Snow Flowering Crabapple			3" CAL	
	Betula Populifolia "Whitespire"	Whitespire Birch		7-8' HT		
	Fagus sylvatica 'Tortuosa Purpurea'	Dwarf Beech		10' HT		
	Chionanthus Virginicus	White Fringetree		10 GAL		
	Cornus Kousa	Kousa Dogwood		10 GAL		
	Hamamelis Virginiana	American witch-hazel		10 GAL		
	Magnolia Virginiana	Sweetbay Magnolia		10' HT		
EVERGREEN/SCREENING TREES						
	Thuja Occidentalis `Smaragd`	Emerald Green Arborvitae		6-10' HT		
	Thuja occidentalis "Nigra"	Arborvitae 'Nigra'		6'-10' HT		
	Picea glauca	White spruce		14'-16' HT		
EVERGREEN SHRUBS						
	Picea pungens 'Glauca Globosa'	Dwarf Colorado Blue Spruce		5 GAL		
	Juniperus conferta	Blue Pacific Shore Juniper		5 GAL		
	Kalmia latifolia	Mountain Laurel		5 GAL		
	Rhodendron Cunningham White	White Rhodondenron		5 GAL		
	Rhododendron 'Olga mezitt'	Olga Mezitt Rhododendron		3-5' HT		
	Ilex glabra	Inkberry		5 GAL		
DECIDIOUS SHRUBS						
	Clethra alnifolia 'Ruby spice'	Sweetsummer		4'-6' HT		
	Enkianthus campanulatus	Redvein Enkianthus		4'-6' HT		
	Cornus sericea variegata	Variegated dogwood				
	Hydrangea paniculata 'Limelight'	Limelight Hardy Hydrangea		6'-8' HT		
	Syringa pubscens patula 'Miss Kim'	Lilac		4-6' HT		
	Ilex verticillata "Red Sprite"	Red Sprite Winterberry		3-5' HT		
	Rosa x'Knock out'	Shrub Rose		3-5' HT		
	Lindera Benzoin	Spicebush		3 GAL		
GROUNDCOVER						
	Rhus Aromatica `Gro-Low`	Gro-Low Fragrant Sumac		3 GAL		
	Hemerocallis X `Happy Returns`	Happy Returns Daylily		1 GAL		
	Anemone X Hybrida `Honorine Jobert`	Honorine Jobert Japanese Anemone		1 GAL		
	Juniperus Chinensis `Sargentii`	Sargent Juniper		1 GAL		
	Waldsteinia Fragarioides	Barren Strawberry		4" POT		
	Juniperus communis var. depressa	Common Juniper		3 GAL		
	Vaccinium angustifolium	Lowbush Blueberry		1 GAL		
	Spiraea 'Magic Carpet'Dwarf	Spirea		1 GAL		
RAINGARDEN						
	Rudbeckia hirta	Blackeyed Susan				
	Asclepias incarnata	Swamp Milkweed				
	Iris versicolor	Blue Flag Iris				
	Lobelia siphilitica	Blue Lobelia				
	Andropogon virginicus	Broomsedge				
	Osmunda cinnamomea	Cinnamon Fern				
	Aster novae-angliae	New England Aster				
	Asarum canadense	Wild Ginger				
	Panicum virgatum	Switchgrass				
	Vernonia noveboracensis	Ironweed				
	Hypericum fasciculatum	St. John's Wort				
	Aquilegia canadensis	Red Columbine				
	Eupatorium fistulosum	Joe-Pye Weed				
	Liatris pycnostachya	Liatris				
SEED MIX						
	NEW ENGLAND CONSERVATION / WILDLIFE MIX					

Virginia Wild Rye (Elymus virginicus), Little Bluestem (Schizachyrium scoparium), Big Bluestem (Andropogon gerardii), Red Fescue (Festuca rubra), Switch Grass (Panicum virgatum), Partridge Pea (Chamaecrista fasciculata), Panicledleaf Tick Trefoil (Desmodium paniculatum), Indian Grass (Sorghastrum nutans), Blue Vervain (Verbena hastata), Butterfly Milkweed (Asclepias tuberosa), Black Eyed Susan (Rudbeckia hirta), Common Sneezeweed (Helenium autunale), Heath Aster (Asterpilosus/Symphyotrichum pilosum), Early Goldenrod (Solidago juncea), Upland Bentgrass (Agrostis perennans).

NEW ENGLAND WETLAND MIX

Fox Sedge (Carex vulpinoidea), Lurid Sedge (Carex lurida), Blunt Broom Sedge (Carex scoparia), Blue Vervain (Verbena hastata), Fowl Bluegrass (Poa palustris), Hop Sedge (Carex lupulina), Green Bulrush (Scirpus atrovirens), Creeping Spike Rush (Eleocharis palustris), Fringed Sedge (Carex crinita), Soft Rush (Juncus effusus), Spotted Joe Pye Weed (Eupatorium maculatum), Rattlesnake Grass (Glyceria canadensis), Swamp aster (Aster puniceus), Blueflag (Iris versicolor), Swamp Milkweed (Asclepias incarnata), Square stemmed Monkey Flower (Mimulus ringens).

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Issued/Revision	By	Appd	YYYY.MM.DD
1 SPECIAL PERMIT PACKAGE			2022.03.30

Permit/Seal

MASSACHUSETTS PAUL J. FINGER NO. 969 REGISTERED LANDSCAPE ARCHITECT

Client/Project

Bulfinch

557 HIGHLAND AVE

NEEDHAM, MA 02494

Project No.: 218421343

File Name: S-PL-PLANTING PLAN.DWG

Scale: 1" = 30'-0"

Dwn. Dsgn. Chkd. YYYY.MM.DD

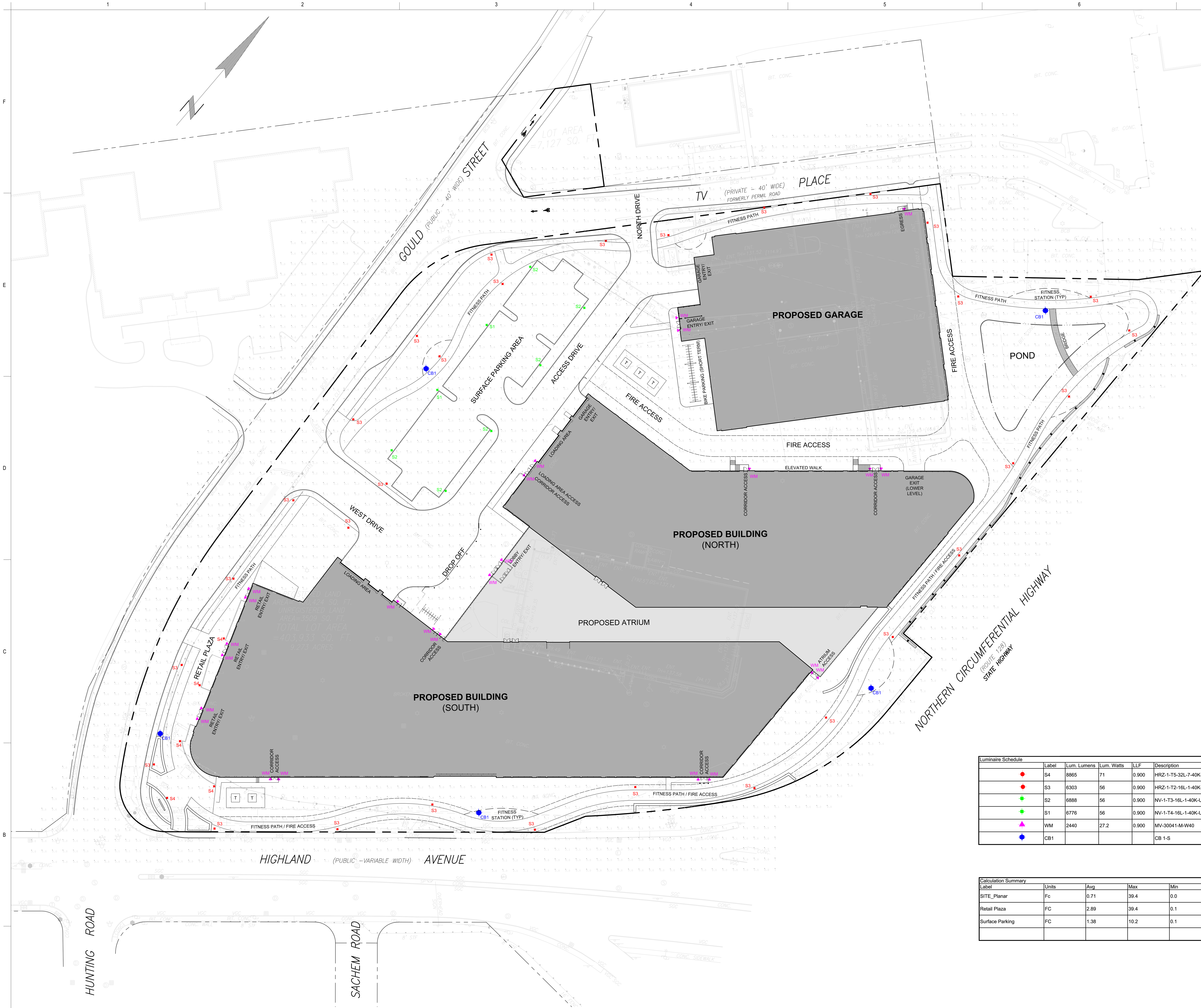
Title

SITE PLANTING PLAN

Revision:

Drawing No.

L-3.0



Luminaire Schedule						
Label	Lum. Lumens	Lum. Watts	LLF	Description	Qty
S4	8865	71	0.900	HRZ-1-T5-32L-7-40K-UNV 12' MH	5
S3	6303	56	0.900	HRZ-1-T2-16L-1-40K-UNV 12' MH	30
S2	6888	56	0.900	NV-1-T3-16L-1-40K-UNV 18' MH	6
S1	6776	56	0.900	NV-1-T4-16L-1-40K-UNV 18' MH	2
WM	2440	27.2	0.900	MV-30041-M-W40	25
CB1				CB 1-S	5

Calculation Summary

Label	Units	Avg	Max	Min	Avg/Min	Max/Min
SITE_Planar	Fc	0.71	39.4	0.0	N.A.	N.A.
Retail Plaza	FC	2.89	39.4	0.1	28.90	394.00
Surface Parking	FC	1.38	10.2	0.1	13.80	102.00

GRAPHIC SCALE 1"=30'

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PAUL FINGER ASSOCIATES
Landscape Architects - Planners
Civil Engineers - Wetland Scientists

Permit/Seal

Client/Project
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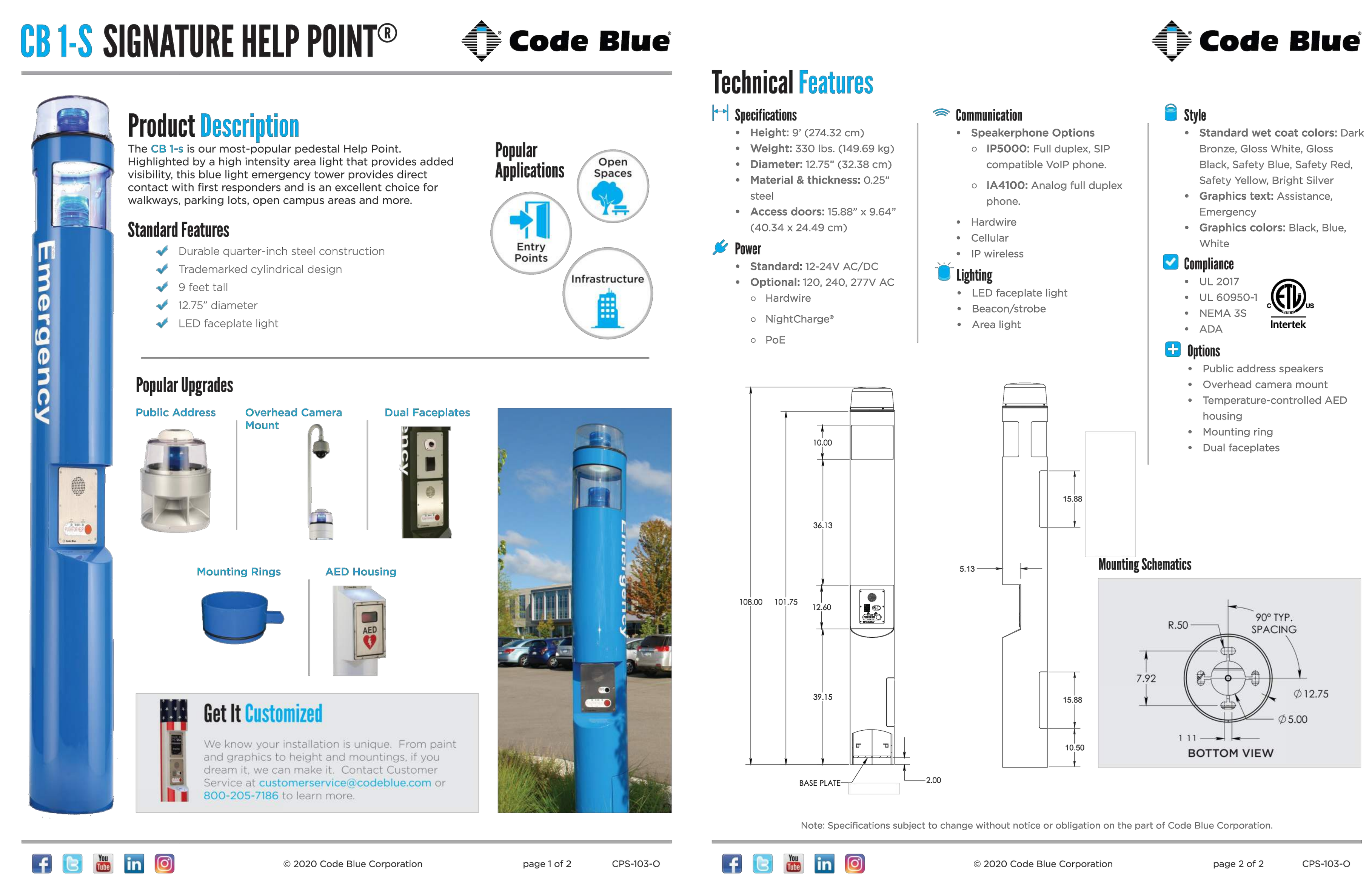
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.: 218421343
File Name: S-LT-LIGHTING PLAN.DWG
Scale: 1" = 30'-0"

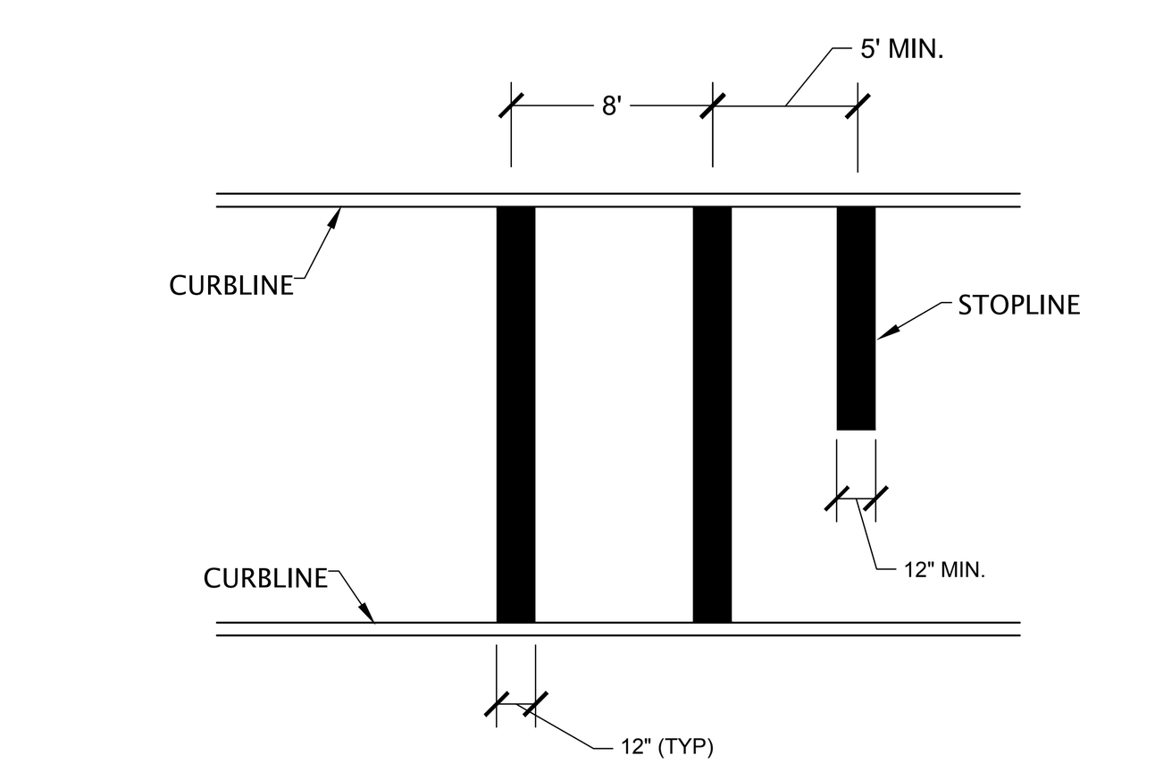
EFJ	LH	EFJ	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
SITE LIGHTING PLAN

Revision:
Drawing No.
L-4.0



BLUE LIGHT EMERGENCY TOWER
NOT TO SCALE

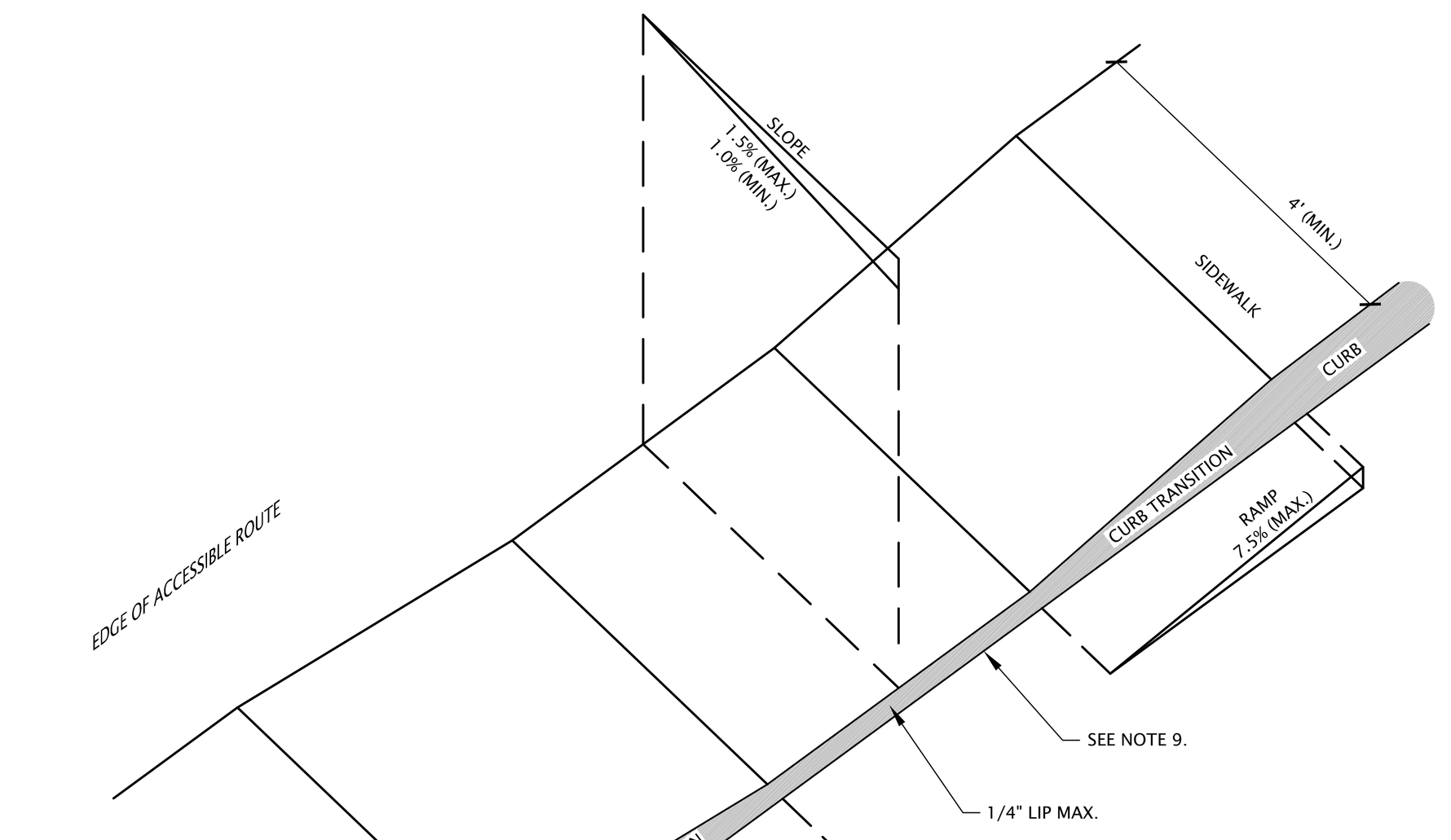


ALL TWELVE INCH (12") THERMO-PLASTIC LINES SHALL BE APPLIED IN ONE (1) APPLICATION, NO COMBINATION OF LINES (I.E. TWO 6" LINES) WILL BE ACCEPTED.

LAYOUT OF CROSSWALKS SHALL BE APPROVED BY A BOSTON TRANSPORTATION DEPARTMENT (BTD) ENGINEER PRIOR TO THERMO-PLASTIC BEING APPLIED.

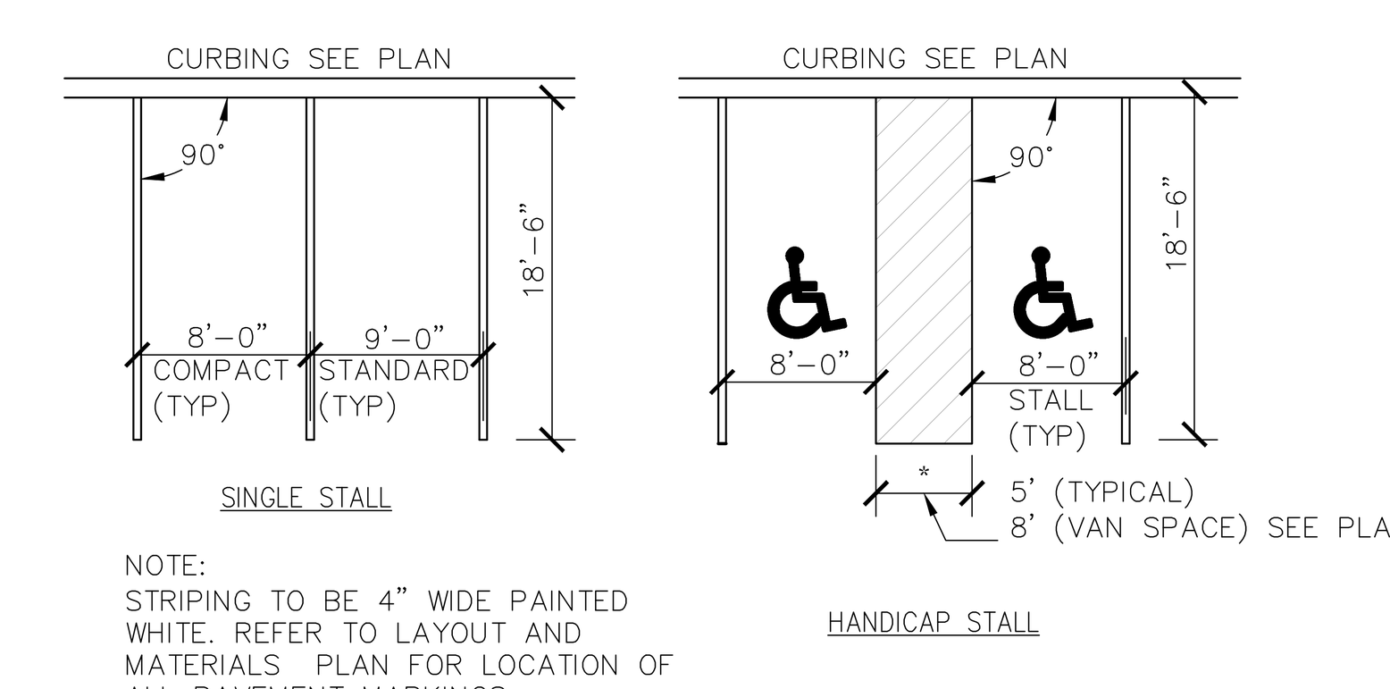
ALL CROSSWALKS INSTALLED SHALL CONFORM TO THE RELEVANT PROVISIONS OF THE MASSACHUSETTS HIGHWAY DEPARTMENT "STANDARD SPECIFICATION FOR HIGHWAY AND BRIDGES" DATED 1988, SECTION 860 FOR REFLECTORIZED LINE (THERMO-PLASTIC) AND MATERIAL M7.01.20, LATEST REVISIONS.

9 PEDESTRIAN CROSS WALK
NOT TO SCALE



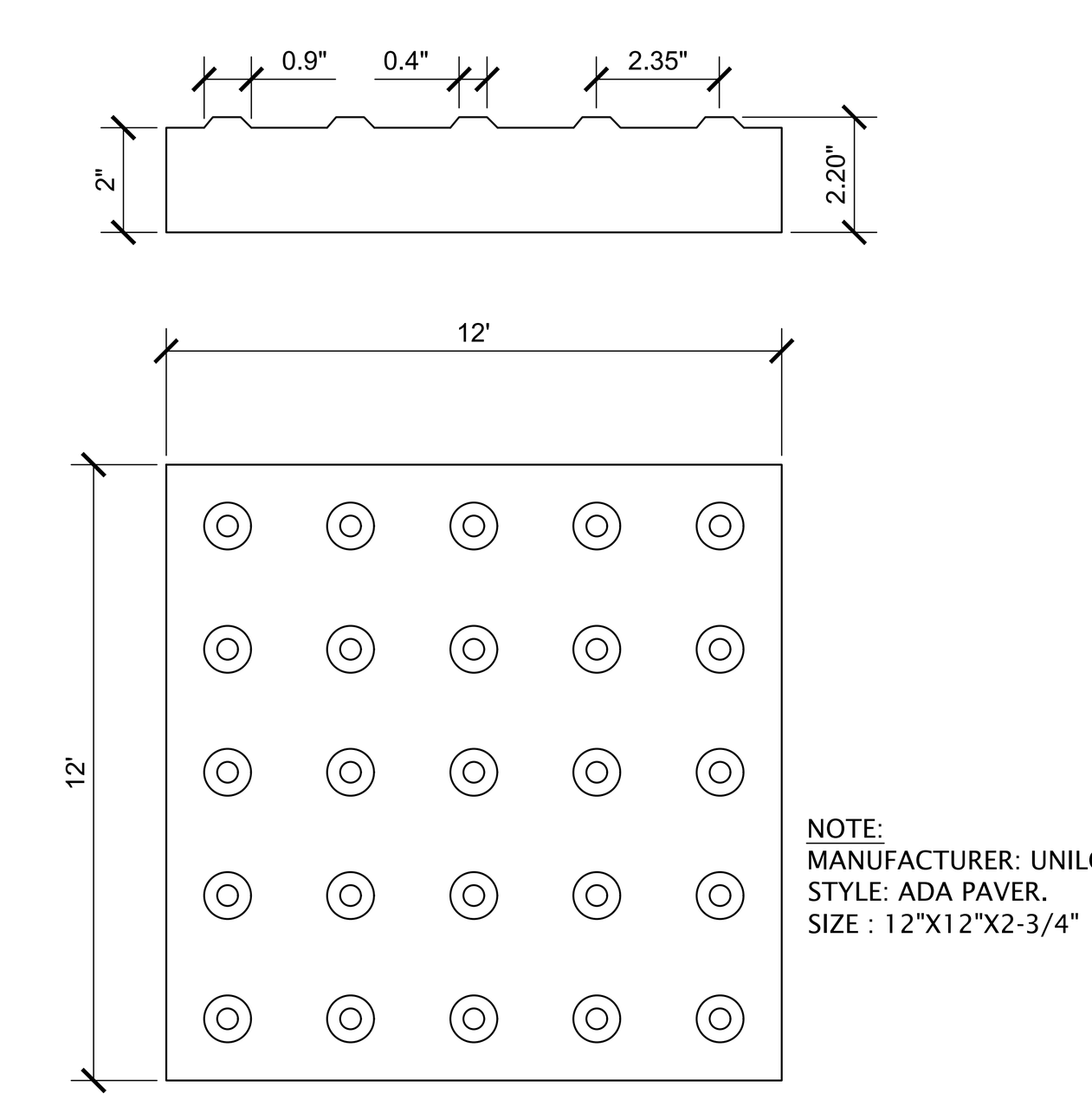
NOTES:
1. THE MAXIMUM ALLOWABLE SIDEWALK AND CURB RAMP CROSS SLOPES SHALL BE 1.5 (1% MIN.).
2. THE MAXIMUM ALLOWABLE SLOPE OF ACCESSIBLE ROUTE EXCLUDING CURB RAMPS SHALL BE 5%.
3. THE MAXIMUM ALLOWABLE SLOPE OF ACCESSIBLE ROUTE CURB RAMPS SHALL BE 7.5%
4. A MINIMUM OF 3 FEET CLEAR SHALL BE MAINTAINED AT ANY PERMANENT OBSTACLE IN ACCESSIBLE ROUTE (I.E., HYDRANTS, UTILITY POLES, TREE WELLS, SIGNS, ETC.).
5. CURB TREATMENT VARIES, SEE PLANS FOR CURB TYPE.
6. RAMP, CURB AND ADJACENT PAVEMENTS SHALL BE GRADED TO PREVENT PONDING.
7. SEE TYPICAL SIDEWALK SECTION FOR RAMP CONSTRUCTION.
8. WHERE ACCESSIBLE ROUTES ARE LESS THATN 5" IN WIDTH (EXCLUDING CURBING) A 5' X 5' PASSING AREA SHALL BE PROVIDED AT INTERVALS NOT TO EXCEED 200 FEET.
9. ELIMINATE CURBING AT RAMP (OTHER THAN VERTICAL CURBING, WHICH SHALL BE SET FLUSH) WHERE IT ABUTS ROADWAY.

ACCESSIBLE CURB RAMP
NOT TO SCALE



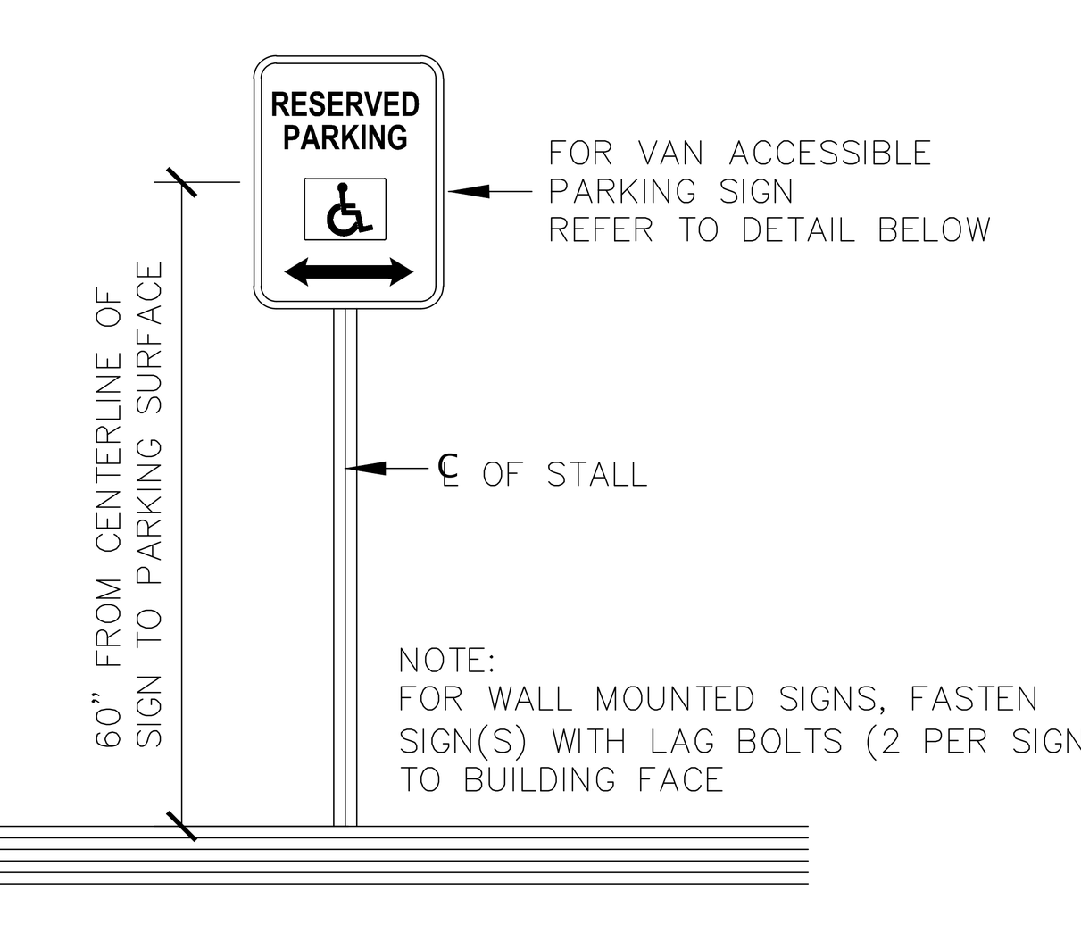
NOTE:
STRIPING TO BE 4" WIDE PAINTED WHITE. REFER TO LAYOUT AND MATERIALS PLAN FOR LOCATION OF ALL PAVEMENT MARKINGS.

PAVEMENT MARKING
NOT TO SCALE



NOTE:
MANUFACTURER: UNILOCK
STYLE: ADA PAVER.
SIZE : 12"X12"X2-3/4"

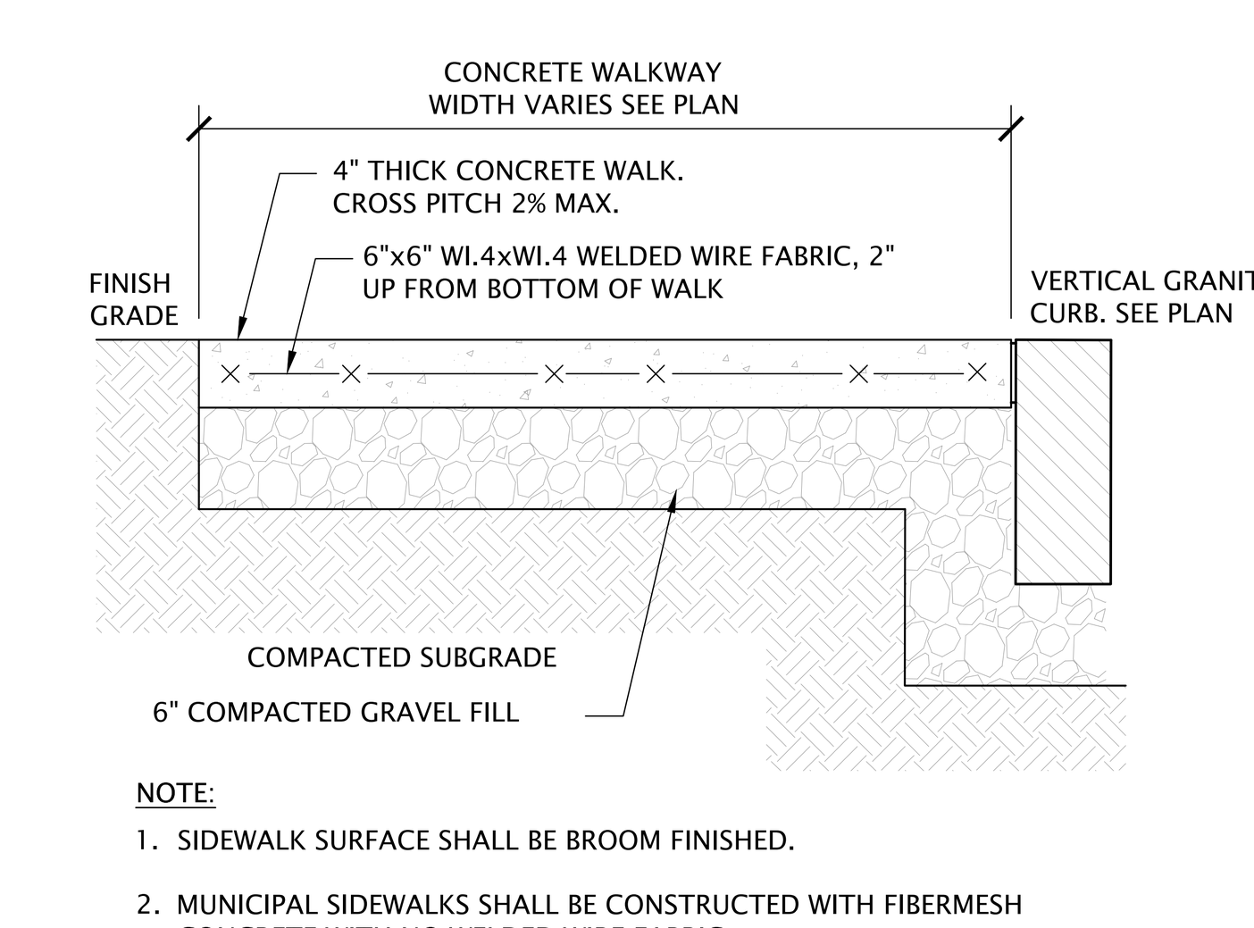
DETECTABLE WARNING PAVER TYPE
NOT TO SCALE



NOTE:
FOR WALL MOUNTED SIGNS, FASTEN SIGN(S) WITH LAG BOLTS (2 PER SIGN) TO BUILDING FACE

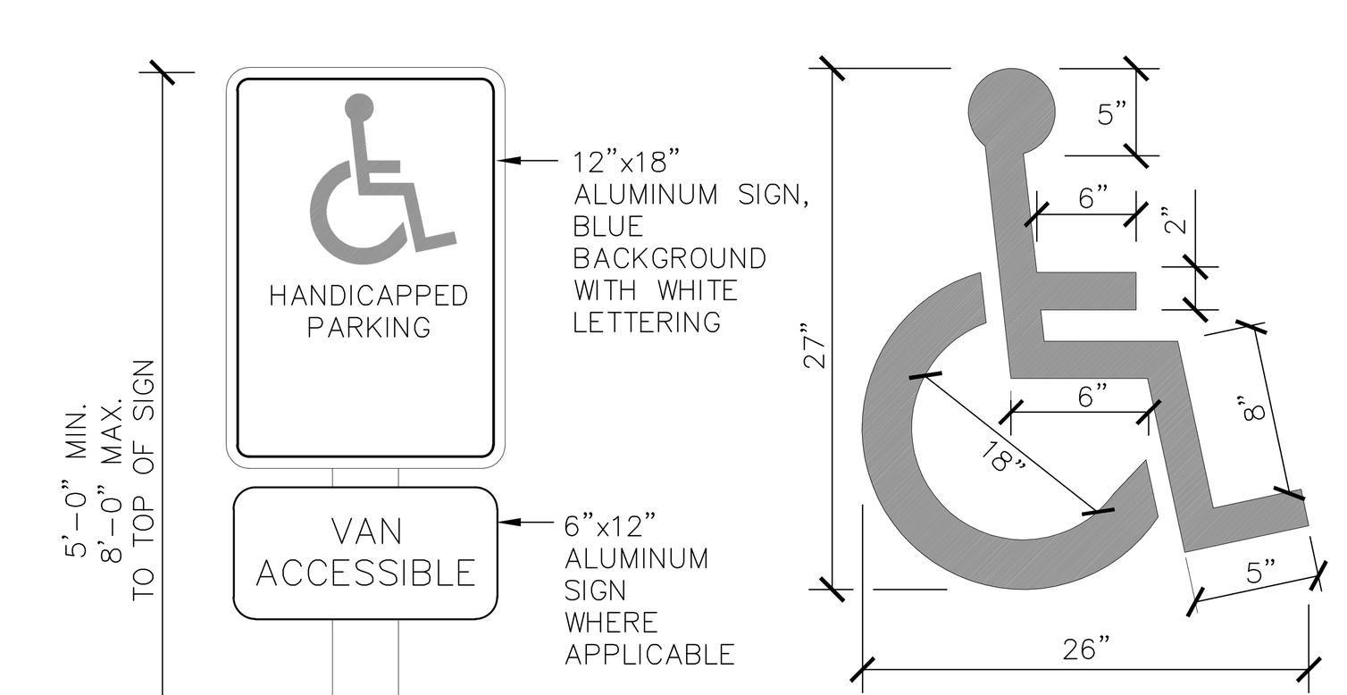
MHD REF. NO. R7-8

ADA HANDICAP PARKING SIGN
NOT TO SCALE



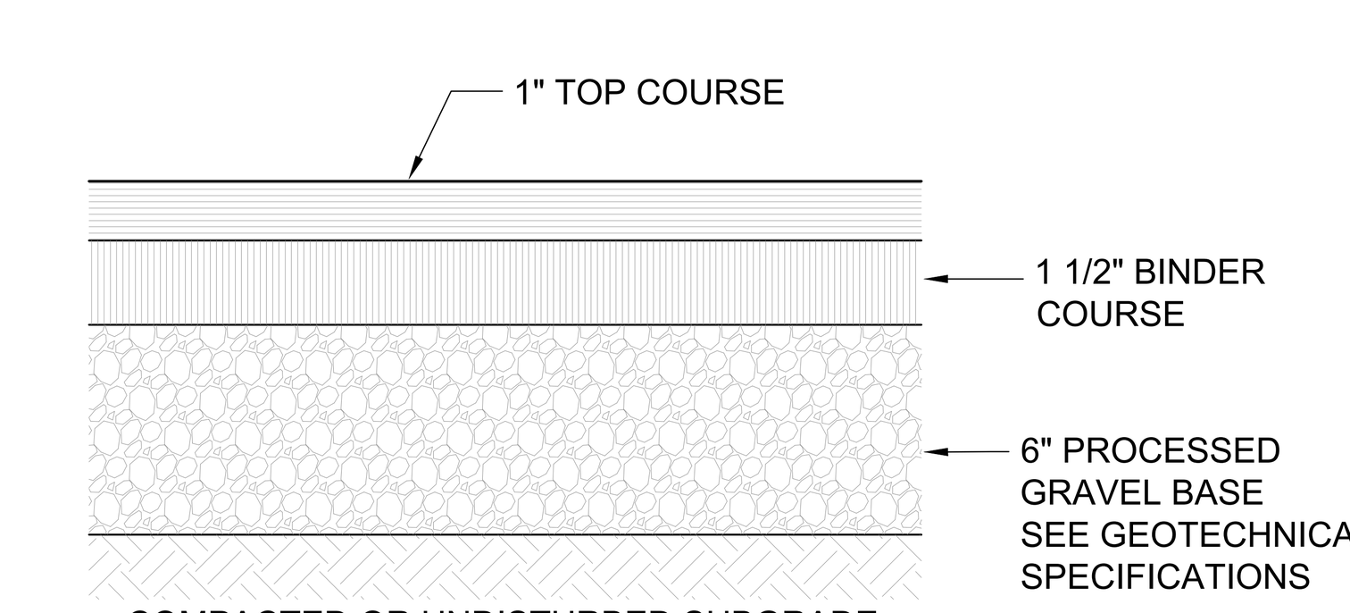
NOTE:
1. SIDEWALK SURFACE SHALL BE BROOM FINISHED.
2. MUNICIPAL SIDEWALKS SHALL BE CONSTRUCTED WITH FIBERMESH CONCRETE WITH NO WELDED WIRE FABRIC.

CONCRETE WALK WITH VERTICAL GRANITE CURB
NOT TO SCALE

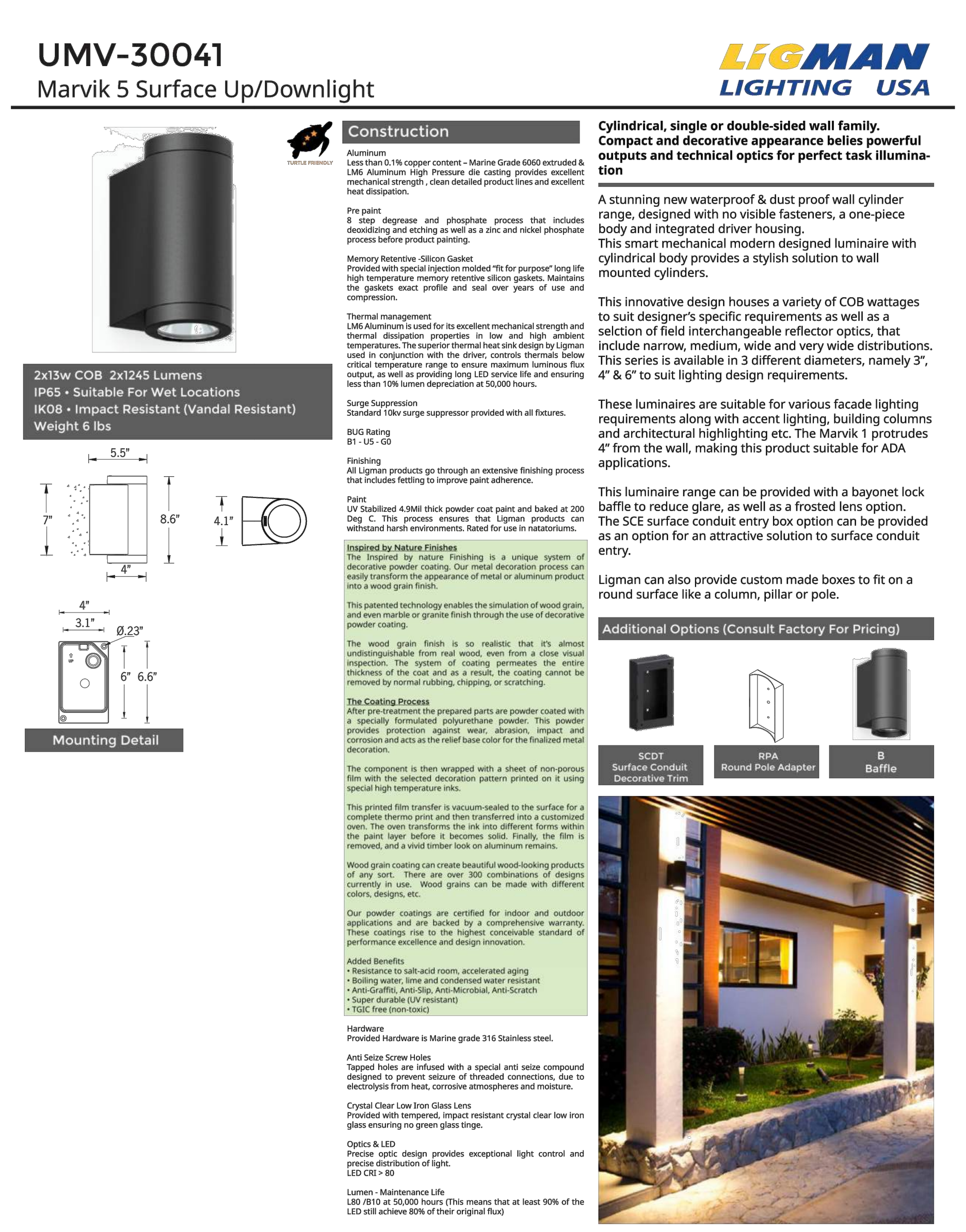


NOTE:
ALL HANDICAP PARKING AND SIGNAGE SHALL BE IN CONFORMANCE WITH THE RULES AND REGULATIONS OF THE AMERICANS WITH DISABILITIES ACT (ADA) AND THE MA ARCHITECTURAL ACCESS BOARD (AAB). SIGN(S) SHALL BE LOCATED SO THEY CANNOT BE OBSCURED BY A VEHICLE PARKED IN THE SPACE, AND LOCATED NOT MORE THAN 10 FEET FROM THE SPACE.

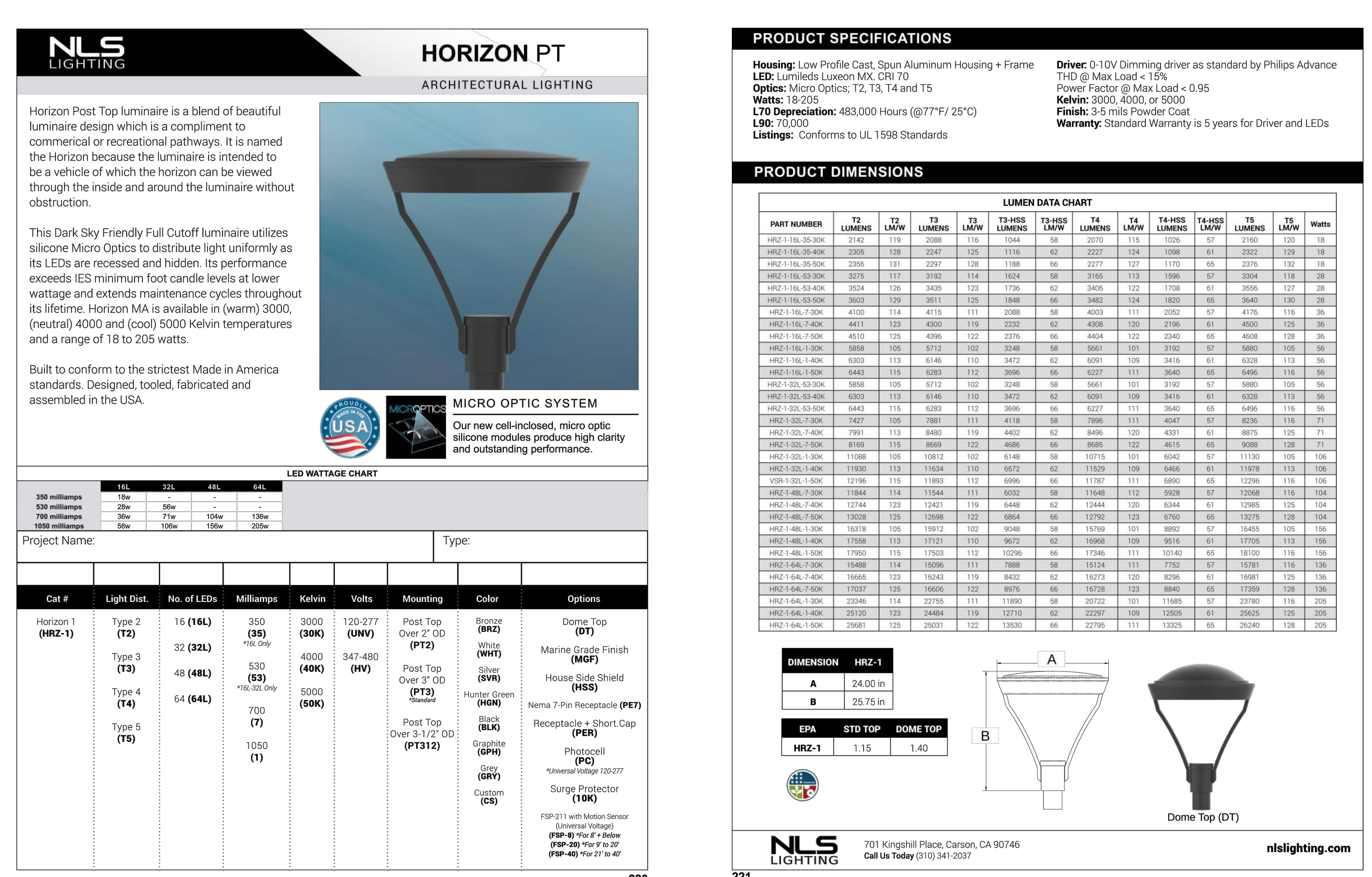
HANDICAP VAN SIGN AND PAVEMENT MARKING
NOT TO SCALE



BITUMINOUS CONCRETE PAVEMENT
NOT TO SCALE



LIGHTING TYPE I
NOT TO SCALE



LIGHTING TYPE II
NOT TO SCALE

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Consultant

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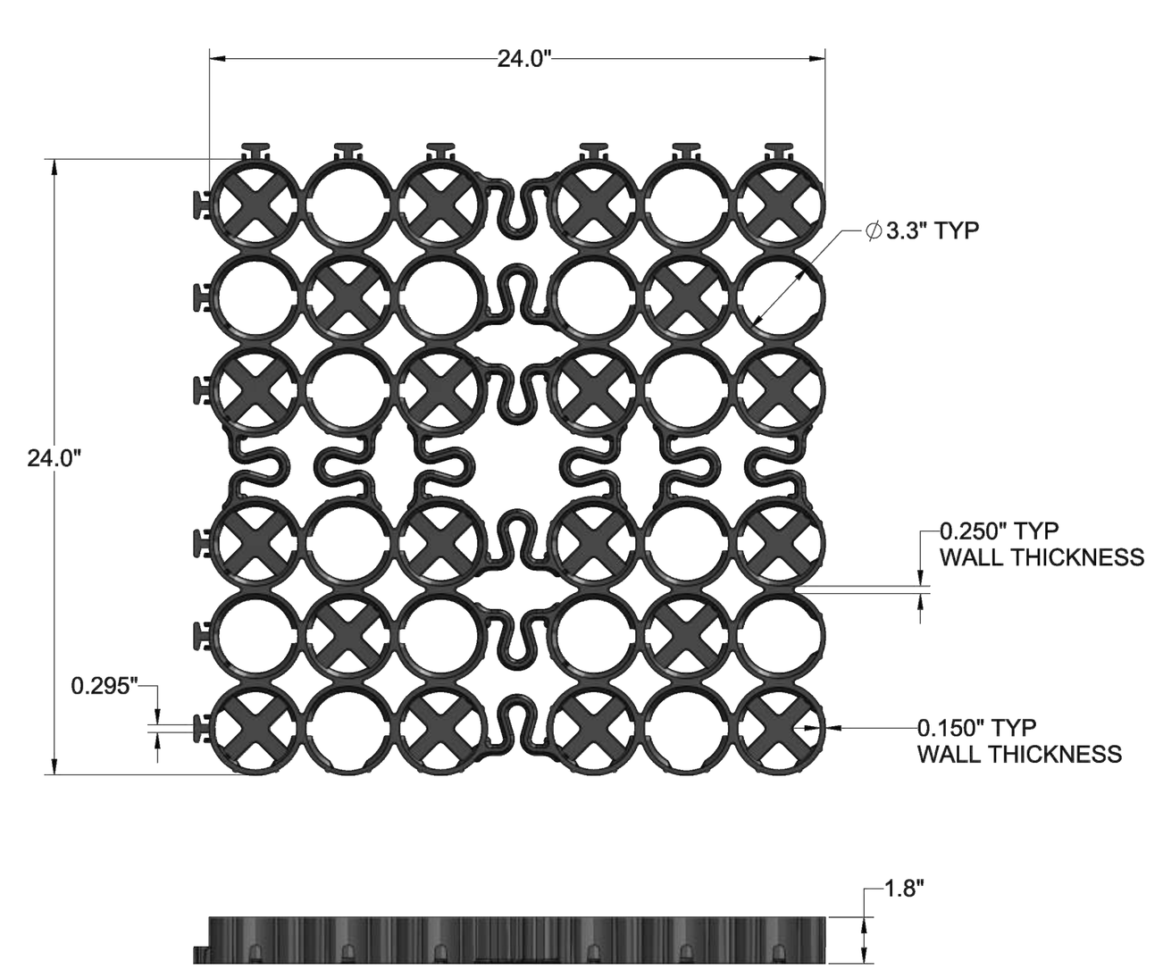
Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.: 218421343
File Name: SP-L-5.0-SITE DETAILS.dwg
Scale: As Specified

Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
SITE
DETAILS #1

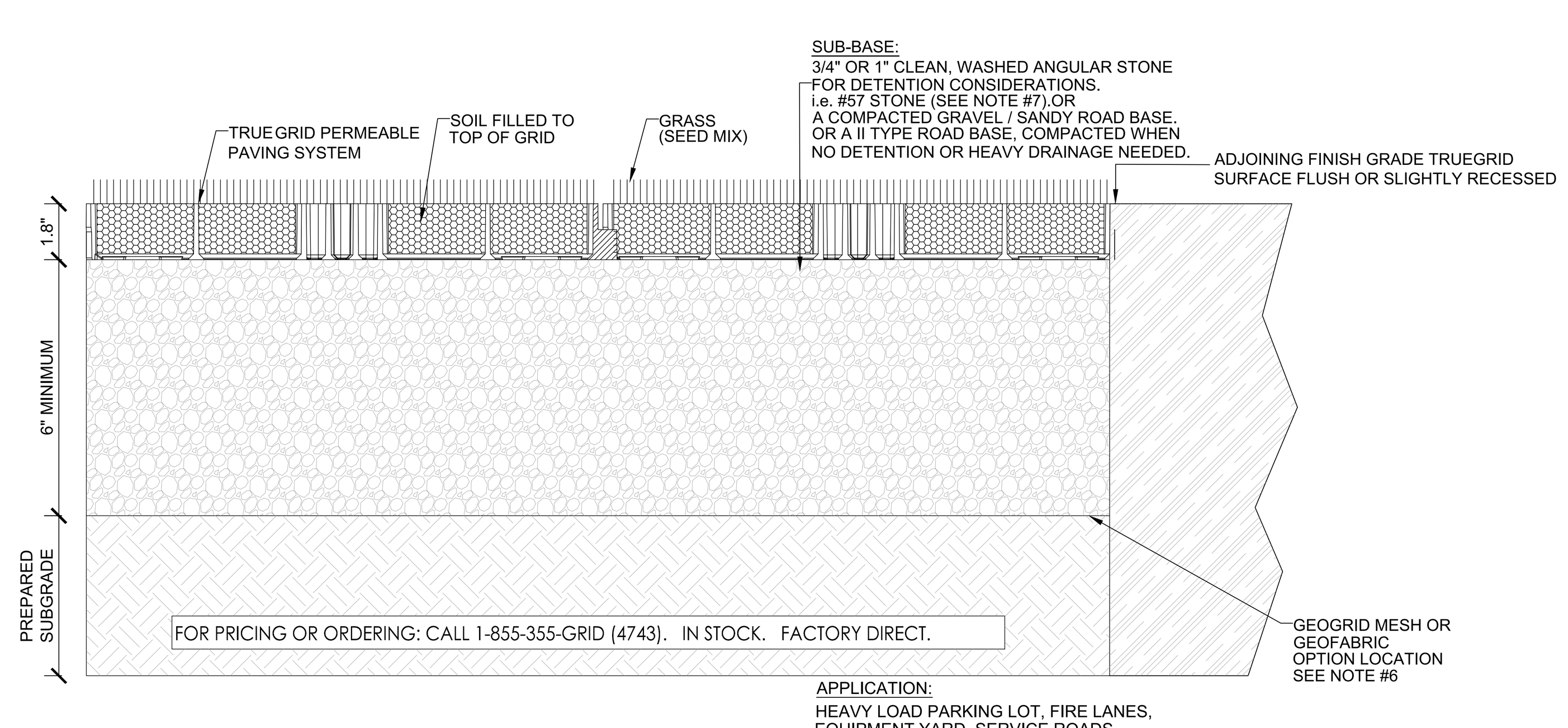
Revision:
Drawing No.
L-5.0



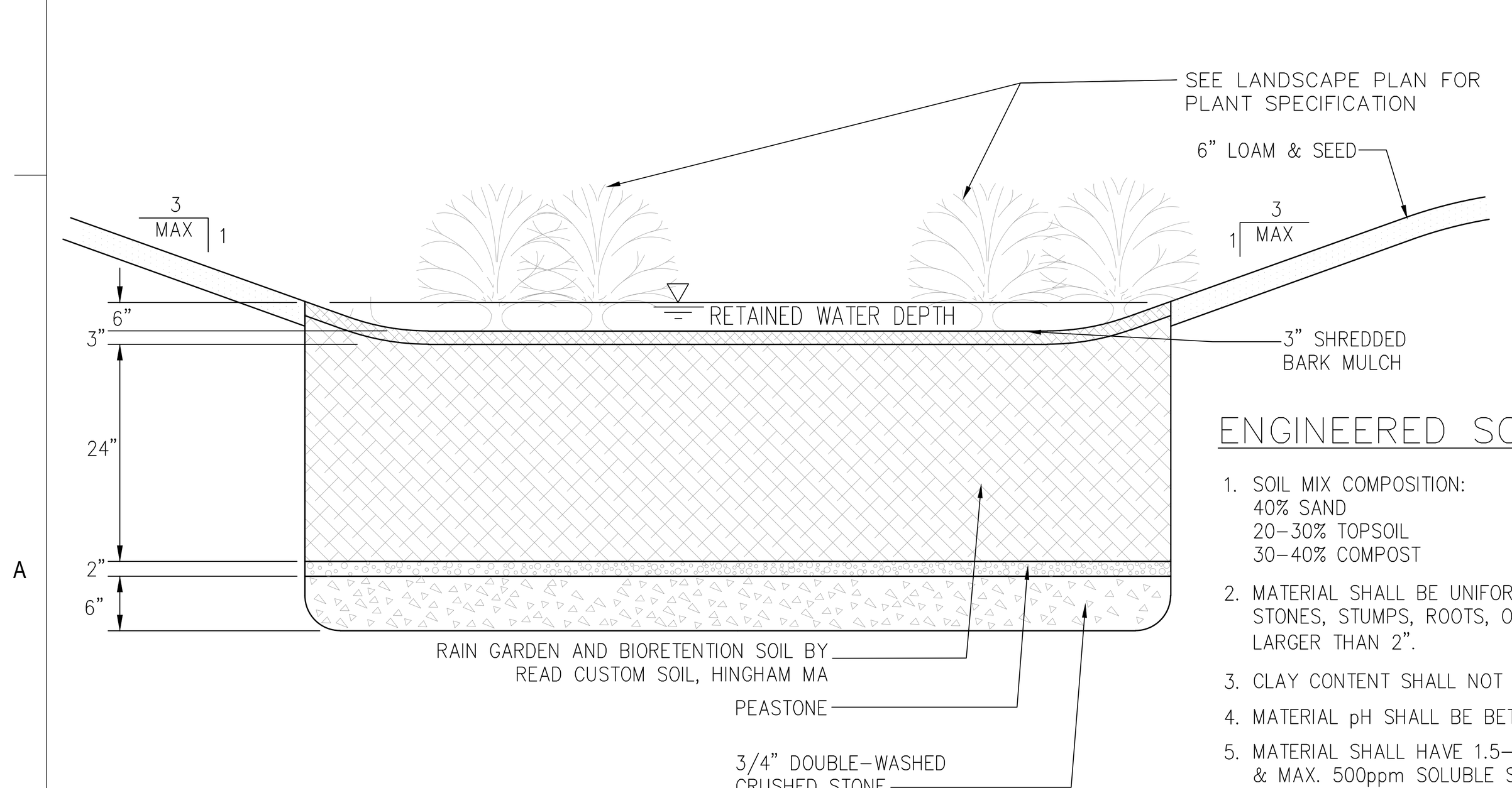
NOTES:

1. SUB-BASE DEPTH AND PREPARATION IS DEPENDENT ON SITE CONDITIONS PLUS LOADING REQUIREMENTS.
2. TRUEGRID PRO PLUS PRODUCTS ARE SUFFICIENTLY RATED FOR H-20 /HS-20 LOADING AND GREATER.
3. TYPICAL SEEDING OR HYDROSEEDING METHODS FOR GRASS GROWTH ARE ACCEPTABLE WITH TRUEGRID.
4. SOD CAN BE LAID ON SOIL FILLED GRID FOR IMMEDIATE GRASS (TYPICAL FOR FIRE LANES)
5. FOR HIGHER TRAFFIC SOD INSTALLATIONS, RECESS SOIL LEVEL WITHIN TRUEGRID AND PRESS IN SOD SO THAT TOP OF GRID IS AT SOIL LEVEL.
6. GEOGRID MESH OR GEOFABRIC MAY BE REQUIRED BETWEEN SUBGRADE & SUBBASE FOR CERTAIN SOILS AND SITE SPECIFIC REQUIREMENTS.
7. FILTER FABRIC MAY BE REQUIRED BETWEEN TRUEGRID AND SUB-BASE MATERIAL IF HIGH VOID RATIO IN SUB-BASE MATERIAL.
8. NO STAKING NECESSARY WITH TRUEGRID PRO PLUS WHEN SLOPE IS BELOW 10 DEGREES. ASSESS PROJECT, AS NEEDED.
9. FINAL ENGINEERED CROSS SECTION AGGREGATES AND DEPTH SHOULD ALLOW FOR EXPECTED INFILTRATION RATES,STORAGE CAPACITIES, OUTLET FLOW RATES, AND OTHER SITE SPECIFIC CONDITIONS AND LOAD REQUIREMENTS.
10. THIS CROSS SECTION IS FOR INFORMATION ONLY.

REINFORCED LAWN - PLAN VIEW



REINFORCED LAWN
NOT TO SCALE



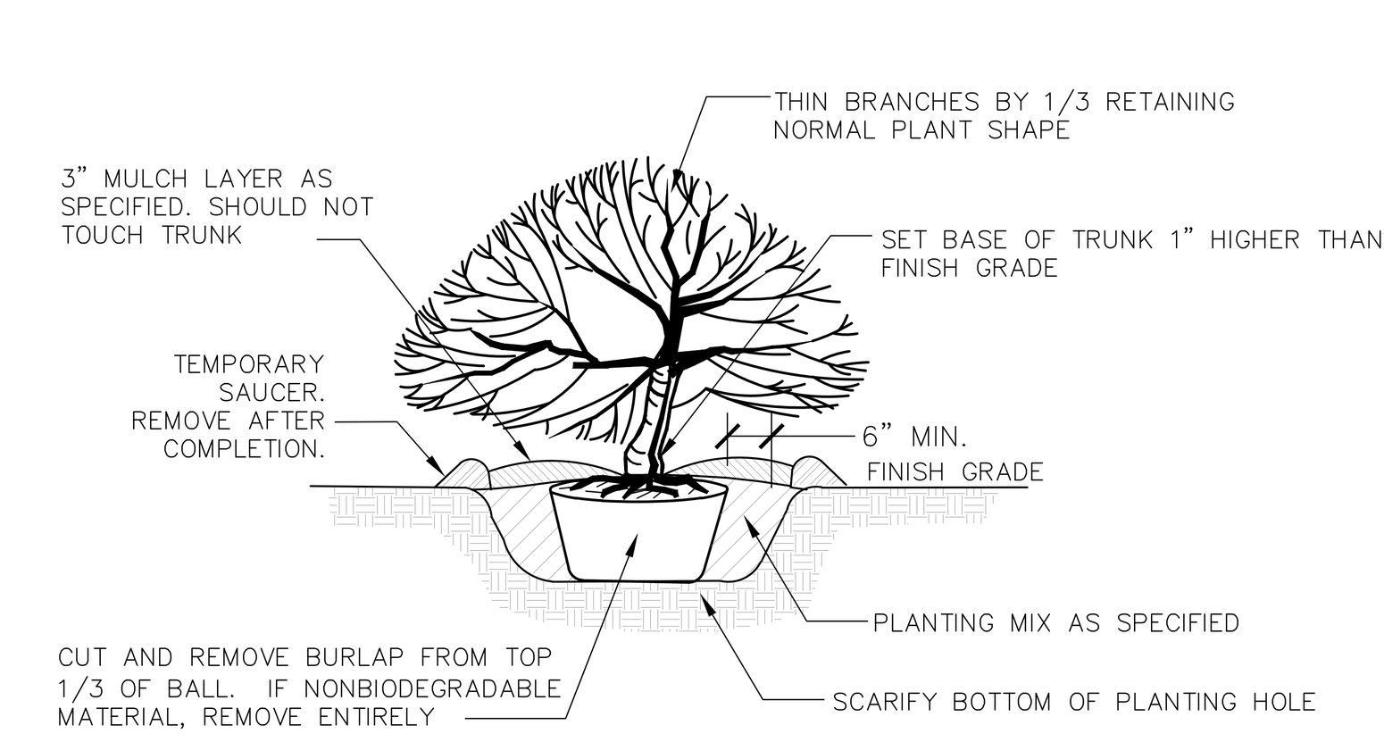
ENGINEERED SOIL MIX SPECIFICATIONS

1. SOIL MIX COMPOSITION:
   40% SAND
   20–30% TOPSOIL
   30–40% COMPOST
2. MATERIAL SHALL BE UNIFORM, FREE FROM STONES, STUMPS, ROOTS, OR OBJECTS LARGER THAN 2".
3. CLAY CONTENT SHALL NOT EXCEED 5%.
4. MATERIAL pH SHALL BE BETWEEN 5.5–6.5.
5. MATERIAL SHALL HAVE 1.5–3% ORGANIC CONTENT & MAX. 500ppm SOLUBLE SALT.
6. SAND COMPONENT SHALL MEET ASTM D 422 AND THE FOLLOWING GRADATION:

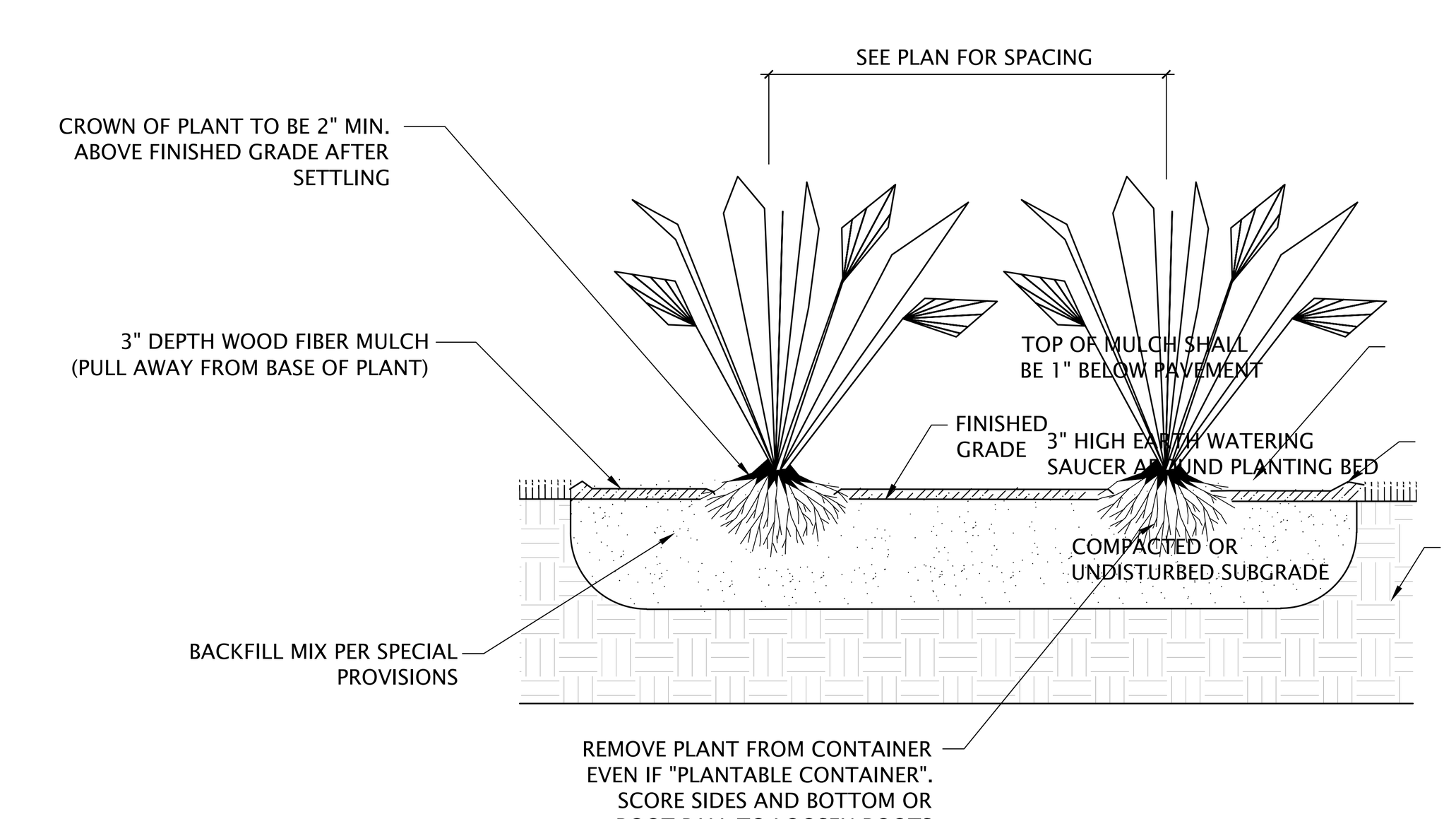
SIEVE SIZE	% PASSING
2–INCH	100
3/4 INCH	70–100
1/4 INCH	50–80
No. 4	15–40
No. 200	0–3

7. TOPSOIL SHALL BE A SANDY LOAM, LOAMY SAND, OR LOAM.
8. COMPOST SHALL BE PROCESSED FROM YARD WASTE IN ACCORDANCE WITH DEP GUIDELINES AND SHALL NOT CONTAIN BIO–SOLIDS.

