benning road streetcar extension

feasibility study

appendices

April 2013

District Department of Transportation

Table of Contents

Appendix A:

Previous Studies

Benning Road Streetcar Extension Feasibility Study – Previous Studies

There are several background projects and studies in the area related to the Benning Road Streetcar Extension Feasibility Study. These are discussed briefly below:

Far Northeast Livability Study (DDOT, study ongoing)
The study has found that many intersections and roadways in the Far Northeast portion of the District of Columbia, including East Capitol Street, Benning Road and Sheriff Road, have been designed primarily to accommodate vehicular commuter traffic. Wide roadways with long green-phase signals encourage speeding, provide few pedestrian crossings, and discourage pedestrian use of marked crossing locations and control devices. Initial recommendations along the Benning Road Streetcar Extension corridor include:

- Full signal and crosswalks of Benning Road at the Benning Branch Library;
- Improvements at the intersection of East Capitol Street, Benning Road, Texas Avenue, and Central Avenue;
- Removal of the southbound left-turn movement at the Grant Street/Minnesota Avenue intersection;
- Provision of a southbound left-turn phase at the Minnesota Avenue/Benning Road intersection; and
- Pedestrian accommodation enhancements along 42^{nd} Street and 44^{th} Street.

East Capitol Street Pedestrian Safety Corridor Study (DDOT, study ongoing)
This study focuses on improving safety for pedestrians, bicyclists, motorists and transit users along East Capitol Street. The study combines community input with traffic condition analyses and field survey to generate and evaluate safety improvements and design alternatives for East Capitol Street. One of the areas under review is the East Capitol Street and Benning Road intersection.

Minnesota Avenue SE Great Streets Framework Plan (DDOT, 2005)
The plan identifies the Minnesota Avenue/Benning Road intersection area as a key mixed-use activity center. Several developments are planned at this location. The *Far Northeast Livability Study* refers to the Minnesota Avenue Great Streets Plan, which proposed realignment of the intersection approaches to eliminate the current skewed intersection angle, reconstruct all curbs to provide shorter turning radii, expand pedestrian refuge medians on the Benning Road approaches, eliminate the westbound left-turning movement, consolidate driveways near the intersection, and relocate the existing bus stops. DDOT is currently undertaking a design study that will produce engineering drawings for the corridor following the recommendations of the Great Streets Plan.

H Street NE/Benning Road Great Streets Framework Plan (DDOT, 2006)
This study covers the H Street NE/Benning Road corridor from North Capitol Street to Southern Avenue SE. The plan recommends landscape treatments, such as new sidewalks, medians, curb and gutter realignments, public art, pedestrian-scaled lighting, and street trees along the corridor. It also identified major reconstruction of Benning Road from Minnesota Avenue to 42^{nd} Street NE, which has recently been completed and open to public use. The pedestrian facilities on the bridge over Kenilworth Avenue were recommended to be improved as part of the Kenilworth Avenue Corridor Study.

Deanwood/Great Streets – Nannie Helen Burroughs Ave and Minnesota Ave NE Strategic Development Plan (DCOP, 2008)
Similar to the *Minnesota Avenue Great Streets Plan*, the *Strategic Development Plan* identifies the Minnesota Avenue/Benning Road intersection area as a key mixed-use activity center and includes

concept sketches of new commercial and residential development at the intersection and extending to the Minnesota Avenue Metrorail station.

Minnesota Avenue Metrorail Station Access Improvement Study (WMATA, 2006)
WMATA conducted the study to assess multimodal access to the Minnesota Avenue Metrorail station within the context of new developments along Minnesota Avenue, increased transit ridership, and increased vehicular traffic on area roadways. The study examined future streetcar service to the station along Minnesota Avenue; stops at the station would be located on-street, rather than within the station site. The study also examined using the northern portion of the Kiss & Ride facility as an off-street streetcar crossover track.

X1, X2, X3 Metrobus Benning Road-H Street Line Study (WMATA, 2010)
This study was undertaken by WMATA as part of its ongoing Priority Corridor Network (PCN) studies. The PCN is comprised of the highest ridership bus routes serving the most significant corridors of surface travel in the Washington metropolitan area. The PCN studies examine each corridor individually and propose strategies to increase the efficiency and effectiveness of the services along those corridors, primarily by reducing travel time while increasing ridership.

For the study of the Benning Road-H Street Line, Metrobus Route X2 was carefully examined, as were the two services that comprise the Benning Road Line (i.e., Metrobus Routes X1 and X3). The study recommended a phased-in approach for the introduction of a new service – the MetroExtra Route X9 – which would provide limited stop service between central Washington and the Capitol Heights Metrorail station, thus enlarging the service area covered by the X-series of Metrobus routes. The new MetroExtra Route X9 was first implemented every 15 minutes during the weekday peak periods, and will eventually be followed by gradual increases in its span of service and improvements in the frequency of service. The study also recommended minor adjustments to Metrobus Route X2 and X1, and the consistent use of articulated buses on Metrobus Route X2. Finally, the study recommended that – due to the existence of other duplicative bus routes – Metrobus Route X3 be eliminated. However, WMATA did not eliminate this bus route, preferring to wait until the proposed MetroExtra Route 99 (proposed in another PCN study) is implemented so that it could then re-evaluate this recommendation.

Kenilworth Avenue Corridor Study (DDOT, 2007)
The study explored options for improving Kenilworth Avenue between Pennsylvania Avenue and Eastern Avenue to provide safer and more pedestrian friendly environment, create a more pleasing urban setting, and improve access for local neighborhoods. The study recommended roadway design and pedestrian safety improvements to the Benning Road and Kenilworth Avenue interchange.

Appendix B:

Public Meeting Notes Summary

Public Involvement Summary

The project team conducted two public meetings throughout the alternatives development process in order to gain feedback on the proposed Benning Road Streetcar Extension alternatives. Brief summaries of those meetings are provided below. See the appendices for the full meeting summaries, all comments received from the public, and all of the public meeting materials.

Public Meeting #1 – September 2012

Public Meeting #1 for the Benning Road Extension Feasibility Study was held from 6:00 to 8:00 p.m. on Thursday, September 6, 2012 at the Department of Employment Services building at 4058 Minnesota Avenue NE in Washington, DC. Forty seven (47) members of the public attended the meeting. The purpose of this meeting was to provide an overview of the streetcar extension study to the public and to solicit input from community stakeholders.

The meeting began with a presentation followed by breakout sessions, wherein the members of public were divided into four groups. At the end of the breakout sessions, the project team reported comments and discussion from each breakout group. Overall, members of the public had the following considerations and input on the Benning Road Streetcar Extension Feasibility Study:

- Existing heavy traffic and complex roadway geometry on Benning Road at the Minnesota Ave and East Capitol Street intersections. This project should try to address these issues to make it easier for pedestrians to cross at these busy intersections.
- Look for streetcar expansion opportunities north to Deanwood Metro, east to Capital Heights Metro, and west of Union Station.
- Need to understand trade-offs between curb-side and median running alignments. Curb-side stations would be best for pedestrian safety/access, but would result in loss of on-street parking. Median running would provide opportunities for dedicated running ways.
- Timing of the construction of the streetcar project with other roadway projects in order to minimize the disruption to the neighborhood.
- Benning Road Metro Terminal option would provide for greater development opportunities for the corridor and would capture more riders.
- Integration of public art elements in the design of the project.
- Questions on how the streetcar operations and bus services will align.

Figure 1: Photos from Benning Road Extension Feasibility Study Public Meeting #1

Public Meeting #2 – November 2012

Public Meeting #2 for the Benning Road Extension Feasibility Study was held from 6:00 to 8:00 p.m. on Tuesday, November 27, 2012 at the Department of Employment Services building at 4058 Minnesota Avenue NE in Washington, DC. Forty seven (47) members of the public attended the meeting. The purpose of this meeting was to present the preliminary findings of the technical work that has been performed as well as present the constraints and opportunities of each alignment and stop location alternative.

The meeting began with a presentation followed by breakout sessions, wherein the members of public were divided into five groups. The discussions at each table were centered on specific areas of interest that the project team was interested in additional feedback from community members. These specific areas of interest include: parking impacts, traffic "hot spots", pedestrian safety, termini connections and connection/availability to current and future transit services in the neighborhood. At each of the five break-out groups, table maps were provided to help the group facilitators lead the discussion on the various series of options. At the end of the breakout sessions, the project team reported comments and discussion from each breakout group. Overall, members of the public had the following considerations and input on the Benning Road Streetcar Extension Feasibility Study:

- Consider both extension options to be advanced, not an either/or option.
- Loss of on-street parking could impact residential areas along the alignments. Need residential parking permits to limit non-residential parking in neighborhoods.
- Consider future extensions north to Deanwood Metro and east to Capitol Heights Metro.
- Combine construction of streetcar project with other reconstruction projects to minimize disruption to the neighborhood. Would like to see additional community benefits for having to go through another reconstruction (i.e. buried utility lines, FIOS)
- Prioritize pedestrian safety and access with streetcar alignment and stop location options. In general, curbside alignments/stop locations are better options for pedestrian access.

Figure 2: Photos from Benning Road Extension Feasibility Study Public Meeting #2

Attachment A:

Public Meeting #1 Press Release

Government of the District of Columbia

Department of Transportation

FOR IMMEDIATE RELEASE
August 27, 2012
Media Contact: Dara Ward, dara.ward@dc.gov 202-289-2001

*** PUBLIC MEETING NOTICE***

DDOT to Host Public Meeting for the Benning Road Streetcar Line Extension Feasibility Study

Community Stakeholders Are Encouraged to Attend and Provide Input on Streetcar Line Extension

(Washington, D.C.) The District Department of Transportation (DDOT) is hosting a public meeting on Thursday, September 6, to discuss a study it has initiated to explore the feasibility of extending the H Street/Benning Road streetcar line east of the Anacostia River, in northeast Washington, and solicit input from community stakeholders.

As part of the study, DDOT will look into how it may be able to link the H Street/Benning Road streetcar line to the Minnesota Avenue Metro Station or the Benning Road Metro Station.

At this meeting DDOT will provide an overview on the scope of the study and explain the technical work that will be performed as part of the study.

The meeting will be structured to allow for 30 minutes of materials review and individual discussion with team members prior to a 30-minute presentation. A one-hour question and answer session will follow the conclusion of the presentation and will offer an opportunity for participants to provide additional input.

Questions about this meeting may be directed to Dara Ward: dara.ward@dc.gov, 202-289-2001

What: Public Meeting for the H Street/Benning Road Streetcar Line Extension Study

When: Thursday, September 6, 2012
6 p.m. to 8 p.m.

Where: Department of Employment Services, Community Room
4058 Minnesota Avenue, NE

Transit: The meeting venue is adjacent to the Minnesota Avenue Metro Station and is accessible by Metrobus routes A31, U2, U4, U5, U6, U7, U8, V7, V8, X1, X2, X3, and X9.

DDOT is committed to ensuring that no person is excluded from participation in, or denied the benefits of, its projects, programs, and services on the basis of race, color, national origin, or gender, as provided by Title VI of the Civil Rights Act of 1964 or on the basis of disability as provided by the Americans with Disabilities Act.

If you need special accommodations or language assistance services (translation or interpretation), please contact the DC Streetcar management team at dcstreetcar@dc.gov or dial (855) 413-2954 no later than 48 hours in advance of the meeting. These services will be provided free of charge.

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Attachment B:

Public Meeting #1 Project Fact Sheet

dcstreetcar

Benning Road Streetcar Extension Feasibility Study

The District of Columbia Department of Transportation (DDOT) has initiated a program to reestablish streetcar service in Washington, DC. The proposed 37-mile, 8-line system would serve all eight wards of the District. The purpose of this effort is to provide an additional high-quality, high-capacity, and sustainable mode of transportation that would improve connections between neighborhoods and spur economic development.

As part of this plan, DDOT is considering an extension of the streetcar line on H Street, NE and Benning Road, currently under construction between Union Station and Oklahoma Avenue, NE. The study will determine the feasibility of extending this line farther east to one of two terminals: Minnesota Avenue Metro Station or Benning Road Metro Station.

The Benning Road Streetcar Extension aims to achieve the following:

- Provide additional transit capacity to relieve crowded bus lines;
- Connect Ward 7 neighborhoods with employment and activity centers west of the river;
- Provide connections to the regional Metrorail system as well as to multimodal transportation services at Union Station; and
- Support neighborhood plans for activity centers at the Minnesota Avenue/Benning Road intersection and elsewhere on the corridor.

JOIN US!

Public Meeting:
Thursday, September 6, 2012

Open House:
6:00 pm to 6:30 pm

Program:
6:30 pm to 8: 00 pm

DC Department of Employment Services
1st Floor
Community Room
4058 Minnesota Ave NE
Washington, DC 20019

Located adjacent to the Minnesota Avenue Metro Station

DDOT is committed to ensuring that no person is excluded from participation in, or denied the benefits of, its projects, programs, and services on the basis of race, color, national origin, or gender, as provided by Title VI of the Civil Rights Act of 1964 or on the basis of disability as provided by the Americans with Disabilities Act.

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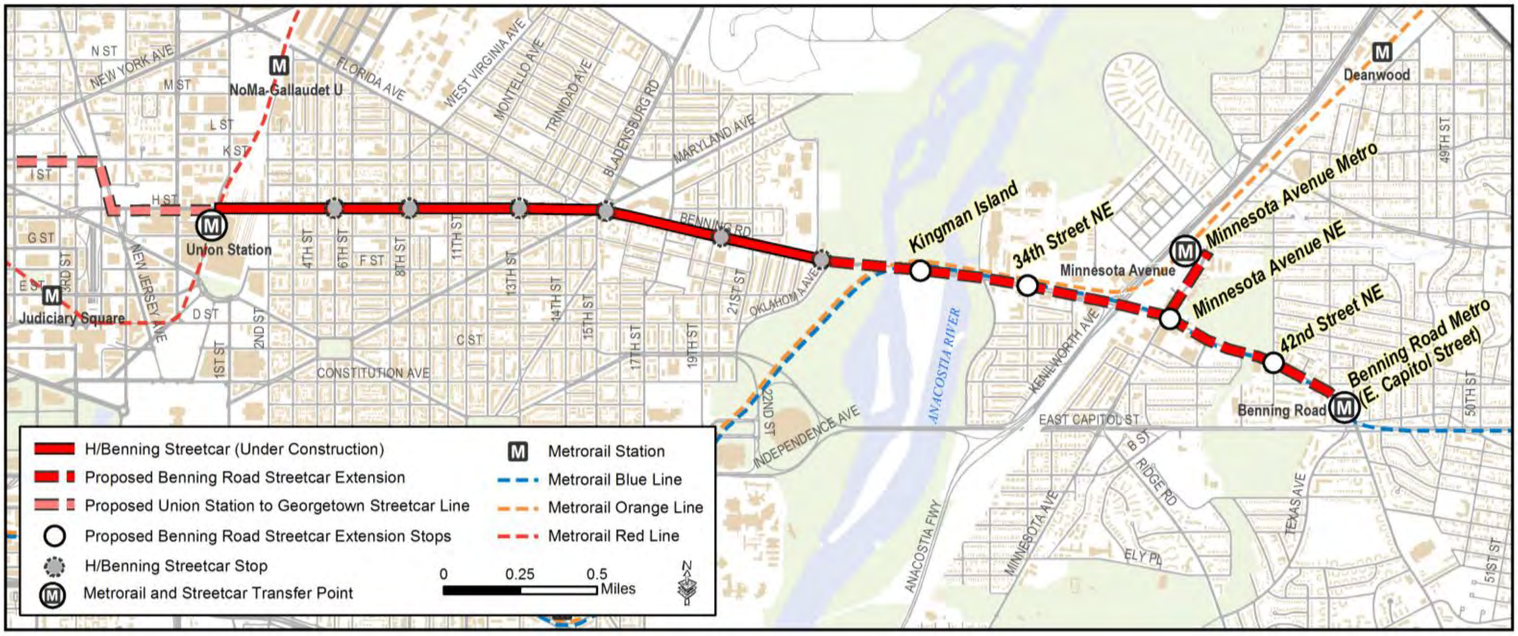
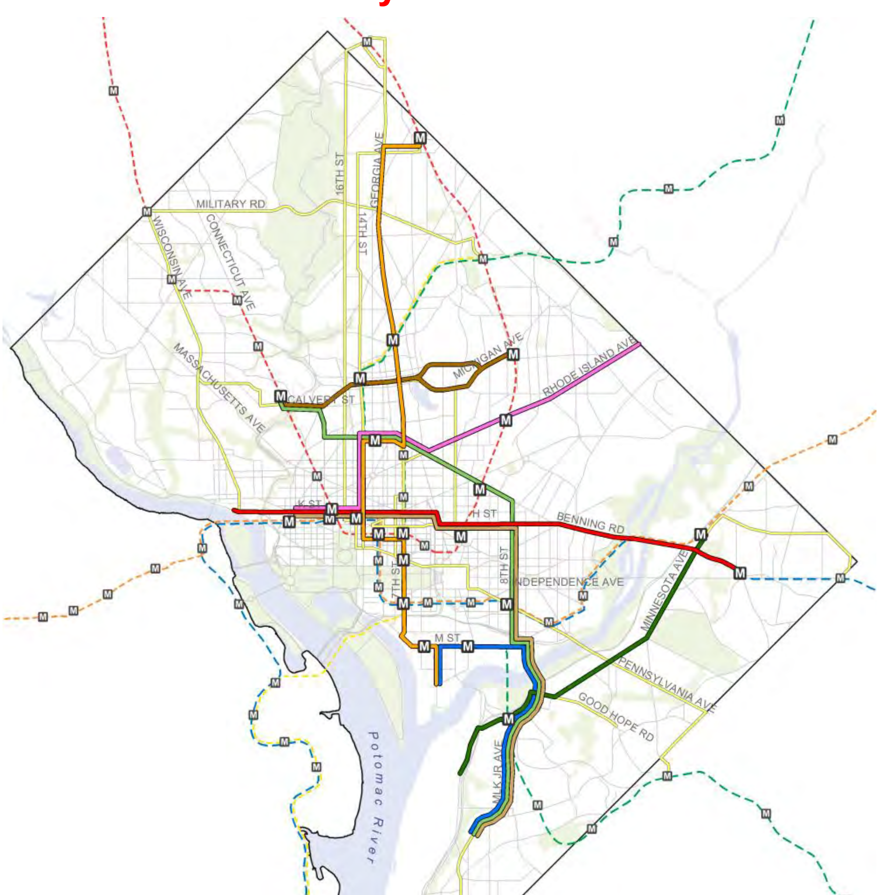
Proposed Benning Road Streetcar Extension



DC's Transit Future System Plan



LEGEND

- Metrorail with Connection to Streetcar
- Metrorail Station
- Metro Express Bus Corridor

Streetcar Lines

- JBAB to Minnesota Avenue Metrorail Station Line
- Georgetown to Benning Road Metrorail Station Line
- Congress Heights to Washington Circle Line
- Congress Heights to Buzzard Point Line
- Takoma Metrorail Station to Buzzard Point Line
- Woodley Park/Adams Morgan to Congress Heights Line
- Rhode Island Avenue/Eastern Avenue to Washington Circle Line
- Woodley Park/Adams Morgan to Brookland Line

Get Connected

DC Streetcar Team
District Department of Transportation (DDOT)
55 M St. SE, 5th Floor
Washington, D.C. 20003

Email: info@dcstreetcar.com
Phone: 1-855-413-2954
Website: www.dcstreetcar.com

Attachment C:

Public Meeting #1 Presentation

dcstreetcar

BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

Public Meeting

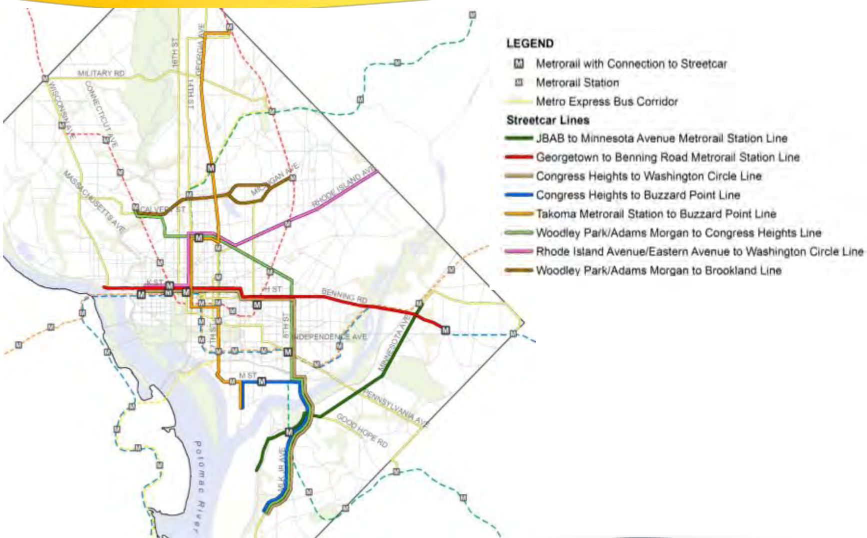
September 6, 2012

Tonight's Meeting

dcstreetcar

6:00 pm	Open House
6:30 pm	Presentation
7:00 pm	Break-out Group Discussions (project staff will lead Q & A and discussion session and take participant comments)
7:30 pm	Break-out Summary & Meeting Wrap-up

DC Streetcar Proposed System Plan



Benning Road Streetcar Extension Feasibility Study

Study Purpose:

The purpose of the study is to assess the engineering and planning feasibility of extending the H Street/Benning Road Streetcar line east of the Anacostia River, in northeast Washington.

Corridor Needs:

- Provide additional transit capacity to relieve crowded bus lines;
- Connect Ward 7 neighborhoods with employment and activity centers;
- Provide connections to the regional Metrorail system as well as to multimodal transportation services at Union Station; and
- Support neighborhood plans for activity centers at the Minnesota Avenue/Benning Road intersection and elsewhere on corridor.

Benning Road Streetcar Extension

dcstreetcar

Study Time Line

dcstreetcar

Study Corridor: Previous Planning

dcstreetcar

Recent studies related to transit improvements:

2005 - DC's Transit Future System Plan and Alternatives Analysis

2005 - Minnesota Avenue SE Great Streets Framework Plan

2006 - H Street NE/Benning Road Great Streets Framework Plan

2006 - Minnesota Avenue Metrorail Station Access Improvement Study

2008 - Deanwood/Great Streets – Nannie Helen Burroughs Ave and Minnesota Ave NE Strategic Development Plan

2010 - Metrobus X1, X2, X3 Benning Rd-H Street Line Study

2010 - DC Streetcar System Plan

2011/12 - Streetcar Land Use Study Phase One

2005 → 2006 → 2008 → 2010 → 2011/12

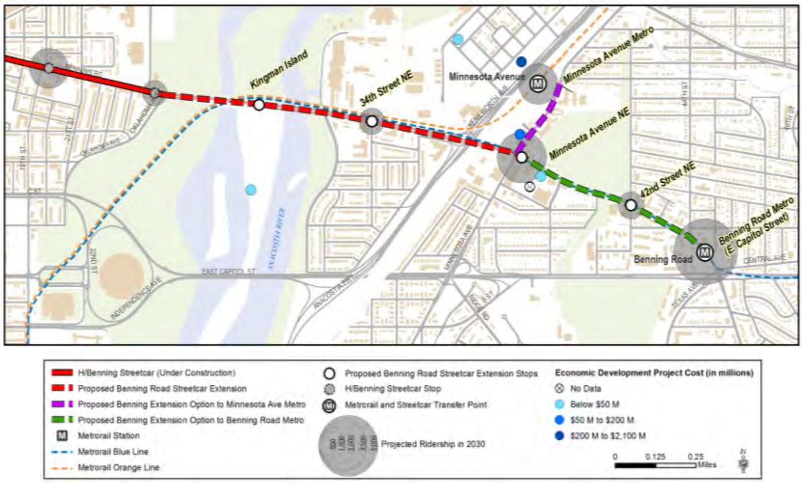
Study Corridor: Related Projects

dcstreetcar

Recently completed or ongoing projects related to the transportation improvements in the study area:

- Far Northeast Livability Study (2012)
- Benning Road Great Streets Improvements (completed mid-2012)
- Revitalization of Minnesota Avenue Project (Ongoing)

Study Corridor: Development



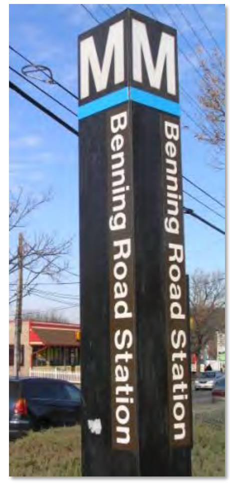
Engineering Considerations

- Bridge structures
- Roadway geometry
- Utilities
- Right-of-way
- Multimodal traffic
- On-street parking effects

Planning Considerations

dcstreetcar

- Stop locations close to activity centers (e.g., Minnesota/Benning intersection)
- Allows for future connections with other proposed streetcar lines
- Convenient connections to Metrorail and Metrobus services along the corridor
- Coordination with bus operations
- Safe and convenient pedestrian access



Initial Terminus Options

dcstreetcar

Benning Road Metro Terminus Option

Legend

- H/Benning Streetcar (Under Construction)
- Proposed Benning Streetcar Extension
- Proposed Streetcar Extension (Alternate)
- Metrorail Blue Line
- Metrorail Orange Line
- Metrorail and Streetcar Transfer Point
- Proposed Streetcar Stop
- Streetcar Stop (Under Construction)
- Metrorail Station

Initial Terminus Options

Minnesota Avenue Metro Terminus Option

Legend

- H/Benning Streetcar (Under Construction)
- Proposed Benning Streetcar Extension
- Proposed Streetcar Extension (Alternate)
- Metrorail Blue Line
- Metrorail Orange Line
- Metrorail and Streetcar Transfer Point
- Proposed Streetcar Stop
- Streetcar Stop (Under Construction)
- Metrorail Station

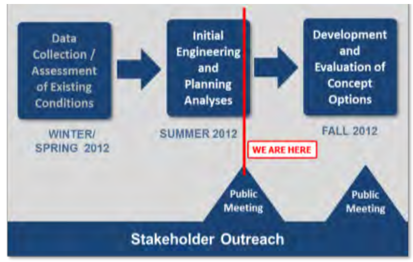
Community Considerations and Input

- Avoids or minimizes adverse impacts to residents and businesses
- Minimizes construction impacts through streetcar coordination with planned street improvement projects
- Incorporates community feedback and is consistent with community planning efforts

Next Steps

Feasibility study technical work to continue through Fall 2012:

- Streetcar and background bus service options
- Stop location options
- Intersection design options
- Terminus options, including connections to Metro stations and vehicle turn-around facilities
- Bridge structural analyses
- Preliminary cost estimates



Public Meeting #2 in Late Fall 2012 to present draft recommendations

Break-Out Group Discussions

<u>Instructions</u>: Please see your break-out discussion table number in top right corner of your meeting agenda.

