Light Rail Surface Station Design: Bringing the Nation's Oldest and Most Heavily Used Light Rail Network into the 21st Century

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14TH NATIONAL LIGHT RAIL & STREETCAR CONFERENCE
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Key Presentation Take-Aways

- Surface light-rail station-design criteria
  - accessibility, universal design, building and safety codes, and railway design
- Conceptual planning process for retrofitting historic light-rail system to 21st Century Standards

Topics

- Background and Objectives
- Comprehensive Design Criteria
- Evaluation of Existing Conditions
- Design and Evaluation of Upgrade Options

Topics

- **Background and Objectives**
- Comprehensive Design Criteria
- Evaluation of Existing Conditions
- Design and Evaluation of Upgrade Options

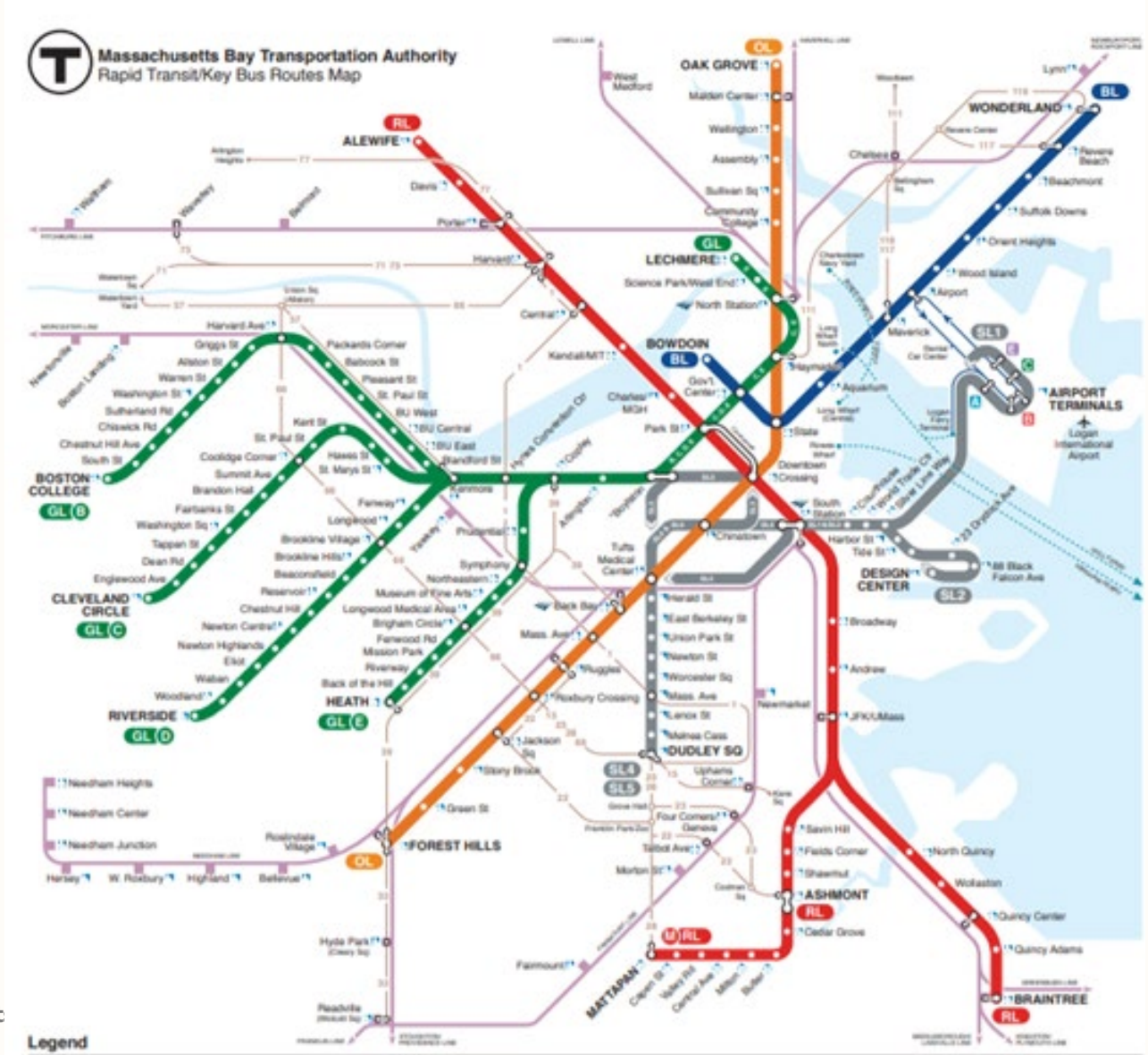
Massachusetts Bay Transportation Authority

Boston's public transport operator since 1964

Six modes:

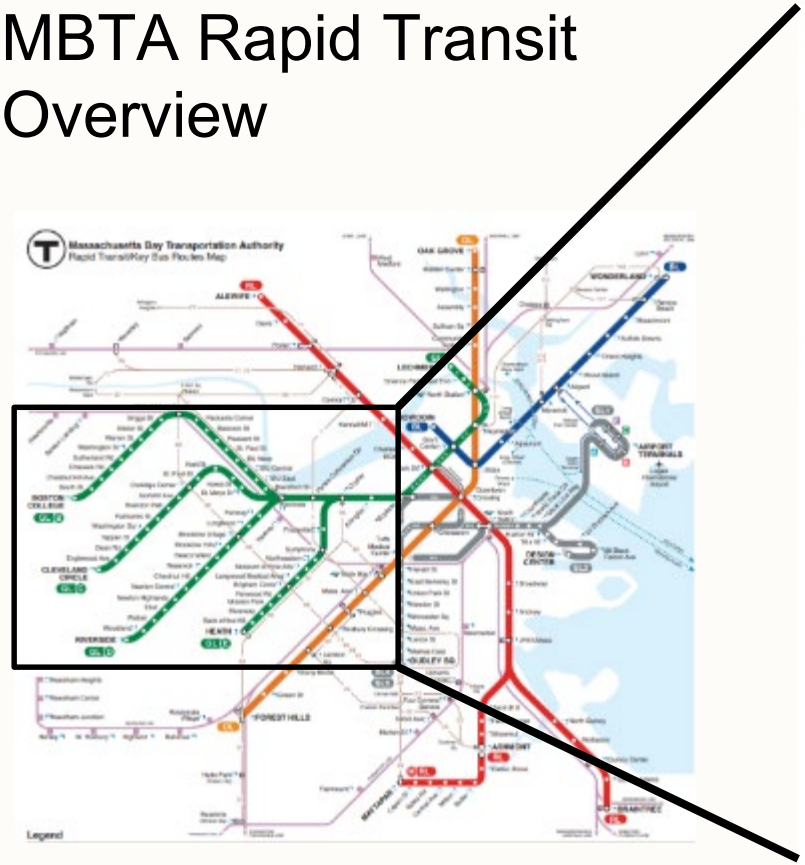
- Heavy rail (subway)
- light rail,
- commuter rail,
- ferry,
- electric trolley bus,
- conventional bus.

Almost 1.3 million passengers per weekday!



Background

MBTA Rapid Transit Overview



Source: MBTA Rapid Transit Map
mbta.com

Background

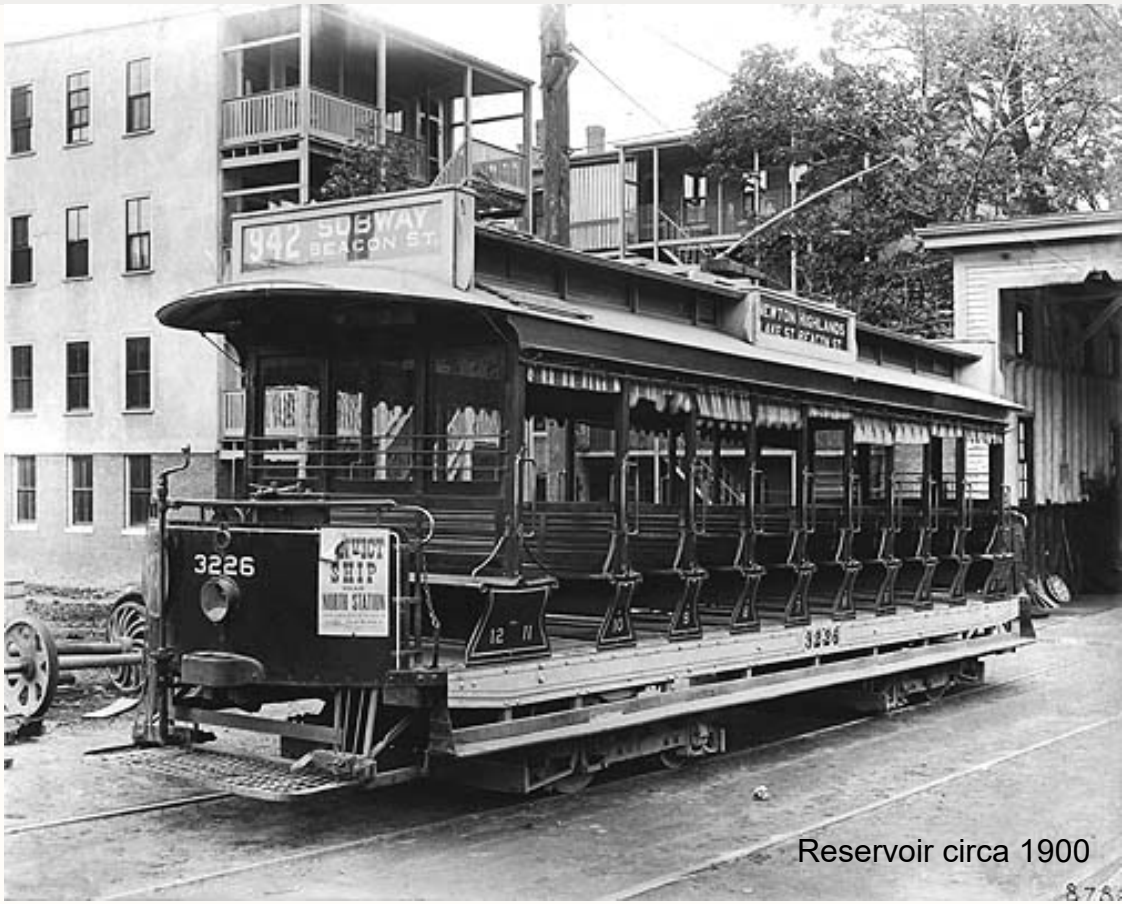
MBTA's Green Line is nation's busiest and among its oldest light rail networks.