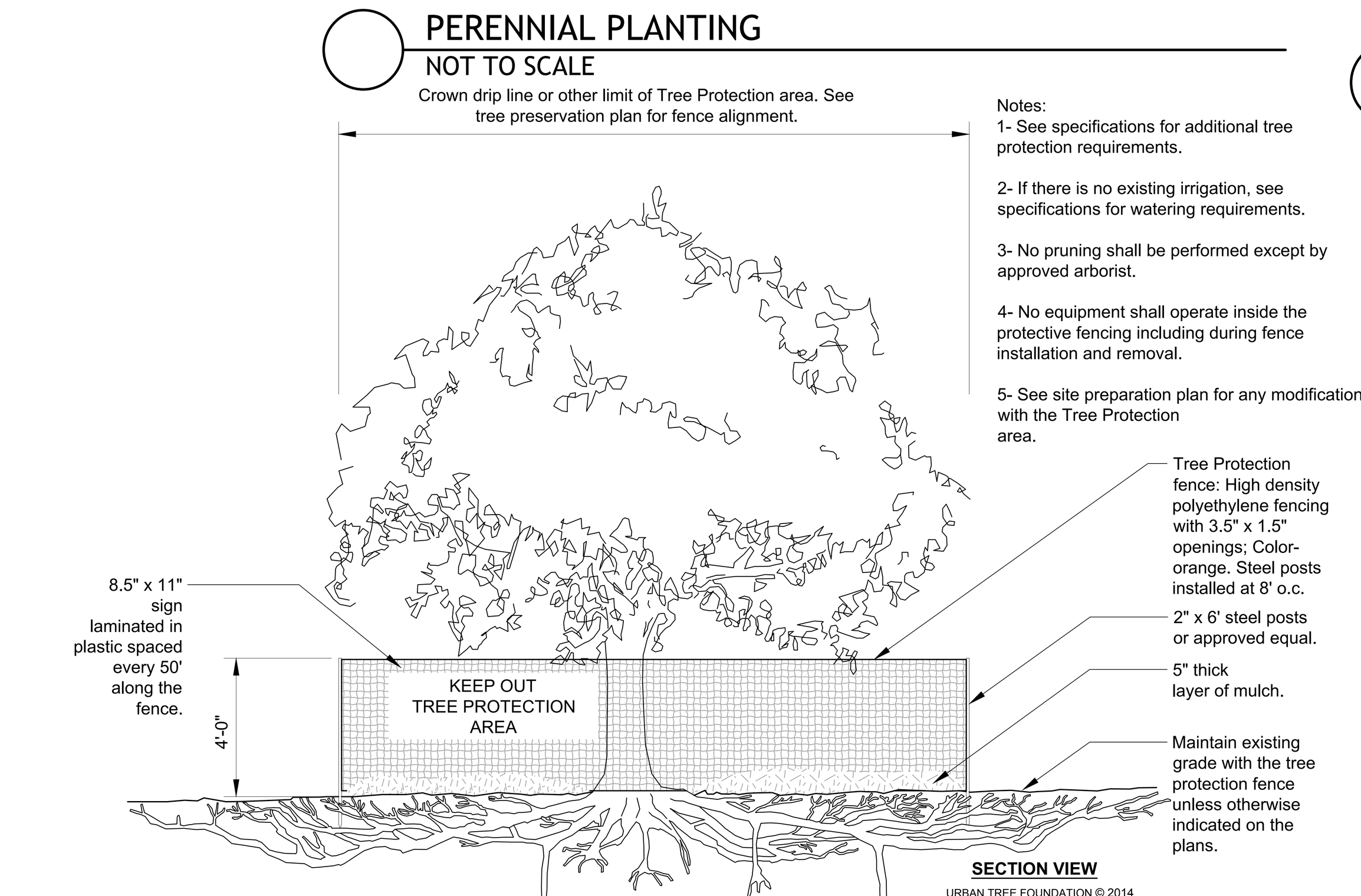
RAIN GARDEN
NOT TO SCALE



SHRUB PLANTING
NOT TO SCALE



PERENNIAL PLANTING
NOT TO SCALE



Notes:
1- See specifications for additional tree protection requirements.

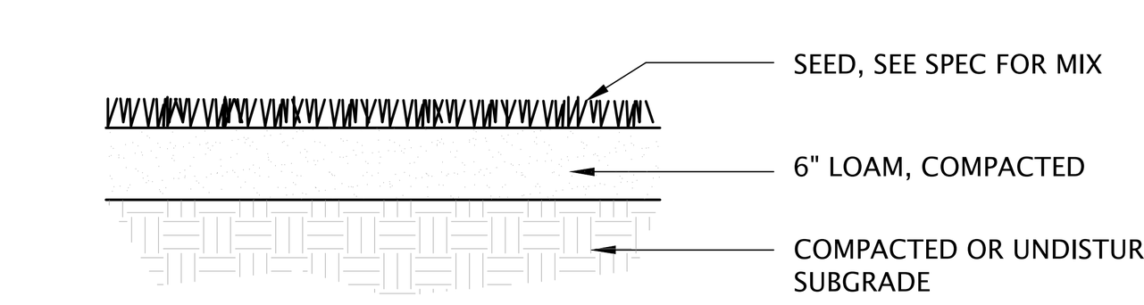
2- If there is no existing irrigation, see specifications for watering requirements.

3- No pruning shall be performed except by approved arborist.

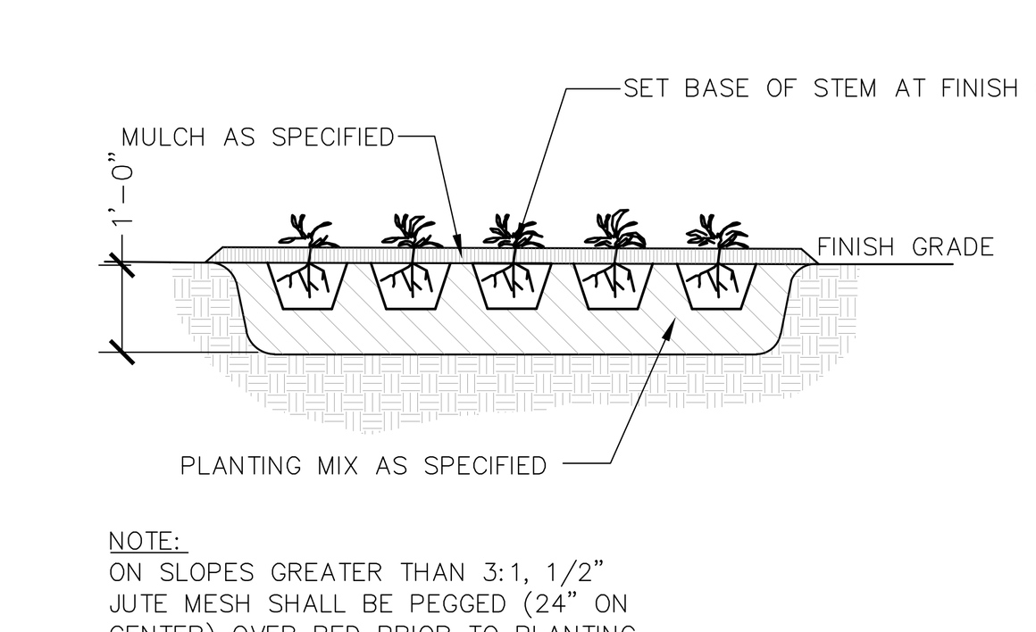
4- No equipment shall operate inside the protective fencing including during fence installation and removal.

5- See site preparation plan for any modifications with the Tree Protection area.

TREE PROTECTION
NOT TO SCALE

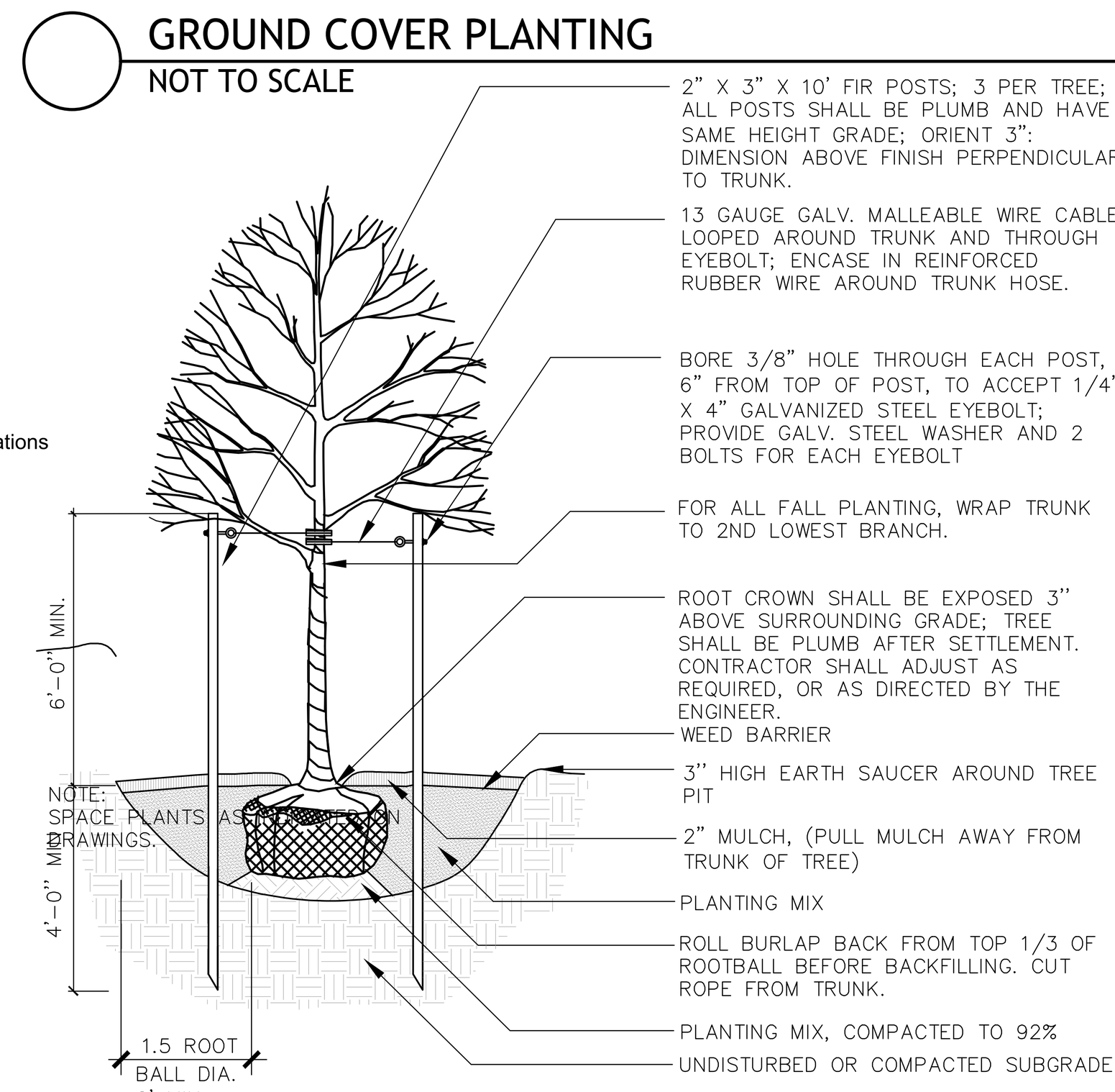


TYPICAL SEEDED NO-MOW LAWN
NOT TO SCALE



NOTE:
ON SLOPES GREATER THAN 3:1, 1/2" JUTE MESH SHALL BE PEGGED (24" ON CENTER) OVER BED PRIOR TO PLANTING.
SPACE PLANTS AS INDICATED ON DRAWINGS

GROUND COVER PLANTING
NOT TO SCALE



TYPICAL TREE PLANTING
NOT TO SCALE

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Landscape Architects - Planners
Civil Engineers - Wetland Scientists

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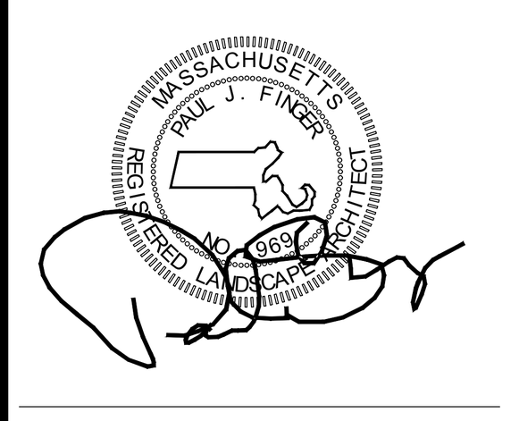

Client/Project
Bulfinch
557 HIGHLAND AVE
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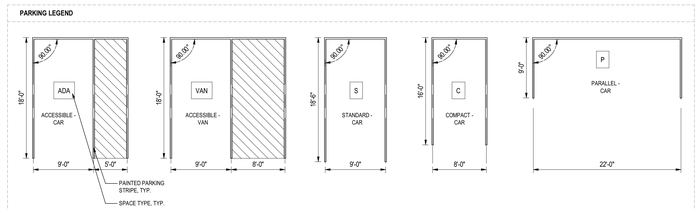
Project No.: 218421343
Scale: As Specified

Title
SITE
DETAILS #2

Revision:
Drawing No.
L-5.1



1 GARAGE LEVEL G1 PLAN
A-100G1 — 1" = 20'-0"

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KEY PLAN

BUILDING BELOW GRADE PARKING	
Type Comments	Count

LEVEL G1	
ACCESSIBLE	6
ACCESSIBLE VAN	2
COMPACT	127
PARALLEL	8
STANDARD	200
LEVEL G1: 343	343
GRAND TOTAL: 343	343

LEGEND

- WF — WHEELED FIRE EXTINGUISHER
- FE — FIRE EXTINGUISHER BRACKET WALL MTD
- FEC — FIRE EXTINGUISHER CABINET WALL MTD

75'-0" MAX. DISTANCE PER CODE, TYP.

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.: 218421343
File Name: N/A
Scale: As indicated

Author	Designer	Checker	2022.03.30
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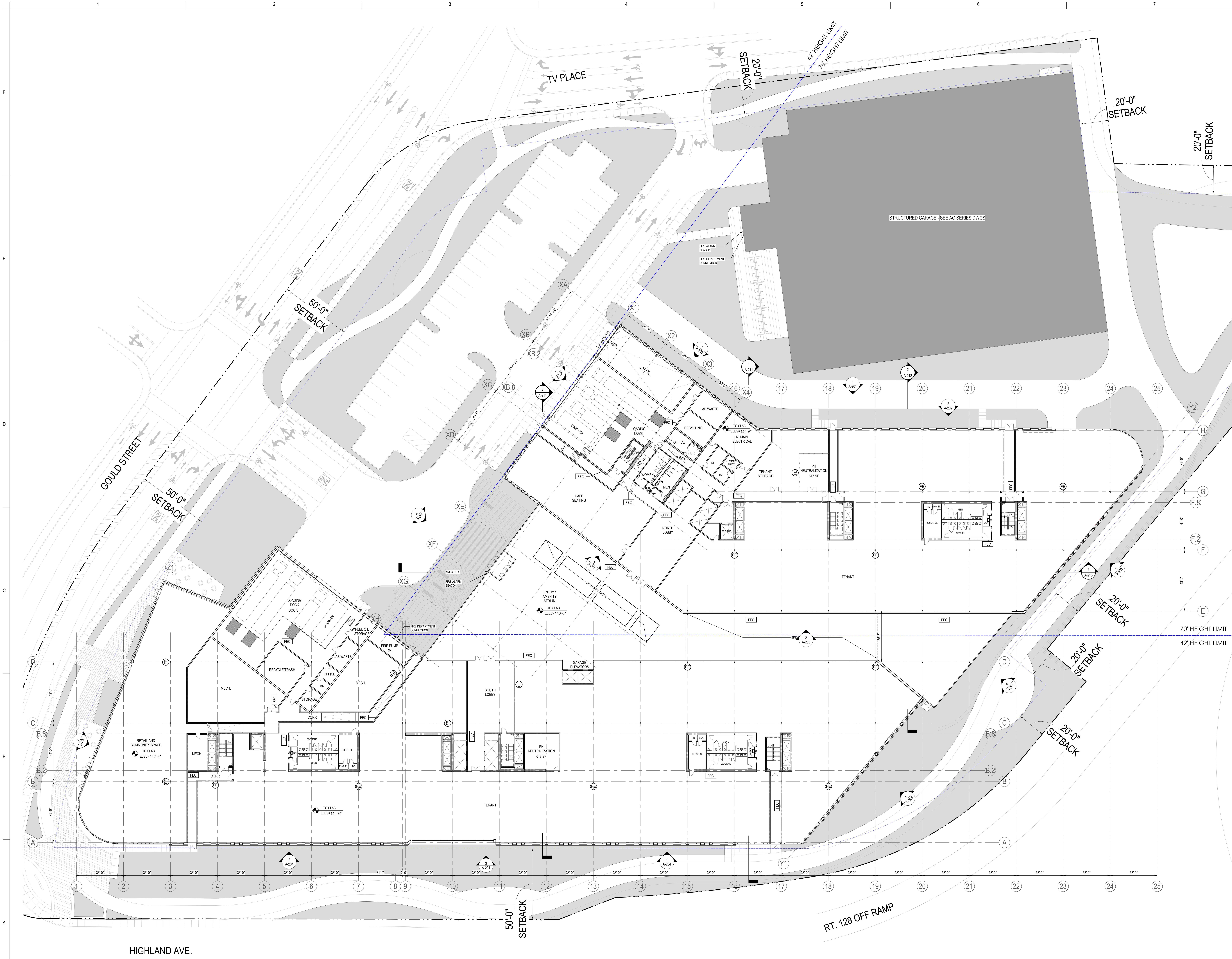
Title
GARAGE LEVEL G1 - OVERALL PLAN

Revision:
Drawing No.
A-100G1



1 A-101 **LEVEL 1 PLAN - ENTRY LEVEL**
1" = 20'-0"

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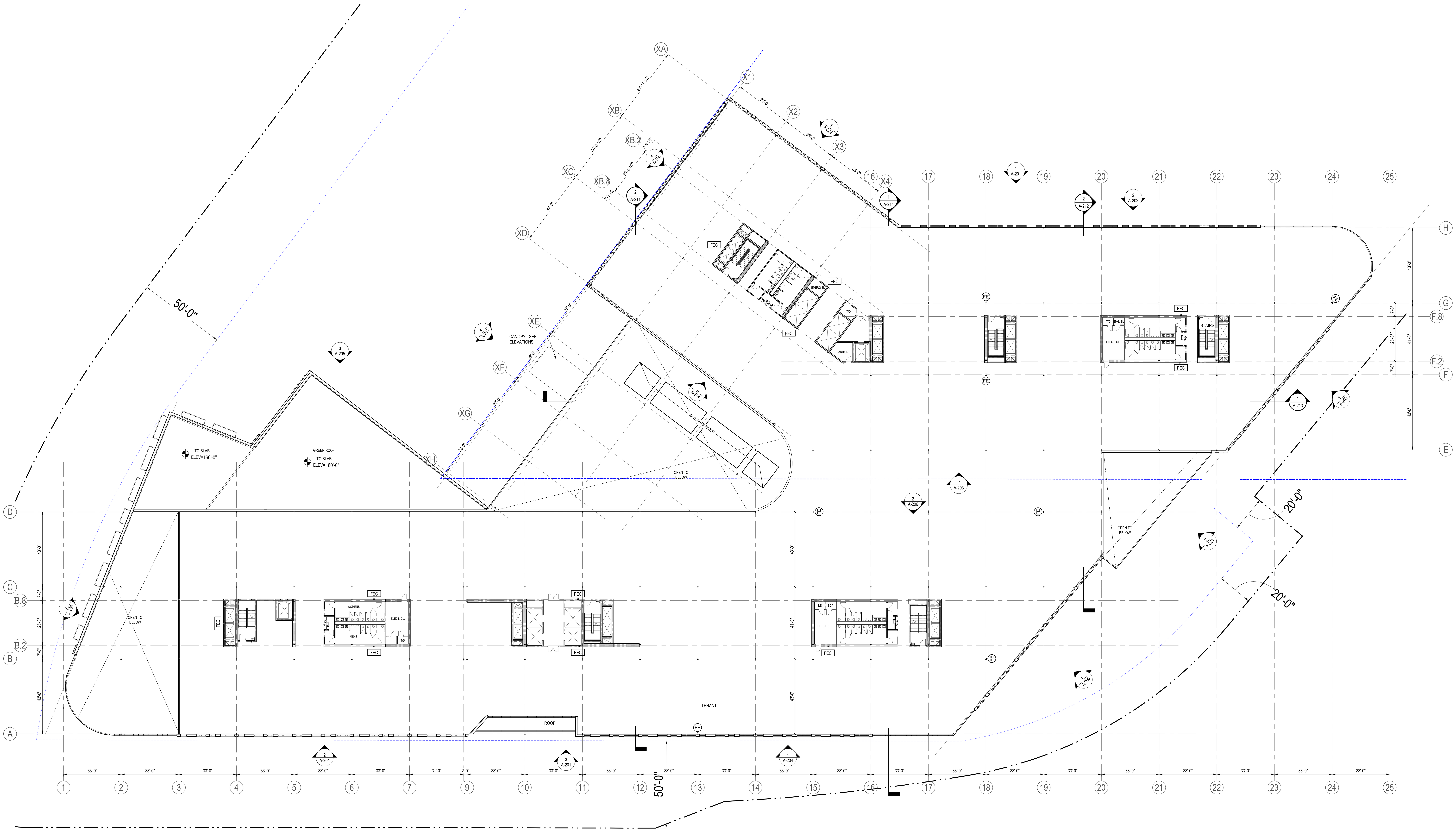
Title
LEVEL 1 - OVERALL PLAN

Revision:
Drawing No.
A-101



1
A-102

LEVEL 2 PLAN - FULL PLAN

1" = 20'-0"

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KEY PLAN

LEGEND

- WF — WHEELED FIRE EXTINGUISHER
- FE — FIRE EXTINGUISHER BRACKET WALL MTD
- FEC — FIRE EXTINGUISHER CABINET WALL MTD

75'-0" MAX. DISTANCE PER CODE, TYP.

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.:218421343
File Name: N/A
Scale: As indicated

Author	Designer	Checker	2022.03.30
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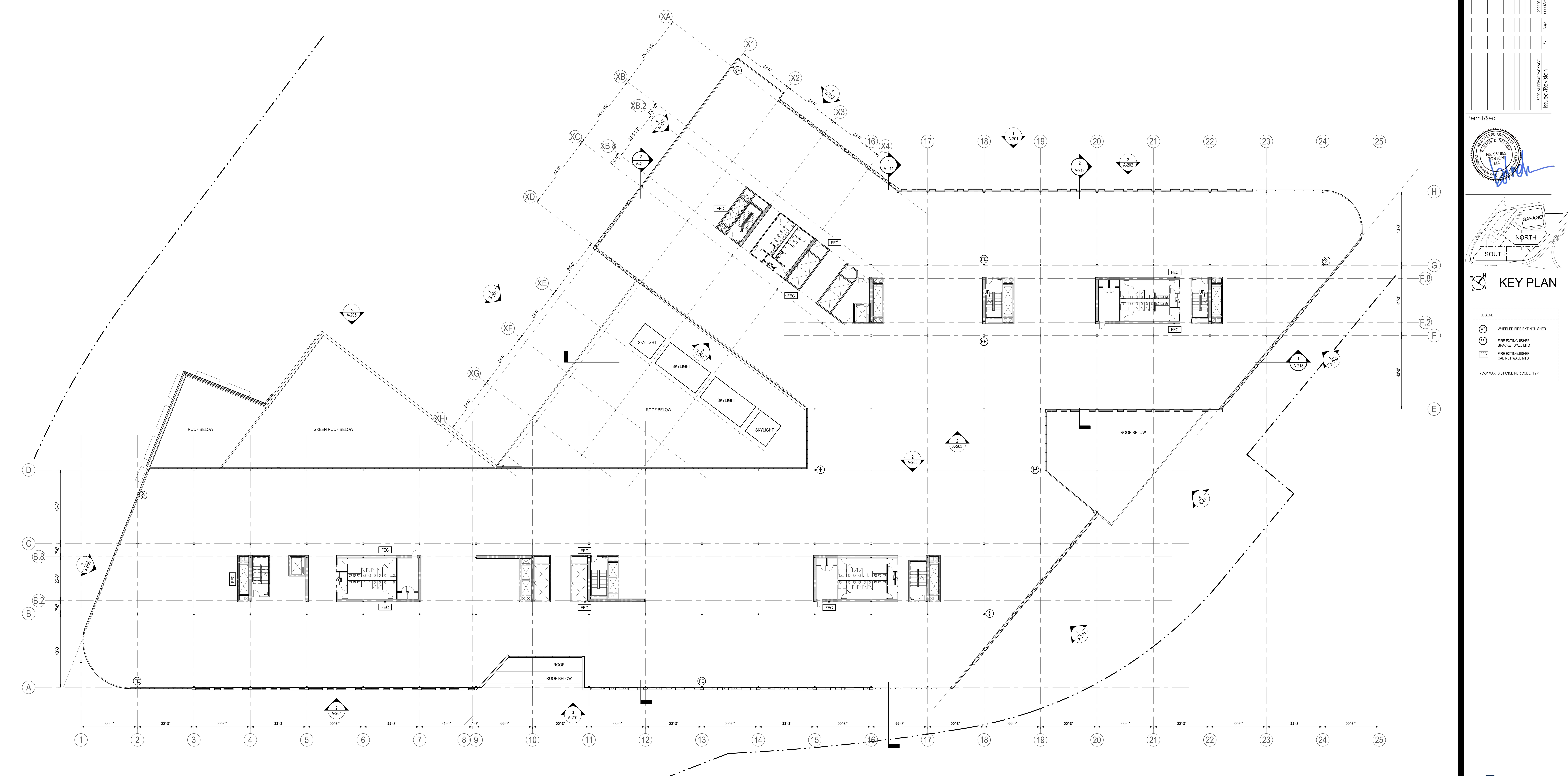
Title
LEVEL 2 - OVERALL PLAN

Revision:

Drawing No.
A-102



1 A-103 **LEVEL 3 - FULL PLAN**
1" = 20'-0"

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File Name: N/A
Scale: As indicated

Author	Designer	Checker	2022.03.30
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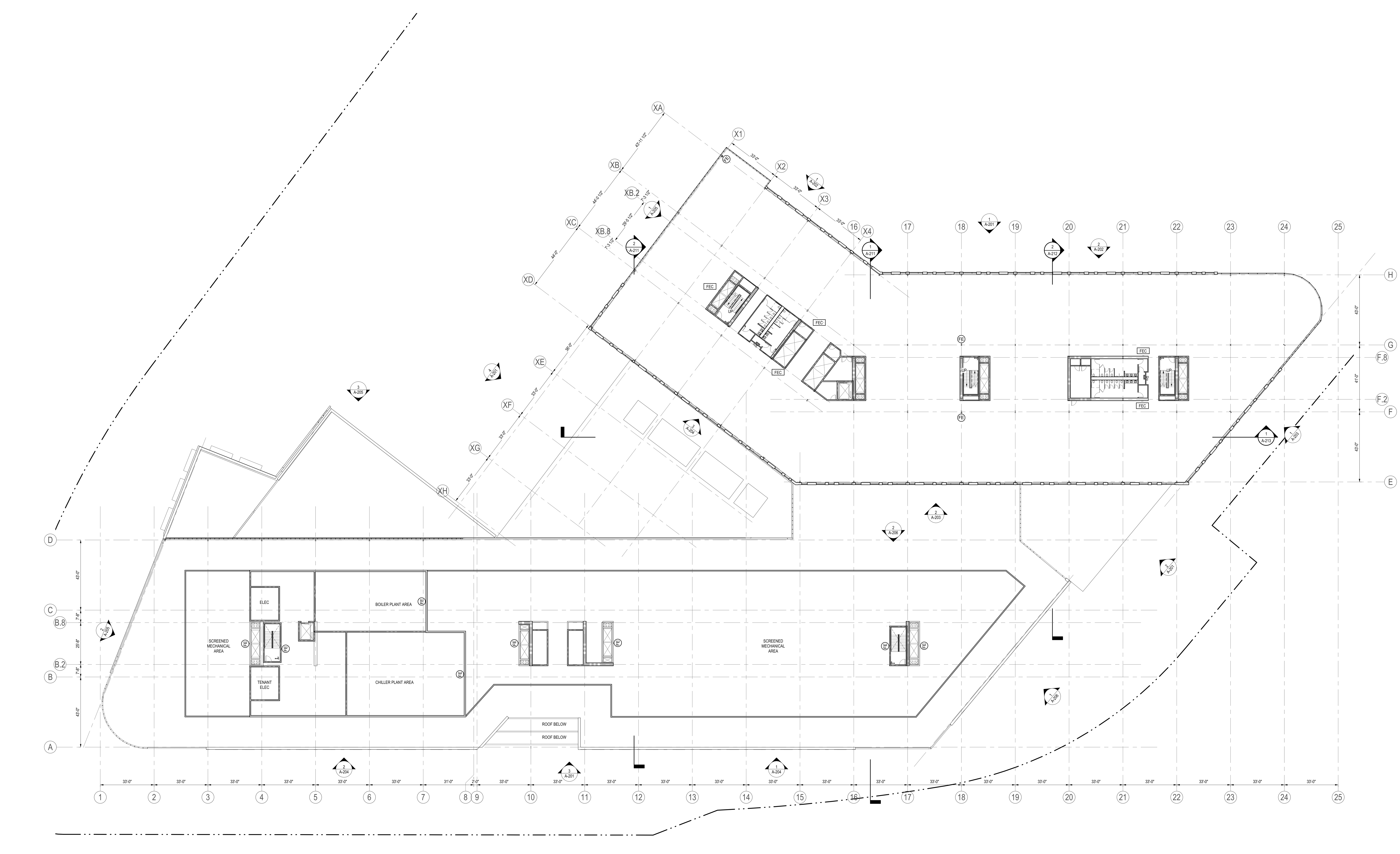
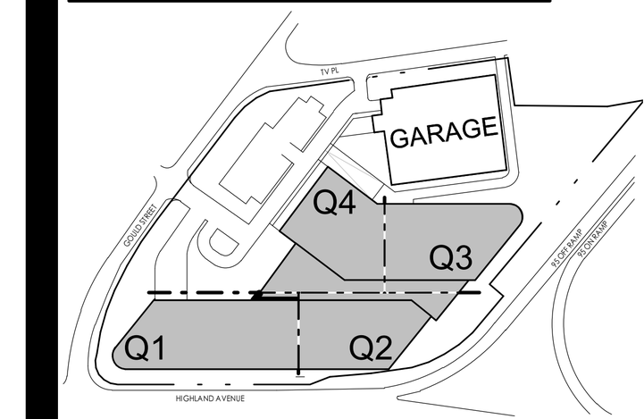
Title
LEVEL 3 - OVERALL PLAN

Revision:
Drawing No.
A-103



1 A-104 **LEVEL 4 - FULL PLAN**

1" = 20'-0"



KEY PLAN

LEGEND	
WF	WHEELED FIRE EXTINGUISHER
FE	FIRE EXTINGUISHER BRACKET WALL MTD
FEC	FIRE EXTINGUISHER CABINET WALL MTD

75'-0" MAX. DISTANCE PER CODE, TYP.

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Project No.:218421343
File Name: N/A
Scale: As indicated

Author	Designer	Checker	2022.03.30
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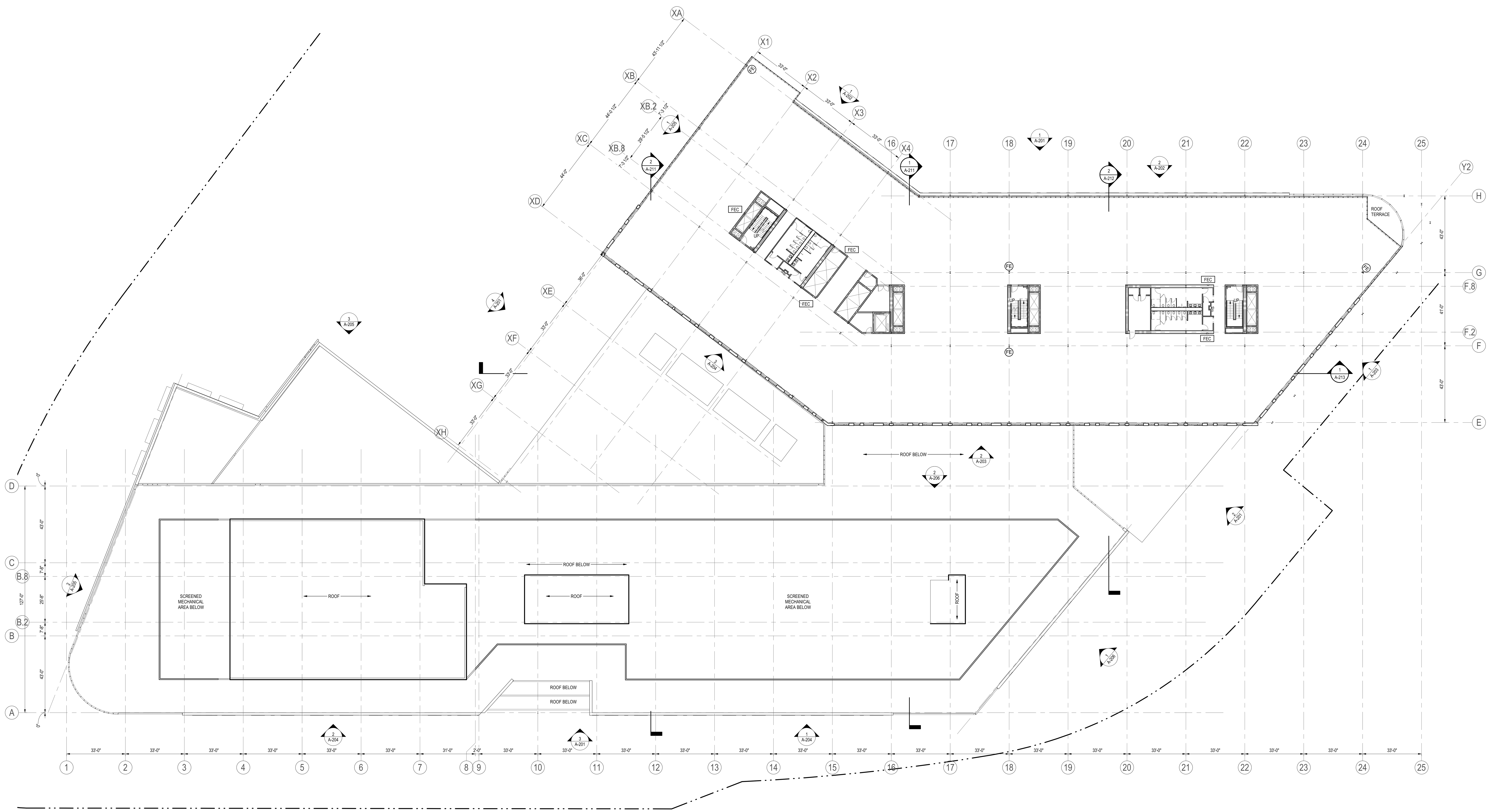
Title
LEVEL 4 - OVERALL PLAN

Revision:

Drawing No.
A-104



1
A-105
LEVEL 5 - FULL PLAN
1" = 20'-0"

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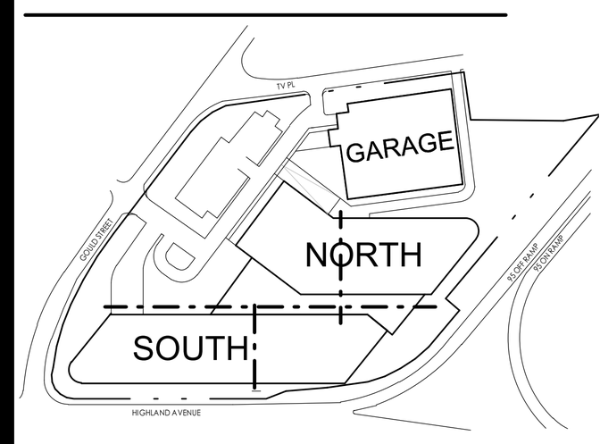
REGISTERED ARCHITECT BARTON D NELSON No. 951652 BOSTON, MA COMMONWEALTH OF MASSACHUSETTS



KEY PLAN

LEGEND

WF	WHEELED FIRE EXTINGUISHER
FE	FIRE EXTINGUISHER BRACKET WALL MTD
FEC	FIRE EXTINGUISHER CABINET WALL MTD

75'-0" MAX. DISTANCE PER CODE, TYP.

Client/Project
Bulfinch
557 HIGHLAND AVE
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Project No.:218421343
File Name: N/A
Scale: As indicated

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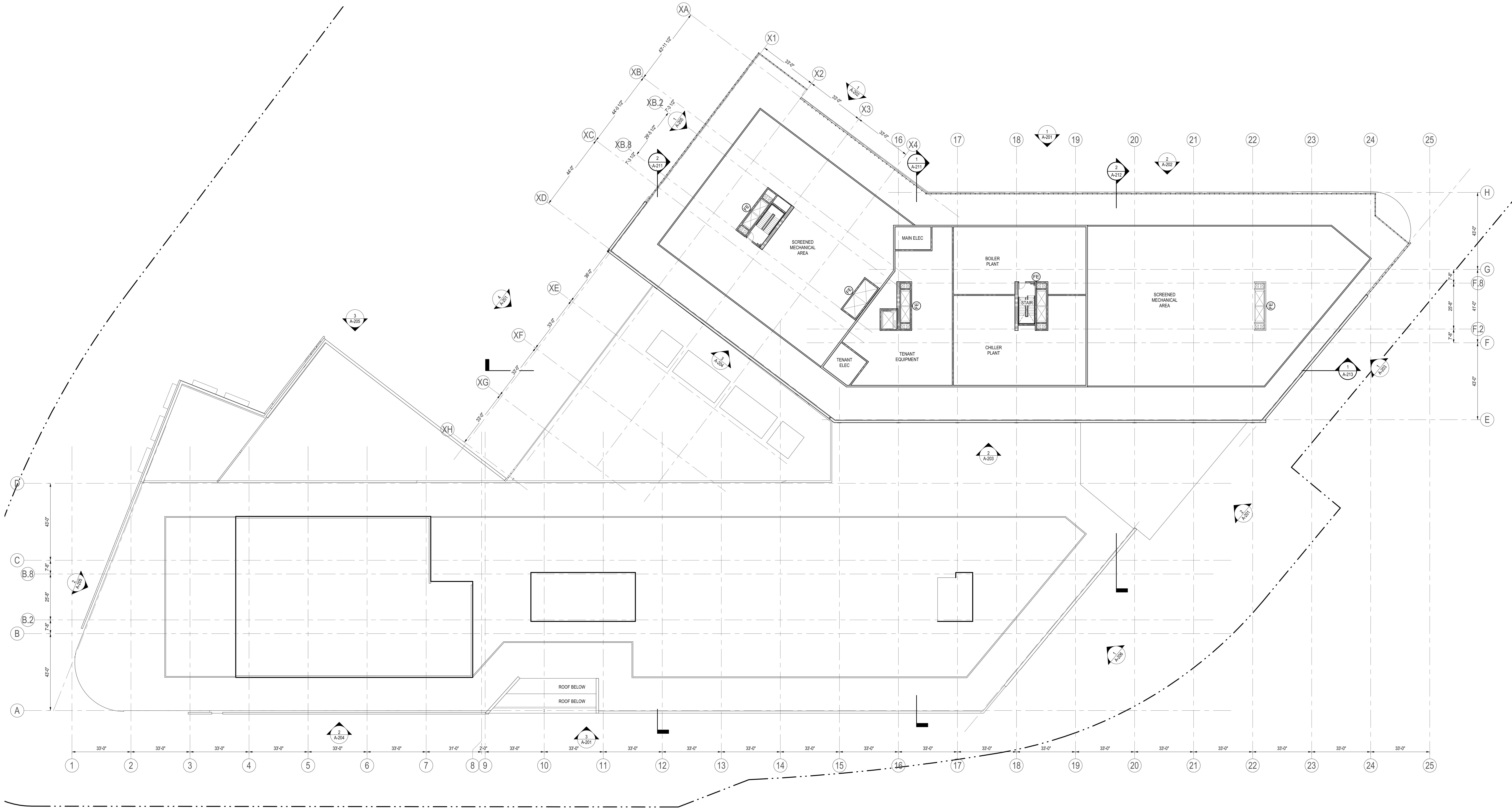
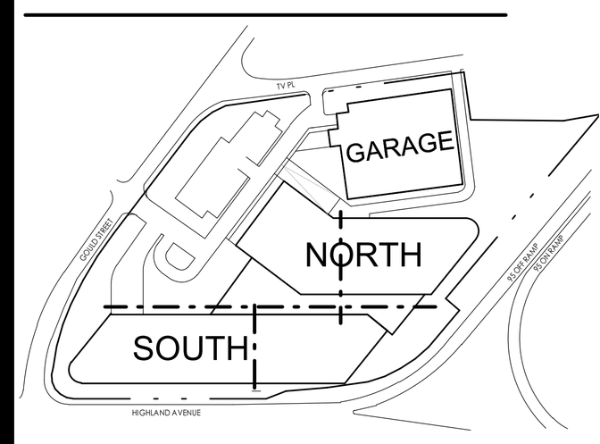
Title
LEVEL 5 - OVERALL PLAN

Revision:

Drawing No.
A-105



1 A-106 **PENTHOUSE - NORTH**
1" = 20'-0"



KEY PLAN

LEGEND

WF	WHEELED FIRE EXTINGUISHER
FE	FIRE EXTINGUISHER BRACKET WALL MTD
FEC	FIRE EXTINGUISHER CABINET WALL MTD

75'-0" MAX. DISTANCE PER CODE, TYP.

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Bulfinch
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NEEDHAM, MA 02494

Project No.:218421343
File Name: N/A
Scale: As indicated

Author	Designer	Checker	2022.03.30
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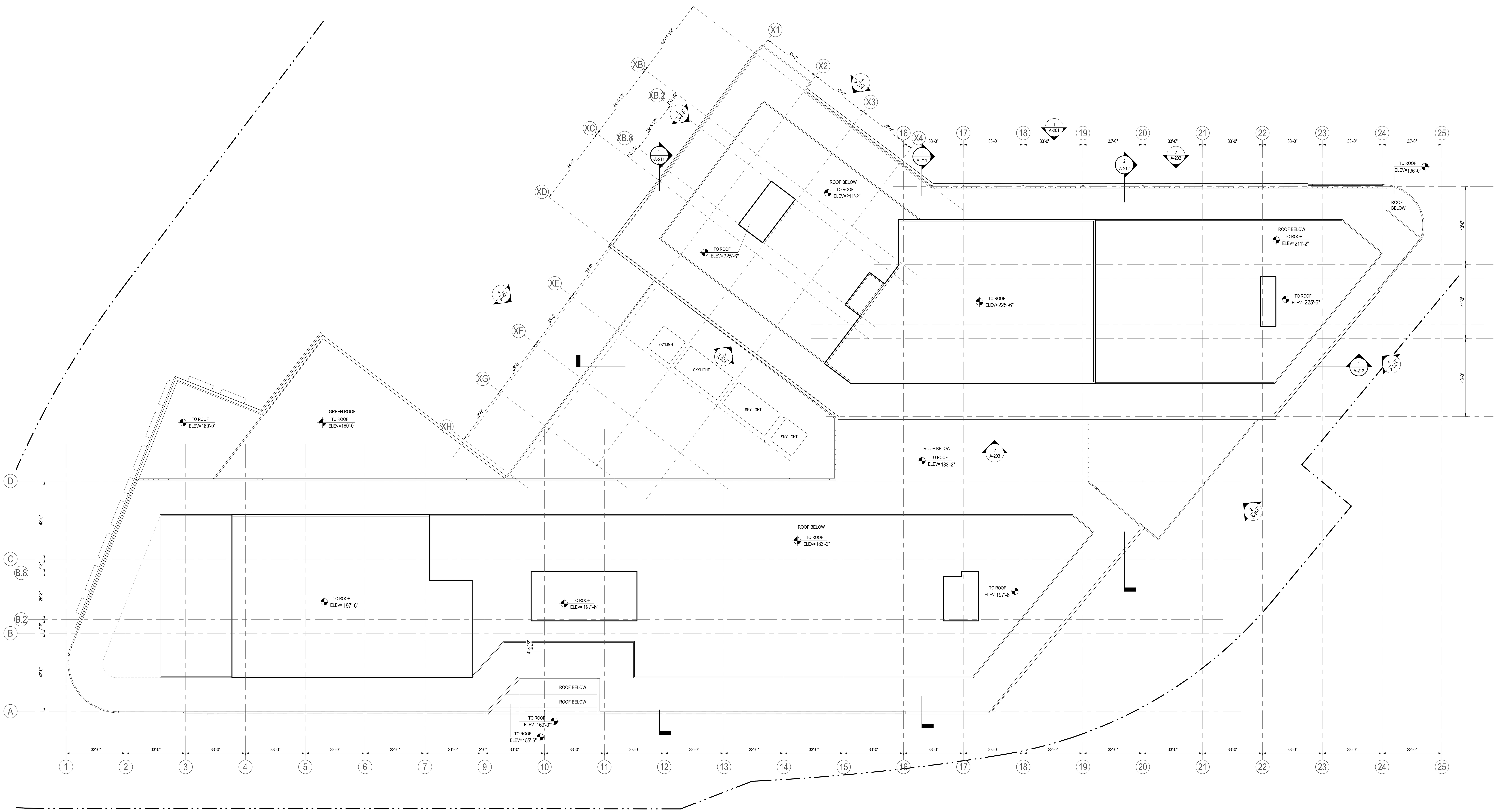
Title
LEVEL 6 - OVERALL PLAN

Revision:
Drawing No.
A-106



1
A-107
ROOF PLAN
1" = 20'-0"

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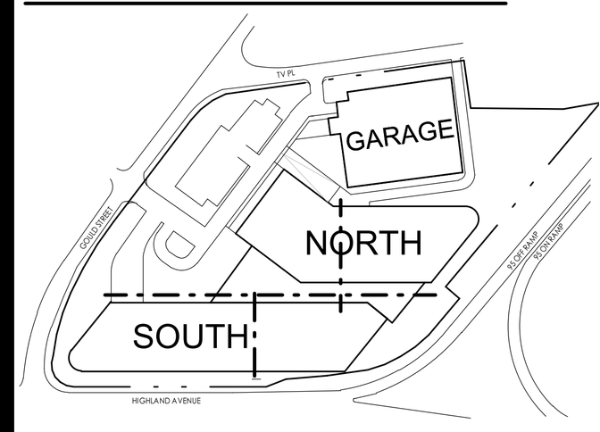
REGISTERED ARCHITECT BARTON D NELSON No. 951652 BOSTON, MA COMMONWEALTH OF MASSACHUSETTS



KEY PLAN

LEGEND

- WF — WHEELED FIRE EXTINGUISHER
- FE — FIRE EXTINGUISHER BRACKET WALL MTD
- FEC — FIRE EXTINGUISHER CABINET WALL MTD

75'-0" MAX. DISTANCE PER CODE, TYP.

Client/Project
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Project No.:218421343
File Name: N/A
Scale: As indicated

Author	Designer	Checker	2022.03.30
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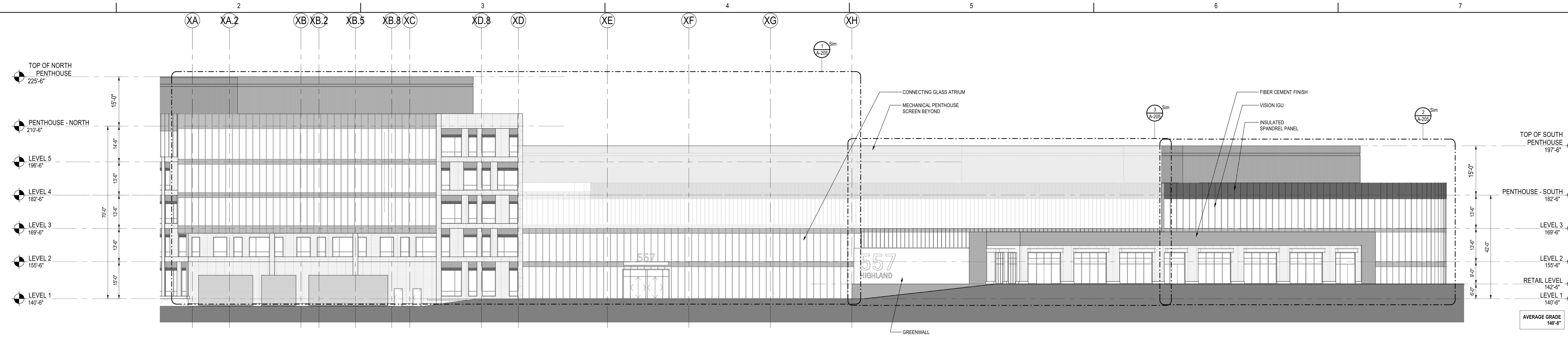
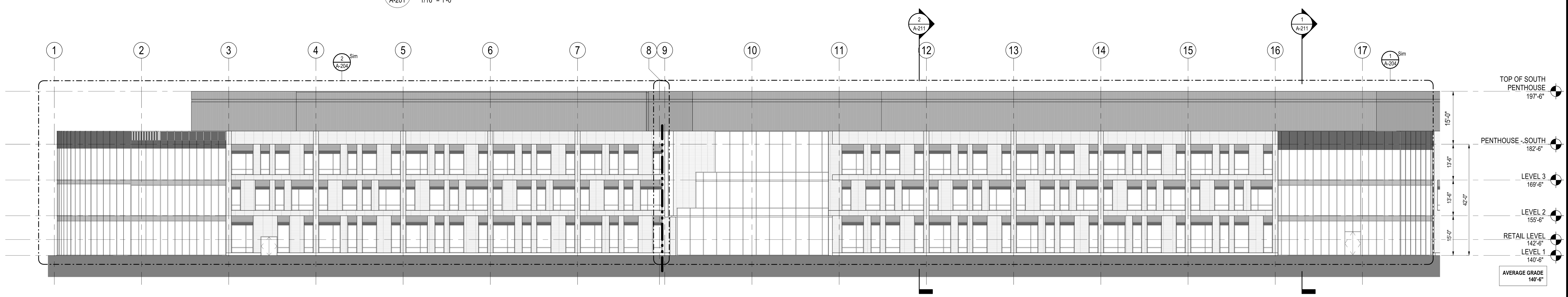
Title
ROOF PLAN

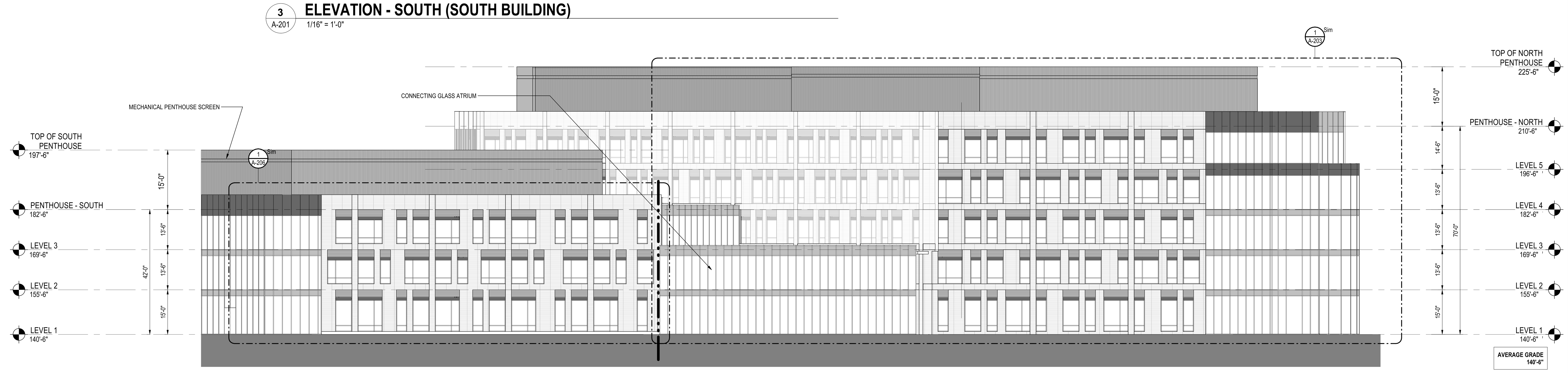
Revision:
Drawing No.
A-107



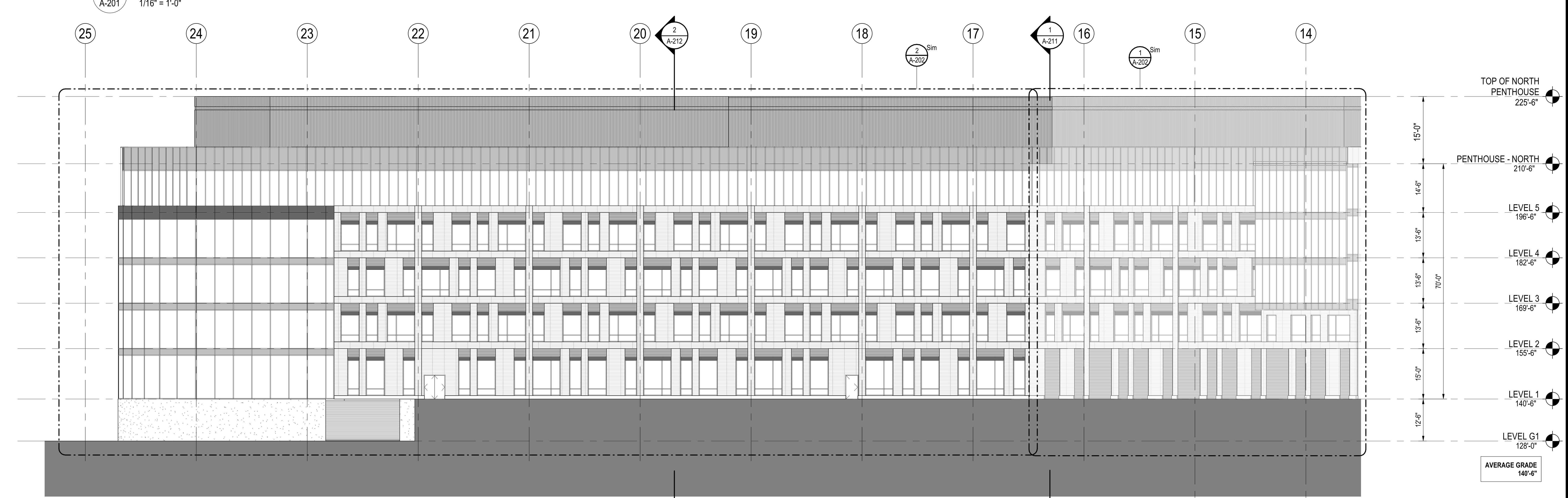
4 A-201 **ELEVATION - WEST**
1/16" = 1'-0"



3 A-201 **ELEVATION - SOUTH (SOUTH BUILDING)**
1/16" = 1'-0"



2 A-201 **ELEVATION - EAST**
1/16" = 1'-0"



1 A-201 **ELEVATION - NORTH (NORTH BUILDING)**
1/16" = 1'-0"

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The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing - any errors or omissions shall be reported to Stantec without delay.

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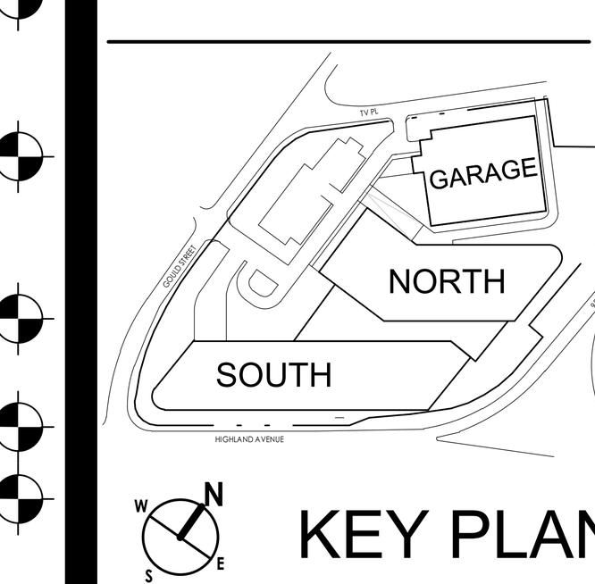
Issued/Revision	By	Appd	YYYY.MM.DD
SPECIAL PERMIT PACKAGE			2022.03.30

Permit/Seal

REGISTERED ARCHITECT BARTON D NELSON No. 951652 BOSTON, MA COMMONWEALTH OF MASSACHUSETTS



KEY PLAN

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

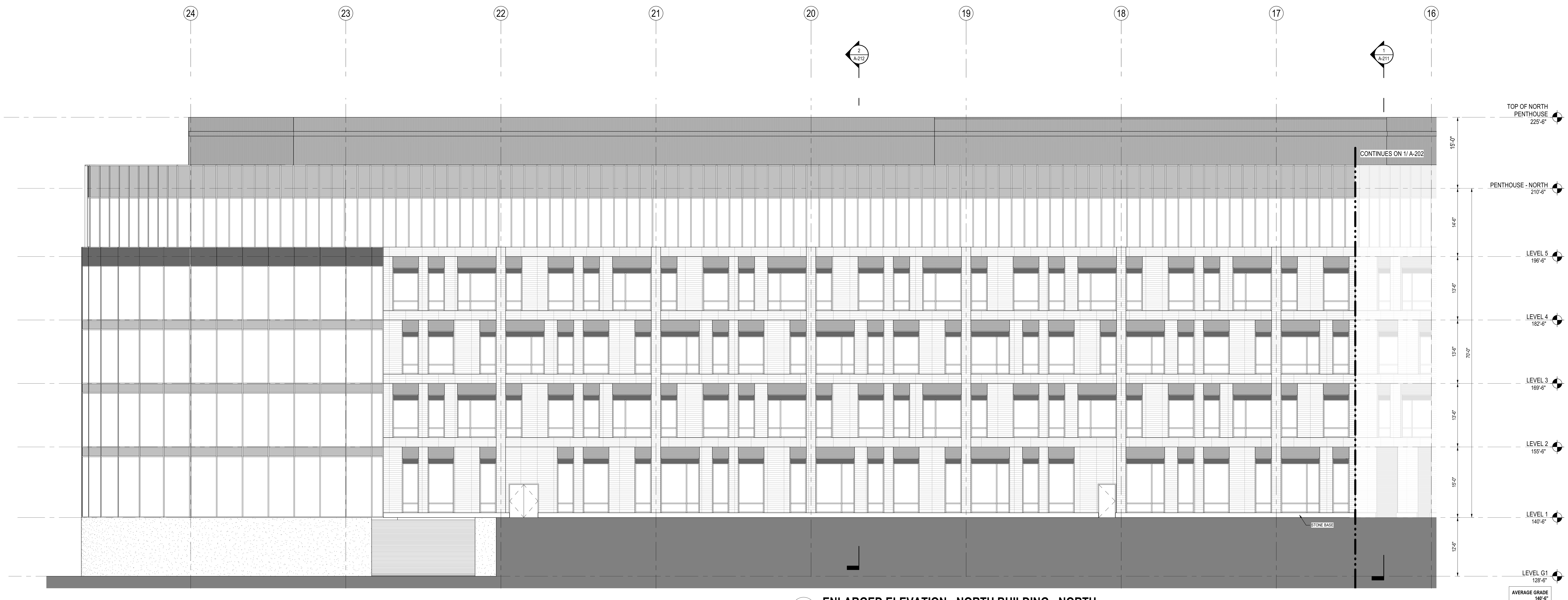
Project No.:218421343
File Name: N/A
Scale: 1/16" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
BUILDING ELEV - LOCATOR ELEVATIONS

Revision:

Drawing No.
A-201



2 A-202 **ENLARGED ELEVATION - NORTH BUILDING - NORTH**
1/8" = 1'-0"

1 A-202 **ENLARGED ELEVATION - NORTH BUILDING - NORTH (ANGLED WALL)**
1/8" = 1'-0"

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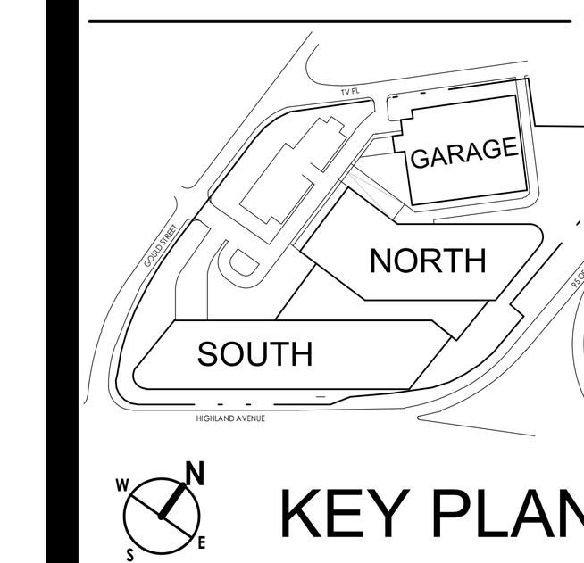
Issued/Revision	By	Appd	YYYY.MM.DD
SPECIAL PERMIT PACKAGE			2022.03.30

Permit/Seal

REGISTERED ARCHITECT BARTON D NELSON No. 951652 BOSTON, MA COMMONWEALTH OF MASSACHUSETTS



KEY PLAN

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

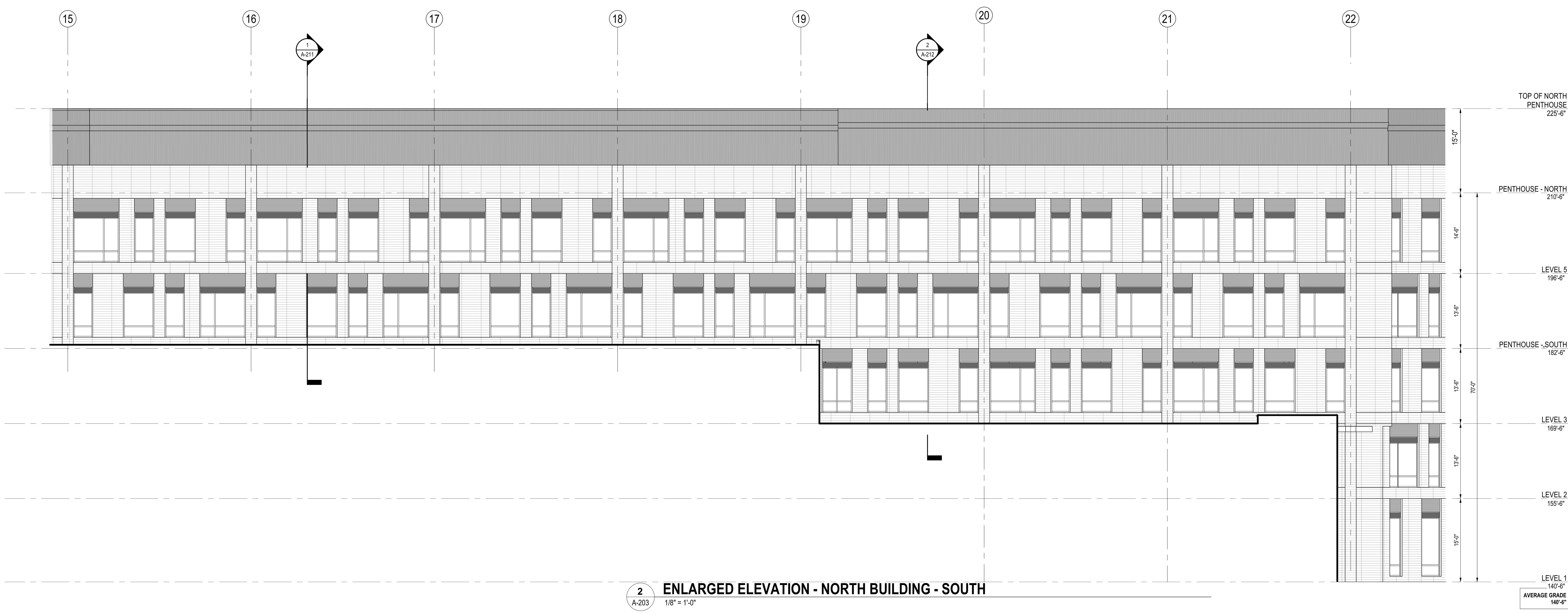
Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
BUILDING ELEV - NORTH BLDG - NORTH

Revision:

Drawing No.
A-202



2 A-203 ENLARGED ELEVATION - NORTH BUILDING - SOUTH
1/8" = 1'-0"

1 A-203 ENLARGED ELEVATION - NORTH BUILDING & ATRIUM - EAST
1/8" = 1'-0"

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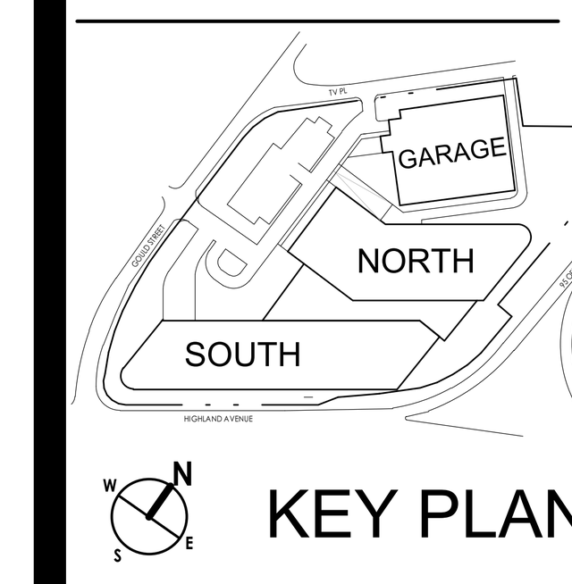


KEY PLAN

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

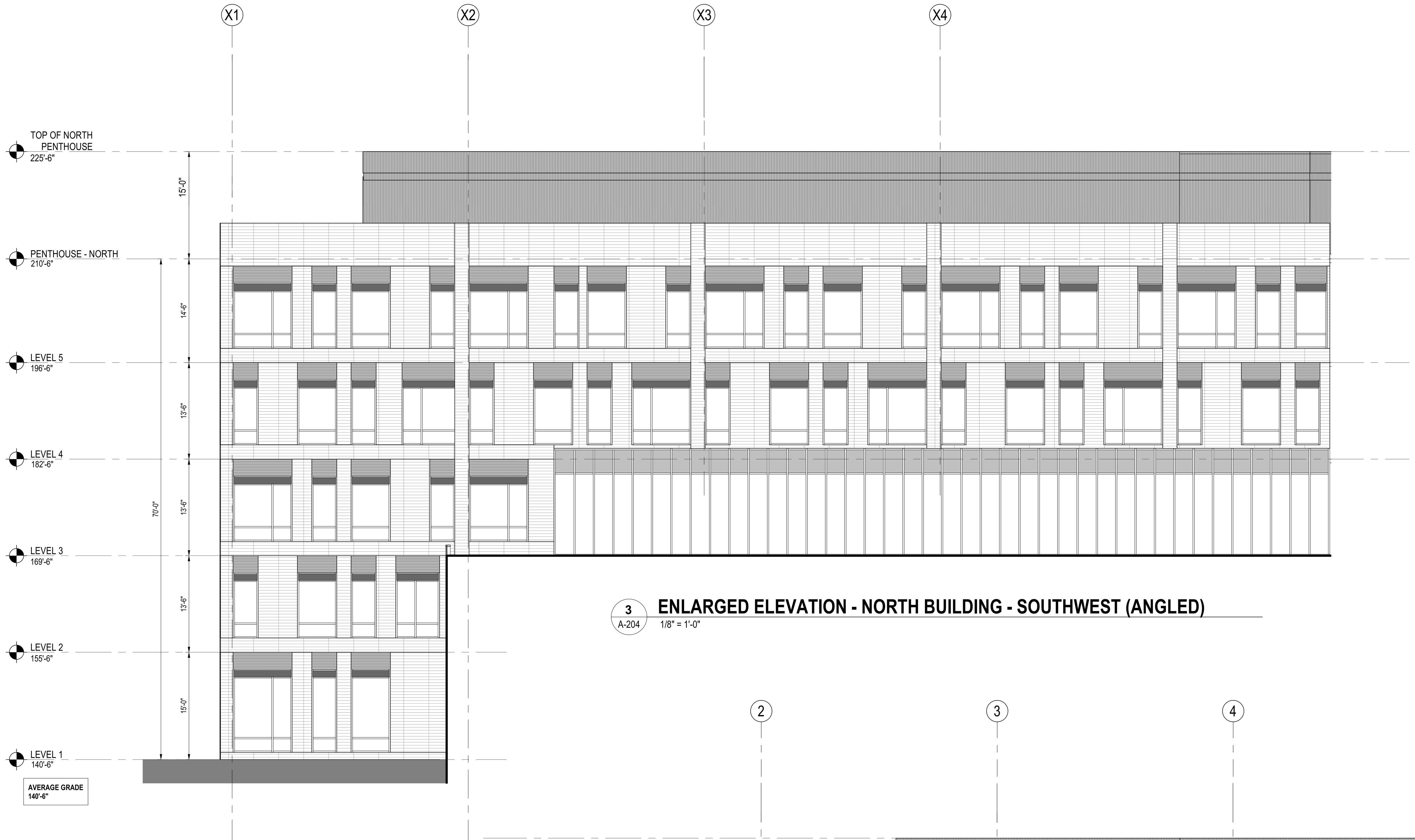
Project No.: 218421343

Scale: 1/8" = 1'-0"