7:00 pm	Break-out Group Discussions (including question & answers with project staff and participant comments)
7:30 pm	Break-out Summary and Meeting Wrap-up

dcstreetcar

Stay Connected!

District Department of Transportation
55 M Street SE, 5th Floor
Washington, DC 20003
Attn: DC Streetcar Team

Email: info@dcstreetcar.com
Hotline: 1 (855) 413-2954
Website: www.dcstreetcar.com
Facebook: dcstreetcar
Twitter: @dcstreetcar

Attachment D:

Public Meeting #1 Boards

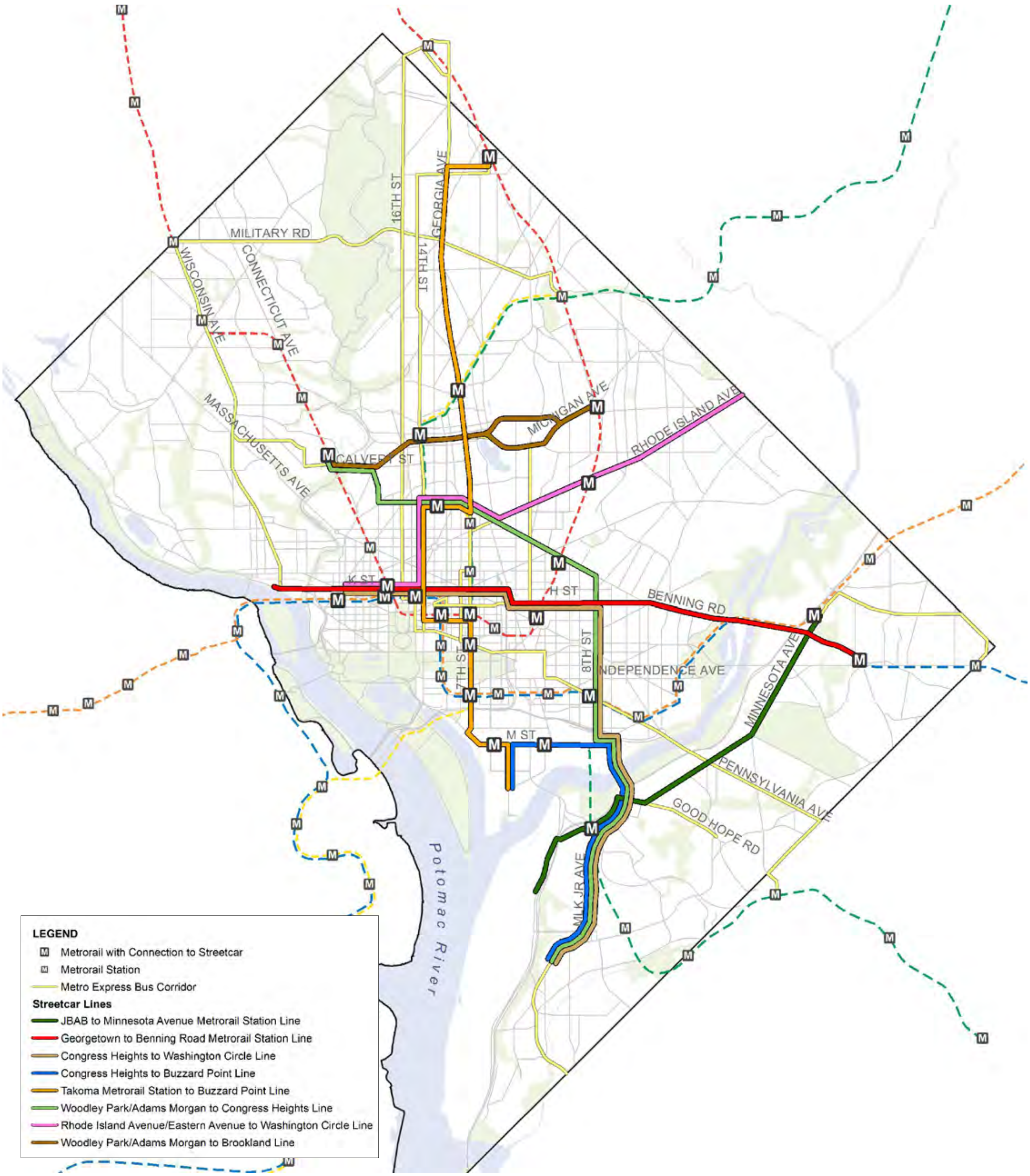
Benning Road Streetcar Extension Feasibility Study

Public Meeting

Welcome!

– Please Sign In –

PROPOSED DC STREETCAR SYSTEM PLAN



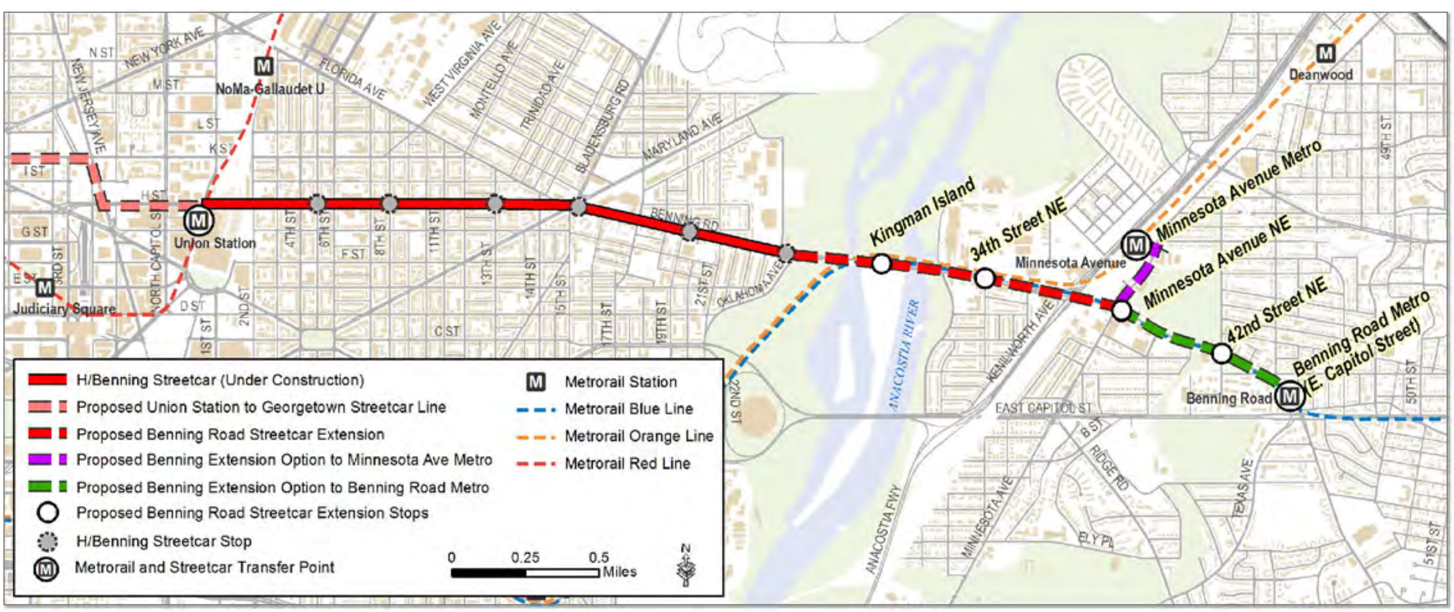
PURPOSE OF THE BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

Study Purpose:

The purpose of the study is to assess the engineering and planning feasibility of extending the H Street/Benning Road Streetcar line east of the Anacostia River, in northeast Washington.

Corridor Needs:

- Provide additional transit capacity to relieve crowded bus lines;
- Connect Ward 7 neighborhoods with employment and activity centers;
- Provide connections to the regional Metrorail system as well as to multimodal transportation services at Union Station; and
- Support neighborhood plans for activity centers at the Minnesota Avenue/Benning Road intersection and elsewhere on corridor.



STUDY CORRIDOR PREVIOUS PLANNING AND RELATED PROJECTS

Recent studies related to transit improvements:

2005 - DC's Transit Future System Plan and Alternatives Analysis

2005 - Minnesota Avenue SE Great Streets Framework Plan

2006 - H Street NE/Benning Road Great Streets Framework Plan

2006 - Minnesota Avenue Metrorail Station Access Improvement Study

2008 - Deanwood/Great Streets – Nannie Helen Burroughs Ave and Minnesota Ave NE Strategic Development Plan

2010 - Metrobus X1, X2, X3 Benning Rd-H Street Line Study

2010 - DC Streetcar System Plan

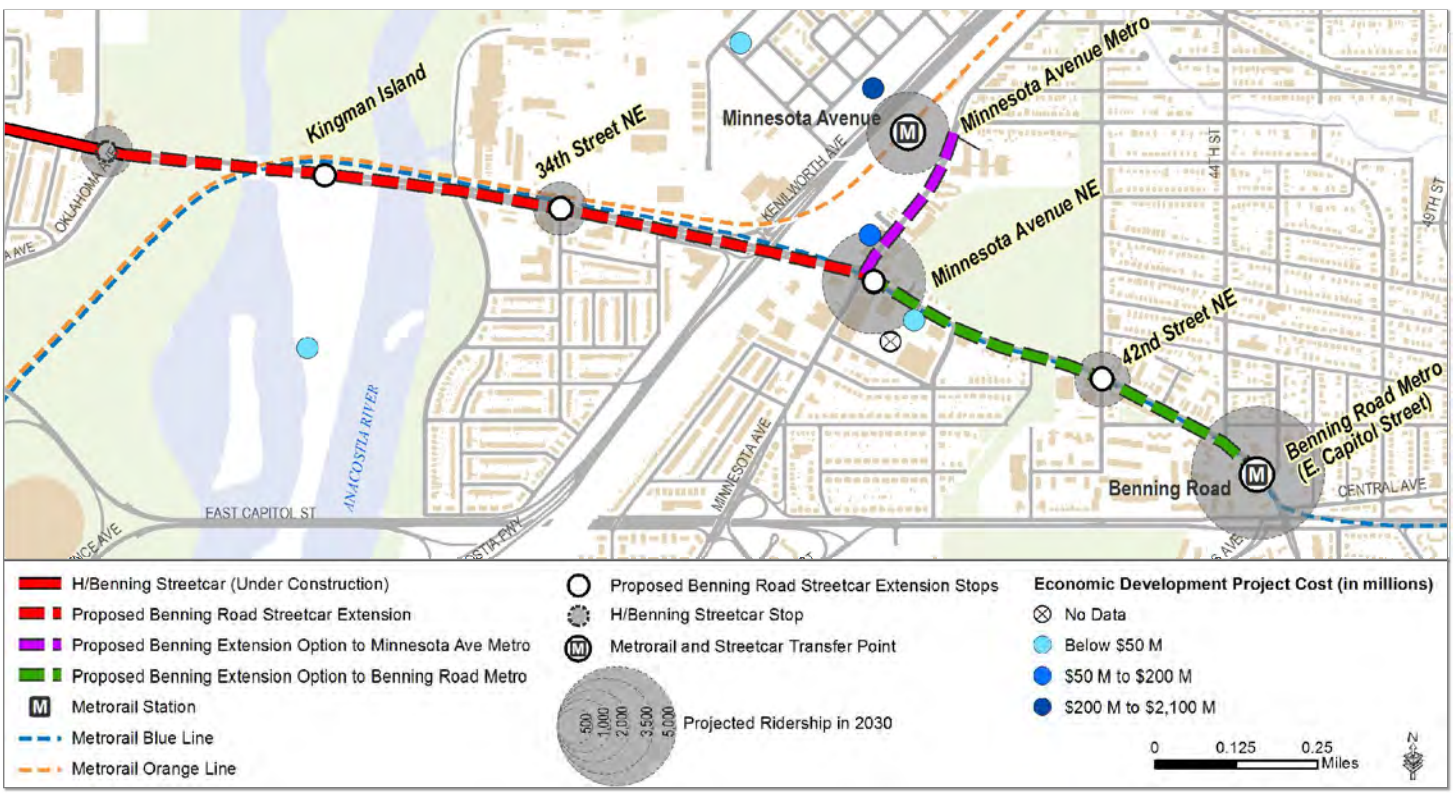
2011/12 - Streetcar Land Use Study Phase One

2005 → 2006 → 2008 → 2010 → 2011/12

Recently completed or ongoing projects related to the transportation improvements in the study area:

- Far Northeast Livability Study (2012)
- Benning Road Great Streets Improvements (completed mid-2012)
- Revitalization of Minnesota Avenue Project (Ongoing)

Planned/Proposed Economic Development Activities Along the Study Corridor



*Note: Economic development data from 2009 DC's Transit Future Study

INITIAL TERMINUS OPTIONS

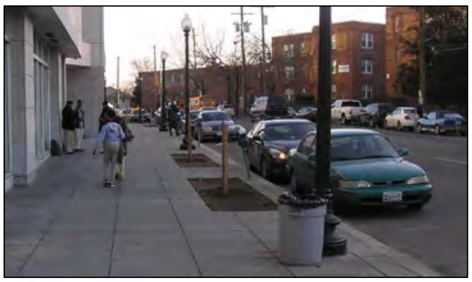
Benning Road Metro Terminus Option

Minnesota Avenue Metro Terminus Option

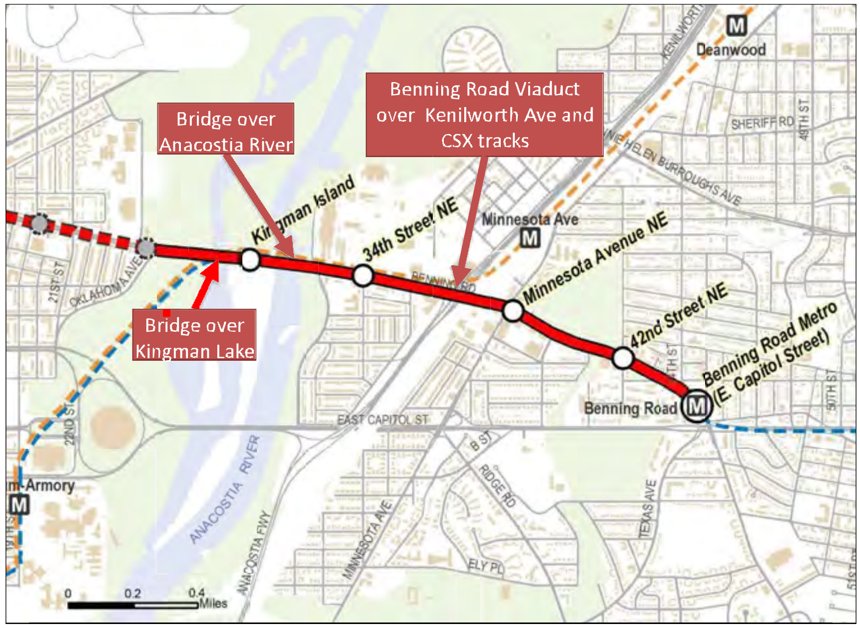
ENGINEERING AND PLANNING CONSIDERATIONS

Engineering Considerations

- Bridge structures
- Roadway geometry
- Utilities
- Right-of-way
- Multimodal traffic
- On-street parking effects



On-street parking along Minnesota Ave



Bridge structures along Benning Road

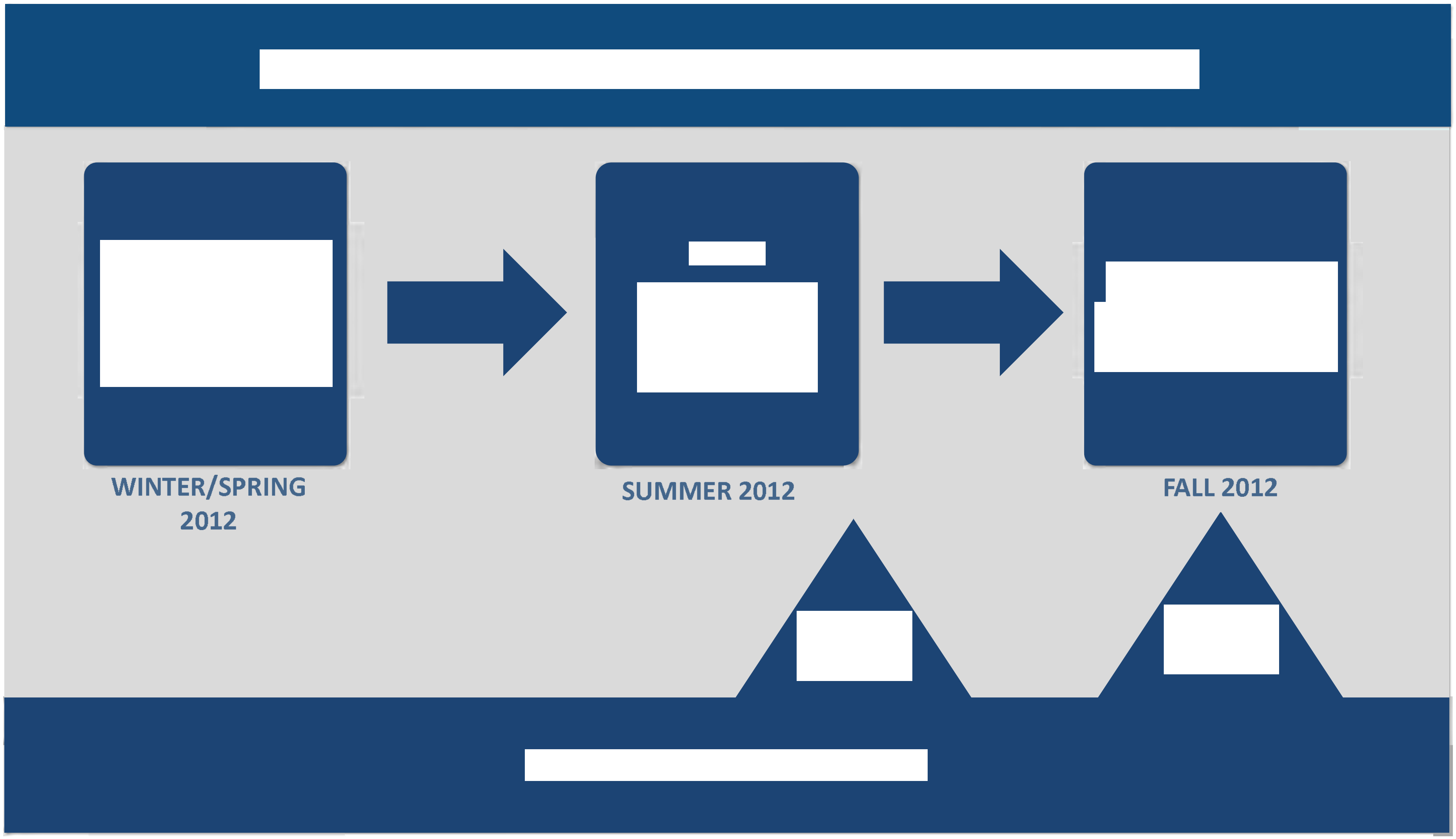
Planning Considerations

- Stop locations close to activity centers (e.g., Minnesota/Benning intersection)
- Allows for future connections with other proposed streetcar lines
- Convenient connections to Metrorail and Metrobus services along the corridor
- Coordination with bus operations
- Safe and convenient pedestrian access

The Minnesota Ave/Benning Rd Intersection is an important activity center

The Metrobus X Line has several heavily used routes along the corridor

STUDY SCHEDULE



Attachment E:

Public Meeting #1 Transcribed Meeting Notes

Benning Road Streetcar Extension Feasibility Study
Transcribed Comments from Public Meeting #1

Department of Employment Services, 4058 Minnesota Avenue NE – September 6, 2012

47 participants

Comment Sheets:

1. I believe that we (residents of Ward 7 east of the Anacostia River) need a streetcar connection to the rest of the city. I'm also interested in public art. I hope the streetcar extension offers more opportunities for public input. For local residents who live one block from the Minnesota Avenue Metro Station: what other community benefits can we have?
2. Why not take the streetcar right up East Capitol Street through the medians and connect to Capitol Heights Metro? This plan would really bring economic development to the ward. It would give businesses and companies a reason to come east of the river. That strip of East Capitol Street is a desert for food, entertainment, community centers, and economic development. I think overhead wires make the streets look cluttered; and with the way Pepco operates, we would never have consistent power for the streetcar system. To pay for streetcars, we should look at selling aesthetically pleasing local advertisements.
3. Refer to "Capitol Traction and Electric Proposal" regarding Route 10.

Question & Answer Session, Following Presentation:

1. What's best for alleviating traffic congestion at the intersection of Minnesota Avenue & Benning Road?
2. Can trains simply go back the way they came, or do they have to turn around in a loop?
3. How many trains would be scheduled in how much time? What will the frequency be?
4. Will the streetcar system be curb running or median running? Will the vehicles operate in dedicated lanes or mixed traffic?
5. How much layover time will there be for train operators at the end of a run?
6. Will propulsion be via catenary or cell/battery power? Will they be hybrid vehicles?
7. What can be done to expand public/private partnerships? Can developers be brought in to help with the financing of the system?

Breakout Session, Table 1:

1. Traffic is very bad on Benning Road. Is it possible to remove the Shrimp Boat?
2. I'm glad DC is doing this extension; it doesn't make sense to end the line at Oklahoma Avenue. Ward 7 needs this.
3. Left turns are difficult at the intersection of Minnesota & Benning. Review the roadway geometry, turn lanes, etc.
4. Streetcars can't go around parked cars. Remove parking lanes on Benning Road east of Minnesota Avenue. Curbside running would force the elimination of on-street parking.
5. The original streetcar system prior to 1963 went to Baltimore, via Kenilworth Avenue. Restore the dedicated right-of-way on Kenilworth (Dean St).
6. Median running is better for dedicated right-of-way.

7. Streetcars should loop at each end. Doors are on one side of the vehicle, and this would allow for more seating on the streetcar.
8. Need special signalization for streetcars, so they can go first through each intersection.
9. Should westbound stops be on the south side of Benning Road before the intersection with Minnesota Avenue, or after the intersection on the east side of Minnesota?
10. Streetcars should replace some bus service on H Street NE and Benning Road (X1-2-3-9).
11. The WMATA board member from DC could suggest supplanting some bus service with streetcar service.
12. Minnesota Avenue is currently scheduled for rehabilitation, so can DDOT put the tracks in simultaneously, as they did with H Street NE?
13. Improvements to Benning Road should include more traffic calming to slow cars. The light at 39th Street NE has helped with pedestrian safety.
14. Why have the streetcar run in mixed traffic? Streetcars get bogged down in the same traffic as cars if there is no dedicated lane.
15. The streetcar terminal should be right here at Minnesota Avenue Metro Station. A loop allows the streetcar to connect with buses and provides a layover/recovery time location.
16. Don't have the streetcar terminate at Benning Road Metro; extend it down East Capitol Street to Capitol Heights Metro. This will provide more economic development. There is already a median on East Capitol Street to facilitate this. A Wal-Mart is planned at 58th Street, and a streetcar extension to Capitol Heights would serve it.
17. The spacing and location of stops seems adequate. Kingman Island could be skipped in non-park hours.
18. Access to areas in the far east of the District will facilitate economic development.
19. How will streetcars turn at the intersection of Benning & Minnesota? It's a complicated intersection. How will new development at this intersection affect turning movements?
20. The frontage along the north side of Benning Road is not owned by the National Park Service. Is there the potential to widen the roadway here?
21. There is not much on-street parking as it is on Benning Road, so removing lanes shouldn't matter.
22. Can the Police Station and Shrimp Boat on Benning Road be relocated?
23. Watch out for "tail-swing" from turning vehicles.
24. Is DDOT looking at extending the streetcar line west of Union Station?
25. Will there be better coordination with traffic and roadway people at DDOT? Don't waste money.
26. *Main Points:*
    a. Redesign the intersection of Benning Road and Minnesota Avenue.
        i. Turning movements, pedestrian safety, etc.
        ii. Egress at Benning Road is dangerous.
    b. Look at future expansion of the streetcar line to Capital Heights Metro, Deanwood, and west of Union Station.

<u>Breakout Session, Table 2</u>:

1. The terminal should be at Minnesota Avenue Metro rather than Benning Road. Residential and commercial density is greater there, and a streetcar should serve more people.
2. Timing of construction and phasing: be sure to communicate road work and lane closures with the public.

3. Potential stops for the streetcar should include all major intersections. Have the streetcar stop close to Metrorail stations and connect with prominent Metrobus stops.
4. Encourage safety at stops and be sure to add crosswalks.
5. How would the removal of on-street parking affect medians in the corridor? Businesses will be against the removal of parking lanes.
6. Be sure to address ADA issues with regard to street crossings and the loading/unloading of streetcars.
7. Median-running streetcars reduce traffic capacity in the corridor.
8. The streetcar system should be coordinated with bus service; stagger the service so that headways are short. Have the streetcar system and bus routes share stops
9. Provide a convenient transit experience for riders.