- 66 stations,
- 22 track miles,
- 205 cars
- nearly 250,000 weekday passengers

Outbound at Fenway

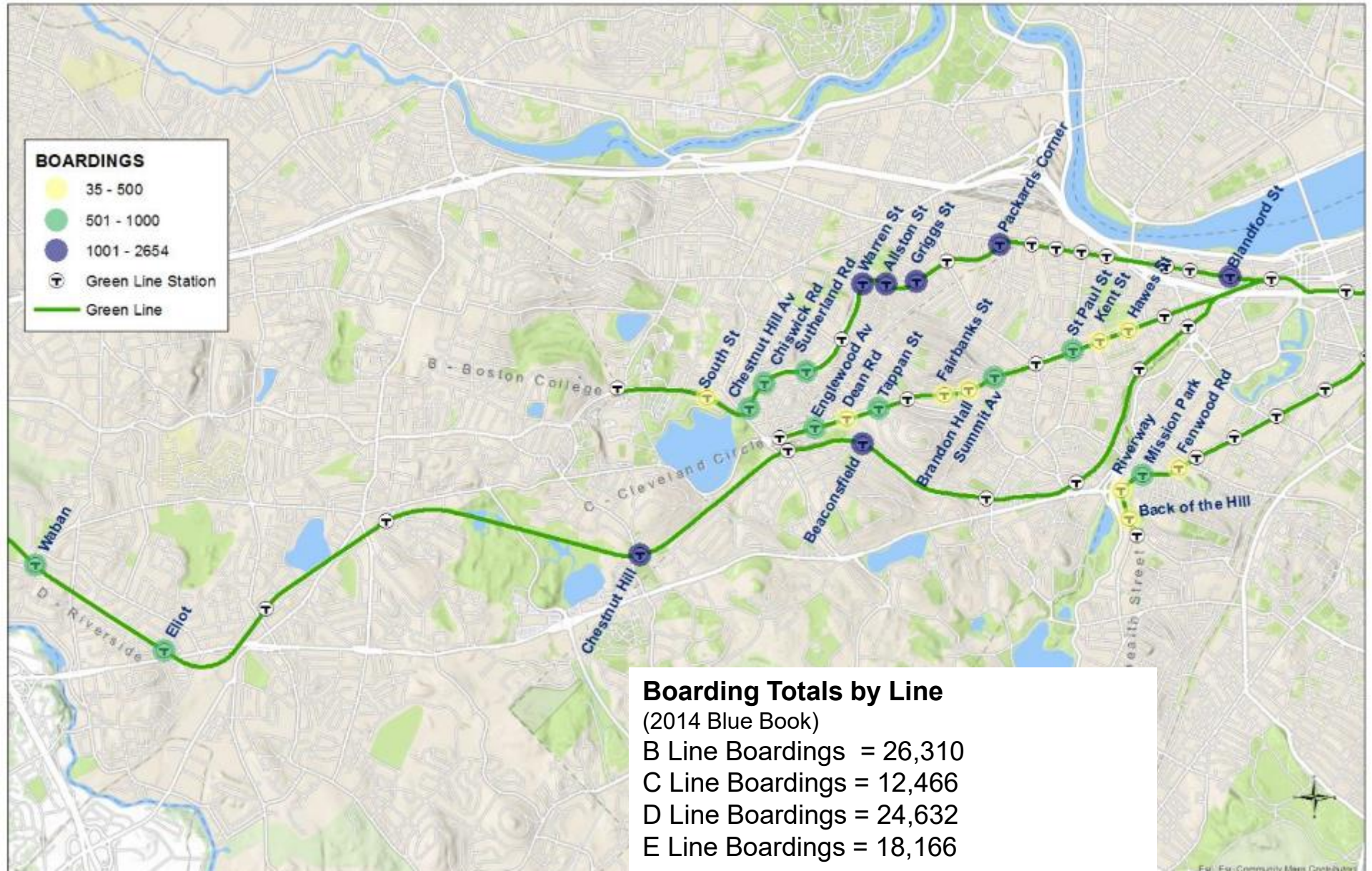
Background

- Some segments opened in 1856
- Portions of the tunnel network are US' oldest subway.
- Most surface stations reflect a bygone era and do not fully meet expectations for a modern transit service



Reservoir circa 1900

26 of 53 Green Line Surface Stations



Boarding Totals by Line
(2014 Blue Book)
B Line Boardings = 26,310
C Line Boardings = 12,466
D Line Boardings = 24,632
E Line Boardings = 18,166

53 Green Line Surface Stations

- 35 on reservation in roadway median
- 14 on former commuter rail line
- 4 informal street car stops

Outbound at Kent Street

B Line – Boston College

Track and platforms in roadway median

Constrained right of way

Side Platforms
Staggered side platforms

Competition for limited road space:

- motorists,
- cyclists,
- pedestrians,
- parking

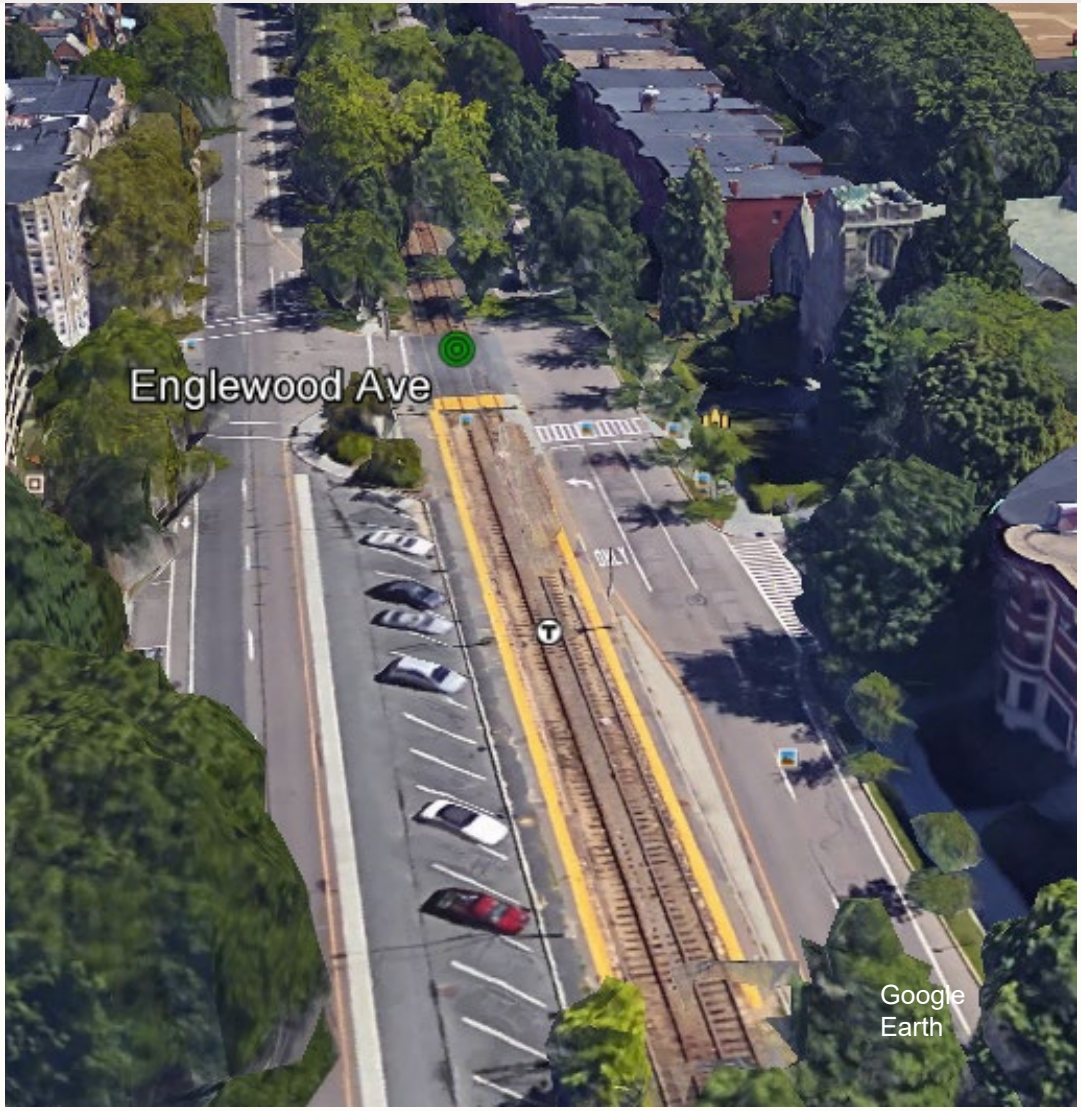
C Line – Cleveland Circle

Less constrained width

Tracks and platforms in the median

Parking competes for platform width

- Side platforms
- Near side staggered platforms



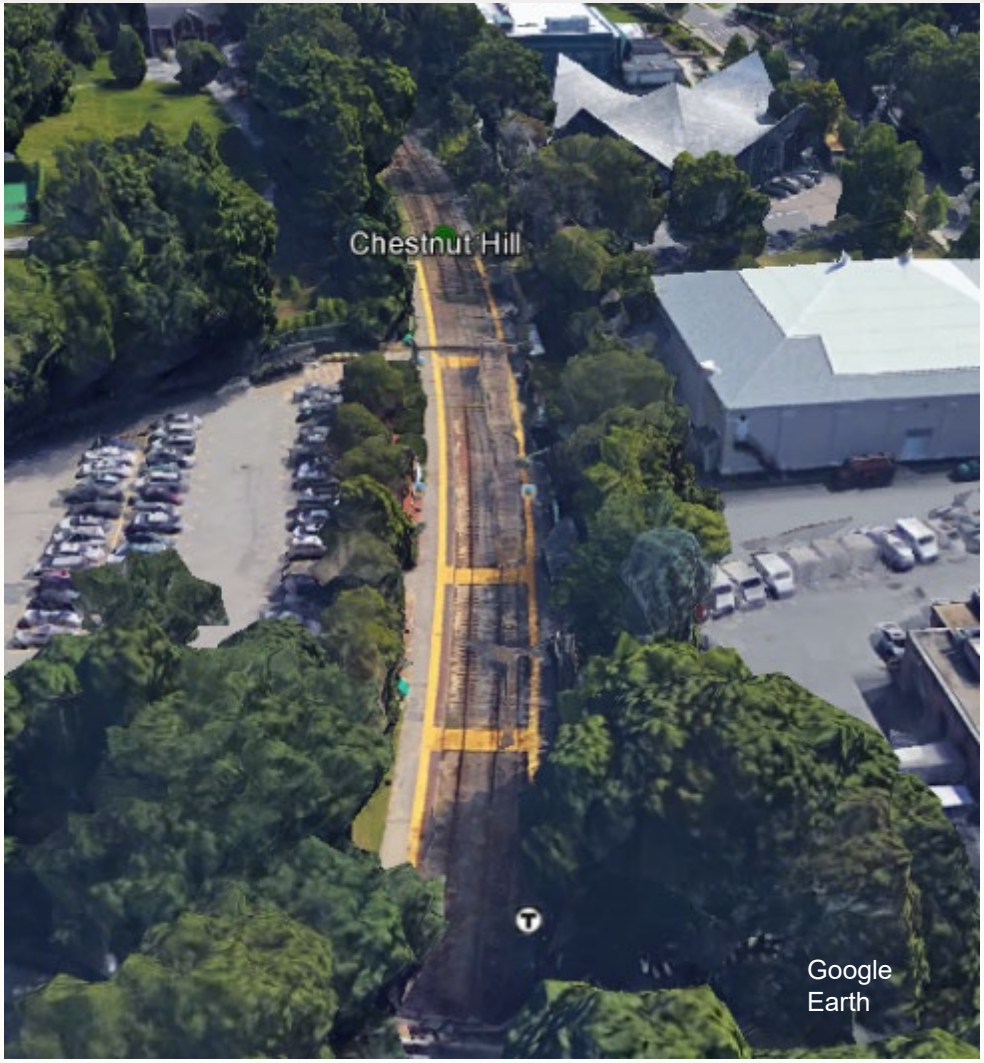
D Line – Riverside

Dedicated right of way

No parallel roadways

Less constrained right of way

Side platforms



E Line – Heath

Tracks in the roadway

Shared space with motor vehicles

No platforms

Fierce competition for limited road space:

- motorists,
- cyclists,
- pedestrians,
- parking

Project Objectives

Develop conceptual designs to upgrade 26 stations that had gone decades without upgrade or significant rehabilitation.