Title
BUILDING ELEV - NORTH BLDG - SOUTH & EAST

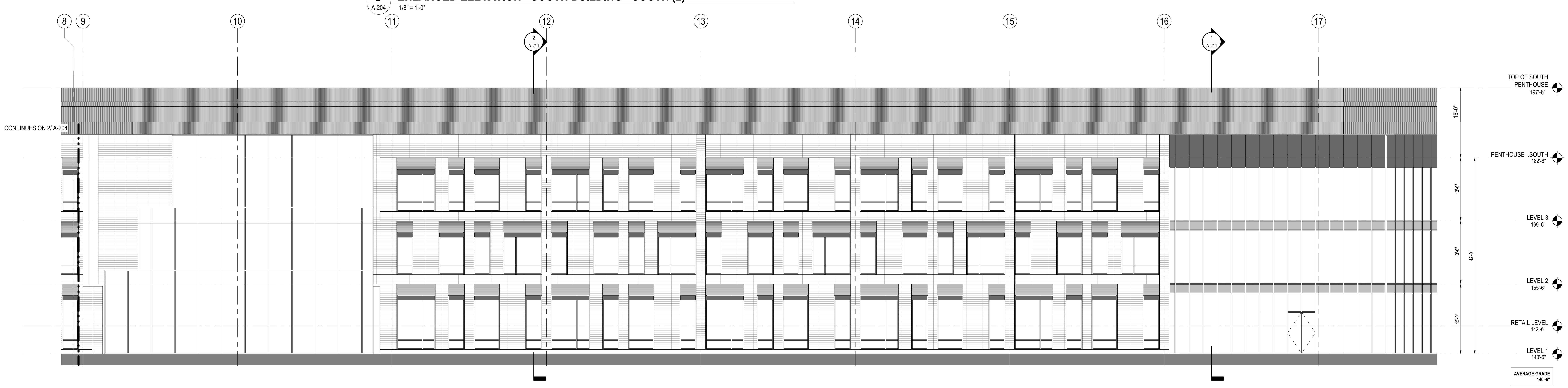
Revision:

Drawing No.
A-203



3 A-204 **ENLARGED ELEVATION - NORTH BUILDING - SOUTHWEST (ANGLED)**
1/8" = 1'-0"

2 A-204 **ENLARGED ELEVATION - SOUTH BUILDING - SOUTH (2)**
1/8" = 1'-0"



1 A-204 **ENLARGED ELEVATION - SOUTH BUILDING - SOUTH (1)**
1/8" = 1'-0"

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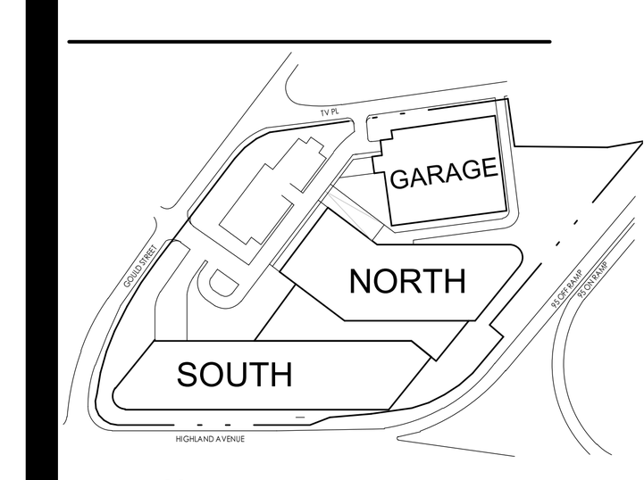
Permit/Seal

REGISTERED ARCHITECT
BARTON D NELSON
No. 951652
BOSTON, MA
COMMONWEALTH OF MASSACHUSETTS



KEY PLAN

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

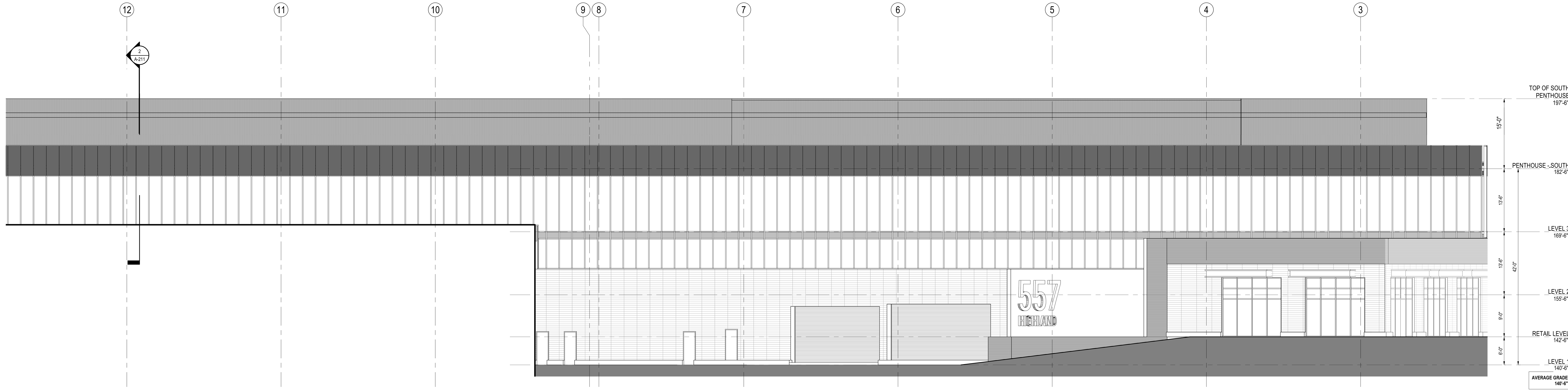
Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

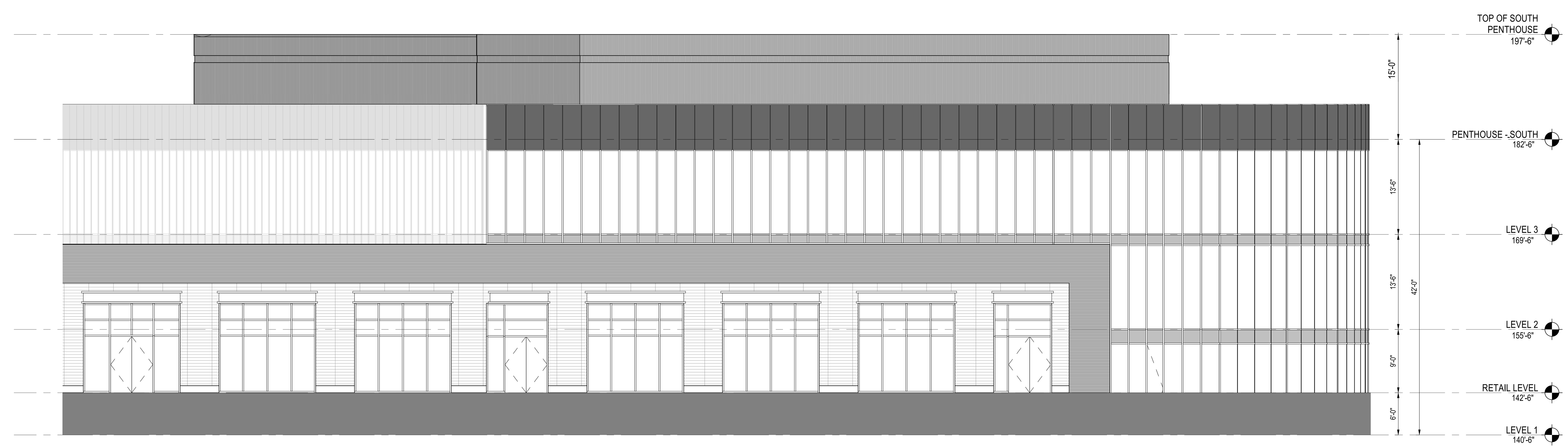
Title
BUILDING ELEV - NORTH BLDG (SOUTHWEST) & SOUTH BLDG (SOUTH)

Revision:

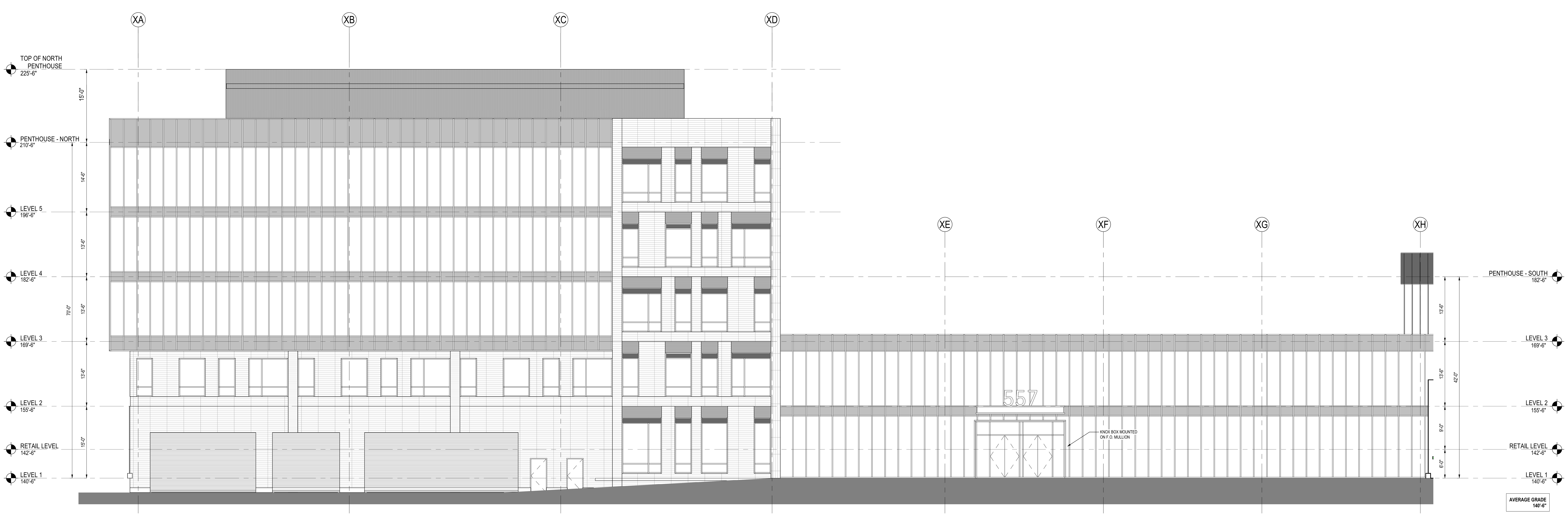
Drawing No.
A-204



3 A-205 **ENLARGED ELEVATION - SOUTH BUILDING - NORTH (1)**
1/8" = 1'-0"



2 A-205 **ENLARGED ELEVATION - SOUTH BUILDING - WEST**
1/8" = 1'-0"



1 A-205 **ENLARGED ELEVATION - NORTH BUILDING - WEST**
1/8" = 1'-0"

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Issued/Revision	By	Appd	YYYY.MM.DD
SPECIAL PERMIT PACKAGE			2022.03.30

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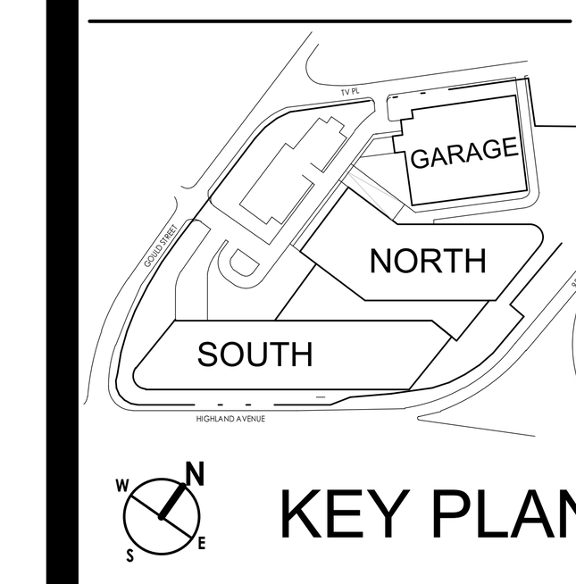
REGISTERED ARCHITECT BARTON D NELSON No. 951652 BOSTON, MA COMMONWEALTH OF MASSACHUSETTS



KEY PLAN

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

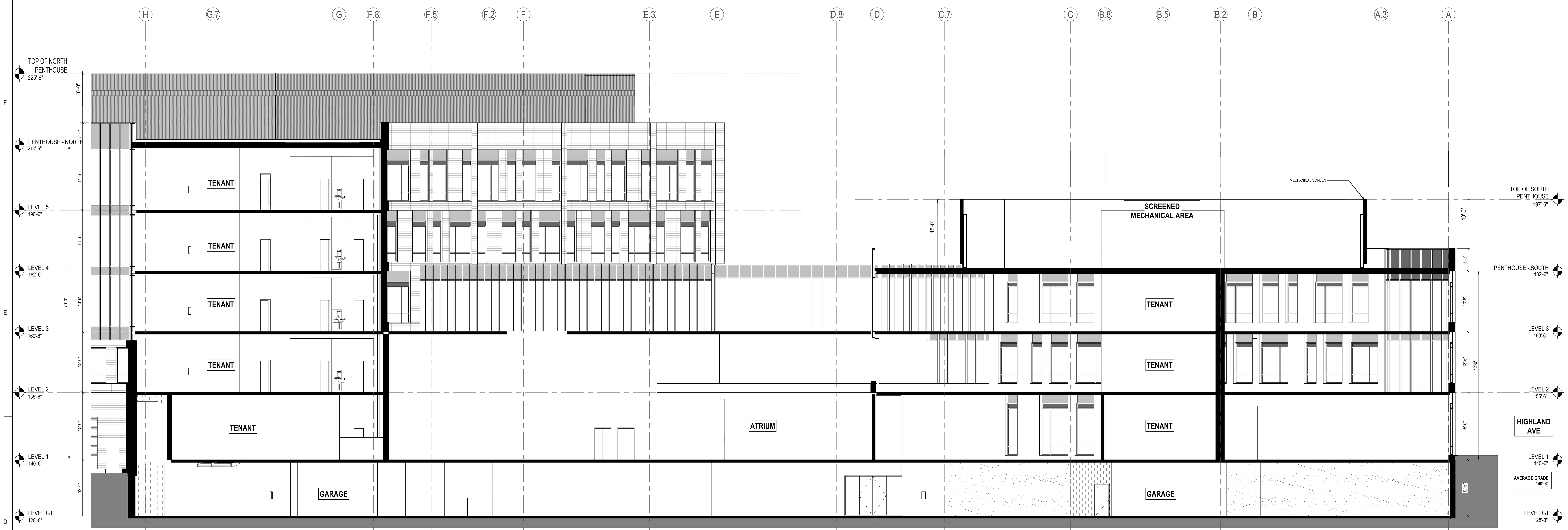
Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
BUILDING ELEV - NORTH BLDG (WEST) & SOUTH BLDG (NORTH & WEST)

Revision:

Drawing No.
A-205



2 A-211 SECTION - N-S NEAR GRID 12
1/8" = 1'-0"

1 A-211 SECTION - N-S NEAR GRID 16
1/8" = 1'-0"

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Issued/Revision	By	Appd	YYYY.MM.DD
SPECIAL PERMIT PACKAGE			2022.03.30

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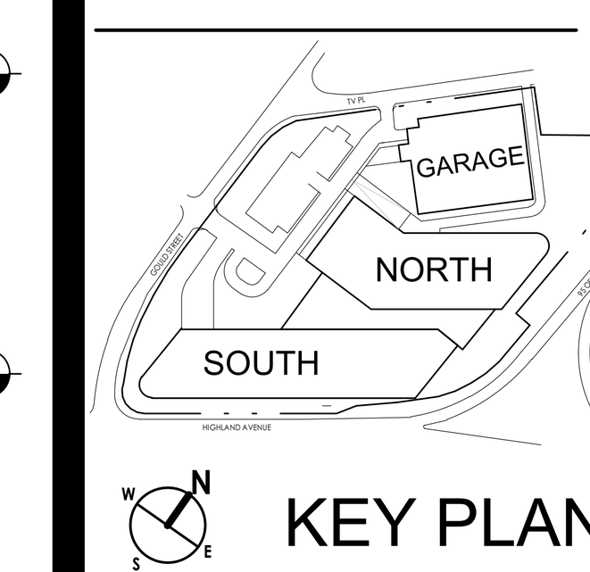
REGISTERED ARCHITECT BARTON D NELSON No. 951652 BOSTON, MA COMMONWEALTH OF MASSACHUSETTS



KEY PLAN

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
BUILDING SECTIONS - OVERALL

Revision:

Drawing No.
A-211

2 SECTION - NORTH BUILDING - SECTION N-S

2 / A-212 — 1/8" = 1'-0"

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KEY PLAN

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

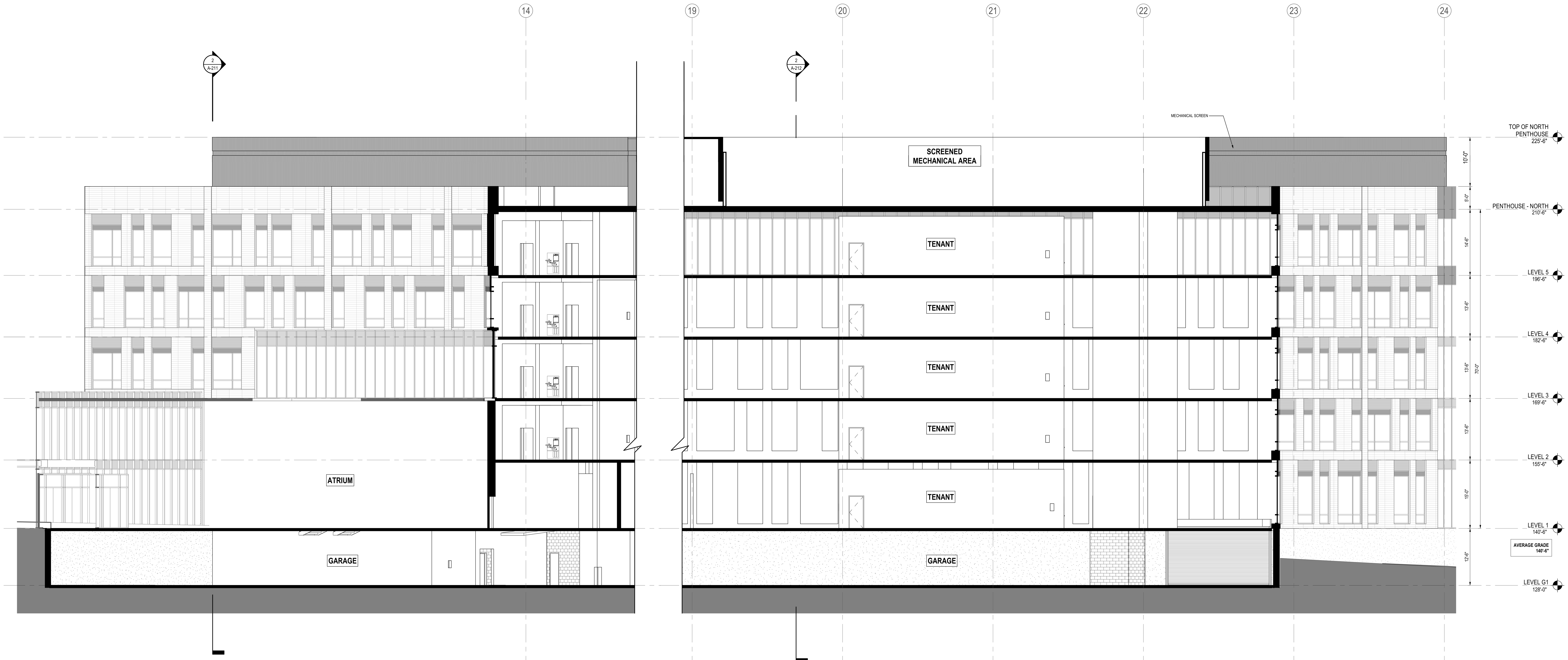
Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
BUILDING SECTIONS - NORTH BLDG

Revision:

Drawing No.
A-212



1
A-213
SECTION - NORTH BUILDING - SECTION E-W
1/8" = 1'-0"

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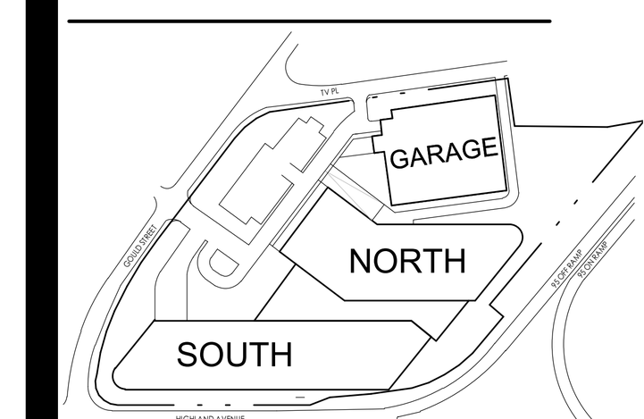


KEY PLAN

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

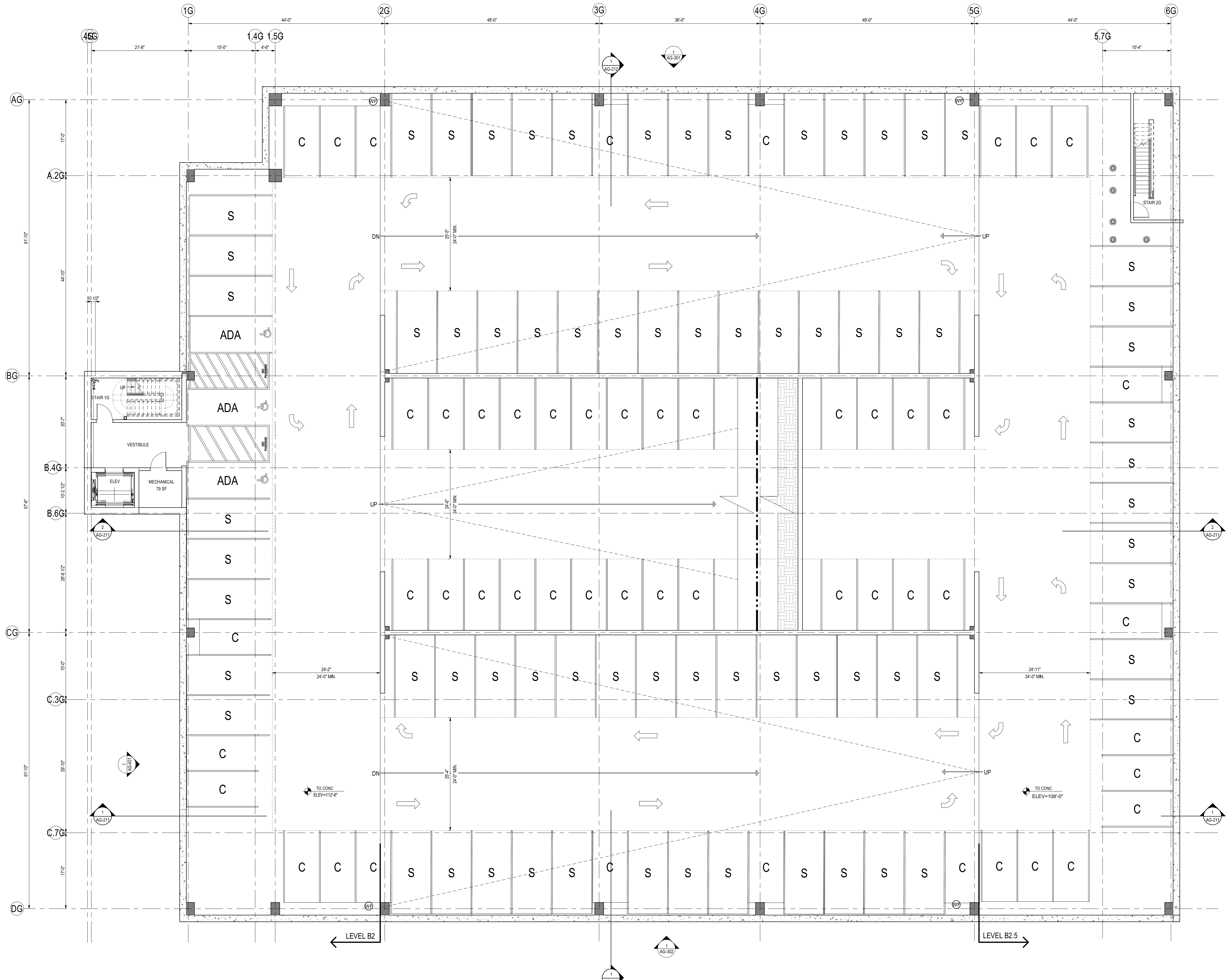
Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

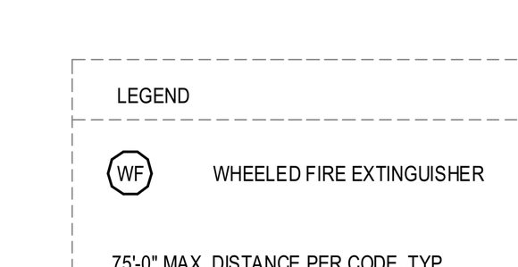
Title
BUILDING SECTIONS - NORTH BLDG

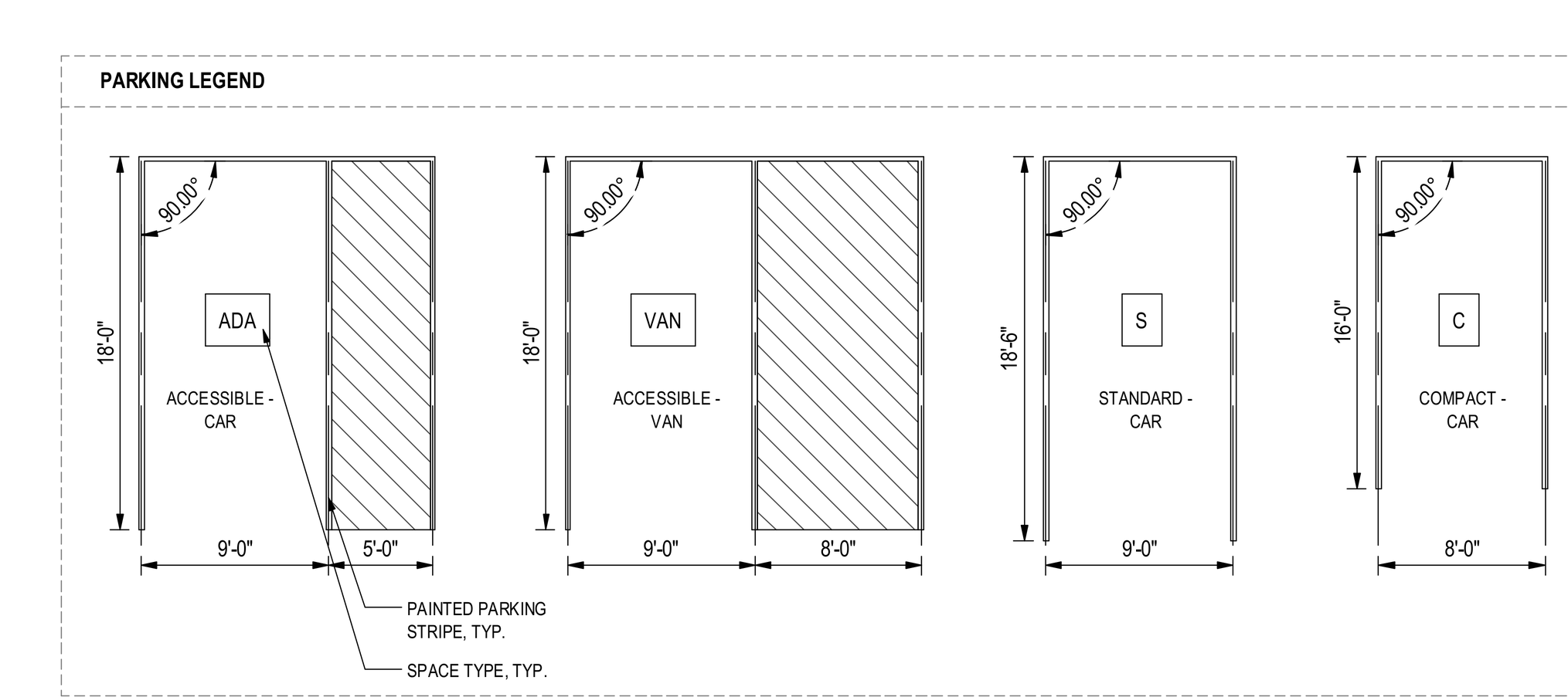
Revision:

Drawing No.
A-213



1 GARAGE - LEVEL B2
AG-100.B2 1/8" = 1'-0"





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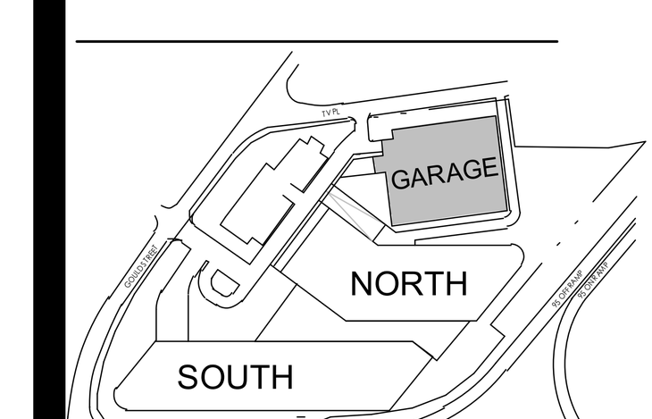
	Issued/Revision	By	Appd	YYYY.MM.DD
2	SPECIAL PERMIT PACKAGE			2022.03.30
1	CONCEPT DEVELOPMENT			2021.11.19

Permit/Seal



KEY PLAN

GARAGE PARKING COUNT	
PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	55
STANDARD	71
	129
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	58
STANDARD	64
	126
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	38
STANDARD	71
	111
TOTAL: 1021	1021

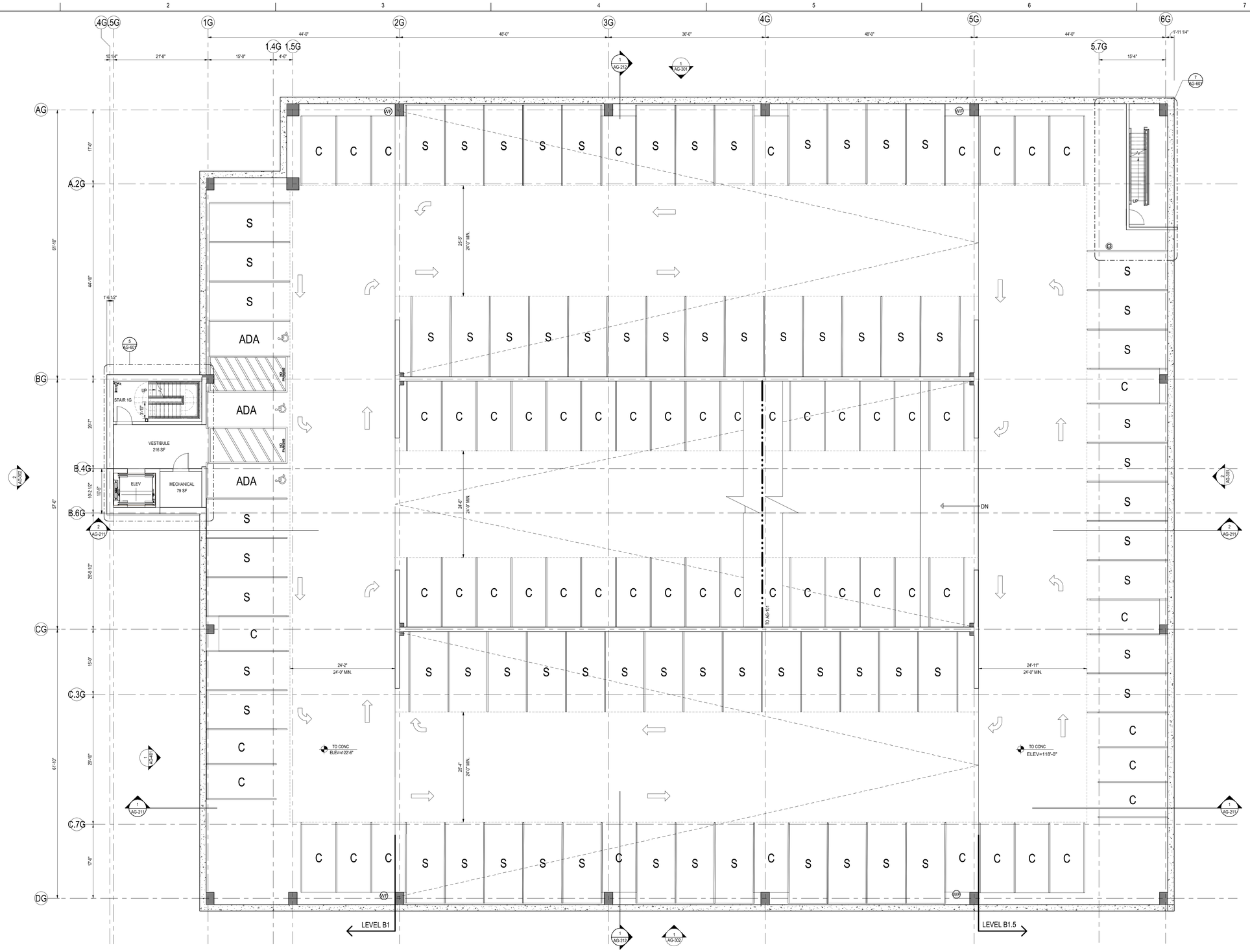
Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE LEVEL B2

Revision:2
Drawing No.
AG-100.B2
GARAGE



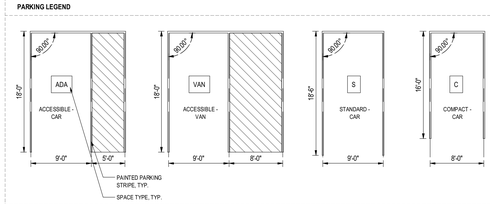
1 GARAGE - LEVEL B1
AG-100.B1 1/8" = 1'-0"

LEGEND

WP WHEELED FIRE EXTINGUISHER

75'-0" MAX. DISTANCE PER CODE, TYP.

PARKING LEGEND



GARAGE PARKING COUNT

PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	55
STANDARD	71
	129
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	58
STANDARD	64
	126
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	38
STANDARD	71
	111
TOTAL: 1021	1021

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No.	Issued/Revision	By	Appd	YYYY.MM.DD
1	PERMIT RESUBMISSION			2022.03.30
0	CONCEPT DESIGN			2021.11.12

Permit/Seal

KEY PLAN

Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

Project No.:218421343
File Name: N/A

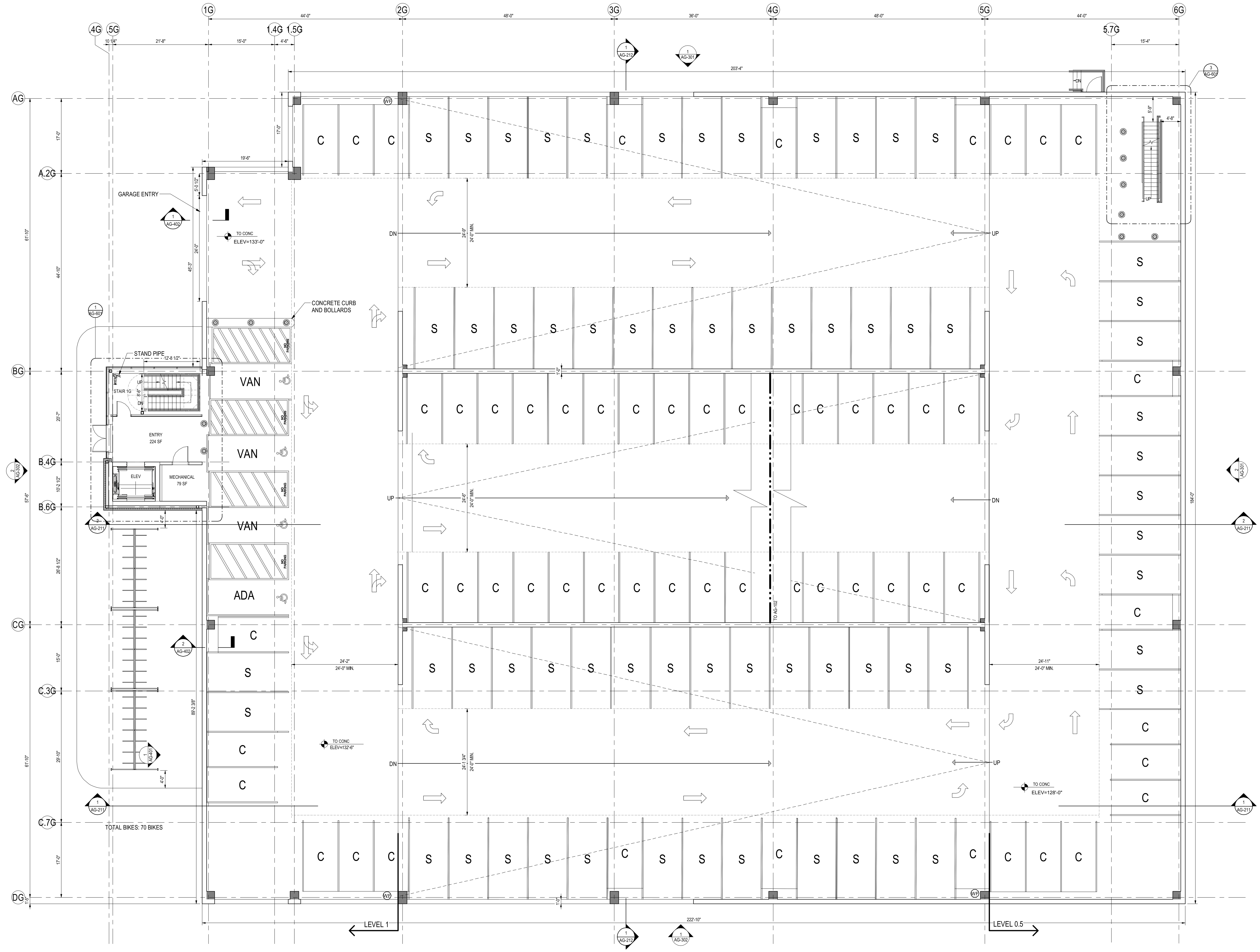
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE LEVEL B1

Revision:2

Drawing No.
AG-100.B1
GARAGE



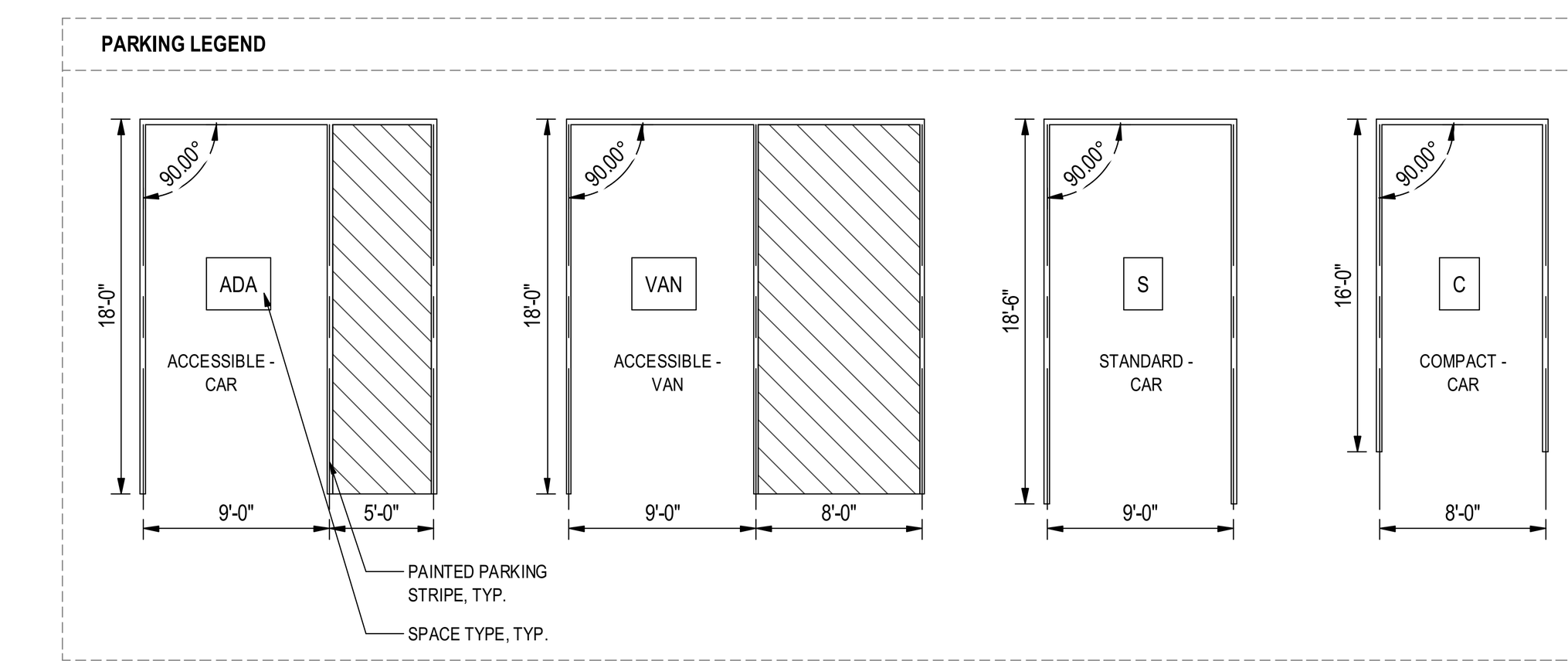
1 AG-101 **GARAGE - LEVEL 1-**

1/8" = 1'-0"

LEGEND

WHEELED FIRE EXTINGUISHER

75'-0" MAX. DISTANCE PER CODE, TYP.



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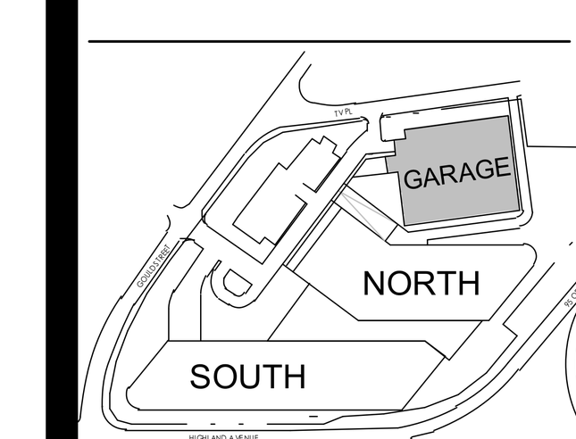
Issued/Revision	By	Appd	YYYY.MM.DD
2 SPECIAL PERMIT PACKAGE			2022.03.30
1 CONCEPT DEVELOPMENT			2021.11.19

Permit/Seal

REGISTERED ARCHITECT BARTON D NELSON No. 951652 BOSTON, MA COMMONWEALTH OF MASSACHUSETTS



KEY PLAN

GARAGE PARKING COUNT	
PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	55
STANDARD	71
	129
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	58
STANDARD	64
	126
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	38
STANDARD	71
	111
TOTAL: 1021	1021

Client/Project

Bulfinch

557 Highland Ave

HIGHLAND GARAGE

Project No.:218421343

File Name: N/A

Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title

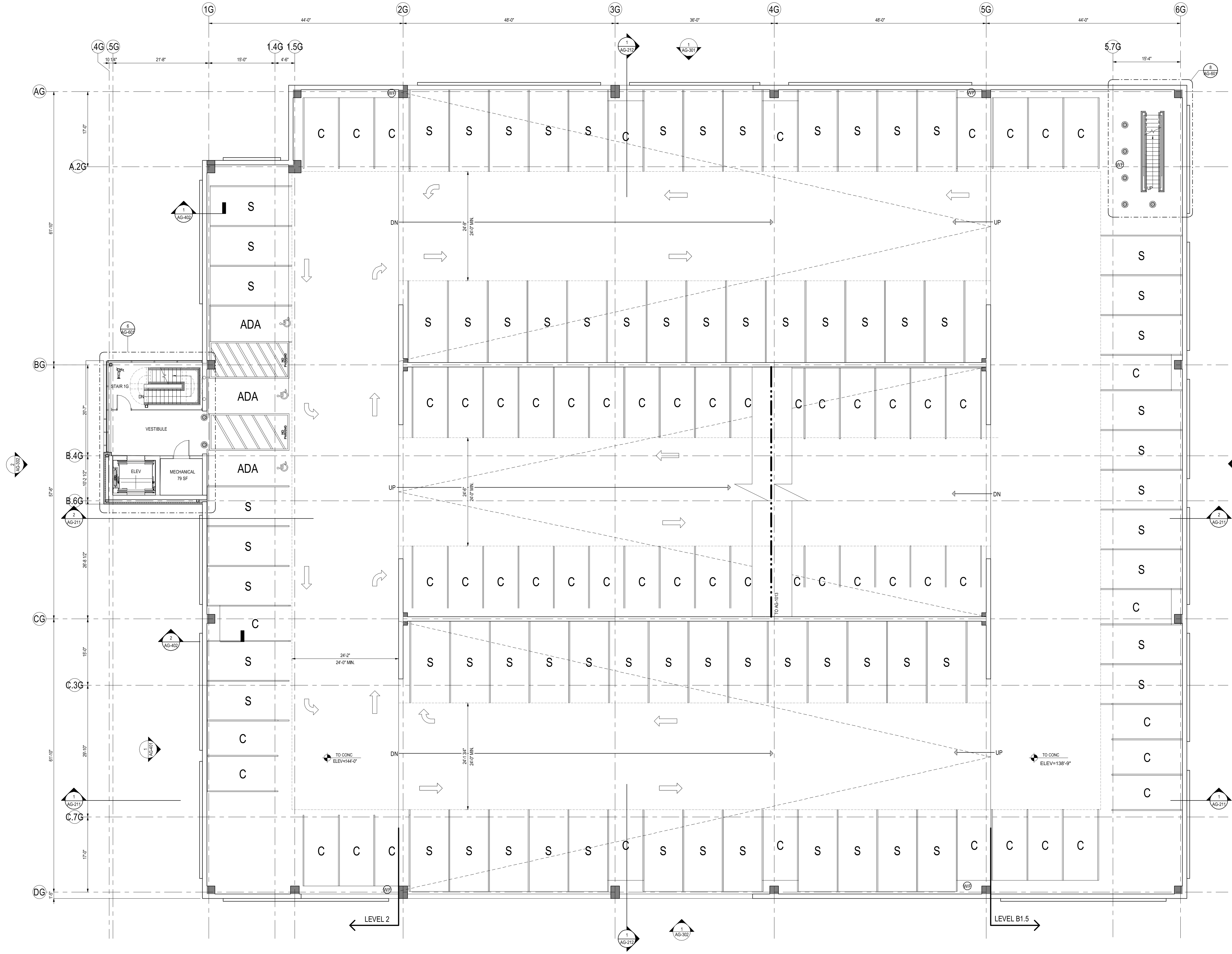
GARAGE LEVEL 1

Revision:2

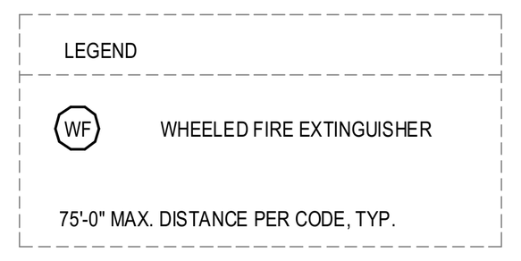
Drawing No.

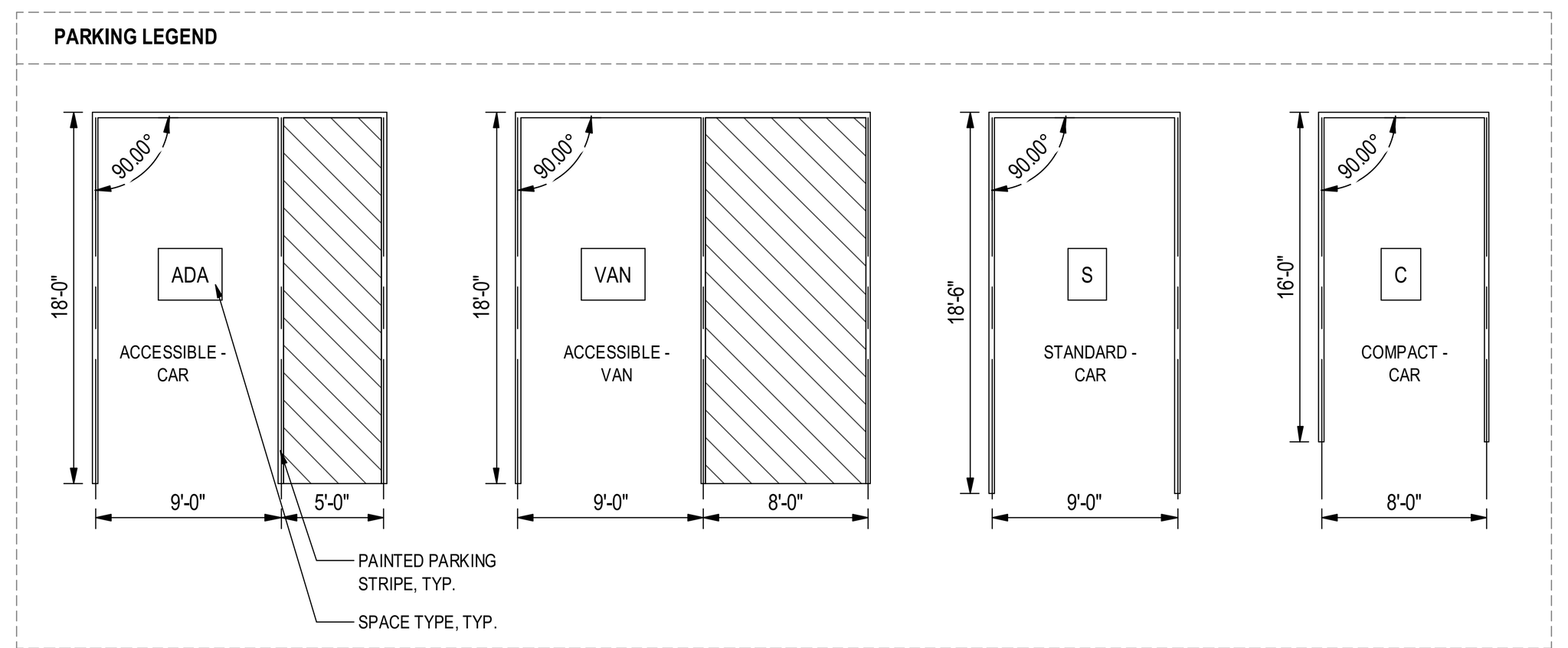
AG-101

GARAGE



1 AG-102 **GARAGE - LEVEL 2**
1/8" = 1'-0"





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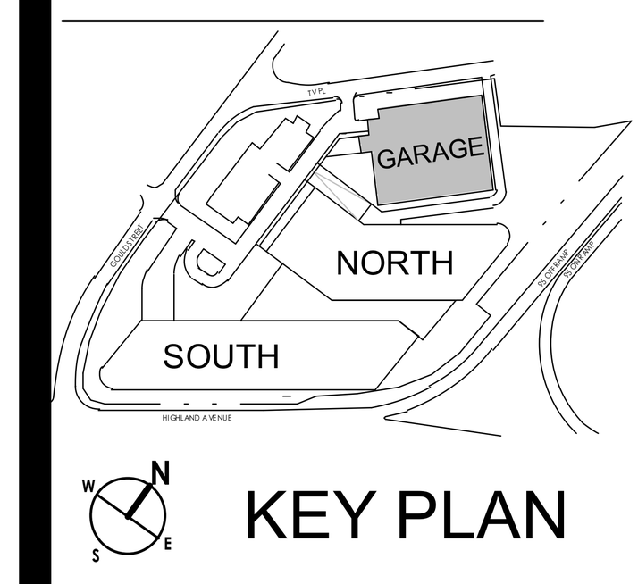


KEY PLAN

GARAGE PARKING COUNT	
PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	55
STANDARD	71
	129
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	58
STANDARD	64
	126
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	38
STANDARD	71
	111
TOTAL: 1021	1021

Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

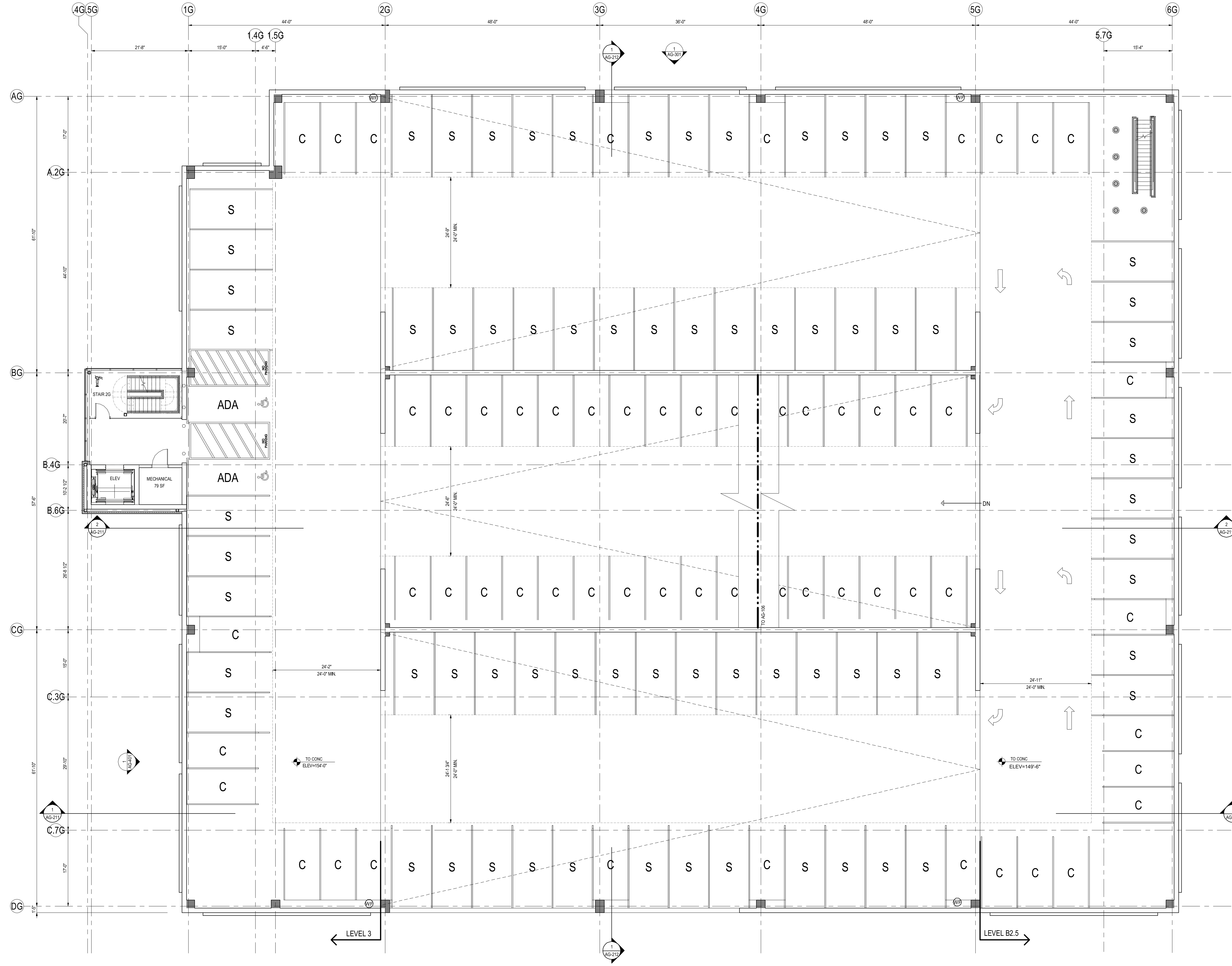
Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE LEVEL 2

Revision:2

Drawing No.
AG-102
GARAGE

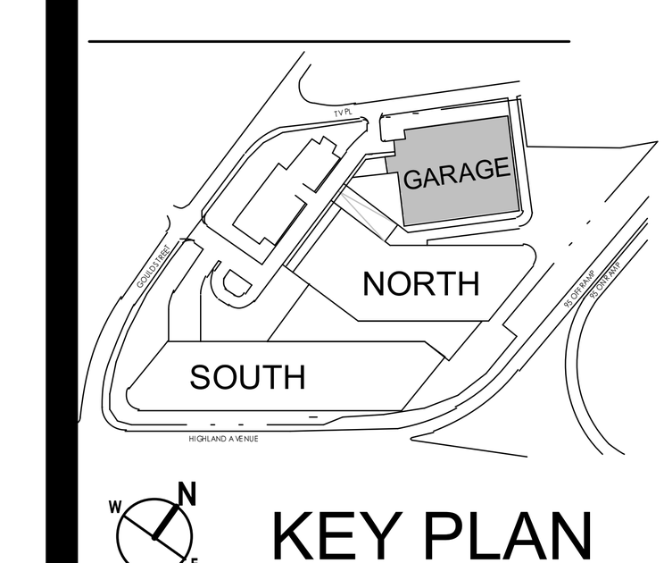


GARAGE - LEVEL 3

1
AG-103
1/8" = 1'-0"

Consultant

Permit/Seal



KEY PLAN

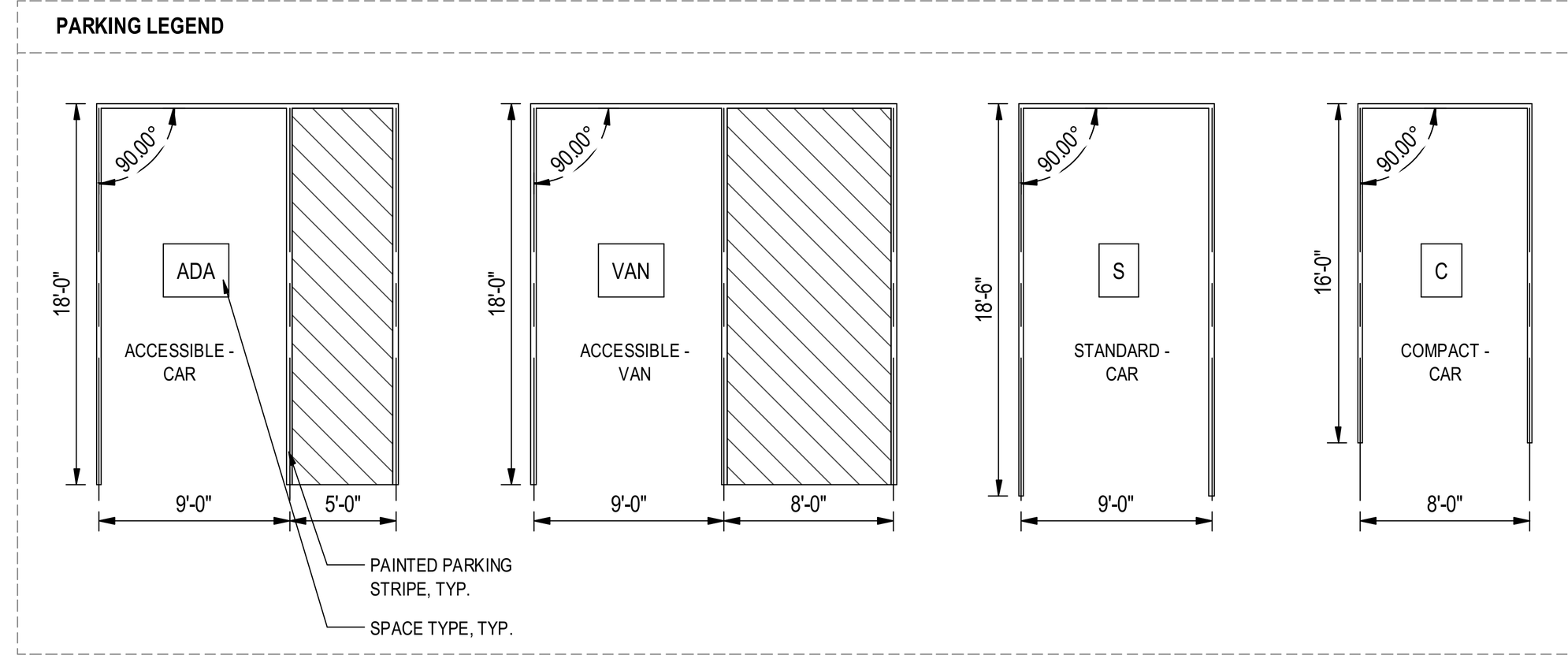
GARAGE PARKING COUNT	
PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	55
STANDARD	71
	129
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	58
STANDARD	64
	126
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	38
STANDARD	71
	111
TOTAL: 1021	1021

LEGEND

WF — WHEELED FIRE EXTINGUISHER

75'-0" MAX. DISTANCE PER CODE, TYP.

PARKING LEGEND



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Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

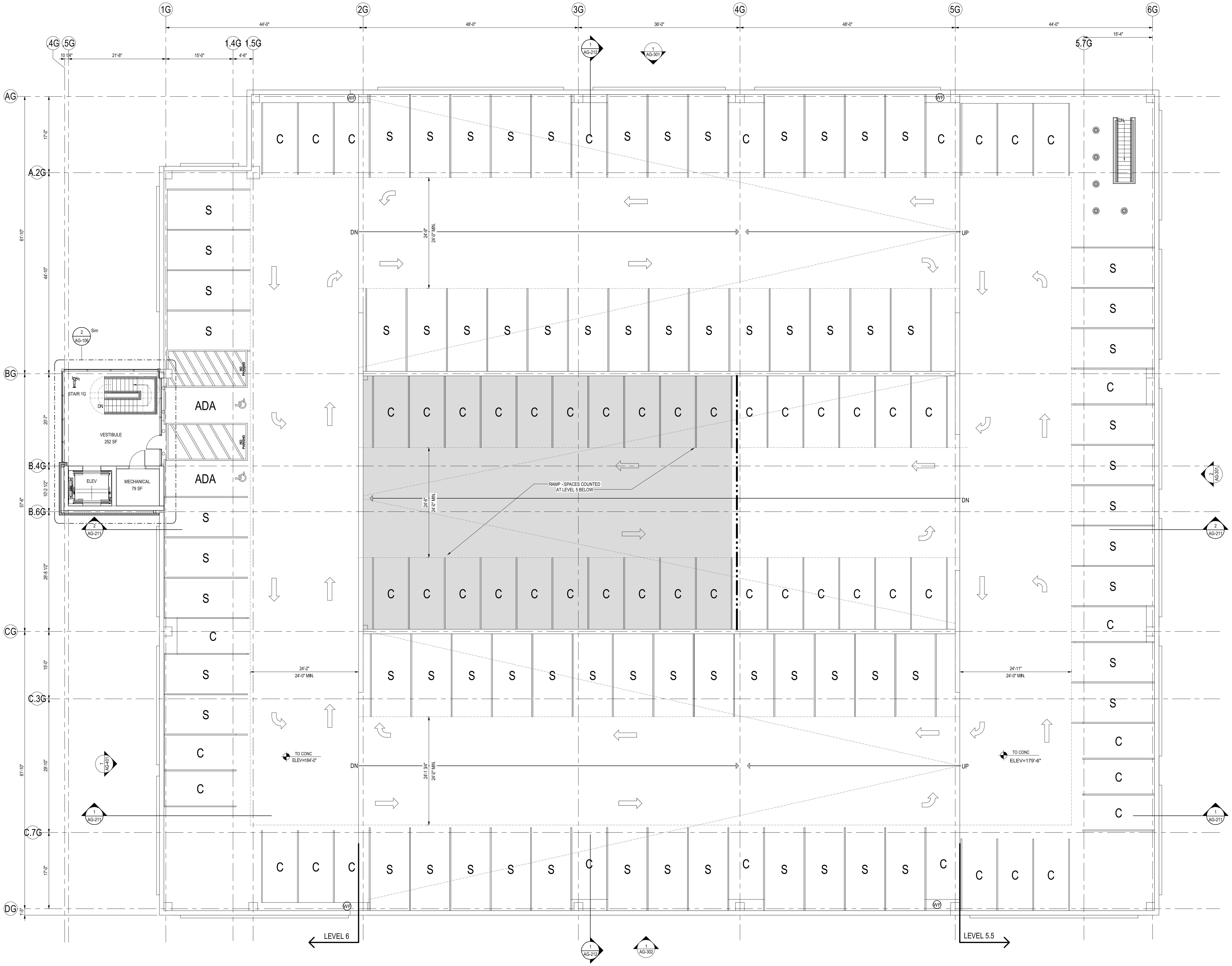
Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE LEVEL 3
(LEVEL 4-5 SIM.)

Revision: 1

Drawing No.
AG-103
GARAGE



GARAGE - LEVEL 6
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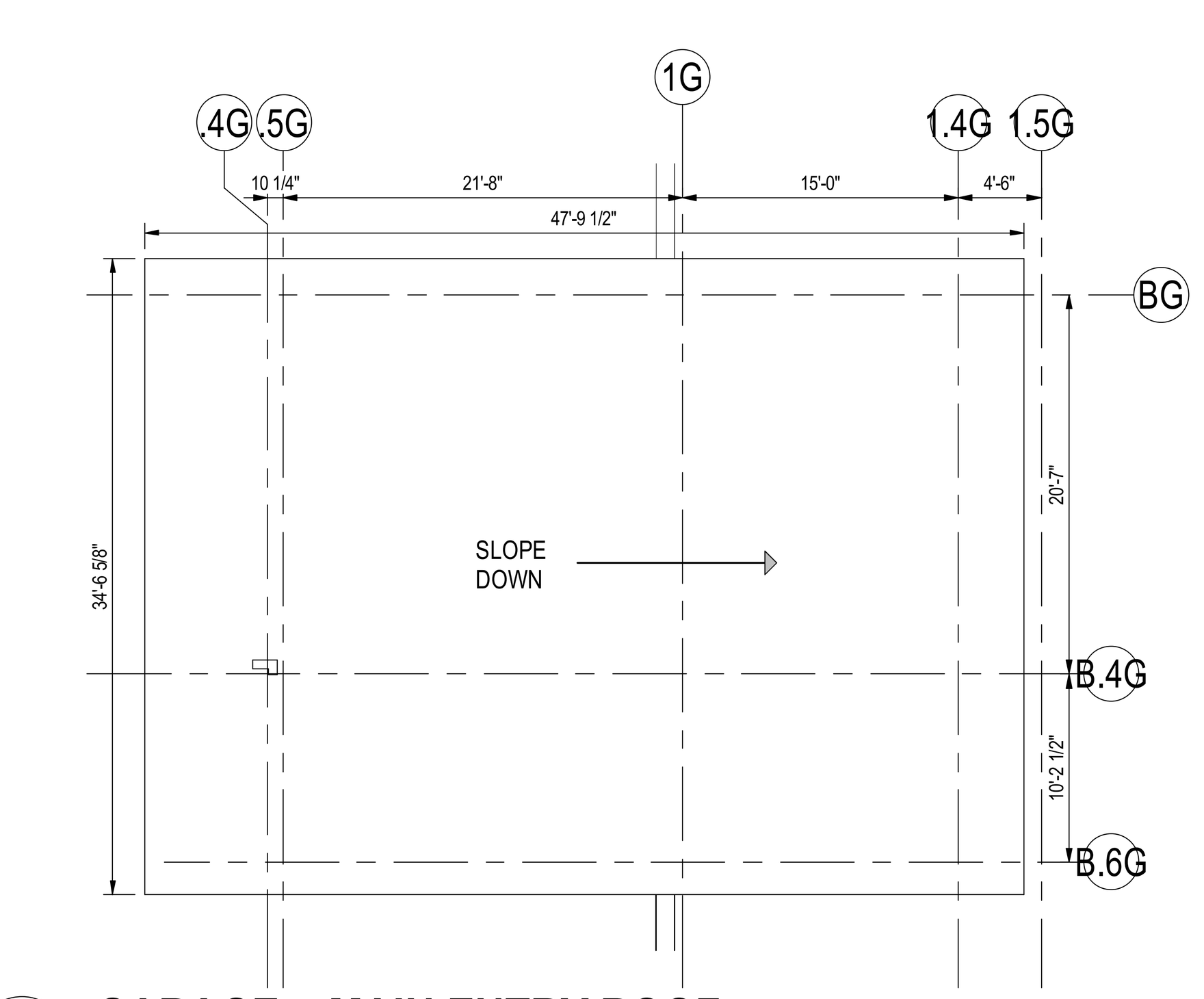

GARAGE - MAIN ENTRY ROOF
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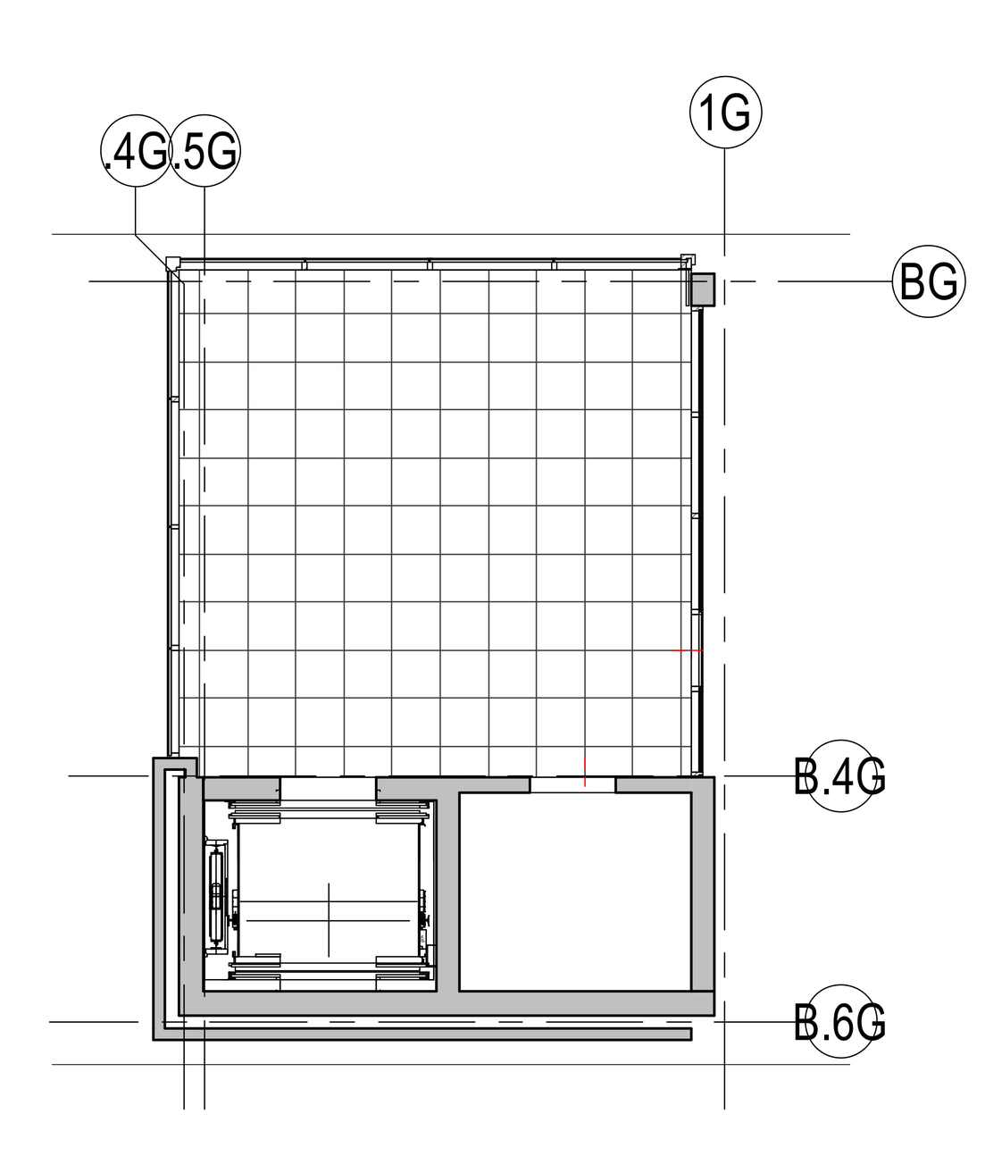
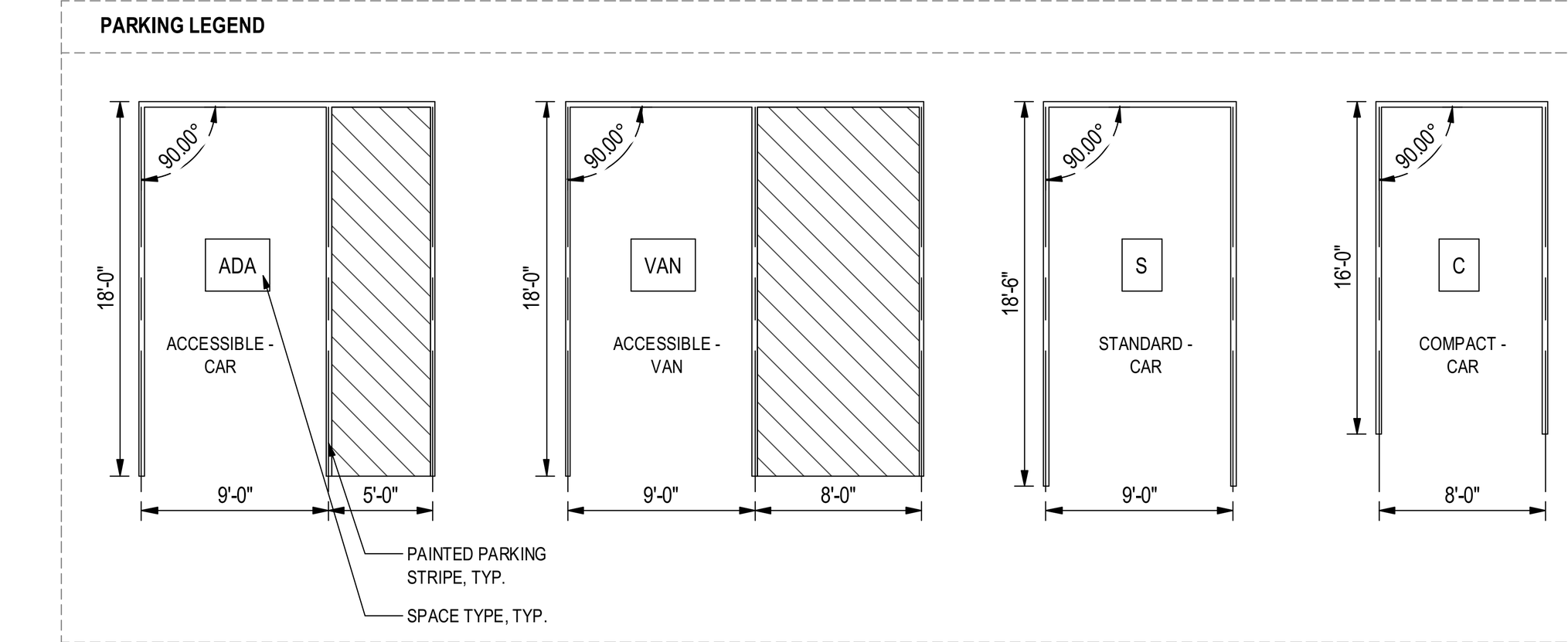


GARAGE - LEVEL 6 - RCP
1/8" = 1'-0"

LEGEND
WHEELED FIRE EXTINGUISHER
75'-0" MAX. DISTANCE PER CODE, TYP.