<u>Breakout Session, Table 3</u>:

1. Having the terminal at Minnesota Avenue Metro makes sense in terms of the turning radius and existing right-of-way. It also will serve more students who go to school there, and will reduce pedestrian conflicts. On the other hand, having the terminal at Benning Road will allow the streetcar to serve more people and provide more opportunity for development. The reconstruction of Benning Road doesn't make a difference.
2. Stoop locations: Need more stops in the River Terrace area – every quarter-mile.
3. Need dedicated right-of-way on the sides of bridges.
4. What will the construction impacts be from Oklahoma to 34th Street NE?
5. A lot of people ride the Metrobus X2. What will the effect of the streetcar be on local bus service?
6. Streetcar operations:
    a. Consideration for disabled people and seniors;
    b. Curbside alignment will allow for more auto traffic, and pedestrians would not have to cross the street;
    c. On Benning Road, the alignment should be curb to median to curb.
    d. There are parking issues for residents who live along Benning Road;
    e. Metrobus should not replicate streetcar service. Have streetcar service be more express, and have buses provide local service;
    f. Can the streetcar tunnel under Benning Road at Kingman Park?
    g. Provide a boarding location near Spingarn High School. Kids cross the street there; so be concerned about pedestrians.
7. Additional concerns:
    a. The location of the car barn should be in the RFK Stadium parking lot, not near Spingarn High School;
    b. Benning Road has a lot of pedestrians and car traffic; and the roadway has just been improved, so why tear it up? The 7D ANC commissioner thinks it's not a good idea to have the streetcar on Benning Road east of Minnesota Avenue;
    c. What is the timeframe for the streetcar extension project?
    d. What will be the economic development impact on the streetcar segment of Benning Road between H Street and Minnesota Avenue?

Breakout Session, Table 4:

1. Having the terminal at Benning Road Metro:
    a. Advantages
        i. Provides longer commuter service
        ii. Allows more development opportunity at Benning Road Metro area
        iii. Captures more riders
        iv. Reduces congestion
        v. Works well with future streetcar lines
    b. Disadvantages
        i. Existing Benning Road construction
        ii. No accommodations for parking
        iii. No Park & Ride – won't alleviate traffic into the District
2. Having the terminal at Minnesota Avenue Metro:
    a. Advantages
        i. The parking lot makes a useful turnaround
        ii. Would work well with future Minnesota Avenue Line development
    b. Disadvantages
        i. Existing traffic
        ii. The left turn onto Minnesota Avenue from Benning Road is difficult
        iii. Competition with existing bus traffic; narrow, single lanes
3. Stations:
    a. Kingman Island – not needed now, but maybe in the future. People can walk there from Oklahoma Avenue. Would there be NPS issues? Is it a waste of money?
    b. 34th Street NE – lots of residential communities south of here; future development to the north.
    c. Minnesota Avenue – can the stop be placed in front of the library? Then it would serve the proposed development at the shopping center.
    d. 42nd Street NE – Move the stop west to the Boys & Girls Club. Concerns about refueling station at this location.
4. Curbside running streetcar is the preferred option, because of safety issues, although it would be noisier for homeowners. Parking may or may not be an issue depending on the location.
5. Bus service may or may not be complementary with streetcar service; it depends on the location and time of day.
6. Additional concerns:
    a. Construction on Benning Road
    b. Power outages
    c. Build a separate bridge for the streetcar
    d. Will mode changes occur? Will people leave their cars at home?

As part of the new bridge design, could the streetcar track stay at grade in between the eastbound and westbound viaducts and make a left before the railroad tracks and stay parallel to and west of Kenilworth Avenue?

Attachment F:

Public Meeting #2 Press Release

Government of the District of Columbia

Department of Transportation

FOR IMMEDIATE RELEASE
November 7, 2012
Media Contact: Dara Ward, dara.ward@dc.gov 202-289-2001

*** PUBLIC MEETING NOTICE***

DDOT to Host Public Meeting for the Benning Road Streetcar Line Extension Feasibility Study

Community Stakeholders Are Encouraged to Attend and Provide Input on Streetcar Line Extension

(Washington, D.C.) The District Department of Transportation (DDOT) is hosting a public meeting on Tuesday, November 27, to provide an update and solicit input from community stakeholders on its study to explore the feasibility of extending the H Street/Benning Road streetcar line east of the Anacostia River, in northeast Washington.

As part of the study, DDOT will look into how it may be able to link the H Street/Benning Road streetcar line to the Minnesota Avenue Metro Station or the Benning Road Metro Station.

At this meeting DDOT will present the preliminary findings of the technical work that has been performed as well as present the constraints and opportunities of each alternative.

The meeting will be structured to allow for 30 minutes of materials review and individual discussion with team members prior to a 30-minute presentation. A one-hour question and answer session will follow the conclusion of the presentation and will offer an opportunity for participants to provide additional input.

Questions about this meeting may be directed to Dara Ward: dara.ward@dc.gov, 202-289-2001

What: Public Meeting for the H Street/Benning Road Streetcar Line Extension Study

When: Tuesday, November 27, 2012
6 p.m. to 8 p.m.

Where: Department of Employment Services, Community Room
4058 Minnesota Avenue, NE

Transit: The meeting venue is adjacent to the Minnesota Avenue Metro Station and is accessible by Metrobus routes A31, U2, U4, U5, U6, U7, U8, V7, V8, X1, X2, X3, and X9.

DDOT is committed to ensuring that no person is excluded from participation in, or denied the benefits of, its projects, programs, and services on the basis of race, color, national origin, or gender, as provided by Title VI of the Civil Rights Act of 1964 or on the basis of disability as provided by the Americans with Disabilities Act.

If you need special accommodations or language assistance services (translation or interpretation), please contact the DC Streetcar management team at dcstreetcar@dc.gov or dial (855) 413-2954 no later than 48 hours in advance of the meeting. These services will be provided free of charge.

###

Attachment G:

Public Meeting #2 Presentation

dcstreetcar

BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

Public Meeting

November 27, 2012

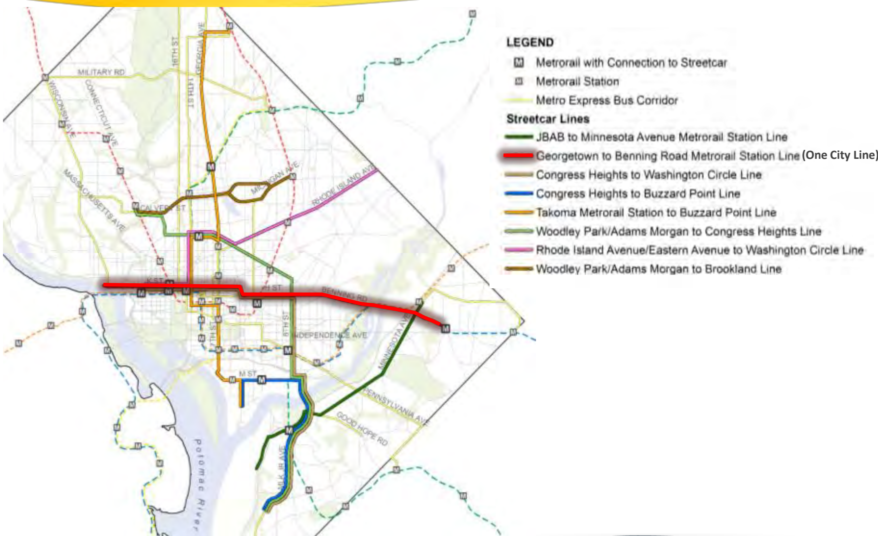
Tonight's Meeting

dcstreetcar

6:00 pm	Open House
6:30 pm	Presentation
7:00 pm	Break-out Group Discussions (project staff will lead Q & A and discussion session and take participant comments)
7:30 pm	Break-out Summary & Meeting Wrap-up

DC Streetcar Proposed System Plan

dcstreetcar



3

BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

Benning Road Streetcar Extension Feasibility Study

dcstreetcar

Study Purpose:

To assess the engineering and planning feasibility of extending the H Street/Benning Road Streetcar line east of the Anacostia River.

Corridor Needs:

- Provide additional transit capacity to relieve crowded bus lines;
- Connect Ward 7 neighborhoods with employment and activity centers;
- Provide connections to the regional Metrorail system as well as to multimodal transportation services at Union Station; and
- Support neighborhood plans for activity centers at the Minnesota Avenue/Benning Road intersection and elsewhere on corridor.

4

BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

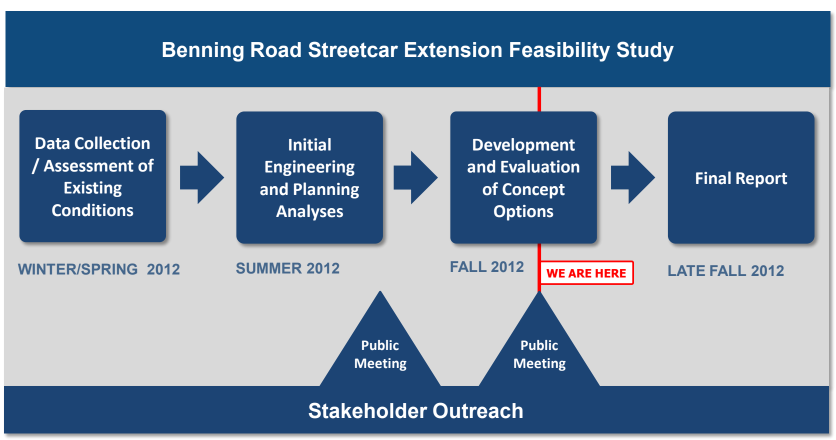
Benning Road Streetcar Extension

dcstreetcar

Two Terminus Options – Minnesota Ave Metro Station & Benning Rd Metro Station

Study Time Line

dcstreetcar



Public Meeting 1 Summary

Sample of Comments:

- Traffic congestion and pedestrian safety at Benning /Minnesota and Benning/E Capitol
- Timing of project after Benning reconstruction
- Minnesota Metro terminus would serve the school and provide turn-around
- Benning Metro would serve more people and provide opportunity for development
- Impacts of on-street parking on Benning Road and Minnesota Avenue
- Integration of public art elements
- How will streetcar and bus services align?
- Considerations of further future extensions: East Capitol Street and Capitol Heights Metro
- Alignment option by Parkside following old streetcar route

Public Meeting 2 – Agenda for Tonight

Feasibility Study Draft Findings focused on:

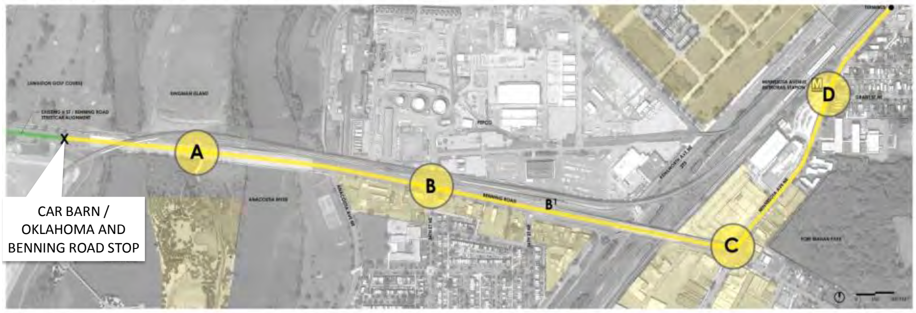
- Engineering Feasibility
  - Stop Locations
  - Turn-around Facilities
  - Track Transitions & Intersection Design
  - Traffic and On-street Parking
  - Bridge Structures & Utilities
- Planning Feasibility
  - Environmental Considerations
  - Projected Ridership

Project's Next Steps

Minnesota Ave Metro Options

dcstreetcar

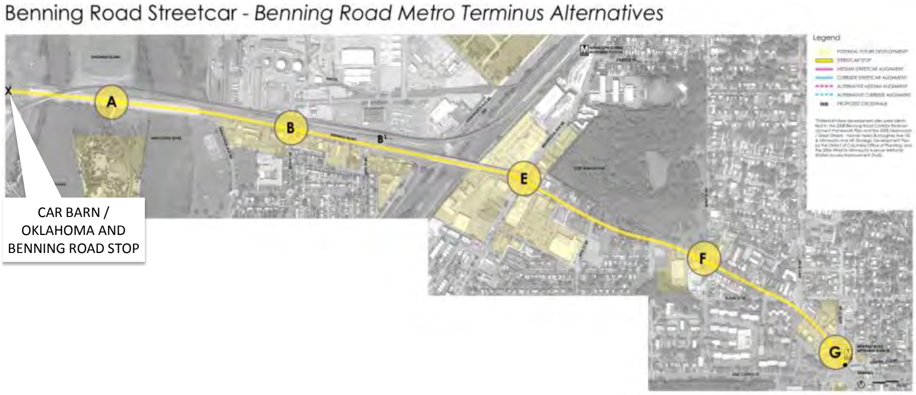
Benning Road Streetcar - *Minnesota Ave Metro Terminus Alternatives*



Benning Road Metro Options

dcstreetcar

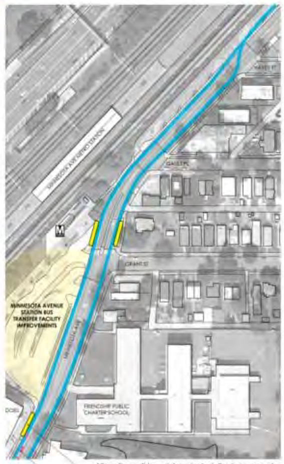
Benning Road Streetcar - *Benning Road Metro Terminus Alternatives*



Terminus Options – Turn-around Facilities

dcstreetcar

D Minnesota Ave Metro Station



D.1 Alternative southbound stop prior to station improvements
Alternative southbound alignment transitions from curbside to median

Alternative southbound alignment transitions from curbside to median at potential traffic signal at bus facility exit

D.2 0 50 100 FEET

Terminus Options – Turn-around Facilities

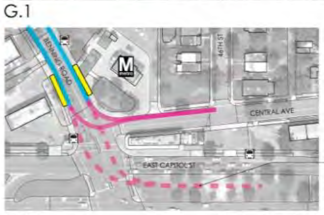
dcstreetcar

G Benning Rd Metro Station

G.1

One-way vehicular traffic east of 46th Street

G.3



Alternative turnaround in median of East Capitol Street

G.2 0 50 100 FEET

G.4 0 50 100 FEET

Track Transitions and Intersection Options

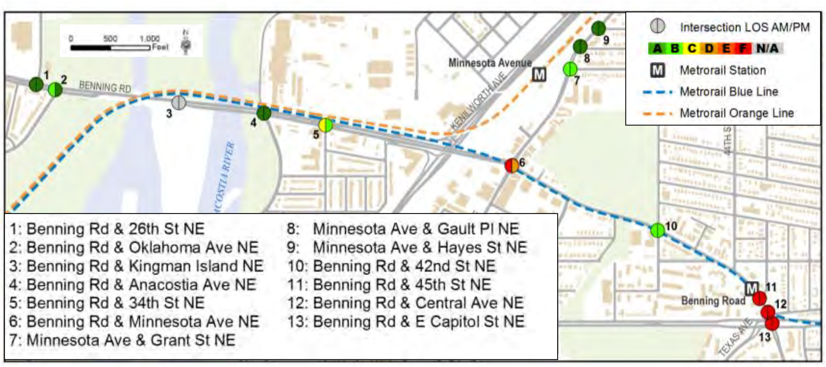
dcstreetcar

- Minimum turning radius
- Necessary track transition distances
- Traffic signal phasing and potential stop bar adjustments
- Special Trackwork Requirements

Traffic Operations

dcstreetcar

2040 No-Build Intersection Level of Service (LOS)



- All study intersections operate acceptably, except for:
  - Benning Rd & Minnesota Ave
  - Benning Rd & E Capitol St

Traffic Operations

dcstreetcar

2040 Build Condition Level of Service (LOS)

- Streetcar is assumed to run every 10 minutes.
- Streetcar does not cause unacceptable LOS at intersections that are projected to operate acceptably in 2040 No-Build condition.
- Benning Rd/Minnesota Ave and Benning Rd/E Capitol St intersections will continue to have capacity constraints with or without the streetcar. On-going studies are addressing the needs of all users, particularly pedestrians.
- Streetcar design could accommodate a pedestrian-friendly environment and facilitate "place-making" along the corridor.

Traffic Operations

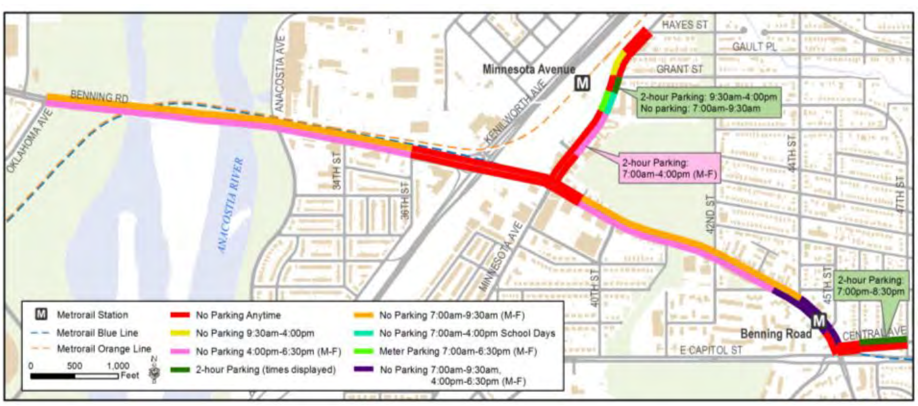
dcstreetcar

D1 Operations

Traffic Operations

D2 Operations

Existing On-Street Parking Conditions



- Curbside-running track affects on-street parking, drop-off and loading activities.
- Center-running track generally needs wider right-of-way to accommodate median stops.

Bridge Structures

dcstreetcar

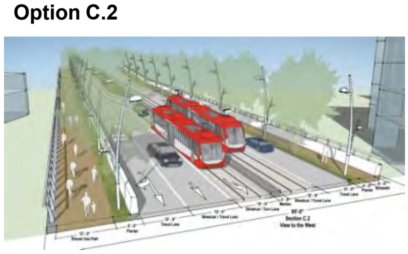
Bridge 77: Bridge over Kingman Lake	Bridge 52: Bridge over Anacostia River	Bridge 503: Benning Road Viaduct
• Dedicated lane is possible • Mixed traffic would also work, but more difficult to build	• Dedicated lane is possible • Mixed traffic would also work, but more difficult to build	• Programmed for reconstruction

Benning Road Viaduct
Ideal Cross Section Concepts

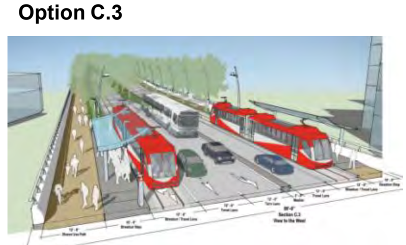
dcstreetcar

Option C.1

Option C.2



Option C.3



Environmental Considerations

To be addressed in detail during the National Environmental Policy Act (NEPA) environmental review process.

Parks – Fort Mahan, Kingman Island, Anacostia River Park

Historic Cultural Resources – Fort Mahan, Langston Golf Course

Potential Hazardous Materials Sites – Pepco generating plant, gasoline stations

Noise & Vibration – further assessment of potential effects

Other resource considerations will include visual, land use and zoning, socio-economic, community resources, water resources, air quality, etc.

Projected 2040 Daily Ridership

Streetcar Segment	2040 Daily Streetcar Ridership*
No Build (without extension) - Oklahoma to Union Station	4,250
Build – Benning Road Metro Extension	7,750
Build – Minnesota Ave Metro Extension	4,800

*Assumes that no buses are removed from service as planned; land use reflects 2040 MWCOG model forecasts.

* Project costs will be refined and included in the final report.

Next Steps

dcstreetcar

Feasibility Study Final Report December 2012:

- Options for streetcar extension termini, stop locations, intersection configurations, roadway and bridge design
- Planning and engineering feasibility
- Public and Stakeholder Feedback

NEPA Environmental Review To Begin Winter 2013:

- Analysis of alternatives under NEPA
- Assessment of:
  - Benning Road Streetcar Extension
  - Bridge 503 EB & WB and Ramps

Break-Out Group Discussions

dcstreetcar

<u>Instructions</u>: Please see your break-out discussion table number in top right corner of your meeting agenda.

7:00 pm	Break-out Group Discussions (including question & answers with project staff and participant comments)
7:30 pm	Break-out Summary and Meeting Wrap-up

dcstreetcar

Stay Connected!

District Department of Transportation
55 M Street SE, 5th Floor
Washington, DC 20003
Attn: DC Streetcar Team

Email: info@dcstreetcar.com
Hotline: 1 (855) 413-2954
Website: www.dcstreetcar.com
Facebook: dcstreetcar
Twitter: @dcstreetcar

Attachment H:

Public Meeting #2 Boards

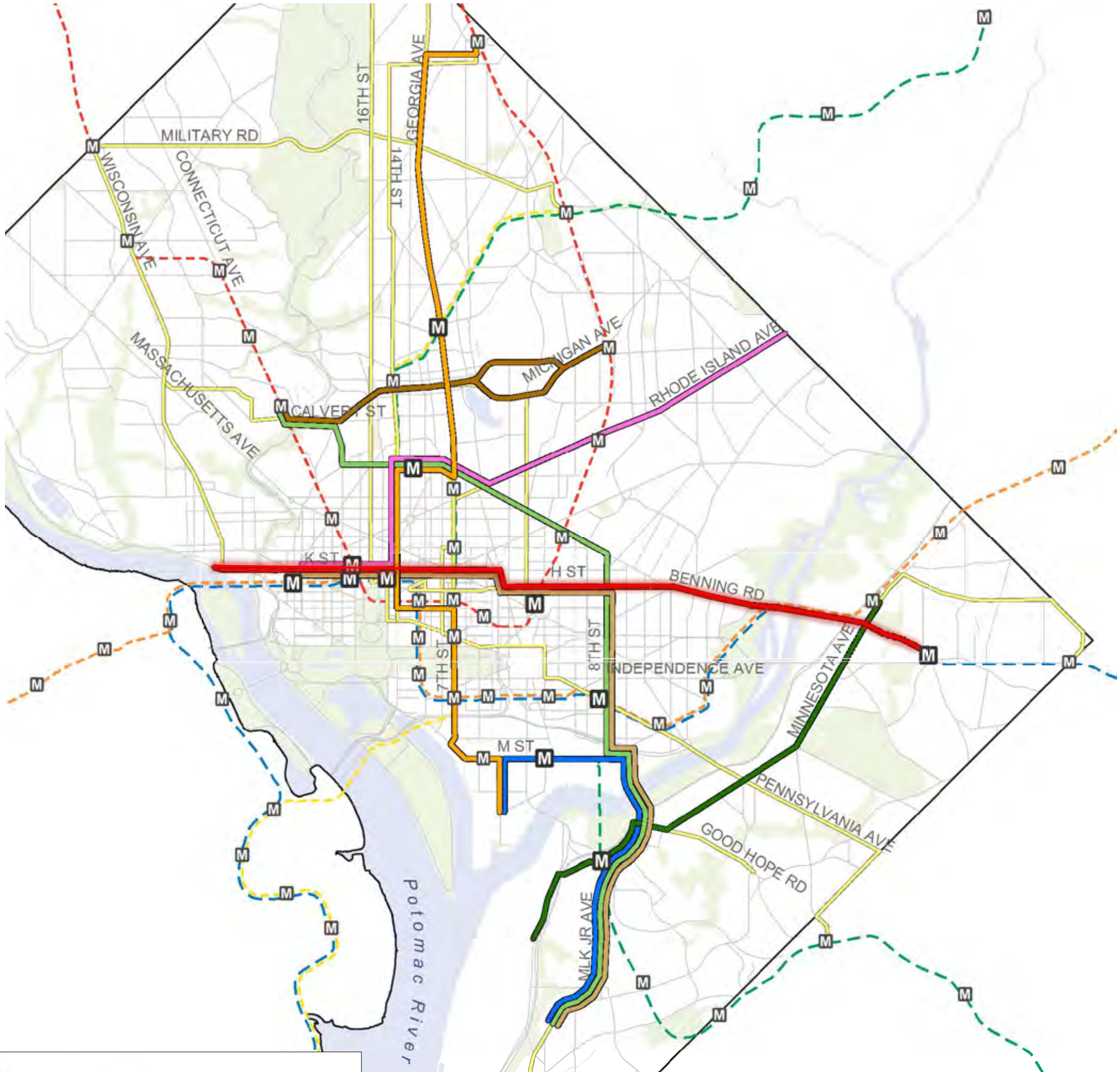
Benning Road Streetcar Extension Feasibility Study

Public Meeting

Welcome!

– Please Sign In –

PROPOSED DC STREETCAR SYSTEM PLAN



LEGEND

- Metrorail with Connection to Streetcar
- Metrorail Station
- Metro Express Bus Corridor

Streetcar Lines

- JBAB to Minnesota Avenue Metrorail Station Line
- Georgetown to Benning Road Metrorail Station Line (One City Line)
- Congress Heights to Washington Circle Line
- Congress Heights to Buzzard Point Line
- Takoma Metrorail Station to Buzzard Point Line
- Woodley Park/Adams Morgan to Congress Heights Line
- Rhode Island Avenue/Eastern Avenue to Washington Circle Line
- Woodley Park/Adams Morgan to Brookland Line

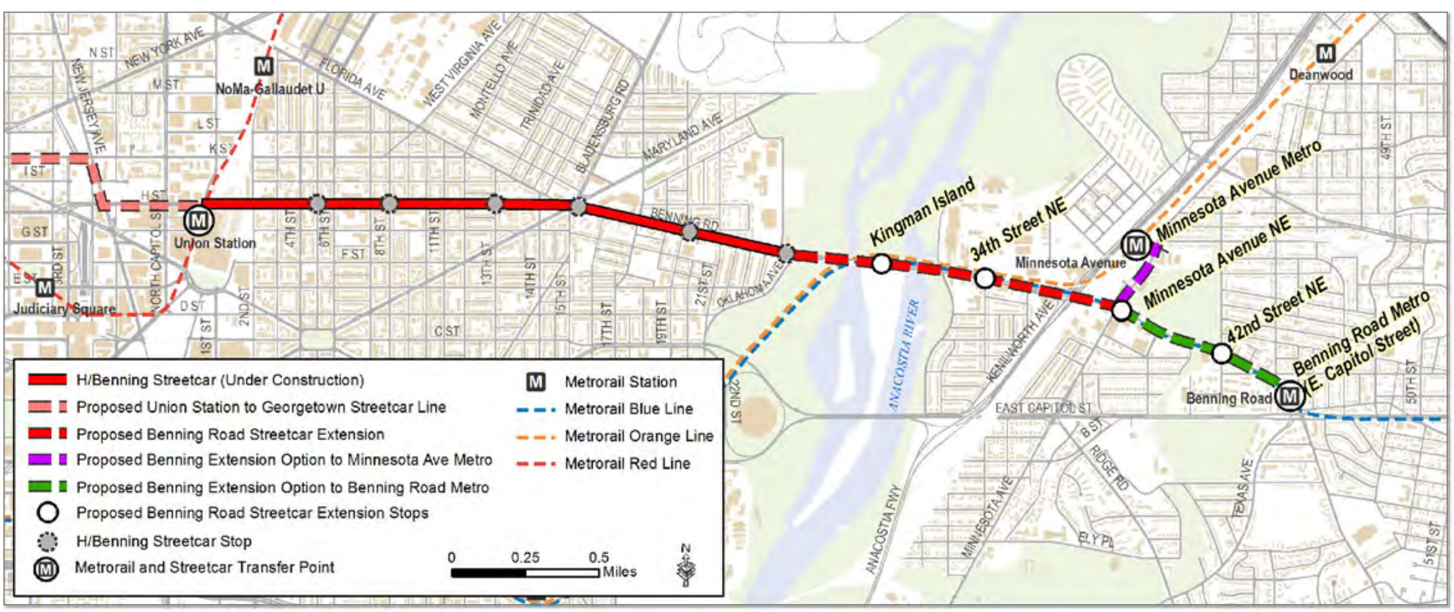
PURPOSE OF THE BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

Study Purpose:

The purpose of the study is to assess the engineering and planning feasibility of extending the H Street/Benning Road Streetcar line east of the Anacostia River, in northeast Washington.