Meet all modern standards related to

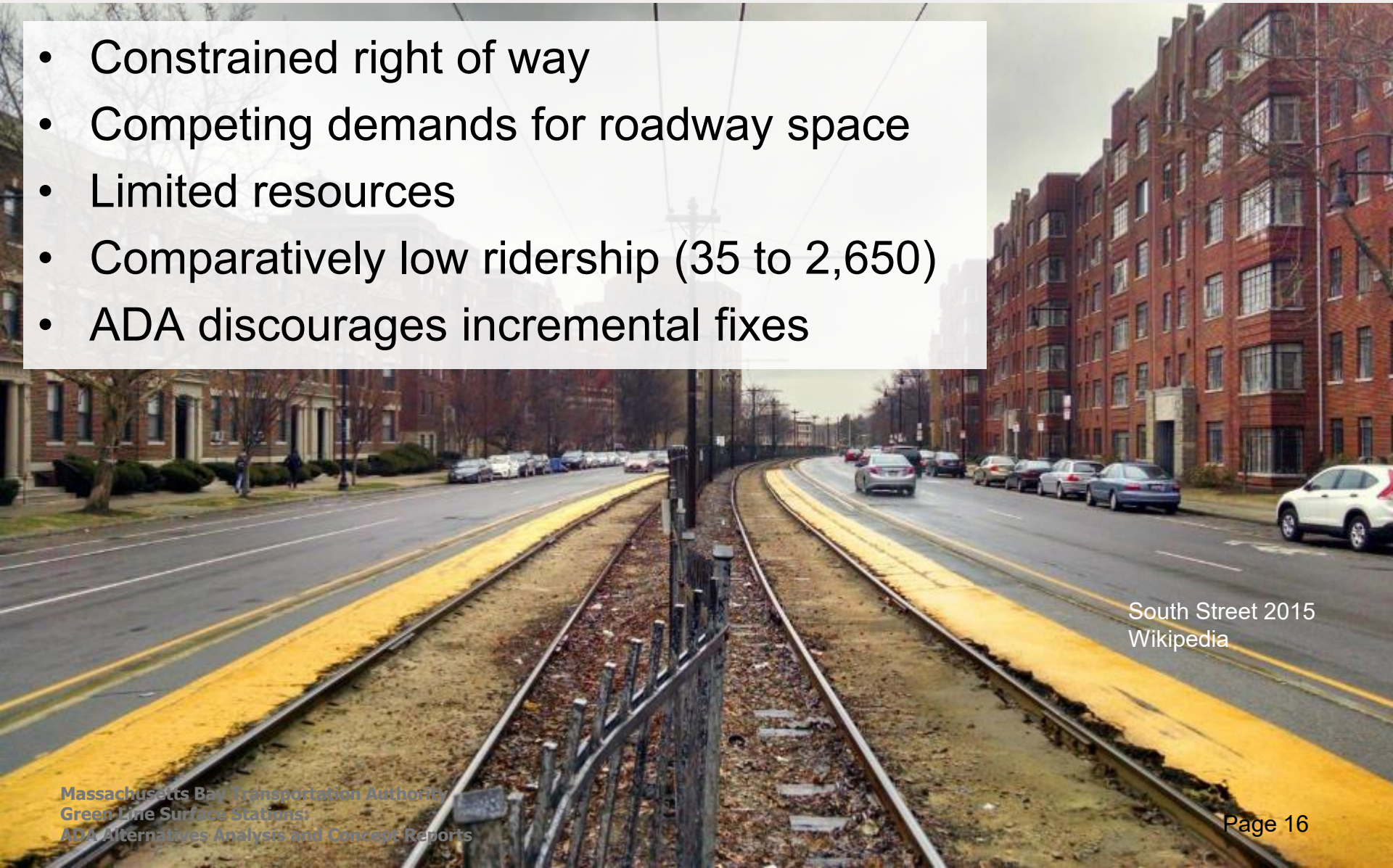
- accessibility,
- emergency egress,
- passenger comfort and convenience

Minimize:

- costs for required upgrades
- impacts on adjacent transportation services
  - roadways, parking, sidewalks and bike lanes

Why so long to upgrade?

- Constrained right of way
- Competing demands for roadway space
- Limited resources
- Comparatively low ridership (35 to 2,650)
- ADA discourages incremental fixes



South Street 2015
Wikipedia

Topics

- Background and Objectives
- **Comprehensive Design Criteria**
- Evaluation of Existing Conditions
- Design and Evaluation of Upgrade Options

Key Design Considerations

- Accessibility Standards
- Emergency Egress
- Mobile Lifts
- Platform Height
- Level Boarding and Track Geometry
- Other Mobility Concerns

Inbound at Saint Paul

Accessibility Standards

Transit Platforms

- 60” of platform width meets minimum code requirements
- 96” preferred for modern motorized mobility devices

Walkways

- 48” width specified by code with 36” minimum allowed when passing obstructions
  - Significant obstructions on Green Line walkways and platforms.
  - Utility and catenary poles,
  - Signal cabinets and fare collection equipment
  - Stored mobile lifts
  - Sand boxes and trash receptacles
  - Benches and canopies

Emergency Platform Egress

Building codes for emergency egress call for platforms that are wider than mandated by accessibility considerations
Standards use concept of "*effective width*" to predict emergency egress capacity.

Effective platform width includes total platform depth minus:

- 18" for track-side edge of platform
- 12" back fence of platform (if any)
- Deductions for any fixed obstacles such as benches, fare vending equipment, lifts, catenary poles, stanchions, etc.

NFPA rate of emergency egress

- 2.08 passengers per minute per inch of effective width.
- Platform must be clear in 4 minutes or less

Emergency Platform Egress

Massachusetts building officials assume worst case egress load

- Structural Load (AW4) car berthed at platform plus passengers waiting for train
- Default Green Line standard = 835 passengers
  - 735 structural load passengers
  - 100 passengers waiting on platform
  - 835 total passengers requires 51” of effective width

Default minimum platform depth = 87”

- 51” effective width
- 18” for platform edge
- 12” for back fence
- 6” allowance for 18” bench against back fence
- **87” minimum platform depth (7’-3”)**

Emergency Exits & Walkways

- Building codes requires two exit paths at every platform
- Exits must be within 82 feet of each end of platform
- Exit paths must be 44” wide with a minimum width of 36” when passing obstructions
- Stored mobile lifts are a 38” obstruction
- Minimum walkway width next active track is 72” including 6” curb at track side
- Project recommendation of 96” is consistent with platform width recommendation.

- New exit paths and walkways are required at nearly all study stations.

Mobile Lifts

- Mobile lifts will be required at all surface stations until the oldest Green Line cars are retired and platforms are raised

- The lifts pose a 38” access and egress constraint on platform and walkway design that will be eventually relieved

Inbound at Blandford Street

Platform Height

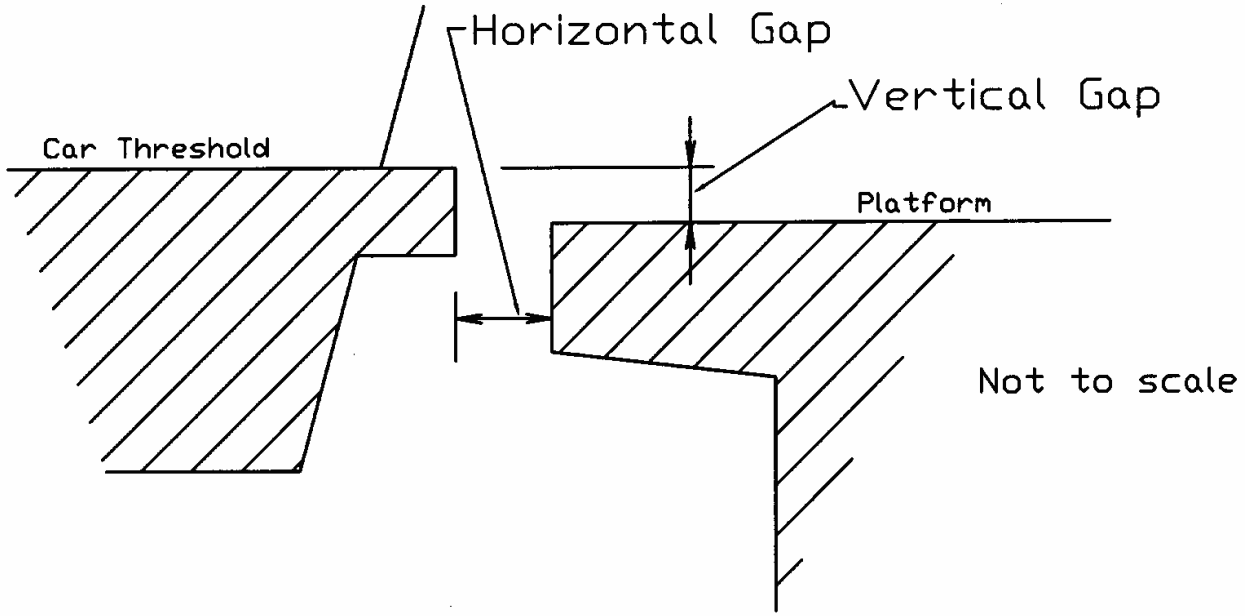
- MBTA currently calls for 8” above top of rail (TOR)
  - At this height, the motorized bridge plates on the Type 8 cars can load passengers with wheeled devices up to 14” high car floor.
- When the entire existing fleet is retired and replaced the MBTA intends to raise platforms to 14” above TOR
  - At this height, no bridge plates will be required and true “level boarding” will be achieved.
- All the study station platforms are currently at or below TOR