PARKING LEGEND



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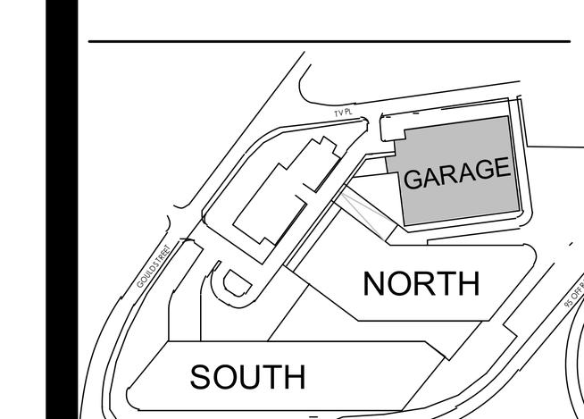


KEY PLAN

GARAGE PARKING COUNT	
PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	55
STANDARD	71
	129
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	58
STANDARD	64
	126
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	38
STANDARD	71
	111
TOTAL: 1021	1021

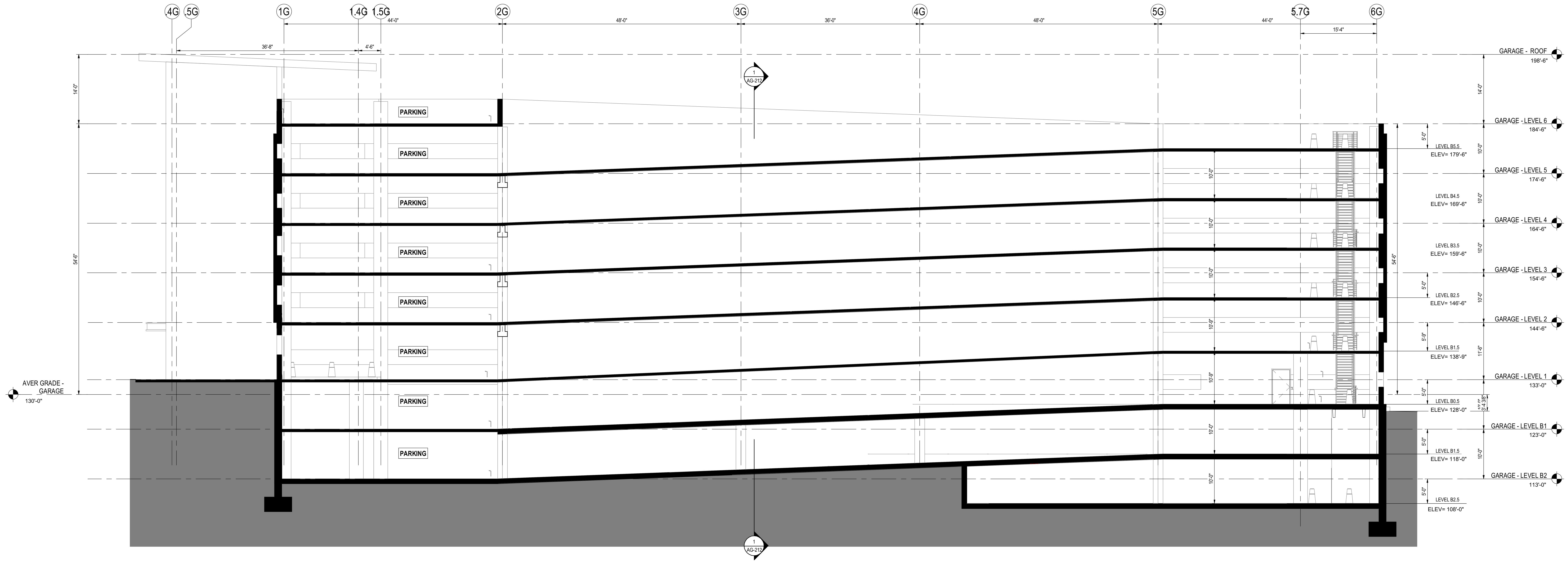
Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE LEVEL 6

Revision:2
Drawing No.
AG-106
GARAGE



2 AG-211 **GARAGE SECTION BB - CENTRAL RAMP**
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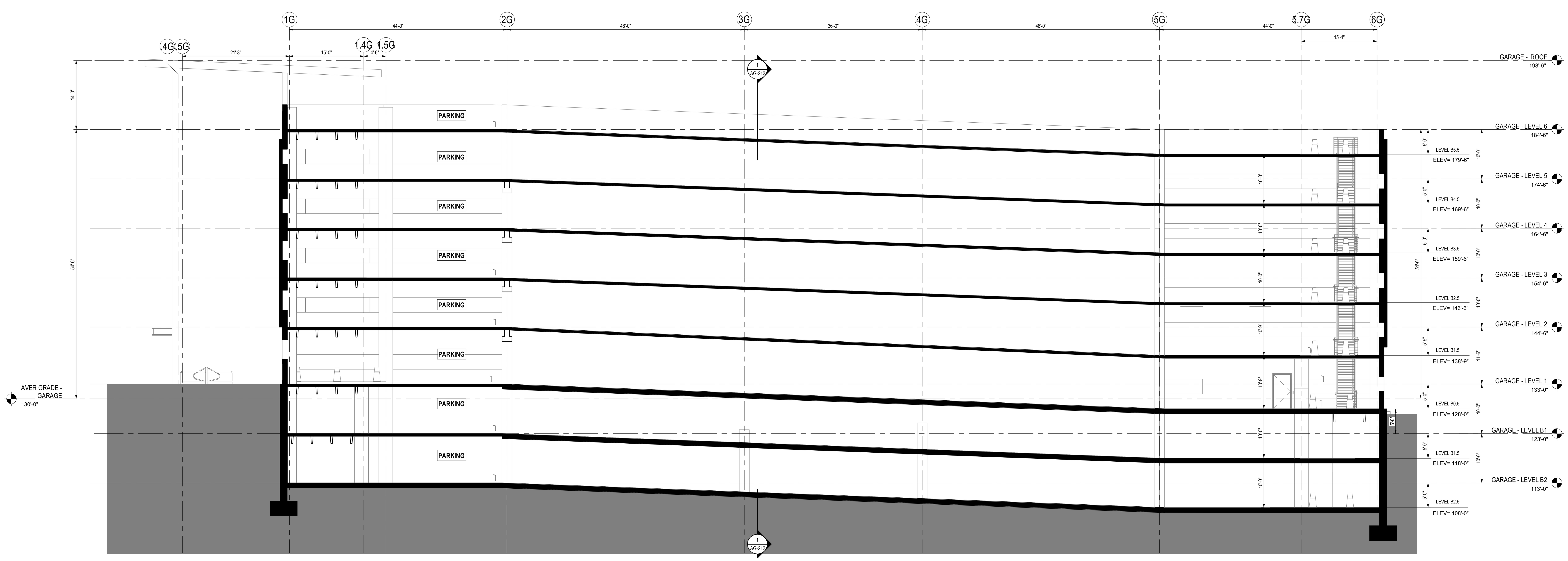

1 AG-211 **GARAGE SECTION AA - OUTER RAMP**
1/8" = 1'-0"

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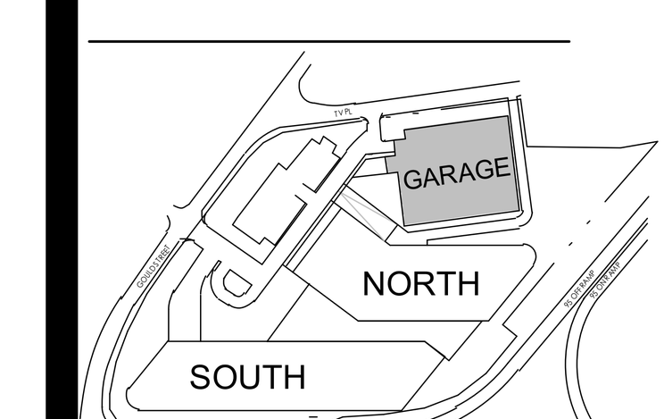
Permit/Seal



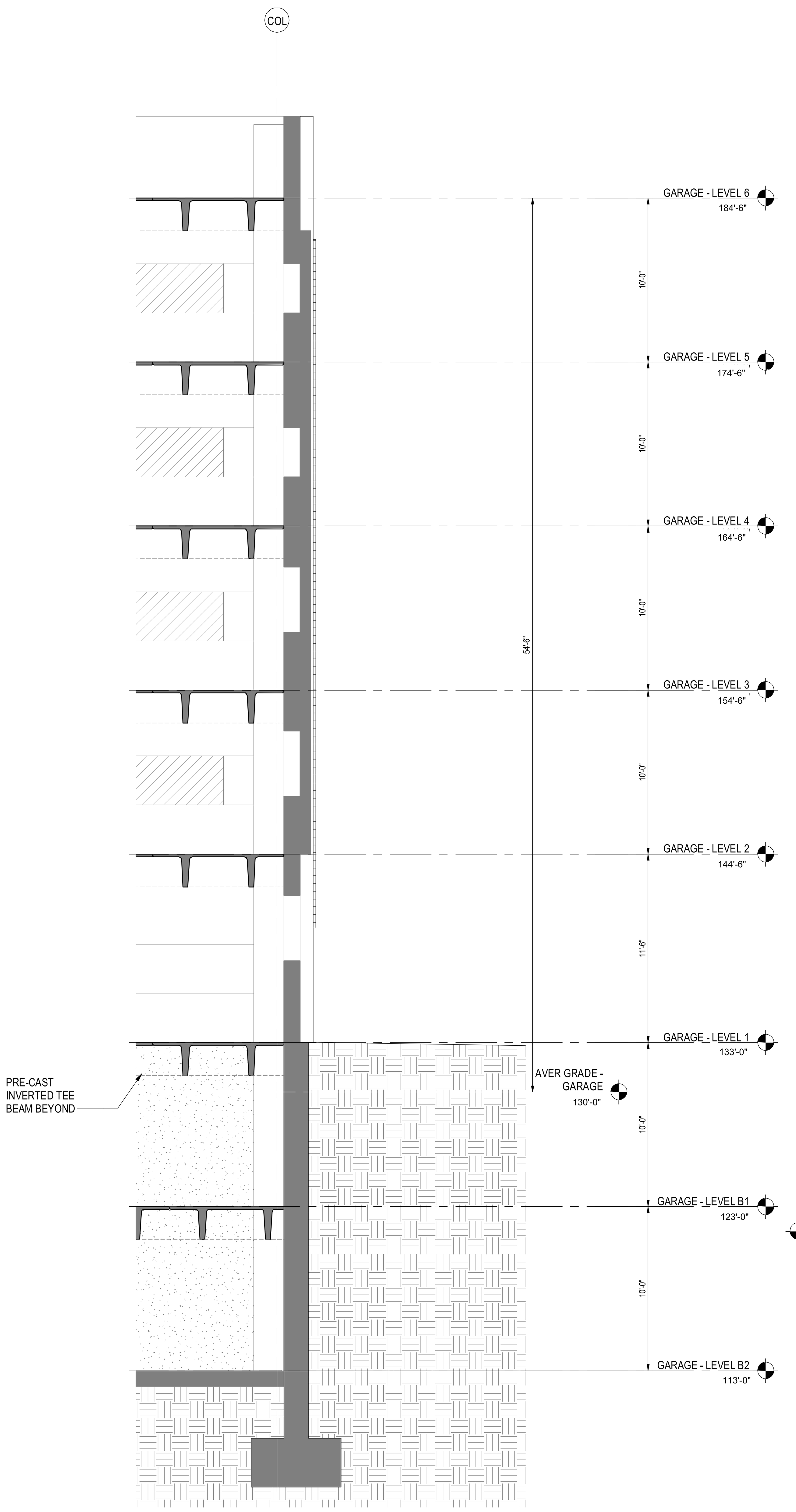
KEY PLAN

Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

Project No.:218421343
Scale: 1/8" = 1'-0"

Title
GARAGE SECTIONS

Revision:2
Drawing No.
AG-211
GARAGE



2 AG-212 **TYP. BAY SECTION - FOUNDATION OUTBOARD**
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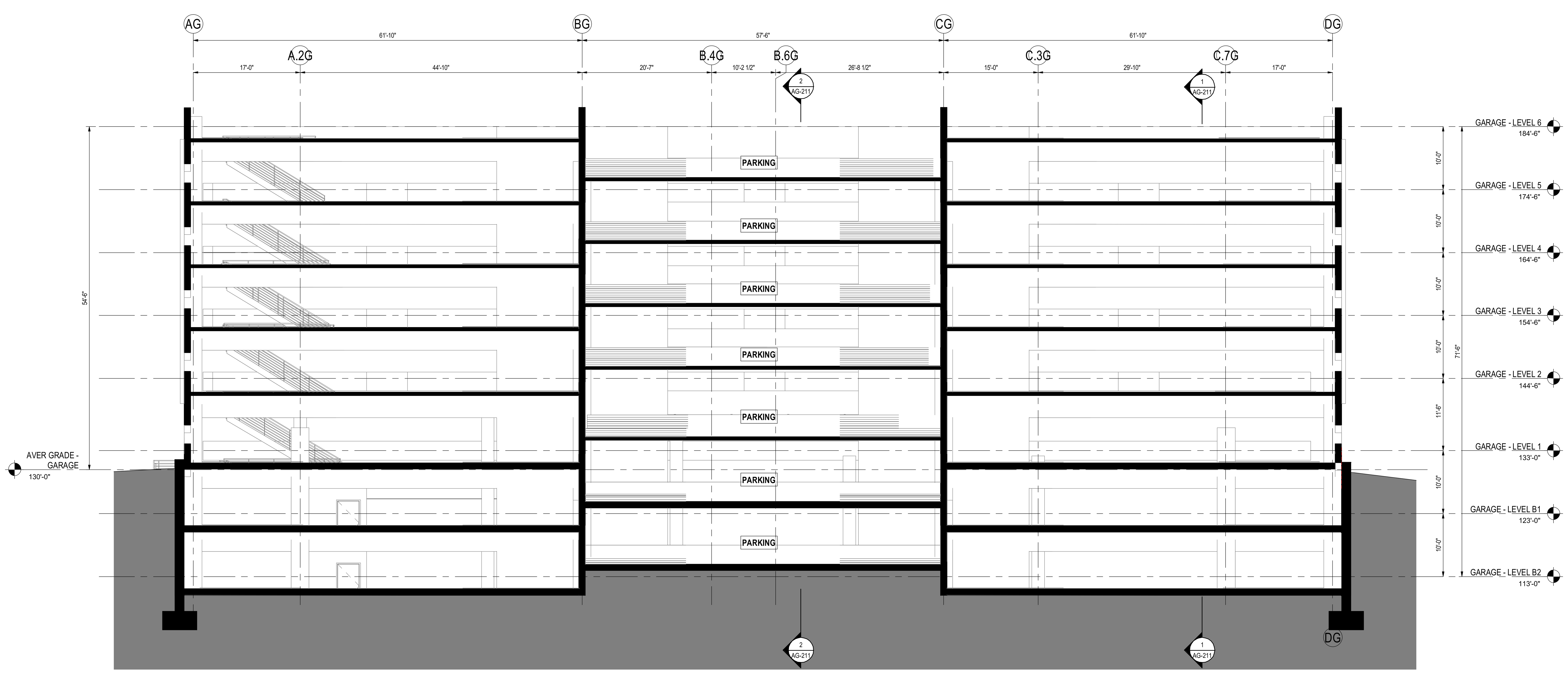

1 AG-212 **GARAGE SECTION CC - Transverse**
1/8" = 1'-0"

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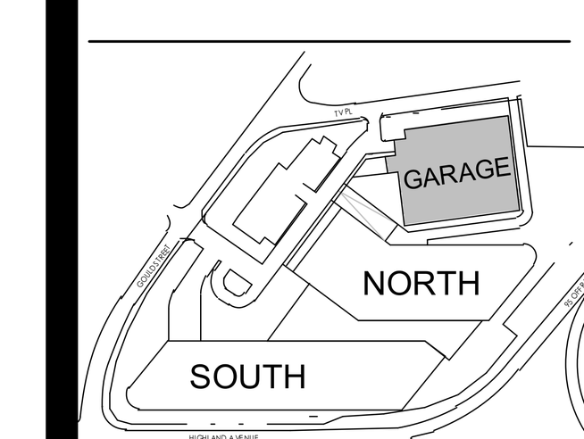
Issued/Revision

Permit/Seal



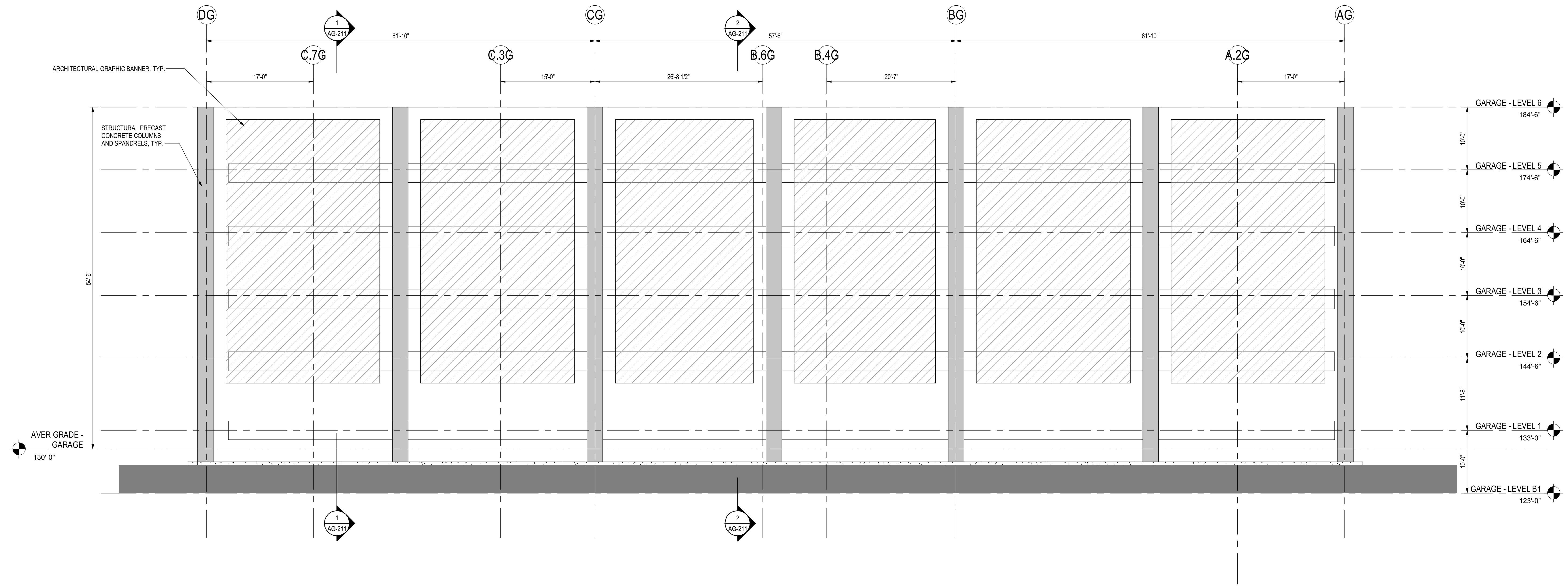
KEY PLAN

Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

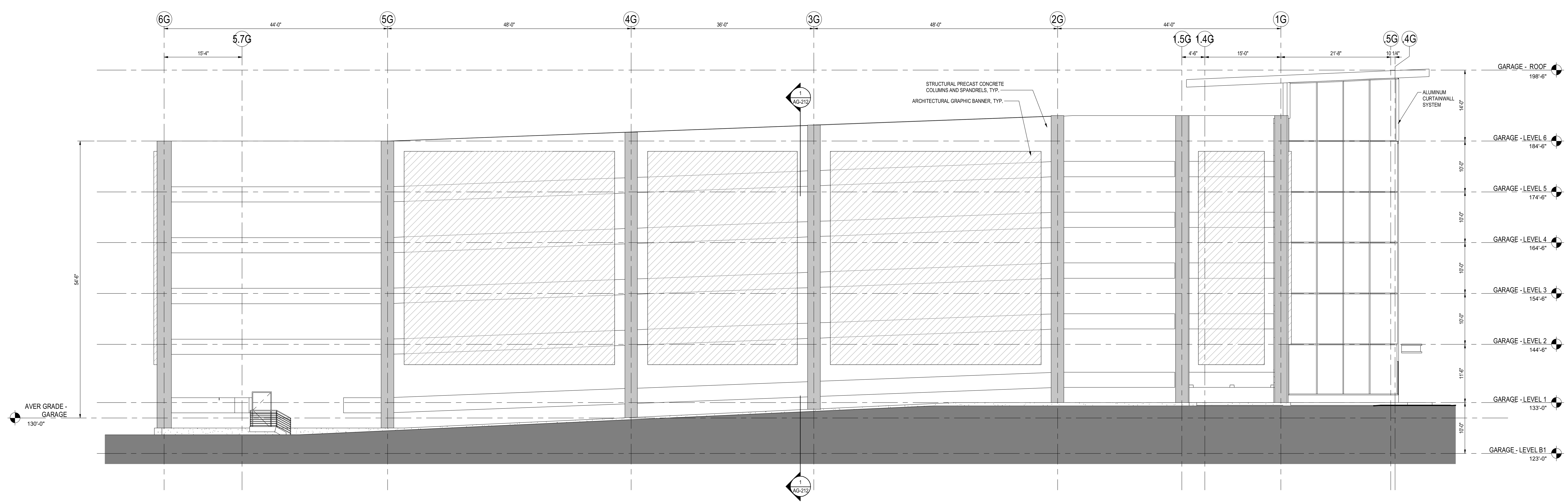
Project No.:218421343
Scale: As indicated

Title
GARAGE SECTIONS

Revision:2
Drawing No.
AG-212
GARAGE



2 EAST ELEVATION
AG-301 1/8" = 1'-0"



1 NORTH ELEVATION
AG-301 1/8" = 1'-0"

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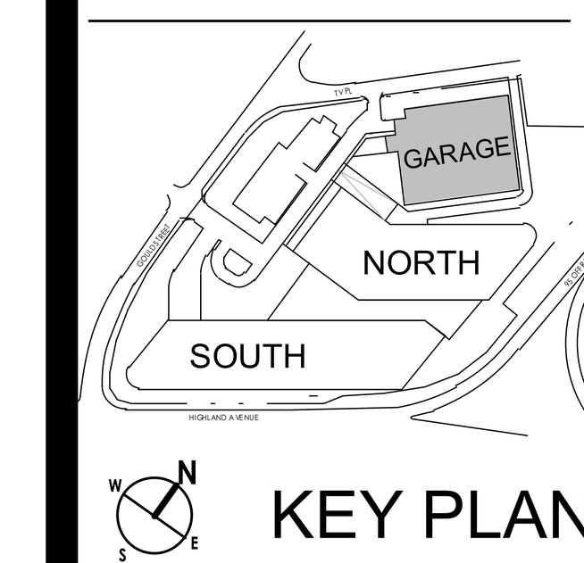
	Issued/Revision	By	Appd	YYYY.MM.DD
2	SPECIAL PERMIT PACKAGE			2022.03.30
1	CONCEPT DEVELOPMENT			2021.11.19

Permit/Seal

REGISTERED ARCHITECT BARTON D NELSON No. 951652 BOSTON, MA COMMONWEALTH OF MASSACHUSETTS



KEY PLAN

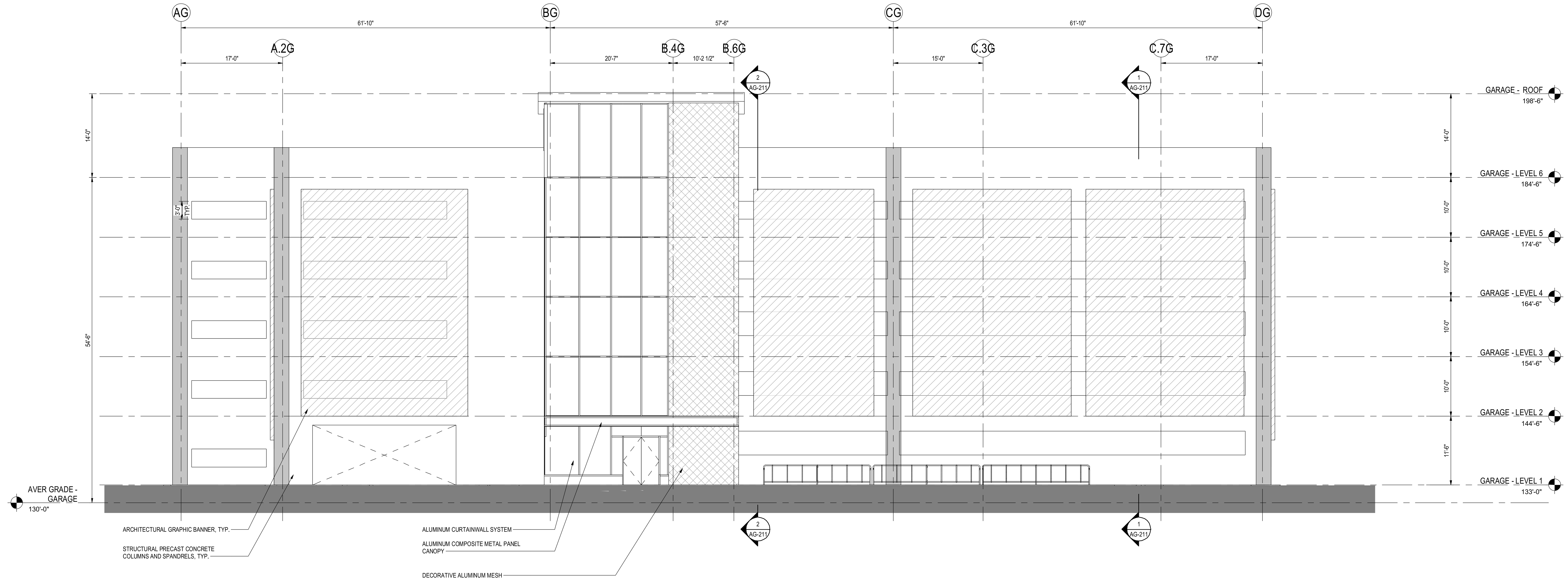
Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

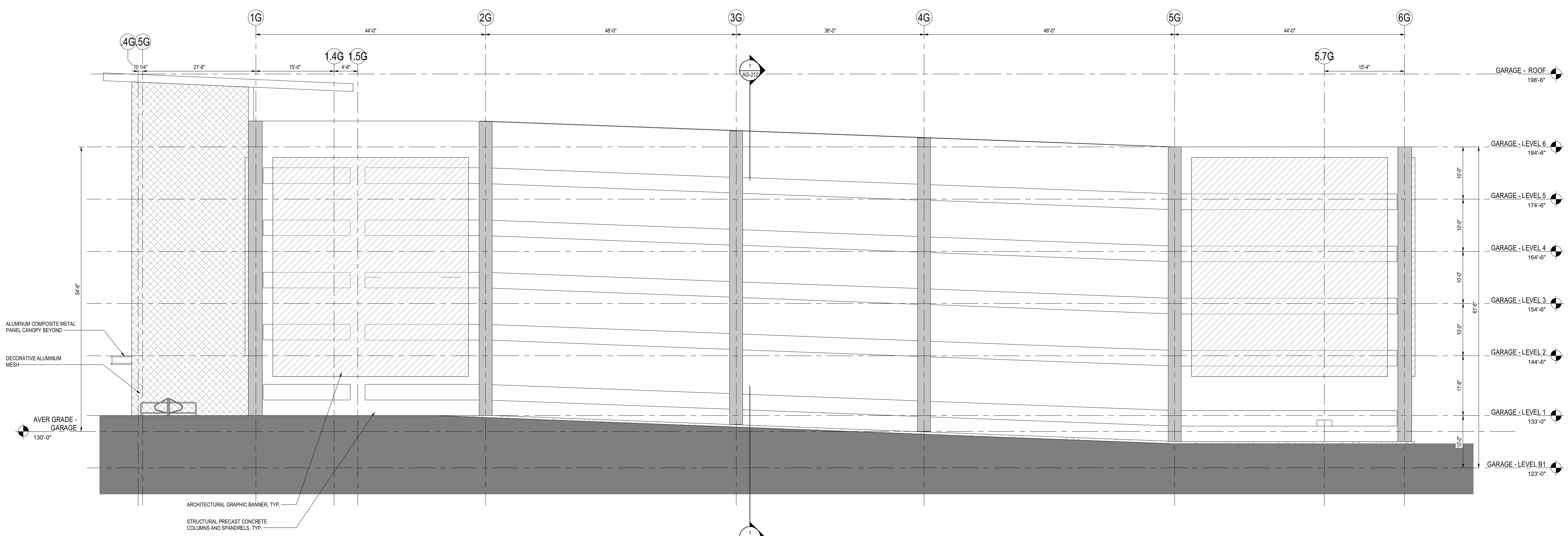
Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
ELEVATIONS - NORTH & EAST

Revision:2
Drawing No.
AG-301
GARAGE



2 AG-302 **WEST ELEVATION**
1/8" = 1'-0"



1 AG-302 **SOUTH ELEVATION**
1/8" = 1'-0"

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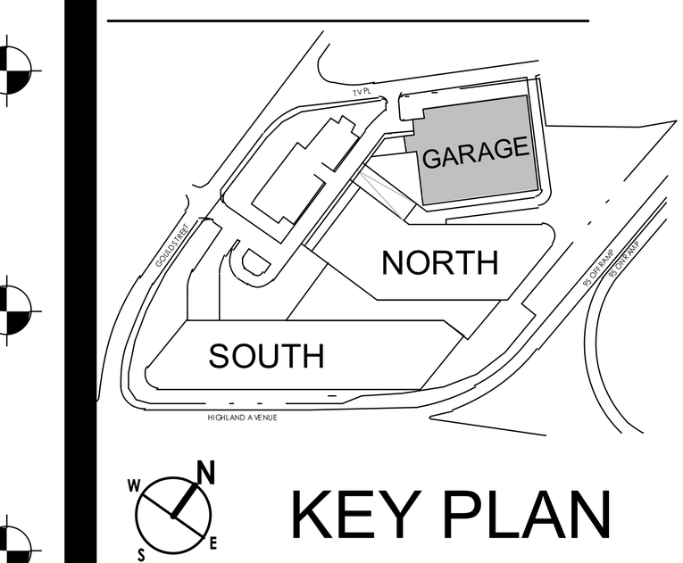
2	SPECIAL PERMIT PACKAGE			2022.03.30
1	CONCEPT DEVELOPMENT			2021.11.19
	Issued/Revision	By	Appd	YYYY.MM.DD

Permit/Seal

REGISTERED ARCHITECT
BARTON D NELSON
No. 951652
BOSTON, MA
COMMONWEALTH OF MASSACHUSETTS



KEY PLAN

Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
ELEVATIONS - SOUTH & WEST

Revision:2
Drawing No.
AG-302
GARAGE

Highland Innovation Center

557 Highland Avenue
Needham, Massachusetts

PREPARED FOR

557 Highland, LLC

c/o

The Bulfinch Companies, Inc.
116 Huntington Avenue
Boston, MA 02116

PREPARED BY

101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

MARCH 2022

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Introduction

Vanasse Hangen Brustlin, Inc. (VHB) has evaluated the potential traffic impacts associated with the proposed development at 557 Highland Avenue in Needham, Massachusetts (the "Site"). The proposed development Project includes up to 506,694 SF of rentable space, with approximately 248,347 SF of office space, approximately 248,347 SF of research and development space, and approximately 10,000 SF of retail space. The Project will also accommodate up to 1,408 off-street parking spaces. The parcel of land was formerly occupied for several decades by a car dealership and car wash.

The Project is consistent with local redevelopment goals for the area as previously studied by the Town of Needham's Department of Planning and Community Development. To support the rezoning effort, a Traffic Study commissioned by the Town of Needham was completed by GPI in November 2020.[1] That study considered rezoning the Muzi Motors and WCVB/Channel 5 properties from Industrial 1 to Highway Commercial 1 while providing a maximum floor area ratio of 1.35. This rezoning was formally codified in the creation of a new use district called Highway Commercial 1 and a corresponding zoning map amendment, which were adopted by Needham Town Meeting on May 3, 2021.

This Transportation Impact and Access Study (TIAS) provides an evaluation and summary of the Project's transportation elements and quantified impacts. It includes an analysis of estimated trip generation characteristics and describes anticipated parking conditions, loading and service activities, drop-off amenities, and other important transportation mitigation and improvement actions that will be provided in connection with the Project. The purposes of these analyses are to:

- Describe the transportation-related characteristics of the Project;
- Quantify the transportation impacts of the Project;
- Develop and clearly commit to a set of mitigation strategies and traffic improvement measures that will help to lessen the transportation effects of the Project, and
- Demonstrate that these transportation mitigation efforts will serve as exceptional public benefits as they relate to transportation issues.

The sections below provide an overview of the Project and a summary of the TIAS findings. Subsequent sections provide a more detailed discussion of estimated traffic generation of the

[1] Traffic Impact Study, Muzi Motors Redevelopment, Greenman-Pederson, Inc. November 20, 2020

Project. The final section presents a detailed summary of transportation mitigation and improvement actions that the Proponent is committed to implementing in connection with the Project. Note that this mitigation plan is reflective of those actions that have been delineated by the Town of Needham in connection with its own recent evaluation supporting rezoning of this site and other adjacent sites.

Summary of Findings and Transportation Mitigation

The Project will result in additional trips generated to and from the Project Site. These new trips can be expected to produce some localized impacts on the surrounding transportation infrastructure. The Proponent has developed a comprehensive series of improvement actions to address existing operating conditions and constraints and to help mitigate future new impacts. Generally, the Project will adopt and incorporate nearly all transportation improvements that were delineated in the Traffic Study commissioned by the Town of Needham in support of their recent rezoning effort for the area. The improvements and the proposed mitigation program are intended to offset the Project's impacts and to provide improved transportation infrastructure to the surrounding area for all users supporting significantly improved area mobility. The Proponent is also committed to implementing an extensive travel demand management (TDM) program in connection with the Project's development and operation. A summary of key findings and mitigation and improvement actions are described below:

- The net-new traffic generated by the Project is estimated to total 583 trips during the morning peak hour (515 entering and 68 exiting), and 565 trips during the evening peak hour (92 entering and 473 exiting).
- The Project will generate 5,005 net new weekday daily trips – or approximately 44% fewer trips than that estimated by GPI's traffic study supporting the recent Town of Needham rezoning effort.
- The Proponent is committed to funding the design and construction of key mitigation and improvement measures, including:
  - Installation of on-road bicycle lanes in each direction of Gould Street between Highland Avenue and just north of TV Place.
  - Addition of shared lane pavement markings and signage in each direction for bicyclists along Gould Street for approximately ½ mile between just north of TV Place and Central Avenue.
  - Design and installation of a fully-actuated traffic signal at the intersection of Gould Street and the main Project Site driveway opposite the Wingate Driveway.
  - Geometric improvements at the intersection of Highland Avenue at Gould Street / Hunting Road.
  - Design and installation of a fully-actuated traffic signal at the intersection of Gould Street and Central Avenue, including associated geometry improvements.
  - Geometric improvements at the intersection of Gould Street at TV Place including turn lanes into and out of TV Place.
- The Proponent will work with the Town of Needham to fund a study of the feasibility of converting the former MBTA railroad ROW north of the Project Site and the Channel 5 property into a shared use path that would connect with Needham Heights to the south and the Charles River to the north.

- The Project includes significant pedestrian and open space amenities, including new sidewalks and accessible crossings adjacent to the site and at key off-site locations (as noted above). An approximately 0.5-mile walking path around the Project Site with landscaping, lighting, and other public amenities will be included and will be open to all members of the general public.
- Connections to the future bicycle accommodations on Highland Avenue that will extend toward Newton to the east and toward Needham Heights to the west.
- Up to 70 bicycle parking spaces will be provided consisting of covered bicycle storage/long-term bicycle parking on-site and outdoor public bike racks/short-term bicycle parking.
- The Project Proponent will explore and look to implement shuttle connectivity through its future proactive involvement in the Route 128 Business Council to improve public transportation access and accessibility to the Project Site.
- On-site parking will be adequate to accommodate the expected employee and visitor demands of the Project. The Project will include up to 1,408 spaces (an increase of 876 net-new spaces over the 532 parking spaces previously provided on Site). This parking demand will be accommodated primarily in a structured parking garage to be located on the northeast portion of the Site adjacent to TV Place. Additional below-grade parking will be provided under each building, and in a surface parking lot intended to be used by visitors.
- Parking facilities will be equipped with Electric Vehicle charging stations, with consideration as to how increased EV capacity can be implemented in the future as warranted by demand and market conditions.
- The Project will include dedicated off-street loading docks to ensure that loading and service operations are handled internal to the buildings and will not impact traffic operations or pedestrian flow on adjacent streets.
- The Proponent will implement a wide array of Transportation Demand Management (TDM) measures to incentivize reduced single occupant driving and increased use of alternative forms of transportation to access the workplace. Key TDM actions to be implemented in connection with the Project include:
  - Providing an Employee Transportation Advisor who will coordinate with the 128 Business Council;
  - Exploring the feasibility of providing shuttle service connectivity to nearby public transportation nodes (commuter rail and Green Line)
  - 50 percent transit pass subsidy to be offered by future tenants to their employees;
  - Carpool assistance and incentives;
  - Emergency ride home;
  - Bicycling/walking incentives and amenities;
  - Telecommuting and compressed workweeks, when feasible;
  - Display in the Main Lobby transportation-related information for employees and visitors; and
  - Promotional efforts.
- The Proponent is also committed to a robust transportation monitoring program to evaluate the effectiveness of its TDM program and to measure the Project's impacts on the transportation network. The monitoring program will include the annual collection of traffic counts and parking garage activity by employees and visitors to the Project Site. The transportation monitoring

program will begin six months after full occupancy of the proposed development and continue for a period of five years. The results of each transportation monitoring program will be summarized in a report and provided to MassDOT and to the Town of Needham.

Study Methodology

This Transportation Study has been performed in conformance with the Massachusetts Executive Office of Energy and Environmental Affairs (EEA)/Executive Office of Transportation (EOT) guidelines. Prior to completing this study, VHB completed a Traffic Scoping Letter (TSL) process with MassDOT to get buy-in on the many facets of the traffic study. That TSL was submitted to MassDOT on November 2, 2021. MassDOT issued an approved scope to the Proponent on February 2, 2022. This study is reflective of the approved scope. TSL materials and related MassDOT correspondence are included in the Appendix to this report for reference. VHB also held preliminary consultation with Town of Needham transportation staff on traffic study requirements and that input is reflected within this Study.

VHB prepared the traffic assessment in three stages. The first stage involved an assessment of existing traffic conditions within the Project study area, including: an inventory of existing roadway geometry; observations of traffic flow, including daily and peak period traffic counts; a summary of existing public transit facilities in the area; and a review of vehicular crash data.

The second stage of the study established the framework for evaluating the transportation impacts of the Project. Specific travel demand forecasts for the Project were assessed along with future traffic demands on the study area roadways due to projected background traffic growth and other proposed area developments that may occur independent of the Project. The year 2029, a seven-year time horizon, was selected as the design year for analysis for the preparation of this traffic impact and access assessment in accordance with the standard industry practices in Massachusetts.

The third and final stage of the study discusses possible measures to improve existing and future traffic operations in the area and offsetting the traffic-related impacts associated with the Project.

Analysis Conditions

This study contains transportation analyses conducted under the following three conditions during the weekday morning and weekday evening peak hours:

- 2022 Existing Conditions
- 2029 No Build Conditions
- 2029 Build Conditions

The 2022 Existing Conditions analyses provide a snapshot of conditions today in the study area. The 2022 Existing Conditions have been conducted based on pre-COVID-19 conditions, and do not take into account the change in travel patterns caused by the COVID-19 pandemic. The 2029 No Build Conditions and 2029 Build Conditions analyses provide a picture of what transportation conditions will look like in the study area in the future with and without the Project in place. These three analyses allow for a comparison of the Project's impact on the transportation network and help to determine what transportation mitigation measures are necessary to offset the impacts of the Project.

Project Description

A detailed review of the proposed building program and Site access plan was conducted as part of this evaluation and is described in the following sections. Included in the review of the Project Site access plan are descriptions of the proposed pedestrian accommodations, bicycle accommodations, loading and delivery activities, and parking supply.

Building Program

The development proposal for the Project Site includes up to 506,694 SF of rentable space, consisting of the following uses:

- Approximately 248,347 SF of office space;
- Approximately 248,347 SF of research and development space; and
- Approximately 10,000 SF of retail.

The building is conceived as one structure articulated as three distinct parts. The first part, the "South Building", is a three-story building located along Highland Avenue and extending toward Gould Street, creating a scale that is recognizable and related to the adjacent context. The second part, "the North Building", is a five-story building that is set back from Highland Avenue and Gould Street by 200 feet and extends toward the Southbound Exit 35C from I-95/Route 128. The third part is a two-story atrium connecting the South Building and the North Building that provides the main entry for the buildings. The atrium will allow opportunities to bring daylight into the deeper sections of the floorplate and allow for internal connections between the South Building and the North Building. Visually, the atrium will create a break within the massing ensuring visual interest and clarity of each of the parts. A five-story parking garage will be located north of the North Building, closest to TV Place.

The Project will create new office and lab space at a highly visible location adjacent to Exit 35C on I-95/Route 128. Under existing conditions, the Project Site consists of a former car dealership and car wash. Both the car dealership and car wash ceased operation in late 2021.

The previous uses of a car dealership and a car wash were frequented throughout the day, as opposed to most of the traffic entering and exiting during the peak hours, as is typical of office and lab uses. Of note, car washes are generally the busiest during the weekends when people are most likely to get their vehicles washed. The former car wash on-Site typically handled up to 18,000 car

washes per month, based on review of sales data and conversation with the former operator. This level of activity translates to about 600 washes/day during peak months (which tend to be during the winter).

The Project will have most traffic entering and exiting during the weekday morning and evening peak hours, meaning that the impacts on the roadway network will be less on the weekends. The Project will match existing office and lab uses located along the I-95/Route 128 corridor, and with the proposed mitigation described in detail in this study, the roadway network will be able to accommodate the Project-generated trips during the busiest weekday peak hours.

Site Access

Existing Site Access

The Project Site is located along Highland Avenue and Gould Street in Needham, Massachusetts. The Project Site is bounded by Highland Avenue to the south, TV Place to the north, Gould Street to the west, and the I-95/Route 128 Exit 35C southbound off-ramp to the east. Access to the Project Site is currently provided by two driveways off Gould Street and one driveway off Highland Avenue. The northern driveway off Gould Street, referred to as TV Place, provides access to the car wash and an egress from the car dealership. TV Place also provides access to an office building and the Channel 5 studios, which are not included in the Project Site and will remain in place with access from TV Place. The southern driveway off Gould Street provides the main access to the car dealership. The driveway off Highland Avenue is for limited use by the dealership and is gated.

A Site location map is provided in Figure 1.

Project Site Access

The Project will include office, research and development, and retail space within newly constructed buildings and a stand-alone parking garage. Existing driveways off Gould Street will remain in place and a full connection will be provided between TV Place and the Project Site. There will be no curb cuts along Highland Avenue with the existing, gated driveway being eliminated.

An internal roadway within the Project Site will connect between the Gould Street driveway and TV Place. This internal roadway will provide connections to the above-ground parking garage, the parking garages located below each building, a small surface parking lot, and all loading and service areas.

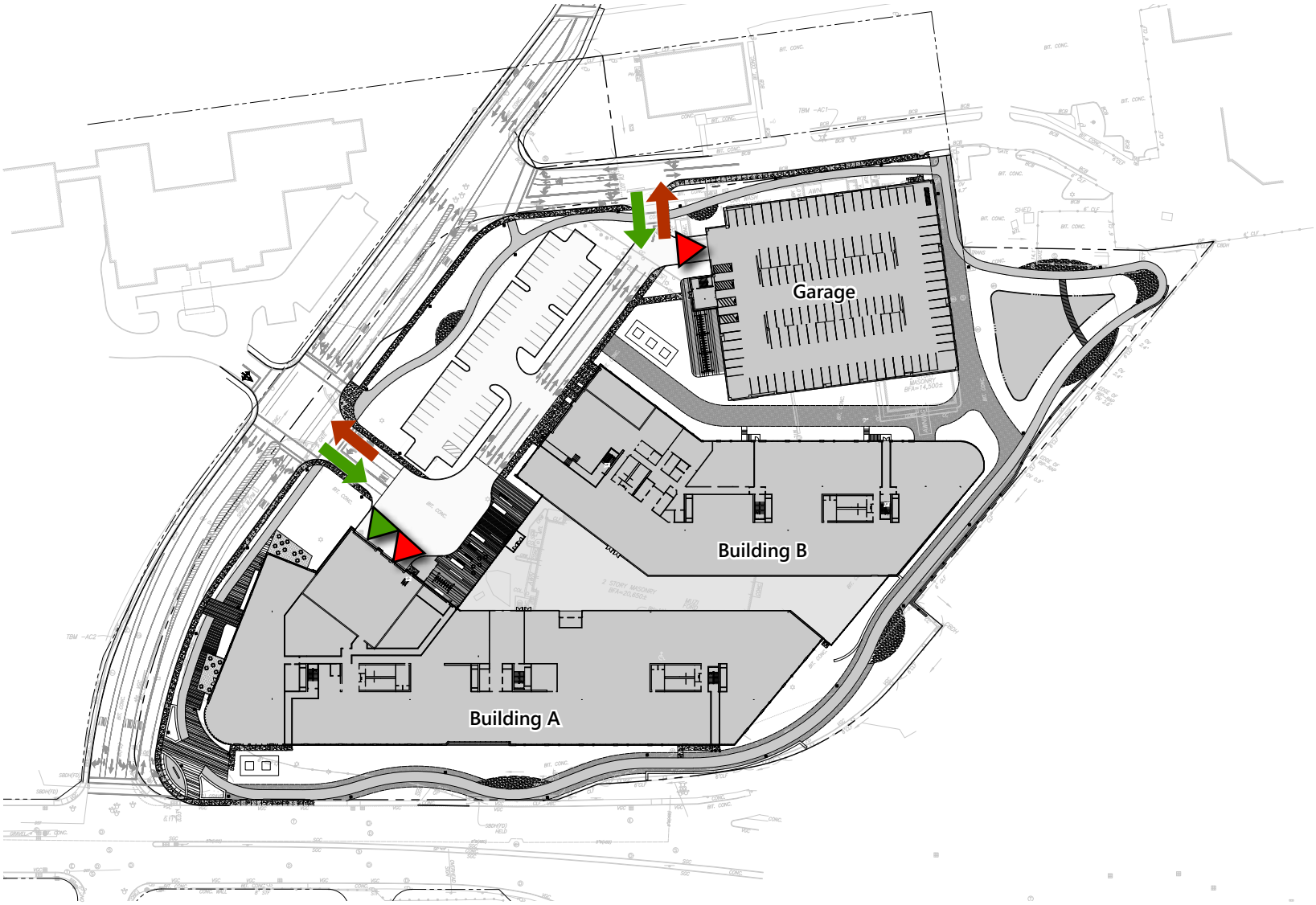
Figure 2 illustrates the site plan and external access points for the Project and includes the garage and loading access points.

Source: NearMap

Figure 1

Site Location Map

Highland Science Center
Needham, Massachusetts



Source: Paul Finger Associates

- Vehicle Access
- Vehicle Egress
- Garage Access
- Loadings Access

Figure 2

Site Plan & Circulation

Highland Science Center
Needham, Massachusetts

Pedestrian Accommodations

As part of the Project, new sidewalks will be provided along the proposed internal street. The internal sidewalks will connect to the sidewalk on the west side of Gould Street at the proposed signalized intersection of Gould Street at the Project Site driveway/Wingate driveway. The signalized intersection will include pedestrian phasing and will have ADA-compliant crosswalks across all four approaches, providing a protected pedestrian crossing of Gould Street that does not currently exist. In addition, a new sidewalk will be provided along the Project Site frontage on the east side of Gould Street where none exists today.

A key aspect of the Project will be the new perimeter path and open spaces. An approximately 0.5-mile walking path will be constructed to circulate around the Project Site with landscaping, lighting, and other public amenities. The walking path will be open to the public and will be used by both employees and visitors to the Project Site and by nearby neighbors. Connections to the walking path will be provided to Highland Avenue and Gould Street.

Bicycle Accommodations

The Project Site will be designed to encourage workers and visitors to travel via bicycle. The internal street network will consist of a low-speed street that will allow for shared bicycle and vehicular traffic. Bicycle lanes will be provided on both Project Site driveways to provide dedicated access for bicyclists. Bicycle racks will be placed in visible, convenient locations on Site for visitors and customers and secure, indoor bicycle spaces will be provided for employees.

The Project Site is adjacent to Highland Avenue, which is currently the subject of a MassDOT construction project that will provide continuous dedicated bicycle facilities for approximately two miles along Highland Avenue and Needham Street between Webster Street in Needham and Route 9 in Newton. Most of the corridor will be constructed with separated bicycle lanes. Located directly on Highland Avenue, the Project Site will have strong bicycle connections with Needham Heights to the southwest and Newton to the northeast.

As mitigation for the Project, the Proponent is proposing to install bicycle lanes in both directions along Gould Street between Highland Avenue and the former MBTA railroad ROW just north of TV Place. Between the former MBTA railroad ROW and Central Avenue, a distance of approximately ½ mile, the Proponent will fund the installation of shared lane pavement markings and signage in each direction. These improvements will provide a new north-south bicycle corridor within this area of Needham and will improve bicycle connectivity to the Project Site with connections to bicycle lanes on TV Place and the Project Site driveway.

In addition, the Proponent will work with the Town of Needham to fund a study of the feasibility of converting the former MBTA railroad ROW north of the Project Site and the Channel 5 property into a shared use path that would connect with Needham Heights in the south and the Charles River in the north.

Bicycle Parking

The Project's potential bicycle parking needs will be accommodated through the provision of secured bicycle parking within the Project building and/or building garages and by outdoor bicycle racks

throughout the Site. Up to 70 bicycle spaces will be provided in outdoor bicycle racks located throughout the Site and in indoor/secure locations.

In addition to designated bicycle parking spaces, a bicycle maintenance station will be available on-site for tenants' employees.

Loading and Deliveries

A service and loading dock location will be provided for the Project Site in the North Building and South Building. The service and loading dock will be accessed via a dedicated driveway off of the internal circulating roadway.

The exact number and timing of deliveries will vary depending on the nature of the various retail establishments, in addition to standard office delivery activity. Retail delivery activity typically occurs during morning hours so as not to interfere with the operation of the business. Due to the smaller sizes of the retail uses, most deliveries likely will be made by smaller, single-unit trucks. These trucks can easily be accommodated and should typically only be on Site for a short time.

Vehicle Parking

The Project will include up to 1,408 off-street parking spaces. The site was formerly occupied by a car dealership and car wash for many years that contained approximately 532 parking spaces[2]. Taking into account the previous parking on Site that will be removed, the Project will include construction of up to 876 net new parking spaces. The existing Site plan showing the number of parking spaces provided for the car dealership and the car wash is included in the Appendix to this report.

Vehicle Parking Demand

Zoning requirements for the Town of Needham require a minimum of one parking space per 300 square feet, which results in an expected employee density for the Project Site of 3.33 employees per 1,000 SF (assuming each parking space corresponds to one employee). However, R&D uses typical have a lower employee per square foot density than office uses due to the square footage needed for lab space. Based on a review of employee density for existing R&D spaces in Cambridge, the average employee density for R&D space is approximately 2.46 employees per 1,000 SF[3].

In addition, the one parking space per 300 SF ratio assumes that each employee will commute alone via private vehicle. In reality, some employees will commute via carpool, walking, biking, or public transit. The Proponent will encourage the use of alternative commuting modes beyond single occupancy vehicles with the implementation of the TDM program outlined in this report. Therefore, it is likely that the Project Site will generate fewer occupied parking spaces than required by zoning.

Table 1 provides a summary of the anticipated parking demand for the Project Site.

[2] The 532 previous parking spaces on Site include spaces that were used to support new and used car inventory. It is estimated that up to 100 parking spaces were used primarily by employees and customers.

[3] Calculations by VHB based on 2018 PTDM Monitoring Reports provided by the City of Cambridge for four existing R&D facilities located at 7 Cambridge Center, 610 Main Street, Tech Square, and Binney Street.

Table 1 Parking Generation Calculations

Use	SF	Employee/Patron Density [a]	Reduction for non-SOV [b]	Parking Demand
Office	248,347	3.33/ksf	0.92	762 spaces
R&D	248,347	2.46/ksf	0.92	562 spaces
Retail	10,000	3.33/ksf	0.92	31 spaces
Total				**1,355 spaces**

a Based on Town of Needham zoning requirements for office and retail and data from existing R&D uses in Cambridge for R&D.

b Estimated 8-percent reduction in required parking spaces to account for incentivized modes of transportation beyond single occupancy vehicles (SOV).

As shown in Table 1, the actual vehicle parking demand for the Project Site may be around 1,355 parking spaces. With approximately 1,408 parking spaces proposed on-Site, there will be adequate parking provided for the Project Site.

The parking calculations above do not consider changes in travel patterns caused by the COVID-19 pandemic. With the rise in popularity of employees working from home either full time or on certain days of the week, it is likely that not all employees for the office and R&D uses will be on-Site all at the same time. Therefore, the future parking demand may be lower than what is reported in Table 1.

Existing Conditions

Evaluation of the transportation impacts associated with the Project requires an understanding of the existing transportation conditions in the study area including: an inventory of the traffic control, roadway, driveway, and intersection geometry in the study area; the collection of peak hour traffic volumes; a review of existing bicycle and pedestrian accommodations in the study area; a summary of public transit options in the area; and a review of recent crash history. Each of these elements is described in detail below.

Study Area

Based on VHB's knowledge of the area transportation network and the operational characteristics of the Project, as well as input from the Town of Needham and MassDOT, a study area comprising of the following intersections in Needham and their approach roadways were selected for review:

- 1: Central Avenue at Cedar Street
- 2: Central Avenue at Webster Street
- 3: Central Avenue at Gould Street
- 4: Central Avenue at Hampton Avenue
- 5: Central Avenue at River Park Street
- 6: Gould Street at Ellis Street
- 7: Gould Street at Kearney Road
- 8: Gould Street at Station Road
- 9: Gould Street at Noanett Road
- 10: Gould Street at TV Place
- 11: Gould Street at Muzi Ford/Wingate Residences driveways
- 12: Highland Avenue at West Street
- 13: Highland Avenue at Hunnewell Street
- 14: Highland Avenue at Webster Street
- 15: Highland Avenue at Gould Street / Hunting Road

- 16: Highland Avenue at I-95 SB Ramps
- 17: Highland Avenue at I-95 NB Ramps
- 18: Highland Avenue at 1st Avenue
- 19: Highland Avenue at 2nd Avenue
- 20: Kendrick Street at Hunting Road

A map of the study area intersections is provided in Figure 3.

The Project Site is located in the Needham Heights neighborhood less than ¼ mile from the Newton town line. The Project Site is directly served by Highland Avenue and Gould Street. Highland Avenue connects the Project Site to the Needham Heights neighborhood to the southwest and to I-95 and Newton in the northeast. The nearest transit stop to the Project Site is Needham Heights on the Needham Branch of the MBTA commuter rail, approximately 0.8 miles southwest of the Project Site.

Roadway Network

Descriptions of the study area roadways and intersections are provided below, including descriptions of the existing lane configurations, traffic control at the study intersections, and the roadway jurisdiction in this area.

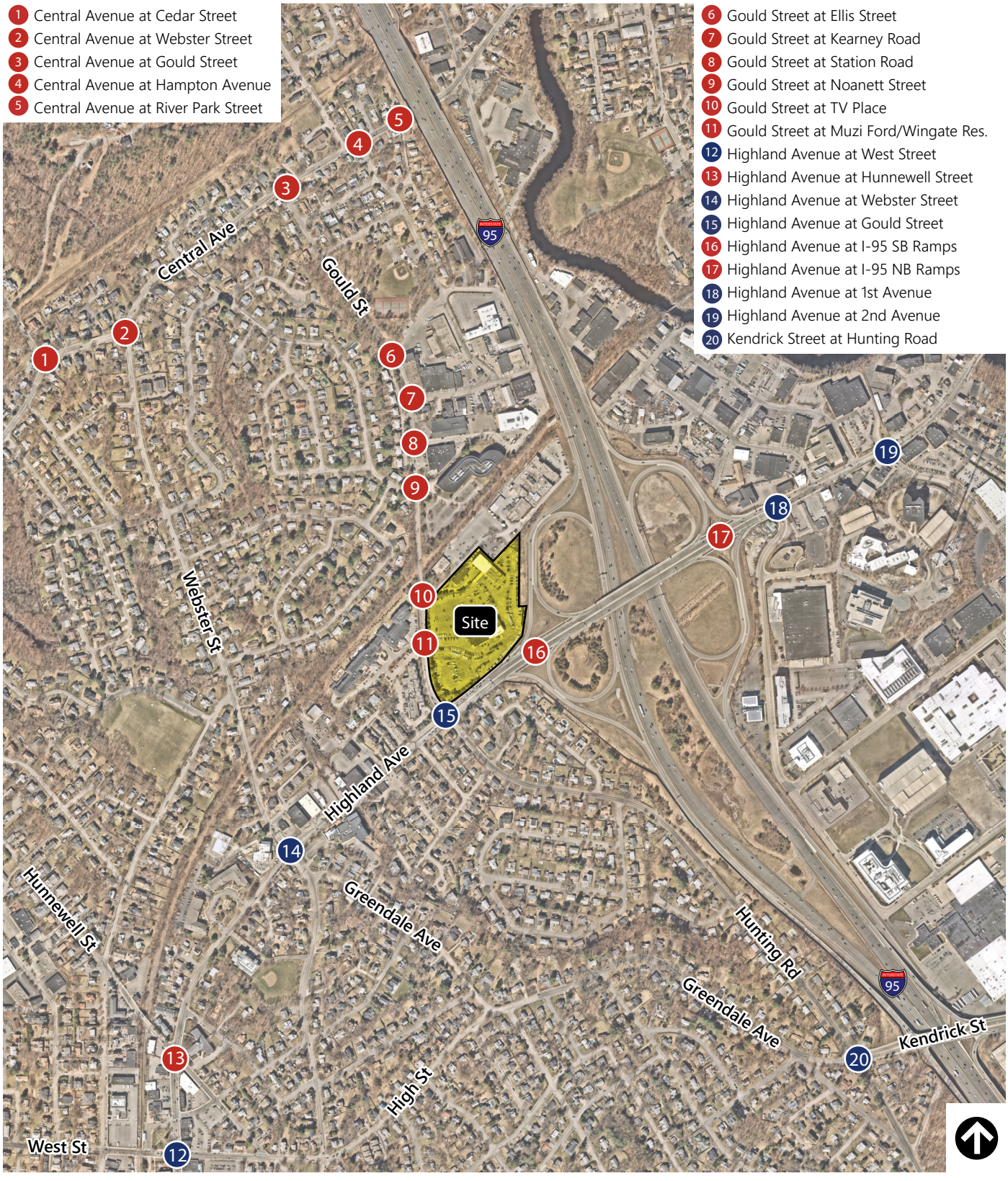
MassDOT is currently reconstructing portions of Highland Avenue.[4] The reconstruction project will enhance bicycle and pedestrian accommodations along the corridor and improve traffic flow. In addition, the MassDOT project will change the lane geometry at several intersections. A functional design report for the reconstruction project was submitted in August 2017 and construction on the project is underway. The roadway and intersection descriptions below are based on existing conditions as of early 2022 and do not take into consideration this ongoing corridor reconstruction project. Full details of the reconstruction project are included later in this TIA.

Study Area Roadways

Highland Avenue

Highland Avenue begins at Great Plain Avenue in the south and turns into Needham Street at the Newton City Line to the north. Within the study area, Highland Avenue is under MassDOT jurisdiction east of Webster Street, *i.e.,* adjacent to the Project Site, and under local jurisdiction west of Webster Street. The roadway within the study area is classified as a principal urban arterial west of I-95/Route 128 and as a minor urban arterial east of I-95/Route 128. Highland Avenue runs in a generally northeast/southwest direction within the study area. Highland Avenue generally consists of two travel lanes in each direction between Gould Street and 2nd Avenue and one travel lane in each direction west of Gould Street and east of 2nd Avenue. There is no posted speed limit within the study area along Highland Avenue. Sidewalks are provided on both sides of the roadway and crosswalks are provided at major intersections. Land use around Highland Avenue is mainly commercial.

[4] Functional Design Report, Reconstruction of Highland Avenue, Needham Street, and Charles River Bridge; MassDOT Project No. 606635; Submitted by Stantec Consulting Services, Inc.; August 2017.



Source: NearMap

- Unsignalized Intersection
- Signalized Intersection

Figure 3

Study Area Intersections

Highland Science Center
Needham, Massachusetts

Gould Street

Gould Street runs from Central Avenue in the north and turns into Hunting Road once it crosses Highland Avenue to the south. It is classified as an urban minor arterial roadway under local jurisdiction. Gould Street runs in a generally north/south direction and consists of one travel lane in each direction. There is no posted speed limit along Gould Street. Sidewalks are provided along one side of the road, along the western side in proximity to the Project Site. Land use along Gould Street is primarily commercial and residential.

Study Area Intersections

1: Central Avenue at Cedar Street

Central Avenue and Cedar Street form a three-way unsignalized intersection. Central Avenue runs east/west and Cedar Street intersects from a southbound approach. Each approach to the intersection consists of a single general-purpose lane.

The southbound approach operates under STOP control while the eastbound and westbound approaches are free flowing. Sidewalks are provided on all sides of the intersection. Crosswalks are provided across the southbound approach of Cedar Street and across the westbound approach of Central Avenue. Land use around the intersection is residential.

2: Central Avenue at Webster Street

Central Avenue and Webster Street form a three-way unsignalized intersection. Central Avenue runs east/west and Webster Street intersects from a northbound approach. Each approach to the intersection consists of a single general-purpose lane. An island separates the approach and exit lanes along Webster Street.

The northbound approach operates under STOP control while the eastbound and westbound approaches are free flowing. Sidewalks are provided on the northern, western, and eastern sides of the intersection. Crosswalks are provided across the southbound approach of Webster Street. Land use around the intersection is residential.

3: Central Avenue at Gould Street

Central Avenue and Gould Street form a three-way unsignalized intersection. Central Avenue runs east/west and Gould Street intersects from a northbound approach. Each approach to the intersection consists of a single general-purpose lane.

The northbound approach operates under STOP control while the eastbound and westbound approaches are free flowing. Sidewalks are provided on all sides of the intersection. Crosswalks are provided across the northbound approach of Gould Street and across the westbound approach of Central Avenue. Land use around the intersection is residential.

4: Central Avenue at Hampton Avenue

Central Avenue and Hampton Street form a three-way unsignalized intersection. Central Avenue runs east/west and Hampton Street intersects from a northbound approach. Each approach to the intersection consists of a single general-purpose lane.

The northbound approach operates under STOP control while the eastbound and westbound approaches are free flowing. Sidewalks are provided on all sides of the intersection. Crosswalks are provided across the northbound approach of Hampton Street and across the westbound approach of Central Avenue. Land use around the intersection is residential.

5: Central Avenue at River Park Street

Central Avenue and River Park Street form a three-way unsignalized intersection. Central Avenue runs east/west and River Park Street intersects from a northbound approach. Each approach to the intersection consists of a single general-purpose lane.

The northbound approach operates under STOP control while the eastbound and westbound approaches are free flowing. Sidewalks are provided on the eastern and western sides of the intersection and no crosswalks are provided. Land use around the intersection is residential.

6: Gould Street at Ellis Street

Gould Street and Ellis Street form a three-way unsignalized intersection. Gould Street runs north/south, and Ellis Street intersects from a westbound approach. Each approach to the intersection consists of a single general-purpose lane.

The westbound approach operates under STOP control while the northbound and southbound approaches are free flowing. Sidewalks are provided on the western side of the intersection. Crosswalks are not provided at this intersection. The land use around the intersection is mostly commercial with some residential buildings on the western side.

7: Gould Street at Kearney Road

Gould Street and Kearney Road form a three-way unsignalized intersection. Gould Street runs north/south and Kearney Road intersects from a westbound approach. Each approach to the intersection consists of a single general-purpose lane.

The westbound approach operates under STOP control while the northbound and southbound approaches are free flowing. Sidewalks are provided on the western side of the intersection. Crosswalks are not provided at this intersection. The land use around the intersection is commercial.

8: Gould Street at Station Road

Gould Street and Station Road form a three-way unsignalized intersection. Gould Street runs north/south and Station Road intersects from a westbound approach. Each approach to the intersection consists of a single general-purpose lane.

The westbound approach operates under STOP control while the northbound and southbound approaches are free flowing. Sidewalks are provided on the western side of the intersection. Crosswalks are not provided at this intersection. The land use around the intersection is commercial.

9: Gould Street at Noanett Road

Gould Street and Noanett Road form a four-way unsignalized intersection with a commercial driveway to the east. Gould Street runs north/south and Noanett Road intersects from an eastbound approach. Each approach to the intersection consists of a single general-purpose lane.

The eastbound and westbound approaches operate under STOP control while the northbound and southbound approaches are free-flowing. Crosswalks are not provided at this intersection. The land uses around the intersection are commercial and residential.

10: Gould Street at TV Place

Gould Street and TV Place form a three-way unsignalized intersection. Gould Street runs north/south and TV Place intersects from a westbound approach. TV Place is a private way and connects to the Project Site as well as the WCVB Channel 5 studios and an office building. Each approach to the intersection consists of a single general-purpose lane.

The westbound approach operates under STOP control while the northbound and southbound approaches are free flowing. Sidewalks are provided on the western side of the intersection. Crosswalks are not provided at this intersection. The land use around the intersection is commercial.

11: Gould Street at Muzi Ford Driveway/Wingate Driveway

Gould Street intersects with the entrances of two establishments, the former Muzi Ford dealership and Wingate Residence, and forms a four-way unsignalized intersection. Gould Street runs north/south and the Muzi Ford entrance intersects from a westbound approach while the entrance of Wingate Residence intersects from an eastbound approach. Each approach to the intersection consists of a single general-purpose lane.

The eastbound and westbound approaches operate under STOP control while the northbound and southbound approaches are free flowing. Sidewalks are provided on the western side of this intersection. The land use around the intersection is commercial.

12: Highland Avenue at West Street

Highland Avenue and West Street form a four-way signalized intersection. Highland Avenue runs north/south and West Street runs east/west. The southbound and northbound approach of Highland Avenue to the intersection consists of a single general-purpose lane with adjacent parking provided. The eastbound and westbound approach of West Street to the intersection consists of a left-turn lane and a shared through/right-turn lane.