Corridor Needs:

- Provide additional transit capacity to relieve crowded bus lines;
- Connect Ward 7 neighborhoods with employment and activity centers;
- Provide connections to the regional Metrorail system as well as to multimodal transportation services at Union Station; and
- Support neighborhood plans for activity centers at the Minnesota Avenue/Benning Road intersection and elsewhere on corridor.



STUDY CORRIDOR PREVIOUS PLANNING AND RELATED PROJECTS

Recent studies related to transit improvements:

2005 - DC's Transit Future System Plan and Alternatives Analysis

2005 - Minnesota Avenue SE Great Streets Framework Plan

2006 - H Street NE/Benning Road Great Streets Framework Plan

2006 - Minnesota Avenue Metrorail Station Access Improvement Study

2008 - Deanwood/Great Streets – Nannie Helen Burroughs Ave and Minnesota Ave NE Strategic Development Plan

2010 - Metrobus X1, X2, X3 Benning Rd-H Street Line Study

2010 - DC Streetcar System Plan

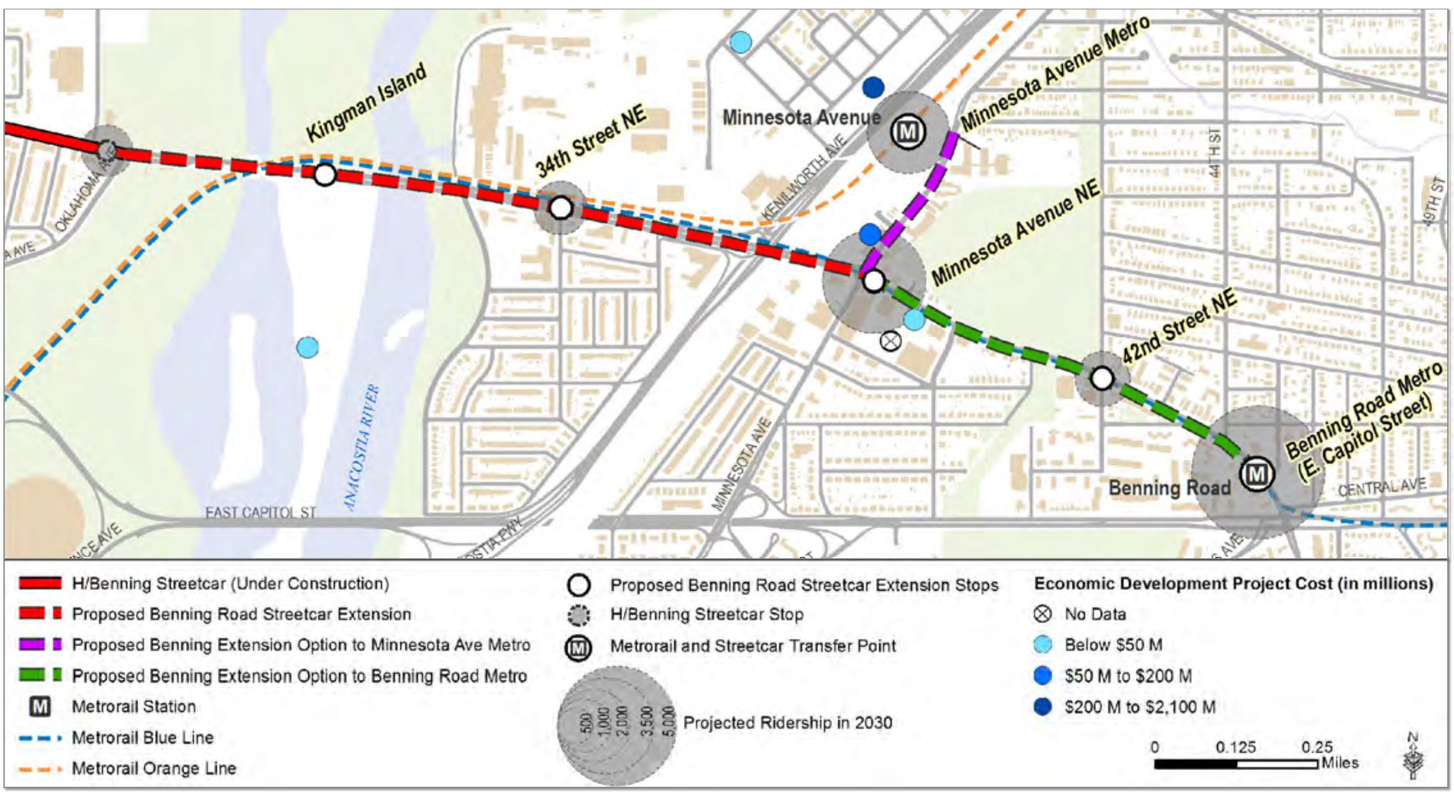
2011/12 - Streetcar Land Use Study Phase One

2005 2006 2008 2010 2011/12

Recently completed or ongoing projects related to the transportation improvements in the study area:

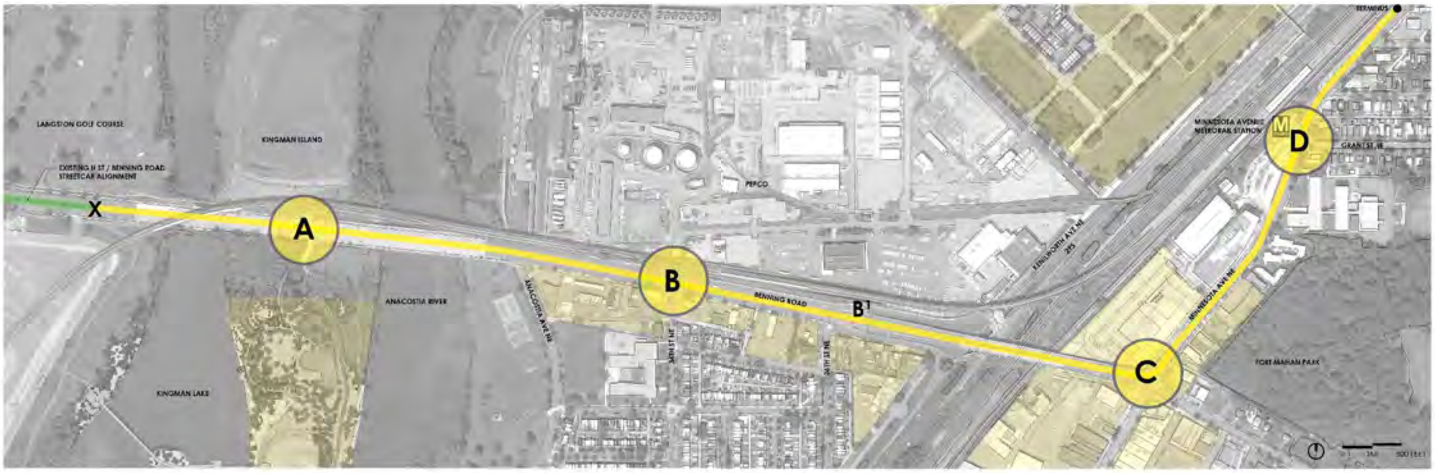
- Far Northeast Livability Study (2012)
- Benning Road Great Streets Improvements (completed mid-2012)
- Revitalization of Minnesota Avenue Project (Ongoing)

Planned/Proposed Economic Development Activities Along the Study Corridor



*Note: Economic development data from 2009 DC's Transit Future Study

Proposed Stop Locations

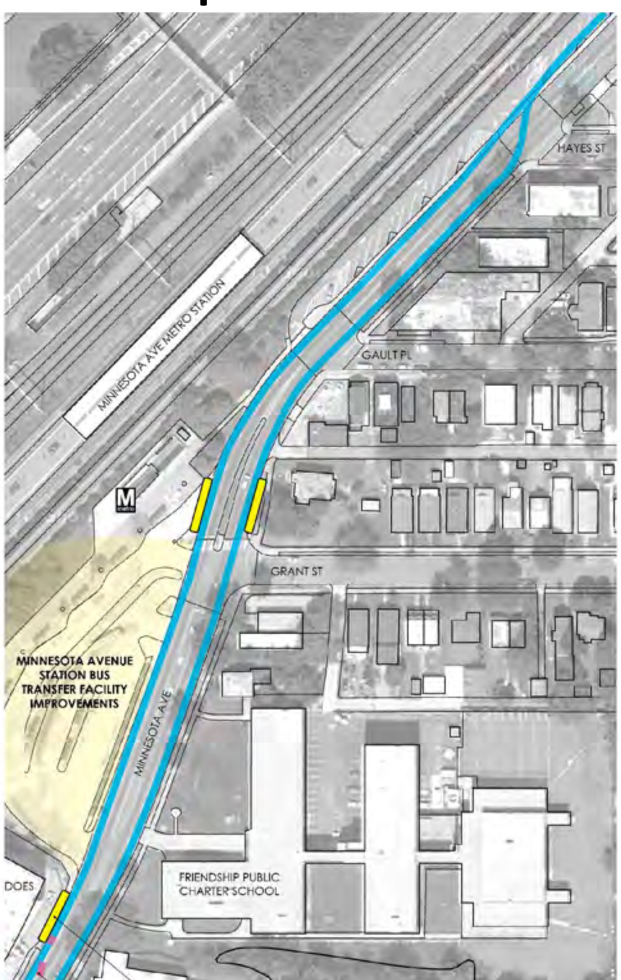


Terminus Options

Legend

- POTENTIAL FUTURE DEVELOPMENT*
- STREETCAR STOP
- MEDIAN STREETCAR ALIGNMENT
- CURBSIDE STREETCAR ALIGNMENT
- ALTERNATIVE MEDIAN ALIGNMENT
- ALTERNATIVE CURBSIDE ALIGNMENT
- PROPOSED CROSSWALK

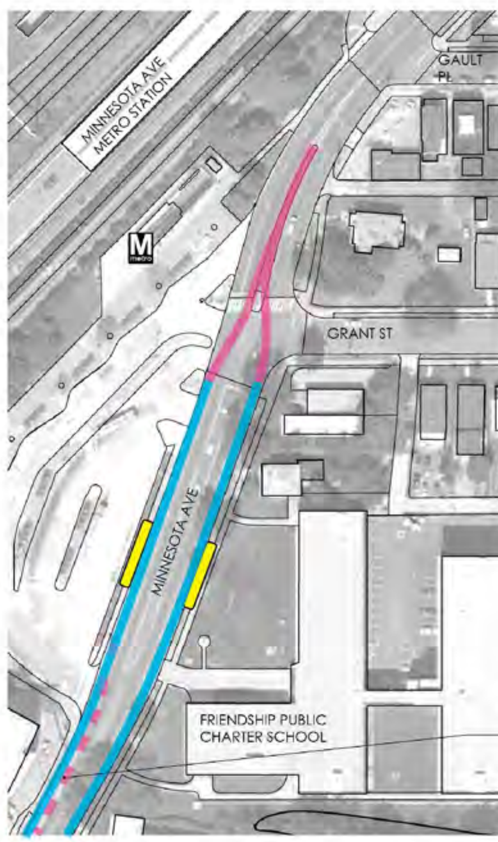
*Potential future development sites were identified in: the 2008 *Benning Road Corridor Redevelopment Framework Plan* and the 2008 *Deanwood / Great Streets - Nannie Helen Burroughes Ave NE & Minnesota Ave NE Strategic Development Plan* by the District of Columbia Office of Planning; and the 2006 WMATA *Minnesota Avenue Metrorail Station Access Improvement Study*.



D.1

Alternative southbound stop prior to station improvements

Alternative southbound alignment transitions from curbside to median



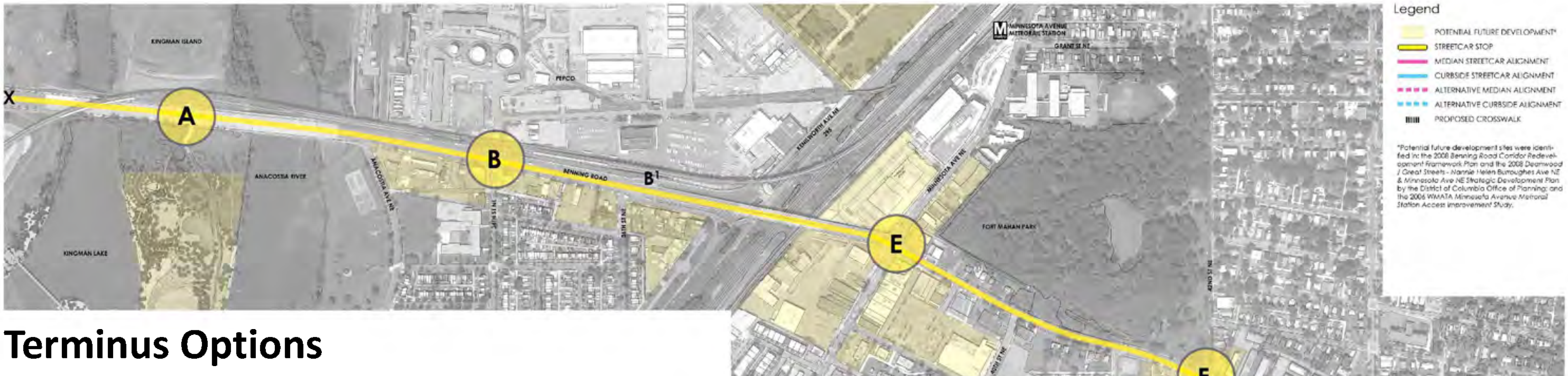
Alternative southbound alignment transitions from curbside to median at potential traffic signal at bus facility exit

D.2

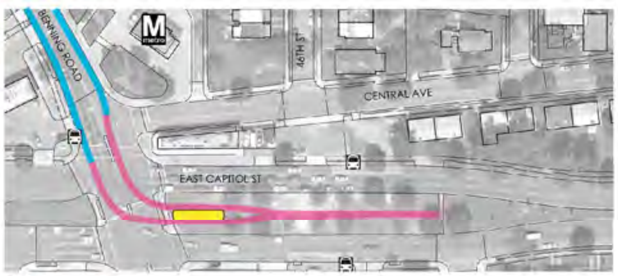
0 50 100 FEET

BENNING ROAD METRO STATION
TERMINUS OPTIONS

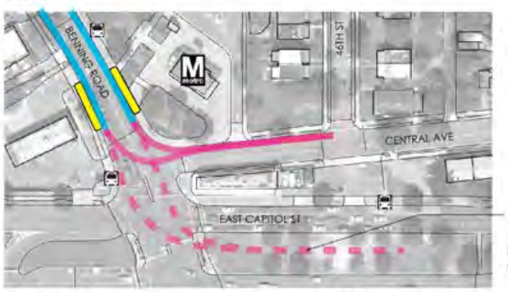
Proposed Stop Locations



Terminus Options



G.1



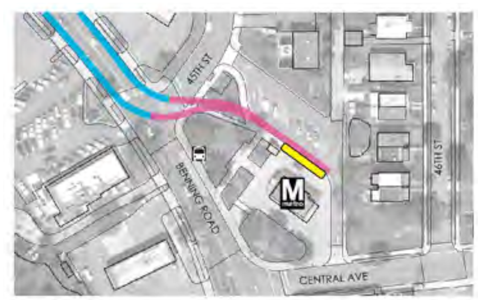
Alternative turnaround in median of East Capitol Street

G.2

0 50 100 FEET

One-way vehicular traffic east of 46th Street

G.3



G.4

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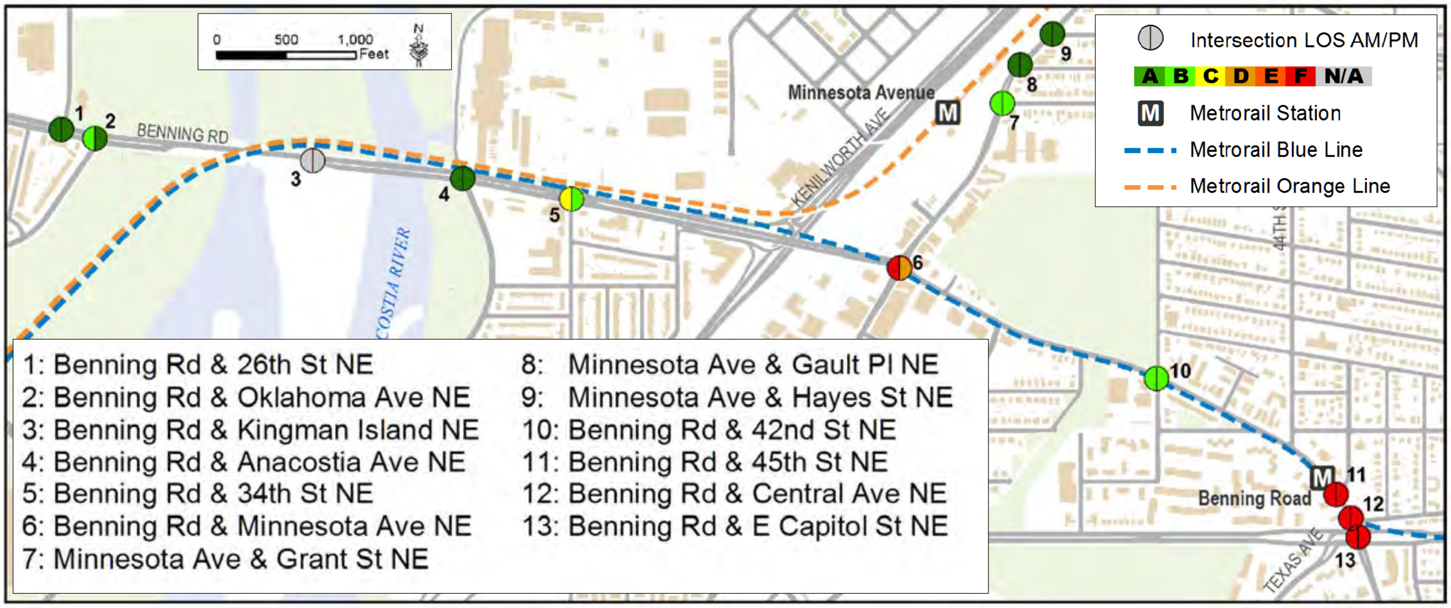
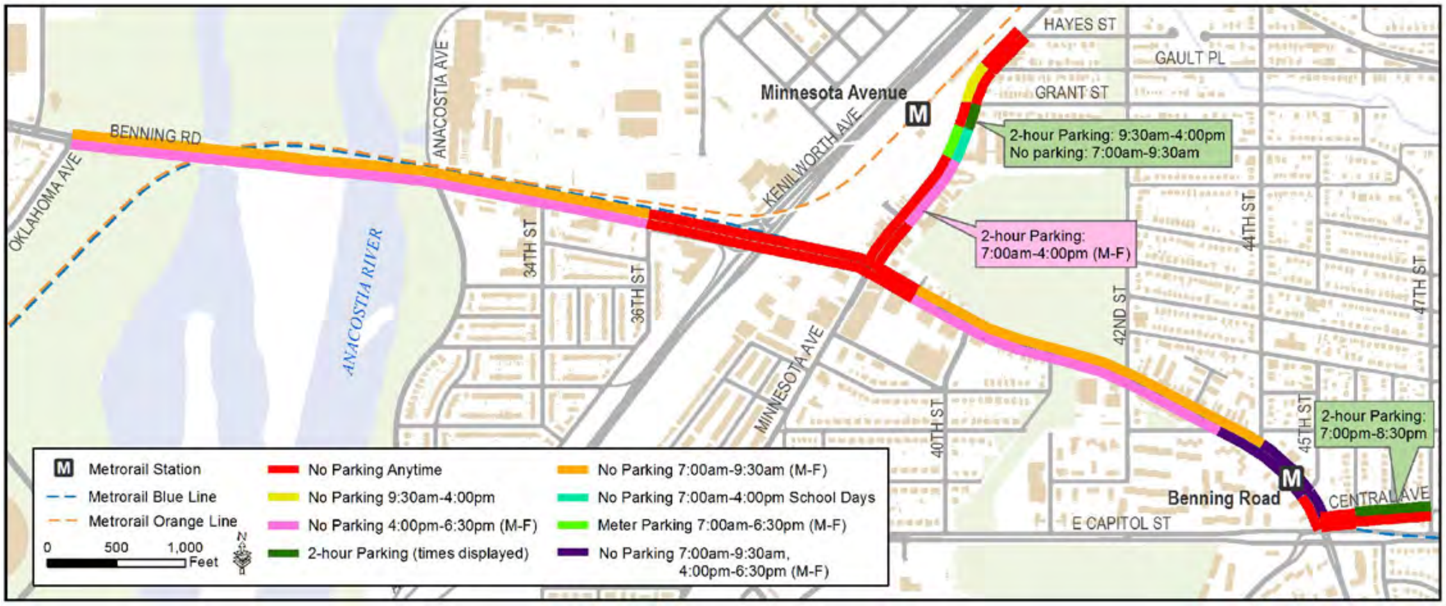
2040 No-Build (without streetcar) Intersection Level of Service (LOS)



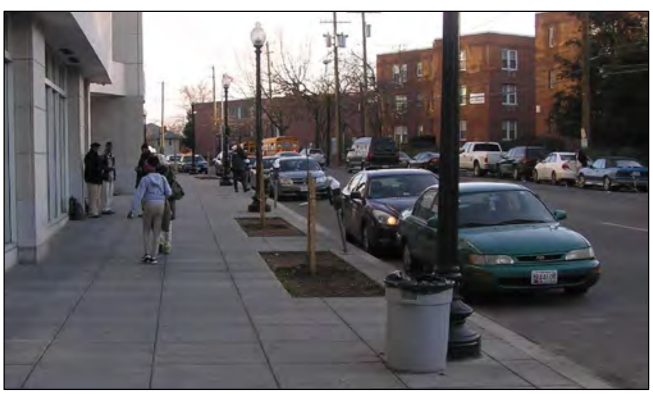
2040 Build (with streetcar) LOS Conditions

- Streetcar is assumed to run every 10 minutes (6 streetcars per hour in each direction).
- Streetcar operations do not cause unacceptable LOS at the study intersections that are projected to operate acceptably in 2040.
- The intersections of Benning Rd & Minnesota Ave as well as Benning Rd & E Capitol St will continue to have capacity constraints with or without the streetcar.
- On-going studies are addressing the needs of all users, particularly pedestrians. Streetcar design could accommodate a pedestrian-friendly environment and facilitate "place-making" along the corridor.

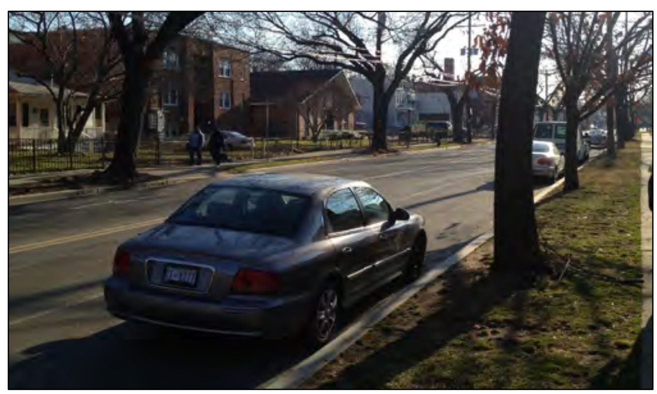
EXISTING ON-STREET PARKING CONDITIONS



- Curbside-running track affects on-street parking, drop-off and loading activities.
- Center-running track generally needs wider right-of-way to accommodate median stops.