Inbound at Englewood

State and Federal Level Boarding Policy

All new passenger rail stations must be designed to offer level boarding with

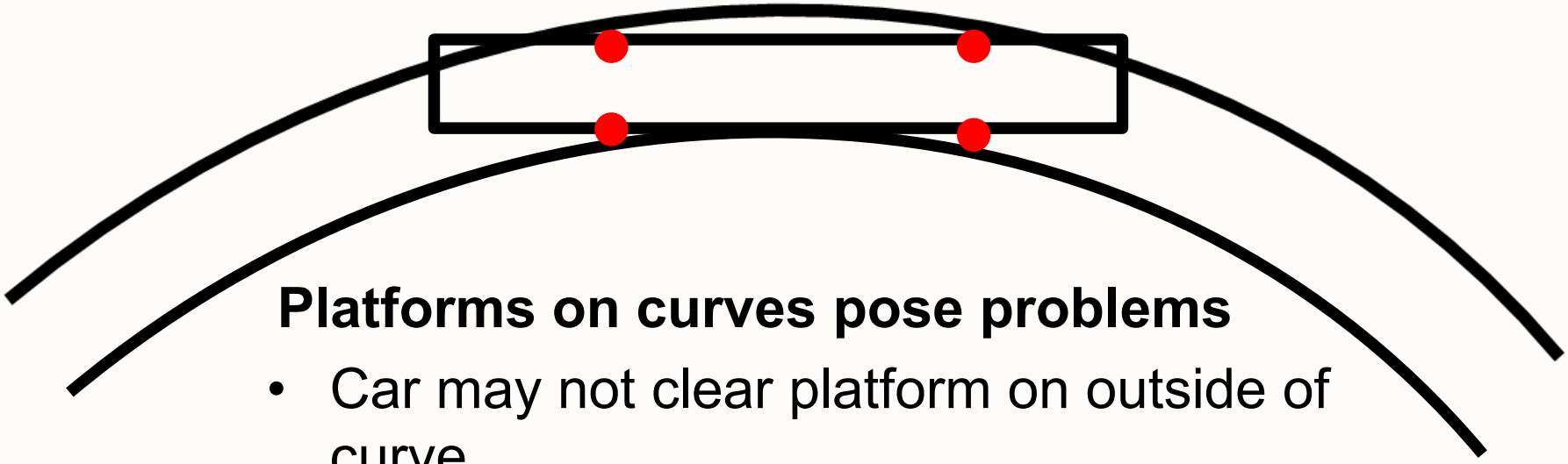
- <=3” horizontal gap between the platform and the vehicle entrance
- <=5/8” vertical gap between the platform and the vehicle entrance



Level Boarding &Track Geometry

- Present Green Line cars
  - Ride at least 6 inches above station platform
  - Doors open outward over the station platform
  - Station platforms on curves are not a problem
  - Outward opening doors are not a problem
- With level boarding
  - Side of the car must match within 3” of the platform
    - otherwise bridge plates will be required
  - Open doors must clear the platform.

Straight cars don't fit on curved platforms.



Platforms on curves pose problems

- Car may not clear platform on outside of curve
- Gap between car and platform may be unacceptably large

Preliminary analysis indicates platforms of <1000' radius are not compatible with Green Line level boarding

Other Mobility Concerns: Platforms

- 225’ long platforms to berth a 3-car train
- Slopes of platforms and walkways much be meet ADA standards
- Roadway crossings must meet ADA safety standards
- Furniture
  - Sited to avoid interfering with door loading zones.
  - One bench every 200 feet on each platform
  - 150’ linear feet of canopy on each platform
  - Sited to avoid interfering with door loading zones.
  - Sizes and locations of trash receptacles, sand boxes and fare vending equipment must be thoughtfully specified on narrow platforms

Information Concerns

- Passenger information must comply with ADA and Universal Design principles
- Must meet MBTA Wayfinding and Information Standards
- Variable message signs (VMS) must be unambiguous with respect to which train is reported on each sign and legible in bright sunlight.
- Audio messages corresponding to the VMS announcements required for visually impaired.

Topics

- Background and Objectives
- Comprehensive Design Criteria
- **Evaluation of Existing Conditions**
- Design and Evaluation of Upgrade Options

Principal Deficiency & Challenge

Inbound at Kent Street

Insufficient Platform Width

- Only 4 of 36 platforms at median stations have sufficient width to construct a compliant platform

Principal Deficiency & Challenge

Added width required from adjacent transport uses of right of way

- Parking
- Shoulders
- Travel Lane Widths

Other Deficiencies & Challenges

Track Curvature

- Four of 26 stations on restrictive curves

Platform Length

- 27 of 44 platforms are substandard length

Egress

- 16 of 22 stations are inappropriately configured

Cross Slope

- 11 of 44 platforms with excessive cross slope

Street Running

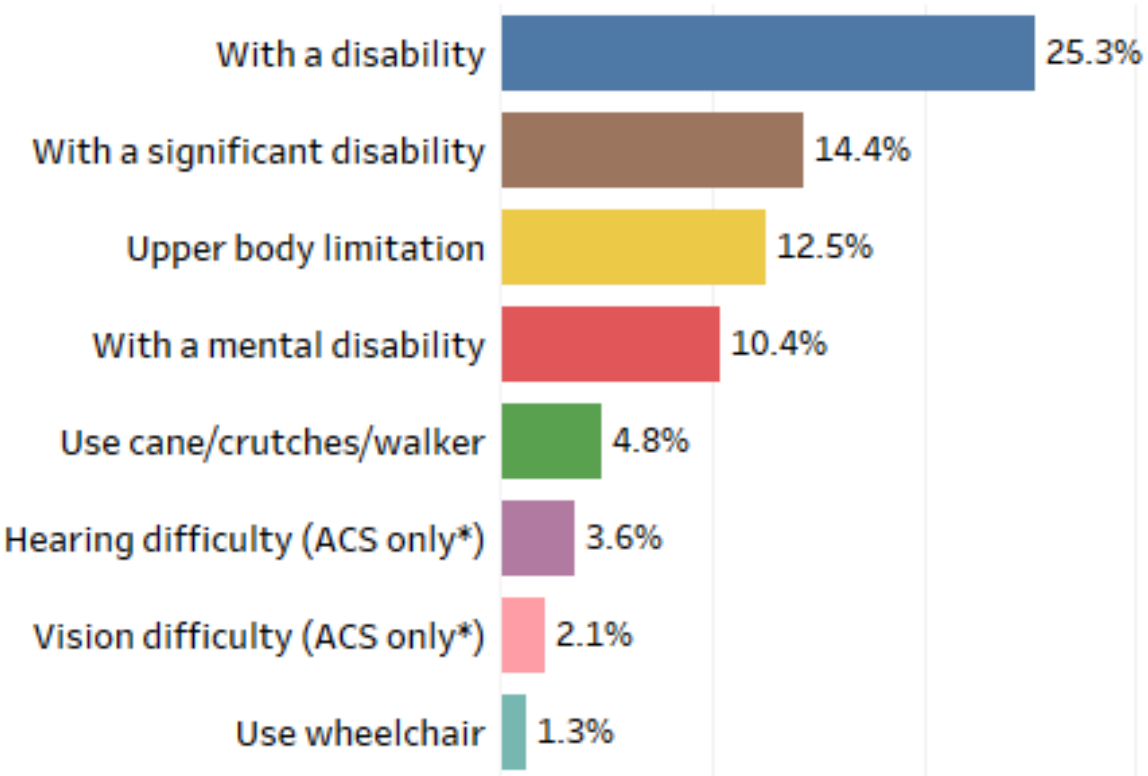
- Four stations with no formal boarding platform.

Street Running

Inbound at
Mission Park

Boarding a train in the middle of road is challenging for everyone

Universal Design
Adults with Disabilities in the MBTA Service Area



Team visited each station with a mix of people with disabilities to generate insight concerning their experience.

Data Sources: U.S. Census Bureau, 2010-2014 American Community Survey and 2008 Survey of Income and Program Participation, Modeled Estimates
Researcher: Matthew Brault, former US Census Bureau lead analyst on disability. Under contract with IHCD
* Data Source: 2010-2014 American Community Survey only

Institute for Human Centered Design

Physical Environment

- Track crossings are commonly hazardous; advise standardizing the use of rubber flangeway fillers that are in use in many stops/stations now but it should be standardized for all of these stations.
- Ensure that each track crossing have detectable warnings on both sides, not currently in place in any of these Green Line crossings.

- Ensure that any platforms, currently without a physical separation from traffic, has at least a railing for safety.

Institute for Human Centered Design

Information Environment

- Improving safety at each of these stops/stations should include visual and auditory alerts about approaching Green Line cars.
- Ensure at a minimum signs with the name of the station and destination signs in both directions.
- Ensure the basic T logo street sign (also referred to as the “T Lollipop”) is provided at all stations.
- Provide Green Line and system maps, maps of the local area including a “you are here” indication.

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Communication Environment

- Consider Rectangular Rapid Flash Beacons (RRFB) for mid-block crossings that are activated by the pedestrian.
- For staggered platforms without signalized crossings between them, consider adding signalized high visibility (ladder-style) crosswalks
- Establish a clear visual and tactile MBTA communication about where to board

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Policy Environment

- Standardize street car policy about opening doors on low-floor cars;
- consider the red STOP panels being placed on those low-floor car doors