All approaches to the intersection are signalized. Sidewalks are provided on all sides of the intersection and a crosswalk is provided across all approaches to the intersection. The land use around the intersection is commercial.

13: Highland Avenue at Hunnewell Street

Highland Avenue and Hunnewell Street form a four-way unsignalized intersection. Highland Avenue runs north/south and Hunnewell Street runs southeast/northwest. Each approach to the intersection consists of a single general-purpose lane.

The northwest bound and southeast bound approaches operate under STOP control while the northbound and southbound approaches are free flowing. Sidewalks are provided on all sides of the intersection and crosswalks are provided at the eastbound and westbound approach and through the middle of the intersection across Highland Avenue. The land use around the intersection is commercial and residential.

14: Highland Avenue at Webster Street

Highland Avenue and Webster Street form a four-way signalized intersection. Highland Avenue runs east/west and Webster Street runs north/south. The eastbound and westbound approach of Highland Avenue to the intersection consists of a left-turn lane and shared through/right-turn lane. The northbound approach of Webster Street consists of a shared through/left-turn lane and right-turn lane. The southbound approach of Webster Street consists of a shared through/left-turn lane and a shared through/right-turn lane.

All approaches are signalized. Sidewalks are provided on all sides of the intersection and a crosswalk is provided on all sides of this intersection. The land uses around the intersection are commercial and residential.

15: Highland Avenue at Gould Street/Hunting Road

Highland Avenue and Gould Street/Hunting Road form a four-way signalized intersection. Highland Avenue runs east/west and Gould Street/Hunting Road runs north/south. The eastbound and westbound approach of Highland Avenue to the intersection consists of a left-turn lane and two through lanes. The northbound approach of Hunting Road consists of a shared through/left-turn lane and right-turn lane. The southbound approach of Gould Street consists of a left-turn lane and a shared left/through/right-turn lane.

All approaches are signalized. Sidewalks are provided on all sides of the intersection and a crosswalk is provided on all sides of this intersection. The land uses around the intersection are commercial and residential.

16: Highland Avenue at I-95 SB Ramps

Highland Avenue and I-95 SB on and off ramps have an unsignalized interchange with merging and diverging lanes along Highland Avenue. Highland Avenue runs east/west and the ramps run parallel. The eastbound and westbound travel lanes of Highland Avenue consist of two travel lanes and one merge/diverge lane. All four I-95 SB ramps consist of one lane.

Sidewalks are provided along Highland Avenue and crosswalks are provided across each of the I-95 SB ramps.

17: Highland Avenue at I-95 NB Ramps

Highland Avenue and I-95 NB have an unsignalized and signalized interchange with merging and diverging lanes along Highland Avenue. Highland Avenue runs east/west and the ramps run parallel. The eastbound and westbound travel lanes of Highland Avenue consist of two travel lanes and one merge/diverge lane. All four I-95 NB ramps consist of one lane except for the off-ramp to Highland Avenue eastbound which consists of 2 lanes.

All approaches are unsignalized, except for the off-ramp to Highland Avenue eastbound which is signalized with Highland Avenue. Sidewalks are provided along Highland Avenue and crosswalks are provided across each of the I-95 NB ramps.

18: Highland Avenue at 1st Avenue

Highland Avenue and 1st Avenue form a four-way signalized intersection. Highland Avenue runs east/west and 1st Avenue approaches the intersection from a northbound approach with a commercial driveway approaching from the north. No left turns are permitted from Highland Avenue. The eastbound approach of Highland Avenue consists of two through lanes, a right-turn lane, and a bike lane. The westbound approach of Highland Avenue to the intersection consists of two through lanes and a bike lane. The northbound approach of 1st Avenue consists of a left-turn and a shared left/through/right-turn lane.

All approaches are signalized. Sidewalks are provided on all sides of the intersection and a crosswalk is provided on the northern, southern, and eastern sides of this intersection. The land use around the intersection is commercial.

19: Highland Avenue at 2nd Avenue

Highland Avenue and 2nd Avenue form a four-way signalized intersection with a commercial driveway to the north. Highland Avenue runs east/west and 2nd Avenue approaches the intersection from a northbound approach. The eastbound and westbound approaches of Highland Avenue to the intersection consist of a shared through/left-turn lane and a shared through/right-turn lane. The northbound approach of 2nd Avenue consists of a left-turn lane, shared through/left-turn lane and a right turn lane. The southbound approach consists of a shared through/left-turn lane and a right turn lane.

All approaches are signalized. Sidewalks are provided on all sides of the intersection and a crosswalk is provided on all approaches to the intersection. The land use around the intersection is commercial.

20: Kendrick Street at Hunting Road

Kendrick Street and Hunting Road form a four-way signalized intersection. Kendrick Street runs east/west and Hunting Road runs north/south. The eastbound approach of Kendrick Street to the intersection consists of a shared through/left-turn lane and a shared through/right-turn lane. The westbound approach of Kendrick Street consists of a left-turn lane and a shared through/right-turn lane. The southbound approach of Hunting Road consists of a shared right-turn/through lane and a left-turn lane. The northbound approach of Hunting Road consists of a left-turn/through lane and a channelized right-turn lane.

All approaches are signalized. Sidewalks are provided on all sides of the intersection and a crosswalk is provided on the northern, southern, and western sides of this intersection. The land use around the intersection is residential.

Existing Traffic Volumes

Traffic volumes were collected during the weekday morning and weekday evening peak periods at each of the study area intersections. Due to the current coronavirus (COVID-19) pandemic, traffic volumes may not represent normal travel conditions along Massachusetts roadways. In accordance with MassDOT guidelines, traffic counts collected after March 13, 2020 may not be representative of

typical traffic volumes and 2019 data should be considered as existing traffic volumes.[5] Based on MassDOT guidance, VHB identified traffic counts conducted prior to the start of the COVID-19 pandemic at most of the study area intersections. At locations where pre-pandemic counts were not available, new traffic counts were conducted in July 2021 and adjusted to represent "pre-pandemic" conditions based on traffic volumes at nearby intersections. The following section documents the initial data collection, the review of adjustment data, and a summary of the 2022 Existing Condition traffic volumes.

Data Collection

Weekday morning and weekday evening turning movement counts for the study area intersections were gathered from several sources, including recently published traffic studies in the area. Based on MassDOT guidance, an emphasis was placed on identifying traffic counts that were conducted prior to the start of the COVID-19 pandemic, between 2014 and 2020. Specifically, data from the following traffic studies were used to develop the existing traffic volumes:

- Traffic Impact Study, Muzi Motors Redevelopment, GPI, November 2020
- Draft Environmental Impact Report, The Northland Newton Development, VHB, August 2020
- Traffic Impact Study, 100-110 West Street, McMahon Associates, April 2020
- Route 128 Add-a-Lane Post Construction Study. McMahon Associates, November 2019
- Functional Design Report, Reconstruction of Highland Avenue, Needham Street, and Charles River Bridge, Stantec, August 2017

For locations where pre-pandemic counts were not available, new traffic counts were conducted by VHB in July 2021. All traffic count data is included in the Appendix to this report.

Traffic Volume Adjustment

Based on MassDOT's guidance on traffic count data, the existing volumes were adjusted, if necessary, for both seasonality and annual growth rates.

The traffic data collected for the study area was obtained during the months of January, February, April, June, July, October, and December. To quantify the seasonal variation of traffic volumes in the area, the MassDOT statewide traffic data 2019 weekday seasonal factors were reviewed based on the roadway classification of the approach to each intersection. For locations where the counts were conducted in months that have traffic volumes slightly lower than average month conditions, each movement was adjusted accordingly to represent average conditions. To provide a conservative analysis, no downward adjustments were made for locations where the counts were conducted in months that have traffic volumes higher than average month conditions. The seasonal adjustment factors are included in the Appendix to this report.

The traffic counts were conducted between 2015 and 2021. As stated previously, MassDOT considers volumes from 2019 to represent "Existing" Conditions. For the counts conducted between 2015 and 2018, the MassDOT Yearly Growth Rates were reviewed based on the roadway classification of the approach to each roadway. Based on those growth rates, the counts conducted between 2015 and

[5] MassDOT Guidance on Traffic Count Data. Apr 2020.

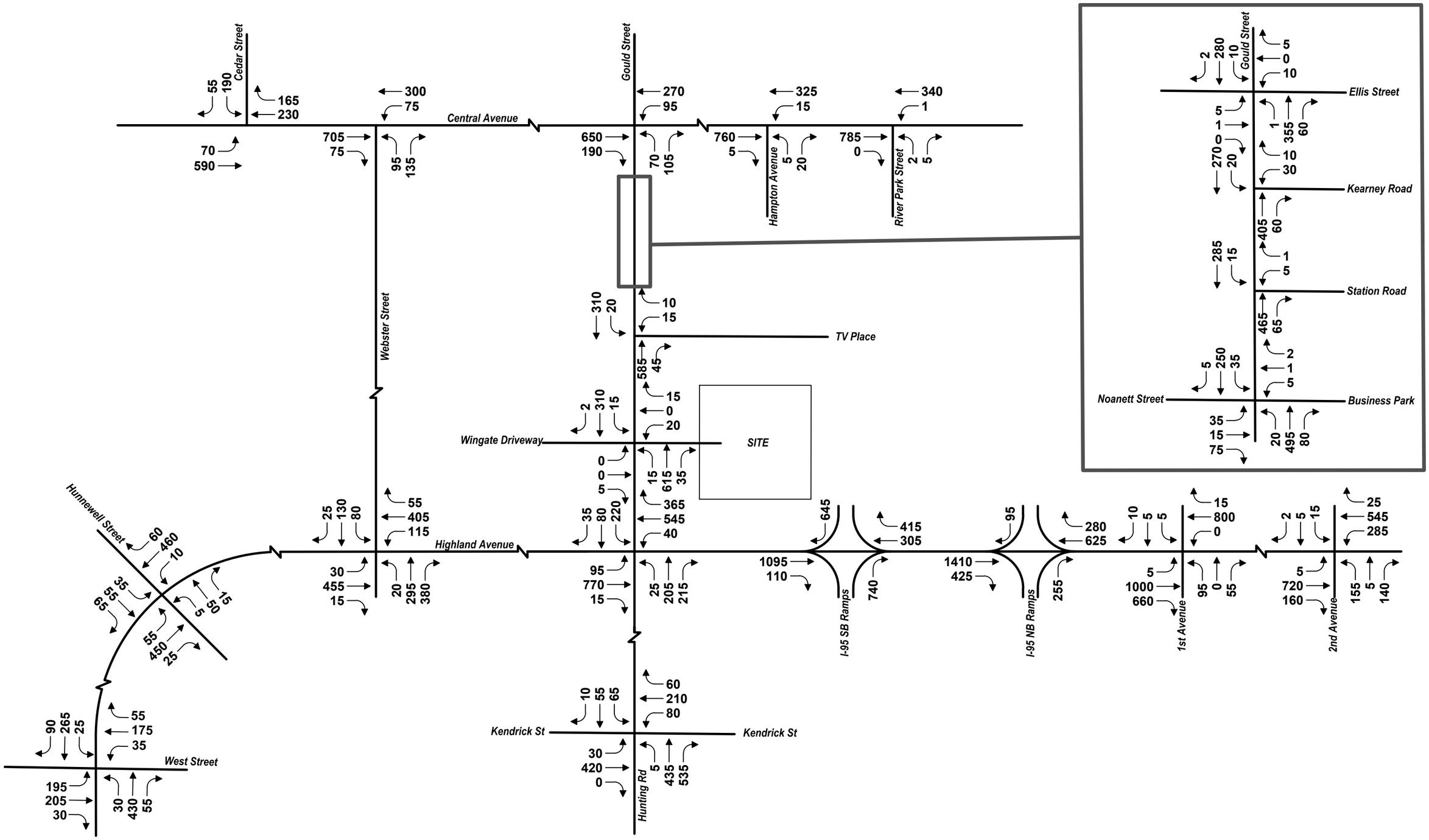
2018 were adjusted accordingly to represent 2019 conditions. The MassDOT yearly growth rate factors are included in the Appendix to this report.

To provide a similar analysis to the Traffic Impact Study completed by GPI in November 2020 to support the rezoning of the Project Site, the volumes used from that study have not been adjusted for seasonal adjustment or annual growth. As stated in the GPI study, the volumes presented in the report have already been adjusted for seasonality. In addition, as stated in that study, a comparison of traffic data between 2015 and 2019 showed that volumes decreased in that period at the intersection of Highland Avenue at Gould Street/ Hunting Road. Therefore, the volumes presented in the GPI study related to the Town of Needham rezoning were not adjusted upward to account for an annual growth rate.

To provide a conservative analysis, traffic volumes were balanced between adjacent intersections where no cross streets intersect the traffic stream. To be consistent with MassDOT's guidance that 2019 volumes represent Existing Conditions, the traffic volumes conducted in 2021 were balanced with adjacent intersections where traffic counts were conducted prior to the start of the COVID-19 pandemic.

2022 Existing Conditions Traffic Volumes

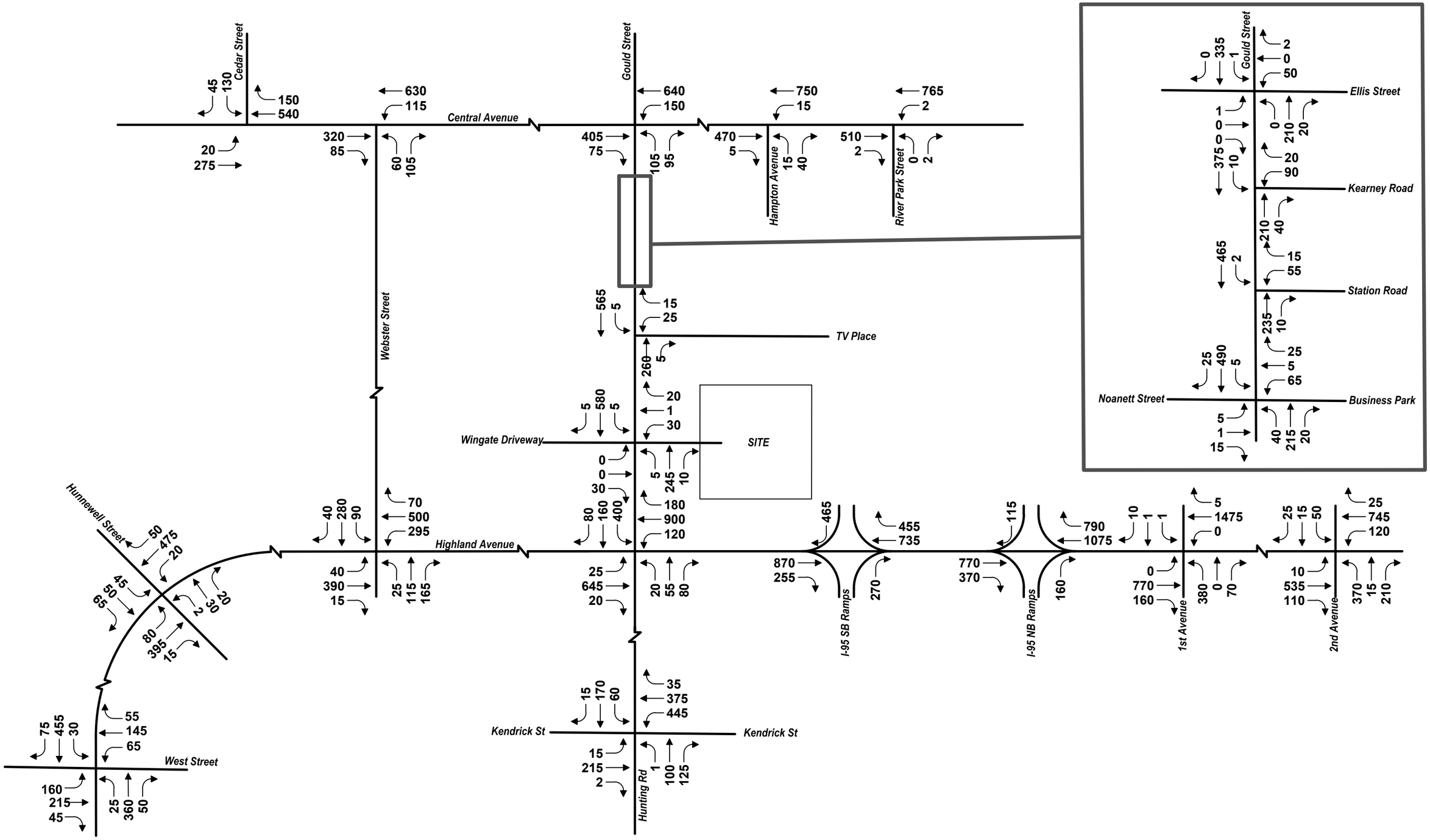
The 2022 Existing Conditions were developed by applying the adjustment factors described above to the counts conducted between 2015 and 2021. Based on MassDOT guidance, the 2022 Existing Conditions represent a pre-pandemic condition and do not take into account any shift in travel patterns caused by the pandemic. The resulting 2022 Existing Conditions weekday morning and weekday evening peak hour traffic volumes are shown in Figures 4, and 5, respectively.



Not to Scale

Existing Conditions Vehicle Volumes
Weekday Morning Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 4



Not to Scale

Existing Conditions Vehicle Volumes
Weekday Evening Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 5

Public Transportation

Public transportation in Needham is provided by the Massachusetts Bay Transportation Authority (MBTA). The proposed development is indirectly served by one MBTA bus route: Bus Route #59. Additional service within close proximity of the Project Site includes the D Branch of the Green Line and the Needham Line of the commuter rail. Figure 6 displays the existing public transportation services provided in the study area. Descriptions of each transit service is provided below, and detailed maps and schedules can be found in the Appendix to this report. The descriptions and analyses of transit services in the area are based on pre-COVID-19 conditions and do not include any temporary changes in service due to COVID-19.

- Bus Route 59 travels between Watertown Square in Watertown and Needham Junction in Needham via Newton. The nearest stops to the Project Site are at the intersections of Hillside Avenue and Webster Street and Central Avenue at Gould Street, both approximately a half mile from the Project Site. Bus Route 59 runs seven days a week and during peak periods has a frequency of approximately 30-40 minutes. Bus Route 59 provides connections to the D Branch of the Green Line at Newton Highlands, to the Needham Line of the commuter rail at Needham Highlands, Needham Center, and Needham Junction, and to the Worcester Line of the MBTA Commuter Rail at Newtonville.
- The D branch of the Green Line connects Newton with Brookline and Boston and travels from Riverside in Newton to Government Center in Downtown Boston. The nearest stop to the Project Site on the D branch of the Green Line is Eliot, approximately two miles northeast of the Project Site on Route 9. Service is provided seven days a week and runs approximately every eight minutes during peak hours.
- The Needham Line of the MBTA Commuter Rail travels between Needham Heights and Back Bay Station and South Station in Boston. The nearest stop to the Project Site is Needham Heights, approximately 0.7 miles southwest of the Project Site on Highland Avenue. Service is provided six days a week, Monday through Saturday; during peak periods, service is provided every 30-50 minutes in peak directions.

Private Shuttle Service

In addition to the MBTA, a private shuttle service is provided in the area by the 128 Business Council. The 128 Business Council operates the Needham Shuttle between the Newton Highlands MBTA Station on the Green Line and different companies in and around the Needham Crossing area that are Council members. The Needham Shuttle runs Monday through Friday and makes seven trips during the weekday morning and weekday evening peak periods. Service is provided approximately every hour between 6:30 AM and 9:22 AM and between 3:15 PM and 6:25 PM. Fares are free for employees who work at member companies and are $4 per ride for non-members. The current nearest stop to the Project Site is at 200 A Street, approximately 3,000 feet east of the Project Site.

Source: NearMap / MBTA 2021 Sytem Map

- Local Bus Stop near Site
- Local Bus Route
- 128 Business Council Needham Private Shuttle Bus Route
- Commuter Rail

Figure 6

Public & Private Transportation

Highland Science Center
Needham, Massachusetts

Active Transportation Infrastructure

Pedestrian Environment

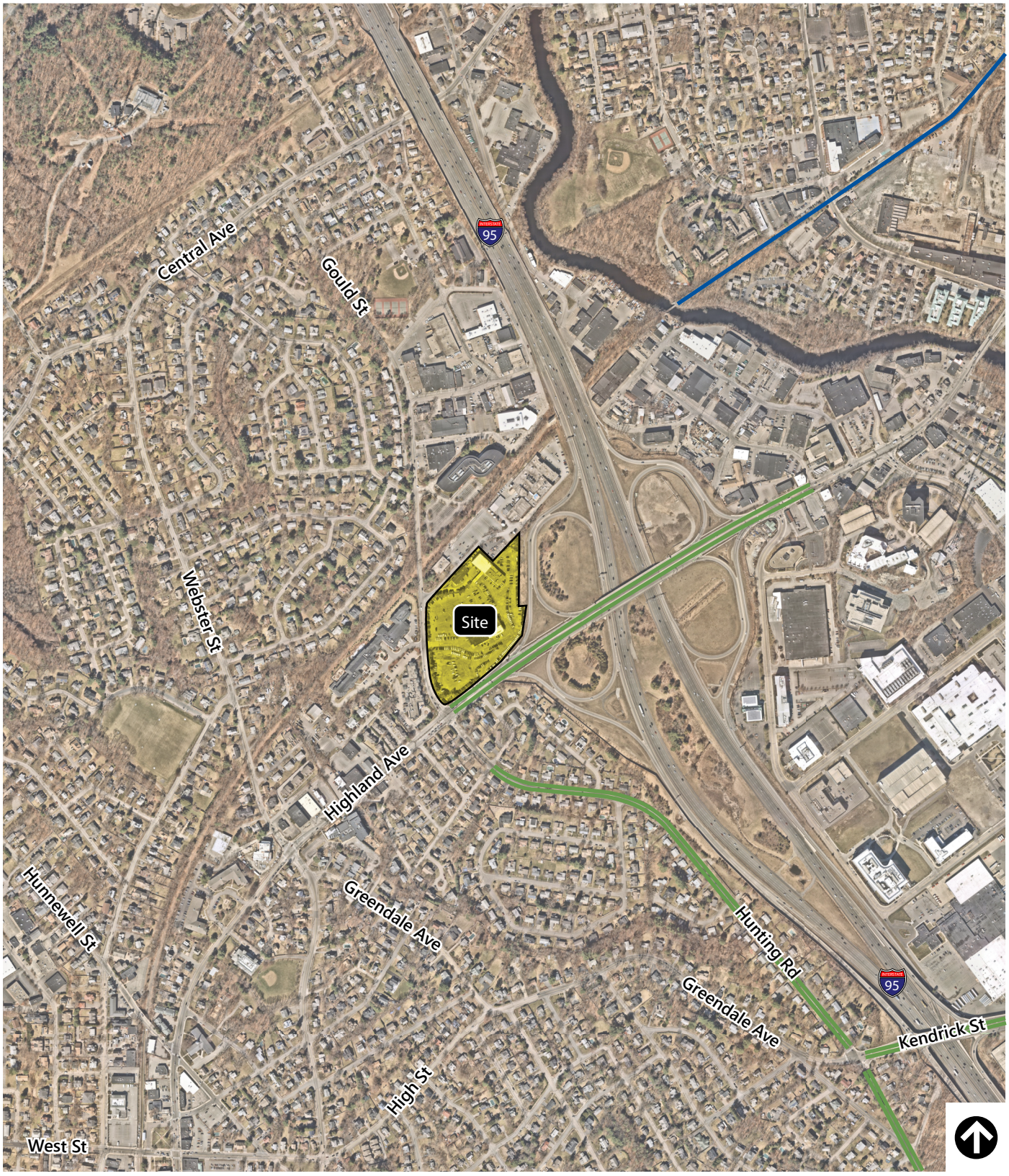
Varying levels of pedestrian accommodations are provided throughout the study area and are representative of the level of pedestrian accommodations throughout Needham. Sidewalks are provided on both sides of all major roadways in the study area, except along the east side of Gould Street between Highland Avenue and Beech Street where the sidewalk terminates in front of the Project Site. Crosswalks are provided at all signalized intersections. At the study area, signalized intersections with pedestrian accommodations provide pedestrian signals for all crosswalks. Crosswalk ramps are provided for most crosswalk approaches, and tactical warning strips are provided on some, but not all, crosswalk ramps.

Significant enhancements to the pedestrian network within the study area are proposed independent of the Project in the next several years.

Bicycle Amenities

Existing dedicated bicycle facilities in the study area are limited. On-street bicycle lanes are provided on both sides of Highland Avenue between Wexford Street and Gould Street/ Hunting Road, on Hunting Road south of Highland Avenue, and on a section of Kendrick Street between Hunting Road and 3rd Avenue. No dedicated on-road bicycle facilities are provided on any of the other study area roadways.

A graphic illustrating the existing pedestrian and bicycle network in the vicinity of the Project Site is provided in Figure 7.



Source: NearMap

Bike Lane

Trail

Figure 7

Existing Bicycle Facilities

Highland Science Center
Needham, Massachusetts

Crash History

A detailed crash analysis was conducted to identify potential vehicle accident trends and/or roadway deficiencies in the traffic study area. The most current vehicle accident data for the traffic study area intersections were obtained from MassDOT for the years 2015 to 2019. The MassDOT database comprises crash data from the Massachusetts Registry of Motor Vehicles (RMV) Division primarily for use in traffic studies and safety evaluations. Data files are provided for an entire city or town for an entire year, though it is possible that some crash records may be omitted either due to individual crashes not being reported, or the municipality's crash records not being provided in a compatible format for RMV use. A summary of the vehicle accident history for the study intersections based on the available RMV data is presented in Table 2 and the detailed crash data is provided in the Appendix to this report for reference.

Crash rates are calculated based on the number of accidents at an intersection and the volume of traffic traveling through that intersection on a daily basis. Rates that exceed MassDOT's average for accidents at intersections in the MassDOT district in which the town or city is located could indicate safety or geometric issues for a particular intersection. For the study area, the calculated crash rates were compared to MassDOT's District 6 average, as Needham is located in District 6. In District 6, the average crash rate is 0.71 for signalized intersections and 0.52 for unsignalized intersections. These rates imply that, on average, 0.71 accidents occurred per million vehicles entering signalized intersections throughout District 6 and 0.52 accidents occurred per million vehicles entering unsignalized intersections in District 6. The locations of some accidents cannot be precisely determined from the database. These locations typically involve interchange intersections. Additionally, some accidents may have occurred but were either not reported or not included in the database, and therefore not considered.

Table 2 Vehicular Crash Summary (2015-2019)

Year	1. Central Ave at Cedar St	2. Central Ave at Webster St	3. Central Ave at Gould St	4. Central Ave at Hampton Ave	5. Central Ave at River Park	6. Gould St at Ellis St	7. Gould St at Kearney Rd
2015	1	1	3	0	2	0	0
2016	0	0	0	0	1	1	0
2017	2	0	6	0	0	0	0
2018	1	0	3	0	0	1	0
2019	0	0	2	1	0	0	0
Total	**4**	**1**	**14**	**1**	**3**	**2**	**0**
Average	0.80	0.20	2.80	0.20	0.60	0.40	0.00
Collision Type							
Angle	0	1	12	0	0	2	0
Front to Front	0	0	0	0	0	0	0
Head-on	0	0	0	0	0	0	0
Rear-end	2	0	2	1	2	0	0
Rear-to-Rear	0	0	0	0	0	0	0
Sideswipe, opp. direction	0	0	0	0	0	0	0
Sideswipe, same dir.	0	0	0	0	0	0	0
Single vehicle crash	2	0	0	0	1	0	0
Unknown/Not reported	0	0	0	0	0	0	0
Total	**4**	**1**	**14**	**1**	**3**	**2**	**0**
Crash Severity							
Fatal injury	0	0	0	0	0	0	0
Non-fatal injury	0	0	2	1	0	0	0
Property damage only	4	1	11	0	3	2	0
Unknown/Not Reported	0	0	1	0	0	0	0
Total	**4**	**1**	**14**	**1**	**3**	**2**	**0**
Time of Day							
Weekday, 7 AM - 9 AM	0	0	1	0	0	0	0
Weekday, 4 PM - 6 PM	0	0	5	0	0	0	0
Saturday, 11 AM - 2 PM	0	0	1	0	0	1	0
Weekday, other time	3	1	6	1	3	1	0
Weekend, other time	1	0	1	0	0	0	0
Total	**4**	**1**	**14**	**1**	**3**	**2**	**0**
Pavement Conditions							
Dry	4	1	11	0	1	1	0
Wet	0	0	1	0	1	0	0
Snow	0	0	1	0	1	1	0
Slush	0	0	0	0	0	0	0
Ice	0	0	0	0	0	0	0
Not reported	0	0	1	1	0	0	0
Other	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0
Total	**4**	**1**	**14**	**1**	**3**	**2**	**0**
Non Motorist (Bike, Ped)	**0**	**0**	**0**	**0**	**0**	**0**	**0**
MassDOT Crash Rates	**0.22**	**0.04**	**0.46**	**0.04**	**0.11**	**0.26**	**0.00**

Table 2 Vehicular Crash Summary (2015-2019) (cont.)

Year	8. Gould St at Station Rd	9. Gould St at Noanett Rd	10. Gould St at TV Place	11. Gould St at Muzi Ford/ Wingate Driveway	12. Highland Ave at West St	13. Highland Ave at Hunnewell St	14. Highland Ave at Webster St
2015	0	0	0	0	6	1	2
2016	0	0	0	0	3	1	3
2017	0	0	0	0	5	1	0
2018	0	0	0	2	3	3	2
2019	0	0	0	0	5	2	2
Total	**0**	**0**	**0**	**2**	**22**	**8**	**9**
Average	0.00	0.00	0.00	0.40	4.40	1.60	1.80
Collision Type							
Angle	0	0	0	0	8	5	1
Front to Front	0	0	0	0	0	0	0
Head-on	0	0	0	1	1	0	0
Rear-end	0	0	0	1	4	2	6
Rear-to-Rear	0	0	0	0	0	0	0
Sideswipe, opp. direction	0	0	0	0	0	0	0
Sideswipe, same dir.	0	0	0	0	6	0	0
Single vehicle crash	0	0	0	0	3	1	2
Unknown/Not reported	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**2**	**22**	**8**	**9**
Crash Severity							
Fatal injury	0	0	0	0	0	0	0
Non-fatal injury	0	0	0	1	2	0	3
Property damage only	0	0	0	0	19	8	6
Unknown/Not Reported	0	0	0	1	1	0	0
Total	**0**	**0**	**0**	**2**	**22**	**8**	**9**
Time of Day							
Weekday, 7 AM - 9 AM	0	0	0	1	2	1	0
Weekday, 4 PM - 6 PM	0	0	0	0	3	2	0
Saturday, 11 AM - 2 PM	0	0	0	1	0	1	0
Weekday, other time	0	0	0	0	13	2	5
Weekend, other time	0	0	0	0	4	2	4
Total	**0**	**0**	**0**	**2**	**22**	**8**	**9**
Pavement Conditions							
Dry	0	0	0	2	18	7	4
Wet	0	0	0	0	3	1	4
Snow	0	0	0	0	0	0	0
Slush	0	0	0	0	0	0	0
Ice	0	0	0	0	0	0	0
Not reported	0	0	0	0	1	0	0
Other	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	1
Total	**0**	**0**	**0**	**2**	**22**	**8**	**9**
Non Motorist (Bike, Ped)	**0**	**0**	**0**	**0**	**3**	**0**	**1**
MassDOT Crash Rates	**0.00**	**0.00**	**0.00**	**0.11**	**0.86**	**0.35**	**0.29**

Table 2 Vehicular Crash Summary (2015-2019) (cont.)

Year	15.Highland Ave at Gould St/ Hunting Rd	16. Highland Ave at I-95 SB Ramps	17. Highland Ave at I-95 NB Ramps	18.Highland Ave at 1st Ave	19. Highland Ave at 2nd Ave	20. Hunting Rd at Kendrick St
2015	5	0	8	1	4	5
2016	6	1	2	8	7	3
2017	4	3	2	4	4	3
2018	4	0	1	3	9	4
2019	5	2	0	8	9	5
Total	**24**	**6**	**13**	**24**	**33**	**20**
Average	4.80	1.20	2.60	4.80	6.60	4.00
Collision Type						
Angle	6	0	0	6	9	9
Front to Front	0	0	0	0	0	0
Head-on	0	0	0	0	2	0
Rear-end	6	5	12	7	6	4
Rear-to-Rear	0	0	0	0	1	0
Sideswipe, opp. direction	0	0	0	0	2	0
Sideswipe, same dir.	8	0	0	9	7	2
Single vehicle crash	2	1	1	1	5	4
Unknown/Not reported	2	0	0	1	1	1
Total	**24**	**6**	**13**	**24**	**33**	**20**
Crash Severity						
Fatal injury	0	0	0	0	0	0
Non-fatal injury	4	1	4	4	2	5
Property damage only	18	5	9	20	31	14
Unknown/Not Reported	2	0	0	0	0	1
Total	**24**	**6**	**13**	**24**	**33**	**20**
Time of Day						
Weekday, 7 AM - 9 AM	3	4	3	8	5	2
Weekday, 4 PM - 6 PM	4	0	1	1	2	1
Saturday, 11 AM - 2 PM	1	0	1	0	1	0
Weekday, other time	12	1	5	13	22	12
Weekend, other time	4	1	3	2	3	5
Total	**24**	**6**	**13**	**24**	**33**	**20**
Pavement Conditions						
Dry	17	5	13	20	24	14
Wet	6	0	0	2	7	3
Snow	0	0	0	0	0	0
Slush	0	0	0	0	0	1
Ice	0	0	0	0	0	1
Not reported	0	1	0	2	0	1
Other	1	0	0	0	1	0
Unknown	0	0	0	0	1	0
Total	**24**	**6**	**13**	**24**	**33**	**20**
Non Motorist (Bike, Ped)	**0**	**0**	**0**	**0**	**2**	**2**
MassDOT Crash Rates	**0.44**	**0.10**	**0.20**	**0.41**	**0.64**	**0.63**

As shown in Table 2, the accident data indicates that the intersection of Highland Avenue at West Street is the only study area intersection above the district crash rate averages.

The majority of crashes throughout the study area were angle crashes and rear-end crashes occurring on dry pavement resulting in property damage only. Based on the MassDOT records, there were no fatal accidents that occurred within the study area during the five-year period studied. The intersection that saw the highest number of crashes involving pedestrians or bicycles was the intersection of Highland Avenue at West Street, which saw three crashes involving pedestrians or bicyclists over the five-year period.

Several of the study area intersections have been reconstructed in recent years or are expected to be reconstructed in future years as part of the MassDOT roadway reconstruction project. These improvements are not reflected in the crash data presented in Table 2 and will address some of the existing safety concerns. The intersections of Highland Avenue at the I-95 Northbound and Southbound Ramps were reconstructed in 2017 and the intersection of Highland Avenue at 1st Avenue was reconstructed in 2018. In addition, several other study area intersections on Highland Avenue are expected to be reconstructed within the next few years. However, all the crash data presented above is from 2015-2019 and does not fully reflect these recent or future improvements.

Highway Safety Improvement Program

In addition to calculating the crash rate, study area intersections also were reviewed in the MassDOT's Highway Safety Improvement Program (HSIP) database. An HSIP-eligible cluster is one in which the total number of "equivalent property damage only"[6] crashes in the area is within the top 5 percent of all clusters in that region. Being HSIP-eligible makes the location eligible for FHWA and MassDOT funds to address the identified safety issues at these locations.

None of the study area intersections are potential HSIP-eligible clusters based on the most recently available data at the time of the HSIP review.

[6] Equivalent property damage only" is a method of combining the number of crashes with the severity of the crashes based on a weighted scale. Crashes involving property damage only are reported at a minimal level of importance, while collisions involving personal injury (or fatalities) are weighted more heavily.

Future Conditions

Traffic volumes in the study area were projected to the year 2029, reflecting a typical seven-year traffic-planning horizon as required by MassDOT. Independent of the Project, volumes on the roadway network under year 2029 No Build Condition were assumed to include existing traffic and new traffic resulting from background traffic. Anticipated Site-generated traffic volumes were added to the 2029 No Build Condition traffic volumes to reflect the 2029 Build Condition in the study area.

2029 No Build Condition

Traffic volumes in the study area were projected to a seven-year traffic-planning horizon. Independent of the Project, volumes on the roadway network under the future 2029 No Build condition were assumed to include existing traffic and new traffic resulting from background traffic growth. Under the Build condition, Project generated traffic volumes were added to the No-Build volumes to reflect the Build conditions within the Project study area.

Background Traffic Growth

Traffic growth on area roadways is a function of the expected land development, economic activity, and changes in demographics. Several methods can be used to estimate this growth. A procedure frequently employed is to estimate an annual percentage increase and apply that increase to study area traffic volumes. An alternative procedure is to identify estimated traffic generated by planned new major developments that would be expected to impact the Project study area roadways. For the purpose of this assessment, both methods were considered.

Historic Traffic Growth

Historic traffic data and previously submitted traffic studies in the vicinity of the Project Site were reviewed to determine an appropriate growth rate. Based on this research and correspondence with the Town of Needham, a growth rate of 1.0 percent was determined to be appropriate for this study. This growth rate is consistent with the Traffic Impact Study prepared by GPI to support the rezoning of the Project Site, which was submitted in November 2020, and overlaps with a majority of the study area.

Project-Specific Growth

In addition to accounting for background growth, the traffic associated with other planned and/or approved developments near the Project Site was also considered. Based on research by VHB and discussions with the Town of Needham, it was determined that there are several planned development projects within the vicinity of the study area that would need to be considered as part of the future traffic conditions, independent of the Project. The planned/approved projects are described below in detail and the traffic volumes associated with them have been included in the No-Build and Build conditions. The associated traffic volumes are included in the Appendix to this report.

- **100 West Street** – This project involves the conversion of a former mill building into 83 assisted living units and 72 independent senior living units. Projected traffic volumes expected to be generated by this project were obtained from the published traffic study submitted as part of the permitting process for the project.
- **Newton Northland Development** – This project involves the redevelopment of 22.6 acres of land on the corner of Needham Street and Oak Street in Newton, Massachusetts. The project will include approximately 1.4 million SF of development including 193,200 SF of office space, 115,100 SF of retail/commercial space, and 800 residential units. Projected traffic volumes expected to be generated by this project were obtained from the published traffic study submitted as part of the permitting process for the project.
- **Boston Children's Hospital at Founders Park** – This project involves the full build-out of the Founders Park development by Boston Children's Hospital. The project will include an approximately 224,000 SF pediatric ambulatory center and 228,000 SF of office space for the hospital. Projected traffic volumes expected to be generated by this project were obtained from the published traffic study submitted as part of the permitting process for the project.
- **589 Highland Avenue** – This project involves the conversion of 142-bed nursing home into 50 independent living units at the existing Wingate at Needham development. Based on a review of estimated trip generation for the existing and proposed uses, the project is expected to result in a net decrease in trips. Therefore, this project is mentioned for reference purposes only and no trips were added or removed from the roadway network to provide a conservative analysis.

Roadway Improvements

In assessing future traffic conditions, proposed and recently completed roadway improvements within the study area were considered. Based on research by VHB and discussions with the Town of Needham and MassDOT, there is one project that may affect traffic volumes within the seven-year horizon and was incorporated into the No-Build and Build condition traffic analyses. The proposed roadway improvement project is described in detail below:

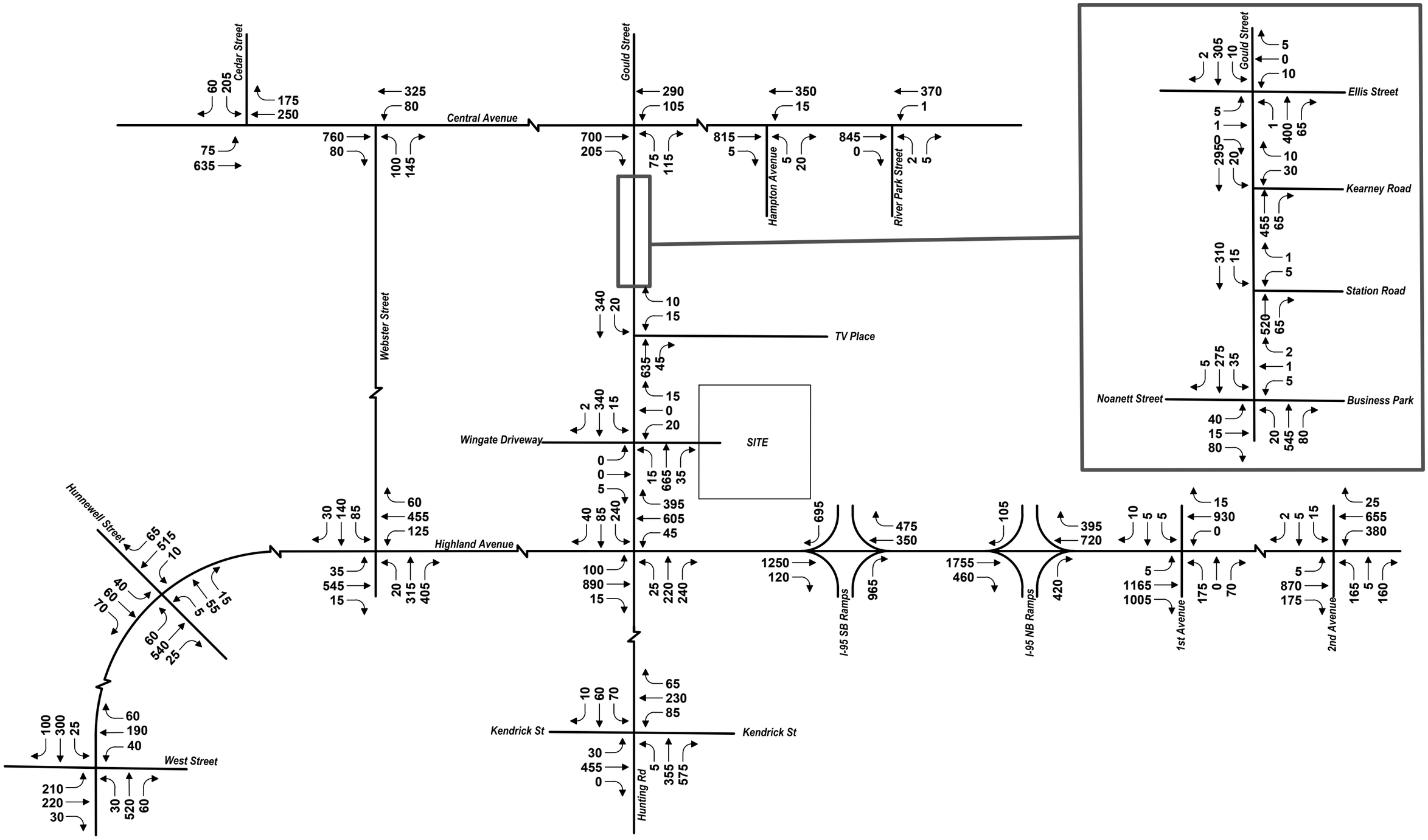
- **Needham-Newton Corridor Project** – This project involves the redesign of Highland Avenue, Needham Street, and Winchester Street in Needham and Newton (MassDOT Project No. 606635). The project involves reconstruction of portions of these three roadways to improve traffic operations, safety, and multimodal accommodations and includes three different segments: Highland Avenue from Webster Street to the I-95 Southbound ramps, Highland Avenue from Wexford Street to Needham Street just west of Oak Street (including the bridge over the Charles

River), and Needham Street from just east of Oak Street to Winchester Street at the Route 9 Eastbound ramps. The project will involve the following improvements:

- New traffic signals at the intersections of Needham Street at Charlemont Street, Winchester Street at Route 9 EB Service Road, and Winchester Street at Route 9 WB Service Road;
- Updated signal timings throughout the corridor to include leading pedestrian intervals and adaptive signal timing technology;
- Raised bike lanes / multiuse off-road paths throughout the corridor;
- Reconstructed sidewalks;
- Seven additional crosswalks: four at signalized intersections and three unsignalized with Rectangular Rapid Flashing Beacons along Needham Street south of Industrial Place, north of Jaconnet Street, and south of Easy Street;
- Additional left-turn lanes along Highland Avenue at unsignalized intersections east of I-95/Route 128; and
- Construction of cantilevered shared use paths on both sides of the bridge over the Charles River to allow for two northbound travel lanes and one southbound travel lane on the bridge.

No-Build Traffic Volumes

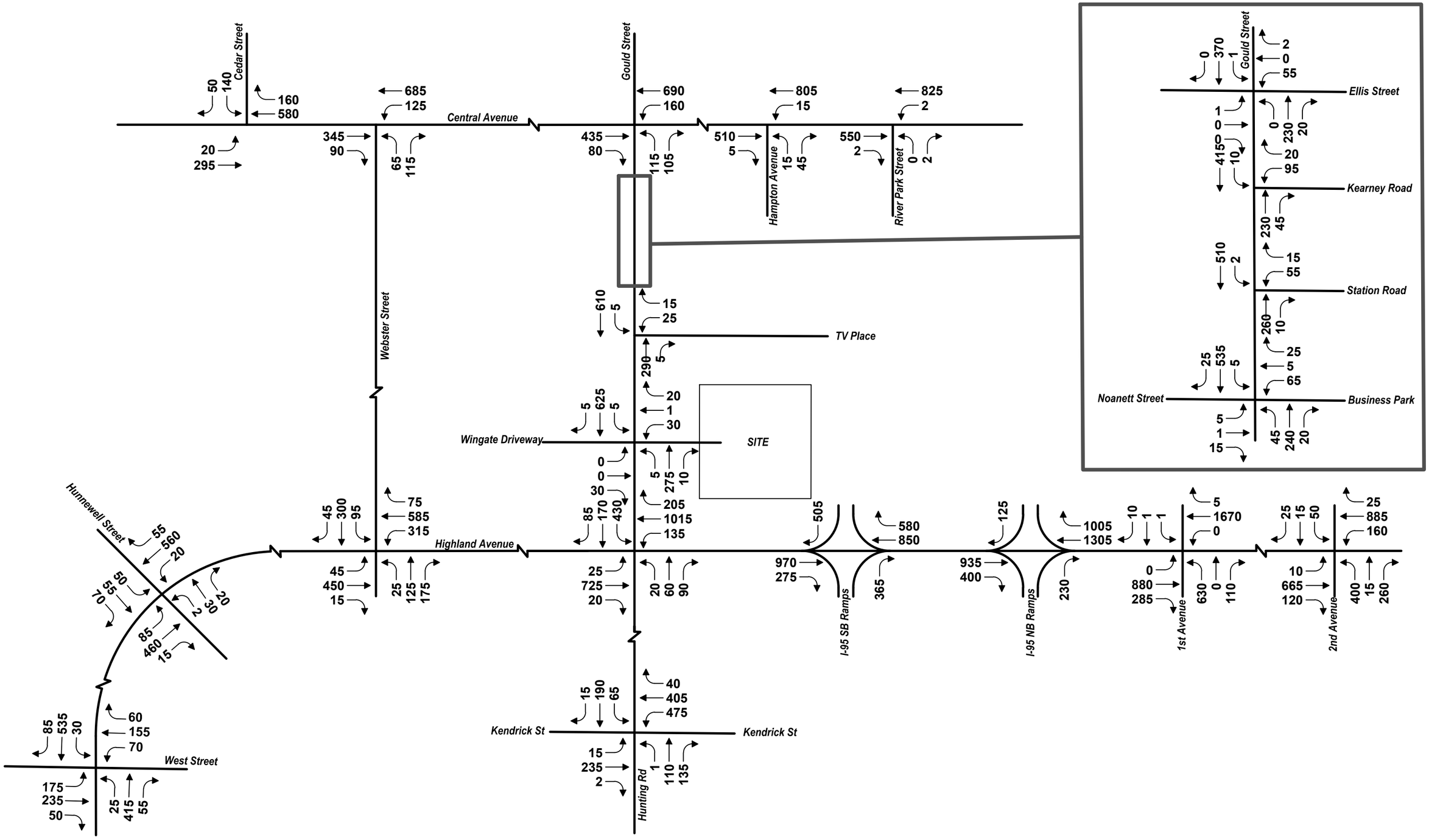
The 2029 No-Build traffic volumes were developed using a growth rate of 1.0 percent per year and adding in the background projects and roadway improvement projects described above. The resulting 2029 No-Build weekday morning and weekday evening peak hour traffic volume networks are illustrated in Figures 8 and 9, respectively.



Not to Scale

No-Build Conditions Vehicle Volumes
Weekday Morning Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 8



Not to Scale

No-Build Conditions Vehicle Volumes
Weekday Evening Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 9

2029 Build Condition

The rate at which any proposed development generates traffic is dependent upon the size, location, and concentration of surrounding developments. As described previously, the Project comprises office, research & development, and retail uses. The ITE *Trip Generation Manual*[7] categorizes these land uses and provides weekday daily, weekday morning, and weekday evening peak hour unadjusted vehicle trip generation estimates for each use. The trip generation estimates for the proposed uses were projected using the following Land Use Codes:

- LUC 710 – General Office Building
- LUC 760 – Research and Development Center
- LUC 822 – Retail Plaza (<40,000 SF)

Project Trip Generation

Estimating future conditions volumes for the Project Site involved a review of the existing development on those parcels, along with the additional trip generation expected from the Project. Adjustments for the site-generated traffic were made based on internal capture rates and pass-by trips.

Existing Site-Generated Traffic

The Site currently is occupied by a former car dealership and car wash. Prior to the closure of these businesses in the Fall of 2021, counts of the Project Site were conducted by VHB in July 2021.

Table 3 summarizes the traffic counts for the existing uses on-Site. The count sheets are included in the Appendix to this report.

Table 3 Existing Site-Generated Trips

	Existing Site Trips [a]
Weekday Daily	
Enter	410
Exit	477
Total	887
Weekday Morning	
Enter	37
Exit	24
Total	61
Weekday Evening	
Enter	29
Exit	57
Total	86

a Based on actual counts by VHB in July 2021.

7 Trip Generation Manual, 11th Edition, Institute of Transportation Engineers, Washington, D.C., 2021.

As shown in Table 3, the existing Site with a car dealership and car wash generated approximately 887 vehicle trips (410 entering/ 477 exiting) over the course of a typical weekday in July 2021, with approximately 61 vehicle trips (37 entering/ 24 exiting) during the weekday morning peak hour and 86 vehicle trips (29 entering/ 57 exiting) during the weekday evening peak hour.

As stated previously, the former uses also likely generated similar, or higher, volumes on weekends. Specifically, car washes are generally busier on weekends than on weekdays because people are more likely to get their vehicles washed on weekends. However, because the Project will consist of mostly office and lab space, the Project Site in the future will generate most trips during the weekday peak periods. Therefore, this study focuses on the roadway impacts of the Project Site-generated trips during an average weekday during traditional morning and evening peak commuter periods.

In addition, trips generated by the car wash were likely to vary by season based on demand, with volumes typically highest in the Winter and lowest in the Summer. Because the existing traffic counts were conducted in July, the Project Site-generated volumes presented in Table 2-3 may represent below-average conditions for the former uses.

The former Wash World typically handled up to 18,000 car washes per month, based on review of sales data and conversation with the former operator. This level of activity translates to about 600 washes/day during peak months (which tend to be during the winter). However, to provide a conservative analysis of the impacts of the Project, and in particular to conservatively assess appropriate infrastructure improvements that will be needed along both Gould Street and Highland Avenue, the existing site-generated trips counted in July 2021 were not adjusted to account for the seasonality of trips generated by the former car wash.

Unadjusted Project-Generated Traffic

The proposed development will consist of a mixture of office, lab, and supporting retail uses. Specifically, the Project is proposed to include approximately 248,347 SF of office space, approximately 248,347 SF of lab space, and approximately 10,000 SF of supporting retail uses.

In March 2022, an Environmental Notification Form (ENF) was submitted for the Project based on a building program of up to 260,500 SF of office space, 260,500 SF of lab space, and 10,000 SF of supporting retail uses. The ENF included a transportation impact and access study based on those proposed square footages. To be consistent with the trip generation and the intersection capacity analyses presented in the ENF, the Project-generated trips presented in this report are also based on the larger building program. This provides a conservative analysis of the trip generation impact of the Project and presents a "worst-case" scenario of the Project's impacts on the roadway network.

Traffic associated with the office space was estimated using ITE LUC 710, traffic associated with the lab space was estimated using ITE LUC 760, and traffic associated with the retail uses was estimated with ITE LUC 822. The retail uses are expected to be smaller businesses catering to the employees on-site and nearby residential neighbors. Potential uses will include small eating establishments, coffee shops, or convenience store uses. While these do not fit the exact description of a traditional ITE "Strip Retail Plaza," retail traffic was estimated using this land use code, which results in an overly conservative (likely high) estimate of traffic associated with this specific use.

The unadjusted vehicle trip estimates are presented in Table 4, and trip generation worksheets are included in the Appendix to this report.

Table 4 Project Trip Generation – ITE Unadjusted Vehicle Trips

	Office [a]	R&D [b]	Retail [c]	Total Unadjusted Vehicle Trips
Weekday Daily				
Enter	1,335	1,387	326	**3,048**
Exit	1,335	1,387	326	**3,048**
Total	2,669	2,775	652	**6,096**
Weekday Morning				
Enter	336	210	17	**563**
Exit	46	46	12	**104**
Total	381	256	29	**667**
Weekday Evening				
Enter	62	39	39	**140**
Exit	305	205	39	**549**
Total	368	244	78	**689**

a Based on ITE LUC 710 (General Office Building) for 260,500 SF, providing a conservative estimate for the currently proposed 248,347 SF of office space.

b Based on ITE LUC 760 (Research and Development Center) for 260,500 SF, providing a conservative estimate for the currently proposed 248,347 SF of lab space.

c Based on ITE LUC 822 (Strip Retail Plaza (<40,000 sf)) for 10,000 SF.

Internal Capture Trips

Because the proposed development is a mixed-use project, the trip generation characteristics of the Project Site will be different from a single-use project. Some of the traffic to be generated by the proposed development will be contained on the Project Site as "internal" or "shared vehicle" trips. For example, workers at the office space on site may patronize the retail uses during lunch or after work. While these shared trips represent new traffic to the individual uses, they would not show up as new vehicle trips on the surrounding roadway network.

As described in the ITE Trip Generation Handbook:

> *because of the complementary nature of these land uses, some trips are made among the on-site uses. This capture of trips internal to the Site has the net effect of reducing vehicle trip generation between the overall development Site and the external street system (compared to the total number of trips generated by comparable land uses developed individually on stand-alone sites) an internal capture rate can generally be defined as the percentage of total person trips generated by a site that are made entirely within the site. The trip origin, destination, and travel path are all within the site.*

Based on the methodology outlined in the ITE Trip Generation Handbook, internal capture rates were applied to the gross person trips. The internal capture rate calculations are included in the Appendix to this report.

Mode Share

It is expected that visitors and commuters to the Project Site will use a variety of transportation options, including private vehicles, walking, bicycling, and public transportation. The Project is connected to the rest of Needham with sidewalks, and the roadway improvements along Highland

Avenue will include separated bicycle facilities providing a connection between the Project Site and Newton. While public transit is provided within Needham, the nearest public transit to the Project Site is located approximately 0.5 miles north, with MBTA bus route 59 traveling on Central Avenue.

To provide a conservative analysis and to account for the lack of public transit immediately serving the Project Site, no mode share credits are applied to the trip generation estimates and the Project-generated trips assume that 100-percent of the Project Site traffic will access the Project Site via private vehicles.

Pass-By Trips

While the ITE rates provide estimates for all the traffic associated with each land use, not all of the traffic generated by the Project will be new to the area roadways. A portion of the vehicle-trips generated by the retail land use will likely be drawn from the traffic volume roadways adjacent to the Project Site. For example, someone traveling on Gould Street may choose to deviate from their original travel path to visit the Project Site retail, before heading back to continue to their final destination. For this evaluation, ITE pass-by rates for LUC 821 (Shopping Plaza) were utilized for the retail trip generation and applied to existing trips on Gould Street. Specifically, 40 percent of the Project Site trip generation was assumed to be drawn from the surrounding roadway network during the weekday evening peak hour, as outlined in the ITE Trip Generation Manual. All other time periods studied assume a 25 percent pass-by rate.

Project-Generated Trips

As described above, internal capture credit and pass-by credit for the Project was applied to the unadjusted new vehicle trips presented in Table 4 to develop the net trips expected to be generated by the Project Site. Table 5 presents the Project-generated net new trips.

Table 5 Project-Generated Trips

	Adjusted Vehicle Trips [a]						
	Office	R&D	Retail	Total	Pass-By [b]	Existing Site Trips [c]	Total Net New Vehicle Trips
Weekday Daily							
Enter	1,330	1,382	313	**3,025**	(-79)	(-410)	**2,536**
Exit	1,328	1,381	316	**3,025**	(-79)	(-477)	**2,469**
Total	2,658	2,763	629	**6,050**	(-158)	(-887)	**5,005**
Weekday Morning							
Enter	334	209	11	**554**	(-2)	(-37)	**515**
Exit	42	44	9	**94**	(-2)	(-24)	**68**
Total	376	253	20	**649**	(-4)	(-61)	**584**
Weekday Evening							
Enter	62	39	36	**136**	(-15)	(-29)	**92**
Exit	303	204	38	**545**	(-15)	(-57)	**473**
Total	365	242	74	**681**	(-30)	(-86)	**565**

a Includes adjustments for internal capture between retail and office/lab uses.
b Pass-by includes trips for the retail uses already traveling on the roadway network under Existing Conditions.
c Existing Site-Generated trips based on empirical counts conducted by VHB in July 2021.

As shown in Table 5, the Project is expected to generate a total of 6,050 daily trips during an average weekday and 649 and 681 new vehicle trips during the respective weekday morning and weekday evening peak hours. However, these totals include traffic already being generated by the Project Site under existing conditions as well as pass-by trips currently on the roadway network. After considering this existing traffic generation and pass-by, the Project will result in an additional 5,005 vehicle trips (2,536 entering/ 2,469 exiting) over the course of a typical weekday, with approximately 584 vehicle trips (515 entering/68 exiting) during the weekday morning peak hour and 565 vehicle trips (92 entering/473 exiting) during the weekday evening peak hour.

Rideshare Trip Generation

In the past decade, a rapidly increasing mode of transportation has been the use of transportation network companies (TNCs), such as Uber and Lyft. That said, it is difficult from a trip generation perspective to estimate the total number of TNC users on any given day. Many riders use TNCs for shopping or entertainment purposes and alternate TNC trips with transit and private vehicle trips. In addition, because the popularity of TNCs is a relatively new phenomenon, ITE does not provide any hard data on the effects of TNCs on trip generation.

It is expected that during the peak hours analyzed, the primary reason for travel to and from the Project Site will be for commuting between people's homes and workplaces. It is likely that a higher percentage of TNC trips will be made during off-peak hours when people are more likely to be traveling for non-work activities. In addition, in the build year 2029 it is unknown what share of trips will be done via TNCs. Seven years prior to 2022 TNCs were just starting to have a notable presence in the Boston area and today they are a regular feature on all area roadways. As such, it would be challenging to forecast the share of TNC trips seven years into the future due to changing travel patterns and technology. Therefore, a separate TNC mode share percentage has not been developed and it is included in the vehicle mode shares presented in the previous sections.

Comparison to Previous Zoning Traffic Study

As noted previously, GPI prepared a Traffic Impact Study in November 2020 to support the rezoning of the Project Site. In that study, a trip generation analysis was conducted estimating the number of new trips that could be generated by the Muzi site and the adjacent Channel 5 site. A comparison of the trip generation presented in the 2020 traffic study with the currently proposed trip generation is provided below in Table 6.

Table 6 Trip Generation Comparison for Previous Zoning Traffic Study

	Currently Proposed Project [a]	Rezoning Assessment [b]	Difference
Weekday Daily			
Enter	**2,536**	4,494	**(-1,958)**
Exit	**2,469**	4,494	**(-2,025)**
Total	**5,005**	8,988	**(-3,983)**
Weekday Morning			
Enter	**515**	625	**(-110)**
Exit	**68**	-5	**+73**
Total	**583**	620	**(-37)**
Weekday Evening			
Enter	**92**	126	**(-34)**
Exit	**473**	743	**(-270)**
Total	**565**	869	**(-304)**

a Total Net New Vehicle Trips as reported in Table 5.

b New Primary Trips for the "No Residential" trip generation alternative (Table 2), Traffic Impact Study to support rezoning of the Muzi site, GPI, November 2020.

As shown in Table 6, the current Project is expected to generate significantly less traffic than what was estimated in the 2020 traffic study supporting the rezoning effort. During the weekday morning and weekday evening peak hours, the Project is expected to generate approximately 37 and 204 fewer trips, respectively, than what was analyzed in the 2020 rezoning memo. Overall, the Project trip generation is estimated to be over 40 percent lower than that estimated during the rezoning effort.[8]

Project Trip Distribution

The directional distribution of the traffic approaching and departing the Project Site is a function of population densities, the location of employment opportunities, existing travel patterns, and the efficiency of the roadway system. Trips made to and from the proposed office/laboratory spaces during the peak hours are expected to be predominantly home-to-work and work-to-home trips in the morning and evening peak hours, respectively. Accordingly, the trip distribution for the office/laboratory portions of the proposed development has been derived based on Journey-to-Work data for the City of Needham with the 2010 U.S. Census data. The retail-generated trips are expected to follow trip distribution patterns similar to the office and lab uses.

Table 7 provides a summary of the trip distribution. Detailed trip distribution calculations are provided in the Appendix to this report.

[8] It should be noted that the traffic study prepared by GPI to support the rezoning of the site assumed redevelopment of both the Muzi parcel and the Channel 5 parcel. The current proposed Project does not include the Channel 5 parcel, and trips generated by the Channel 5 studios are assumed to remain on the network in the 2029 Build Conditions

Table 7 Trip Distribution Summary

Travel Route	Direction	Trips
I-95 North	North	32%
I-95 South	South	32%
Needham Street	East	7%
Highland Avenue	West	7%
Central Street	East	7%
Central Street	West	5%
Kendrick Street	East	4%
Cedar Street	North	3%
West Street	West	3%
Total		100%

Source: 2010 US Census Data

Figure 10 provides an illustration of the Project Site trip distribution.

Vehicles will be able to access the Project Site via Gould Street from both the main driveway across from the Wingate driveway and from TV Place. The trip distribution calculations assume that of the Project Site-generated trips accessing the Project Site to/from the south on Gould Street, 80-percent will use the main Project Site driveway and 20-percent will use TV Place. Conversely, of the Project Site-generated trips accessing the Project Site to/from the north on Gould Street, it is assumed that 20-percent will use the main Project Site driveway and 80-percent will use TV Place to access the Project Site.

Project Trip Assignment

The Project-related traffic volumes for the Build Condition are assigned to the study area roadway network based on the trip distribution patterns shown in Table 7. The assigned volumes are then added to the 2029 No-Build peak hour traffic volume networks to develop the 2029 Build Condition for the weekday morning and weekday evening peak hour traffic volume networks, respectively. The site-generated trip traffic volume networks for the morning and evening peak periods are shown in Figures 11 and 12.

The 2029 Build Condition traffic volumes are shown in Figures 13 and 14 for the weekday morning and weekday evening, respectively.

Source: NearMap

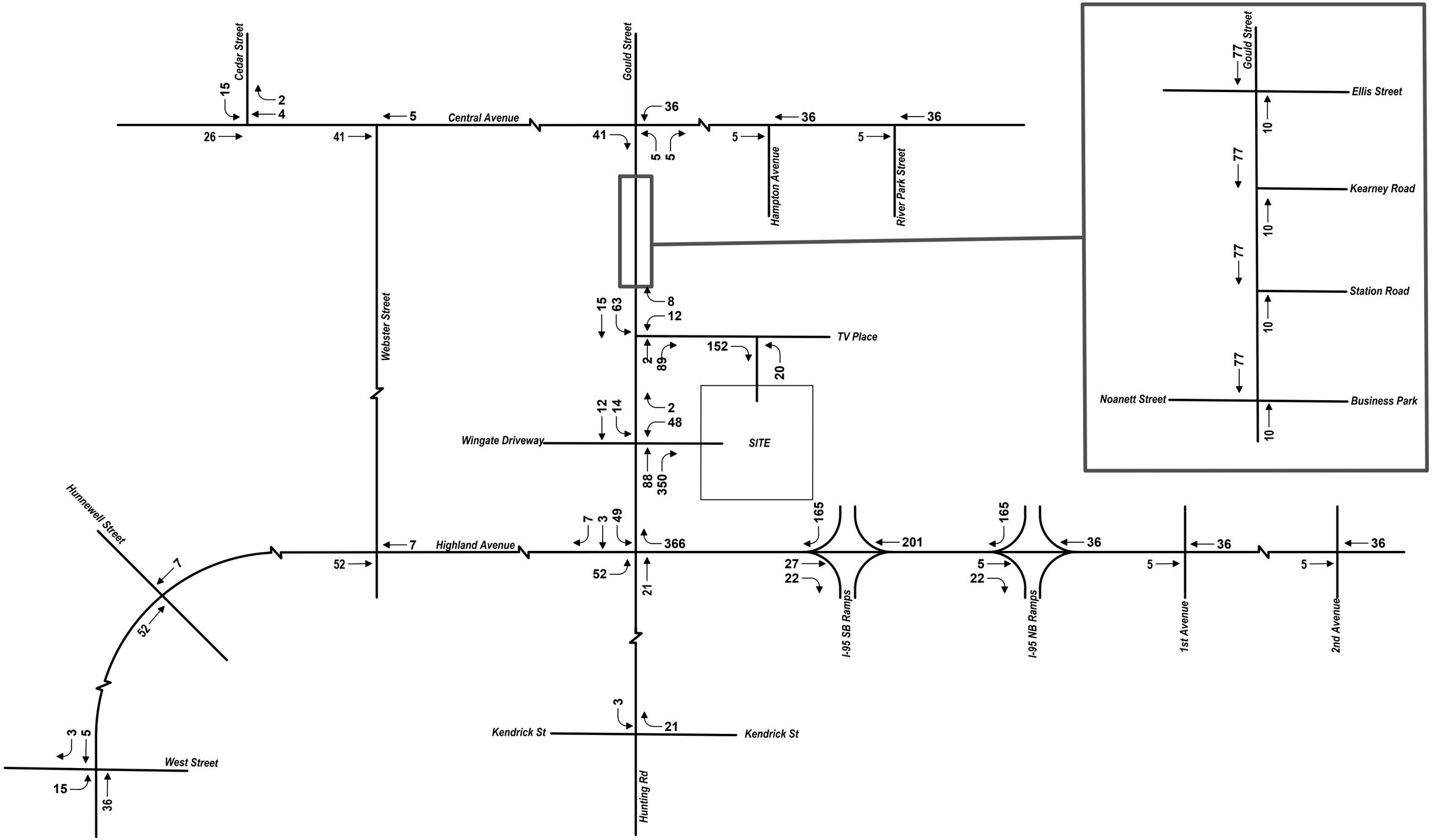
% Outbound

% Inbound

Figure 10

Trip Distribution

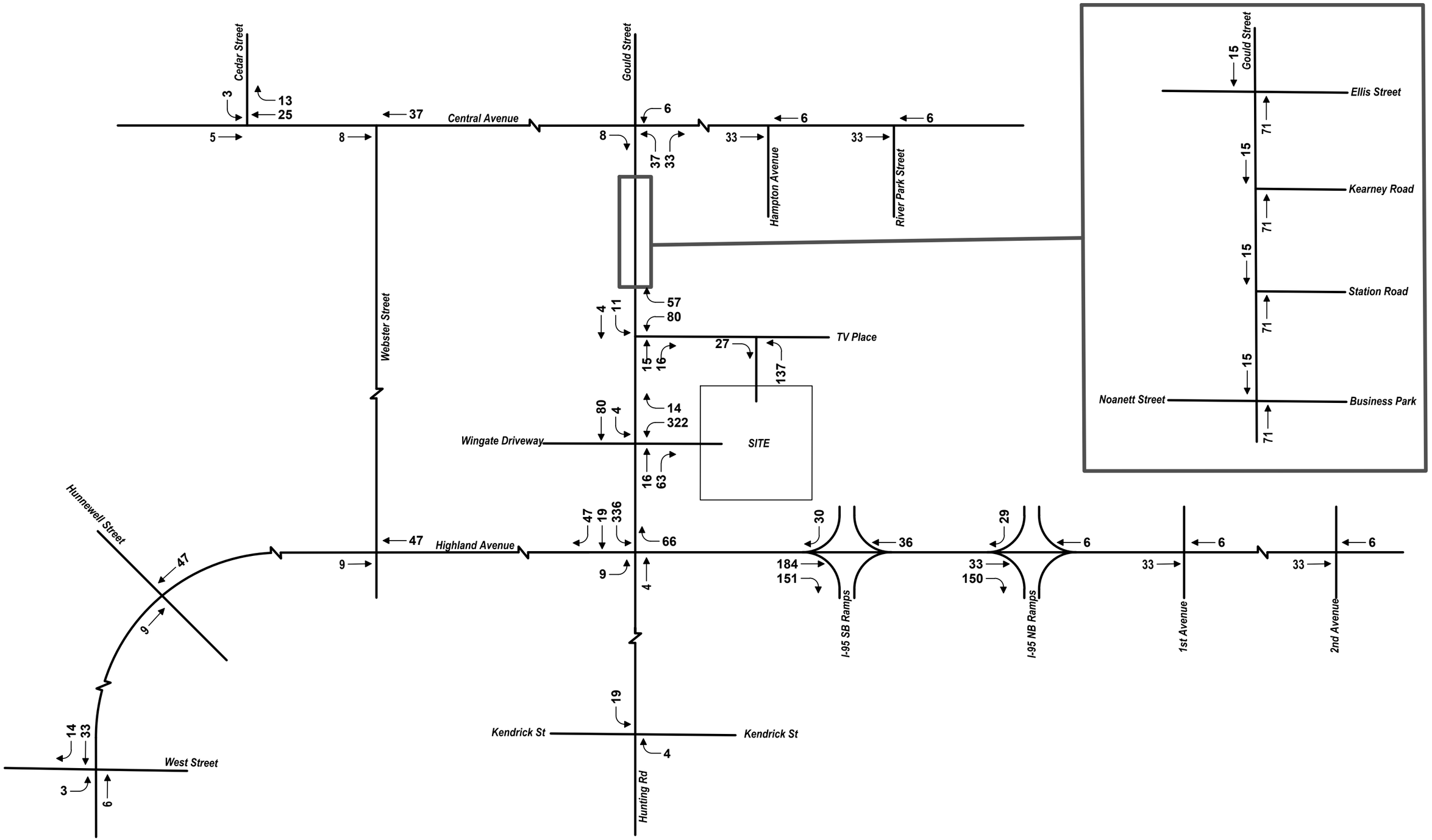
Highland Science Center
Needham, Massachusetts



Not to Scale

Project Generated Vehicle Volumes
Weekday Morning Peak Hour
Highland Science Center
Needham, Massachusetts

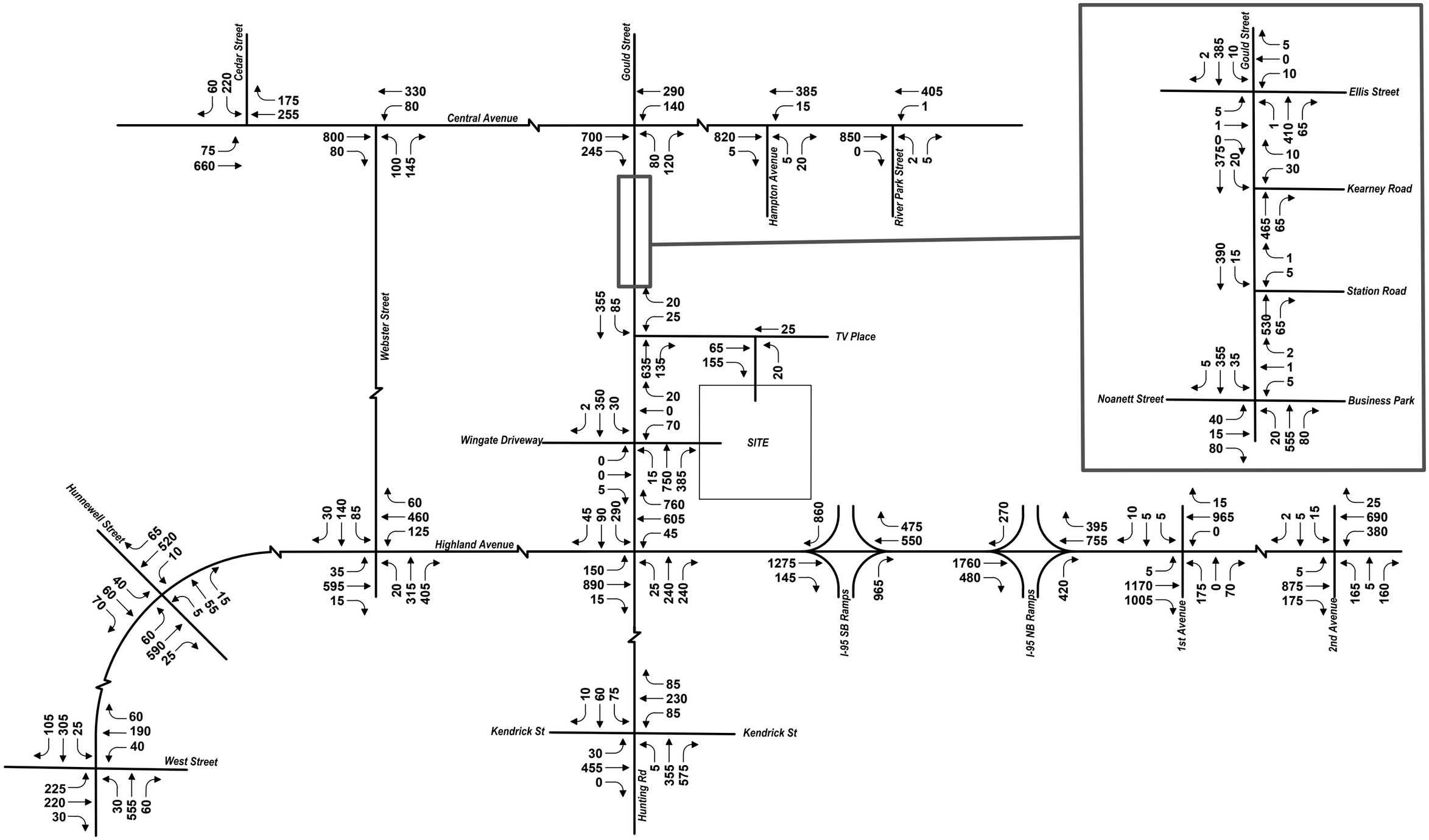
Figure 11



Not to Scale

Project Generated Vehicle Volumes
Weekday Evening Peak Hour
Highland Science Center
Needham, Massachusetts

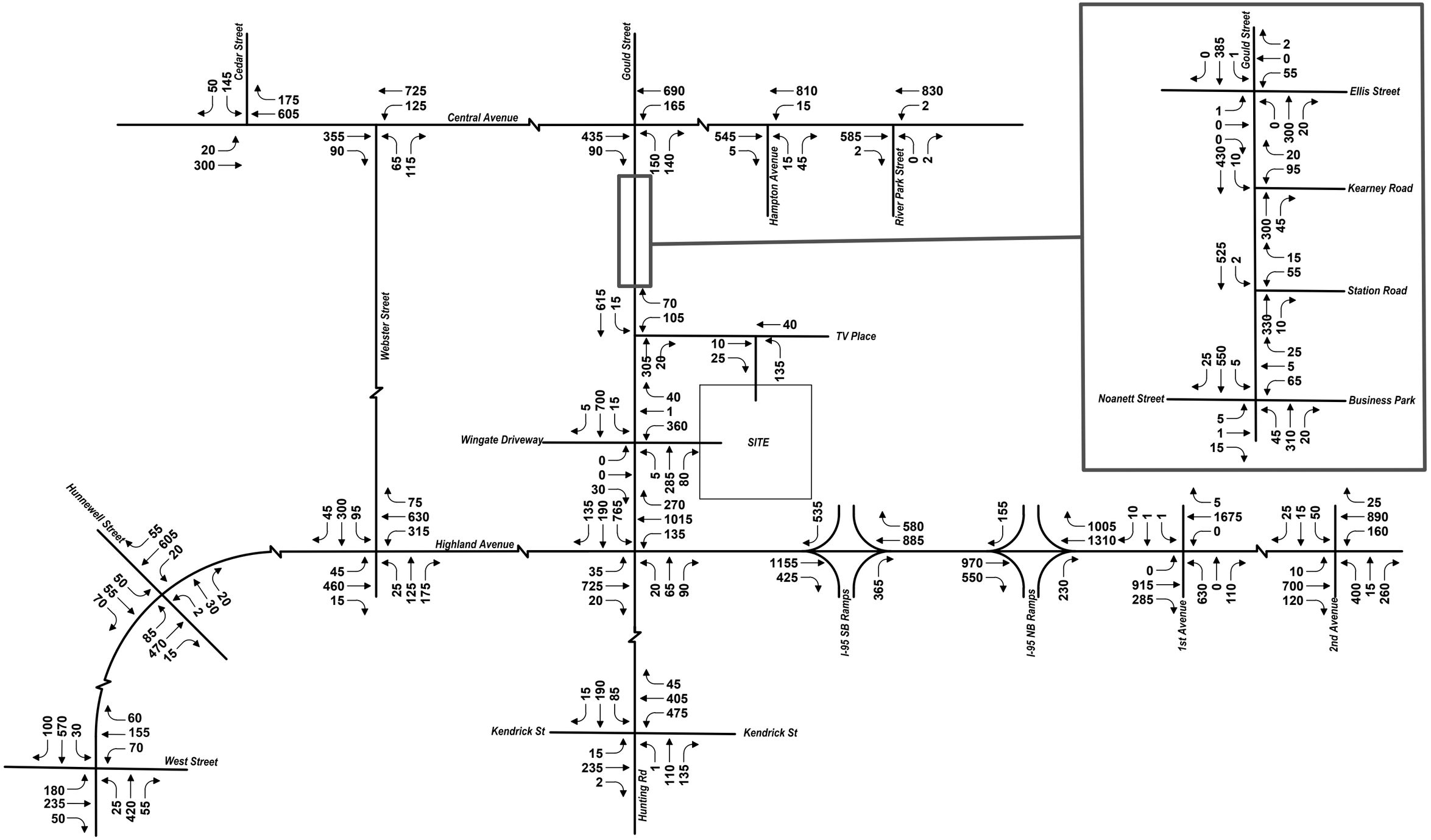
Figure 12



Not to Scale

Build Conditions Vehicle Volumes
Weekday Morning Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 13



Not to Scale

Build Conditions Vehicle Volumes
Weekday Evening Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 14

Transportation Operations Analyses

Measuring existing traffic volumes and projecting future traffic volumes quantifies traffic flow within the study area. To assess the quality of flow, roadway capacity analyses were conducted with respect to Existing and projected No-Build and Build traffic volumes for both weekday morning and weekday evening peak hours. Capacity analyses provide an indication of how well the roadway facilities can serve the traffic demands placed upon them. Roadway operating conditions are classified by calculated levels of service.