On-street parking along Minnesota Ave



On-street parking along Benning Road

PROJECTED 2040 DAILY RIDERSHIP ESTIMATES

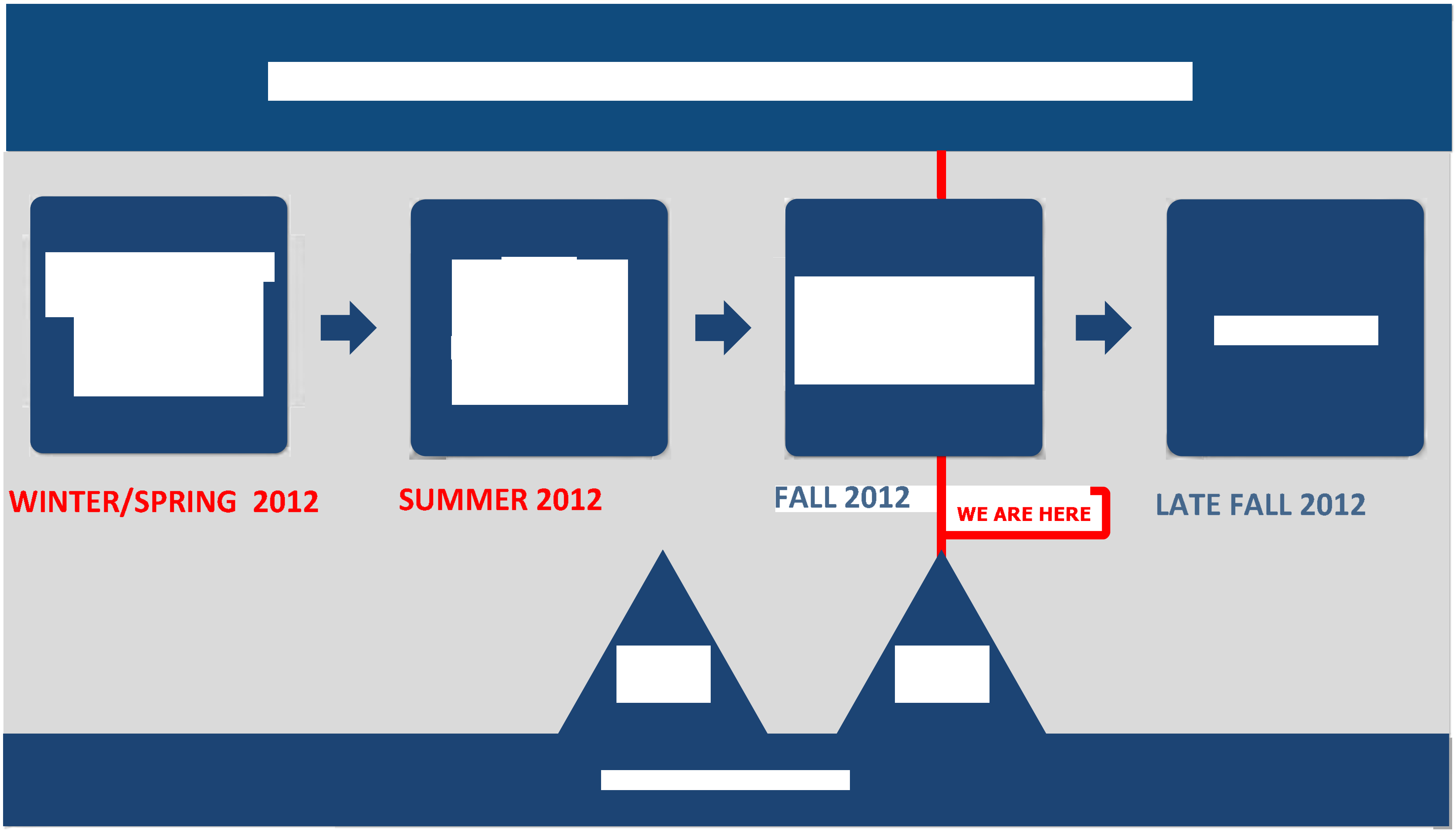
Streetcar Segment	2040 Daily Streetcar Ridership*
No Build (without extension) - Oklahoma to Union Station	4,250
Build – Benning Road Metro Extension	7,750
Build – Minnesota Ave Metro Extension	4,800

**Assumes that no buses are removed from service as planned; land use reflects 2040 MWCOG population and employment forecasts.*

The Minnesota Ave/Benning Rd Intersection is an important activity center

The Metrobus X Line has several heavily used routes along the corridor

STUDY SCHEDULE



NEPA environmental documentation is expected to begin Winter 2013 for further study of the project.

Attachment I:

Public Meeting #2 Transcribed Meeting Notes

Benning Road Streetcar Extension Feasibility Study
Transcribed Comments from Public Meeting #2

Location:
Department of Employment Services, 4058 Minnesota Avenue NE
Tuesday, November 27, 2012

Meeting Time: 6:00pm-8:00pm

Total Number of Participants: 47 participants

Meeting Agenda:

6:00pm	Open House
6:30pm	Presentation
7:00pm	Break-out Group Discussions
7:30pm	Break-out Summary & Meeting Wrap-up

Welcome – Circe Torruellas, DDOT

Study Overview –Selman Altun, AECOM

Q: *The way you all presented the options, it looks like we have to choose from either Minnesota Avenue or Benning Road Metro Stops, is that the case?*

A (Circe): *Right now it is either/or. That doesn't mean another alternative could not be pursued later down the road through an environmental review process.*

Q: *Will your study report make a final recommendation? Who will ultimately make the decision between the two?*

A: No. *The report will take into consideration the pros and cons of both options and based on all of your feedback and, a combination of studies, including traffic analysis, bridge analysis, ridership forecast, etc., these considerations will then move forward to further study through an environmental document. The environmental document will provide the final* *recommendation. If this project becomes federalized, meaning federal dollars might be used for a portion of the project, we will work with partners such as FHWA and FTA following the NEPA process. That process will result in a preferred alternative and a final decision document being produced.*

Q (Committee of 100 Chair): *On the H/Benning line, you all still allow for parking with bump-out station platforms, why couldn't the same be done on this end?*

A (Selman): *For sections of this area one could, but not for others. For one, the roads are much narrower over here. That is the goal of our table discussions to have you review several series of options and give us your input.*

Break-out Group Discussions

At the conclusion of the study overview presentation by Selman Altun, the public was organized into five groups to further discuss the various alignments and stop location options. The discussions at each table were centered on specific areas of interest that the project team was interested in additional feedback from community members. These specific areas of interest include: parking impacts, traffic "hot spots", pedestrian safety, termini connections and connection/availability to current and future transit services in the neighborhood. At each of the five break-out groups, table maps were provided to help the group facilitators lead the discussion on the various series of options. The transcribed notes and key points made from each of the discussion break-out groups are found below:

Breakout Session, Table 1:

- How does the Minnesota Avenue Great Streets project plays into all of this? Pleased to see pedestrian friendly options being included in the concept designs.
  Good idea to extend to Benning Road Metro, leaving the possibility for East Capitol connection.
- Majority of parking on sections of Benning Rd and East Capitol is residential.
- Traffic on the Minnesota Avenue extension –
  - Peak scheduling would have to be considered to mitigate the rush hour congestion
  - People will have to adjust to streetcar operations
- Does the study preclude other extensions?
- Recommend maintaining BOTH extensions, not either/or
- Consider using the CSX lines – being decommissioned and would cut construction costs
- Benning Road Metro Terminus
  - Central Ave less congested for tail track
  - WMATA-owned storage yard across from the Shrimp Boat
  - Loop idea – E. Capitol St median, then north near 46th St, west on Central Ave back to Benning Rd
- Consider an extension to Deanwood Metro

    - Far less congested than this area.
    - More development opportunities for that area, which has space to grow.
    - Increase revenue from MD commuters in the neighborhood (DC), since it borders Prince George's County.
- Friendship School – evening and Saturday activity on Minnesota Ave – pick-ups and drop-offs will be impacted by streetcar
- Median alignment seems better – allows for dedicated right of way.
- Streetcar Signals – use bars of white light similar to Baltimore
- On-Street parking – note some is used by police station at Benning and 42nd St

Breakout Session, Table 2:

- Structural concerns with the bridge – length of reconstruction process
- Construction impacts to residences nearby
- Timing of Pepco burying wires vs. adding more for streetcar – visual clutter already a concern
- How will future construction be phased?
- Kingman Island Stop: Both options seem fine
- 34th Street Stop: loss of parking with the B3 option needs to be explored – especially with regard to residential parking (currently no restrictions).
- Minnesota Ave/Benning Rd (C Series):
    - C2 seems to be against traffic calming measures and pedestrian safety plans.
    - Buses already pile up at this intersection and impede traffic flow. Will stops on the bridge (C3) back up traffic on the bridge?
    - Is C2 a better option because it allows the streetcar to turn onto Minnesota Ave first?
    - C3 better for pedestrians because they don't have to cross traffic lanes.
    - Maintains business focus with whatever C option is chosen.
- Minnesota Ave Metro: Be sure to combine reconstruction projects to lessen impacts to residents
- Three main points of table:
    - Loss of parking in residential areas (E & F) and trickle down issues into the residential neighborhoods.
    - Single-lane traffic is a no-go on Benning where a median stop will take a lane of traffic.
    - Prioritize pedestrian safety and business access with all options.

Breakout Session, Table 3:

- Section A
    - Why not build up for pedestrian safety (pedestrian crossing, dedicated travel lane for streetcar)
- Section B
    - Issue with room for parking and sidewalk

- Section C
    - Accessing Stops
    - Curbside access better for pedestrians
- Section D
    - Curb to Kiss and Ride

<u>Breakout Session, Table 4</u>:

- Concern about additional construction impacts on Benning Road (and Minnesota) and East Capitol St.
    - Could there be other community benefits (FIOS) if streets are reconstructed?
- Concern about bike accommodations at stations and trackways
- Would like ANC/Civic Association Presentations
- Curbside parking not an issue on Benning- even less in future with streetcar
- Concerned about having to cross Benning Road to access center platforms
- At 34th Street Stop should enhance access to existing strip mall (in front) – in median best
- Want plan to include quality street trees
- Prefer G options that stay off of East Capitol Street. Best stop is behind Benning Metro.
- Can headway be less than 10 minutes?

<u>Breakout Session, Table 5</u>:

- Curbside stops work better with Minnesota Ave Terminus
- Kiss and Ride drop off could be relocated
- Minnesota Ave congestion
    - Metrobus Traffic
    - Commercial Traffic
- Bad Idea with stop in front of school (D2)
    - Kids drop off
    - Buses turning
    - Alternate option – stop beyond the school
- C3
    - Safer to allow/facilitate pedestrian access
    - Residential parking
    - Most traffic is from Maryland or other areas
        - How can we get them to choose another way thru the area?
- C2
    - Bus stop impacts
        - Carry out/24 Hour Shop (may be redeveloped)
- Option C – get off Benning Road Bridge
- How will handicapped residents access the streetcar stations?
- Residential parking both sides of Benning Road
- Police Station is being relocated; opportunity for development/parking

- Can streetcar loop around for option G2?
- City property at East Capitol Street availability is an advantage (G1)
- Bad stop location (E3)
- E2 is a good location
- Historic site (old movie theatre south of Benning Rd/Minnesota Ave)
- F2 is good, minimizes conflicts
- Extend alignment to East Capitol Street near St. Luke Church – Central Avenue
- Parking for disabled residents near station stops
- Don't duplicate Metro line alignment
- Why tear up Benning Road again to accommodate streetcar?
- Could the kiss and ride at Minnesota Ave Station be moved up?
- D2 is not a good idea
    - Wheelchair access is required
    - Conflicts with buses
    - 80' turning radius
- What would make the times quicker
- What times will they run at 10 minute headway?
- How many new streetcars are required?
    - 4 for Minnesota Ave option
    - 5 for Benning Road option
- How many people?
    - Capacity is 130 persons/car
- Why is the Minnesota Avenue Option being considered also?
- Why is 2040 the horizon year?
- Curbside alignment/stop location is better option
- Maryland traffic needs to stay away from neighborhood streets
- Lots of residential parking on Benning Road to consider

Debriefing following Summary given by Facilitators:

Q (Janis Hazel, President of Central Northeast Civic Association): *The issue is not just living through four more years of having our roads torn up, but what is the net benefit for residents? Could additional "telco" lines or Fios be installed when the streets are dug up again?*

A: *These are considerations and recommendation we want to hear from the community and there is an opportunity here to have this conversation about the overall benefits in the future including the possibility to work with the utilities.*

Q: *Can we get a before and after detailed analysis of the traffic study you mentioned, so we know what the real impacts are?*

A: The Final Report that will include this information will be completed in December 2012 and posted on the DC Streetcar Website.

Comments after meeting:

Janis Hazel: *What is the communications plan to reach this demographic over here? Tweeting, Facebooking and emailing won't work exclusively, there needs to me more hands-on outreach. It's good to have traffic studies and development projections (Council of Governments report), but surveys and studies need to be conducted to weigh the impact on consumers. Why not poll PG or MD residents to determine how their transportation planning would change as a result of streetcar? There is a restaurant and entrainment desert in Capitol Heights, District Heights, and Largo. How can we capture those people and bring them into the H/Benning Corridor? Right now when they want to go somewhere, they're going to western portion of downtown, VA, and other parts of MD.*

Comment Sheets received at meeting:

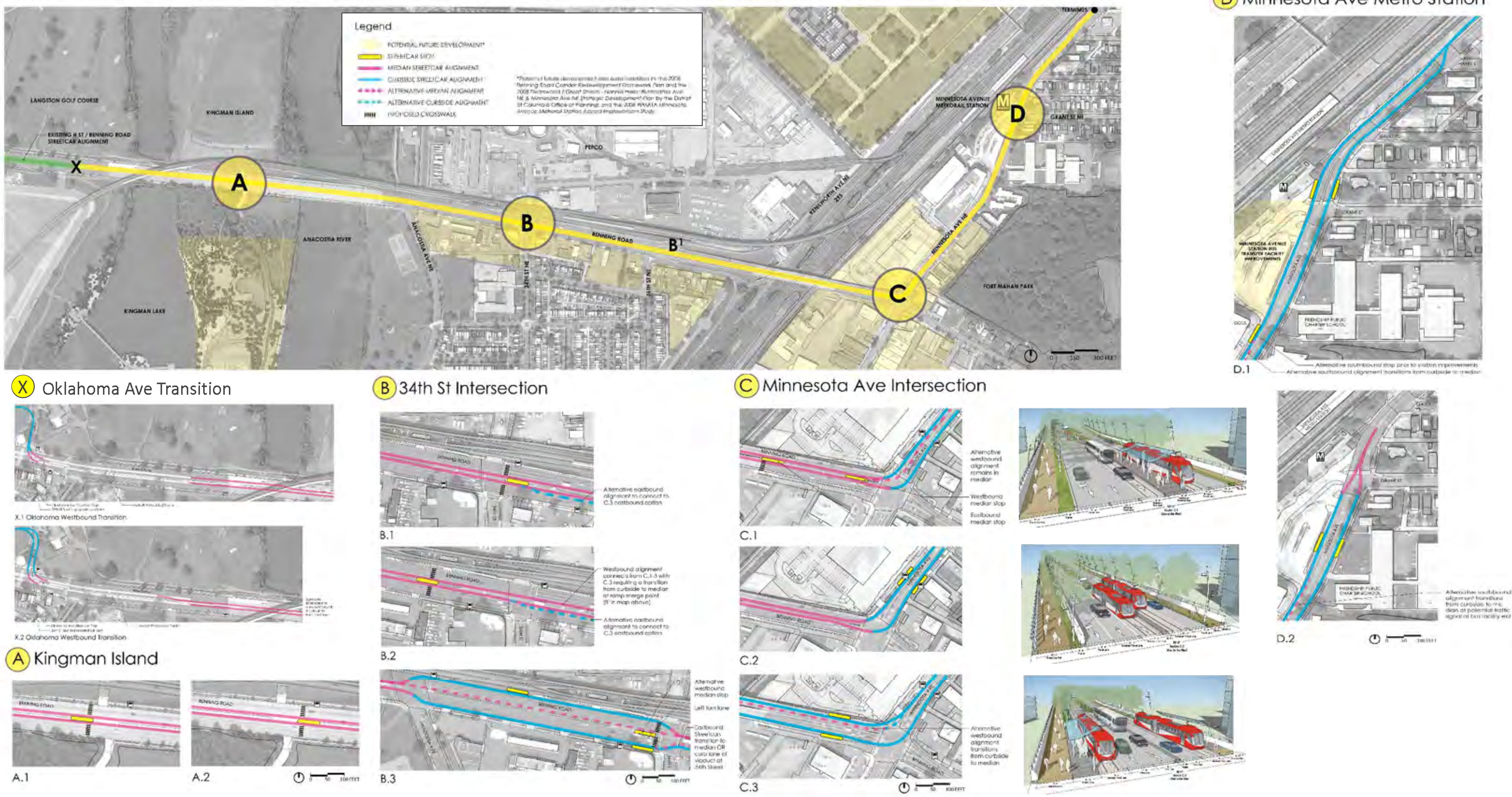
1. One should arrange overhead contact wire in such a way that it might accommodate both pantographs and trolley poles. Streetcar switches should function in such a way that they should not require that a streetcar operator should leave or reach out of his/her streetcar.
2. DC Streetcars should have large windows that one can open and close.
3. I am in the preproduction stages of a documentary film on DC Streetcars – Then and Now. I would love to be kept up to date on Streetcar events.
4. Residential effect of streetcar along the Benning Road area where construction has already taken place. Traffic and pollution concerns. Property Stability for residents already living in areas where stability is a concern along Benning Rd/Minnesota Ave and East Capitol.
5. Extending the "One City line to Minnesota Ave Metro Station is a far better option than extending it to the Benning Road Metro Station because:
    - Shorter distance would improve service along entire line with shorter waits with fixed number of streetcars operating.
    - With the massive development planned and under construction in Parkside neighborhood – City Interests Planned Unit Development, MetroTowns, etc. – ridership at Minnesota Ave is vastly underestimated as are future ridership needs.
    - Fort Mahan Park severely limits development potential adjacent to a streetcar line to Benning Road Metro Station.
    - Shorter distance reduces both capital and operating costs.
6. Very clear and concise presentation. I'd like to see this happen as speedily as possible, would like to see streetcars serve both Minnesota Ave and Benning Road Stations, and would prefer curbside running.
7. Capitol Traction and Electric suggests roadway-center alignment with side loading platforms. This would allow dedication of right-of-way.

8. Capitol Traction and Electric suggests that DDOT configure Benning Road's viaduct bridge to allow CT&E's Route 10 (more information available elsewhere) to service Deanwood. Please refer Capitol Traction and Electric's streetcar proposal.
9. Consider Deanwood Metro.
10. Streetcar signals should consist of bar of white light where streetcars should move differently than surrounding traffic. Whilst a vertical bar will indicate that a streetcar may proceed straight, a horizontal bar of white light will serve as a streetcar stop signal.
11. DC needs to prioritize transit over cars, take car lanes, parking for dedicated transit lanes. Transit must be fast!
12. Need streetcar to extend to Capitol Heights Station!! Benning Road Extension is a must have!
13. Could Streetcar extend to Capitol Heights?
14. Include SmarTrip card to be used for streetcars without double or additional costs.
15. Will there be quality bicycle parking near the streetcar platforms? Will there be on-street bicycle accommodations? With there be quality landscape design and large street trees planted along the corridor?
16. The streetcar is only useful if a trip takes less time than it would in a car. Therefore, the rails should be separated from cars (no mixed traffic). For pedestrian safety, as many stops on the curb as possible is better.
17. Highly recommend option to extend to Benning Road and not Minnesota Ave. The ridership increase cannot be ignored and would provide a greater return on investment.

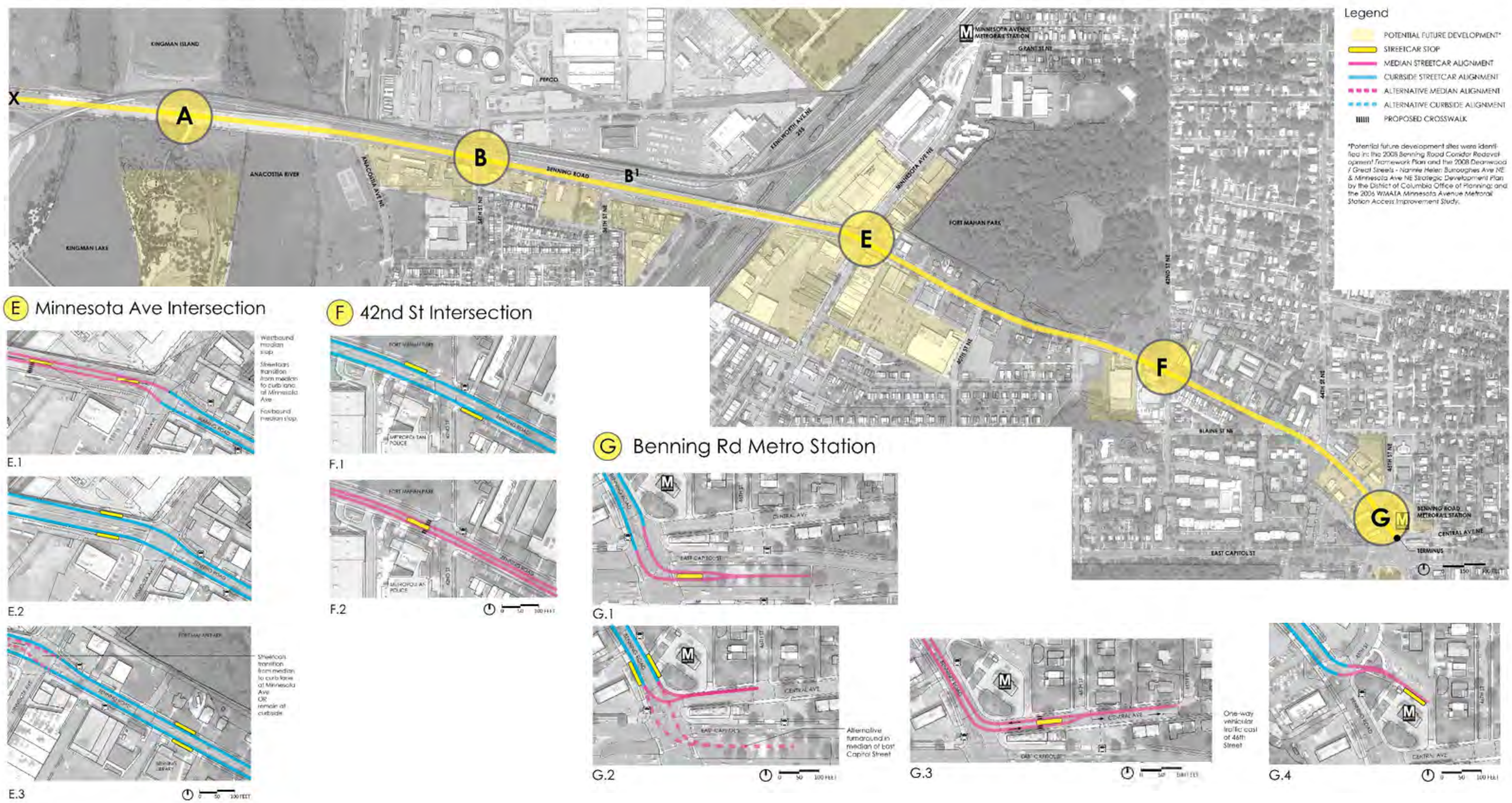
Attachment J:

Public Meeting #2 Table Maps

Benning Road Streetcar - *Minnesota Ave Metro Terminus Alternatives*



Benning Road Streetcar - *Benning Road Metro Terminus Alternatives*



Appendix C:

Conceptual Track Alignments Analysis Technical Memorandum

District Department of Transportation

BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

CONCEPTUAL TRACK ALIGNMENTS ANALYSIS TECHNICAL MEMORANDUM

November 2012

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Introduction

This memorandum provides a detailed discussion of the development of conceptual track alignments for the Benning Road Streetcar Feasibility Study.

Description:

Track alignment design establishes a series of horizontal and vertical geometric components that, when connected together, create a guideway on which the streetcar can operate. Vehicle clearance design defines a physical clearance envelope, into which no object can intrude for the streetcar to operate safely. The clearance envelope is derived based on physical properties of the streetcar, track alignment, and construction and maintenance tolerances.

Conceptual track design included development of horizontal track alignments, and clearance envelopes to validate the feasibility of the Conceptual Alternatives X, and A – G, as described herein. Vertical track geometry was only reviewed at this conceptual design level. It is anticipated that only the vertical alignment at the Benning Road / Minnesota Ave intersection, which locates in Alternatives C and E, will impact guideway design.

Design Criteria:

The DC Streetcar Design Criteria, and DC Streetcar Standard Drawings, both dated January 2012, were used as the basis for conceptual track design. As the project progressed however, it became obvious that basing track alignment design in accordance with the requirements of the design criteria, specifically in relation to spiraled curves, and minimum component lengths, would create a guideway that required significant roadway reconstruction, and traffic control modifications. Based on these initial findings, senior DDOT staff directed that the track designs be modified to closely match the roadway geometry, but that the minimum curve radius of 66' be maintained. This resulted in removing spirals in many of the curves, introducing relatively short geometric element lengths, and the creation of aggressively short reverse curves when transitioning from median to curbside running. Direction was given that a list of design criteria violations be created, and an explanation be provided for each violation. This list is included in this memorandum as Appendix B, The Track Alignment Design Exceptions Report.

While alignment geometry criteria was violated to meet to match the existing roadway geometry, the design criteria requirement to provide tangent alignment at streetcar stops, and the vehicle clearance criteria was maintained when developing the guideway design.

Typical Section Development:

Track alignment was developed to meet the needs of the general schematics, and the design criteria. The starting point for design was developing typical roadway sections. Typical section design requires a knowledge of the existing roadway configuration, where the alignment will locate within the section, and the clearance envelope required for safe operation of the streetcar vehicle.

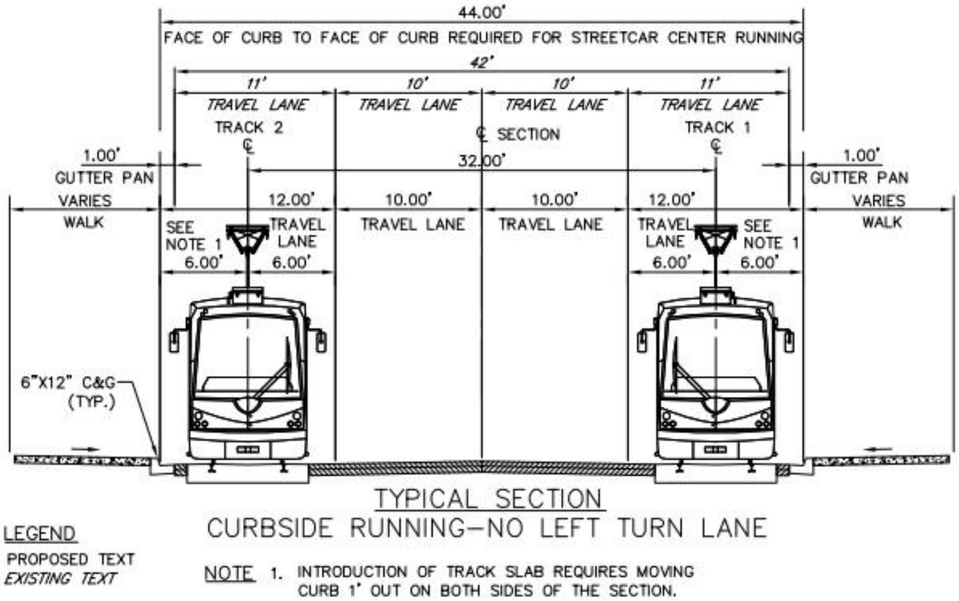
The roadway typical sections along Benning Road were developed using data provided by DDOT or from GIS sources. The DDOT data included curb lines and pavement markings, while the GIS data only included curb lines. Where only curb lines were available, an educated guess was made as to lane widths by field investigation, and web based data such as Google Earth. The existing typical section on Minnesota Avenue and along Benning Road in the general vicinity of the Benning Road / Minnesota Avenue intersection was developed using data provided by DDOT from the proposed Minnesota Avenue Revitalization Project, 90% design plans, designed by AMT Consulting Engineers. This project is in the design stage, and proposes to revitalize Minnesota Avenue between A Street and Sheriff Road, including repaving, and providing new signage and pavement markings.