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Topics

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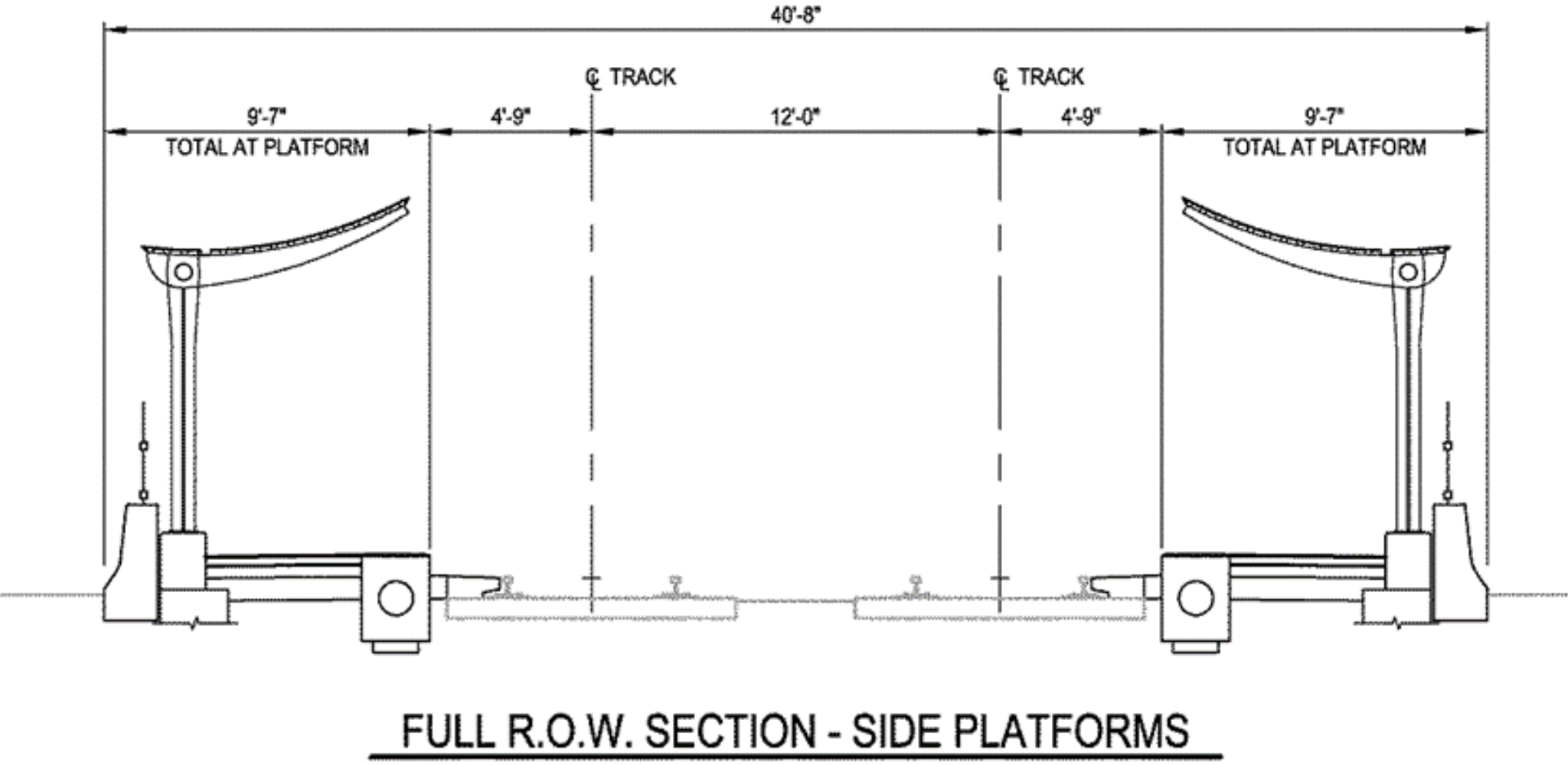
Three prototypical station designs

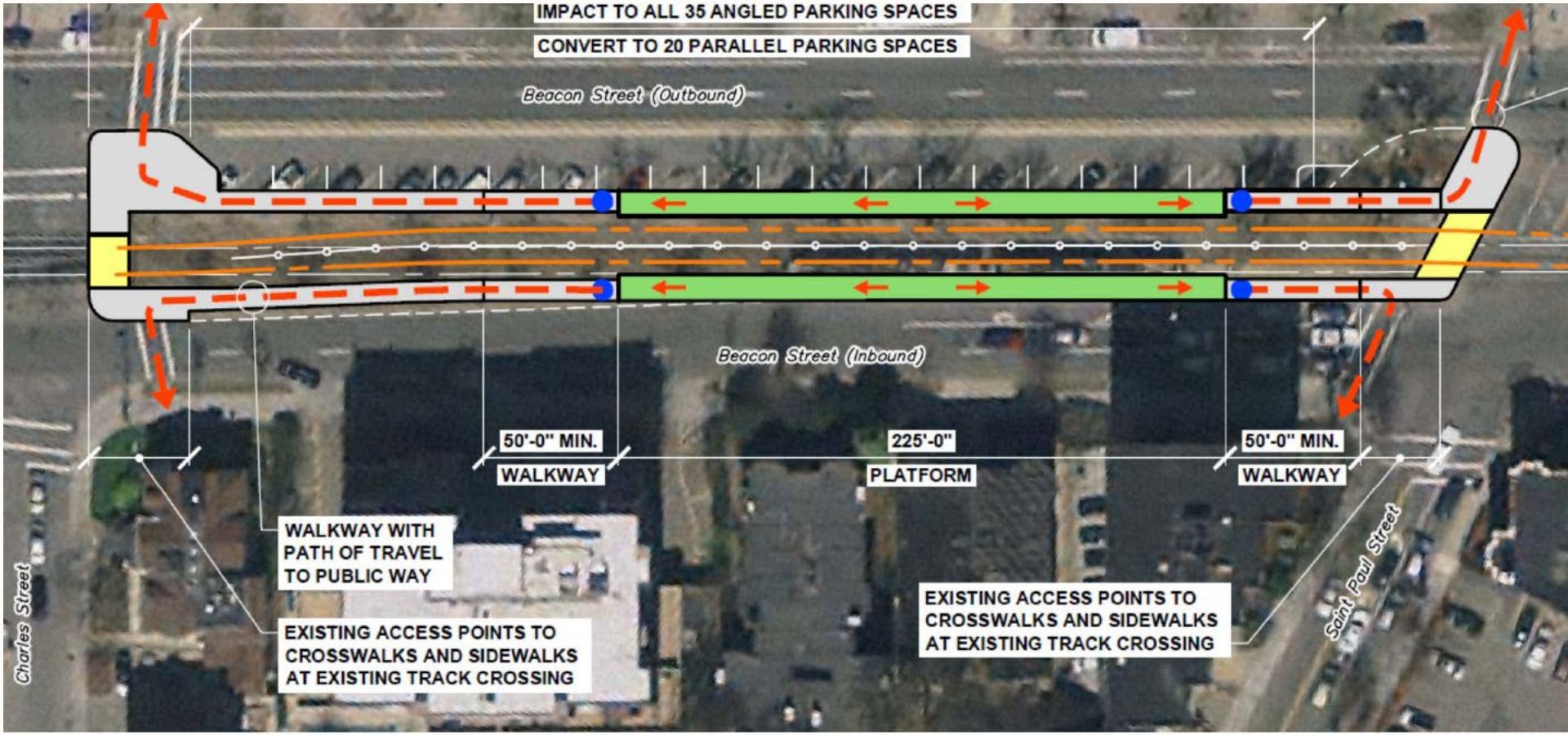
Design Category	Description	Minimum Cross Section
Side Platform	Two 8-foot side platforms on outside each track	**40’-8”**
Center Island Platform	One 12’-6” platform between two tracks	**36’-0”**
Staggered Platform	Side platform on outside of one track east of a roadway grade crossing. Side platform on outside of the other track west of the crossing	**33’-4”**

Side Platform
(40’- 8” minimum cross section)



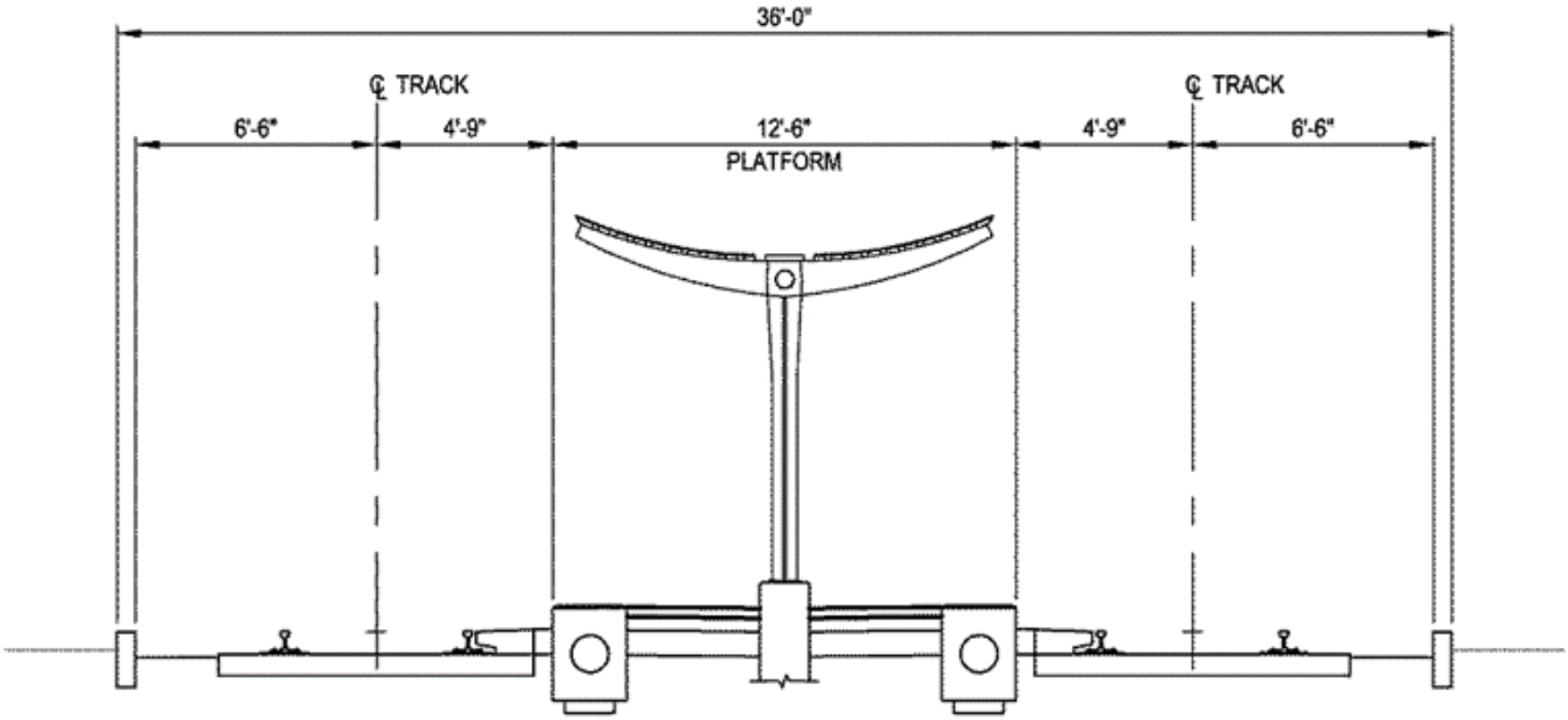
FULL R.O.W. SECTION - SIDE PLATFORMS

Side Platform
(40’- 8” minimum cross section)