Intersection Capacity Analyses

Consistent with MassDOT guidelines, Synchro 10 software was used to model LOS operations at the Project Study Area intersections. Both signalized and unsignalized intersection capacity analyses were conducted under 2022 Existing, 2029 No-Build, and 2029 Build conditions.

Level-of-Service Criteria

The evaluation criteria used to analyze area intersections in this traffic study are based on the Highway Capacity Manual (HCM).[9] The term 'Level of Service' (LOS) denotes the different operating conditions that occur on a given roadway segment under various traffic volume loads. It is a qualitative measure that considers a number of factors including roadway geometry, speed, travel delay and freedom to maneuver. LOS provides an index to the operational qualities of a roadway segment or an intersection. LOS designations range from A to F, with LOS A representing the best operating conditions and LOS F representing the worst operating conditions.

In addition to LOS, two other measures of effectiveness are typically used to quantify the traffic operations at intersections; volume-to-capacity ratio (v/c) and delay (expressed in seconds per vehicle). For example, an existing v/c ratio of 0.90 for an intersection indicates that the intersection is operating at 90 percent of its available capacity. A delay of 15 seconds for a particular vehicular movement or approach indicates that vehicles on the movement or approach will experience an average additional travel time of 15 seconds. For a given LOS letter designation there may be a wide

[9] Transportation Research Board, *Highway Capacity Manual*, 6th Edition, Washington, D.C., 2016.

range of values for both v/c ratios and delay. Comparison of intersection capacity results therefore requires that, in addition to the LOS, the other measures of effectiveness should also be considered.

The LOS designations, which are based on delay, are reported differently for signalized and unsignalized intersections. For signalized intersections, the analysis considers the operation of all traffic entering the intersection and the LOS designation is for overall conditions at the intersection. For unsignalized intersections, however, the analysis assumes that traffic on the mainline is not affected by traffic on the side streets. Thus, the LOS designation is for the critical movement exiting the side street and for the conflicting movement on the mainline, which is generally the left turn from the mainline into a side street or driveway. Table 8 shows the LOS criteria for both signalized intersections and unsignalized intersections.

Table 8 Intersection Level-of-Service Criteria

Level of Service	Signalized Intersection Delay	Unsignalized Intersection Delay
A	0 to 10 seconds	0 to 10 seconds
B	10 to 20 seconds	10 to 15 seconds
C	20 to 35 seconds	15 to 25 seconds
D	35 to 55 seconds	25 to 35 seconds
E	55 to 80 seconds	35 to 50 seconds
F	Greater than 80 seconds	Greater than 50 seconds

Source: Highway Capacity Manual, 6th Edition.

The analytical methodologies typically used for unsignalized intersections use conservative analysis parameters, such as long critical gaps. Actual field observations indicate that drivers on minor streets generally accept shorter gaps in traffic than those used in the analysis procedures and therefore experience less delay than reported by the analysis software. The analysis methodologies also do not fully take into account the beneficial grouping effects caused by nearby signalized intersections. The net effect of these analysis procedures is the over-estimation of calculated delays at unsignalized intersections in the study area. Cautious judgment should therefore be exercised when interpreting the capacity analysis results at unsignalized intersections.

Signalized Intersection Capacity Analyses

Table 9 summarizes the intersection capacity analyses for the signalized study area intersections and the capacity analysis worksheets are included in the Appendix to this report.

Table 9 Signalized Intersection Capacity Analysis Summary

Location / Movement	2022 Existing Condition					2029 No-Build Condition					2029 Build Condition				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
Highland Avenue at West Street															
Weekday Morning															
West St EB L	0.62	28.3	C	83	#210	0.83	50.7	D	105	#225	0.89	61.0	E	114	#258
West St EB T/R	0.36	21.6	C	102	236	0.42	27.5	C	128	252	0.42	27.5	C	128	252
West St WB L	0.16	30.6	C	19	58	0.20	35.9	D	25	65	0.20	35.9	D	25	65
West St WB T/R	0.69	39.4	D	141	286	0.78	51.1	D	176	313	0.78	51.1	D	176	313
Highland Ave NB L/T/R	0.82	29.0	C	265	#648	0.88	33.7	C	367	#842	0.92	40.3	D	407	#913
Highland Ave SB L/T/R	0.58	19.6	B	150	376	0.59	19.3	B	183	439	0.60	19.7	B	189	453
Overall	**0.73**	**27.4**	**C**	-	-	**0.83**	**34.1**	**C**	-	-	**0.88**	**37.9**	**D**	-	-
Weekday Evening															
West St EB L	0.54	25.1	C	64	142	0.60	26.2	C	70	154	0.61	26.7	C	73	159
West St EB T/R	0.43	20.8	C	110	228	0.46	20.9	C	123	251	0.46	20.9	C	123	251
West St WB L	0.35	30.9	C	33	84	0.36	30.7	C	35	88	0.36	30.7	C	35	88
West St WB T/R	0.65	36.0	D	108	213	0.66	36.3	D	117	229	0.66	36.3	D	117	229
Highland Ave NB L/T/R	0.71	21.9	C	175	#547	0.82	28.1	C	225	#664	0.83	29.0	C	229	#675
Highland Ave SB L/T/R	0.83	28.3	C	236	#726	0.97	50.7	D	320	#889	1.05	72.0	E	369	#978
Overall	**0.72**	**26.2**	**C**	-	-	**0.81**	**35.3**	**D**	-	-	**0.85**	**43.3**	**D**	-	-
Highland Ave at Webster Street															
Weekday Morning															
Highland Ave EB L	0.11	12.1	B	7	22	0.14	22.7	C	13	50	0.14	22.7	C	13	50
Highland Ave EB T/R	0.79	22.3	C	138	#236	1.00	67.6	E	290	#745	1.08	93.4	F	330	#830
Highland Ave WB L	0.43	9.8	A	20	40	0.55	20.9	C	32	109	0.55	21.5	C	32	109
Highland Ave WB T/R	0.56	9.7	A	102	167	0.64	18.5	B	180	473	0.64	18.6	B	182	480
Webster St NB L/T	0.66	19.4	B	105	#204	0.90	56.0	E	189	#471	0.90	56.0	E	189	#471
Webster St NB R	0.41	12.7	B	45	105	0.40	24.4	C	25	122	0.40	24.4	C	25	122
Webster St SB L/T/R	0.38	15.1	B	36	66	>1.20	35.0	D	69	#160	>1.20	35.0	D	69	#160
Overall	**0.75**	**15.3**	**B**	-	-	**0.91**	**39.2**	**D**	-	-	**0.95**	**46.3**	**D**	-	-
Weekday Evening															
Highland Ave EB L	0.18	14.2	B	10	32	0.21	26.0	C	19	67	0.22	26.2	C	20	68
Highland Ave EB T/R	0.79	24.2	C	125	#275	0.88	47.0	D	260	#656	0.90	49.4	D	268	#673
Highland Ave WB L	0.86	28.2	C	51	#171	0.88	44.0	D	109	#399	0.90	48.7	D	115	#409
Highland Ave WB T/R	0.63	11.0	B	117	229	0.69	19.1	B	231	#672	0.74	20.6	C	257	#750
Webster St NB L/T	0.32	14.5	B	39	75	0.56	36.9	D	83	191	0.56	36.9	D	83	191
Webster St NB R	0.23	10.1	B	30	56	0.33	22.7	C	62	162	0.33	22.7	C	62	162
Webster St SB L/T/R	0.51	15.6	B	62	96	0.80	44.1	D	134	#271	0.80	44.1	D	134	#271
Overall	**0.77**	**17.3**	**B**	-	-	**0.85**	**35.1**	**D**	-	-	**0.87**	**36.4**	**D**	-	-

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.

Table 9 Signalized Intersection Capacity Analysis Summary (cont.)

Location / Movement	2022 Existing Condition					2029 No-Build Condition					2029 Build Condition				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
Highland Avenue at Gould Street and Hunting Road															
Weekday Morning															
Highland Ave EB L	1.14	>120	F	~68	#235	1.04	>120	F	~93	#234	>1.20	>120	F	~190	#353
Highland Ave EB T/R	0.72	28.0	C	232	413	0.86	40.2	D	364	#512	0.79	36.6	D	364	#512
Highland Ave WB L	0.51	45.8	D	23	72	0.58	58.6	E	36	83	0.61	65.3	E	38	83
Highland Ave WB T/R	0.79	31.1	C	220	410	0.94	52.1	D	362	#545	1.15	117.8	F	~616	#841
Hunting Rd NB L/T	0.79	47.5	D	137	#395	0.96	89.0	F	206	#434	1.13	>120	F	~263	#480
Hunting Rd NB R	0.15	28.9	C	0	46	0.48	39.8	D	48	102	0.51	44.0	D	52	102
Gould St SB L	0.71	45.6	D	96	#246	0.82	64.8	E	145	#281	0.91	84.5	F	182	#347
Gould St SB SB L/T/R	0.67	43.4	D	91	#224	0.78	59.4	E	137	#264	0.88	77.3	E	175	#335
Overall	**0.77**	**38.8**	**D**	-	-	**0.98**	**55.1**	**E**	-	-	**1.20**	**100.2**	**F**	-	-
Weekday Evening															
Highland Ave EB L	0.47	45.1	D	15	40	>1.20	>120	F	19	57	>1.20	>120	F	27	72
Highland Ave EB T/R	0.57	24.8	C	173	242	0.81	42.30	D	287	440	0.81	42.40	D	290	442
Highland Ave WB L	0.53	37.2	D	67	120	0.86	83.30	F	100	194	0.87	84.50	F	101	196
Highland Ave WB T/R	0.70	21.5	C	206	368	1.00	61.70	E	~535	#774	1.07	84.00	F	~599	#861
Hunting Rd NB L/T	0.94	112.1	F	52	#130	0.56	51.40	D	66	127	0.58	52.20	D	70	134
Hunting Rd NB R	0.05	28.9	C	0	23	0.10	35.70	D	4	24	0.10	35.70	D	4	24
Gould St SB L	1.09	109.8	F	~262	#393	0.91	61.10	E	295	#574	>1.20	>120	F	~681	#1051
Gould St SB SB L/T/R	1.05	96.0	F	~244	#377	0.88	56.90	E	284	#554	>1.20	>120	F	~653	#1022
Overall	**0.86**	**47.2**	**D**	-	-	**1.03**	**59.50**	**E**	-	-	**>1.20**	**>120**	**F**	-	-
Highland Avenue at I-95 NB Ramps															
Weekday Morning															
Highland Ave EB T	0.68	8.3	A	165	232	0.75	9.3	A	268	327	0.75	9.2	A	270	328
I-95 Off Ramp NB R	0.54	23.3	C	53	118	1.03	85.2	F	~146	#371	1.04	87.8	F	~151	#380
Overall	**0.65**	**9.6**	**A**	-	-	**0.80**	**21.1**	**C**	-	-	**0.80**	**21.4**	**C**	-	-
Weekday Evening															
Highland Ave EB T	0.47	5.6	A	50	89	0.56	7.3	A	75	129	0.55	7.0	A	82	138
I-95 Off Ramp NB R	0.42	13.7	B	16	44	0.44	15.0	B	30	70	0.46	16.6	B	33	77
Overall	**0.46**	**6.4**	**A**	-	-	**0.53**	**8.1**	**A**	-	-	**0.52**	**8.0**	**A**	-	-

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.

Table 9 Signalized Intersection Capacity Analysis Summary (cont.)

Location / Movement	2022 Existing Condition					2029 No-Build Condition					2029 Build Condition				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
Highland Avenue at 1st Avenue															
Weekday Morning															
Highland Ave EB L/T	0.57	12.4	B	181	#470	0.77	21.2	C	~607	#802	0.77	21.3	C	~611	#806
Highland Ave EB R	0.44	5.2	A	0	35	0.70	8.6	A	11	#103	0.70	8.6	A	11	#103
Highland Ave WB L/T	0.41	8.3	A	55	226	0.55	16.2	B	193	337	0.57	16.5	B	203	354
1st Ave NB L	0.45	38.5	D	49	91	0.44	32.8	C	73	140	0.44	32.8	C	73	140
1st Ave NB L/T/R	0.06	36.1	D	0	18	0.13	30.4	C	7	58	0.13	30.4	C	7	58
Driveway SB L/T/R	0.19	39.3	D	15	10	0.19	39.3	D	15	10	0.19	39.3	D	15	10
Overall	**0.55**	**11.3**	**B**	**-**	**-**	**0.74**	**17.0**	**B**	**-**	**-**	**0.74**	**17.2**	**B**	**-**	**-**
Weekday Evening															
Highland Ave EB L/T	0.43	13.0	B	101	273	0.65	23.6	C	192	#418	0.68	24.2	C	203	#444
Highland Ave EB R	0.11	3.0	A	0	10	0.19	2.4	A	0	12	0.19	2.4	A	0	12
Highland Ave WB L/T	0.81	17.2	B	163	#674	>1.20	>120	F	~626	#975	>1.20	>120	F	~630	#980
1st Ave NB L	0.74	41.3	D	149	210	0.69	27.3	C	222	296	0.69	27.3	C	222	296
1st Ave NB L/T/R	0.47	32.7	C	71	134	0.55	23.9	C	144	216	0.55	23.9	C	144	216
Driveway SB L/T/R	0.10	44.5	D	2	15	0.10	44.5	D	2	15	0.10	44.5	D	2	15
Overall	**0.79**	**18.6**	**B**	**-**	**-**	**0.99**	**81.5**	**F**	**-**	**-**	**0.99**	**82.0**	**F**	**-**	**-**
Highland Avenue at 2nd Avenue															
Weekday Morning															
Highland Ave EB L	-	-	-	-	-	0.02	9.5	A	1	11	0.02	9.0	A	1	11
Highland Ave EB T/R	-	-	-	-	-	0.61	14.3	B	201	485	0.59	13.6	B	203	488
Highland Ave EB L/T/R	0.47	6.2	A	42	143	-	-	-	-	-	-	-	-	-	-
Highland Ave WB L/T/R	>1.20	15.5	B	184	#383	>1.20	24.6	C	157	#672	>1.20	27.9	C	164	#731
2nd Ave NB L	0.41	38.2	D	49	91	0.41	36.6	D	52	126	0.43	39.1	D	52	126
2nd Ave NB L/T	0.42	38.3	D	51	93	0.42	36.6	D	53	127	0.44	39.2	D	53	127
2nd Ave NB R	0.10	36.3	D	0	27	0.11	30.2	C	0	57	0.11	32.6	C	0	57
Driveway SB L/T	0.38	44.2	D	17	32	0.29	41.1	D	16	36	0.29	43.2	D	16	36
Driveway SB R	0.00	42.3	D	0	0	0.00	39.9	D	0	0	0.00	41.9	D	0	0
Overall	**0.76**	**15.1**	**B**	**-**	**-**	**0.62**	**21.6**	**C**	**-**	**-**	**0.61**	**23.0**	**C**	**-**	**-**
Weekday Evening															
Highland Ave EB L	-	-	-	-	-	0.06	15.1	B	4	22	0.06	15.1	B	4	22
Highland Ave EB T/R	-	-	-	-	-	0.53	19.3	B	179	389	0.56	19.6	B	190	412
Highland Ave EB L/T/R	0.40	4.9	A	129	34	-	-	-	-	-	-	-	-	-	-
Highland Ave WB L/T/R	0.74	19.4	B	220	#420	0.90	26.9	C	211	#722	0.92	29.3	C	213	#733
2nd Ave NB L	0.69	40.4	D	125	187	0.73	43.3	D	135	268	0.73	43.3	D	135	268
2nd Ave NB L/T	0.68	40.2	D	125	187	0.72	42.7	D	134	266	0.72	42.7	D	134	266
2nd Ave NB R	0.15	31.9	C	0	56	0.38	30.0	C	44	142	0.40	30.2	C	48	148
Driveway SB L/T	0.59	44.5	D	53	74	0.55	43.0	D	52	91	0.55	43.0	D	52	91
Driveway SB R	0.02	38.9	D	0	0	0.02	38.8	D	0	0	0.02	38.8	D	0	0
Overall	**0.78**	**21.4**	**C**	**-**	**-**	**0.95**	**28.2**	**C**	**-**	**-**	**0.02**	**38.8**	**C**	**-**	**-**

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.

Table 9 Signalized Intersection Capacity Analysis Summary (cont.)

Location / Movement	2022 Existing Condition					2029 No-Build Condition					2029 Build Condition				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
Greendale Avenue and Kendrick Street at Hunting Road															
Weekday Morning															
Kendrick St EB L/T/R	0.42	21.0	C	102	#226	0.43	19.5	B	109	#252	0.43	19.6	B	110	#253
Kendrick St WB L	0.22	12.2	B	19	68	0.23	11.0	B	20	71	0.23	11.0	B	20	71
Kendrick St WB T/R	0.30	13.7	B	66	195	0.31	12.4	B	72	213	0.33	12.7	B	78	227
Hunting Rd NB T/R	>1.20	>120	F	~390	#579	>1.20	>120	F	~285	#461	>1.20	>120	F	~285	#461
Hunting Rd NB R	0.36	0.6	A	0	0	0.39	0.7	A	0	0	0.39	0.7	A	0	0
Hunting Rd SB L	0.37	37.2	D	29	62	0.42	38.0	D	32	65	0.45	38.2	D	34	69
Hunting Rd SB T/R	0.12	23.0	C	25	57	0.14	24.3	C	28	60	0.14	24.3	C	27	60
Overall	**0.72**	**66.5**	**E**	-	-	**0.68**	**41.7**	**D**	-	-	**0.68**	**42.1**	**D**	-	-
Weekday Evening															
Kendrick St EB L/T/R	0.43	31.2	C	59	86	0.57	36.3	D	68	97	0.57	36.5	D	68	97
Kendrick St WB L	0.53	7.8	A	115	180	0.58	9.0	A	126	196	0.58	9.2	A	126	196
Kendrick St WB T/R	0.37	7.0	A	100	157	0.41	7.8	A	112	174	0.42	8.0	A	113	176
Hunting Rd NB T/R	0.61	38.1	D	58	100	0.58	35.2	D	64	109	0.58	35.2	D	64	109
Hunting Rd NB R	0.10	0.10	A	0	0	0.10	0.10	A	0	0	0.10	0.1	A	0	0
Hunting Rd SB L	0.25	24.4	C	24	54	0.26	23.5	C	26	57	0.33	23.7	C	34	71
Hunting Rd SB T/R	0.44	26.2	C	77	136	0.46	25.4	C	87	150	0.45	25.2	C	87	150
Overall	**0.61**	**15.4**	**B**	-	-	**0.65**	**16.5**	**B**	-	-	**0.65**	**16.6**	**B**	-	-

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.

As shown in Table 9, the following signalized intersections are expected to see a degrade in overall LOS between the 2029 No-Build Conditions and the 2029 Build Conditions:

- **Highland Avenue at West Street** – LOS C to LOS D during the weekday morning peak period (increase in overall delay of 4 seconds).
- **Highland Avenue at Gould Street/Hunting Road** – LOS E to LOS F during the weekday morning and weekday evening peak periods (increase in overall delay of greater than 30 seconds).

All other intersections and time periods are expected to see the overall LOS maintained from the 2029 No-Build Condition to the 2029 Build Conditions.

To offset the impacts of the additional Project-generated trips at the intersection of Highland Avenue at Gould Street / Hunting Road, the proponent is proposing geometric and signal timing mitigation. Details of the proposed mitigation are described later in this report.

Unsignalized Intersection Capacity Analyses

Table 10 summarizes the intersection capacity analyses for the unsignalized study area intersections and the capacity analysis worksheets are included in the Appendix to this report.

Table 10 Unsignalized Intersection Capacity Analysis Summary

Location / Movement	2022 Existing Condition				2029 No-Build Condition				2029 Build Condition			
	v/c [a]	Del [b]	LOS [c]	95 Q [d]	v/c	Del	LOS	95 Q	v/c	Del	LOS	95 Q
Central Avenue at Cedar Street												
Weekday Morning												
Cedar St SB L/R	>1.20	>120	F	759	>1.20	>120	F	926	>1.20	>120	F	1027
Weekday Evening												
Cedar St SB L/R	0.69	43.9	E	116	0.83	64.7	F	162	0.90	81.6	F	188
Central Avenue at Webster Street												
Weekday Morning												
Webster St NB L/R	>1.20	>120	F	434	>1.20	>120	F	554	>1.20	>120	F	587
Weekday Evening												
Webster St NB L/R	0.86	76.2	F	166	1.12	>120	F	254	>1.20	>120	F	281
Central Avenue at Gould Street												
Weekday Morning												
Gould St NB L/R	0.99	100.1	F	227	>1.20	>120	F	327	>1.20	>120	F	428
Weekday Evening												
Gould St NB L/R	>1.20	>120	F	662	>1.20	>120	F	828	>1.20	Err [e]	F	Err
Central Avenue at Hampton Avenue												
Weekday Morning												
Hampton Ave NB L/R	0.08	17.3	C	7	0.09	18.7	C	8	0.10	19.0	C	8
Weekday Evening												
Hampton Ave NB L/R	0.18	18.0	C	16	0.21	19.5	C	19	0.22	20.5	C	20
Central Avenue at River Park Street												
Weekday Morning												
River Park St NB L/R	0.02	17.7	C	2	0.03	19.2	C	2	0.03	19.6	C	2
Weekday Evening												
River Park St NB L/R	0.00	11.8	B	0	0.00	12.2	B	0	0.00	12.6	B	0
Gould Street at Ellis Street / Driveway												
Weekday Morning												
Driveway EB L/T/R	0.04	18.4	C	3	0.04	20.5	C	3	0.05	23.5	C	4
Ellis St WB L/T/R	0.07	16.6	C	6	0.08	18.3	C	6	0.09	20.6	C	7
Weekday Evening												
Driveway EB L/T/R	0.01	16.6	C	1	0.01	18.1	C	1	0.02	20.5	C	1
Ellis St WB L/T/R	0.21	19.1	C	20	0.26	21.9	C	25	0.31	26.1	D	31

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 95th percentile queue, in feet.
e Movement beyond capacity, no results reported.

Table 10 Unsignalized Intersection Capacity Analysis Summary (cont.)

Location / Movement	2022 Existing Condition v/c [a]	Del [b]	LOS [c]	95 Q [d]	2029 No-Build Condition v/c	Del	LOS	95 Q	2029 Build Condition v/c	Del	LOS	95 Q
Gould Street at Kearney Road												
Weekday Morning												
Kearney Rd WB L/R	0.15	17.4	C	13	0.17	19.2	C	15	0.19	21.8	C	17
Weekday Evening												
Kearney Rd WB L/R	0.38	20.7	C	43	0.44	24.6	C	54	0.51	30.0	D	67
Gould Street at Station Road												
Weekday Morning												
Station Rd WB L/R	0.02	15.9	C	1	0.02	17.3	C	2	0.02	19.0	C	2
Weekday Evening												
Station Rd WB L/R	0.18	15.6	C	17	0.20	17.0	C	19	0.23	19.0	C	22
Gould Street at Noanett Road and Driveway												
Weekday Morning												
Driveway WB L/T/R	0.04	23.4	C	3	0.05	26.8	D	4	0.05	30.2	D	4
Weekday Evening												
Driveway WB L/T/R	0.35	23.5	C	38	0.40	27.8	D	45	0.46	33.9	D	55
Gould Street at TV Place												
Weekday Morning												
TV Place WB L/R	0.14	18.4	C	12	0.15	20.5	C	13	0.36	32.0	D	39
Weekday Evening												
TV Place WB L/R	0.17	19.3	C	15	0.19	21.7	C	17	0.88	72.7	F	183
Gould Street at Muzi Fold Driveway and Wingate Res. Driveway												
Weekday Morning												
Muzi Ford WB L	0.14	31.4	D	12	0.17	37.5	E	14	1.15	>120	F	152
Weekday Evening												
Muzi Ford WB L	0.20	26.9	D	19	0.24	31.2	D	22	>1.20	Err [e]	F	Err
Highland Avenue at Hunnewell Street												
Weekday Morning												
Hunnewell St EB L/T//R	>1.20	>120	F	314	>1.20	Err [e]	F	Err	>120	Err [e]	F	Err
Weekday Evening												
Hunnewell St EB L/T//R	1.01	118.2	F	220	>1.20	>120	F	383	>1.20	>120	F	433

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 95th percentile queue, in feet.
e Movement beyond capacity, no results reported.

As shown in Table 10, the critical movements at the majority of the unsignalized study area intersections currently operate at acceptable levels of service, with a few key exceptions. These conditions generally are expected to continue under the future 2029 conditions with and without the addition of site-generated traffic.

Examples of unsignalized movements that are expected to operate at LOS F (delay greater than 50 seconds) under 2029 No Build Conditions and 2029 Build Conditions include:

- Cedar Street southbound approach to Central Avenue during the weekday morning and weekday evening peak periods.
- Webster Street northbound approach to Central Avenue during the weekday morning and weekday evening peak periods.

- Gould Street northbound approach to Central Avenue during the weekday morning and weekday evening peak periods.
- Hunnewell Street eastbound approach to Highland Avenue during the weekday morning and weekday evening peak periods.

Unsignalized Site Driveway Operations

At the unsignalized Project Site driveway and TV Place, operations are expected to operate at poor conditions. The Project Site driveway is expected to operate at LOS F with v/c ratios greater than 1.00 during both the weekday morning and weekday evening peak period. The TV Place approach is expected to operate at LOS F with a v/c ratio of 0.88 during the weekday evening peak period.

To improve operations at the Project Site driveway that will improve the LOS and reduce the v/c ratios to lower than 1.00, the Proponent is proposing mitigation that includes adding a traffic signal to the intersection. To improve operations at TV Place, the Proponent is proposing mitigation that includes dedicated left-turn and right-turn lanes. Details of the proposed mitigation are described later in this report.

Ramp Junction Capacity Analyses

At the interchange of Highland Avenue at I-95, the intersection generally does not operate as a standard signalized or unsignalized intersection. Traffic enters and exits the interstate ramps through merge, diverge, and weaving movements, similar to traffic operations on an interstate. Therefore, the conflicting movements have been analyzed using methodology for merge, diverge, and weaving conflicts.

The one exception to this is the junction of the I-95 northbound ramp with Highland Avenue eastbound. At this intersection, both approaches are signalized. Therefore, results for that ramp junction are summarized previously in the signalized intersection capacity analyses.

Level-of-Service Criteria

The capacity analyses conducted include merge/diverge analyses and weave analyses. Each analysis is based on procedures presented in the Highway Capacity Manual (HCM).

A merge or diverge segment is defined as a location that involves the interaction between freeway mainline through traffic and traffic merging from or diverging to ramps. The analyses for merge and diverge segments takes into account geometric and operational factors such as the length and taper of the acceleration/deceleration lanes, free-flow vehicle speed along the mainline and on the ramps themselves, and the number of vehicles in the right-most (or left-most for left exits) two lanes of the mainline. The focus of the analysis is at the ramp junction with the mainline where entering vehicles attempt to find gaps in the adjacent traffic stream. The action of this merging traffic creates vehicle turbulence along the mainline which can affect freeway operations. The converse of this action is the diverge movement which forces exiting vehicles to shift in advance and occupy the correct travel lane in order to exit the freeway causing temporary instability as the vehicles shift lanes and decelerate. According to the HCM, the influence area for both of these movements is approximately 1,500 feet before the diverge areas and beyond the merge areas (including acceleration and deceleration lanes).

A weaving segment is defined as a location that involves the interaction between two or more crossing traffic streams traveling in the same direction. A common weaving segment is formed by a one-lane freeway on-ramp followed by a one-lane freeway off-ramp, with the two connected by an auxiliary lane, which describes the geometry of Highland Avenue in both directions between the I-95 northbound and southbound ramps. The analysis for a weaving segment takes into account geometric and operational factors such as the length of the weaving section, free-flow vehicle speed along the mainline facility, and the number of vehicles in the weaving lanes. The focus of the analysis is within the weaving segment itself, where vehicles must attempt to find gaps and also accelerate or decelerate as they traverse the weaving segment.

Table 11 shows the level-of-service criteria for basic merge/diverge and weaving segments.

Table 11 Level-of-Service Criteria for Highway Capacity Analyses

Level-of-Service	Merge/Diverge Segment Density Range [a]	Weaving Segment Density Range [b]
A	0 to 10 pc/mi/ln	0 to 12 pc/mi/ln
B	10 to 20 pc/mi/ln	12 to 24 pc/mi/ln
C	20 to 28 pc/mi/ln	24 to 32 pc/mi/ln
D	28 to 35 pc/mi/ln	32 to 36 pc/mi/ln
E	Greater than 35 pc/mi/ln	36 to 40 pc/mi/ln
F	Demand Exceeds Capacity	Greater than 40 pc/mi/ln

Source: Highway Capacity Manual, Washington, D.C., 2016.
Note: Criteria measured in vehicle density (passenger car/mile/lane).
a Merge/Diverge density range (HCM, Exhibit 14-3).
b Weaving segment density range for multilane highways or C-D Roads (HCM, Exhibit 13-6).

Merge/Diverge Segment Analyses

Merge and diverge segment analyses were conducted at the following three ramp junction locations:

- Highland Avenue Eastbound at the I-95 Southbound On-Ramp (diverge location)
- Highland Avenue Westbound at the I-95 Northbound On-Ramp (diverge location)
- Highland Avenue Westbound at the I-95 Southbound Off-Ramp (merge location)

Analyses were conducted during the weekday morning and weekday evening peak hours under the 2022 Existing, 2029 No Build, and 2029 Build Conditions. A summary of the merge and diverge segment analyses are presented in Table 12 and the detailed analysis worksheets are provided in the Appendix to this report.

Table 12 Merge/Diverge Capacity Analysis Summary

	2022 Existing Conditions		2029 No Build Conditions		2029 Build Conditions	
Location/Period	**Density[a]**	**LOS[b]**	**Density**	**LOS**	**Density**	**LOS**
Highland Avenue EB at I-95 SB On-Ramp *(Diverge Movement)*						
Weekday Morning	13.5	B	15.6	B	15.8	B
Weekday Evening	11.6	B	13.0	B	14.7	B
Highland Avenue WB at I-95 NB On-Ramp *(Diverge Movement)*						
Weekday Morning	9.8	A	10.8	B	11.2	B
Weekday Evening	13.5	B	16.2	B	16.3	B
Highland Avenue WB at I-95 SB Off-Ramp *(Merge Movement)*						
Weekday Morning	12.1	B	13.3	B	16.4	B
Weekday Evening	14.4	B	16.0	B	16.5	B

a density in ramp influence area, in passenger cars per mile per lane
b level of service

As shown in Table 12, the merge and diverge locations for the interchange of Highland Avenue at I-95 are expected to operate at LOS B or better during the weekday morning and weekday evening peak hours under the 2022 Existing, 2029 No Build, and 2029 Build Conditions.

Weave Segment Analyses

Weaving segment analyses were conducted at the following two ramp junction locations:

- Highland Avenue Eastbound between the I-95 Southbound Off-Ramp and the I-95 Northbound On-Ramp
- Highland Avenue Westbound between the I-95 Northbound Off-Ramp and the I-95 Southbound On-Ramp

Analyses were conducted during the weekday morning and weekday evening peak hours under the 2022 Existing, 2029 No Build, and 2029 Build Conditions. A summary of the weave segment analyses is presented in Table 13 and the detailed analysis worksheets are provided in the Appendix to this report.

Table 13 Weave Segment Capacity Analysis Summary

Location/Period	2022 Existing Conditions			2029 No Build Conditions			2029 Build Conditions		
	v/c[a]	Density[b]	LOS[c]	Demand	Density	LOS	Demand	Density	LOS
Highland Avenue EB between I-95 SB Off-Ramp and I-95 NB On-Ramp									
Weekday Morning	0.53	18.5	B	0.66	24.3	C	0.66	24.7	C
Weekday Evening	0.30	10.2	A	0.38	13.0	B	0.44	15.2	B
Highland Avenue WB between I-95 NB Off-Ramp and I-95 SB On-Ramp									
Weekday Morning	0.22	6.5	A	0.26	7.9	A	0.34	10.1	A
Weekday Evening	0.31	10.9	A	0.38	13.9	B	0.40	14.3	B

a volume to capacity ratio
b density, in passenger cars per mile per lane
c level of service

As shown in Table 13, the weaving locations for the interchange of Highland Avenue at I-95 are expected to operate at LOS C or better during the weekday morning and weekday evening peak hours under the 2022 Existing, 2029 No Build, and 2029 Build Conditions.

Signal Warrant Analysis

To determine the feasibility of potential mitigation measures, signal warrant analyses were conducted at two intersections: Central Avenue at Gould Street and Gould Street at the Project Site driveway / Wingate Driveway. Signalization of both intersections was proposed as mitigation for redevelopment of the Muzi site in the traffic memo conducted by GPI in 2020.

Warrant Analysis Summary

The Federal Highway Administration (FHWA) has established criteria for evaluating the need for traffic signal control at an intersection. Several warrants, published in the Manual on Uniform Traffic Control Devices (MUTCD),[10] provide guidelines for determining the need for a signal based on such factors as traffic volume, pedestrian volume, progressive movement of traffic, vehicular delay, and others. While satisfaction of one or more of these warrants alone does not necessarily justify installation of a traffic signal, warrants in combination with capacity analysis, crash analysis, and a study of intersection safety provide valuable criteria for evaluating the need for a traffic signal.

There are nine warrants defined in the MUTCD. The warrants consider the roadway geometry, traffic volume entering the intersection, travel speeds, pedestrian activity, and special considerations such as proximity to schools and active railroad grade crossings. Even if these warrants are satisfied, other considerations such as traffic flow progression, sight distance, and physical constraints must be considered before pursuing traffic signal control.

Traffic volumes were evaluated for the following three volume-based warrants:

[10] Manual on Uniform Traffic Control Devices, 2009 Edition; U.S. Department of Transportation Federal Highway Administration, Washington DC, December 2009.

- **Warrant 1 (Eight Hour Vehicular Volume)** – Warrant 1 is based on any eight hours of a day where the traffic entering the intersection reaches a threshold that warrants considering signal control.
- **Warrant 2 (Four Hour Vehicular Volume)** – Warrant 2 is for any four hours of a day.
- **Warrant 3 (Peak Hour)** – Warrant 3 is for the peak hour of any given day.

The signal warrant analysis was conducted based on the 2022 Existing Conditions, 2029 No Build Conditions, and 2029 Build Conditions for the intersection of Central Avenue at Gould Street and based on the 2029 Build Conditions for the intersection of Gould Street at the Project Site driveway / Wingate driveway. The daily distribution of site-generated volumes was based on the Institute of Transportation Engineers (ITE) Trip Generation Manual, and the daily distribution of existing and future roadway traffic was based on the proportion of peak hour traffic experienced throughout the rest of the day at a nearby MassDOT count station on Highland Avenue. Calculations projecting the hourly volumes at each intersection are included in the Appendix to this report.

Table 14 presents the results of the three-traffic volume-based warrant analyses at the intersections of Central Avenue at Gould Street and Gould Street at the Project Site driveway / Wingate driveway. The signal warrant analysis worksheets are provided in the Appendix to this report.

Table 14 Traffic Signal Warrants Analysis Summary

Location	Condition	Warrant 1 (8-Hour) Met	Warrant 2 (4-Hour) Met	Warrant 3 (Peak Hour) Met
Central Avenue at Gould Street	2022 Existing	Yes	Yes	No
	2029 No Build	Yes	Yes	Yes
	2029 Build	Yes	Yes	Yes
Gould Street at Project Site Driveway / Wingate Driveway	2022 Existing	n/a	n/a	n/a
	2029 No Build	n/a	n/a	n/a
	2029 Build	Yes	Yes	Yes

Note: Based on 85th-percentile speeds under 40 miles per hour.

As shown in Table 14, all the volume-based warrants are met at the intersection of Central Avenue at Gould Street under all conditions, except for the peak hour warrant under 2022 Existing Conditions, and all the volume-based warrants are met at the intersection of Gould Street at the Project Site driveway / Wingate driveway under the 2029 Build Conditions.

In addition to the three warrants described above, there are six other traffic signal warrants outlined in the MUTCD. While none of the six additional warrants are met at this intersection, the warrants are listed below with the reasoning why they do not apply at this location:

- **Warrant 4 (Pedestrian Volume) –** This warrant is not applicable because the current number of pedestrians at either location does not meet the minimum number of pedestrians required to meet any of the cases for Warrant 4.
- **Warrant 5 (School Crossing) –** This warrant is not applicable because there are not established school crossing across Central Avenue or Gould Street in these locations.
- **Warrant 6 (Coordinated Signal System) –** This warrant is not applicable because Central Avenue and Gould Street do not currently contain a coordinated traffic signal system with spacing of 1,000 feet.

- **Warrant 7 (Crash Experience) –** Warrant 7 is satisfied when five collisions correctable by signalization occur over the most recent 12 months. A review of crash data determines that this warrant is not applicable at either location because less than five total crashes occurred over the most recent 12-month period with data available.
- **Warrant 8 (Roadway Network) –** This warrant is not applicable because the study intersections are not the common intersection of two major routes.
- **Warrant 9 (Intersection Near a Grade Crossing) –** This warrant is not applicable because the intersections are not near active grade crossings.

Transportation Mitigation

In general, the Project will have a minor impact at most study area intersections on the operations or safety of the roadway network. This is reflected in the operational analyses presented previously in this study. The following chapter discusses actions that the Project Proponent will implement to limit the Project's impacts to the roadway system and to enhance the overall transportation network in the area, including off-site roadway mitigation and a robust transportation demand management system.

Off-Site Roadway Mitigation

To mitigate the impacts of the Project and to improve the overall transportation network, the Proponent is proposing improved pedestrian and bicycle accommodations as well as roadway improvements at four intersections: Central Avenue at Gould Street, Gould Street at the Project Site driveway / Wingate driveway, Highland Avenue at Gould Street / Hunting Street, and Gould Street at TV Place. The mitigation proposed is based on the proposed mitigation from the traffic study completed by GPI in 2020 to assist in the rezoning of the Project Site. Details of the proposed pedestrian and bicycle improvements as well as the mitigation proposed at each intersection are provided below.

Proposed Pedestrian and Bicycle Improvements

Gould Street Bicycle Accommodations

The Proponent is proposing to add on-road bicycle accommodations along Gould Street to create a new north-south bicycle network within this area of Needham and connect Mills Field and the commercial and residential uses on Gould Street with the under-construction bicycle accommodations along Highland Avenue and the existing bicycle lanes in each direction on Hunting Road. The bicycle accommodations will consist of on-road bicycle lanes in each direction for approximately 900 feet between Highland Avenue and the former MBTA railroad ROW just north of TV Place. Between the former MBTA railroad ROW and Central Avenue, a distance of approximately ½ mile, the Proponent will fund the installation of shared lane pavement markings and signage in each direction. The design of the on-road bicycle accommodations will be coordinated with the Town of Needham.

Shared-Use Path Planning Study

North of the Project Site and the Channel 5 property is a former MBTA railroad ROW. There are long-term plans to convert this right-of-way into a shared-use path that would connect to the regional pedestrian and bicycle network of Eastern Massachusetts. To the north, the path would cross I-95/Route 128 and the Charles River and connect to the existing Upper Falls Greenway in Newton. To the south, the path would connect to the existing Bay Colony Rail Trail via Needham Heights and Needham Center. This would create a continuous off-road pedestrian and bicycle facility that would one day extend between Newton, Needham, Dover, and Medfield.

While there are long-term plans to create this shared-use path network, there is currently no funding for the part of the project between the Charles River and Needham Heights. The Proponent is proposing to coordinate with the Town of Needham to fund a study evaluating the feasibility of converting the former railroad ROW into a shared-use path between the Charles River and the commuter rail at Needham Heights. As part of the proposed improvements along Gould Street, the Proponent will include a crosswalk at the location of the future shared-use path.

Proposed Intersection Improvements

Central Avenue at Gould Street

Based on the analyses presented previously, without mitigation, the Gould Street approach is expected to operate at LOS F during the weekday morning and weekday evening peak hours under all scenarios, with v/c ratios greater than 1.00. The addition of Site traffic in the 2029 Build Condition will increase the delay on the Gould Street approach, as approximately 15-percent of Site-generated traffic is expected to travel through this intersection. Also as reported previously, this location meets the volume-based traffic signal warrants under the 2022 Existing, 2029 No Build, and 2029 Build Conditions. With mitigation, Gould Street is proposed to operate at LOS D or E with a v/c ratio under 1.00.

As recommended in the 2020 GPI Traffic Impact Study for the rezoning of the Project Site, the Proponent is proposing to fund the installation of a traffic signal at the intersection of Central Avenue at Gould Street. The traffic signal is proposed to be actuated-uncoordinated and include an exclusive pedestrian phase. The geometry of the intersection is proposed to be maintained on the Central Avenue eastbound and Gould Street northbound approaches with one general purpose lane in each direction while the geometry of the Central Avenue westbound approach is proposed to consist of a dedicated left-turn lane and a dedicated through lane. The westbound approach is anticipated to be restriped to provide a dedicated left-turn lane by narrowing the existing travel lanes and without changing the curb lines. Crosswalks will be provided across all approaches.

Although the installation of a traffic signal at this location will not require altering the curb line of the roadway, some minor right-of-way impacts may be necessary to locate signal equipment and to provide ADA-compliant sidewalk ramps at each crosswalk.

Figure 15 provides an illustration of the proposed intersection improvement concept. A summary of the traffic operations with the proposed mitigation in place is provided in the following section.

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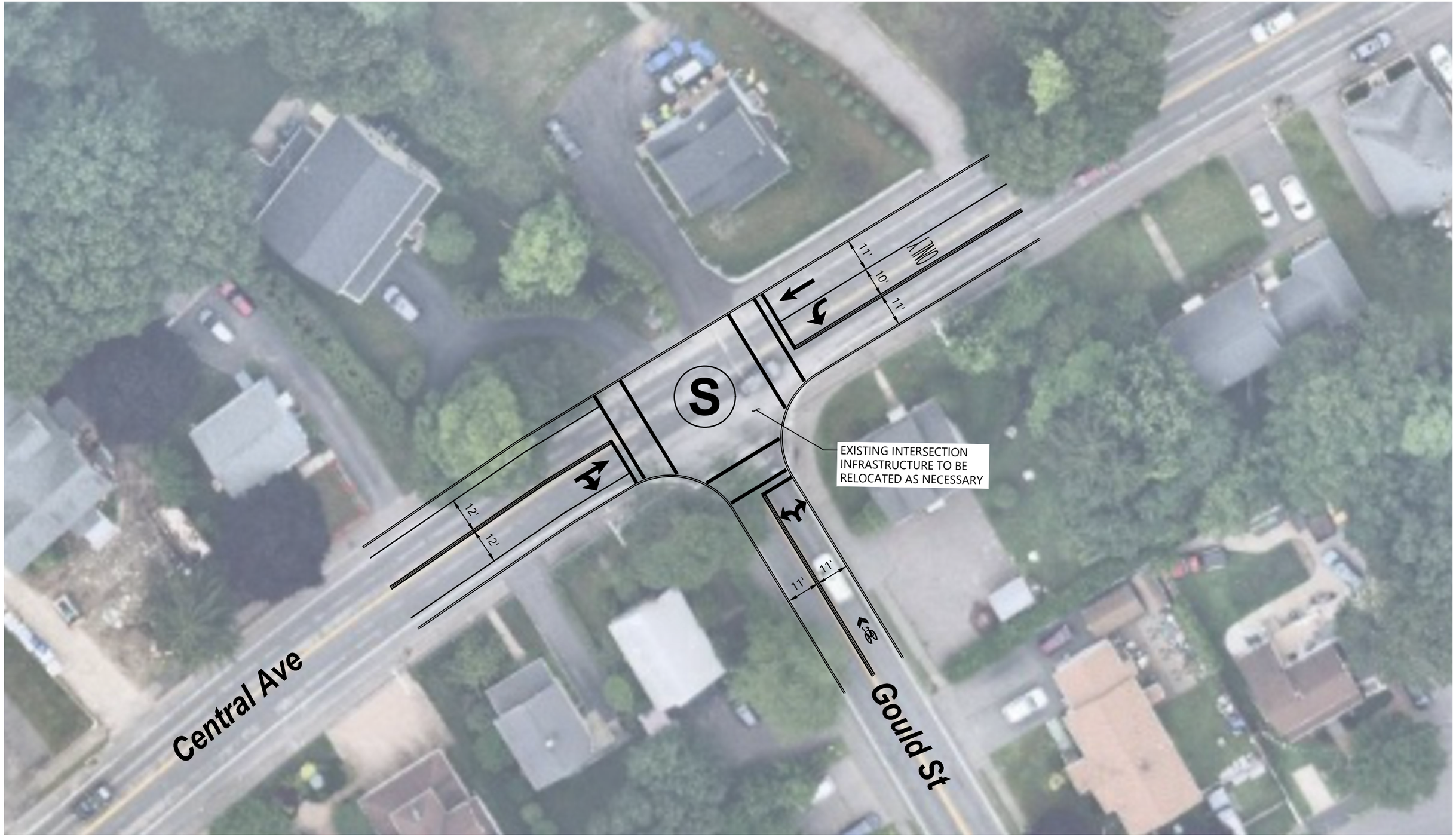


NOT FOR CONSTRUCTION

0 15 30 60 Feet

Proposed Intersection Improvements
Central Avenue at Gould Street
Highland Science Center
Needham, Massachusetts

Figure 15

03.30.22

Gould Street at Site Driveway / Wingate Driveway

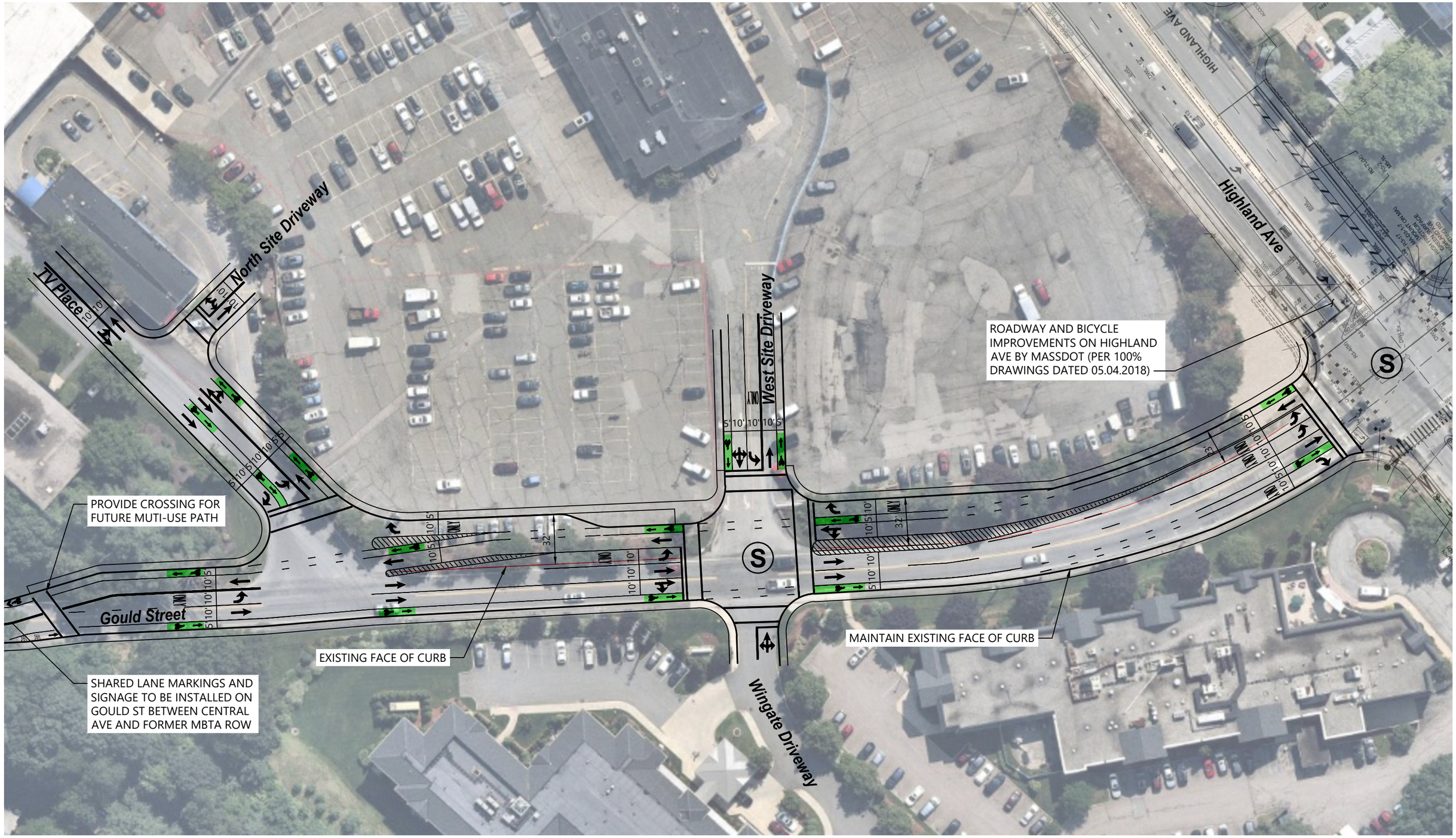
Based on the analyses presented previously, without mitigation, the Project Site driveway approach is expected to operate at LOS F during the weekday morning and weekday evening peak hours under the 2029 Build Condition, with v/c ratios greater than 1.00. Also as reported previously, this location meets all three volume-based traffic signal warrants under 2029 Build Conditions. In addition, there are no pedestrian facilities at this intersection, except for the sidewalk on the west side of Gould Street. With mitigation, the Project Site driveway during the weekday evening hour is proposed to operate at LOS D with a v/c ratio of 0.75 or lower and dedicated pedestrian and bicycle facilities will be provided.

As recommended in the 2020 GPI Traffic Impact Study for the rezoning of the Project Site, the Proponent is proposing to fund the installation of a traffic signal at the intersection of Gould Street at the Project Site Driveway / Wingate driveway. A traffic signal at this location will help employees and visitors access the Project Site via vehicle and will also improve pedestrian and bicycle connectivity to the Project Site by providing a protected crossing across Gould Street. The traffic signal is proposed to be actuated and coordinated with the signal at the intersection of Highland Avenue at Gould Street / Hunting Road, as the two traffic signals will be less than 400 feet apart.

As outlined in the GPI Traffic Impact Study, Gould Street is proposed to be expanded to a five-lane cross section. The northbound approach will consist of a shared left-turn/through lane and a dedicated right-turn lane and the southbound approach will consist of a dedicated left-turn lane, a dedicated through lane, and a shared through/right-turn lane. The geometry of the Wingate driveway eastbound approach is proposed to be maintained with one general purpose lane. The Project Site driveway approach is proposed to consist of a dedicated left-turn lane and a shared left-turn/through/right-turn lane. One inbound lane into the Project Site is proposed. Crosswalks will be provided across all approaches and bicycle lanes will be provided in each direction on Gould Street and on the Project Site driveway.

To accommodate the expanded cross-section on Gould Street, the roadway will need to be expanded by up to 32 feet. Any expansion of the roadway is expected to occur to the east into the Project Site and the western curb line along the Wingate frontage will be maintained.

Figure 16 provides an illustration of the proposed improvements along Gould Street and at this intersection. A summary of the traffic operations with the proposed mitigation in place is provided in the following section.



NOT FOR CONSTRUCTION

0 30 60 120 Feet

Proposed Intersection Improvements **Figure 16**
Gould Street between TV Place and Highland Avenue
Highland Science Center
Needham, Massachusetts 03.30.22

Highland Avenue at Gould Street / Hunting Road

Based on the analyses presented previously, without mitigation, the intersection of Highland Avenue at Gould Street / Hunting Road is expected to operate at overall LOS F during the weekday morning and weekday evening peak hours under the 2029 Build Condition. The Gould Street southbound and Highland Avenue westbound approaches are expected to be impacted the greatest by the additional Site-generated traffic under the 2029 Build Conditions, with both approaches operating at LOS F with v/c ratios greater than 1.00. With mitigation, the intersection is expected to improve to overall LOS D during both peak hours.

As recommended in the 2020 GPI Traffic Impact Study for the rezoning of the Project Site, the Proponent is proposing to fund geometric improvements at this location that include the addition of a second dedicated southbound left turn lane as well as a dedicated southbound right-turn lane. Without mitigation, the southbound approach consists of a dedicated left-turn lane and a shared left/through/right-turn lane. Under the proposed mitigation, the southbound approach will consist of two dedicated left-turn lanes, a dedicated through lane, and a dedicated right-turn lane. This will provide additional capacity for the Project Site-generated traffic accessing I-95 and Needham Heights while minimizing the impacts for other drivers on the roadway. Bicycle lanes in each direction are also proposed on Gould Street.

In addition, the signal timings at this intersection are proposed to be modified to provide adequate green time for each approach. As part of the improvements, the signal is proposed to be coordinated with the signal at the intersection of Gould Street at the Project Site driveway / Wingate driveway, as the two traffic signals will be less than 400 feet apart.

Highland Avenue is currently being reconstructed as part of the Needham-Newton Corridor Project and will include improved pedestrian and bicycle accommodations. The proposed bicycle lanes on Gould Street will connect to the Highland Avenue bicycle accommodations at this intersection providing access toward Newton to the east and toward Needham Heights to the west. The Proponent will work with MassDOT to coordinate how the proposed improvements on Gould Street will tie into the roadway improvements on Highland Avenue as well as any changes needed to the signal equipment.

Figure 16 provides an illustration of the proposed improvements along Gould Street and at this intersection. A summary of the traffic operations with the proposed mitigation in place is provided in the following section.

Gould Street at TV Place

Based on the analyses presented previously, without mitigation, the TV Place single-lane approach to Gould Street is expected to operate at LOS D during the weekday morning and LOS F during the weekday evening peak hours under the 2029 Build Condition, with queues up to 185 feet. There are also no pedestrian or bicycle accommodations at this intersection, except for the sidewalk on the west side of Gould Street.

As recommended in the 2020 GPI Traffic Impact Study for the rezoning of the Project Site, the Proponent is proposing to provide turn lanes on TV Place and on Gould Street. TV Place is proposed to consist of a dedicated left-turn lane and a dedicated right-turn lane. Gould Street northbound is proposed to consist of a through lane and a dedicated right-turn lane and Gould Street southbound is proposed to consist of a through lane and a dedicated left-turn lane. This will help traffic entering and exiting the Project Site and other businesses on TV Place by providing additional storage space

for vehicles turning into and out of TV Place. In addition, a new crosswalk is proposed across TV Place and bicycle lanes are proposed in both directions on Gould Street and TV Place. The crosswalk will be ADA compliant and will connect with the proposed pedestrian facility along the Project Site frontage on the east side of Gould Street and the south side of TV Place.

To accommodate the expanded cross-sections on TV Place and Gould Street, the curb-to-curb width on each roadway will need to be widened. It is expected that roadway widening will take place into the Project Site east of Gould Street and south of TV Place. The Proponent also owns a small parcel of land north of TV Place that can accommodate the expanded cross-section of Gould Street north of the intersection.

As noted previously, the proposed improvements at this intersection match what was proposed in the 2020 GPI Traffic Impact Study for the rezoning of the Project Site. While the rezoning study looked at the potential redevelopment of the Project Site as well as the Channel 5 site and the small office building north of TV Place, the current Project only includes redevelopment of the former car dealership and car wash sites. However, the Proponent is proposing to construct all improvements at this intersection at this time to prepare for any potential redevelopment of the Channel 5 and office building sites in the future.

Figure 16 provides an illustration of the proposed improvements along Gould Street and at this intersection. A summary of the traffic operations with the proposed mitigation in place is provided in the following section.

Traffic Operations Analysis with Roadway Mitigation

To understand how traffic will operate with the proposed mitigation at each intersection, additional intersection capacity analyses have been conducted for the 2029 Build Conditions with the proposed improvements in place. Tables 15 and 16 summarize the intersection capacity analyses for the signalized and unsignalized mitigated study area intersections, respectively, and the capacity analysis worksheets are included in the Appendix to this report.

Table 15 Signalized Intersection Capacity Analysis Summary - with Proposed Mitigation

	2029 No-Build Conditions					2029 Build Without Mitigation					2029 Build With Mitigation				
Location / Movement	**v/c [a]**	**Del [b]**	**LOS [c]**	**50 Q [d]**	**95 Q [e]**	**v/c**	**Del**	**LOS**	**50 Q**	**95 Q**	**v/c**	**Del**	**LOS**	**50 Q**	**95 Q**
Central Avenue at Gould Street															
Weekday Morning															
Central Ave EB T/R											1.05	59.3	E	368	#960
Central Ave WB T											0.72	28.7	C	18	#151
Central Ave WB L											0.27	5.1	A	36	141
Gould St NB L/R											0.85	55.7	E	82	#199
Overall	*Intersection unsignalized under 2029 No Build Conditions*					*Intersection unsignalized under 2029 Build without Mitigation Conditions*					**0.93**	**46.0**	**D**	**-**	**-**
Weekday Evening															
Central Ave EB T/R											0.81	30.0	C	228	#554
Central Ave WB T											0.67	20.0	C	41	#130
Central Ave WB L											0.86	24.4	C	287	#661
Gould St NB L/R											0.91	48.8	D	206	242
Overall											**0.89**	**31.1**	**C**	**-**	**-**
Gould Street at Wingate Driveway and the Project Site Driveway															
Weekday Morning															
Wingate Dwy EB L/T/R											0.01	54.4	D	0	0
Site Dwy WB L											0.46	57.1	E	40	82
Site Dwy WB L/T/R											0.27	54.6	D	22	63
Gould St NB L/T											0.59	2.9	A	172	m202
Gould St NB R											0.29	1.4	A	19	m17
Gould St SB L											0.09	3.4	A	3	25
Gould St SB T/R											0.15	3.2	A	19	89
Overall	*Intersection unsignalized under 2029 No Build Conditions*					*Intersection unsignalized under 2029 Build without Mitigation Conditions*					**0.55**	**5.8**	**A**	**-**	**-**
Weekday Evening															
Wingate Dwy EB L/T/R											0.03	43.4	D	0	12
Site Dwy WB L											0.75	44.2	D	174	187
Site Dwy WB L/T/R											0.70	41.6	D	163	176
Gould St NB L/T											0.31	10.2	B	48	m245
Gould St NB R											0.06	14.7	B	0	m25
Gould St SB L											0.03	8.8	A	4	21
Gould St SB T/R											0.37	11.4	B	124	270
Overall											**0.44**	**21.7**	**C**	**-**	**-**

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal.

Table 15 Signalized Intersection Capacity Analysis Summary - with Proposed Mitigation (cont.)

Location / Movement	2029 No-Build Conditions					2029 Build Without Mitigation					2029 Build With Mitigation				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
Highland Avenue at Gould Street and Hunting Road															
Weekday Morning															
Highland Ave EB L	1.04	>120	F	~93	#234	>1.20	>120	F	~190	#353	0.97	110.4	F	~148	#277
Highland Ave EB T/R	0.86	40.2	D	364	#512	0.79	36.6	D	364	#512	0.68	28.4	C	336	433
Highland Ave WB L	0.58	58.6	E	36	83	0.61	65.3	E	38	83	0.38	53.8	D	37	76
Highland Ave WB T/R	0.94	52.1	D	362	#545	1.15	117.8	F	~616	#841	0.97	51.4	D	510	#718
Hunting Rd NB L/T	0.96	89.0	F	206	#434	1.13	>120	F	~263	#480	1.02	107.2	F	~241	#409
Hunting Rd NB R	0.48	39.8	D	48	102	0.51	44.0	D	52	102	0.55	41.8	D	81	130
Gould St SB L	0.82	64.8	E	145	#281	0.91	84.5	F	182	#347	0.72	62.3	E	105	180
Gould St SB L/T/R	0.78	59.4	E	137	#264	0.88	77.3	E	175	#335	-	-	-	-	-
Gould St SB T	-	-	-	-	-	-	-	-	-	-	0.41	56.1	E	64	136
Gould St SB R	-	-	-	-	-	-	-	-	-	-	0.03	46.2	D	0	10
Overall	**0.98**	**55.1**	**E**	**-**	**-**	**1.20**	**100.2**	**F**	**-**	**-**	**0.98**	**52.5**	**D**	**-**	**-**
Weekday Evening															
Highland Ave EB L	>1.20	>120	F	19	57	>1.20	>120	F	27	72	0.60	58.2	E	24	57
Highland Ave EB T/R	0.81	42.3	D	287	440	0.81	42.4	D	290	442	0.71	31.4	C	248	#360
Highland Ave WB L	0.86	83.3	F	100	194	0.87	84.5	F	101	196	0.78	61.6	E	89	#182
Highland Ave WB T/R	1.00	61.7	E	~535	#774	1.07	84.0	F	~599	#861	0.99	53.0	D	~515	#689
Hunting Rd NB L/T	0.56	51.4	D	66	127	0.58	52.2	D	70	134	0.93	108.6	F	66	#150
Hunting Rd NB R	0.10	35.7	D	4	24	0.10	35.7	D	4	24	0.07	35.5	D	0	6
Gould St SB L	0.91	61.1	E	295	#574	>1.20	>120	F	~681	#1051	0.95	56.5	E	307	#364
Gould St SB L/T/R	0.88	56.9	E	284	#554	>1.20	>120	F	~653	#1022	-	-	-	-	-
Gould St SB T	-	-	-	-	-	-	-	-	-	-	0.44	32.5	C	134	134
Gould St SB R	-	-	-	-	-	-	-	-	-	-	0.10	81.4	F	12	22
Overall	**1.03**	**59.5**	**E**	**-**	**-**	**>1.20**	**>120**	**F**	**-**	**-**	**1.05**	**50.6**	**D**	**-**	**-**

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal.

Table 16 Unsignalized Intersection Capacity Analysis Summary - with Proposed Mitigation

Location / Movement	2029 No-Build Conditions				2029 Build Without Mitigation				2029 Build With Mitigation			
	v/c [a]	Del [b]	LOS [c]	95 Q [d]	v/c	Del	LOS	95 Q	v/c	Del	LOS	95 Q
Gould Street at TV Place												
Weekday Morning												
TV Place WB L/R	0.15	20.5	C	13	0.36	32.0	D	39	-	-	-	-
TV Place WB L	-	-	-	-	-	-	-	-	0.28	26.7	D	27
TV Place WB R	-	-	-	-	-	-	-	-	0.39	0.0	A	0
Gould Street SB L	0.03	0.8	A	2	0.12	3.2	A	10	0.12	10.3	B	10
Weekday Evening												
TV Place WB L/R	0.19	21.7	C	17	0.88	72.7	F	183	-	-	-	-
TV Place WB L	-	-	-	-	-	-	-	-	0.78	50.2	F	148
TV Place WB R	-	-	-	-	-	-	-	-	0.24	0.0	A	0
Gould Street SB L	0.01	0.2	A	0	0.02	0.5	A	1	0.02	8.2	A	1

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 95th percentile queue, in feet.

As shown in Table 15, the intersection of Central Avenue at Gould Street with the proposed mitigation is expected to operate at overall LOS D during the weekday morning peak hour and LOS C during the weekday evening peak hour. While the eastbound and northbound approaches are expected to operate at LOS E during the weekday morning peak hour, this is because each approach is proposed to consist of a single lane in order to limit right-of-way impacts.