Guideway location within the typical sections was set based on the needs of the schematics. Typically, the guideway would locate in one of two configurations in the section; curbside or median. Curbside location places the streetcar alignment in the outside traffic lane adjacent to the curb. Median location places the streetcar alignment in the inside traffic lane, adjacent to the median. Where no median exists, the alignment locates in the inside traffic lanes.

With the guideway location and existing roadway schematic developed, the last step in the process of typical section design was to identify the vehicle dynamic clearance envelope, and fit that envelope within the confines of the typical section. In accordance with the design criteria, the streetcar vehicle dynamic width, on tangent track, is nominally 11 feet. This means that for safe operation, on tangent track, the traffic lane for which the streetcar vehicle operates must be at least 11 feet wide. When the alignment negotiates horizontal curvature, or superelevation, this dimension will increase to account for end and mid-ordinate overhang of the vehicle. Given that the 11 feet dimension is absolute minimum, it was decided to increase the width of streetcar lane to 12 feet. This would provide a lane of continuous width, and eliminate the need to widen and reduce lane widths at the beginning and ending of horizontal curves. Unfortunately, the existing travel lanes within the study area are less than 12 feet, with the center turn lane being between 10 and 11 feet wide, the inside travel lanes being 10 feet wide, and the outside travel lanes being 10 feet wide with an additional 1 foot wide gutter pan. Therefore, introduction of a 12 feet travel lane to accommodate the streetcar clearance envelope will require widening of the overall typical section. The extent of widening of the existing typical section was dictated by the streetcar guideway location within the section.

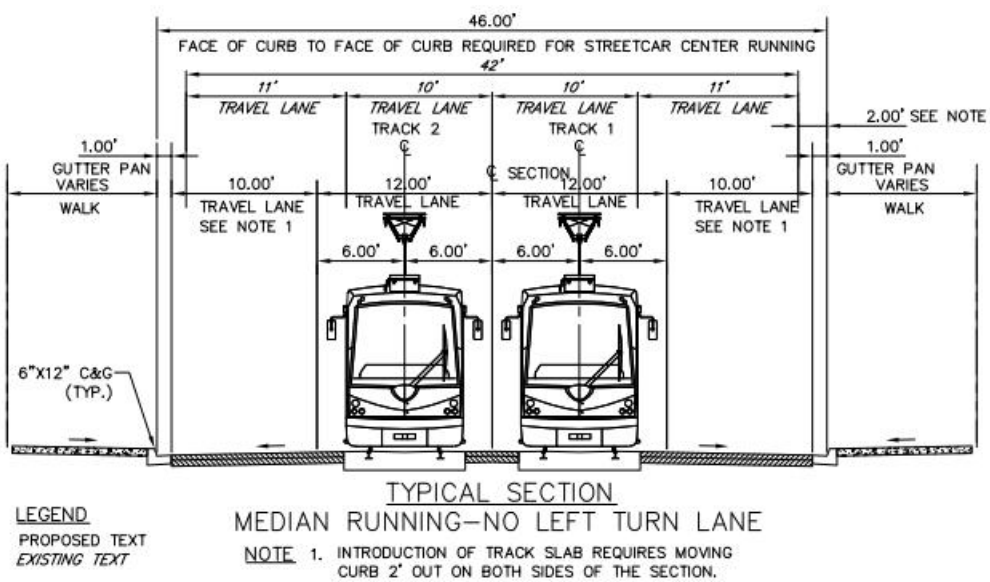
When the guideway was proposed as curbside running, the centerline of streetcar alignment was set 6 feet toward the curb line, from the pavement strip that delineates the right and left travel lanes. This places the centerline of track 5 feet from the existing curb line. To accommodate the clearance envelope of 6 feet on either side of centerline of track, the typical section would need to be widened by 1 foot on either side of the section, creating a proposed section 44 feet wide, or 2 feet wider than the existing 42 feet wide section. Figure TYP 011B illustrates this section.

Figure TYP 011B Typical Section; Curbside Running – No Left Turn Lane



When the guideway was proposed as median running, the centerline of streetcar alignment was set 6 feet toward the curb line, from the pavement strip that delineates the travel lanes at about the centerline of roadway. This creates a 12 feet center to center track spacing, and effectively widens the center travel lanes from 10 feet wide to 12 feet wide. Adding two 10 feet wide outside travel lanes and two 1 foot wide gutter pans creates a typical section 46 feet wide, or 4 feet wider than the existing 42 feet wide section. Figure TYP 006A illustrates this section.

Figure TYP 006A Typical Section; Median Running – No Left Turn Lane



It should be noted that for the median running scenario, the 12 feet track center spacing is not wide enough to accommodate a center catenary pole, and would require a span wire system where the catenary poles would be located curbside, clear of the roadway, and include a span wire that spans the roadway perpendicular to the typical section. The contact wire would be affixed to the span wire, perpendicular to the span wire and parallel to the roadway. From a catenary perspective, this is a more costly solution than using a center pole, however, use of a center pole would require a 14 feet track center, and a further widening of the typical section.

A similar method of setting the guideway was performed when the existing typical section included a center turning lane. For the curbside running scenario, the guideway was required to widen by 2 feet, or 1 foot on either side. Figure TYP 011A illustrates this section. For the median running scenario, the section width depended on the location of the center running alignments relative to the turning lane. In some cases, it was desired to locate the streetcar guideway in the center turn lane, and in others it was desired to locate the streetcar guideway in the center travel lane. If it was desired to locate the alignments outside of the center turning lane, the section was required to widen by a total of 3 feet where the existing turning lane width is 11 feet wide, and 2 feet total where the existing turning lane is 10 feet wide. For both scenarios, the proposed turning lane was restored to a width of 10 feet. Figure TYP 012A illustrates a section where one guideway locates in the center turn lane. Figure TYP 012B illustrates a section where the existing section includes a center turning lane, and the guideways locate in the center travel lanes.

Figure TYP 011A Typical Section; Curbside Running – Center Left Turn Lane

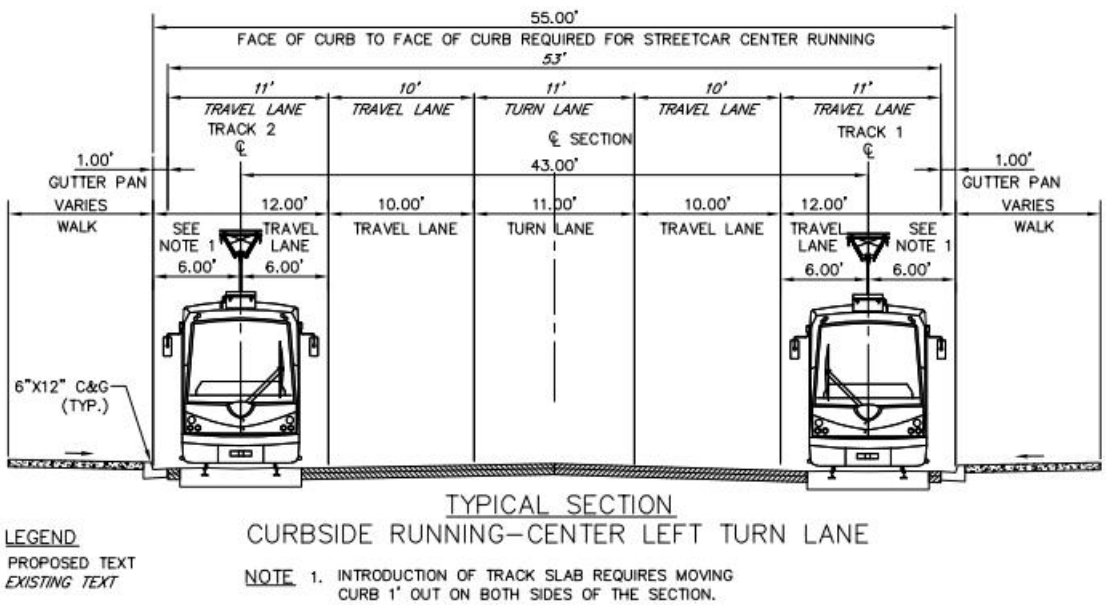


Figure TYP 012A Typical Section; Median Running In Center Left Turn Lane

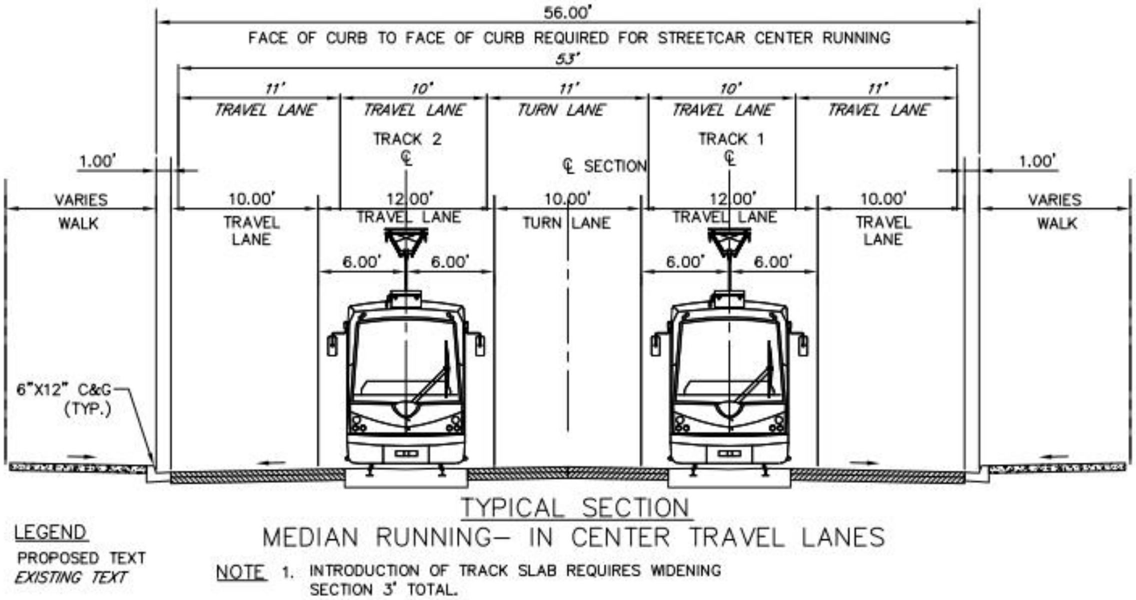
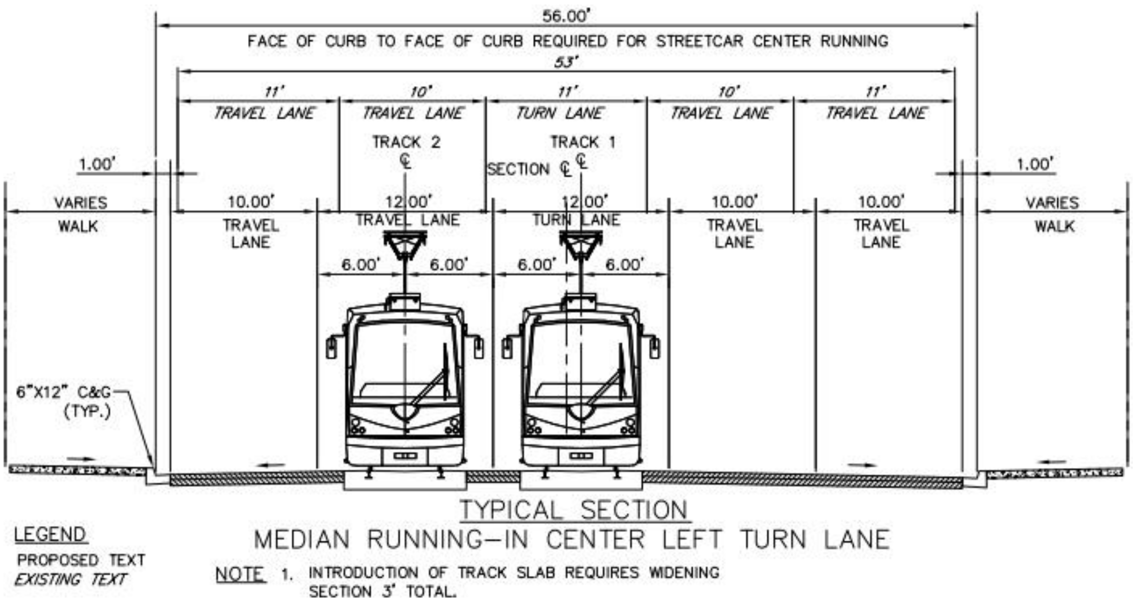


Figure TYP 012B Typical Section; Median Running In Center Travel Lanes



Introduction of streetcar stops creates additional typical section width requirements. The design criteria specifies several different sizes of streetcar stop platform. This design task did not include a design element for sizing of the stop platforms relative to the travel demand. As such, it was necessary to assume a standard stop platform size. The design criteria illustrates curbside stops with a width ranging from 9.5 feet to 14.5 feet, and a length ranging from 49 feet to 70 feet, and median stops with a width of 12 feet minimum, and a length ranging from 49 feet to 70 feet. For purposes of developing the conceptual design, a platform of 12 feet nominal wide by 70 feet long was assumed.

Spatial requirements for introduction of the platforms within the typical section varied depending on curbside or median running scenarios. For curbside running, placing the platform relative to the centerline of track to meet the ADA minimum gap requirements, and maintaining the proposed track alignment tangent bearing, results in a travel lane adjacent to the platform that is 10.19 feet wide, with a 14 inch high platform at the outside edge of lane. The platform acts as a barrier, and creates a substandard lane width condition. It is possible to introduce reverse curves in the track alignment to move the alignment closer to the curb line. This would propose to locate the edge of platform at the proposed curb line, and maintain the proposed 12 feet wide travel lane. However, this needs to be reviewed at the next level of design to weigh the benefits of a 12 feet wide lane, with the increased section width required for the streetcar stop platform. Figure TYP 013A illustrates this section. When the streetcar stop was to be located within a median running guideway schematic, the overall roadway limits must be widened by as much as 16 feet, 8 feet both sides, to accommodate the median streetcar stop platform. Figure TYP 013B illustrates this section.

Figure TYP 013A Typical Section; Curbside Running – Side Platform

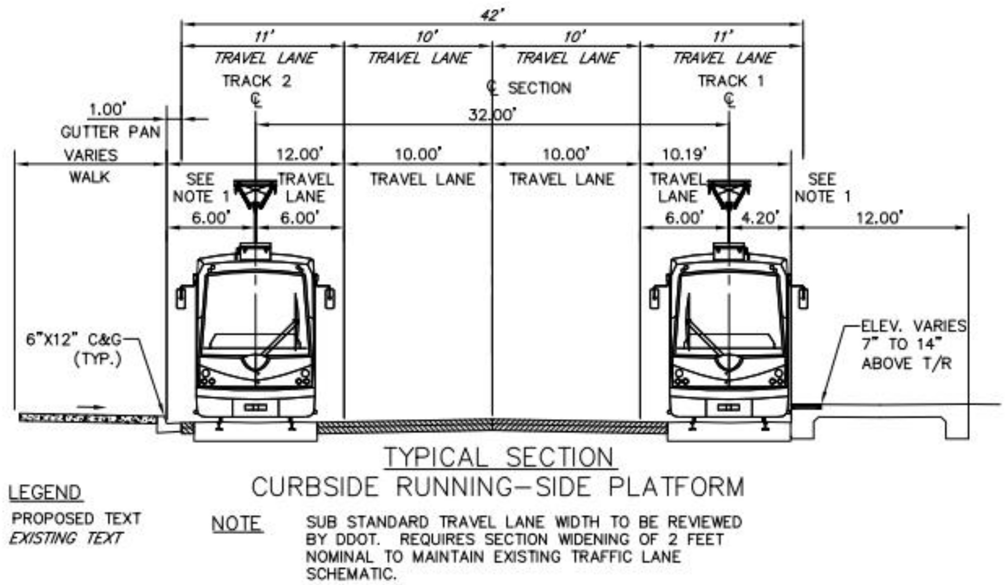
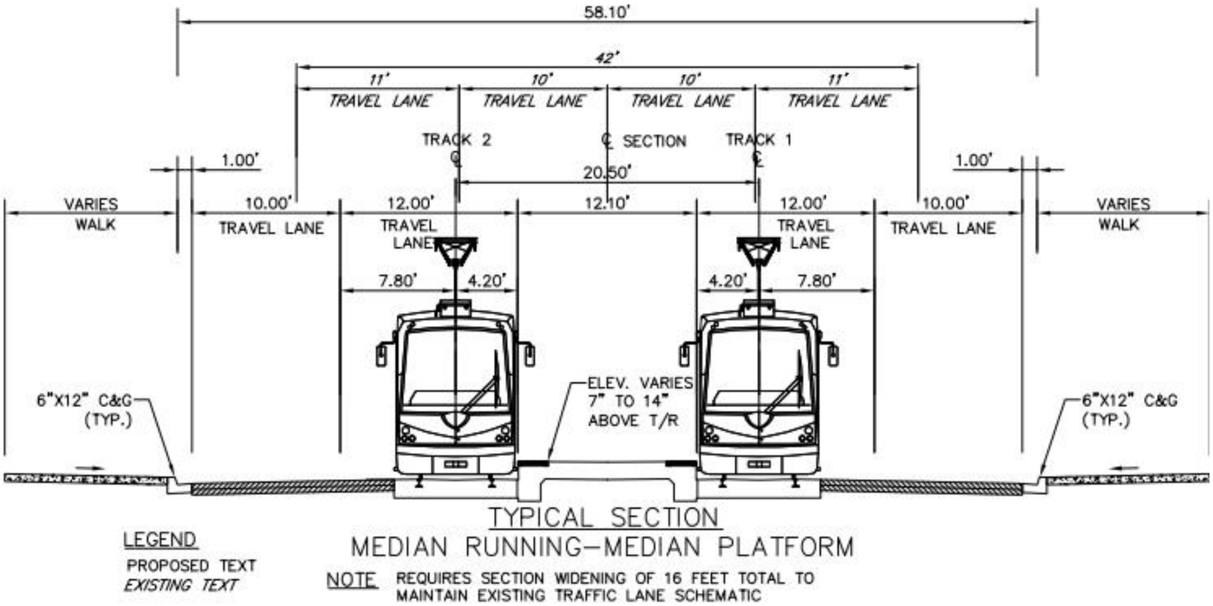


Figure TYP 013B Typical Section; Median Running – Median Platform



There are three aerial structures on Benning Road located within the project limits. These include Benning Road over Kingman Lake, Benning Road over the Anacostia River, and Benning Road over Kenilworth Avenue, I-295, and CSXT. The guideway location was developed to coordinate with the existing and proposed structural configuration and capacity of the bridges. Development of the typical sections on these structures is discussed in detail in the Bridge Structure Engineering Memorandums submitted under separate cover.

Alignment Alternatives Discussion:

In depth descriptions of alignment alternatives in terms of general planning and engineering contexts were discussed in the Development of Alternatives Report. This section identifies critical track alignment and guideway design elements incorporated in the Alternatives for purposes of meeting the needs of the schematic. Discussion is segregated to individual Alternatives. Concept Alternative Plans are included as Appendix A of this document for reference. The reader is encouraged to review those documents, when reading the Alignment Alternatives Discussion.

Alternative X: Oklahoma Tie-in

The “X” Alignment Alternatives serve as a yard lead from the proposed Car Storage and Training Center (CBTC) located on the northwest corner of Benning Road NE, and the Benning Road mainline guideway. The mainline guideway at this location has been constructed, however the CBTC has not. For design purposes, the existing guideway was established based on as-built data provided by DDOT. The CBTC yard lead was established by assuming general dimensions from the site rendering included in the document titled, “DC Streetcar Quarterly Update Meeting”, dated December 6, 2011, on the page titled, “Proposed Car Barn Training Center (CBTC).

X.1 Oklahoma Westbound Unsignalized Transition

The X.1 Alternative includes a single yard lead, located on the west side of 26th Street NE. As this is a single track bi-directional yard lead, a segment of dedicated guideway will be required. Three 20 meter turnouts are included to make the required connections. The 25 meter turnout was not used, as it does not fit within the existing physical space constraints. To provide the necessary tangent geometry required at the special trackwork, it was necessary to set a tangent alignment on the west side of the roadway. The existing roadway is curving at this location. By inserting the tangent it will be necessary to move the west curb west by up to 4 feet, over a distance of up to 175 feet. The location of the diverging track, connecting the westbound Benning Road alignment to the CBTC yard lead will require traffic control to allow streetcar operations operating westbound on Benning Road to the CBTC.

East of the CBTC, Alternative X.1 proposes to maintain the existing as-build guideway track centers to a point at about the the Benning Road Structure over Kingman Lake. At about that location, the track centers are proposed to narrow by moving the north track centerline south. The track centers must narrow to meet the requirements of the bridge structure, as described in the Bridge Structure Engineering Memorandums submitted under separate cover.

X.2 Oklahoma West Bound Signalized Transition

The X.2 Alternative includes two yard lead tracks along 26th Street NE. The alignments converge within the CBTC footprint, which will be dedicated guideway. As with Alternative X.1, there are three 20 meter turnouts included with this Alternative. The 25 meter turnout was not used due to exiting physical space constraints. The alignment geometry associated with turning from the westbound travel lanes of Benning Road to the northbound travel lanes of 26th Street NE require moving the curb line at the northwest corner of the intersection back by as much as 5 feet for a distance of up to 70 feet. The location of the diverging track, connecting the eastbound Benning Road alignment to the CBTC yard lead and northbound on 26th Street to the CBTC will require traffic control to allow streetcar operations operating westbound on Benning Road access the CBTC.

East of the CBTC, Alternative X.2 proposes to maintain the existing as-build guideway track centers to a point at about 275 feet west of the west abutment of the Benning Road Structure over Kingman Lake. At about that location, the track centers are proposed to narrow by moving the north track centerline south. Similar to X.1, the track centers must narrow to meet the requirements of locating the guideway on the structure.

Alternative X, Advantages and Disadvantages:

Regarding the entrance schematic to the CBTC, Alternative X.2 is advantageous over X.1 in that it provides duel access along 26^{th} Street NE. However, as both Alternatives converge to a single track, the both include a single point of failure at the east end of the CBTC. Alternative X.1 includes about double the typical section impact as does X.2. However, X.1’s impact is on the CBTC side, which will presumable be reconstructed as part of the project work, so X.1 would be at an advantage over X.2 with respect to typical section impact. Both options require signalization to allow eastbound to CTBC connectivity.

Alternative A: Kingman Island

A.1 West Median Stop & A.2 East Median Stop

Alternatives A.1 and A.2 propose a streetcar stop on Benning Road, at Kingman Island. At Kingman Island, Benning Road is at-grade for a distance of about 770 feet. On either side of the Island, Benning Road is on aerial structure. The guideway is proposed to be median running in this location. Alternative A.1 proposes the streetcar stop be located west of the Benning Road / entrance to Kingman Island intersection, And Alternative A.2 proposes the stop to be east of that intersection. There are two elements to guideway design within this Alternative which are critical to progressing the design. These elements include the type of guideway proposed on the adjacent aerial structures, and the typical section width at the stop platform.

The project proposes two types of guideway on the adjacent structures; a build up design which would require a streetcar dedicated guideway, and a build down design which would allow for a streetcar mixed traffic guideway. Because Kingman Island locates between these structures, it will be necessary maintain the guideway type through this area that is proposed on the adjacent structures. This is due to the length required to transition the guideway from the raised condition on the structure, to the existing pavement elevation in the mixed traffic condition. This transition length would nominally be in the range of 150 feet, per transition. As well, the vertical tangent required for the platforms introduces another constraint which favors holding the same alignment type between the structures. One item of consideration is that if the streetcar guideway is proposed as dedicated and raised on Kingman Island, cross-traffic movements at the intersection on Kingman Island will need to be eliminated due to the raised streetcar guideway.

Introduction of the stop platform introduces a typical section width issue. The existing typical roadway section includes eight 10 feet wide travel lanes with a 10 feet wide median. Introducing the streetcar stop in a mixed traffic guideway scenario, creates two center lanes of 10.2 feet width, and two 8.75 feet outside lanes. This occurs at the location of the streetcar stop and for a distance on either side of the stop required to transition from wide (20.5 feet) to narrow (12 feet) track centers. The two inside lanes of 10.2 feet in width are substandard in that they locate against the platform which acts as a 14 inch high raised barrier, and the 8.75 feet lanes are substandard in that they do not meet the DDOT requirement for minimum lane width. A similar situation occurs for a dedicated guideway in this Alternative, however, only the outside lanes, which reduce to 8.75 feet wide are affected. In the dedicated guideway Alternative, only the outside lanes are affected as the two center lanes are eliminated due to introduction of dedicated guideway. This substandard condition would occur for about 200 feet on either side of the platform if the alignment design is set to meet the project design criteria for horizontal track alignment.

Alternative A, Advantages and Disadvantages:
From a track alignment and guideway perspective, A.1 and A.2 are essentially the same Alternative, and have the same advantages and disadvantages. The difference is introduced when the option of dedicated or mixed traffic guideway is discussed. That issue will be resolved by the structural analysis, however, transit operators will typically prefer a dedicated guideway option whenever possible for safety and maintenance factors. Regardless of a dedicated or shared guideway option, the typical section will either need to be widened or travel lanes reduced to accommodate the additional section width required by the stop platform in this Alternative.