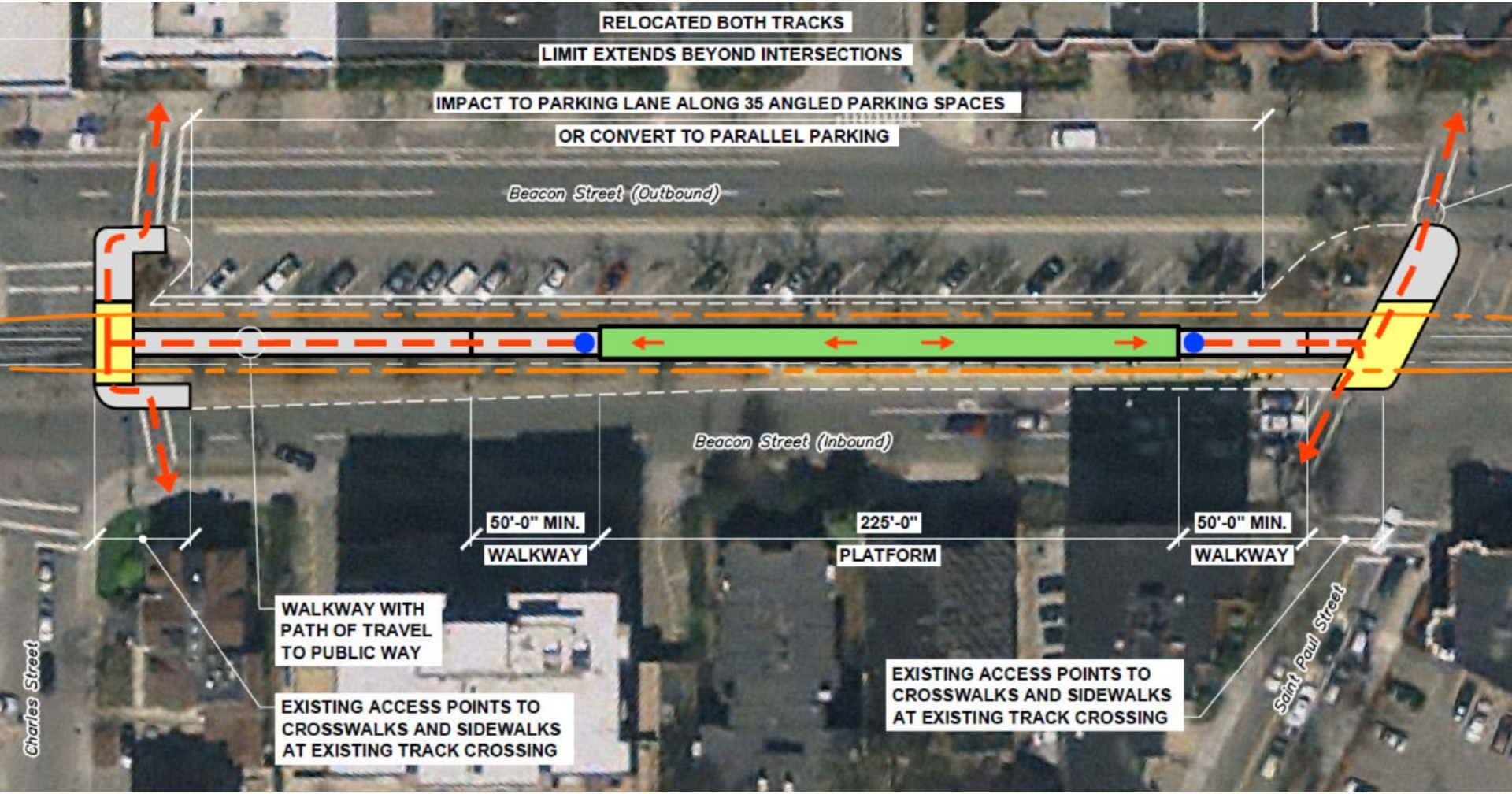
Side Platform Plan for Saint Paul Station on the C-Line

Center Island Platform
(36’- 0” minimum cross section)



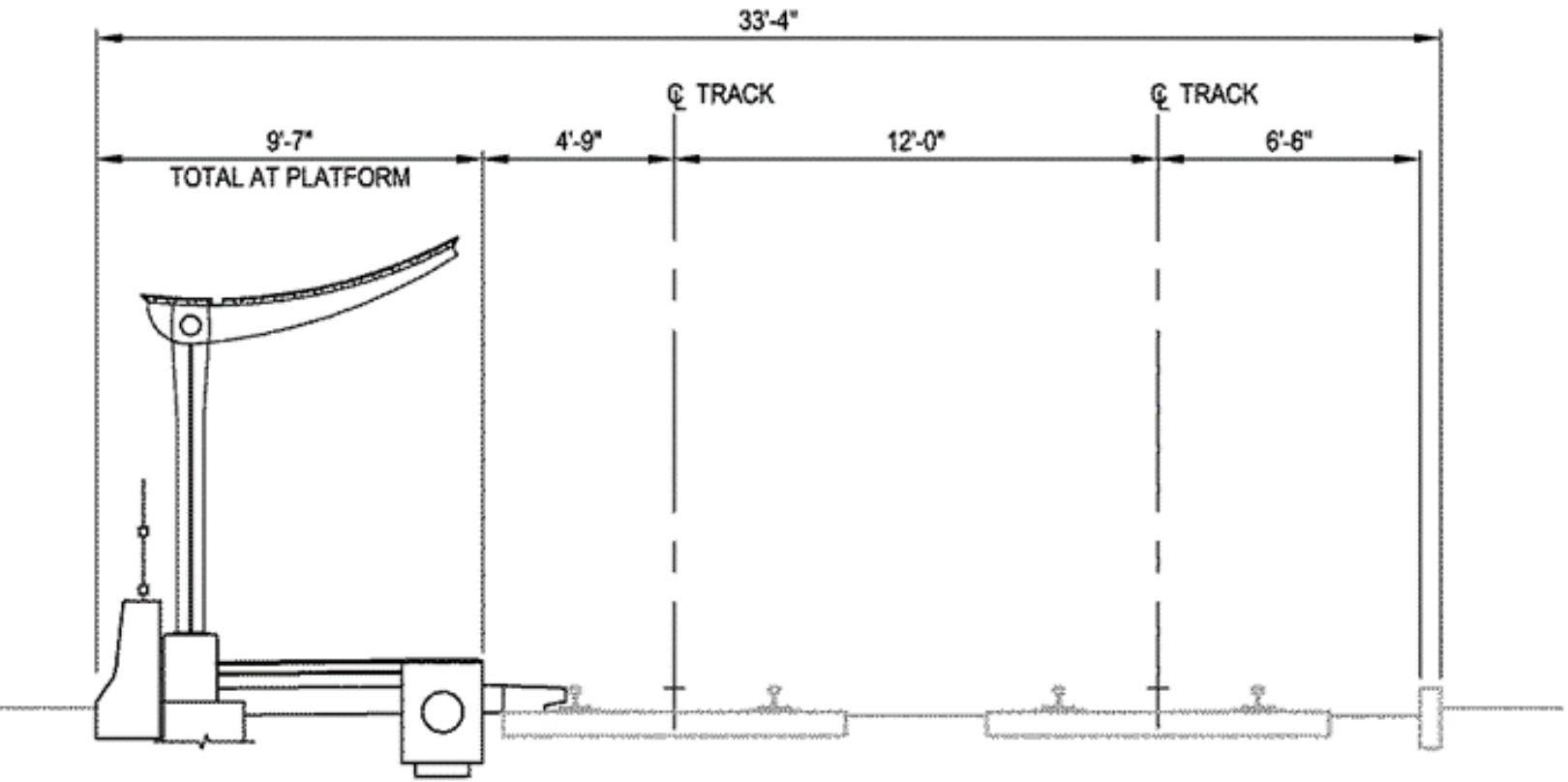
FULL R.O.W. SECTION - CENTER ISLAND PLATFORM

Center Island Platform
(36’- 0” minimum cross section)



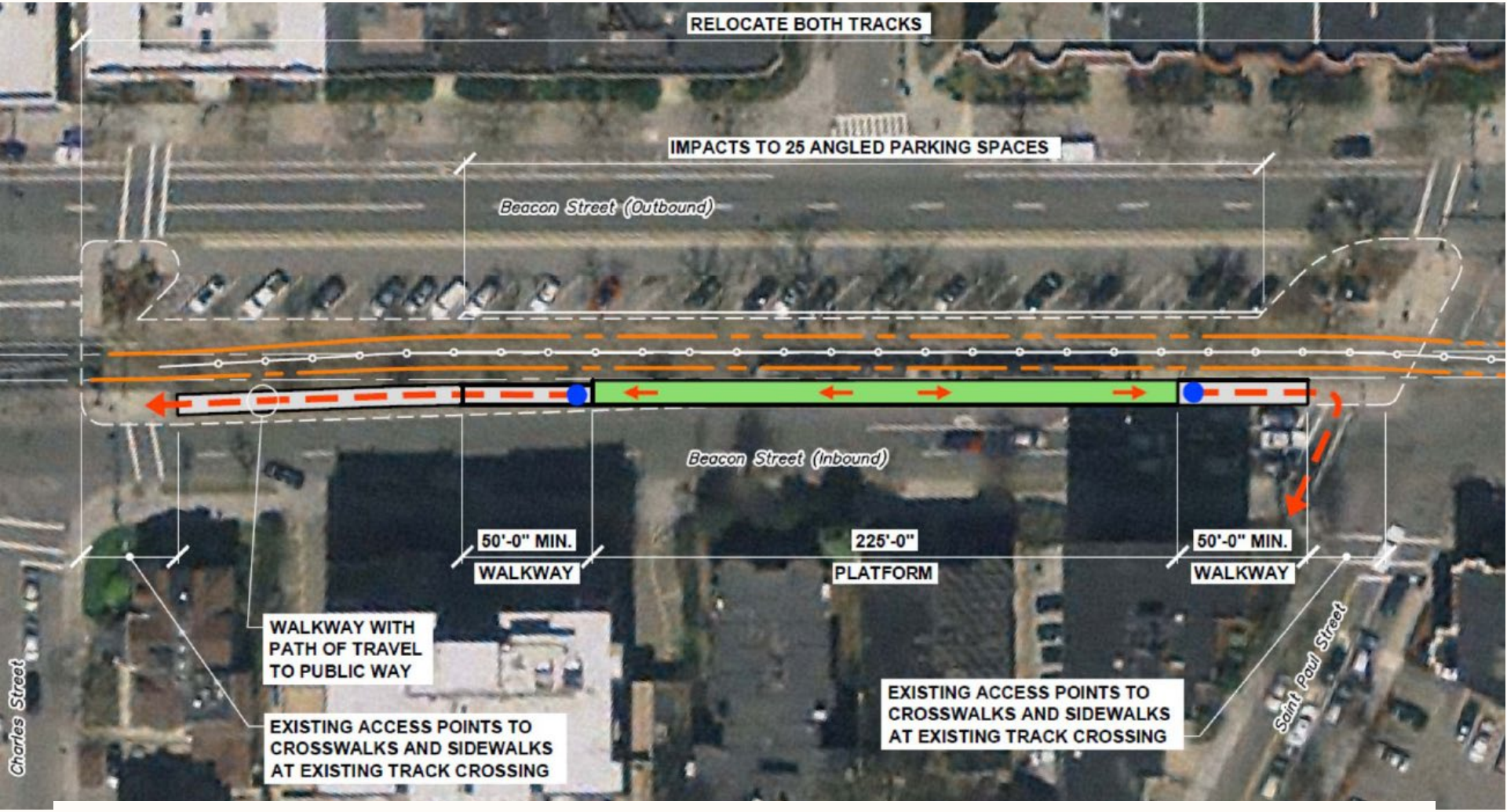
Center Island Platform Plan for Saint Paul Station on the C-Line