The intersection of Gould Street at the Project Site driveway / Wingate Driveway with the proposed mitigation is expected to operate at overall LOS A during the weekday morning peak hour and LOS C during the weekday evening peak hour. While the westbound site driveway approach is expected to operate at LOS E during the weekday morning peak hour, the volume to capacity ratio is less than 0.50. The intersection is proposed to be coordinated with the intersection of Highland Avenue at Gould Street / Hunting Road and the northbound queues at this intersection are not expected to extend back to the upstream intersection. The inclusion of two southbound through lanes will provide adequate queueing storage that is not expected to extend more than 300 feet.

The intersection of Highland Avenue at Gould Street / Hunting Road with the proposed mitigation is expected to operate at overall LOS D during the both the weekday morning and weekday evening peak hours, which is an improvement over the 2029 No Build Conditions. The intersection is proposed to be coordinated with the intersection of Gould Street at the Project Site driveway / Wingate driveway and the southbound queues at this intersection are not expected to extend back to the upstream intersection. In addition, in the 2020 GPI traffic study to support the rezoning of the Project Site, additional mitigation at this intersection included the construction of a dedicated westbound right-turn lane. Without the dedicated right-turn lane, the westbound approach is expected to operate at LOS E with v/c below 1.00. While adding a dedicated right-turn lane would improve right-turning operations, it would add a new weaving conflict between drivers coming off the I-95 Southbound off-ramp and drivers turning right onto Gould Street, which could cause a safety issue. To not add a new weaving conflict, no dedicated westbound right-turn lane is proposed as mitigation.

As shown in Table 16, while the unsignalized TV Place approach to Gould Street is still expected to operate at LOS F with the mitigation in place under the 2029 Build Conditions during the weekday evening peak hour, creating dedicated left-turn and right-turn lanes is expected to reduce the average delay by over 20 seconds for left-turning vehicles, from 73 seconds to 50 seconds. With a v/c ratio of 0.78, the intersection is expected to be able to handle the additional Site-generated traffic. The additional northbound and southbound turn lanes into TV Place will provide vehicles space to turn without blocking through traffic and will also be able to accommodate any potential future development along TV Place.

Transportation Demand Management

The Proponent is exploring a wide array of TDM measures to offer as a means to reduce single occupant driving and increase use of alternative forms of transportation to access the workplace.

- Providing an Employee Transportation Advisor who will coordinate with the 128 Business Council;
- Provide covered and secure bicycle parking spaces on-site;
- Exploring the feasibility of providing shuttle service connectivity to nearby public transportation nodes (commuter rail and Green Line);

- Requiring tenants to provide a 50 percent transit pass subsidy for their employees;
- Carpool assistance and incentives;
- Emergency ride home;
- Bicycling/walking incentives and amenities;
- Provide on-site locker rooms and showers for employees;
- Offer on-site amenities for employees to reduce mid day trip making;
- Telecommuting and compressed workweeks, when feasible;
- Display in the Main Lobby transportation-related information for tenants' employees and visitors; and
- Promotional efforts.

Transportation Management Association

The Transportation Management Association serving businesses in Needham is the 128 Business Council. The Proponent will join and become an active member of the 128 Business Council.

Transportation Monitoring

The Proponent is committed to a robust transportation monitoring program to evaluate the effectiveness of its TDM program and to measure the Project's impacts on the transportation network. As detailed next, the monitoring program will include the annual collection of traffic counts and parking garage activity by tenants' employees and visitors to the Project Site. The transportation monitoring program will begin six months after full occupancy of the proposed development and continue for a period of five years. The results of each transportation monitoring program will be summarized in a report and provided to MassDOT and to the Town of Needham.

Traffic Monitoring: Vehicle Volumes and Parking Activity

Annual traffic counts will be conducted both on-Site and off-Site to evaluate the impact of the Project as compared to the estimated impact as outlined in this report.

On-Site Traffic Monitoring: Parking Activity

The actual number of weekday morning peak hour, weekday evening peak hour, and weekday daily vehicle trips generated by the Project will be measured using simultaneous automatic traffic recorder (ATR) counts or via a parking revenue control system at each parking entrance/exit for a continuous 24-hour period on a typical weekday.

These volumes entering and exiting each parking facility will be compared against the estimated Project-generated vehicle trips presented in this report to determine if the Project Site is generating trips at a rate higher or lower than what was projected.

Off-Site Traffic Monitoring

The traffic monitoring program will include collecting weekday morning and weekday evening peak period turning movement counts at the following study area intersections:

- Central Avenue at Gould Street
- Gould Street at TV Place
- Gould Street at the Project Site driveway
- Highland Avenue at Gould Street / Hunting Road

These area intersections represent the key vehicular gateways to the Project Site and are the focus of the proposed roadway mitigation.

In addition to peak period turning movement counts at the identified intersections above, the traffic monitoring program will include collecting continuous 48-hour ATR counts along Gould Street north of Highland Avenue.

These counts will be collected on a non-holiday week, during midweek days.

BARRETT
PLANNING GROUP LLC

March 20, 2021

Lee Newman
Planning Director
500 Dedham Avenue
Needham, MA 02492

Reference: 2021 Fiscal Impact Analysis, Highway Commercial I Rezoning

Dear Lee,

I am submitting a revised report on the fiscal impact of commercial and mixed-use development options for the proposed Highway I Commercial District. The purposes of this revision are to address comments you provided to us by email on Tuesday, March 16. As noted in the enclosed report, we find that development in the proposed district would lead to the following fiscal outcome for the Town:

1. At maximum buildout with a floor area ratio (FAR) of 1.0, development in the new district would provide $6,733,100 in tax revenue per year and create demands on municipal services of approximately $381,000 per year. For development at this level, the net revenue would be $6,352,100, for a cost-revenue ratio of 0.060.

2. In addition, if development occurs at 1.35 FAR, development in the new district would provide $8,844,400 in tax revenue per year and create demands on municipal services of approximately $502,000 per year. The net revenue would be $8,342,400, for a cost-revenue ratio would be 0.060.

3. As for the mixed-use development options, a project comprised of multiple nonresidential uses (retail, lab space, and offices) and 170 apartments, with a combined total FAR of 1.0, would generate $5,807,600 in taxes per year and create demands on municipal and school services of approximately $1,154,900. The net revenue would be $4,652,700 for a cost-revenue ratio of 0.199.

4. A project comprised of multiple nonresidential uses and 226 apartments, with a combined total FAR of 1.35, would generate $7,508,500 in taxes per year and create demands on municipal and school services of approximately $1,479,600. The net revenue would be $6,028,900 for a cost-revenue ratio of 0.197.

5. Finally, you asked us to evaluate a potential mix of warehouse/distribution space and television studio. We estimate that the Town would receive $922,900 in tax revenue and spend approximately $179,000 for municipal services to meet the demands of these two uses. The net revenue would be $743,900, for a cost-revenue ratio of 0.241.

Under existing conditions, the parcels in the proposed district pay the Town about $490,500 in taxes per year. As a result, the gain in tax revenue from the new nonresidential options or the mixed-use development options will be anywhere from 11 to 18 times what the Town receives today.

Sincerely,

Judith A. Barrett

Judi Barrett
Barrett Planning Group LLC

FISCAL IMPACT ANALYSIS: HIGHWAY COMMERCIAL I

INTRODUCTION

In September 2019, the Needham Planning Department asked Barrett Planning Group to review a potential rezoning of four parcels (15 acres) at Highland Avenue and Gould Street west of the Route 128 highway layout. The Town subsequently decided to study the proposal further before presenting the proposed Highway Commercial I District to Town Meeting. We were asked to update our analysis in February 2021, and to expand it by including other uses not contemplated in the original concept for this district. For the new study, we reviewed and considered the following information:

1. Highway Commercial 1 Zoning District Planning Presentation, February 3, 2021;
2. Property Assessment and Tax Information, provided by the Needham Planning Department;
3. CoStar Office, Industrial, Retail, and Multifamily Market Data and Trends, Newton-Needham-Brookline-Dover Submarkets;
4. Town of Needham, FY 2021 Operating Budget;
5. Department of Revenue, Municipal Data Bank, Misc. Financial Data (Tax Rates, Assessed Values, Revenue Sources, Tax Levy); and
6. Buildout Analysis prepared by John Connery for Needham Planning Department (2015).

SUMMARY

The following chart compares the current assessed values and tax payments for the area included in our analysis to the estimated values and tax revenue of the same area, assuming the parcels are assembled and redeveloped under the proposed Highway Commercial I zoning.

TABLE 1. ASSESSED VALUE AND REVENUE CHANGE, 2021 PROPOSED HIGHWAY COMMERCIAL I

	Existing Conditions	If Redeveloped at 1.0 FAR for Nonresidential Uses	Gain/Loss at 1.0 FAR Outcome	If Redeveloped at 1.35 FAR for Nonresidential Uses	Gain/Loss at 1.35 FAR Outcome
Assessed Value	$19,087,100	$261,582,100	$242,495,000	$343,604,200	$324,517,100
Tax Revenue	$490,500	$6,733,100	$6,242,600	$8,844,400	$8,353,900
	Existing Conditions	**If Redeveloped at 1.0 FAR as Mixed-Use Option**	**Gain/Loss at 1.0 FAR Outcome**	**If Redeveloped at 1.35 FAR as Mixed-Use Option**	**Gain/Loss at 1.35 FAR Outcome**
Assessed Value	$19,087,100	$262,226,000	$243,138,900	$340,356,200	$321,269,100
Tax Revenue	$490,500	$5,807,600	$5,317,100	$7,508,500	$7,018,000
	Existing Conditions	**If Redeveloped at as Warehouse/TV Studio**	**Gain/Loss**		
Assessed Value	$19,087,100	$35,854,000	$16,766,900		
Tax Revenue	$490,500	$922,900	$432,400		

Source: Barrett Planning Group, with data from Town of Needham, Municipal Data Bank, and CoStar.

APPROACH AND METHODOLOGY

Proportional Valuation

Nonresidential development places different demands on municipal services depending on the class of use. For example, retail uses usually demand more from public safety personnel than any other municipal department, but industrial uses tend to require higher expenditures for public works. Food service establishments also require periodic inspections by the health department, and uses ranging from nursing homes and day care centers to performing arts centers require semiannual or more frequent inspections by health, fire, and building authorities. In some towns, nonresidential development of all types places demands on services traditionally thought of as "residential," e.g., public libraries. When a community invests in waterworks and sewer system upgrades, the benefits are often shared by residential and nonresidential ratepayers.

Recognizing that each class of use has both unique needs and needs common to all uses, fiscal impact analysts have developed models to identify, estimate, and assign service costs to various types of development. The most widely used model for estimating the cost to serve nonresidential land uses is known as *proportional valuation*. This two-part model embraces a long-standing fiscal impact principle: the average cost of nonresidential municipal services can be inferred from the relationship between nonresidential real property values and the total value of real property in a community, adjusted for type of community and size of tax base.

TABLE 2. PROPORTIONAL VALUATION ANALYSIS: EXISTING CONDITIONS, NEEDHAM

A	2021 General Fund Operating Budget	$190,247,800	*Town of Needham*
B	Less Education	$81,835,000	*Town of Needham*
C	Less Education Debt	$10,766,800	*Town of Needham*
D	Less Education Fixed Costs	$26,592,400	*Consultant Estimate*
E	Total Municipal	$71,053,600	*Town of Needham*
F	Non-Residential Real Property Value	$1,153,202,700	*Dept. of Revenue*
G	Total Real Property Assessed Value	$10,742,368,800	*Dept. of Revenue*
H	Ratio	0.107	*F/G*
I	Non-Residential Parcels	441	*Dept. of Revenue*
J	Total Parcels	10,211	*Dept. of Revenue*
K	Average Value: Non-Residential Parcel	$2,615,000	*FI*
L	Average Value: All Parcels	$1,052,000	*G/J*
M	Ratio	2.49	*K/L*
N	Refinement Coefficient	0.686	*Consultant (Burchell)*
O	Non-Residential Expenditures	$5,232,600	*Consultant*
P	Residential Expenditures	$185,015,200	*Consultant*

Average Cost Per Capita/Student, Adjusted

After establishing the approximate share of nonresidential expenditures under existing conditions, analysts can use a similar process to estimate the cost of services that will be used by new growth. For our 2019 study of Highway Commercial I, we applied the principles of proportional valuation to estimate the revenue and cost of services impact of new development under that plan. People familiar with that study may remember that a critical step in proportional valuation involves using a *refinement coefficient* to modify the average cost of nonresidential services in order to adjust for significant differences in scale between the proposed project and existing conditions in the tax base as a whole. We repeated the process for this report. However, since the new plan for the district includes options for mixed-use development with housing, the updated study is more complicated.

The development scenarios that could occur under the proposed zoning include multifamily units in mixed-use projects. This means the fiscal impact analysis must also consider the net new cost of residential demands on municipal services and schools. To estimate these costs, we used the following procedures.

The average cost of non-school services used by Needham residents is $2,130. This represents the total cost of residential non-school services, $65,821,000, divided by the Town's estimated 2019 population, 30,970.[1] When we prepare a fiscal impact analysis, our goal is to simulate as much as possible what the Town's *net new cost of services* will be – that is, the *incremental cost* of services associated with growth. Toward that end, we adjusted the average cost of municipal services per capita, just as we modified the average cost for the nonresidential portion of this study. For the residential analysis, we eliminated costs that would not necessarily change just because the Town attracts a modest number of new residents. For example, the Town would not hire more personnel in the Town Manager's office or the management/administrative tiers of other general government offices or the public safety and public works departments just because the Town gained 330-400 new residents. Still, population growth will impose some additional burdens on day-to-day service delivery, and those burdens come with some costs.

To account for these new demands, we assumed the *average variable cost* in municipal departments is approximately 18 percent, so we used 82 percent of the average municipal cost of services to estimate the cost of new growth:

Average cost of new municipal services =	Existing cost of municipal services	X 82%	/ Existing Population
$1,740 =	$65,821,000	$53,973,200	30,970

**Numbers may not total due to rounding.*

The cost of new services was multiplied by the new household population assumptions for each mixed-use scenario to arrive at the estimated cost of new demands on town services.

[1] U.S. Census Bureau, 2015-2019 American Community Survey (ACS) Five-Year Estimates).

The potential cost of new school services was estimated in a similar way. We consulted the detailed version of Needham's most recent Per Pupil Cost report from the Massachusetts Department of Elementary and Secondary Education (DESE) and identified what we assumed would be costs most directly affected by enrollment growth: teachers, instructional support personnel, instructional materials, and pupil services, including transportation. On a per-student basis, the sum of these expenditures is $7,530. Since the most recent report reflects FY 2019 conditions, we adjusted for inflation and non-inflation spending growth with a multiplier of 1.12. This explains how we arrived at the average cost per student for our study, $8,400.

We used the following procedures and data sources to estimate the new household population:

- The Town supplied us with the school enrollment counts for three existing Chapter 40B mixed-income developments: Charles River Landing, Modera Needham, and The Kendrick. The total number of units in these developments is 943 and total number of school students, 105 (October 1, 2020). Since 70 percent of the apartments at Charles River Landing are one-bedroom units, the number of school-age children is very low (18). We eliminated Charles River Landing from our analysis and focused on the other projects. The average number of students living at Modera Needham (136 units) and The Kendrick (390 units) is 87, or an average of 0.165 per unit. We used that number to estimate the school enrollment impact of the mixed-use options for the subject property: 28 students in 170 units or 38 students in 226 units.
- The household population estimate is based on the average household size of two-bedroom apartments per the U.S. Census Bureau, *American Housing Survey*: 1.945 persons per unit. For 170 units, the result is 331 new residents and for 226 units, 440.

The proportional valuation models for each of the development options the Town asked us to evaluate are presented on the following pages. They are:

1. **A nonresidential project with a maximum floor area ratio (FAR) of 1.0., comprised of:**
- Office: 280,305 sq. ft.
- Research Center/Lab: 280,305 sq. ft.
- Retail: 98,925 sq. ft.
- Total: 659,535 sq. ft.

2. **A nonresidential project with a maximum floor area ratio (FAR) of 1.35., comprised of:**
- Office: 368,200 sq. ft.
- Research Center/Lab: 368,200 sq. ft.
- Retail: 129,940 sq. ft.
- Total: 866,340 sq. ft.

3. **A mixed-use project with a maximum floor area ratio (FAR) of 1.0, comprised of:**
- Office: 197,860 sq. ft.
- Research Center/Lab: 197,860 sq. ft.
- Retail: 69,250 sq. ft.

- Apartments: 170
- Total: 659,535 sq. ft.

4. A mixed-use project with a maximum floor area ratio (FAR) of 1.35., comprised of:

- Office: 259,130 sq. ft.
- Research Center/Lab: 259,130 sq. ft.
- Retail: 91,460 sq. ft.
- Apartments: 226
- Total: 866,340 sq. ft.

5. A warehouse/distribution facility and television studio mix as of right:

- Warehouse: 158,900 sq. ft.
- TV studio: 90,002
- Total: 248,902 sq. ft.

Part II. Est. Impact of Five Development Scenarios
II.A. Office/Research/Retail Mix @ 1.0 FAR

	NEW PROJECT VALUE (Z)	$261,582,100	NOTES
A	New Value / Total Nonresidential Value	0.23	
B	Refinement Coefficient	0.321	
C	New Nonresidential Service Costs	$381,000	*(A*B*NonResTot)*
D	Est. Nonresidential Tax Revenue	$6,733,100	*Value/1000/*$25.74*
E	New Residential Service Costs		
F	Est. Residential Tax Revenue		
G	Net Revenue	$6,352,100	*D-C*
H	Cost/Revenue Ratio	0.060	*C/D*
	Project Use(s)		
I	Total Sq. Ft.	659,535	*From Town*
J	Office	280,305	*From Town*
K	Research Center	280,305	*From Town*
L	Retail	98,925	*From Town*
M	Warehouse	0	*From Town*
N	Residential (Units)	0	*From Town*
	Rent		
O	Office sq. ft.	$42.00	*CoStar*
P	Research Center sq. ft.	$60.00	*CoStar*
Q	Retail sq. ft.	$36.80	*CoStar*
R	Warehouse sq. ft.	$19.61	*Loopnet*
S	Residential (per unit)	$2,637	*CoStar*
	Income & Value		
T	Gross Nonresidential Income	$32,231,550	*Sq. ft.*rents*
U	Nonresidential Exp. Ratio 39.2%	$13,920,800	*CoStar*
V	Nonresidential NOI	$18,310,750	*T-U*
W	Residential Income	$0	
X	Residential Exp. Ratio 38%	$0	
Y	Residential NOI	$0	
Z	Submarket NonRes. Cap Rate 7%	$261,582,100	*Town; consultant modified*
AA	Submarket Res. Cap Rate 4.50%	$0	
AB	Total Value	$261,582,100	(Z+AA)

Part II. Est. Impact of Five Development Scenarios
II.B. Office/Research/Retail Mix @ 1.35 FAR

	NEW PROJECT VALUE (Z)	$343,604,200	NOTES
A	New Value / Total Nonresidential Value	0.30	
B	Refinement Coefficient	0.322	
C	New Nonresidential Service Costs	$502,000	*(A*B*NonResTot)*
D	Est. Nonresidential Tax Revenue	$8,844,400	*Value/1000/*$25.74*
E	New Residential Service Costs		
F	Est. Residential Tax Revenue		
G	Net Revenue	$8,342,400	*D-C*
H	Cost/Revenue Ratio	0.060	*C/D*
	Project Use(s)		
I	Total Sq. Ft.	866,340	*From Town*
J	Office	368,200	*From Town*
K	Research Center	368,200	*From Town*
L	Retail	129,940	*From Town*
M	Warehouse	0	*From Town*
N	Residential (Units)	0	*From Town*
	Rent		
O	Office	$42.00	*CoStar*
P	Research Center	$60.00	*CoStar*
Q	Retail	$36.80	*CoStar*
R	Warehouse	$19.61	*Loopnet*
S	Residential (Units)	$2,637	*CoStar*
	Income & Value		
T	Gross Nonresidential Income	$42,338,192	*Sq. ft.*rents*
U	Nonresidential Exp. Ratio 39.2%	$18,285,900	*CoStar*
V	Nonresidential NOI	$24,052,292	*T-U*
W	Residential Income	$0	
X	Residential Exp. Ratio 38%	$0	
Y	Residential NOI	$0	
Z	Submarket NonRes. Cap Rate 7%	$343,604,200	*Town; consultant modified*
AA	Submarket Res. Cap Rate 4.50%	$0	
AB	Total Value	$343,604,200	

Part II. Est. Impact of Five Development Scenarios
II.C. Office/Research/Retail/Residential Mix @ 1.0 FAR

	NEW PROJECT VALUE (Z)	$262,226,000	NOTES
A	New Value / Total Nonresidential Value	0.23	
B	Refinement Coefficient	0.289	
C	New Nonresidential Service Costs	$343,900	*(A*B*NonResTot)*
D	Est. Nonresidential Tax Revenue	$4,841,900	*Value/1000/*$25.74*
E	New Residential Service Costs[2]	$810,951	*See Assumptions*
F	Est. Residential Tax Revenue	$965,700	*Value/1000/*$13.03*
G	Net Revenue	$4,652,749	*(D+F)-(C+E)*
H	Cost/Revenue Ratio	0.199	*(C+E)/(D+F)*
	Project Use(s)		
I	Total Sq. Ft.*	659,535	*From Town*
J	Office	197,860	*From Town*
K	Research Center	197,860	*From Town*
L	Retail	69,250	*From Town*
M	Warehouse	0	*From Town*
N	Residential (Units)	170	*From Town*
	Rent		
O	Office	$42.00	*CoStar*
P	Research Center	$60.00	*CoStar*
Q	Retail	$36.80	*CoStar*
R	Warehouse	$19.61	*Loopnet*
S	Residential (Units)	$2,637	*CoStar*
	Income & Value		
T	Gross Nonresidential Income	$23,178,410	*Sq. ft.*rents*
U	Nonresidential Exp. Ratio 39.2%	$10,010,800	*CoStar for exp. ratio*
V	Nonresidential NOI	$13,167,610	*T-U*
W	Residential Income	$5,379,480	*Units * rents*
X	Residential Exp. Ratio 38%	$2,044,200	*CoStar for exp. ratio*
Y	Residential NOI	$3,335,280	*W-X*
Z	Submarket NonRes. Cap Rate 5.90%	$188,108,700	*CoStar for cap rate*
AA	Submarket Res. Cap Rate 4.50%	$74,117,300	*CoStar for cap rate*
AB	Total Value	$262,226,000	*Z+AA*

[2] 331 residents, 28 students

Part II. Est. Impact of Five Development Scenarios
II.D. Office/Research/Retail/Residential Mix @ 1.35 FAR

	NEW PROJECT VALUE (AB)	$340,356,200	NOTES
A	New Value / Total Nonresidential Value	0.30	
B	Refinement Coefficient	0.26	
C	New Nonresidential Service Costs	$401,500	*(A*B*NonResTot)*
D	Est. Nonresidential Tax Revenue	$6,224,600	*Value/1000/*$25.74*
E	New Residential Service Costs[3]	$1,078,100	*See Assumptions*
F	Est. Residential Tax Revenue	$1,283,900	*Value/1000/*$13.03*
G	Net Revenue	$6,028,900	*(D+F)-(C+E)*
H	Cost/Revenue Ratio	0.197	*(C+E)/(D+F)*
	Project Use(s)		
I	Total Sq. Ft.*	863,010	*From Town*
J	Office	259,130	*From Town*
K	Research Center	259,130	*From Town*
L	Retail	91,460	*From Town*
M	Warehouse	0	*From Town*
N	Residential (Units)	226	*From Town*
	Rent		
O	Office	$42.00	*CoStar*
P	Research Center	$60.00	*CoStar*
Q	Retail	$36.80	*CoStar*
R	Warehouse	$19.61	*Loopnet*
S	Residential (Units)	$2,637	*CoStar*
	Income & Value		
T	Gross Nonresidential Income	$29,796,988	*Sq. ft.*rents*
U	Nonresidential Exp. Ratio 39.2%	$12,869,300	*CoStar for exp. ratio*
V	Nonresidential NOI	$16,927,688	*T-U*
W	Residential Income	$7,151,544	*Units * rents*
X	Residential Exp. Ratio 38%	$2,717,600	*CoStar for exp. ratio*
Y	Residential NOI	$4,433,944	*W-X*
Z	NonRes Value: NonRes. Cap Rate 7%	$241,824,100	*Town; consultant modified*
AA	ResValue: Submarket Res. Cap Rate 4.50%	$98,532,100	*CoStar for cap rate*
AB	Total Value	$340,356,200	*Z+AA*

[3] 440 residents, 38 students.

Part II. Est. Impact of Five Development Scenarios
II.E. Warehouse/Distribution

	NEW PROJECT VALUE (AB)	$35,854,000	NOTES
A	New Value / Total Nonresidential Value	0.03	
B	Refinement Coefficient	0.55	
C	New Nonresidential Service Costs	$179,000	*(A*B*NonResTot)*
D	Est. Nonresidential Tax Revenue	$922,900	*Value/1000/*$25.74*
E	New Residential Service Costs	N/A	
F	Est. Residential Tax Revenue	N/A	
G	Net Revenue	$743,900	*D-C*
H	Cost/Revenue Ratio	0.241	*C/D*
	Project Use(s)		
I	Total Sq. Ft.	0	*From Town*
J	Office	0	*From Town*
K	Research Center	0	*From Town*
L	Retail	0	*From Town*
M	Warehouse	158,900	*From Town*
M.1	TV Studio (No Change)	90,002	*From Town*
N	Residential (Units)	0	*From Town*
	Rent		
O	Office	$42.00	*CoStar*
P	Research Center	$60.00	*CoStar*
Q	Retail	$36.80	*CoStar*
R	Warehouse	$19.61	*Loopnet*
S	Residential (Units)	$2,637	*CoStar*
	Income & Value		
T	Gross Nonresidential Income	$3,116,000	*Warehouse only*
U	Nonresidential Exp. Ratio 35%	$1,345,800	*CoStar for exp. ratio*
V	Nonresidential NOI	$1,770,200	*T-U*
W	Residential Income	$0	*Units * rents*
X	Residential Exp. Ratio 38%	$0	*CoStar for exp. ratio*
Y	Residential NOI	$0	*W-X*
Z	Submarket NonRes. Cap Rate 5.50%	$35,854,000	*Warehouse + TV Studio*
AA	Submarket Res. Cap Rate 4.50%		*CoStar for cap rate*
AB	Total Value	$35,854,000	*Z+AA*

STORMWATER REPORT

Highland Innovation Center

557 Highland Avenue
Needham, Massachusetts

PREPARED FOR

Bulfinch

116 Huntington Avenue
Suite 600
Boston, MA 02116
781.707.4000

PREPARED BY

vhb

101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

MARCH, 2022

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Appendices

List of Tables

Stormwater Report Narrative

This Stormwater Report has been prepared to demonstrate compliance with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) and Water Quality Certification Regulations (314 CMR 9.00). This report also demonstrates compliance with the Town of Needham Stormwater By-Law.

Project Description

The Applicant, Bulfinch, is proposing to construct a Research & Development and Office building at 557 Highland Avenue (the Project). As proposed, the Project consists of 422,400 square feet of building space, ancillary landscape improvements, surface parking, structured parking, and utility improvements to support this use.

The Project will entail the construction of approximately 1,408 total parking spaces and a portion of the site is considered a Land Use with Higher Potential Pollutant Loads (LUHPPL).

Site Description

The Project Site is a 9.27-acre parcel of land (the Site) located at 577 Highland Ave in Needham, Massachusetts (see Figure 1). The Site lies within the surface watershed of Charles River and is bounded by TV Place to the north, Highland Ave to the south, Interstate 95 to the east, and Gould Street to the west. See Figure 1, Site Locus Map.

According to the National Resources Conservation Service (NRCS), surface soils on the Site consist of Urban Land and do not have an associated Hydrologic Soil Group (HSG). For the purposes of this stormwater report, surface soils have conservatively been assumed to be HSG D. Based on the soil evaluation included in Appendix C, the Site is not considered to be within an area of rapid infiltration (soils with a saturated hydraulic conductivity greater than 2.4 inches per hour).

Existing Drainage Conditions

Under existing conditions, the Site is developed, consisting of existing building and surface parking which result in nearly complete impervious coverage. The Site generally pitches from east to west, with the majority of the site draining towards a swale located adjacent to the Route 95/128 off-ramp. Figure 2 illustrates the existing drainage patterns on the Site. Currently, the Site

is divided into 3 drainage areas as stormwater runoff flows to 3 Design Points, which have been identified as MassDOT Drainage Swale, TV Place Closed Drainage, and Highland Avenue Closed Drainage. Table 1 below provides a summary of the existing conditions hydrologic data.

Table 1 Existing Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (Acres)	Curve Number	Time of Concentration (min)
1 – Main Site	MassDOT Drainage Swale	DP-1	8.74	97	5.3
2 – Gould/TV Place Landscaping	TV Place Closed Drainage	DP-2	0.40	88	7.8
3 – Highland Ave Landscaping	Highland Ave Closed Drainage	DP-3	0.15	81	5.0

Proposed Drainage Conditions

Figure 3 illustrates the proposed "post construction" drainage conditions for the project. As shown, the Site will be divided into 6 drainage areas that discharge treated stormwater to the 3 existing Design Points. Table 2 below provides a summary of the proposed conditions hydrologic data.

Table 2 Proposed Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (Acres)	Curve Number	Time of Concentration (min)
10 – Parking Lot and Drives	MassDOT Drainage Swale	DP-1	3.48	90	5.0
11 – Building	Bioretention Basin	DP-1	3.54	98	5.0
12 – Garage	MassDOT Drainage Swale	DP-1	0.95	98	5.0
13 – South of Building	Bioretention Basin	DP-1	1.06	84	5.0
20 – Overland to TV Place	TV Place Closed Drainage	DP-2	0.26	87	5.0
30 – Overland to Highland Ave	Highland Ave Closed Drainage	DP-3	0.01	80	5.0

The site design integrates a comprehensive stormwater management system that has been developed in accordance with the Massachusetts Stormwater Handbook. Because portions of the Site are considered a LUHPPL, the proposed stormwater management system has been designed to treat the one inch Water Quality Volume for those areas. The proposed stormwater

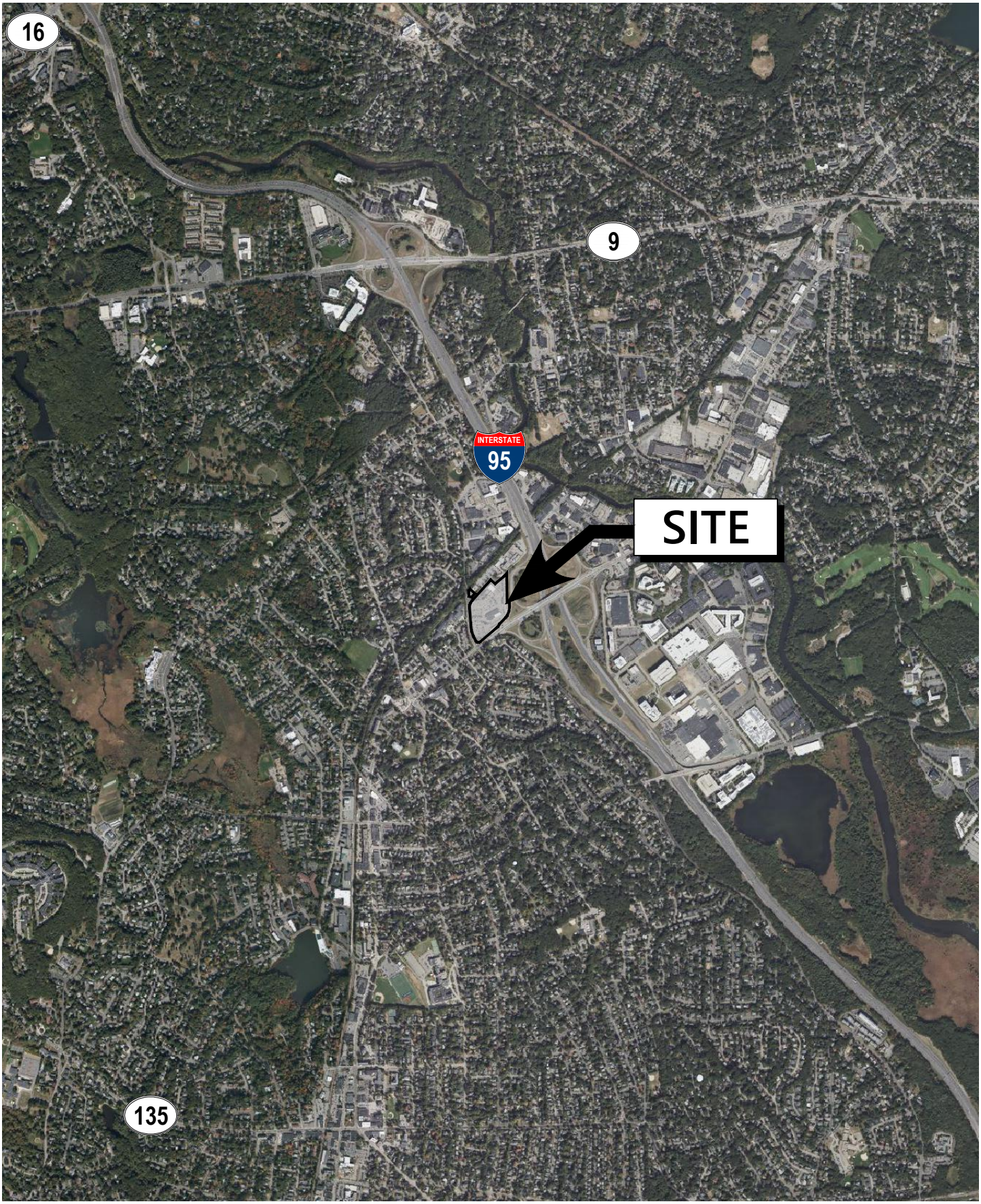
management system has been designed to treat the half inch Water Quality Volume for the remainder of the Site.

Environmentally Sensitive and Low Impact Development (LID) Techniques

Low Impact Development (LID) techniques and stormwater Best Management Practices (BMPs) implemented into the site design include a 1.8-Acre reduction of impervious area and a proposed surface detention basin to reduce peak runoff rates. In general, stormwater from the proposed paved surfaces is collected in deep-sump and hooded catch basins and routed through a proprietary media filter unit. Stormwater from the proposed building and garage roof areas is routed through proprietary hydrodynamic water quality units, to the surface basin, and then through a proprietary media filter unit. Treated stormwater is discharged to the existing design point DP-1 via a stone level spreader.

Figure 1 Site Locus Map

\\vhb\gbl\proj\Boston\15306.00\cad\ld\Eng\Appendix Drawings\Site Locus Map.dwg



0 1,000 2,000 Feet

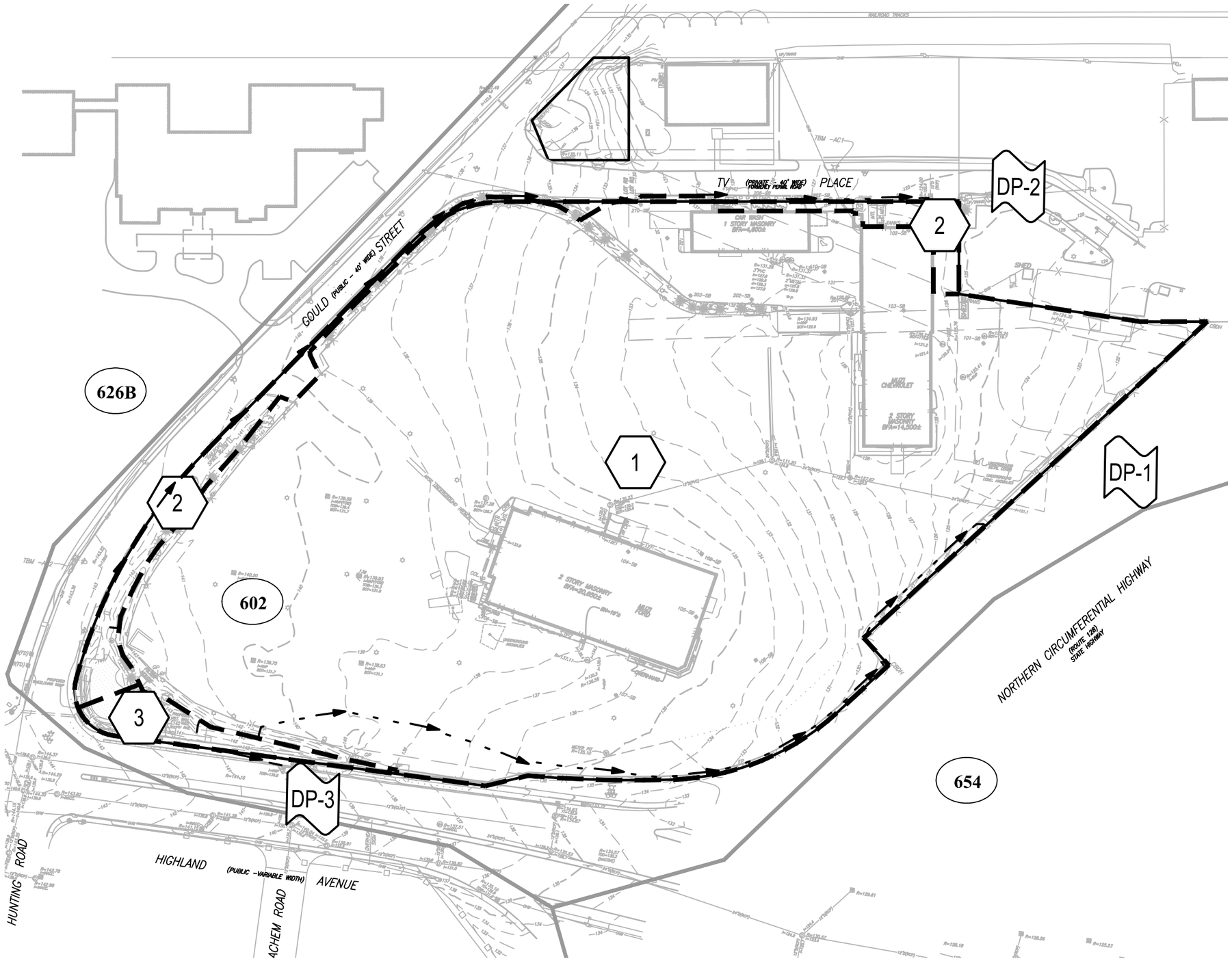
Site Locus Map

577 Highland Avenue
Needham, MA

Figure 1

March 2022

Figure 2 Existing Drainage Area



0 50 100 Feet

Legend

SYMBOLS

- X — **DESIGN POINT**
- X — **DRAINAGE AREA DESIGNATION**
- X — **POND**

LINETYPES

- **DRAINAGE AREA BOUNDARY**
- **TIME OF CONCENTRATION FLOW LINE**
- **SOIL TYPE BOUNDARY**

SCS SOIL CLASSIFICATIONS

602	**URBAN LAND, 0 TO 15 PERCENT SLOPES**
628B	**MERRIMAC-URBAN LAND COMPLEX, 0 TO 8 PERCENT SLOPES, HSG A**
654	**UDORTHENTS, LOAMY, HSG A**

vhb

Existing Drainage Conditions

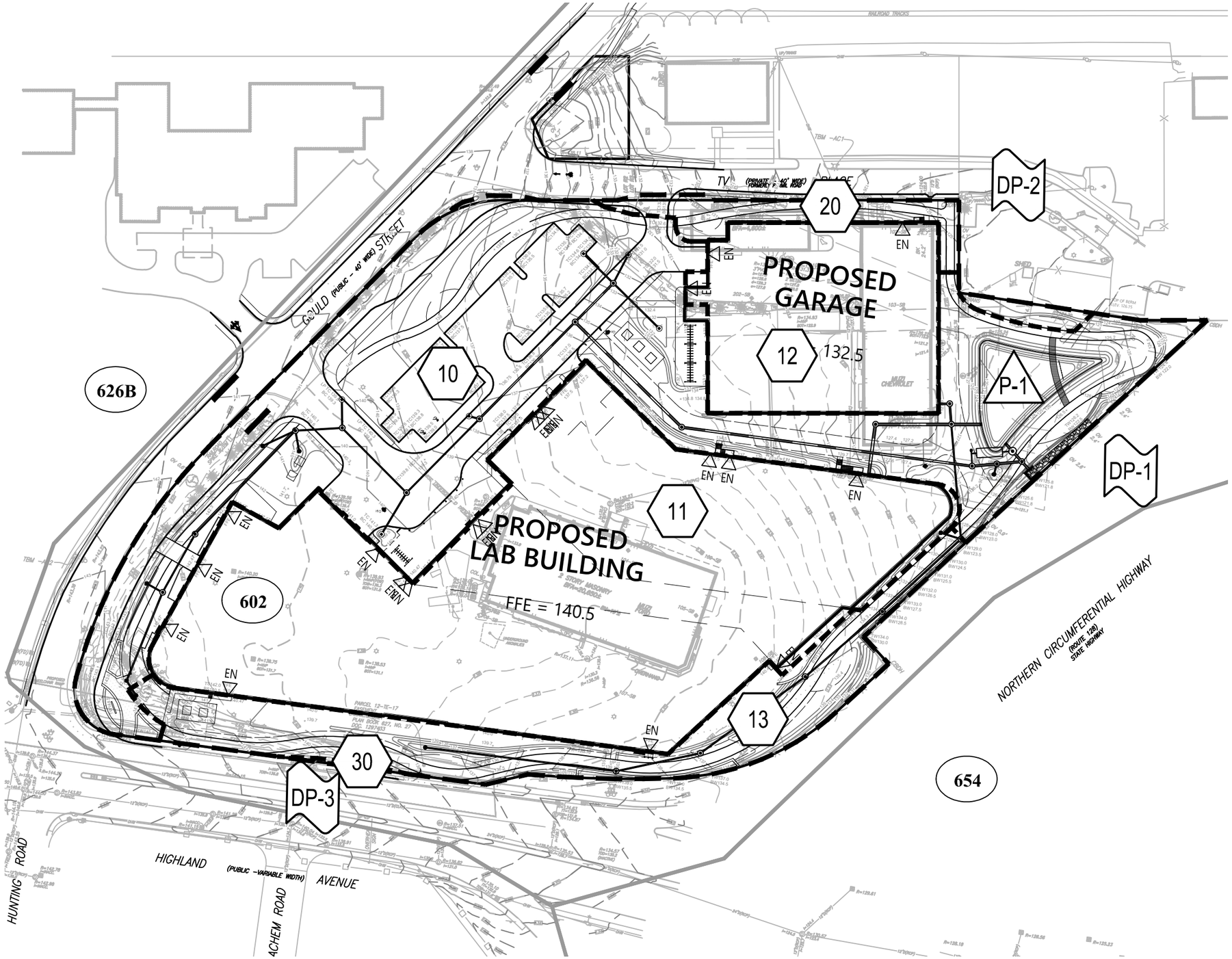
557 Highland Avenue
Needham, MA

Figure 2

March 2022

Figure 3 Proposed Drainage Area

\\vhb\gbl\proj\Boston\15306.00\cad\ld\Eng\Stormwater\15306.00 - PR Drainage.dwg



Legend

SYMBOLS

- X — **DESIGN POINT**
- X — **DRAINAGE AREA DESIGNATION**
- X — **POND**

LINETYPES

- **DRAINAGE AREA BOUNDARY**
- **TIME OF CONCENTRATION FLOW LINE**
- **SOIL TYPE BOUNDARY**

SCS SOIL CLASSIFICATIONS

- 602 — **URBAN LAND**
- 628B — **MERRIMAC-URBAN LAND COMPLEX, 0 TO 8 PERCENT SLOPES, HSG A**
- 654 — **UDORTHENTS, LOAMY, HSG A**

0 50 100 Feet

Proposed Drainage Conditions

557 Highland Avenue
Needham, MA

Figure 3

March 2022

Regulatory Compliance

Massachusetts Department of Environmental Protection (DEP) – Stormwater Management Standards

As demonstrated below, the proposed Project fully complies with the DEP Stormwater Management Standards.

Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to comply with Standard 1.

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook. Supporting information and computations demonstrating that no new untreated discharges will result from the Project are presented through compliance with Standards 4 through 6.

All proposed Project stormwater outlets and conveyances have been designed to not cause erosion or scour to wetlands or receiving waters. Outlets from closed drainage systems have been designed with headwalls and stone protection to dissipate discharge velocities. Overflows from BMP's that impound stormwater have been designed with stone material to protect downgradient areas from erosion.

Computations and supporting information for the sizing and selection of materials used to protect from scour and erosion are included in Appendix A.

Standard 2: Peak Rate Attenuation

The Project has been designed to comply with Standard 2.

The rainfall-runoff response of the Site under existing and proposed conditions was analyzed for storm events with recurrence intervals of 2, 10, 25, and 100 years. The results of the analysis, as summarized in Table 3 below, indicate that there is no increase in peak discharge rates between the existing and proposed conditions

Computations and supporting information regarding the hydrologic modeling are included in Appendix B.

Table 3 Peak Discharge Rates (cfs*)

Design Point	2-year	10-year	25-year	100-year
Design Point: 1				
Existing	28.4	45.2	55.6	71.7
Proposed	20.4	36.4	46.0	59.0
Design Point: 2				
Existing	0.9	1.6	2.1	2.8
Proposed	0.6	1.2	1.5	2.0
Design Point: 3				
Existing	0.3	0.6	0.8	1.1
Proposed	0.0	0.0	0.0	0.0

Standard 3: Stormwater Recharge

The Project has been designed to comply with Standard 3.

The project represents a net decrease in impervious coverage compared to the existing condition. Therefore, there is no Required Recharge Volume in accordance with the Stormwater Handbook.

Additionally, geotechnical exploration performed by the Project's Geotechnical Engineer indicated existing onsite soils with infiltration rates of 0.014 – 0.070 inches/hour, which are well below the minimum required to infiltrate per the MassDEP Stormwater Handbook. Accordingly, stormwater infiltration is not technically feasible on the Site and no infiltration BMPs are proposed.

Soil evaluation is included in Appendix C.

Standard 4: Water Quality

The Project has been designed to comply with Standard 4.

The proposed stormwater management system implements a treatment train of BMPs that has been designed to provide 80% TSS removal of stormwater runoff from all proposed impervious surfaces.

The Project Site is located within the watershed of the Charles River, which is regulated under Total Maximum Daily Loads (TMDLs) for nutrients and pathogens. The proposed media filters have been sized to provide at least 65% removal of Total Phosphorus, which meets the EPA's TMDL removal target for commercial land use.

Computations and supporting information, including the Long-Term Pollution Prevention Plan, are included in Appendix D.

Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs)

Portions of the Project Site are subject to greater than 1,000 vehicle trips per day and are therefore considered a LUHPPL. Accordingly, the stormwater system has been designed with suitable BMPs sized to treat the 1 inch Water Quality Volume for those portions of the Site. Proposed source controls and pollution prevention measures have been identified in the Long-Term Pollution Prevention Plan included in Appendix D.

For computations and supporting information regarding the sizing of BMPs suitable for treatment of runoff from LUHPPLs, see Appendix D.

Standard 6: Critical Areas

The Project will not discharge stormwater near or to a critical area.

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The Project has been designed to comply with all ten of the Stormwater Management Standards.

Refer directly to each Standard for applicable computations and supporting information demonstrating compliance with each.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The Project will disturb approximately 9 acres of land and is therefore required to obtain coverage under the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit. As required under this permit, a Stormwater Pollution Prevention Plan (SWPPP) will be developed and submitted before land disturbance begins. Recommended construction period pollution prevention and erosion and sedimentation controls to be finalized in the SWPPP are included in Appendix E.

Standard 9: Operation and Maintenance Plan

In compliance with Standard 9, a Post Construction Stormwater Operation and Maintenance (O&M) Plan has been developed for the Project. The O&M Plan is included in Appendix D as part of the Long Term Pollution Prevention Plan.

Standard 10: Prohibition of Illicit Discharges

Sanitary sewer and storm drainage structures remaining from previous development which are part of the redevelopment area will be removed or will be incorporated into updated sanitary sewer and separate stormwater sewer systems. The design plans submitted with this report have been designed so that the components included therein are in full compliance with current standards. No statement is made with regard to the drainage system in portions of the site not

included in the redevelopment project area. The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges.

Local Municipal Rules and Regulations

Due to the low-permeability soils onsite, infiltration of the 1-inch rainfall depth over impervious areas is not feasible as noted under Standard 3, above. The proposed stormwater management system has otherwise been designed in accordance with the Needham Stormwater By-Law and MassDEP standards as outlined in the preceding sections. Supporting documentation demonstrating compliance has been provided in the Technical Appendices to this report.

Appendix A: Standard 1 Computations and Supporting Information

› Flow/Velocity calculations for basin overflow swale and level spreader

Velocity Over Overflow Weirs

Project Name: 557 Highland Avenue **Proj. No.:** 15306.00
Date: March 2022
Project Location: Needham, MA **Calculated by:** DMK
Checked by:

Detention Basin Spillway Flows and Velocities

Storage Area	Elev of Weir (feet)	Peak Water Surface Elevation (feet) 2-year	25-year	100-year	Overflows over Weir 2-year	25-year	100-year	Overflow Q (cfs) 2-year	25-year	100-year	Overflow V (ft/s) 2-year	25-year	100-year
P1	126.25	125.70	126.24	126.54	**no**	**no**	**yes**	-	-	4.7	-	-	1.7

The maximum weir overflow velocity for the detention basin is 1.3 fps during the 100-year event.
This velocity is not typically erosive to vegetative cover in good condition.
The spillway of the detention basin has been designed with stone material to protect down gradient areas from erosion as a conservative measure.

Level Spreader Flows and Velocities

Design Point	25-Year Peak Flow (cfs)	Maximum Flow Depth (in)	Level Spreader Length (ft)	Overflow V (ft/s)
DP-1	46.0	2.0	70	3.9

The maximum weir overflow velocity for the detention basin is 3.9 fps during the 25-year event.
This velocity is not typically erosive to vegetative cover in good condition.

Permissible Velocities for Vegetated Spillways [1]

Vegetative Cover	Permissible Velocity [2] (ft/s) Erosion Resistant Soils [3] Slope of Exit Channel 0-5%	5-10%	Easily Erodible Soils [4] Slope of Exit Channel 0-5%	5-10%
Bermuda Grass Bahiagrass	8	7	6	5
Buffalograss Kentucky Bluegrass Smooth Bromegrass Tall Fescue Reed Canary Grass	7	6	5	4
Sod Forming Grass-Legume Mixtures	5	4	4	3
Lespedeza Weeping Lovegrass Yellow Bluestem Native Grass Mixtures	3.5	3.5	2.5	2.5

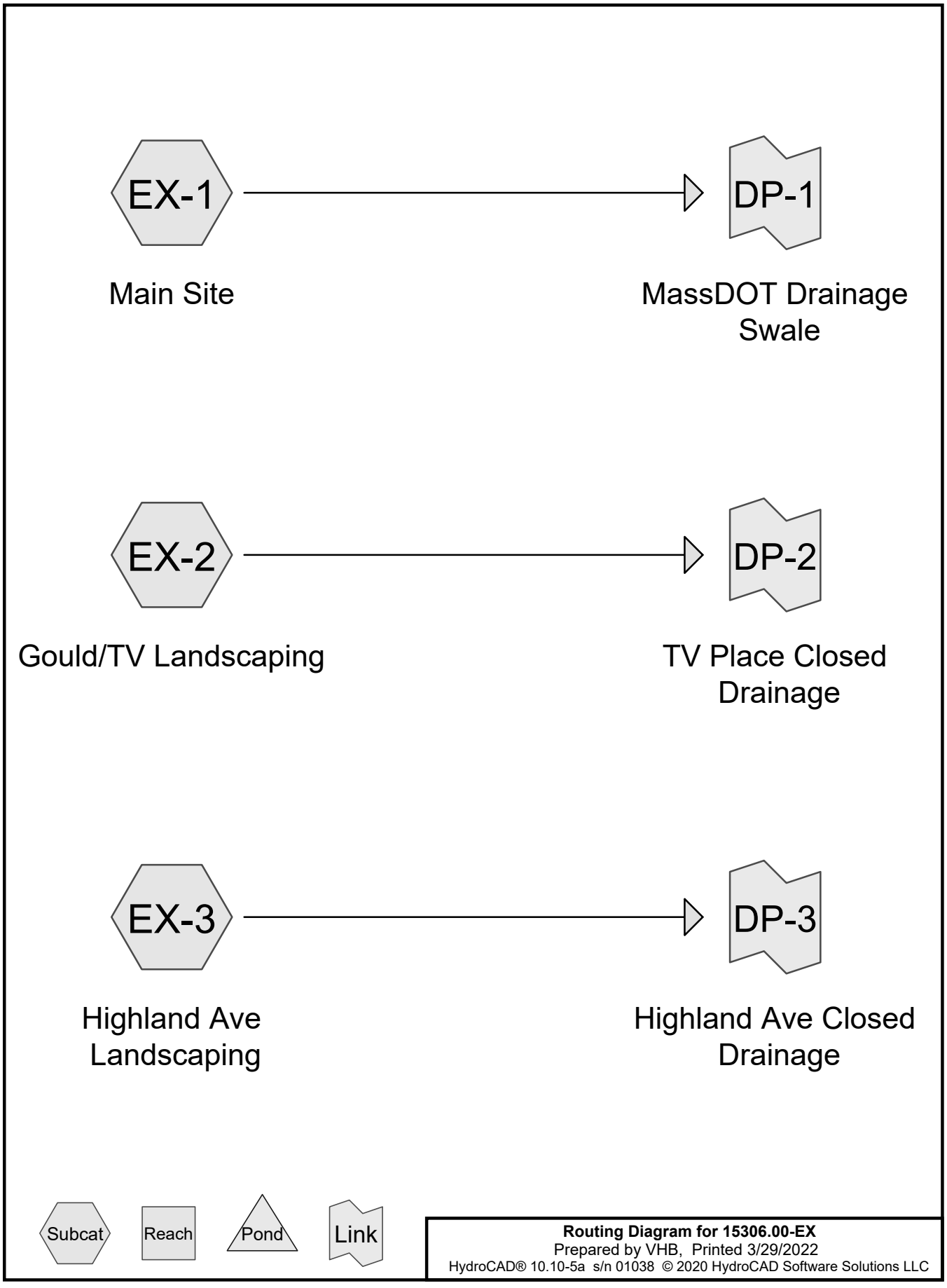
[1] SCS-TP-61
[2] Increase values 25 percent when the anticipated average use of the spillway is not more frequent than once in 10 years.
[3] Those with a high clay content and high plasticity. Typical soil textures are silty clay, sandy clay, and clay.
[4] Those with a high content of fine sand or silty and lower plasticity or non-plastic. Typical soil textures are fine sand, silt, sandy loam, and silty loam.

Source - USDA-SCS Engineering Field Manual

Appendix B: Standard 2 Computations and Supporting Information

The rainfall-runoff response of the Site under existing and proposed conditions was evaluated for storm events with recurrence intervals of 2, 10, 25 and 100-years. Rainfall volumes used for this analysis were based on the Natural Resources Conservation Service (NRCS) Type III, 24-hour storm and NOAA Atlas 14 precipitation depths for the site: 3.31, 5.19, 6.36, and 8.17 inches, respectively. Runoff coefficients for the pre- and post-development conditions, as previously shown in Tables 1 and 2 respectively, were determined using NRCS Technical Release 55 (TR-55) methodology as provided in HydroCAD. Drainage areas used in the analyses were described in previous sections and shown on Figures 2 and 3. The HydroCAD model is based on the NRCS Technical Release 20 (TR-20) Model for Project Formulation Hydrology.

HydroCAD Analysis: Existing Conditions



Routing Diagram for 15306.00-EX
Prepared by VHB, Printed 3/29/2022

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
32,880	80	>75% Grass cover, Good, HSG D (EX-1, EX-2, EX-3)
332,070	98	Paved parking, HSG D (EX-1, EX-2, EX-3)
39,750	98	Roofs, HSG D (EX-1)
404,700	**97**	**TOTAL AREA**

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Main Site Runoff Area=380,680 sf 95.71% Impervious Runoff Depth=2.97"
Flow Length=855' Tc=5.3 min CN=97 Runoff=28.4 cfs 94,084 cf

Subcatchment EX-2: Gould/TV Runoff Area=17,320 sf 41.86% Impervious Runoff Depth=2.10"
Flow Length=1,025' Tc=7.8 min CN=88 Runoff=0.9 cfs 3,025 cf

Subcatchment EX-3: Highland Ave Runoff Area=6,700 sf 3.28% Impervious Runoff Depth=1.56"
Flow Length=110' Tc=5.0 min CN=81 Runoff=0.3 cfs 869 cf

Link DP-1: MassDOT Drainage Swale Inflow=28.4 cfs 94,084 cf
Primary=28.4 cfs 94,084 cf

Link DP-2: TV Place Closed Drainage Inflow=0.9 cfs 3,025 cf
Primary=0.9 cfs 3,025 cf

Link DP-3: Highland Ave Closed Drainage Inflow=0.3 cfs 869 cf
Primary=0.3 cfs 869 cf

Total Runoff Area = 404,700 sf Runoff Volume = 97,978 cf Average Runoff Depth = 2.91"
8.12% Pervious = 32,880 sf 91.88% Impervious = 371,820 sf

Summary for Subcatchment EX-1: Main Site

Runoff = 28.4 cfs @ 12.07 hrs, Volume= 94,084 cf, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
324,600	98	Paved parking, HSG D
39,750	98	Roofs, HSG D
16,330	80	>75% Grass cover, Good, HSG D
380,680	97	Weighted Average
16,330		4.29% Pervious Area
364,350		95.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	11	0.1820	0.27		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
4.6	844	0.0230	3.08		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
5.3	855	Total			

Summary for Subcatchment EX-2: Gould/TV Landscaping

Runoff = 0.9 cfs @ 12.11 hrs, Volume= 3,025 cf, Depth= 2.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
7,250	98	Paved parking, HSG D
10,070	80	>75% Grass cover, Good, HSG D
17,320	88	Weighted Average
10,070		58.14% Pervious Area
7,250		41.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	24	0.0830	0.23		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
6.1	1,001	0.0180	2.72		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
7.8	1,025	Total			

Summary for Subcatchment EX-3: Highland Ave Landscaping

Runoff = 0.3 cfs @ 12.08 hrs, Volume= 869 cf, Depth= 1.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
220	98	Paved parking, HSG D
6,480	80	>75% Grass cover, Good, HSG D
6,700	81	Weighted Average
6,480		96.72% Pervious Area
220		3.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	24	0.1670	0.30		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
0.6	86	0.0120	2.22		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
1.9	110	Total, Increased to minimum Tc = 5.0 min			

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 380,680 sf, 95.71% Impervious, Inflow Depth = 2.97" for 2-Year event
Inflow = 28.4 cfs @ 12.07 hrs, Volume= 94,084 cf
Primary = 28.4 cfs @ 12.07 hrs, Volume= 94,084 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 17,320 sf, 41.86% Impervious, Inflow Depth = 2.10" for 2-Year event
Inflow = 0.9 cfs @ 12.11 hrs, Volume= 3,025 cf
Primary = 0.9 cfs @ 12.11 hrs, Volume= 3,025 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 6,700 sf, 3.28% Impervious, Inflow Depth = 1.56" for 2-Year event
Inflow = 0.3 cfs @ 12.08 hrs, Volume= 869 cf
Primary = 0.3 cfs @ 12.08 hrs, Volume= 869 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Main Site Runoff Area=380,680 sf 95.71% Impervious Runoff Depth=4.84"
Flow Length=855' Tc=5.3 min CN=97 Runoff=45.2 cfs 153,429 cf

Subcatchment EX-2: Gould/TV Runoff Area=17,320 sf 41.86% Impervious Runoff Depth=3.85"
Flow Length=1,025' Tc=7.8 min CN=88 Runoff=1.6 cfs 5,556 cf

Subcatchment EX-3: Highland Ave Runoff Area=6,700 sf 3.28% Impervious Runoff Depth=3.15"
Flow Length=110' Tc=5.0 min CN=81 Runoff=0.6 cfs 1,761 cf

Link DP-1: MassDOT Drainage Swale Inflow=45.2 cfs 153,429 cf
Primary=45.2 cfs 153,429 cf

Link DP-2: TV Place Closed Drainage Inflow=1.6 cfs 5,556 cf
Primary=1.6 cfs 5,556 cf

Link DP-3: Highland Ave Closed Drainage Inflow=0.6 cfs 1,761 cf
Primary=0.6 cfs 1,761 cf

Total Runoff Area = 404,700 sf Runoff Volume = 160,746 cf Average Runoff Depth = 4.77"
8.12% Pervious = 32,880 sf 91.88% Impervious = 371,820 sf

Summary for Subcatchment EX-1: Main Site

Runoff = 45.2 cfs @ 12.07 hrs, Volume= 153,429 cf, Depth= 4.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
324,600	98	Paved parking, HSG D
39,750	98	Roofs, HSG D
16,330	80	>75% Grass cover, Good, HSG D
380,680	97	Weighted Average
16,330		4.29% Pervious Area
364,350		95.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	11	0.1820	0.27		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
4.6	844	0.0230	3.08		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
5.3	855	Total			

Summary for Subcatchment EX-2: Gould/TV Landscaping

Runoff = 1.6 cfs @ 12.11 hrs, Volume= 5,556 cf, Depth= 3.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
7,250	98	Paved parking, HSG D
10,070	80	>75% Grass cover, Good, HSG D
17,320	88	Weighted Average
10,070		58.14% Pervious Area
7,250		41.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	24	0.0830	0.23		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
6.1	1,001	0.0180	2.72		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
7.8	1,025	Total			

Summary for Subcatchment EX-3: Highland Ave Landscaping

Runoff = 0.6 cfs @ 12.07 hrs, Volume= 1,761 cf, Depth= 3.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
220	98	Paved parking, HSG D
6,480	80	>75% Grass cover, Good, HSG D
6,700	81	Weighted Average
6,480		96.72% Pervious Area
220		3.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	24	0.1670	0.30		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
0.6	86	0.0120	2.22		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
1.9	110	Total, Increased to minimum Tc = 5.0 min			

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 380,680 sf, 95.71% Impervious, Inflow Depth = 4.84" for 10-Year event
Inflow = 45.2 cfs @ 12.07 hrs, Volume= 153,429 cf
Primary = 45.2 cfs @ 12.07 hrs, Volume= 153,429 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 17,320 sf, 41.86% Impervious, Inflow Depth = 3.85" for 10-Year event
Inflow = 1.6 cfs @ 12.11 hrs, Volume= 5,556 cf
Primary = 1.6 cfs @ 12.11 hrs, Volume= 5,556 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 6,700 sf, 3.28% Impervious, Inflow Depth = 3.15" for 10-Year event
Inflow = 0.6 cfs @ 12.07 hrs, Volume= 1,761 cf
Primary = 0.6 cfs @ 12.07 hrs, Volume= 1,761 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Main Site Runoff Area=380,680 sf 95.71% Impervious Runoff Depth=6.00"
Flow Length=855' Tc=5.3 min CN=97 Runoff=55.6 cfs 190,446 cf

Subcatchment EX-2: Gould/TV Runoff Area=17,320 sf 41.86% Impervious Runoff Depth=4.97"
Flow Length=1,025' Tc=7.8 min CN=88 Runoff=2.1 cfs 7,178 cf

Subcatchment EX-3: Highland Ave Runoff Area=6,700 sf 3.28% Impervious Runoff Depth=4.21"
Flow Length=110' Tc=5.0 min CN=81 Runoff=0.8 cfs 2,352 cf

Link DP-1: MassDOT Drainage Swale Inflow=55.6 cfs 190,446 cf
Primary=55.6 cfs 190,446 cf

Link DP-2: TV Place Closed Drainage Inflow=2.1 cfs 7,178 cf
Primary=2.1 cfs 7,178 cf

Link DP-3: Highland Ave Closed Drainage Inflow=0.8 cfs 2,352 cf
Primary=0.8 cfs 2,352 cf

Total Runoff Area = 404,700 sf Runoff Volume = 199,976 cf Average Runoff Depth = 5.93"
8.12% Pervious = 32,880 sf 91.88% Impervious = 371,820 sf

Summary for Subcatchment EX-1: Main Site

Runoff = 55.6 cfs @ 12.07 hrs, Volume= 190,446 cf, Depth= 6.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
324,600	98	Paved parking, HSG D
39,750	98	Roofs, HSG D
16,330	80	>75% Grass cover, Good, HSG D
380,680	97	Weighted Average
16,330		4.29% Pervious Area
364,350		95.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	11	0.1820	0.27		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
4.6	844	0.0230	3.08		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
5.3	855	Total			

Summary for Subcatchment EX-2: Gould/TV Landscaping

Runoff = 2.1 cfs @ 12.11 hrs, Volume= 7,178 cf, Depth= 4.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
7,250	98	Paved parking, HSG D
10,070	80	>75% Grass cover, Good, HSG D
17,320	88	Weighted Average
10,070		58.14% Pervious Area
7,250		41.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	24	0.0830	0.23		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
6.1	1,001	0.0180	2.72		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
7.8	1,025	Total			

Summary for Subcatchment EX-3: Highland Ave Landscaping

Runoff = 0.8 cfs @ 12.07 hrs, Volume= 2,352 cf, Depth= 4.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
220	98	Paved parking, HSG D
6,480	80	>75% Grass cover, Good, HSG D
6,700	81	Weighted Average
6,480		96.72% Pervious Area
220		3.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	24	0.1670	0.30		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
0.6	86	0.0120	2.22		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
1.9	110	Total, Increased to minimum Tc = 5.0 min			

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 380,680 sf, 95.71% Impervious, Inflow Depth = 6.00" for 25-Year event
Inflow = 55.6 cfs @ 12.07 hrs, Volume= 190,446 cf
Primary = 55.6 cfs @ 12.07 hrs, Volume= 190,446 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 17,320 sf, 41.86% Impervious, Inflow Depth = 4.97" for 25-Year event
Inflow = 2.1 cfs @ 12.11 hrs, Volume= 7,178 cf
Primary = 2.1 cfs @ 12.11 hrs, Volume= 7,178 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 6,700 sf, 3.28% Impervious, Inflow Depth = 4.21" for 25-Year event
Inflow = 0.8 cfs @ 12.07 hrs, Volume= 2,352 cf
Primary = 0.8 cfs @ 12.07 hrs, Volume= 2,352 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Main Site Runoff Area=380,680 sf 95.71% Impervious Runoff Depth=7.81"
Flow Length=855' Tc=5.3 min CN=97 Runoff=71.7 cfs 247,767 cf

Subcatchment EX-2: Gould/TV Runoff Area=17,320 sf 41.86% Impervious Runoff Depth=6.73"
Flow Length=1,025' Tc=7.8 min CN=88 Runoff=2.8 cfs 9,720 cf

Subcatchment EX-3: Highland Ave Runoff Area=6,700 sf 3.28% Impervious Runoff Depth=5.90"
Flow Length=110' Tc=5.0 min CN=81 Runoff=1.1 cfs 3,296 cf

Link DP-1: MassDOT Drainage Swale Inflow=71.7 cfs 247,767 cf
Primary=71.7 cfs 247,767 cf

Link DP-2: TV Place Closed Drainage Inflow=2.8 cfs 9,720 cf
Primary=2.8 cfs 9,720 cf

Link DP-3: Highland Ave Closed Drainage Inflow=1.1 cfs 3,296 cf
Primary=1.1 cfs 3,296 cf

Total Runoff Area = 404,700 sf Runoff Volume = 260,782 cf Average Runoff Depth = 7.73"
8.12% Pervious = 32,880 sf 91.88% Impervious = 371,820 sf

Summary for Subcatchment EX-1: Main Site

Runoff = 71.7 cfs @ 12.07 hrs, Volume= 247,767 cf, Depth= 7.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
324,600	98	Paved parking, HSG D
39,750	98	Roofs, HSG D
16,330	80	>75% Grass cover, Good, HSG D
380,680	97	Weighted Average
16,330		4.29% Pervious Area
364,350		95.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	11	0.1820	0.27		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
4.6	844	0.0230	3.08		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
5.3	855	Total			

Summary for Subcatchment EX-2: Gould/TV Landscaping

Runoff = 2.8 cfs @ 12.11 hrs, Volume= 9,720 cf, Depth= 6.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
7,250	98	Paved parking, HSG D
10,070	80	>75% Grass cover, Good, HSG D
17,320	88	Weighted Average
10,070		58.14% Pervious Area
7,250		41.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	24	0.0830	0.23		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
6.1	1,001	0.0180	2.72		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
7.8	1,025	Total			

Summary for Subcatchment EX-3: Highland Ave Landscaping

Runoff = 1.1 cfs @ 12.07 hrs, Volume= 3,296 cf, Depth= 5.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
220	98	Paved parking, HSG D
6,480	80	>75% Grass cover, Good, HSG D
6,700	81	Weighted Average
6,480		96.72% Pervious Area
220		3.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	24	0.1670	0.30		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
0.6	86	0.0120	2.22		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
1.9	110	Total, Increased to minimum Tc = 5.0 min			

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 380,680 sf, 95.71% Impervious, Inflow Depth = 7.81" for 100-Year event
Inflow = 71.7 cfs @ 12.07 hrs, Volume= 247,767 cf
Primary = 71.7 cfs @ 12.07 hrs, Volume= 247,767 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 17,320 sf, 41.86% Impervious, Inflow Depth = 6.73" for 100-Year event
Inflow = 2.8 cfs @ 12.11 hrs, Volume= 9,720 cf
Primary = 2.8 cfs @ 12.11 hrs, Volume= 9,720 cf, Atten= 0%, Lag= 0.0 min