Alternative B: 34th Street Stop Location and Alignment Options

The B Alternatives propose locating a streetcar stop on Benning Road in the vicinity of 34th Street. The existing typical roadway section includes eight 10 feet wide travel lanes with an 8 - 10 feet wide median.

B.1 East Median Stop
A median running guideway is proposed in Alternative B.1. A stop is proposed to locate on the east side of 34th Street. Because of the median platform schematic, this Alternative includes similar issues as the A Alternatives in regards to the typical section width. Introduction of the platform within the confines of the existing curb to curb typical section creates substandard center and outside travel lanes, of 10.2 feet and 8.75 feet respectively. This substandard condition exists for about 200 feet on either side of the platform. Of note, the track alignment design for this Alternative meets the requirements of the design criteria. The 200 feet transitions could be reduced to 100 feet, if it is desired to violate the design criteria.

Alternative B.1 includes an Alternative for the eastbound (south) track, which would transition from median to curbside running east of the platform. If this Alternative were pursued, traffic signalization would need to be installed to protect the movement from median to curbside running.

B.2 West Median Stop

Alternative B.2 is similar to B.1 in that it proposes a median running alignment, with a median platform, and an option for the eastbound (south) track to transition from median to curbside running east of the 34th Street intersection. The proposed median streetcar stop will require modifications to the typical section or traffic lane schematic to accommodate the platform as discussed in Alternative B.1. There are two differences in B.2 in that the stop is proposed to locate about 200 feet west of the 34th Street intersection, and the eastbound track transition from median to curbside for the eastbound alternative alignment begins at the Benning Road / 34th Street Intersection.

B.3 Curbside Stops (Including Option Benning Road Westbound Transition at Kenilworth Off-Ramp)

Alternative B.3 proposes the streetcar guideway be located curbside between Anacostia Avenue to the west and 34th Street to the east. Transitions from median running to curbside running, or vice versa would occur at either intersection. The Alternative proposes an eastbound curbside platform close to the Benning Road / 34th Street intersection, and a westbound curbside platform about mid-block between Anacostia Avenue and 34th Street. As this Alternative proposes a curbside running schematic, minor modifications to the typical section would need to be considered as discussed in the Typical Section Development section of this memorandum. The alignment geometry in this option includes relatively short sharp horizontal simple curves at the transition points from curbside to median running. These curves do not meet the requirements of the design criteria. The purpose of this aggressive design is to transition the alignment at the intersections.

B.3 includes an Alternative option for the westbound track, which maintains a median running configuration through the limits of the Alternative with a median stop about 60 feet east of the Benning Road / 34th Street intersection.

Alternative B, Advantages and Disadvantages:

From a track alignment perspective, Alternatives B.1 and B.2 are very similar. Implementing either Alternative will require typical section modifications including a lane reduction or significant widening to accommodate the streetcar stop platform. If the option to transition the eastbound alignment from median to curbside running is chosen, B.2 would have an operational advantage in that the transition occurs at the Benning Road / 34th Street intersection which would require less streetcar running time from the intersection, to the point of full transition to curbside running than that proposed in the B.1 Alternative. B.3 includes the least disruption to the typical section in that it only requires consideration of moving the curb lines back by as much as 1 foot, as discussed in the Typical Section Development part of this memorandum. The transitions from median running to curbside running could be designed to meet the requirements of the design criteria, but the transitions from median to curbside running are a disadvantage in that they require interrupting traffic flow on Benning Road while the streetcar vehicle is negotiating the transition. B.3 also includes more aggressive curvature than B.1 and B.2, which would lead to increased rail maintenance issues than the B.1 and B.2 alignments.

Operationally the choice between a median running option (Alternatives B.1 and B.2), or a curbside option (Alternative B.3) depends on the final proposed typical section. If the decision is made to widen the typical section at the proposed median platform, then Alternative B.1 or B.2 have operational advantages and future maintenance advantages over B.3. If it is not possible to widen the typical section up to 4 feet to accommodate a median platform, and lane reduction is necessary, then Alternative B.3 may have an advantage in that it maintains the existing travel lane configuration, with a relatively minor 1 foot widening on each side of the section.

Alternative C: Minnesota Avenue Intersection

Alternatives C and E focus on the Benning Road / Minnesota Avenue Intersection. It is at this location where the proposed guideway either continues east on Benning Road to the Benning Road Metrorail Station, or turns north on Minnesota Avenue to the Minnesota Avenue Metrorail Station. The C Alternative schematic turns north on Minnesota Avenue, while the E Alternative continue east on Benning Road. Additionally, a future north – south streetcar guideway is proposed along Minnesota Avenue as part of the DC Transit Future System Plan. The DC Transit Future System Plan includes both the Minnesota Avenue north-south alignment, and the Benning Road east-west alignment with an at-grade crossing, and a south to west, and east to north connection at the intersection. This future schematic was considered when developing Alternatives C and E.

Because of tight physical constraints and irregular roadway geometry at the intersection, a roadway design was created to modify the intersection to accommodate a 12 foot wide streetcar lane, and necessary section widths to acceptable lane widths adjacent to streetcar stop platforms on Benning Road west of the intersection. Modifications to Minnesota Avenue and Benning Road east of the intersection were made only to facilitate the proposed Benning Road changes. Lane widths and configurations on Minnesota Avenue were not changed.

The proposed horizontal roadway geometry was created to provide capacity for implementation of a streetcar guideway for the Alternatives proposed in this memorandum and for future streetcar guideways as proposed in the DC Transit Future System Plan and indicated herein. The C Alternative track alignments have been designed to accommodate the future streetcar plans in that special trackwork geometry is incorporated in the designs to allow for standard streetcar turnouts to be set in place at a future date without significant modification to the guideway. However, grading at the intersection must be considered as well. At the time this design was developed, sufficient existing electronic data was not available for purposes of developing vertical geometry through the intersection. DDOT did provide centerline of roadway profiles however this was not enough detail to develop the type of grading plan required. The special trackwork components dictate specific vertical geometry constraints. At turnouts, both alignments must be at the same grade and elevation through the limits of turnout. At the crossing diamonds, both alignments crossing must be at a zero percent grade, and the same elevation. When all special trackwork components are installed to meet the needs of the DC Transit Future System Plan, grading requirements at the intersection become very constrained. To understand these constraints, a detailed intersection grading plan would need to be created that incorporates the vertical track alignments, pavement cross-slopes, and curb and drainage inlet elevations. Performing this task requires a detailed electronic model of the existing elevations. This model is commonly referred to as a Digital Terrain Model (DTM). A DTM was not available at the time this design was performed. If DDOT determines that the intersection should be re-constructed to meet the needs of the DC Transit Future System Plan, it is recommended that a grading plan be designed to ensure that the pavement grades can be set to maintain the vertical alignment requirements of the streetcar guideway, and provide pavement surface that drains storm water, and provides a safe driving surface.

C.1 Median Stops on Viaduct

Alternative C1 proposes a median running guideway on Benning Road, and a curbside guideway on Minnesota Ave. A westbound median streetcar stop is proposed on Benning Road about 400 feet west of the Benning Road / Minnesota Avenue Intersection, and an eastbound median streetcar stop is proposed on Benning Road about 75 feet west of the Benning Road / Minnesota Avenue Intersection. The horizontal alignment geometry was set to accommodate future turnouts connecting to the Minnesota Avenue north south alignment, as well as continuation east of the Benning Road alignment. These turnouts are labeled as future. Alignment curves C1-EB03 and C1-EB04 do not meet design criteria as they do not include transition spirals. Curves C1-EB05, 06, and 07 do not include transition spirals, however, these curves represent the future street switch turnout geometry. This Alternative requires modification of the northwest curb line at the intersection for a setback of up to 4 feet for a distance of up to 100 feet in length.

Alternative C1 includes an option for the southbound to eastbound alignment which would locate in a median configuration on Minnesota Avenue, and transition to curbside on Benning Road. This Alternative is not illustrated in the detailed drawings, but was considered in the schematics as a method to eliminate the impact the northwest curb line at the intersection.

C.2 Curbside Stops on Minnesota Avenue

Alternative C2 proposes a median running guideway on Benning Road, and a curbside guideway on Minnesota Ave. Westbound and eastbound median streetcar stops are proposed on Minnesota Avenue about 80 feet north of the Benning Road / Minnesota Avenue Intersection. The horizontal alignment geometry was set to accommodate future turnouts connecting to the Minnesota Avenue north-south alignment, as well as continuation east of the Benning Road alignment. The turnouts are labeled as future. Alignment curves C2-EB01 and C2-EB02 do not meet design criteria as they do not include transition spirals. Curves C1-EB03, and 04 do not include transition spirals however these curves represent the future street switch turnout geometry. This Alternative requires modification of the northwest curb line at the intersection for a setback of up to 4 feet for a distance of up to 100 feet in length.

C.3 Curbside Stops on Viaduct

Alternative C3 proposes a curbside running guideway on Benning Road, and a curbside guideway on Minnesota Ave. Westbound and eastbound median streetcar stops are proposed on Benning Road about 80 feet west of the Benning Road / Minnesota Avenue Intersection. The horizontal alignment geometry was set to accommodate future turnouts connecting to the Minnesota Avenue north south alignment, as well as continuation east of the Benning Road alignment. The turnouts are labeled as future. Curves C3-EB02, and 03, and C3-WB02 do not include transition spirals however these curves represent the future street switch turnout geometry. This Alternative requires modification of the northwest curb line at the intersection for a setback of up to 7 feet for a distance of up to 100 feet in length.

Alternative C3 includes an option for the southbound to eastbound alignment which would locate in a curbside configuration on Minnesota Avenue, and transition to median on Benning Road. This Alternative is not illustrated in the detailed drawings, but was considered in the schematics as a method to eliminate the impact the northwest curb line at the intersection.

Alternative C, Advantages and Disadvantages:

All three alignment Alternatives include similar issues at the Benning Road / Minnesota Avenue Intersection that will be challenging from an operation and maintenance perspective. The proposed Alternatives include very sharp curvature at the intersection, which creates a 5 mile per hour streetcar operating speed through the intersection, significant noise pollution as the streetcar vehicle negotiates the curvature, and increased maintenance required to mitigate rail wear. These items are the same for all of the C Alternatives, but will be a reality if the schematic in Alternative C is implemented.

Another issue that all Alternatives include is the location of future special trackwork elements within crosswalks. The special trackwork turnouts include moving switch points. These provide an opening of about 4.5 to 5 inches, on both rails, at the switch points. This gap is a hazard to cross-walk traffic. The switch points move as a means of directing streetcar vehicular traffic from one routing to another. Throwing of the switches could either be accomplished by a person in a central location, or the streetcar vehicle operator at the intersection. When locating the switches the tight physical constraints of alignment geometry forced the turnouts to locate at their present location. Unfortunately, this required some switches to be placed in crosswalks. As the Alternatives are progressed, design in these areas should be refined to keep the crosswalk outside of the limits of switch.

From a trackwork perspective, Alternative C.3 has advantages over Alternatives C.1 and C.2 in that it includes less curvature. Operationally, from a signalization perspective, Alternative C.3 is disadvantaged in that the eastbound to northbound streetcar movement at the intersection will require all traffic to be stopped, where in the other C Alternatives the streetcar movement can be accomplished with the normal movement of traffic through the intersection. The stop platforms in C.3 conflict with the bus stop locations being proposed in the DDOT Minnesota Avenue Streetscapes Project. Unfortunately, the streetcar stop platform in C.3 is constrained to the area shown by existing roadway geometry, specifically the need to locate the stop on tangent alignment. There is a vertical grade issue in Alternative C.1 that creates a disadvantage for that Alternative. The westbound stop platform in Alternative C.1 is located on a 4.8% vertical grade. The ADA design criteria for maximum grade at a stop platform, for new construction is 2%, however there is a clause in the criteria which allows a grade steeper than 2% when locating the platform in existing streets, to match the existing grades. As the existing grade is 4.8%, this clause would seem to apply and allow a grade greater than 2%. However, the horizontal alignment is proposed to be reconfigured in this Alternative which may be interpreted by the ADA as new construction and trigger the requirement that the platform to be placed on a grade not exceeding 2%. Because it is unknown how the criteria will be interpreted, there is some risk in continuing to pursue Alternative C.1.

Alternative D: Minnesota Avenue Metrorail Station

Alternative D proposes to extend the alignments developed in Alternative C, north along Minnesota Avenue to a terminal streetcar stop and turnaround (tail) track near the existing Minnesota Avenue Metrorail Station. Both D Alternatives maintain a curbside running scenario north to Grant Street NE. The typical section in this area consists of four 10 foot lanes, two in each direction. Some intersections include a center turning lane. As indicated in the Typical Section Development Section, curbside running with on this type of existing section requires widening of the typical section on both sides. There is some street parking located within these limits. Where street parking is present, it is assumed that the typical section would be re-built to provide the same parking lane widths as currently exist, except where a streetcar stop locates within the parking lane, in which case the parking area at the stop would not be restored.

D.1 Stops By Station Entrance; Kiss & Ride Turnaround

Alternative D.1 proposes two curbside streetcar stops on the north side of the Minnesota Avenue / Grant Street NE intersection. The existing roadway alignment at this location is curving right in the northbound direction. It was necessary to place a segment of tangent alignment in the curve to allow for the insertion of the streetcar stop platforms. Insertion of this tangent created issue for both tracks. On the west side, the existing curb line adjacent to the southbound track back, must be set back up to 8 feet, for a distance up to 175 feet in length. At the north end of the curve, the southbound alignment is able to locate back in the typical curbside configuration, which it maintained to the existing Kiss and Ride area about 275 feet north of Hayes Street NE. On the east side, south of the platform, introduction of the tangent at the platform requires setting back the east curb about 4 feet for a distance of about 150. North of the platform, the tangent forced the northbound alignment to cross into the median northbound lane, at the north end of the stop. Special signalization will be required to protect the streetcar movement as it transitions between lanes. After transitioning the northbound alignment maintains a median running configuration until reaching the Kiss and Ride area about 275 feet north of Hayes Street NE. At about the Kiss and Ride area, the alignments turn to the west, converge to single track via a turnout, and continue for another 100 feet to a termination point. This 100 feet segment of track, commonly called a tail track, is dedicated guideway and used for turning streetcar vehicles. At 100 feet in length, the tail track is only long enough to accommodate a single streetcar vehicle.

D.2 Stops by Bus Facility; Minnesota Avenue Turnaround

Alternative D.2 proposes two curbside streetcar stops on the north side of the Minnesota Avenue / Department of Employee Services Building driveway intersection. The southbound platform is proposed to locate about 50 feet north of the intersection, while the northbound platform is proposed to locate about 75 feet north of the intersection within an existing parking lane. The existing roadway alignment within this area is not tangent, so it was necessary to best fit a track alignment tangent section to accommodate the platforms. Inserting the tangent track alignment to accommodate the streetcar stop platform will necessitate roadway curbside modification in addition to what is required as described in the Typical Section Development Section. On the west side, the existing curb line adjacent to the southbound track must be set back up to 5 feet, for a distance up to 220 feet in length. On the east side, the existing curb line adjacent to the northbound track must be set back up to 4 feet for a distance of up to 150 feet in length. North of the streetcar stop platforms, the alignments continue curbside running north to the Minnesota Avenue / Grant Street NE intersection. At the intersection, the alignments, converge to single track via a turnout, and continue for another 190 feet at about the centerline of the roadway to a termination point. This 190 feet segment tail track, is proposed as dedicated guideway and used for turning streetcar vehicles. At 190 feet in length, the tail track is long enough to accommodate two streetcar vehicles. Introduction of the proposed 190 feet of dedicated guideway will require significant changes to the roadway typical section. The existing typical section includes four 10 feet wide travel lanes. Inserting a 12 feet wide dedicated guideway in the center of this section will require either reducing the travel lanes from four to two, and widening the guideway by 2 feet nominal, or widening the existing typical section 12 feet to maintain the existing travel lane schematic.

Alternative D, Advantages and Disadvantages

Alternatives D.1 and D.2 include similar alignment conditions in that there are several locations where design criteria was violated in an effort to fit the proposed schematic with the most aggressive of these violations occurring at the transition points to the tail tracks. As well, each Alternative includes similar levels of curb line and sideway reconstruction required to accommodate the streetcar stop platforms. However, Alternative D.2 requires significant impacts to the existing roadway typical section to implement the tail track dedicated guideway north of Grant Street NE.

Operationally, both Alternatives include a single tail track for turning vehicles. Single tail tracks are considered undesirable as they restrict operations to single streetcar vehicle movements at the alignment terminus. However, Alternative D.2 has an operational advantage over D.1 in that the D.2 tail track provides capacity for two streetcars versus a single streetcar in D.2. As well, D.2 fits with the existing signalization scheme, as the traffic control at the Minnesota Avenue / Grant Street NE intersection could be modified to control streetcar movements in and out of the tail track at the intersection, whereas Alternative D.1 would require a special mid-block signal to be installed in to allow northbound movements to access the tail track.

Alternative E: Minnesota Avenue Intersection

As stated previously, Alternatives C and E focus on the Benning Road / Minnesota Avenue Intersection. The E Alternatives continue east on Benning Road. The E Alternatives designs have many similar characteristics with the D Alternatives designs. These similarities include a proposed roadway reconfiguration, as well as grading constraints required to meet the DC Transit Future System Plan. The reader is directed to the Alternative D section of this memorandum to understand these elements.

One item to clarify regarding the proposed roadway design at the intersection that is not discussed in the Alternative D section is that with the exception of one sub-option (E.1-A), the proposed roadway design includes 10 feet lanes on Benning Road, east of the intersection. The 10 feet wide lanes do not accommodate the full streetcar clearance envelope.

E.1 Median Stops on Viaduct

Alternative E.1 includes three sub-options (A, B, and C), which include varying roadway design on Benning Road, east of the Benning Road / Minnesota Avenue intersection. Option A includes 12 feet wide travel lanes on Benning Road east of Minnesota Avenue, while Options B and C include 10 feet wide lanes. There are slight differences in the track alignments east of the intersection to support these Options, but essentially, the alignments are very similar. For simplicity regarding track alignment and guideway discussion, discussion of Alternative E.1 herein is based Option B. Note however, that if Option A was progressed, there would be no impact to the curb lines on Benning Road east of the Minnesota Avenue intersection, as this option includes 12 feet wide travel lanes.

West of the Benning Road / Minnesota Avenue intersection, the proposed alignment and stop conditions are similar to what is being proposed in Alternative C.1, with median running condition, and a split median stop configuration. Refer to Alternative C.1 for more detail west of the intersection.

The alignment transitions from median running at the west end of the intersection to curbside running on the east end of the intersection. The transition occurs within the intersection, and is facilitated by relatively short and sharp radius simple curves. These curves do not meet the requirements of the design criteria as they do not include transition spirals. The design criteria violation was due to the need to transition within the relative limits of the intersection.

East of the intersection, the alignment locates in a curbside configuration, in the proposed 10 feet wide travel lanes. The typical section will require widening by 1 foot on each side to accommodate the vehicle clearance envelope, as described in the Typical Section Development Section.

E.2 Curbside Stops East of Intersection

West of the Benning Road / Minnesota Avenue intersection, the proposed alignment and stop conditions are similar to what is being proposed in Alternative C.3, with curb side running condition, and curbside stops located at the west side of the intersection. Refer to Alternative C.3 for more detail west of the intersection.

The alignment continues curbside running on the east side of the intersection. A small track alignment transition occurs within the intersection to match the curbside lane travel lane alignment on the east side of the intersection. This transition is facilitated by relatively short and medium radius simple curves. These curves do not meet the requirements of the design criteria as they do not include transition spirals. The design criteria violation was due to the need to transition within the relative limits of the intersection.

East of the intersection, the alignment locates in a curbside configuration, in the proposed 10 feet wide travel lanes. The typical section will require widening by 1 foot on each side to accommodate the vehicle clearance envelope, as described in the Typical Section Development Section.

E.3 Curbside Stops East of Intersection

Alternative E.3 is similar to E.2 in that it incorporates curbside running on both sides of the intersection. As the proposed roadway work is similar to the E.2 design, the track alignment is similar to the E.2 Alternative. The only difference between the E.2 and E.3 Alternatives is the location of the stop platforms. Alternative E.3 proposes to locate the stop platforms about 300 feet east of the Benning Road / Minnesota Avenue intersection in a curbside configuration.

Similar to E.2, the alignment transitions at the intersection do not include spiral curves, and the typical section must be widened by 1 foot on each side.

Alternative E, Advantages and Disadvantages

As Alternatives D and E both fit into the DC Transit Future System Plan they include the same issues regarding grading conditions at the intersection. To that topic, Alternative E.1 has advantages in that at the west side of the intersection, the track centers are narrower than what is proposed in E.2 and E.3. This will tighten up the special trackwork elements at the west end of the intersection, allowing more room outside of the special trackwork for transitioning the pavement grading. However, Alternative E.1 is disadvantaged in that it includes a stop on a 4.8% vertical grade (see Alternative C, Advantages and Disadvantage), and includes aggressive alignment geometry to transition from median running to side running at the intersection.

Alternatives E.2 and E.3 include the same alignment geometry. While this geometry is superior to that of E.1, it does not meet the design criteria for spiraled curves. The main difference between E.2 and E.3 is the stop locations. From an engineering, construction and typical section perspective, E.3 is advantageous over E.2 as it locates the stop platform well outside of the limits of the intersection. Understanding that challenges of re-grading the intersection, and the need for the platform to be located on vertical tangent at a grade not to exceed 2%, Alternative E.3 moves the platform outside of the intersection limits and includes 70 feet of additional alignment length for which the vertical track alignment can be adjusted to ease grading work at the intersection as compared to E.2. However, that being said, operationally, the platform in E.2 may be more advantageous than that of E.3 in that the E.2 platform locates at the intersection, in an area where traffic will normally be stopping, where as the E.3 platform locates almost mid block, and will require streetcar to stop in an area where motor vehicle drivers would not be expecting.

Alternative F: 42nd Street

The F Alternatives propose locating a streetcar stop on Benning Road in the vicinity of 42nd Street. The existing typical roadway section includes four 10 feet wide travel lanes. The existing horizontal roadway geometry is curving to the west of the Benning Road / 42nd Street intersection, and tangent east of the intersection. East of 42^{nd} Street to Blaine Street, the eastbound outside 10 feet wide lane becomes a parking lane for the residences in along Benning Road.

F.1 Curbside Stops

Alternative F.1 proposes the streetcar guideway be located curbside on Benning Road from Minnesota Avenue to the west to 43rd Street to the east. The Alternative proposes an eastbound platform on the east side of the Benning Road / 42th Street intersection, and a westbound platform on the west side of the Benning Road / 42th Street intersection. As this Alternative proposes a curbside running schematic, widening of the typical section would need to be performed as discussed in the Typical Section Development part of this memorandum. The eastbound stop platforms in this Alternative will not require modification to the typical section, except at the stop, where the curb and sidewalk will require changes to accommodate the stop platform. However, the existing roadway alignment at the westbound platform is curving left in the westbound direction. It was necessary to place a segment of tangent alignment in the curve to allow for the insertion of the streetcar stop platform. Insertion of this tangent requires the north side curb line be set back up to 6 feet, for a distance up to 350 feet in length. Alignment geometry as illustrated in this option does not include spiral curves. However, it appears spiral curves could be added as a refinement in the alignment geometry.

F.2 Median Stops
A median running guideway is proposed in Alternative F2. The Alternative does not address where the guideway would transition from curbside to median to the west, however, it is assumed that the transition would occur at an intersection, with the exact location to be determined at the next level of design. To the east, the guideway would continue median running to the east end terminal stops identified in the G Alternatives. The median stop is proposed to locate on the west side of the Benning Road / 42th Street intersection. Because of the median platform schematic, this Alternative includes issues with respect to the typical section width. Introduction of the platform within the confines of the existing curb to curb typical section creates substandard center and outside travel lanes. Also, the existing roadway alignment at the platform is curving left in the westbound direction. It was necessary to place a segment of tangent alignment in the curve to allow for the insertion of the streetcar stop platform. Insertion of this tangent and restoring the existing travel lane configuration would require widening the section on the north side by as much as 8 feet for a distance up to 300 feet in length and on the south side by as much 4 feet for a distance up to 300 feet in length. The track alignment design for this Alternative does not transition spirals and therefore does not meet the requirements of the design criteria. This was done to minimize impacts to the typical section.

Alternative F, Advantages and Disadvantages
Alternative F.2 includes several disadvantages which should be considered before progressing the Alternative. The track alignment includes relatively short and sharp horizontal curvature, which do not include transition spirals. If it is decided to redesign the transition curves to include spirals to meet the requirements of the criteria, the typical section work would be extended by an additional 300 feet. Implementing Alternative F.2 will require significant widening of the existing roadway section. In addition to the obvious impacts this would create to the adjacent properties, this would also introduce roadway lane geometric challenges associated with travel lane transitions, at the intersection, and in the curve to the west.

While Alternative F.1 will require some increase in roadway width to accommodate both the median running typical section, and the westbound horizontal tangent at the platform, it includes much less section work than what is required in Alternative F.2. As well, the alignment geometry is much less aggressive than that of Alternative F.1. As the Alternative is curbside running, it will not require a transition from median to curbside running to match the curbside running scenario proposed in the E Alternatives. However, if F.1 is chosen, it will be necessary to eliminate the on street parking within the eastbound outside travel lane on Benning Road between 42nd Street and Blaine Streets. This parking serves local residents for which do not have parking in front of their homes. They do however appear to have parking at the rear of their residences.

Alternative G: Benning Road Metrorail Station and Turnaround
The G Alternatives propose a terminal streetcar and turnaround (tail) track stop near the existing Benning Road Metrorail Station in the vicinity of the Benning Road / East Capitol Street NE intersection. All G Alternatives are configured with a curbside running scenario on Benning Road west of 45th Street NE. The typical section of Benning Road in this area consists of four 10 foot lanes, two in each direction, with a center eastbound left hand turn lane at the Benning Road / East Capitol Street NE intersection. As indicated in the Typical Section Development Section, curbside running with this type of existing section requires widening of the typical section. The Benning Road alignment curves right, in an eastbound direction, east of 45th Street NE.