Staggered Platform
(33’- 4” minimum cross section)



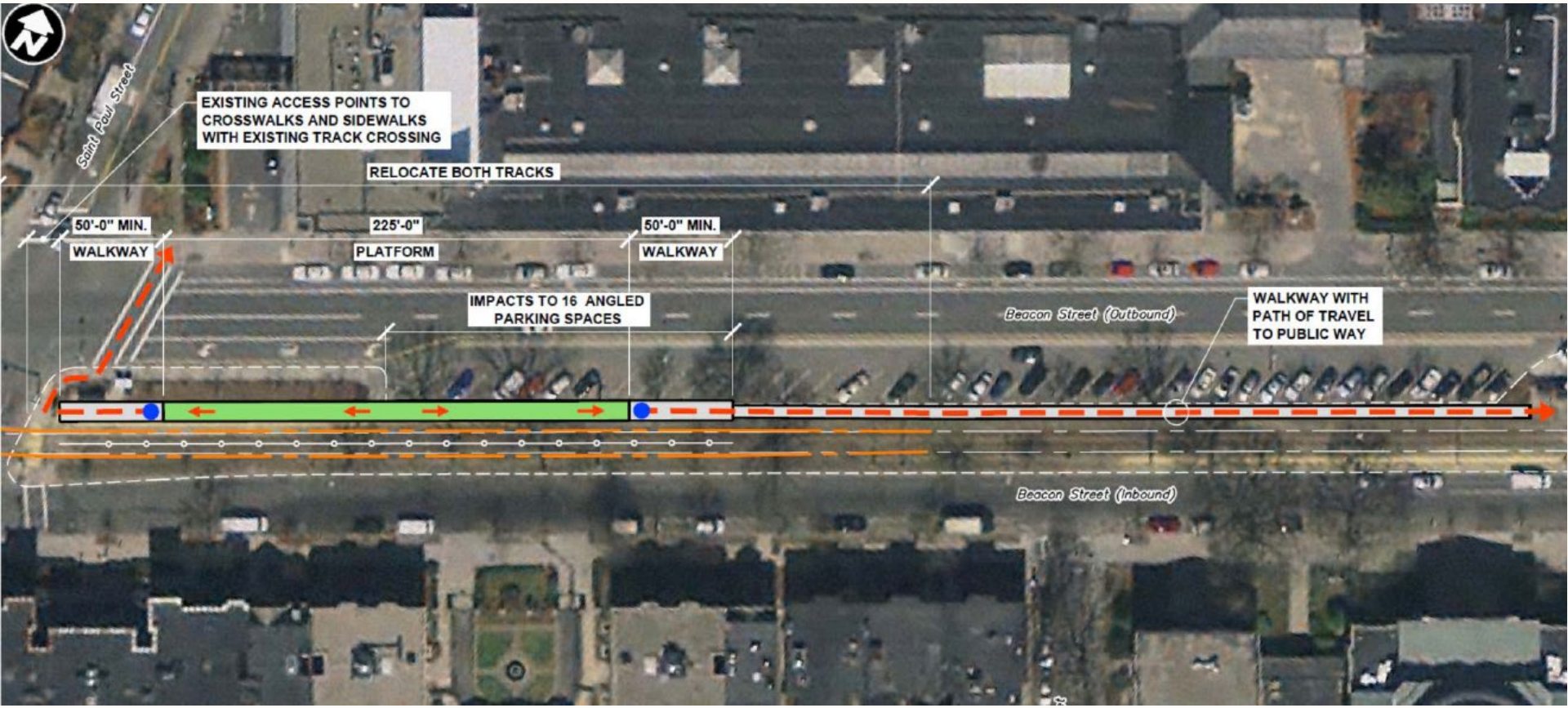
FULL R.O.W. SECTION - STAGGERED PLATFORMS

Staggered Platform
(33’- 4” minimum cross section)



Staggered Eastbound Platform Plan for Saint Paul Station on the C-Line

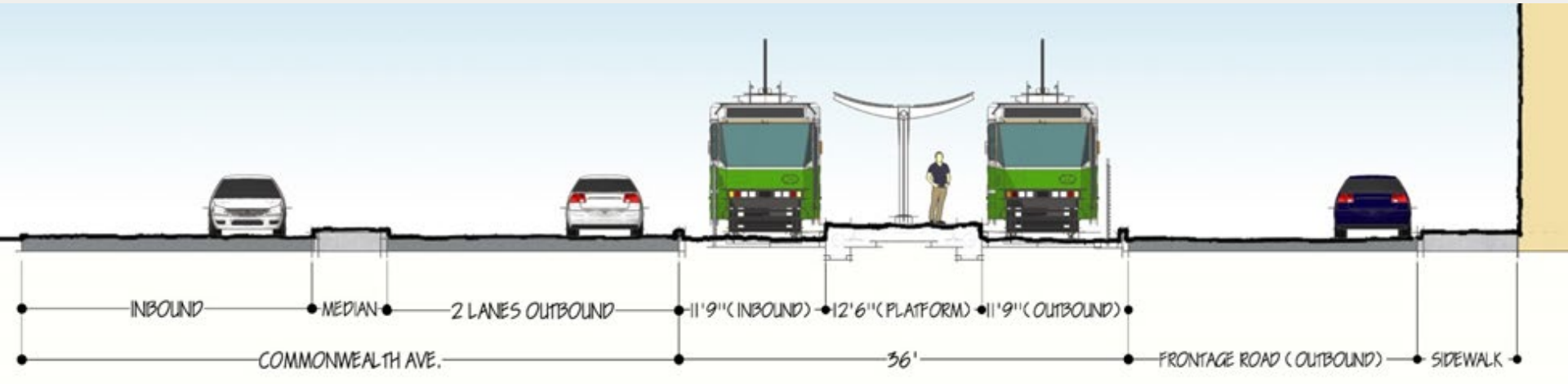
Staggered Platform
(33’- 4” minimum cross section)



Staggered Westbound Platform Plan for Saint Paul Station on the C-Line

Boston College: B-Line

(Commonwealth Avenue, Boston)



- Nine study stations
- Existing platforms average 5’-8” wide: 2’-5” minimum
- Most constrained median alignments
- Sandwiched between motor vehicle travel lanes.
- Center Island Platforms generally preferred
  - Least right of way from parking, shoulders and auto travel lanes
  - Lower costs than staggered platforms

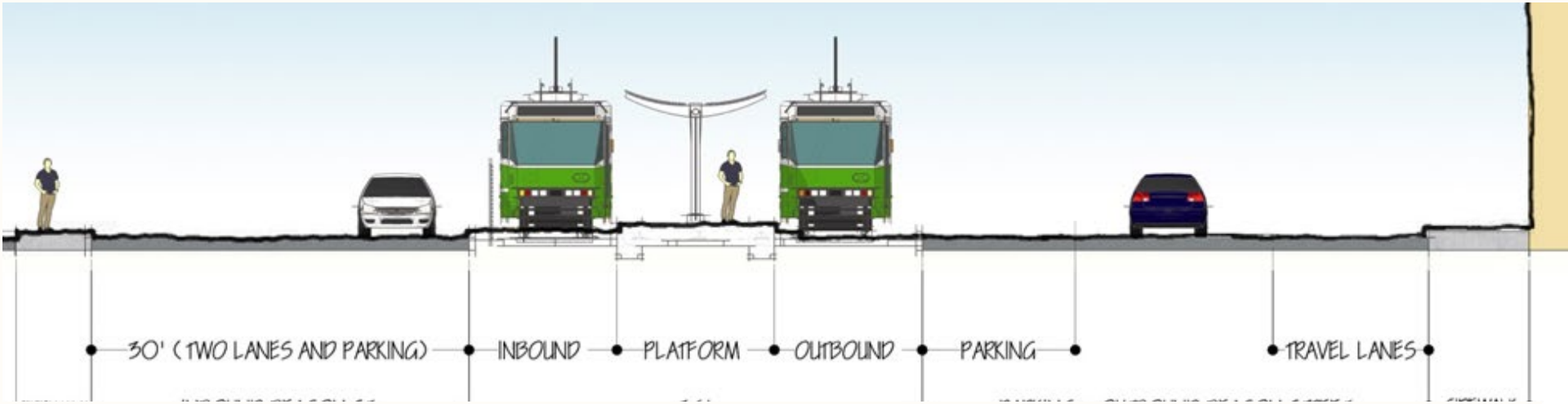
Boston College: B-Line

(Commonwealth Avenue, Boston)

Rendering of conceptual design for recommended center island platform: Allston Street Station on Commonwealth Avenue

Cleveland Circle Line: C-Line

(Beacon Street, Brookline)



- Nine study stations
- Existing platforms average 6’-6” wide: 4’-2” minimum
- Wider median reservation
- Angled parking generally shares median with railway
- Center Island Platforms generally preferred
  - Least right of way diverted from neighborhood parking
  - Lower costs than staggered platforms

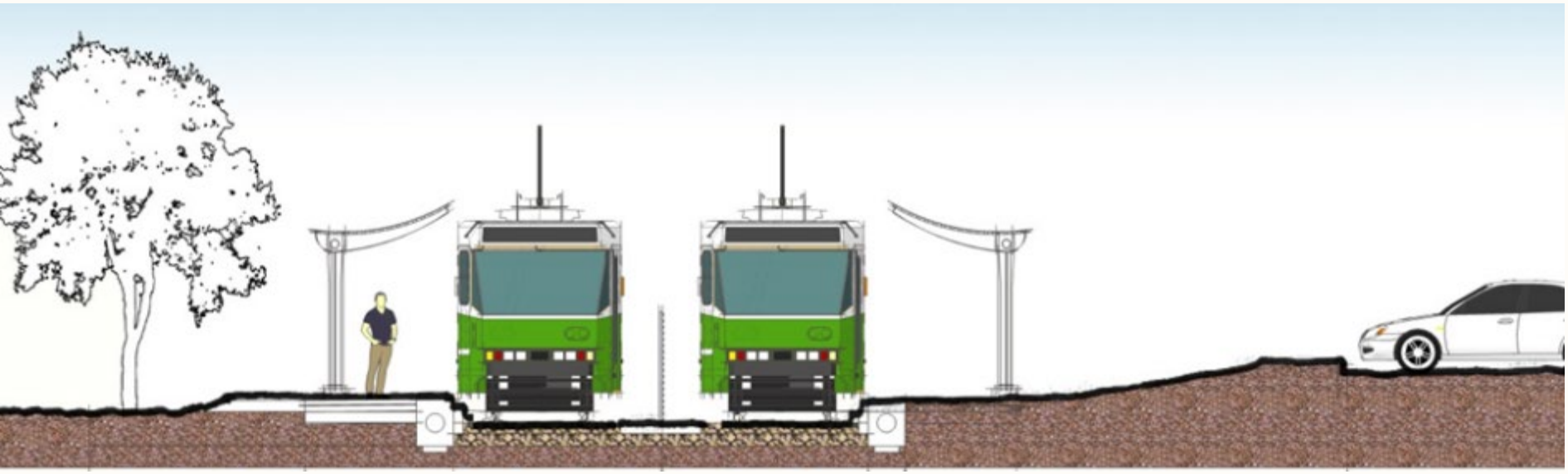
Cleveland Circle : C-Line

(Beacon Street, Brookline)

Rendering of conceptual design for recommended center island platform: Summit Avenue Station on Beacon Street

Riverside Line: D-Line

(Former Highland Branch of Boston and Albany Railroad)



- Four study stations
- Existing platforms average 8” wide: 7’-2” minimum
- Wide former commuter railroad right of way
- Does not share right of way with automobiles
- Side Platforms can be replaced at current locations
  - Least disruption to riders and neighborhood.