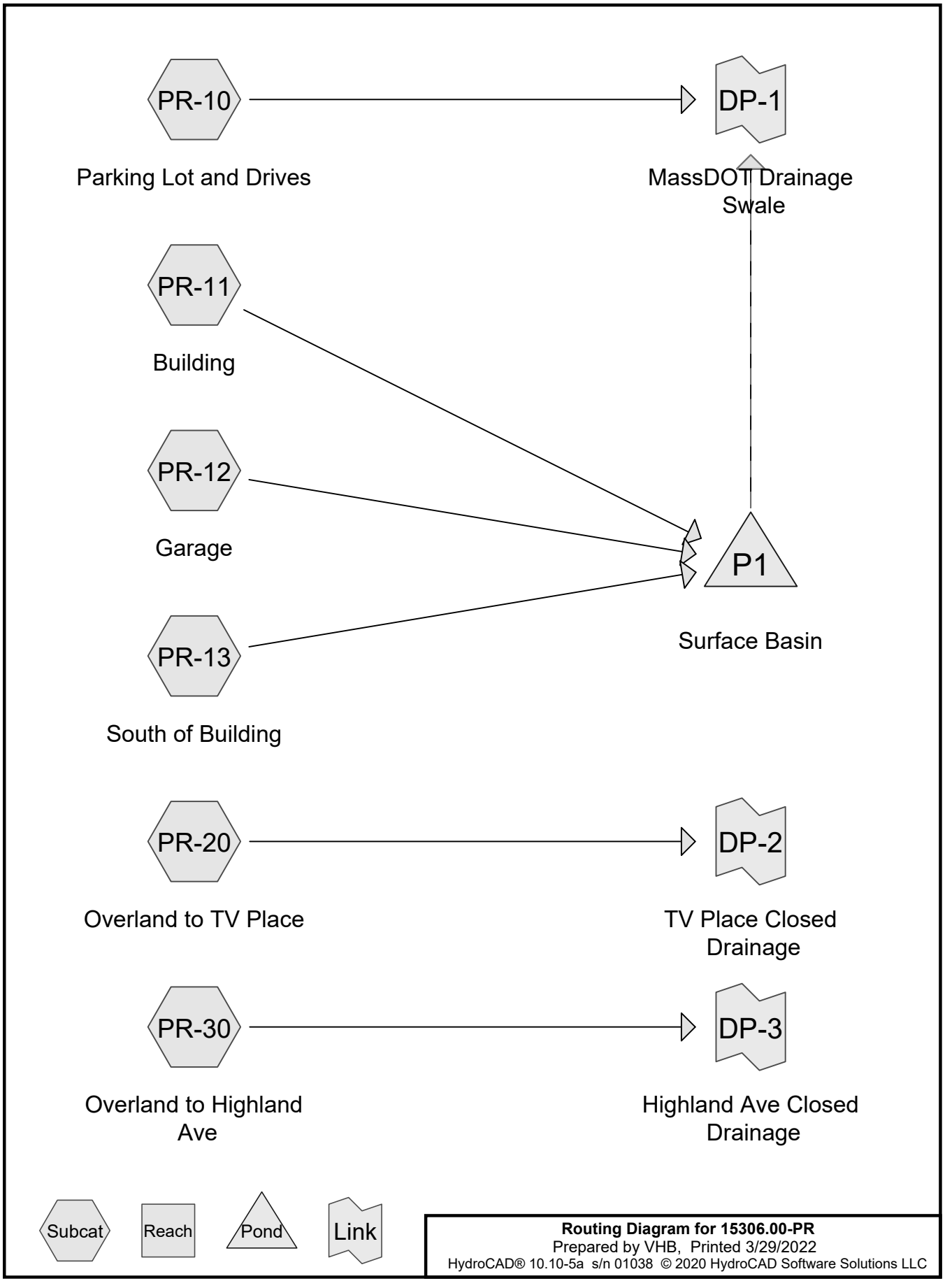
Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 6,700 sf, 3.28% Impervious, Inflow Depth = 5.90" for 100-Year event
Inflow = 1.1 cfs @ 12.07 hrs, Volume= 3,296 cf
Primary = 1.1 cfs @ 12.07 hrs, Volume= 3,296 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

HydroCAD Analysis: Proposed Conditions



Routing Diagram for 15306.00-PR
Prepared by VHB, Printed 3/29/2022

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
108,450	80	>75% Grass cover, Good, HSG D (PR-10, PR-13, PR-20, PR-30)
3,850	96	Gravel surface, HSG D (PR-10, PR-13, PR-20)
96,800	98	Paved parking, HSG D (PR-10, PR-13, PR-20)
195,600	98	Roofs, HSG D (PR-11, PR-12)
404,700	**93**	**TOTAL AREA**

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-10: Parking Lot and Runoff Area=151,400 sf 56.01% Impervious Runoff Depth=2.27"
Tc=5.0 min CN=90 Runoff=9.5 cfs 28,649 cf

Subcatchment PR-11: Building Runoff Area=154,250 sf 100.00% Impervious Runoff Depth=3.08"
Tc=5.0 min CN=98 Runoff=11.8 cfs 39,553 cf

Subcatchment PR-12: Garage Runoff Area=41,350 sf 100.00% Impervious Runoff Depth=3.08"
Tc=5.0 min CN=98 Runoff=3.2 cfs 10,603 cf

Subcatchment PR-13: South of Building Runoff Area=46,000 sf 18.48% Impervious Runoff Depth=1.77"
Tc=5.0 min CN=84 Runoff=2.3 cfs 6,804 cf

Subcatchment PR-20: Overland to TV Place Runoff Area=11,400 sf 30.70% Impervious Runoff Depth=2.01"
Tc=5.0 min CN=87 Runoff=0.6 cfs 1,912 cf

Subcatchment PR-30: Overland to Highland Runoff Area=300 sf 0.00% Impervious Runoff Depth=1.49"
Tc=5.0 min CN=80 Runoff=0.0 cfs 37 cf

Pond P1: Surface Basin Peak Elev=125.70' Storage=14,946 cf Inflow=17.2 cfs 56,960 cf
Primary=11.1 cfs 19,729 cf Secondary=0.0 cfs 0 cf Tertiary=1.2 cfs 36,909 cf Outflow=12.4 cfs 56,639 cf

Link DP-1: MassDOT Drainage Swale Inflow=20.4 cfs 85,287 cf
Primary=20.4 cfs 85,287 cf

Link DP-2: TV Place Closed Drainage Inflow=0.6 cfs 1,912 cf
Primary=0.6 cfs 1,912 cf

Link DP-3: Highland Ave Closed Drainage Inflow=0.0 cfs 37 cf
Primary=0.0 cfs 37 cf

Total Runoff Area = 404,700 sf Runoff Volume = 87,558 cf Average Runoff Depth = 2.60"
27.75% Pervious = 112,300 sf 72.25% Impervious = 292,400 sf

Summary for Subcatchment PR-10: Parking Lot and Drives

Runoff = 9.5 cfs @ 12.07 hrs, Volume= 28,649 cf, Depth= 2.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
84,800	98	Paved parking, HSG D
64,650	80	>75% Grass cover, Good, HSG D
1,950	96	Gravel surface, HSG D
151,400	90	Weighted Average
66,600		43.99% Pervious Area
84,800		56.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Base**

Summary for Subcatchment PR-11: Building

Runoff = 11.8 cfs @ 12.07 hrs, Volume= 39,553 cf, Depth= 3.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
154,250	98	Roofs, HSG D
154,250		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-12: Garage

Runoff = 3.2 cfs @ 12.07 hrs, Volume= 10,603 cf, Depth= 3.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
41,350	98	Roofs, HSG D
41,350		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-13: South of Building

Runoff = 2.3 cfs @ 12.08 hrs, Volume= 6,804 cf, Depth= 1.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
1,150	96	Gravel surface, HSG D
29,350	80	>75% Grass cover, Good, HSG D
7,000	80	>75% Grass cover, Good, HSG D
8,500	98	Paved parking, HSG D
46,000	84	Weighted Average
37,500		81.52% Pervious Area
8,500		18.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-20: Overland to TV Place

Runoff = 0.6 cfs @ 12.07 hrs, Volume= 1,912 cf, Depth= 2.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
750	96	Gravel surface, HSG D
7,150	80	>75% Grass cover, Good, HSG D
3,500	98	Paved parking, HSG D
11,400	87	Weighted Average
7,900		69.30% Pervious Area
3,500		30.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-30: Overland to Highland Ave

Runoff = 0.0 cfs @ 12.08 hrs, Volume= 37 cf, Depth= 1.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
300	80	>75% Grass cover, Good, HSG D
300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Pond P1: Surface Basin

Inflow Area = 241,600 sf, 84.48% Impervious, Inflow Depth = 2.83" for 2-Year event
Inflow = 17.2 cfs @ 12.07 hrs, Volume= 56,960 cf
Outflow = 12.4 cfs @ 12.14 hrs, Volume= 56,639 cf, Atten= 28%, Lag= 4.2 min
Primary = 11.1 cfs @ 12.14 hrs, Volume= 19,729 cf
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf
Tertiary = 1.2 cfs @ 12.14 hrs, Volume= 36,909 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 125.70' @ 12.14 hrs Surf.Area= 8,835 sf Storage= 14,946 cf

Plug-Flow detention time= 102.0 min calculated for 56,623 cf (99% of inflow)
Center-of-Mass det. time= 98.4 min (861.8 - 763.4)

Volume	Invert	Avail.Storage	Storage Description
#1	123.75'	24,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
123.75	6,450	0	0
124.00	6,850	1,663	1,663
125.00	8,000	7,425	9,088
126.00	9,200	8,600	17,688
126.75	10,150	7,256	24,944

Device	Routing	Invert	Outlet Devices
#1	Primary	122.00'	**24.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 122.00' / 121.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	125.00'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Secondary	126.25'	**12.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83
#4	Tertiary	123.75'	**6.0" Round Culvert** L= 10.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 123.75' / 123.65' S= 0.0100 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 0.20 sf

Primary OutFlow Max=11.1 cfs @ 12.14 hrs HW=125.70' (Free Discharge)
↑**1=Culvert** (Passes 11.1 cfs of 24.8 cfs potential flow)
↑**2=Sharp-Crested Rectangular Weir** (Weir Controls 11.1 cfs @ 2.73 fps)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=123.75' (Free Discharge)
↑**3=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Tertiary OutFlow Max=1.2 cfs @ 12.14 hrs HW=125.70' (Free Discharge)
↑**4=Culvert** (Inlet Controls 1.2 cfs @ 6.27 fps)

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 393,000 sf, 73.51% Impervious, Inflow Depth > 2.60" for 2-Year event
Inflow = 20.4 cfs @ 12.10 hrs, Volume= 85,287 cf
Primary = 20.4 cfs @ 12.10 hrs, Volume= 85,287 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 11,400 sf, 30.70% Impervious, Inflow Depth = 2.01" for 2-Year event
Inflow = 0.6 cfs @ 12.07 hrs, Volume= 1,912 cf
Primary = 0.6 cfs @ 12.07 hrs, Volume= 1,912 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 300 sf, 0.00% Impervious, Inflow Depth = 1.49" for 2-Year event
Inflow = 0.0 cfs @ 12.08 hrs, Volume= 37 cf
Primary = 0.0 cfs @ 12.08 hrs, Volume= 37 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-10: Parking Lot and Runoff Area=151,400 sf 56.01% Impervious Runoff Depth=4.06"
Tc=5.0 min CN=90 Runoff=16.5 cfs 51,221 cf

Subcatchment PR-11: Building Runoff Area=154,250 sf 100.00% Impervious Runoff Depth=4.95"
Tc=5.0 min CN=98 Runoff=18.6 cfs 63,665 cf

Subcatchment PR-12: Garage Runoff Area=41,350 sf 100.00% Impervious Runoff Depth=4.95"
Tc=5.0 min CN=98 Runoff=5.0 cfs 17,067 cf

Subcatchment PR-13: South of Building Runoff Area=46,000 sf 18.48% Impervious Runoff Depth=3.44"
Tc=5.0 min CN=84 Runoff=4.4 cfs 13,205 cf

Subcatchment PR-20: Overland to TV Place Runoff Area=11,400 sf 30.70% Impervious Runoff Depth=3.75"
Tc=5.0 min CN=87 Runoff=1.2 cfs 3,559 cf

Subcatchment PR-30: Overland to Highland Runoff Area=300 sf 0.00% Impervious Runoff Depth=3.06"
Tc=5.0 min CN=80 Runoff=0.0 cfs 76 cf

Pond P1: Surface Basin Peak Elev=126.05' Storage=18,171 cf Inflow=28.0 cfs 93,937 cf
Primary=20.4 cfs 44,547 cf Secondary=0.0 cfs 0 cf Tertiary=1.4 cfs 49,046 cf Outflow=21.8 cfs 93,593 cf

Link DP-1: MassDOT Drainage Swale Inflow=36.4 cfs 144,813 cf
Primary=36.4 cfs 144,813 cf

Link DP-2: TV Place Closed Drainage Inflow=1.2 cfs 3,559 cf
Primary=1.2 cfs 3,559 cf

Link DP-3: Highland Ave Closed Drainage Inflow=0.0 cfs 76 cf
Primary=0.0 cfs 76 cf

Total Runoff Area = 404,700 sf Runoff Volume = 148,793 cf Average Runoff Depth = 4.41"
27.75% Pervious = 112,300 sf 72.25% Impervious = 292,400 sf

Summary for Subcatchment PR-10: Parking Lot and Drives

Runoff = 16.5 cfs @ 12.07 hrs, Volume= 51,221 cf, Depth= 4.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
84,800	98	Paved parking, HSG D
64,650	80	>75% Grass cover, Good, HSG D
1,950	96	Gravel surface, HSG D
151,400	90	Weighted Average
66,600		43.99% Pervious Area
84,800		56.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Base**

Summary for Subcatchment PR-11: Building

Runoff = 18.6 cfs @ 12.07 hrs, Volume= 63,665 cf, Depth= 4.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
154,250	98	Roofs, HSG D
154,250		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-12: Garage

Runoff = 5.0 cfs @ 12.07 hrs, Volume= 17,067 cf, Depth= 4.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
41,350	98	Roofs, HSG D
41,350		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-13: South of Building

Runoff = 4.4 cfs @ 12.07 hrs, Volume= 13,205 cf, Depth= 3.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
1,150	96	Gravel surface, HSG D
29,350	80	>75% Grass cover, Good, HSG D
7,000	80	>75% Grass cover, Good, HSG D
8,500	98	Paved parking, HSG D
46,000	84	Weighted Average
37,500		81.52% Pervious Area
8,500		18.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-20: Overland to TV Place

Runoff = 1.2 cfs @ 12.07 hrs, Volume= 3,559 cf, Depth= 3.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
750	96	Gravel surface, HSG D
7,150	80	>75% Grass cover, Good, HSG D
3,500	98	Paved parking, HSG D
11,400	87	Weighted Average
7,900		69.30% Pervious Area
3,500		30.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-30: Overland to Highland Ave

Runoff = 0.0 cfs @ 12.07 hrs, Volume= 76 cf, Depth= 3.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
300	80	>75% Grass cover, Good, HSG D
300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Pond P1: Surface Basin

Inflow Area = 241,600 sf, 84.48% Impervious, Inflow Depth = 4.67" for 10-Year event
Inflow = 28.0 cfs @ 12.07 hrs, Volume= 93,937 cf
Outflow = 21.8 cfs @ 12.13 hrs, Volume= 93,593 cf, Atten= 22%, Lag= 3.6 min
Primary = 20.4 cfs @ 12.13 hrs, Volume= 44,547 cf
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf
Tertiary = 1.4 cfs @ 12.13 hrs, Volume= 49,046 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 126.05' @ 12.13 hrs Surf.Area= 9,266 sf Storage= 18,171 cf

Plug-Flow detention time= 82.3 min calculated for 93,593 cf (100% of inflow)
Center-of-Mass det. time= 79.8 min (834.9 - 755.1)

Volume	Invert	Avail.Storage	Storage Description
#1	123.75'	24,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
123.75	6,450	0	0
124.00	6,850	1,663	1,663
125.00	8,000	7,425	9,088
126.00	9,200	8,600	17,688
126.75	10,150	7,256	24,944

Device	Routing	Invert	Outlet Devices
#1	Primary	122.00'	**24.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 122.00' / 121.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	125.00'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Secondary	126.25'	**12.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83
#4	Tertiary	123.75'	**6.0" Round Culvert** L= 10.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 123.75' / 123.65' S= 0.0100 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 0.20 sf

Primary OutFlow Max=20.4 cfs @ 12.13 hrs HW=126.05' (Free Discharge)
↑**1=Culvert** (Passes 20.4 cfs of 26.4 cfs potential flow)
↑**2=Sharp-Crested Rectangular Weir** (Weir Controls 20.4 cfs @ 3.35 fps)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=123.75' (Free Discharge)
↑**3=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Tertiary OutFlow Max=1.4 cfs @ 12.13 hrs HW=126.05' (Free Discharge)
↑**4=Culvert** (Inlet Controls 1.4 cfs @ 6.90 fps)

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 393,000 sf, 73.51% Impervious, Inflow Depth > 4.42" for 10-Year event
Inflow = 36.4 cfs @ 12.10 hrs, Volume= 144,813 cf
Primary = 36.4 cfs @ 12.10 hrs, Volume= 144,813 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 11,400 sf, 30.70% Impervious, Inflow Depth = 3.75" for 10-Year event
Inflow = 1.2 cfs @ 12.07 hrs, Volume= 3,559 cf
Primary = 1.2 cfs @ 12.07 hrs, Volume= 3,559 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 300 sf, 0.00% Impervious, Inflow Depth = 3.06" for 10-Year event
Inflow = 0.0 cfs @ 12.07 hrs, Volume= 76 cf
Primary = 0.0 cfs @ 12.07 hrs, Volume= 76 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-10: Parking Lot and Runoff Area=151,400 sf 56.01% Impervious Runoff Depth=5.20"
Tc=5.0 min CN=90 Runoff=20.8 cfs 65,569 cf

Subcatchment PR-11: Building Runoff Area=154,250 sf 100.00% Impervious Runoff Depth=6.12"
Tc=5.0 min CN=98 Runoff=22.9 cfs 78,687 cf

Subcatchment PR-12: Garage Runoff Area=41,350 sf 100.00% Impervious Runoff Depth=6.12"
Tc=5.0 min CN=98 Runoff=6.1 cfs 21,094 cf

Subcatchment PR-13: South of Building Runoff Area=46,000 sf 18.48% Impervious Runoff Depth=4.53"
Tc=5.0 min CN=84 Runoff=5.7 cfs 17,382 cf

Subcatchment PR-20: Overland to TV Place Runoff Area=11,400 sf 30.70% Impervious Runoff Depth=4.86"
Tc=5.0 min CN=87 Runoff=1.5 cfs 4,619 cf

Subcatchment PR-30: Overland to Highland Runoff Area=300 sf 0.00% Impervious Runoff Depth=4.11"
Tc=5.0 min CN=80 Runoff=0.0 cfs 103 cf

Pond P1: Surface Basin Peak Elev=126.24' Storage=19,936 cf Inflow=34.7 cfs 117,162 cf
Primary=26.0 cfs 61,624 cf Secondary=0.0 cfs 0 cf Tertiary=1.4 cfs 55,182 cf Outflow=27.4 cfs 116,807 cf

Link DP-1: MassDOT Drainage Swale Inflow=46.0 cfs 182,375 cf
Primary=46.0 cfs 182,375 cf

Link DP-2: TV Place Closed Drainage Inflow=1.5 cfs 4,619 cf
Primary=1.5 cfs 4,619 cf

Link DP-3: Highland Ave Closed Drainage Inflow=0.0 cfs 103 cf
Primary=0.0 cfs 103 cf

Total Runoff Area = 404,700 sf Runoff Volume = 187,453 cf Average Runoff Depth = 5.56"
27.75% Pervious = 112,300 sf 72.25% Impervious = 292,400 sf

Summary for Subcatchment PR-10: Parking Lot and Drives

Runoff = 20.8 cfs @ 12.07 hrs, Volume= 65,569 cf, Depth= 5.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
84,800	98	Paved parking, HSG D
64,650	80	>75% Grass cover, Good, HSG D
1,950	96	Gravel surface, HSG D
151,400	90	Weighted Average
66,600		43.99% Pervious Area
84,800		56.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Base**

Summary for Subcatchment PR-11: Building

Runoff = 22.9 cfs @ 12.07 hrs, Volume= 78,687 cf, Depth= 6.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
154,250	98	Roofs, HSG D
154,250		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-12: Garage

Runoff = 6.1 cfs @ 12.07 hrs, Volume= 21,094 cf, Depth= 6.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
41,350	98	Roofs, HSG D
41,350		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-13: South of Building

Runoff = 5.7 cfs @ 12.07 hrs, Volume= 17,382 cf, Depth= 4.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
1,150	96	Gravel surface, HSG D
29,350	80	>75% Grass cover, Good, HSG D
7,000	80	>75% Grass cover, Good, HSG D
8,500	98	Paved parking, HSG D
46,000	84	Weighted Average
37,500		81.52% Pervious Area
8,500		18.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-20: Overland to TV Place

Runoff = 1.5 cfs @ 12.07 hrs, Volume= 4,619 cf, Depth= 4.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
750	96	Gravel surface, HSG D
7,150	80	>75% Grass cover, Good, HSG D
3,500	98	Paved parking, HSG D
11,400	87	Weighted Average
7,900		69.30% Pervious Area
3,500		30.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-30: Overland to Highland Ave

Runoff = 0.0 cfs @ 12.07 hrs, Volume= 103 cf, Depth= 4.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
300	80	>75% Grass cover, Good, HSG D
300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Pond P1: Surface Basin

Inflow Area = 241,600 sf, 84.48% Impervious, Inflow Depth = 5.82" for 25-Year event
Inflow = 34.7 cfs @ 12.07 hrs, Volume= 117,162 cf
Outflow = 27.4 cfs @ 12.13 hrs, Volume= 116,807 cf, Atten= 21%, Lag= 3.5 min
Primary = 26.0 cfs @ 12.13 hrs, Volume= 61,624 cf
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf
Tertiary = 1.4 cfs @ 12.13 hrs, Volume= 55,182 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 126.24' @ 12.13 hrs Surf.Area= 9,505 sf Storage= 19,936 cf

Plug-Flow detention time= 74.6 min calculated for 116,807 cf (100% of inflow)
Center-of-Mass det. time= 72.6 min (824.4 - 751.8)

Volume	Invert	Avail.Storage	Storage Description
#1	123.75'	24,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
123.75	6,450	0	0
124.00	6,850	1,663	1,663
125.00	8,000	7,425	9,088
126.00	9,200	8,600	17,688
126.75	10,150	7,256	24,944

Device	Routing	Invert	Outlet Devices
#1	Primary	122.00'	**24.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 122.00' / 121.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	125.00'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Secondary	126.25'	**12.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83
#4	Tertiary	123.75'	**6.0" Round Culvert** L= 10.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 123.75' / 123.65' S= 0.0100 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 0.20 sf

Primary OutFlow Max=26.0 cfs @ 12.13 hrs HW=126.24' (Free Discharge)
↑**1=Culvert** (Passes 26.0 cfs of 27.2 cfs potential flow)
↑**2=Sharp-Crested Rectangular Weir** (Weir Controls 26.0 cfs @ 3.64 fps)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=123.75' (Free Discharge)
↑**3=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Tertiary OutFlow Max=1.4 cfs @ 12.13 hrs HW=126.24' (Free Discharge)
↑**4=Culvert** (Inlet Controls 1.4 cfs @ 7.21 fps)

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 393,000 sf, 73.51% Impervious, Inflow Depth > 5.57" for 25-Year event
Inflow = 46.0 cfs @ 12.10 hrs, Volume= 182,375 cf
Primary = 46.0 cfs @ 12.10 hrs, Volume= 182,375 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 11,400 sf, 30.70% Impervious, Inflow Depth = 4.86" for 25-Year event
Inflow = 1.5 cfs @ 12.07 hrs, Volume= 4,619 cf
Primary = 1.5 cfs @ 12.07 hrs, Volume= 4,619 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 300 sf, 0.00% Impervious, Inflow Depth = 4.11" for 25-Year event
Inflow = 0.0 cfs @ 12.07 hrs, Volume= 103 cf
Primary = 0.0 cfs @ 12.07 hrs, Volume= 103 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-10: Parking Lot and Runoff Area=151,400 sf 56.01% Impervious Runoff Depth=6.97"
Tc=5.0 min CN=90 Runoff=27.5 cfs 87,975 cf

Subcatchment PR-11: Building Runoff Area=154,250 sf 100.00% Impervious Runoff Depth=7.93"
Tc=5.0 min CN=98 Runoff=29.4 cfs 101,935 cf

Subcatchment PR-12: Garage Runoff Area=41,350 sf 100.00% Impervious Runoff Depth=7.93"
Tc=5.0 min CN=98 Runoff=7.9 cfs 27,326 cf

Subcatchment PR-13: South of Building Runoff Area=46,000 sf 18.48% Impervious Runoff Depth=6.26"
Tc=5.0 min CN=84 Runoff=7.8 cfs 23,991 cf

Subcatchment PR-20: Overland to TV Place Runoff Area=11,400 sf 30.70% Impervious Runoff Depth=6.62"
Tc=5.0 min CN=87 Runoff=2.0 cfs 6,285 cf

Subcatchment PR-30: Overland to Highland Runoff Area=300 sf 0.00% Impervious Runoff Depth=5.78"
Tc=5.0 min CN=80 Runoff=0.0 cfs 145 cf

Pond P1: Surface Basin Peak Elev=126.54' Storage=22,887 cf Inflow=45.1 cfs 153,252 cf
Primary=28.5 cfs 88,016 cf Secondary=4.7 cfs 1,715 cf Tertiary=1.5 cfs 63,147 cf Outflow=34.7 cfs 152,877 cf

Link DP-1: MassDOT Drainage Swale Inflow=59.0 cfs 240,853 cf
Primary=59.0 cfs 240,853 cf

Link DP-2: TV Place Closed Drainage Inflow=2.0 cfs 6,285 cf
Primary=2.0 cfs 6,285 cf

Link DP-3: Highland Ave Closed Drainage Inflow=0.0 cfs 145 cf
Primary=0.0 cfs 145 cf

Total Runoff Area = 404,700 sf Runoff Volume = 247,656 cf Average Runoff Depth = 7.34"
27.75% Pervious = 112,300 sf 72.25% Impervious = 292,400 sf

Summary for Subcatchment PR-10: Parking Lot and Drives

Runoff = 27.5 cfs @ 12.07 hrs, Volume= 87,975 cf, Depth= 6.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
84,800	98	Paved parking, HSG D
64,650	80	>75% Grass cover, Good, HSG D
1,950	96	Gravel surface, HSG D
151,400	90	Weighted Average
66,600		43.99% Pervious Area
84,800		56.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Base**

Summary for Subcatchment PR-11: Building

Runoff = 29.4 cfs @ 12.07 hrs, Volume= 101,935 cf, Depth= 7.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
154,250	98	Roofs, HSG D
154,250		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-12: Garage

Runoff = 7.9 cfs @ 12.07 hrs, Volume= 27,326 cf, Depth= 7.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
41,350	98	Roofs, HSG D
41,350		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-13: South of Building

Runoff = 7.8 cfs @ 12.07 hrs, Volume= 23,991 cf, Depth= 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
1,150	96	Gravel surface, HSG D
29,350	80	>75% Grass cover, Good, HSG D
7,000	80	>75% Grass cover, Good, HSG D
8,500	98	Paved parking, HSG D
46,000	84	Weighted Average
37,500		81.52% Pervious Area
8,500		18.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-20: Overland to TV Place

Runoff = 2.0 cfs @ 12.07 hrs, Volume= 6,285 cf, Depth= 6.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
750	96	Gravel surface, HSG D
7,150	80	>75% Grass cover, Good, HSG D
3,500	98	Paved parking, HSG D
11,400	87	Weighted Average
7,900		69.30% Pervious Area
3,500		30.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-30: Overland to Highland Ave

Runoff = 0.0 cfs @ 12.07 hrs, Volume= 145 cf, Depth= 5.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
300	80	>75% Grass cover, Good, HSG D
300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Pond P1: Surface Basin

Inflow Area = 241,600 sf, 84.48% Impervious, Inflow Depth = 7.61" for 100-Year event
Inflow = 45.1 cfs @ 12.07 hrs, Volume= 153,252 cf
Outflow = 34.7 cfs @ 12.13 hrs, Volume= 152,877 cf, Atten= 23%, Lag= 3.7 min
Primary = 28.5 cfs @ 12.13 hrs, Volume= 88,016 cf
Secondary = 4.7 cfs @ 12.13 hrs, Volume= 1,715 cf
Tertiary = 1.5 cfs @ 12.13 hrs, Volume= 63,147 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 126.54' @ 12.13 hrs Surf.Area= 9,890 sf Storage= 22,887 cf

Plug-Flow detention time= 66.1 min calculated for 152,877 cf (100% of inflow)
Center-of-Mass det. time= 64.5 min (812.5 - 748.1)

Volume	Invert	Avail.Storage	Storage Description
#1	123.75'	24,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
123.75	6,450	0	0
124.00	6,850	1,663	1,663
125.00	8,000	7,425	9,088
126.00	9,200	8,600	17,688
126.75	10,150	7,256	24,944

Device	Routing	Invert	Outlet Devices
#1	Primary	122.00'	**24.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 122.00' / 121.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	125.00'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Secondary	126.25'	**12.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83
#4	Tertiary	123.75'	**6.0" Round Culvert** L= 10.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 123.75' / 123.65' S= 0.0100 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 0.20 sf

Primary OutFlow Max=28.5 cfs @ 12.13 hrs HW=126.54' (Free Discharge)
└**1=Culvert** (Inlet Controls 28.5 cfs @ 9.06 fps)
└**2=Sharp-Crested Rectangular Weir** (Passes 28.5 cfs of 35.7 cfs potential flow)

Secondary OutFlow Max=4.7 cfs @ 12.13 hrs HW=126.54' (Free Discharge)
└**3=Broad-Crested Rectangular Weir** (Weir Controls 4.7 cfs @ 1.32 fps)

Tertiary OutFlow Max=1.5 cfs @ 12.13 hrs HW=126.54' (Free Discharge)
└**4=Culvert** (Inlet Controls 1.5 cfs @ 7.68 fps)

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 393,000 sf, 73.51% Impervious, Inflow Depth > 7.35" for 100-Year event
Inflow = 59.0 cfs @ 12.09 hrs, Volume= 240,853 cf
Primary = 59.0 cfs @ 12.09 hrs, Volume= 240,853 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 11,400 sf, 30.70% Impervious, Inflow Depth = 6.62" for 100-Year event
Inflow = 2.0 cfs @ 12.07 hrs, Volume= 6,285 cf
Primary = 2.0 cfs @ 12.07 hrs, Volume= 6,285 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 300 sf, 0.00% Impervious, Inflow Depth = 5.78" for 100-Year event
Inflow = 0.0 cfs @ 12.07 hrs, Volume= 145 cf
Primary = 0.0 cfs @ 12.07 hrs, Volume= 145 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Appendix C: Standard 3 Computations and Supporting Documentation

› Soil Evaluation in accordance with Volume 3, Chapter 1 of the Handbook

Soil Evaluation and Analysis

Memorandum

Date:	March 18, 2022
Recipient:	The Bulfinch Companies, Inc.
Attention:	Mr. Robert Schlager
Copy:	Mr. Thomas Urtz (Stantec)
	Mr. Daniel Keches, P.E. (VHB)
Sender:	Nathan Davis, PhD, P.E.; Brendan A. O'Neil, P.E.
Project:	557 Highland Avenue
Project No:	7307.2.01
Subject:	Preliminary Evaluation of Soil Hydraulic Conductivity

This memorandum provides a summary of our preliminary evaluation of the estimated hydraulic conductivity of fill material in the general vicinity of two (2) proposed locations for groundwater infiltration systems for the proposed development to be located at 557 Highland Avenue in Needham, Massachusetts. The purpose of this evaluation is to assess the feasibility of installing stormwater recharge systems for the proposed development as well as to provide infiltration rates to be used for initial sizing of the systems.

Existing Site Conditions

The subject site occupies an approximate 9.3-acre plan area bounded by Highland Avenue to the south, Gould Street to the West, Interstate 95 and associated ramps to the east, and commercial properties to the north. Formerly, the site was occupied by three (3) buildings: a 2-story masonry car dealership and garage occupying an approximately 20,650 square-foot plan area located near the center of the site; a 2-story masonry car dealership and garage occupying an approximately 14,500 square-foot plan area located near the northeastern corner of the site; and a single-story masonry car wash along the northern property line. These buildings have recently been demolished and the site is currently occupied by paved parking areas, with landscaped areas along Gould Street and Highland Avenue, a depressed drainage swale/water feature located at the southwestern corner of the site, and leveled soil in the areas of the former buildings.

Proposed Construction

The current scope of proposed development is understood to consist of a 3- to 5-story lab, office and retail building, a 6-story garage, and a surface parking area. The proposed lab, office and retail building is understood to be an L-shaped building, with the 3-story portion parallel to Highland Avenue and occupying a plan area of approximately 70,442 square feet, and the 5-story portion extending away from Highland Avenue and occupying a plan area of approximately 54,670 square feet. The two portions of the building are understood to be connected via an approximately 4,355-square-foot atrium overlying an approximately

20,361-square-foot plaza. It is understood that the entire building is proposed to be underlain by a 2-level below-grade garage with lowest level slab at approximately Elevation +112.5 that occupies a plan area of approximately 146,023 square feet. The garage is understood to contain 6 above-grade levels of parking along with 2 below-grade levels and occupy a plan are of approximately 41,824 square feet. The proposed garage lowest-level slab elevation is not currently known, but it is anticipated to be at approximately Elevation +110 based on the proposed site grades surrounding the garage.

Exploration Program

The following subsurface explorations were completed at the project site under contract to McPhail:

- Twenty-three (23) borings, completed during the period of December 30, 2021 through January 24, 2022 by Carr Dee Corp. of Medford, MA.
- Sixty-seven (67) geoprobes, completed during the period of December 20, 2021 through January 6, 2022 by Geosearch of Sterling, MA.

Subsurface Conditions

Underlying the surface treatments on-site, the explorations encountered a deposit of fill that extends to a depth of up to 38 feet below ground surface. The fill material was observed to be highly variable, consisting of a mixture of silt, sand, and gravel and containing varying amounts of brick, ash, cinders, and rubber. Portions of the fill deposit were observed to contain numerous boulders ranging up to approximately 6 feet in largest dimension. Underlying the fill material, successive deposits of organic material, alluvium, glacial outwash, glacial till, and bedrock were encountered in the explorations. The alluvial deposit was observed to be interbedded with deposit of organic silt. Explorations performed to depths of up to 64 feet below ground surface in the central portion of the site did not encounter a bedrock deposit. Bedrock, or refusal on suspected bedrock was encountered in the southwestern and northern portions of the site at depths ranging from 14.5 to 22.5 feet below ground surface.

Evaluation of Soil Hydraulic Conductivity

At the completion of the exploration program, soil samples obtained from the borings and geoprobes were returned to our laboratory for more detailed classification, analysis, and testing. The laboratory testing consisted of sieve analyses to determine the soil gradations to confirm the visual classifications and to estimate the coefficient of hydraulic conductivity for site soils. Laboratory test procedures were in general accordance with applicable ASTM Standards.

Using the above-referenced laboratory-derived grain-size distributions, the coefficient of hydraulic conductivity of the fill was estimated using the Kozeny-Carman formula. This method involves the use of additional parameters such as void ratio and particle shape,

which are estimated from the boring data and the representative soil samples. The results from the Kozeny-Carman formula were then compared with referenced infiltration rates (Rawls rates) based on the USDA textural classification.

The results of the Kozeny-Carman formula applied using the grain-size distributions obtained from laboratory analysis indicate a coefficient of hydraulic conductivity in the fill layer at the depths indicated ranging from about $1.9x10^{-5}$ to $6.1x10^{-5}$ cm/s. The Rawls rates estimated from the USDA textural classifications range from $6.4x10^{-5}$ to $1.2x10^{-4}$ cm/s. In consideration of the above, as well as the presence of numerous boulders, shallow bedrock along the edges of the site and varying amounts of rubber encountered in the boreholes, a coefficient of hydraulic conductivity of $5x10^{-5}$ cm/s is recommended for evaluation of recharge into the fill layer.

It should be noted that the fill layer is heterogeneous in composition and variable in density, thus, it is anticipated that the coefficient of hydraulic conductivity in this layer will be highly variable, and the results of the permeability testing may not be representative of the entire deposit. In addition, it should be noted that a relatively thin organic layer is intermittently present on the subject site which may lower the effective hydraulic conductivity of the overlying fill layer where present.

We trust that the above information is sufficient for your present requirements. Should you have any questions concerning the information presented herein, please contact us.

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Appendix D: Standard 4 Computations and Supporting Information

- Operation and Maintenance Plan
- Water Quality Volume Calculations
- TSS Removal Worksheets
- Water Quality Unit Sizing Calculations

Operations and Maintenance Plan

557 Highland Avenue

Needham, MA

PREPARED FOR

Bulfinch

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Suite 600
Boston, MA 02116
781.707.4000

PREPARED BY

vhb

101 Walnut Street
PO Box 9151
Watertown, MA 02471
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MARCH, 20220

A Source Control

A comprehensive source control program will be implemented at the Project Site, which includes the following components:

- Regular pavement sweeping in the private ways
- Catch basin cleaning
- Clearing litter from the parking area, islands, and perimeter landscape areas
- Enclosure and regular maintenance of all dumpsters
- Spill Prevention training

B Spill Prevention

Spill prevention equipment and training will be provided by the property management company.

B.1 Initial Notification

In the event of a spill the facility and/or construction manager or supervisor will be notified immediately.

Facility Manager (name): _____

Facility Manager (phone): _____

Construction Manager (name) : _____

Construction Manager (phone): _____

The supervisor will first contact the Fire Department and then notify the Police Department, the Public Health Commission and the Conservation Commission. The Fire Department is ultimately responsible for matters of public health and safety and should be notified immediately.

B.2 Further Notification

Based on the assessment from the Fire Chief, additional notification to a cleanup contractor may be made. The Massachusetts Department of Environmental Protection (DEP). and the EPA may be notified depending upon the nature and severity of the spill. The Fire Chief will be responsible for determining the level of cleanup and notification required. The attached list of emergency phone numbers shall be posted in the main construction/facility office and readily accessible to all employees. A hazardous waste spill report shall be completed as necessary using the attached form.

Emergency Notification Phone Numbers

1. FACILITY MANAGER

Name: _____ Phone: _____

Beeper/Cell: _____

Home Phone: _____

Alternate Contact: _____ Phone: _____

Beeper/Cell: _____

Home Phone: _____

2. FIRE & POLICE DEPARTMENT Emergency: 911

3. CLEANUP CONTRACTOR

Address: _____ Phone: _____

4. MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION (DEP) Emergency: 888-304-1133

5. NATIONAL RESPONSE CENTER Phone: 800-424-8802

Alternate: U.S. Environmental Protection Agency Business: 617-918-1111

6. MUNICIPAL HEALTH DEPARTMENT Phone: 781-455-7940

Municipal Conservation Commission: Phone: 781-455-7550

Hazardous Waste & Oil Spill Report

Date: _____ **Time:** _____ **AM / PM**

Exact location (Transformer #): _____

Type of equipment: _____ **Make:** _____ **Size:** _____

S / N: _____ **Weather Conditions:** _____

On or near water? ☐ Yes ☐ No **If yes, name of body of water:** _____

Type of chemical / oil spilled: _____

Amount of chemical / oil spilled: _____

Cause of spill: _____

Measures taken to contain or clean up spill: _____

Amount of chemical / oil recovered: _____ **Method:** _____

Material collected as a result of cleanup:

_____ drums containing _____

_____ drums containing _____

_____ drums containing _____

Location and method of debris disposal: _____

Name and address of any person, firm, or corporation suffering charges: _____

Procedures, method, and precautions instituted to prevent a similar occurrence from recurring: _____

Spill reported by General Office by: _____ **Time:** _____ **AM / PM**

Spill reported to DEP / National Response Center by: _____

DEP Date: _____ **Time:** _____ **AM / PM** **Inspector:** _____

NRC Date: _____ **Time:** _____ **AM / PM** **Inspector:** _____

Additional comments: _____

B.3 Assessment – Initial Containment

The supervisor or manager will assess the incident and initiate containment control measures with the appropriate spill containment equipment included in the spill kit kept on-site. A list of recommended spill equipment to be kept on site is included on the following page.

Fire / Police Department: 911

Municipality Health Department 781-455-7940

Municipality Conservation Commission: 781-455-7550

Emergency Response Equipment

The following equipment and materials shall be maintained at all times and stored in a secure area for long-term emergency response need.

Supplies	Quantity	Recommended Suppliers
› Sorbent Pillows/"Pigs"	2	http://www.newpig.com Item # KIT276 — mobile container with two pigs
› Sorbent Boom/Sock	25 feet	http://www.forestry-suppliers.com
› Sorbent Pads	50	
› Lite-Dri® Absorbent	5 pounds	
› Shovel	1	Item # 33934 — Shovel (or equivalent)
› Pry Bar	1	Item # 43210 — Manhole cover pick (or equivalent)
› Goggles	1 pair	Item # 23334 — Goggles (or equivalent)
› Gloves – Heavy	1 pair	Item # 90926 — Gloves (or equivalent)

C Snow Management

- Snow storage areas will be managed to prevent blockage of storm drain catch basins and stormwater drainage swales. Snow combined with sand and debris may block a storm drainage system, diminishing the capacity of the system and causing localized flooding.
- Sand and debris deposited on vegetated or paved areas shall be cleared from the site and properly disposed of at the end of the snow season, no later than May 15.
- Snow shall not be dumped into any waterbody, pond, or wetland resource area.

D Maintenance of Stormwater Management Systems

D.1 Pavement Systems

D.1.1 Standard Asphalt Pavement

- Sweep or vacuum standard asphalt pavement areas at least four times per year with a rotary brush or vacuum sweeper and properly dispose of removed material.
- Recommended sweeping schedule:
- Oct/Nov
- Feb/Mar
- Apr/May
- Aug/Sep
- More frequent sweeping of paved surfaces will result in less accumulation in catch basins, less cleaning of subsurface structures, and less disposal costs.
- Check loading docks and dumpster areas frequently for spillage and/or pavement staining and clean as necessary.

D.2 Structural Stormwater Management Devices

D.2.1 Catch Basins

The proper removal of sediments and associated pollutants and trash occurs only when catch basin inlets and sumps are cleaned out regularly. The more frequent the cleaning, the less likely sediments will be re-suspended and subsequently discharged. In addition, frequent cleaning also results in more volume available for future deposition and enhances the overall performance. As noted in the pavement Operation and Maintenance (O&M) section, more frequent sweeping of paved surfaces will result in less accumulation in catch basins, less cleaning of subsurface structures, and less disposal costs.

Catch basins are constructed with sumps (minimum 4 feet) and hooded outlets to trap debris, sediments, and floating contaminants. Disposal of all sediments must be in accordance with applicable local, state, and federal guidelines.

Inspections and Cleaning

- All catch basins shall be inspected at least four times per year and cleaned a minimum of at least once per year.
- Sediment (if more than six inches deep) and/or floatable pollutants shall be pumped from the basin and disposed of at an approved offsite facility in accordance with all applicable regulations.
- Any structural damage or other indication of malfunction will be reported to the site manager and repaired as necessary
- During colder periods, the catch basin grates must be kept free of snow and ice.
- During warmer periods, the catch basin grates must be kept free of leaves, litter, sand, and debris.

D.2.2 Structural Water Quality Devices

The stormwater drainage system has structural water quality devices and media filters. These include Contech CDS units, JellyFish and StormFilter units, which efficiently remove sediment and hydrocarbons from stormwater runoff.

- Inspect devices monthly for the first three months after construction.
- After initial three month period, all water quality units are to be inspected at least four times per year and cleaned a minimum of at least once per year (when sediment reaches 8" in depth).
- Maintain and replace media filters in accordance with manufacturer's recommendations.
- Follow manufacturer instructions and contact manufacturer if system is malfunctioning.

D.2.3 Stormwater Outfalls

- Inspect outfall locations monthly for the first three months after construction to ensure proper functioning and correct any areas that have settled or experienced washouts.
- Inspect outfalls annually after initial three month period.
- Annual inspections should be supplemented after large storms, when washouts may occur.
- Maintain vegetation around outfalls to prevent blockages at the outfall.
- Maintain rip rap pad below each outfall and replace any washouts.
- Remove and dispose of any trash or debris at the outfall.

D.2.4 Roof Drain Leaders

- Perform routine roof inspections quarterly.
- Keep roofs clean and free of debris.

- Keep roof drainage systems clear.
- Keep roof access limited to authorized personnel.
- Clean inlets twice per year or as necessary.

D.3 Vegetated Stormwater Management Devices

D.3.1 Surface Detention Basins

There is a surface detention ponds on the Site. The detention pond is a partially vegetated basin that are designed to detain roadway and rooftop runoff. The maintenance of the detention basins may affect the functioning of stormwater management practices. This includes the condition of the side slope vegetation and the sediment deposits in the bottom of the ponds.

Initial Post-construction Inspection

- Basin should be inspected after every major storm for the first few months to ensure proper stabilization and function.

Long-term Maintenance

- The grass on the sideslopes and in the buffer areas should be mowed, and grass clippings, organic matter, and accumulated trash and debris removed, at least twice during the growing season.
- Eroded or barren spots should be reseeded immediately after inspection to prevent additional erosion and accumulation of sediment.
- Deep tilling can be used to break up a clogged surface area.
- Sediment should be removed from the basin as necessary. Removal procedures should not take place until the floor of the basin is thoroughly dry.

Inspections and Cleaning

- Detention basin should be inspected at least twice a year to ensure proper stabilization and function.
- Light equipment, which will not compact the underlying soil, should be used to remove the top layer.

D.3.2 Vegetated Areas Maintenance

Although not a structural component of the drainage system, the maintenance of vegetated areas may affect the functioning of the stormwater management system. This includes the health/density of vegetative cover and activities such as the application and disposal of lawn and garden care products, disposal of leaves and yard trimmings and proper aeration of soils.

- Inspect planted areas on a semi-annual basis and remove any litter.
- Maintain planted areas adjacent to pavement to prevent soil washout.

- Immediately clean any soil deposited on pavement.
- Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming.
- Plant alternative mixture of grass species in the event of unsuccessful establishment.
- The grass vegetation should be cut to a height between three and four inches.
- Pesticide/Herbicide Usage – No pesticides are to be used unless a single spot treatment is required for a specific control application.
- Fertilizer usage should be avoided. If deemed necessary, slow release fertilizer should be used. Fertilizer may be used to begin the establishment of vegetation in bare or damaged areas, but should not be applied on a regular basis unless necessary.
- Annual application of compost amendments and aeration are recommended.

Water Quality Volume Calculations

Water Quality Volume Calculations

Project	557 Highland Ave	**Project #**	15306.00
Calculated by	SRD	**Date**	3/15/2022
Checked by	DMK	**Date**	3/15/2022

DETENTION BASIN P1

Runoff from subcatchment areas 11, 12, 13

Water Quality Storm Runoff Depth	(in)	0.5
Total Impervious Area	(ft^2)	204,100

BASIN WQV:

Required Volume:

Runoff Depth to be Treated (in)	Required Volume (ft^3)
0.5	**8,504**

Provided Volume:

Elevation	Area (ft^2)	Cumulative Volume (ft^3)
123.75	6,450	0
124.00	6,850	1,663
125.00	8,000	**9,088**

TSS Removal Worksheets

TSS Removal Calculation Worksheet

VHB, Inc..
101 Walnut Street
Post Office Box 9151
Watertown, MA 02471
P 617.924.1770

Project Name:	**557 Highland Ave**	Sheet:	**1 of 2**
Project Number:	**15306.00**	Date:	**3/15/2022**
Location:	**Needham, MA**	Computed by:	**SRD**
Discharge Point:	**DP-1**	Checked by:	**DMK**
Drainage Area(s):	**10**		

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D E)
Deep Sump and Hooded Catch Basin	**25%**	**1.00**	**0.25**	**0.75**
Media Filter	**80%**	**0.75**	**0.60**	**0.15**

* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1. Removal rates for proprietary devices are from approved studies and/or manufacturer data.

** Equals remaining load from previous BMP (E)

*** Contech Jellyfish sizing calculation gives a TSS removal rate of 80%. Refer to attached calculations.

Treatment Train TSS Removal = **85%**

TSS Removal Calculation Worksheet

VHB, Inc..
101 Walnut Street
Post Office Box 9151
Watertown, MA 02471
(617) 924-1770

Project Name:	**557 Highland Ave**	Sheet:	**2 of 2**
Project Number:	**15306.00**	Date:	**3/15/2022**
Location:	**Needham, MA**	Computed by:	**SRD**
Discharge Point:	**DP-1**	Checked by:	**DMK**
Drainage Area(s):	**11, 12**		

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D E)
Water Quality Unit	**80%**	**1.00**	**0.80**	**0.20**

* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1. Removal rates for proprietary devices are from approved studies and/or manufacturer data.
** Equals remaining load from previous BMP (E)
*** Contech CDS unit sizing calculation gives TSS removal rates of 81-83%. Refer to attached calculations.

Treatment Train TSS Removal = **80%**

Water Quality Unit Sizing

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD

557 HIGHLAND AVE
NEEDHAM, MA

Area	0.95 ac	Unit Site Designation	WQU-203
Weighted C	0.9	Rainfall Station #	69
t_c	5 min		
CDS Model	1515-3	CDS Treatment Capacity	**1.0 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	10.2%	10.2%	0.02	0.02	10.1
0.04	9.6%	19.8%	0.03	0.03	9.5
0.06	9.4%	29.3%	0.05	0.05	9.2
0.08	7.7%	37.0%	0.07	0.07	7.4
0.10	8.6%	45.6%	0.09	0.09	8.1
0.12	6.3%	51.9%	0.10	0.10	5.9
0.14	4.7%	56.5%	0.12	0.12	4.3
0.16	4.6%	61.2%	0.14	0.14	4.2
0.18	3.5%	64.7%	0.15	0.15	3.2
0.20	4.3%	69.1%	0.17	0.17	3.9
0.25	8.0%	77.1%	0.21	0.21	6.9
0.30	5.6%	82.7%	0.26	0.26	4.7
0.35	4.4%	87.0%	0.30	0.30	3.5
0.40	2.5%	89.5%	0.34	0.34	2.0
0.45	2.5%	92.1%	0.38	0.38	1.9
0.50	1.4%	93.5%	0.43	0.43	1.0
0.75	5.0%	98.5%	0.64	0.64	2.9
1.00	1.0%	99.5%	0.85	0.85	0.4
1.50	0.0%	99.5%	1.28	1.00	0.0
2.00	0.0%	99.5%	1.71	1.00	0.0
3.00	0.5%	100.0%	2.56	1.00	0.1
					89.2
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.3%
				Predicted Net Annual Load Removal Efficiency =	**82.7%**

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

557 HIGHLAND AVE
NEEDHAM, MA

Area	3.54 ac	Unit Site Designation	WQU-204
Weighted C	0.9	Rainfall Station #	69
t_c	5 min		
CDS Model	2020-5	CDS Treatment Capacity	**2.2 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	10.2%	10.2%	0.06	0.06	10.2
0.04	9.6%	19.8%	0.13	0.13	9.5
0.06	9.4%	29.3%	0.19	0.19	9.2
0.08	7.7%	37.0%	0.25	0.25	7.4
0.10	8.6%	45.6%	0.32	0.32	8.1
0.12	6.3%	51.9%	0.38	0.38	5.9
0.14	4.7%	56.5%	0.45	0.45	4.3
0.16	4.6%	61.2%	0.51	0.51	4.2
0.18	3.5%	64.7%	0.57	0.57	3.2
0.20	4.3%	69.1%	0.64	0.64	3.8
0.25	8.0%	77.1%	0.80	0.80	6.7
0.30	5.6%	82.7%	0.96	0.96	4.5
0.35	4.4%	87.0%	1.12	1.12	3.4
0.40	2.5%	89.5%	1.27	1.27	1.9
0.45	2.5%	92.1%	1.43	1.43	1.8
0.50	1.4%	93.5%	1.59	1.59	0.9
0.75	5.0%	98.5%	2.39	2.20	2.5
1.00	1.0%	99.5%	3.19	2.20	0.4
1.50	0.0%	99.5%	4.78	2.20	0.0
2.00	0.0%	99.5%	6.37	2.20	0.0
3.00	0.5%	100.0%	9.56	2.20	0.1
					87.8
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	92.5%
				Predicted Net Annual Load Removal Efficiency =	**81.4%**

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH Stormwater Solutions Inc. Engineer: JBS
Date Prepared: **3/25/2022**

Site Information

Project Name	**557 Highland Ave -**	WQU-108
Project State	**MA**	
Project City	**Needham**	

Total Drainage Area, Ad	**1.95**	ac
Post Development Impervious Area, Ai	**1.95**	ac
Pervious Area, Ap	**0.00**	ac
% Impervious	**100%**	
Runoff Coefficient, Rc	**0.95**	

Mass Loading Calculations

Mean Annual Rainfall, P	**49.0**	in
Agency Required % Removal	**80%**	
Percent Runoff Capture	**90%**	
Mean Annual Runoff, Vt	**296,554**	ft^3
Event Mean Concentration of Pollutant, EMC	**75**	mg/l
Annual Mass Load, M total	**1388**	lbs

Filter System

Filtration Brand	**Jelly Fish**	
Cartridge Length	**54**	in

Jelly Fish Sizing

Mass to be Captured by System	**1110**	lbs
Water Quality Flow	**1.44**	cfs

Method to Use **FLOW BASED**

Summary			
Flow	Treatment Flow Rate	1.60	cfs
	Required Size	**JFPD0806-8-2**	

Determining Number of Cartridges for Systems Downstream of Detention

CONTECH Stormwater Solutions Inc. Engineer:	JBS	
Date	3/28/2022	
Site Information		
Project Name	557 Highland Ave - WQU-131	
Project State	MA	
Project Location	Needham	
Drainage Area, Ad	9.02	ac
Impervious Area, Ai	6.63	ac
Pervious Area, Ap	2.39	
% Impervious	74	%
Runoff Coefficient, Rc	0.71	
Upstream Detention System		
Peak release rate from detention, $Q_{release\ peak}$	0.60	cfs
Treatment release rate from detention, $Q_{release\ treat}$	0.60	cfs
Detention pretreatment credit (from removal efficiency calcs)	50%	
Mass loading calculations		
Mean Annual Rainfall, P	49	in
Agency required % removal	80%	
Percent Runoff Capture	90%	
Mean Annual Runoff, V_t	1,027,717	ft^3
Event Mean Concentration of Pollutant, EMC	60	mg/l
Annual Mass Load, M_{total}	3847.17	lbs
Water Quality Volume		
90% Rainfall Depth	0.50	in
Volume to be treated	0.267	ac-ft
Volume to be treated by filters	11652.1185	ft^3
Filter System		
Filtration brand	StormFilter	
Cartridge height	18	in
Specific Flow Rate	1.67	gpm/ft^2
Number of cartridges - mass loading		
Mass removed by pretreatment system, M_{pre}	1923.58	lbs
Mass load to filters after pretreatment, M_{pass1}	1923.58	lbs
Mass to be captured by filters, M_{filter}	1538.87	lbs
Allowable Cartridge Flow rate, Q_{cart}	12.53	
Mass load per cartridge, M_{cart} (lbs)	27.00	lbs
Number of Cartridges required, N_{mass}	57	
Treatment Capacity	1.59	cfs
Determine Critical Sizing Value		
Number of Cartridges using $Q_{release\ treat}$, N_{flow}	22	
Method to Use:	MASS-LOADING	

SUMMARY

Treatment Flow Rate, cfs	1.59
Cartridge Flow Rate, gpm	12.5
Number of Cartridges	57

Estimated Filtration Practice Phosphorus Reduction

Date Prepared: **3/28/2022**

Site Information

Project Name	**557 Highland Ave -**	WQU-131
Project City	**Needham**	
Project State	**MA**	
System Designation	**StormFilter**	
Total Drainage Area, Ad	**9.02**	ac
Post Development Impervious Area, Ai	**6.63**	ac
Pervious Area, Ap	**2.39**	ac
% Impervious	**74%**	
Runoff Coefficient, Rc	**0.71**	
Calculated Phosphorus Load*	**10.19**	lb/yr
*Per Table 1-1 Attachment 1 to Appendix F	**1.13**	lb/ac/yr (Commercial)

Results

Contech Treatment Practice	**StormFilter**	
Filtration Practice Efficiency**	**86**	%
Calculated Phosphorus Reduction	**8.77**	lb/yr

ATTACHMENT 1 TO APPENDIX F

Method to Calculate Baseline Phosphorus Load (Baseline), Phosphorus Reduction Requirements and Phosphorus load increases due to development (P_{DEVinc})

The methods and annual phosphorus load export rates presented in Attachments 1, 2 and 3 are for the purpose of measuring load reductions for various stormwater BMPs treating runoff from different site conditions (i.e. impervious or pervious) and land uses (e.g. commercial, industrial, residential). The estimates of annual phosphorus load and load reductions due to BMPs are intended for use by the permittee to measure compliance with its Phosphorus Reduction Requirement under the permit.

This attachment provides the method to calculate a baseline phosphorus load discharging in stormwater for the impaired municipalities subject to Lakes and Ponds TMDL. A complete list of municipalities subject to these TMDLs is presented in Appendix F, Table F-6. This method shall be used to calculate the following annual phosphorus loads:

1) Baseline Phosphorus Load for Permittees
2) Phosphorus Reduction Requirement

This attachment also provides the method to calculate stormwater phosphorus load increases due to development for the municipalities subject to the Charles River TMDL requirements and the Lakes & Ponds TMDL requirements:

3) Phosphorus Load Increases due to Development

The **Baseline Phosphorus Load** is a measure of the annual phosphorus load discharging in stormwater from the impervious and pervious areas of the impaired Lake Phosphorus Control Plan (LPCP) Area.

The **Baseline Phosphorus Pounds Reduction** referred to as the permittee's **Phosphorus Reduction Requirement** represents the required reduction in annual phosphorus load in stormwater to meet the WLA for the impaired watershed. The percent phosphorus reduction for each watershed (identified in Appendix F, Table F-6) is applied to the Baseline Phosphorus Load to calculate the Phosphorus Pounds Reduction.

The **Phosphorus load increases due to development (P_{DEVinc})** is the stormwater phosphorus load increases due to development over the previous reporting period and incurred to date. Increases in stormwater phosphorus load from development will increase the permittee's baseline phosphorus load and therefore, the phosphorus reduction requirement.

Examples are provided to illustrate use of the methods. Table 1-1 below provides annual composite phosphorus load export rates (PLERs) by land use category for the Baseline Load and Phosphorus Reduction Requirement calculations. The permittee shall select the land use category that most closely represents the actual use of the watershed. For watersheds with institutional type uses, such as government properties, hospitals, and schools, the permittee shall use the commercial land use category for the purpose of calculating phosphorus loads. Table 1-2 provides annual PLERs by land use category for impervious and pervious areas. The permittee shall select the land use category that most closely represents the actual use of the watershed. For pervious areas, if the hydrologic soil group (HSG) is known, use the appropriate value. If the HSG is not known, assume HSG C conditions for the phosphorus load export rate. For watersheds with

institutional type uses, such as government properties, hospitals, and schools, the permittee shall use the commercial/industrial land use category for the purpose of calculating phosphorus loads. Table 1-3 provides a crosswalk table of land use codes between Tables 1-1 and 1-2 and the codes used by MassGIS.

The composite PLERs in Table 1-1 to be used for calculating Baseline Phosphorus Load are based on the specified directly connected impervious area (DCIA). If the permittee determines through mapping and site investigations that the overall DCIA for the collective area for each land use category is different than the corresponding values in Table 1-1, then the permittee is encouraged to submit this information in its annual report and request EPA to recalculate the composite PLERs for the permittees to use in refining the Baseline Phosphorus Load calculation for the LPCP.

(1) Baseline Phosphorus Load: The permittee shall calculate the **Baseline Phosphorus Load** by the following procedure:

1) Determine the total area (acre) associated with the impaired watershed;

2) Sort the total area associated with the watershed into land use categories;

3) Calculate the annual phosphorus load associated with each land use category by multiplying the total area of land use by the appropriate land use-based composite phosphorus load export rate provided in Table 1-1; and

4) Determine the Baseline Phosphorus Load by summing the land use loads.

Example 1-1 to determine Baseline Phosphorus Load:
Watershed A is 18.0 acres, with 11.0 acres of industrial area (e.g. access drives, buildings, and parking lots), 3.0 acres of medium-density residential and 4.0 acres of unmanaged wooded area.

The **Baseline Phosphorus Load** = (Baseline P Load $_{IND}$) + (Baseline P Load $_{MDR}$) + (Baseline P Load $_{FOR}$)

Where:
Baseline P Load $_{IND}$ = (TA_{IND}) x (PLER for industrial use (Table 1-1))
= 11.0 acre x 1.27 lbs/acre/year
= 14.0 lbs P/year

Baseline P Load $_{MDR}$ = (TA_{MDR}) x (PLER for medium density residential (Table 1-1))
= 3.0 acre x 0.49 lbs/acre/year
= 1.5 lbs P/year

Baseline P Load $_{FOR}$ = (TA_{FOR}) x (PLER for forest (Table 1-1))
= 4.0 acre x 0.12 lbs/acre/year
= 0.5 lbs P/year

Baseline Phosphorus Load = 14.0 lbs P/year + 1.5 lbs P/year + 0.5 lbs P/year
= **16.0 lbs P/year**

(2) Baseline Phosphorus Pounds Reduction (Phosphorus Reduction Requirement): The Baselines Phosphorus Reduction requirement is the amount of reduction in annual phosphorus load (in pounds) that the permittee is required to achieve in the Watershed. The permittee shall calculate the **Phosphorus Reduction Requirement** by multiplying the **Baseline Phosphorus Load** by the applicable percent phosphorus reduction for that watershed specified in Table F-6 (Appendix F).

Example 1-2 to determine Watershed Phosphorus Reduction Requirement:
Table F-6 identifies Watershed A's percent phosphorus reduction as 45%; therefore the Watershed Phosphorus Reduction Requirement is:

Phosphorus Reduction Requirement = (Baseline Phosphorus Load) x (0.45)
= (16.0 lbs P/year) x (0.45)
= **7.2 lbs P/year**

(3) Phosphorus load increases due to development (P_{DEVinc}): To estimate the increases in stormwater phosphorus load due to development in the Watershed (either PCP or LPCP Area), the permittee will use the following procedure:

1) Determine the total area of development by land use category and calculate the baseline load from that area using the composite PLERs in Table 1-1;

2) Distribute the total development area into impervious and pervious subareas by land use category;

3) Calculate the phosphorus load due to development (P_{DEV}) for each land use-based impervious and pervious subarea by multiplying the subarea by the appropriate phosphorus load export rate provided in Table 1-2; and

4) Determine the phosphorus load increase (P_{DEVinc}) by subtracting the baseline phosphorus load from the increased phosphorus load due to development.

Note: If structural BMPs are installed as part of new development, the P_{DEVinc} will be reduced by the amount of BMP load treated by that BMP as calculated in Attachment 3.

Example 1-3 to determine Phosphorus Load Increases: For the same 15.11 acre Watershed A as specified in Example 1-1, a permittee has tracked development in the LPCP Area in the last year that resulted in 1.5 acres of medium density residential area and 0.5 acres of forest land being converted to high density residential impervious area as detailed below. The undeveloped MDR area is pervious area, HSG C soil and the undeveloped forest area is pervious, HSG B soil.

Land Use Category	Baseline Area (acres)	(lbs P/acre/yr)*	Baseline area unchanged (acres)	P export rate (lbs P/acre/yr)**	Developed Area converted to HDR IA (acres)	P export rate (lbs P/acre/yr)**
Industrial	11.0	1.27	No change	--	No change	--
MDR	3.0	0.49	1.5	0.21	1.5	2.32

Forest	4.0	0.12	3.5	0.12	0.5	2.32

*From Table 1-1; ** From Table 1-2

The phosphorus load increase is calculated as:

Baseline Load = (Baseline P Load $_{IND}$) +
(Baseline P Load $_{MDR}$) +
(Baseline P Load $_{FOR}$)
= **16.0 lb/year** (determined in Example 1-1)

P_{DEV} = $(TA_{IND} \times PLER_{IND})+(IA_{HDR} \times PLER_{HDR})+(PA_{MDR} \times PLER_{MDR})+(PA_{FOR} \times PLER_{For})$
= (11.0 acres * 1.27) + (2.0 acres * 2.32) + (1.5 acres * 0.21) + (3.5 * 0.12)
= **19.0 lbs P/year**

$\mathbf{P_{DEVinc}}$ = P_{DEV} – Baseline Load
= 19.0 – 16.0
= **3.0 lbs/year**

Table 1-1. Annual composite phosphorus load export rates

Land Cover	Representative DCIA, %	Composite PLERs, lb/ac/yr	Composite PLERs, kg/ha/yr
Commercial	**57**	**1.13**	**1.27**
Industrial	**67**	**1.27**	**1.42**
High Density Residential	**36**	**1.04**	**1.16**
Medium Density Residential	**16**	**0.49**	**0.55**
Low Density Residential	**11**	**0.30**	**0.34**
Freeway	**44**	**0.73**	**0.82**
Open Space	**8**	**0.26**	**0.29**
Agriculture	**0.4**	**0.45**	**0.50**
Forest	**0.1**	**0.12**	**0.13**

Table 1-2: Proposed average annual distinct P Load export rates for use in estimating P Load reduction credits the MA MS4 Permit

Phosphorus Source Category by Land Use	Land Surface Cover	P Load Export Rate, lbs/acre/year	P Load Export Rate, kg/ha/yr
Commercial (Com) and Industrial (Ind)	Directly connected impervious	1.78	2.0
	Pervious	See* DevPERV	See* DevPERV
Multi-Family (MFR) and High-Density Residential (HDR)	Directly connected impervious	2.32	2.6
	Pervious	See* DevPERV	See* DevPERV
Medium -Density Residential (MDR)	Directly connected impervious	1.96	2.2
	Pervious	See* DevPERV	See* DevPERV
Low Density Residential (LDR) - "Rural"	Directly connected impervious	1.52	1.7
	Pervious	See* DevPERV	See* DevPERV
Highway (HWY)	Directly connected impervious	1.34	1.5
	Pervious	See* DevPERV	See* DevPERV
Forest (For)	Directly connected impervious	1.52	1.7
	Pervious	0.13	0.13
Open Land (Open)	Directly connected impervious	1.52	1.7
	Pervious	See* DevPERV	See* DevPERV
Agriculture (Ag)	Directly connected impervious	1.52	1.7
	Pervious	0.45	0.5
*Developed Land Pervious (DevPERV)- Hydrologic Soil Group A	Pervious	0.03	0.03
*Developed Land Pervious (DevPERV)- Hydrologic Soil Group B	Pervious	0.12	0.13
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group C	Pervious	0.21	0.24
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group C/D	Pervious	0.29	0.33
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group D	Pervious	0.37	0.41

Table 1-3: Crosswalk of MassGIS land-use categories to land-use groups for P Load Calculations

Mass GIS Land Use LU_CODE	Description	Land Use group for calculating P Load - 2013/14 MA MS4
1	Crop Land	Agriculture
2	Pasture (active)	Agriculture
3	Forest	Forest
4	Wetland	Forest
5	Mining	Industrial
6	Open Land includes inactive pasture	open land
7	Participation Recreation	open land
8	spectator recreation	open land
9	Water Based Recreation	open land
10	Multi-Family Residential	High Density Residential
11	High Density Residential	High Density Residential
12	Medium Density Residential	Medium Density Residential
13	Low Density Residential	Low Density Residential
14	Saltwater Wetland	Water
15	Commercial	Commercial
16	Industrial	Industrial
17	Urban Open	open land
18	Transportation	Highway
19	Waste Disposal	Industrial
20	Water	Water
23	cranberry bog	Agriculture
24	Powerline	open land
25	Saltwater Sandy Beach	open land
26	Golf Course	Agriculture
29	Marina	Commercial
31	Urban Public	Commercial
34	Cemetery	open land
35	Orchard	Forest
36	Nursery	Agriculture
37	Forested Wetland	Forest
38	Very Low Density residential	Low Density Residential
39	Junkyards	Industrial
40	Brush land/Successional	Forest

Appendix E: Standard 8 Supporting Information

- List of recommended Construction Period BMPs
- Recommended construction period maintenance checklist

Recommended Construction Period Pollution Prevention and Erosion and Sedimentation Controls

Erosion and Sedimentation Control Measures

The following erosion and sedimentation controls are for use during the earthwork and construction phases of the project. The following controls are provided as recommendations for the site contractor and do not constitute or replace the final Stormwater Pollution Prevention Plan that must be fully implemented by the Contractor and owner in Compliance with EPA NPDES regulations.

Straw Bale Barriers

Straw bale barriers will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site. Bales will be set at least four inches into the existing ground to minimize undercutting by runoff.

Silt Fencing

In areas where high runoff velocities or high sediment loads are expected, straw bale barriers will be backed up with silt fencing. This semi-permeable barrier made of a synthetic porous fabric will provide additional protection. The silt fences and straw bale barrier will be replaced as determined by periodic field inspections.

Catch Basin Protection

Newly constructed and existing catch basins will be protected with straw bale barriers (where appropriate) or silt sacks throughout construction.

Gravel and Construction Entrance/Exit

A temporary crushed-stone construction entrance/exit will be constructed. A cross slope will be placed in the entrance to direct runoff to a protected catch basin inlet or settling area. If deemed necessary after construction begins, a wash pad may be included to wash off vehicle wheels before leaving the project site.

Diversion Channels

Diversion channels will be used to collect runoff from construction areas and discharge to either sedimentation basins or protected catch basin inlets.

Temporary Sediment Basins

Temporary sediment basins will be designed either as excavations or bermed stormwater detention structures (depending on grading) that will retain runoff for a

sufficient period of time to allow suspended soil particles to settle out prior to discharge. These temporary basins will be located based on construction needs as determined by the contractor and outlet devices will be designed to control velocity and sediment. Points of discharge from sediment basins will be stabilized to minimize erosion.

Vegetative Slope Stabilization

Stabilization of open soil surfaces will be implemented within 14 days after grading or construction activities have temporarily or permanently ceased, unless there is sufficient snow cover to prohibit implementation. Vegetative slope stabilization will be used to minimize erosion on slopes of 3:1 or flatter. Annual grasses, such as annual rye, will be used to ensure rapid germination and production of root mass. Permanent stabilization will be completed with the planting of perennial grasses or legumes. Establishment of temporary and permanent vegetative cover may be established by hydro-seeding or sodding. A suitable topsoil, good seedbed preparation, and adequate lime, fertilizer and water will be provided for effective establishment of these vegetative stabilization methods. Mulch will also be used after permanent seeding to protect soil from the impact of falling rain and to increase the capacity of the soil to absorb water.

Maintenance

- The contractor or subcontractor will be responsible for implementing each control shown on the Sedimentation and Erosion Control Plan. In accordance with EPA regulations, the contractor must sign a copy of a certification to verify that a plan has been prepared and that permit regulations are understood.

- The on-site contractor will inspect all sediment and erosion control structures periodically and after each rainfall event. Records of the inspections will be prepared and maintained on-site by the contractor.

- Silt shall be removed from behind barriers if greater than 6-inches deep or as needed.

- Damaged or deteriorated items will be repaired immediately after identification.

- The underside of straw bales should be kept in close contact with the earth and reset as necessary.

- Sediment that is collected in structures shall be disposed of properly and covered if stored on-site.

- Erosion control structures shall remain in place until all disturbed earth has been securely stabilized. After removal of structures, disturbed areas shall be re-graded and stabilized as necessary.

Merrimack College – Campus Parking Improvements, North Andover, Massachusetts
Construction Best Management Practices – Maintenance/ Evaluation Checklist

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed ☐yes ☐no (List Items)	Date of Cleaning/Repair	Performed by:
Straw Bales/Silt Fencing	In accordance with NPDES CGP			• Accumulated sediment • Separation of straw bales with the earth and each other • Damaged or broken straw bales/ silt fence	☐**yes** ☐**no**		
Gravel Construction Entrance	In accordance with NPDES CGP			• Accumulated sediment • Tracking of sediment outside limit of work	☐**yes** ☐**no**		
Catch Basin Protection	In accordance with NPDES CGP			• Accumulated sediment within silt sacks • Rips or torn silt sacks	☐**yes** ☐**no**		
Diversion Channels	In accordance with NPDES CGP			• Cracking, • Erosion, • Leakage in the embankments	☐**yes** ☐**no**		
Temporary Sedimentation Basins	In accordance with NPDES CGP			• Cracking, • Erosion, • Leakage in the embankments • Accumulation of sediment	☐**yes** ☐**no**		
Vegetated Slope Stabilization	In accordance with NPDES CGP			• Cracking, • Erosion	☐**yes** ☐**no**		

Stormwater Control Manager _____