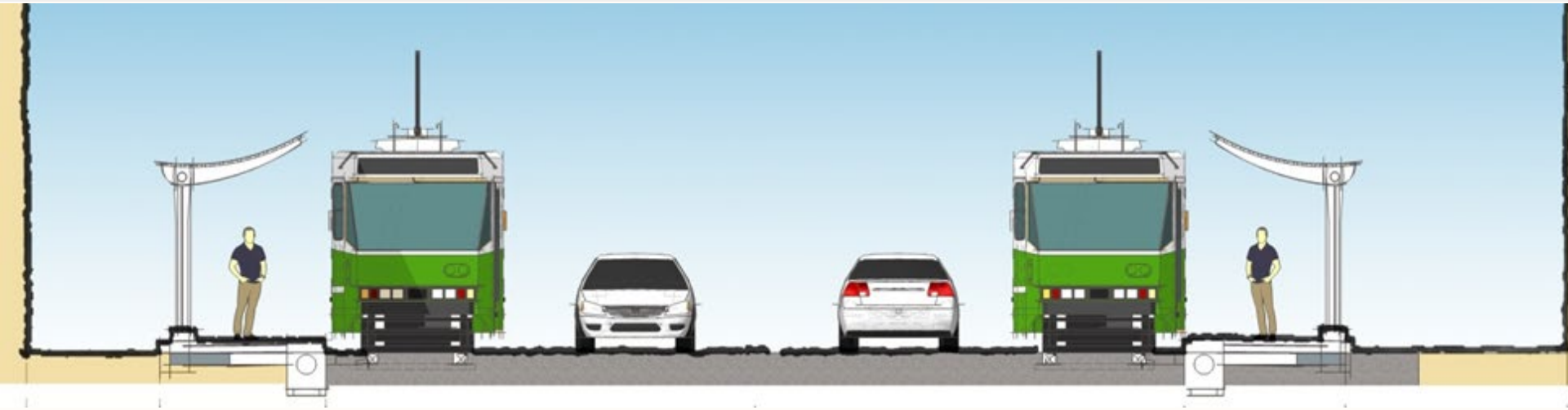
Riverside Line: D-Line

(Former Highland Branch of Boston and Albany Railroad)

Rendering of conceptual design for replacement side platforms: Chestnut Hill Station on Riverside Line

Heath Street Line: E-Line

(Huntington and South Huntington Avenues, Boston)



- Four study stations
- No formal station stops, passengers board in middle of the road
- Street running in 57’ to 60’ right of way shared with four travel and two parking lanes
- Recommend “sidewalk” platforms
  - Least impact on automobile capacity and on street parking
  - Reduced concerns for passenger safety

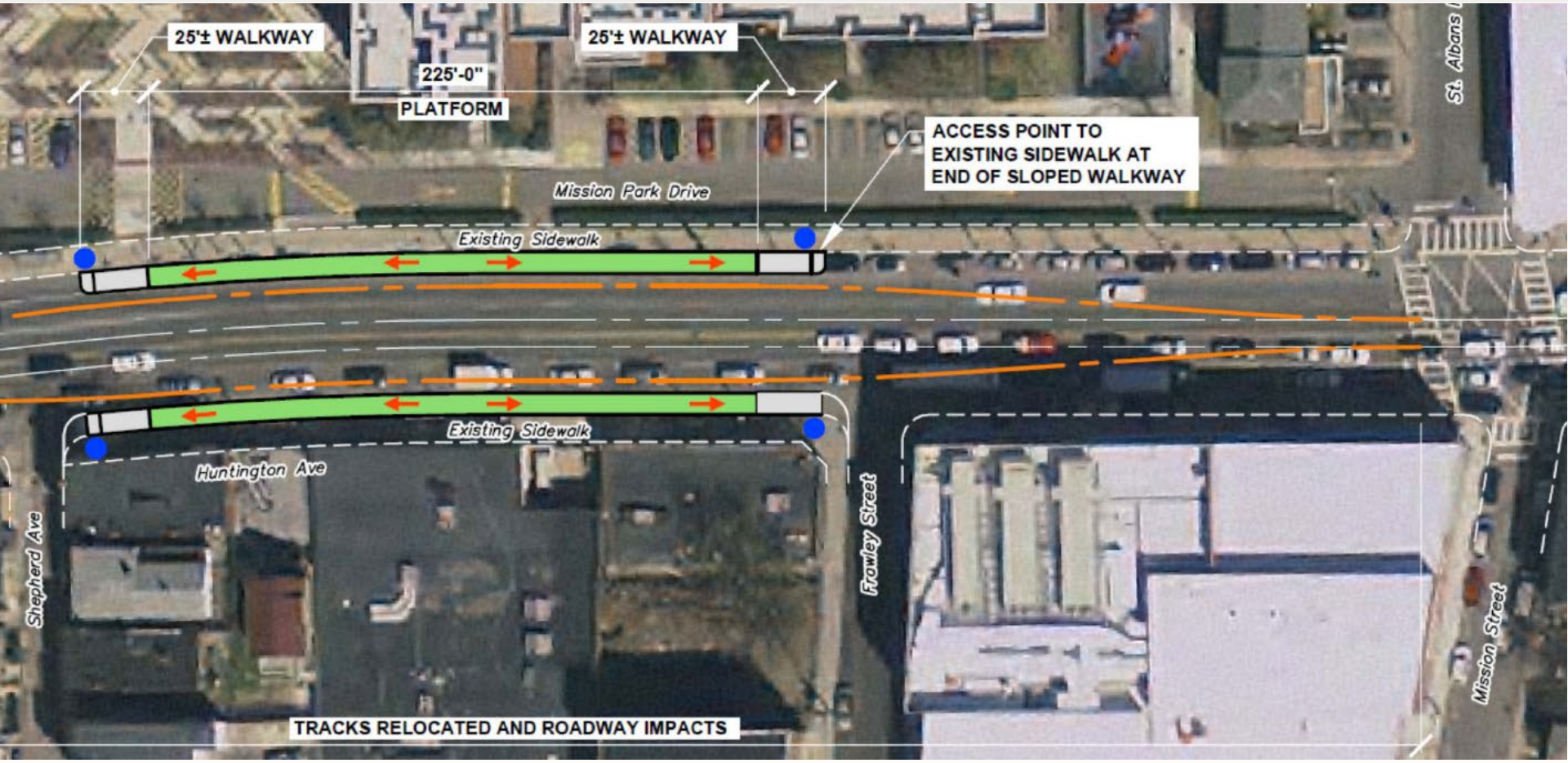
Heath Street: E-Line

(Huntington and South Huntington Avenues, Boston)

Rendering of conceptual design Huntington Ave: Mission Park Stop on the E Line

Heath Street: E-Line

("Sidewalk Platform" Design



Sidewalk Platform Design for Mission Park Stop on the E Line

47 Design Options

Table 5. Summary of Alternative Conceptual Designs

Line	Station	Curent Station Configuration	Conceptual Designs and Estimated Costs			
			Side Platforms	Center Island	Staggered Platforms	Sidewalk Platforms
B	**Blanford Street**	Short and narrow side platforms in median of Comm. Ave	**$4.4**			
B	**Packards Corner**	Side platforms between Comm. Ave and WB service road	$4.3	**$3.7**		
B	**Griggs Street**	Staggered platforms b/w Comm. Ave and WB service road	$4.3	**$3.8**	$5.4	
B	**Allston Street**	Staggered platforms b/w Comm. Ave and WB service road	$4.0	**$3.6**		
B	**Warren Street**	Staggered platforms in median of Comm, Ave	N/A			
B	**Sutherland Road**	Side platforms in median of Comm. Ave	$4.6	**$4.0**		
B	**Chiswick Road**	Side platforms in median of Comm. Ave	$5.0	**$4.4**		
B	**Chestnut Hill Ave**	Side platforms in median of Comm. Ave	N/A			
B	**South Street**	Side platforms in median of Comm. Ave	$5.2	**$4.0**		
C	**Hawes Street**	Side platforms in broad median of Beacon Street	$5.1	**$3.7**	$5.4	
C	**Kent Street**	Staggered platforms in broad median of Beacon Street	$5.3	**$3.9**	$5.8	
C	**Saint Paul Street**	Staggered platforms in broad median of Beacon Street	$5.6	**$4.4**	$6.1	
C	**Summit Avenue**	Side platforms in broad median of Beacon Street	$5.0	**$4.2**	$5.3	
C	**Brandon Hall**	Side platforms in broad parkway median of Beacon Street	$8.6	**$7.4**		
C	**Fairbanks Street**	Side platforms in broad parkway median of Beacon Street	$8.5	**$7.3**		
C	**Tappan Street**	Side platforms in broad median of Beacon Street	$5.3	**$3.9**	$5.7	
C	**Dean Road**	Staggered platforms in broad median of Beacon Street	$5.4	**$4.0**	$5.8	
C	**Englewood Avenue**	Side platforms in broad median of Beacon Street	$5.2	**$4.1**	$5.5	
D	**Beaconsfield**	Side platforms in former urban commuter rail ROW	**$4.1**			
D	**Chestnut Hill**	Side platforms in former suburban commuter rail ROW	**$4.2**			
D	**Eliot**	Side platforms in former suburban commuter rail ROW	**$4.0**			
D	**Waban**	Side platforms in former suburban commuter rail ROW	**$4.2**			
E	**Fenwood Road**	Street car stop in middle road: 4 travel and 2 parking lanes	N/A			
E	**Mission Park**	Street car stop in middle road: 4 travel and 2 parking lanes		$3.7	$4.8	**$4.7**
E	**Riverway**	Street car stop in middle road: 4 travel and 2 parking lanes				**$5.0**
E	**Back of the Hill**	Street car stop in middle road: 4 travel and 2 parking lanes				**$4.2**

47 Total Designs for 23 Stations

Design Category	Conceptual Designs Prepared	Average Forecast Cost (Millions)	Minimum	Maximum
Side Platform	20	$5.1	$4.0	$8.6
Center Island Platform	16	$4.4	$3.6	$7.4
Staggered Platform	9	$5.5	$4.8	$6.1
Sidewalk Platform	3	$4.6	$4.2	$5.0

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