G.1 East Capitol Street Median Stop and Turnaround
Alternative G.1 proposes a terminal stop and two tail tracks within the median area of East Capitol Street NE, east of the Benning Road / East Capitol Street NE intersection. To reach the terminal stop, the

eastbound alignment transitions from curbside to median running east (compass south) of 45th Street. The alignment attempts to locate in the median lane to Central Avenue. NE, then the left turn lane between Central Avenue NE and East Capitol Street NE, however, the roadway geometry is changing quickly in this area, and it is difficult for the track alignment keep up with the roadway changes. Because of this, it will be necessary to modify the typical sections and lane configuration to accommodate the alignment. The westbound alignment transitions from curbside running to median running east (compass south) of Central Avenue NE. The alignment has similar issues associated with locating in defined travel lanes. Both alignments turn compass east at the Benning Road / East Capitol Street NE intersection, and locate in the median of East Capitol Street, within a section of dedicated guideway. A center platform terminal stop, double crossover and two tail tracks are proposed in the median section. The two tail tracks include capacity for one streetcar each.

West of 45th Street, the curb lines will need to be moved out 1 foot on either side to support the proposed typical section associated with curbside running as defined in the Typical Section Development Section. Between 45th Street, and the East Capitol Street, the north (compass east) curb lines will need to be widened at least 2 feet to accommodate the median running typical section as defined in the Typical Section Development Section. Between 45th Street and East Capitol Street the south (compass west) curb lines will need to be moved out between 2 and 4 feet for a distance of 200 feet. This additional width is greater than what is identified for median running configuration in the Typical Section Development Section as the track alignment is not able to fully match the roadway geometry, and additional width is required to reestablish the existing lane configuration.

The horizontal track alignment geometry includes numerous relatively short simple curves of medium and sharp radius. The use of simple curves does not meet the requirements of the design criteria, but were included as a means of best fitting to the existing roadway geometry and minimizing of the typical section.

G.2 Benning Curbside Stops and Central Avenue Turnaround

Alternative G.2 proposes a terminal stop, in the form of curb side platforms on Benning Road, between 45th Street and Central Avenue NE, in the vicinity of the Benning Road Metrorail Station. A single tail track is proposed on Central Avenue for purposes of turning the streetcar vehicles.

East of 45th Street, the alignments continue curbside running to Central Avenue. The streetcar stops locate between 45th Street NE and Central Ave NE. The existing roadway alignment is curving in this area, so it was necessary to force a tangent track alignment section in this area to accommodate the stop platforms. This tangent will require bumping out the curb lines about 5 feet, on the north (compass east) side for a distance of 350 feet, and about 4 feet, on the south (compass west) side for a distance of 350 feet. West of 45th Street, the curb lines will need to be moved out 1 foot on either side to support the proposed typical section associated with curbside running as defined in the Typical Section Development Section.

At the Benning Road / Central Ave NE intersection, the alignments turn compass east, converge to single tail track via a turnout, and is proposed to locate on the north side of Central Avenue NE in a curbside configuration. The alignment is dedicated, and continues on Central Avenue NE to a termination point between 46th Street and 46th Place. It will be necessary to modify the travel lane configuration to accommodate this segment of dedicated guideway. The tail track provides capacity for storing a single vehicle. However, it could be used to store a vehicle and turn a second vehicle, if operationally it is possible to foul the 45th Street intersection, for the length of time required for the vehicle operator to change ends, and begin westbound revenue service.

Alignment G.2 includes an alternate alignment which diverges from the baseline alignment at the Benning Road / Central Avenue NE intersection, and continues along Benning Road to East Capitol Street NE. The alignments turns compass east and converge to a single tail track via a turnout, and locate in the median of East Capitol Street NE. The tail track provides capacity for two vehicles.

The horizontal track alignment curves G-2-EB02 and G2-WB02 do not include transition spirals. This was done in an effort to match the existing roadway alignment geometry, and insert the tangent section at the stop platforms.

G.3 Central Avenue Media Stop and Turnaround

Alternative G.3 proposes a terminal stop, in the form of a center platform, on Central Avenue NE, between the Benning Road Metrorail Station driveway and 46th Street NE. To reach the terminal stop, the eastbound alignment transitions from curbside to median running east (compass south) of 45th Street. The alignment attempts to locate in the median lane to Central Avenue. NE, however the roadway geometry is changing quickly in this area, and it is difficult for the track alignment keep up with the roadway. Because of this, it will be necessary to modify the typical sections and lane configuration to accommodate the alignment. The westbound alignment maintains a curbside configuration from to Central Avenue NE. At the Benning Road / Central Avenue NE intersection, both alignments turn compass east and locate on Central Avenue NE. The westbound track locates on the north curbside of the intersection, and is on a segment of dedicated guideway, and the eastbound track locates on the south curbside in a mixed traffic guideway. A center terminal streetcar stop platform is located between the Benning Road Metrorail station driveway and 46th Street NE. East of the terminal platform, both tracks converge to single tail track via a turnout, and locate on the north side of Central Avenue NE in a curbside configuration. The alignment is dedicated, and continues on Central Avenue NE to a termination point at the west end of the Central Avenue NE / 46th Place intersection. It will be necessary to modify the travel lane configuration to accommodate this segment of dedicated guideway.

West of 45th Street, the curb lines will need to be moved out 1 foot on either side to support the proposed typical section associated with curbside running as defined in the Typical Section Development Section. Between 45th Street, and Central Avenue NE, the south (compass west) curb lines will need to be widened between 2 and 4 feet for a distance of 120 feet to accommodate the median running typical section and travel lane configuration. This additional width is greater than what is identified for median running configuration in the Typical Section Development Section as the track alignment is not able to fully match the roadway geometry, and additional width is required to reestablish the existing lane configuration. On Central Ave NE, the south curb line will need to be widened about 2 feet for a distance of 100 feet to accommodate the proposed track alignment and typical section.

The horizontal track alignment geometry includes numerous relatively short simple curves of medium and sharp radius. The use of simple curves does not meet the requirements of the design criteria. There is also a reverse curve on the eastbound track at the Central Avenue NE intersection which includes a very small tangent between curves.

G.4 Kiss & Ride Site Stop and Turnaround

Alternative G.4 proposes a single track terminal stop within the Benning Road Metrorail Station parking lot. The alignments turn east from a curb side running configuration at the Benning Road / 45th and weave into the northeast side of the Metrorail Station parking lot. The alignments converge to a single track via a turnout. The terminal streetcar stop platform is located on the single track immediately beyond the point of switch of the turnout. The alignment terminates immediately beyond the platform. There is no capacity on the platform for storage of vehicles.

The horizontal track alignment geometry includes numerous sharp radius simple curves. The use of simple curves does not meet the requirements of the design criteria. There is also a reverse curve on the westbound track which includes a very small tangent between curves.

West of 45th Street, the curb lines will need to be moved out 1 foot on either side to support the proposed typical section associated with curbside running as defined in the Typical Section Development Section. Between 45th Street, and the terminal stop, the alignment includes significant impacts to the northeast curb line, and the Metrorail parking lot.

Alternative G, Advantages and Disadvantages

Alternative G.1 is advantageous in that it provides a double track, dedicated guideway terminal stop, with two tail tracks and a double crossover. This allows the maximum operational flexibility for a terminal stop. However, operationally, alternative G.1 disadvantaged to G.2 and G.3 in that the alignment is longer than the other G alternatives, and requires crossing the westbound lanes of East Capitol Street NE, which is a very busy intersection. The typical section impacts and horizontal geometry issues of G.1 are similar to those in G.2, and G.3.

Alternative G.2 (base option) has an advantage over G.1 in that it includes a shorter alignment length, and does not enter the East Capitol Street Intersection. It also is advantageous in that it maintains a curbside configuration on Benning Road, which would simplify changes to traffic lanes. However, it would require signalization of the Benning Road / Central Avenue NE intersection to allow eastbound streetcar movements to cross traffic lanes to enter the tail track on Central Avenue. Regarding tail track, G.2 is disadvantaged versus G.1, in that it does not include double tail tracks, but advantaged over G.3 in that it has potential capacity of storing a single streetcar and turning another. The typical section impacts and horizontal geometry issues of G.2 are similar to those in G.1, and G.3. However, Alternative G.2 includes serious impacts to Central Avenue NE in that it removes a traffic lane between Benning Road and 46th Place.

The Alternative G.2 Alternate Alignment option includes an additional disadvantage of the G.2 base alternative in that the alignment must enter East Capitol Street to access the tail track turnaround.

Advantages and disadvantages comparing G.3 with Alternatives G.2 and G.3 with respect to alignment length, typical section impacts and exclusive guideway have been discussed above. Operationally, G.3 would require special signalization at the Benning Road / 45th Street intersection and the Benning Road / Central Avenue NE intersection for westbound movements. It is disadvantaged over G.2, and Alternative for which G.3 is similar in that the tail track only has capacity for a single vehicle.

Alternative G.4 includes two issues which should screen it from further development. These issues include alignment geometry, and terminal stop capacity. The horizontal alignment includes a series of very aggressive reverse curves, which include serious maintenance and vehicle tracking concerns. Additionally, the Alternative does not include a tail track sufficient for storage of a vehicle. While this alternative was developed to show an option that located a stop platform within the Metrorail Station property, it is believed that the disadvantages in doing so outweigh the advantages of the platform location.

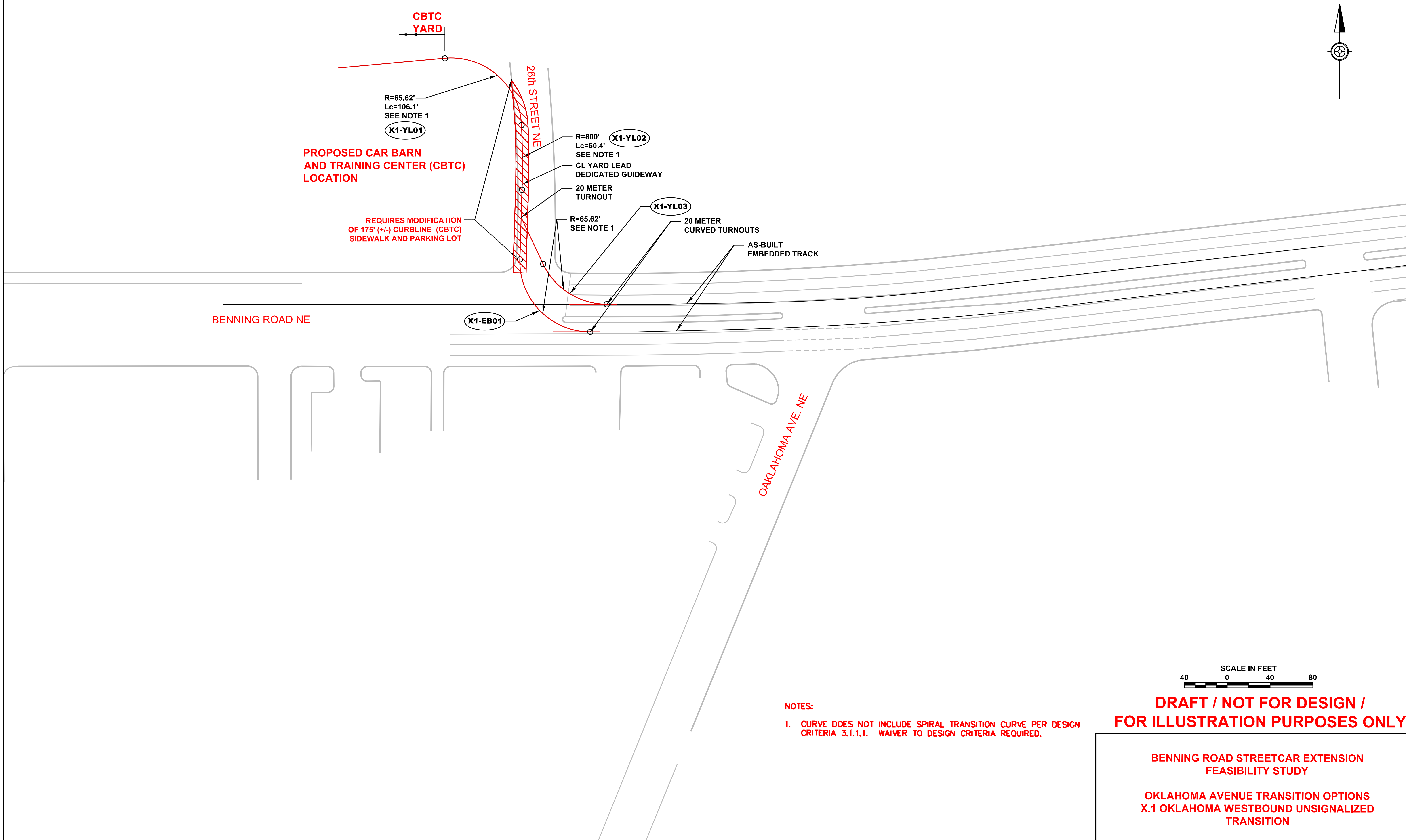
Track Geometry Conclusion:

Track geometry was developed to a conceptual level as described herein. At the conceptual level, track geometry is typically developed as a means of determining the feasibility of the guideway to meet the needs of the planning schematic. As such, track design is a small component of the big picture. As the project progresses and Alternatives are either refined or screened out, it is recommended additional guideway design be performed to further improve and validate the designs developed in this memorandum. It is recommended that the following items be considered during the refinement process:

- Review the Design Exceptions Report. A threshold should be developed which identifies acceptable and unacceptable design exceptions. This item is directly related to the DDOT's position regarding use of the DC Streetcar Design Criteria relative to track alignment design in an urban condition. Development of the threshold should include input from the vehicle manufacturer, and maintenance professionals from peer transit agencies. It is recommended that the findings of this review be used to modify the published design criteria such that the document better represent the DDOT's expectation of track alignment design in the District of Columbia.
- Review the DC Streetcar Design Criteria relative to vehicle clearance. While this criteria was not violated in this study, there is skepticism within DDOT for the need of a 12 feet wide streetcar lane. As stated previously, the Design Criteria requires an 11 feet wide nominal lane for streetcar. That dimension was increased to 12 feet, by adding an additional 6 inches to either side to maintain consistent lane widths along the guideway to account for the vehicle end overhang, and mid-ordinate widening as the vehicle negotiates horizontal curvature. Also of note, the 11 feet wide dimension assumes zero superelevation, or level cross-slope of the track slab. It will be necessary to further increase the 11 feet wide envelope if it is desired to maintain the existing cross-slope.
- Develop a grading plan for the Benning Road / Minnesota Avenue Intersection. Determine the feasibility of meeting the needs of the DC Transit Future System Plan. Impacts associated with installing the special trackwork elements and providing a drivable pavement surface should be fully understood. This understanding should drive a decision on what streetcar connectivity would be proposed at the intersection.

Perform a preliminary catenary design at the Benning Road / Minnesota Avenue Intersection to a level that illustrates the placement of catenary poles. Catenary design was not included at the current design level, however, the complexity of the special trackwork elements at the intersection, will require an equally complex catenary solution. It is recommended that DDOT understand the catenary layout at the intersection, specifically the number and location of catenary poles that will be required to support the DC Transit Future System Plan, for purposes of creating a sense of aesthetics at the intersection

APPENDIX A: Track Alignment Drawings



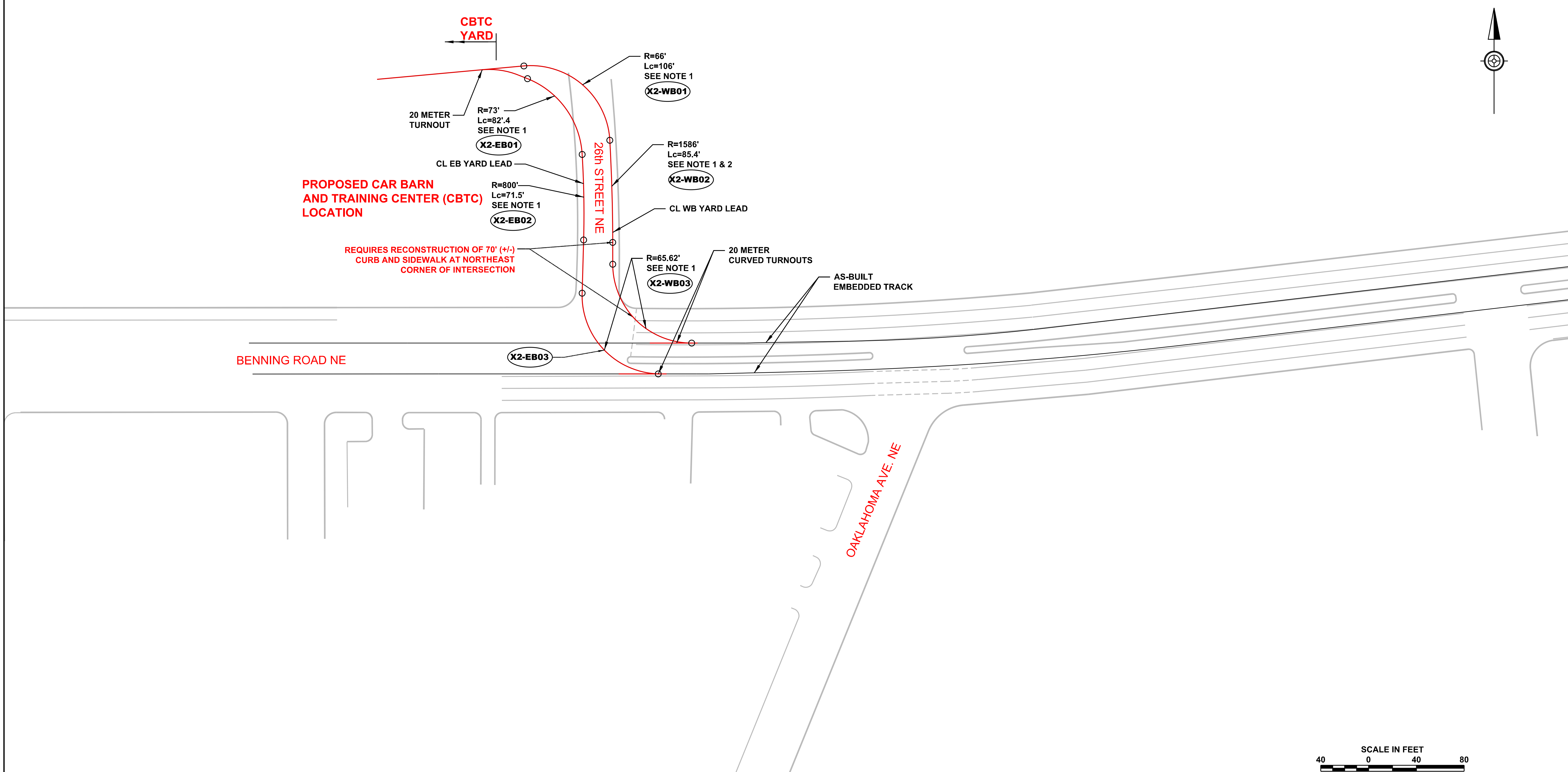
NOTES:

1. CURVE DOES NOT INCLUDE SPIRAL TRANSITION CURVE PER DESIGN CRITERIA 3.1.1.1. WAIVER TO DESIGN CRITERIA REQUIRED.

DRAFT / NOT FOR DESIGN / FOR ILLUSTRATION PURPOSES ONLY

BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

OKLAHOMA AVENUE TRANSITION OPTIONS
X.1 OKLAHOMA WESTBOUND UNSIGNALIZED TRANSITION



DRAFT / NOT FOR DESIGN / FOR ILLUSTRATION PURPOSES ONLY

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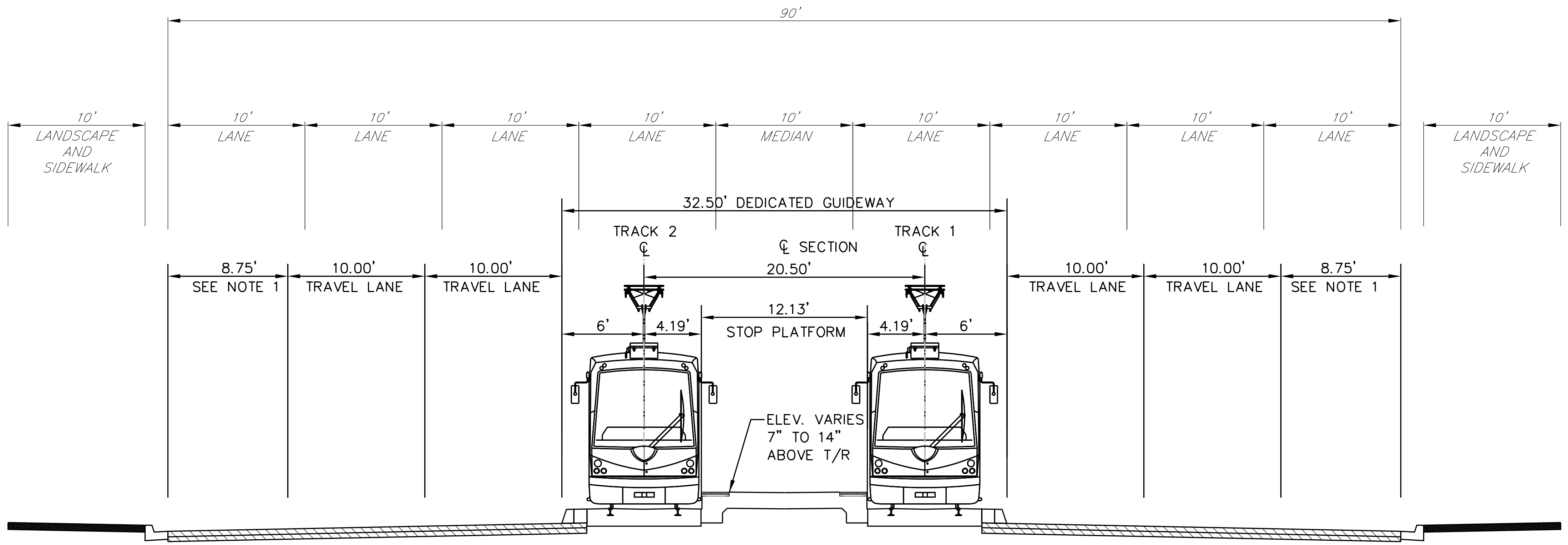
2. TANGENT LENGTH BETWEEN REVERSE CURVES DOES NOT MEET MINIMUM LENGTH OF 33' AS SET BY DESIGN CRITERIA 3.1.1.1. APPROVAL FROM AUTHORITY REQUIRED.
3. GUIDEWAY AS SHOWN REQUIRES A 6 FOOT WIDE CLEARANCE ENVELOPE, AND WILL REQUIRE MOVING CURB LINES AS FOLLOWS:

3.1. FOR SIDE RUNNING, 1 FOOT NOMINAL PER SIDE

BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

OKLAHOMA AVENUE TRANSITION OPTIONS
X.2 OKLAHOMA WESTBOUND SIGNALIZED TRANSITION



TYPICAL SECTION
STREETCAR STOP
MEDIAN RUNNING WITH PLATFORM – KINGMAN ISLAND –
DEDICATED OPTION

SCALE IN FEET
10 0 10 20

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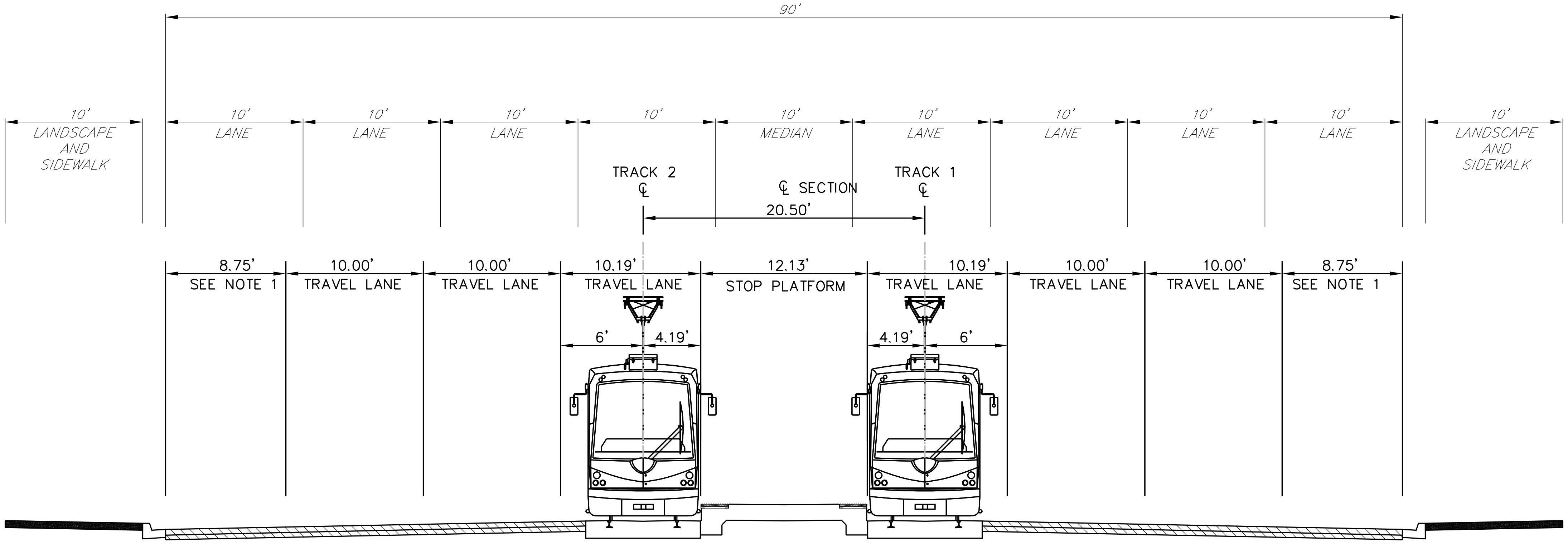
NOTES:
1. PROPOSED TYPICAL SECTION AS SHOWN REQUIRES ELIMINATION OF 2 TRAVEL LANES.

LEGEND
PROPOSED TEXT
EXISTING TEXT

BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

KINGMAN ISLAND
A.1 TYPICAL DEDICATED USE OPTION



TYPICAL SECTION
STREETCAR STOP
MEDIAN RUNNING WITH PLATFORM – KINGMAN ISLAND – MIXED USE OPTION

SCALE IN FEET
10 0 10 20

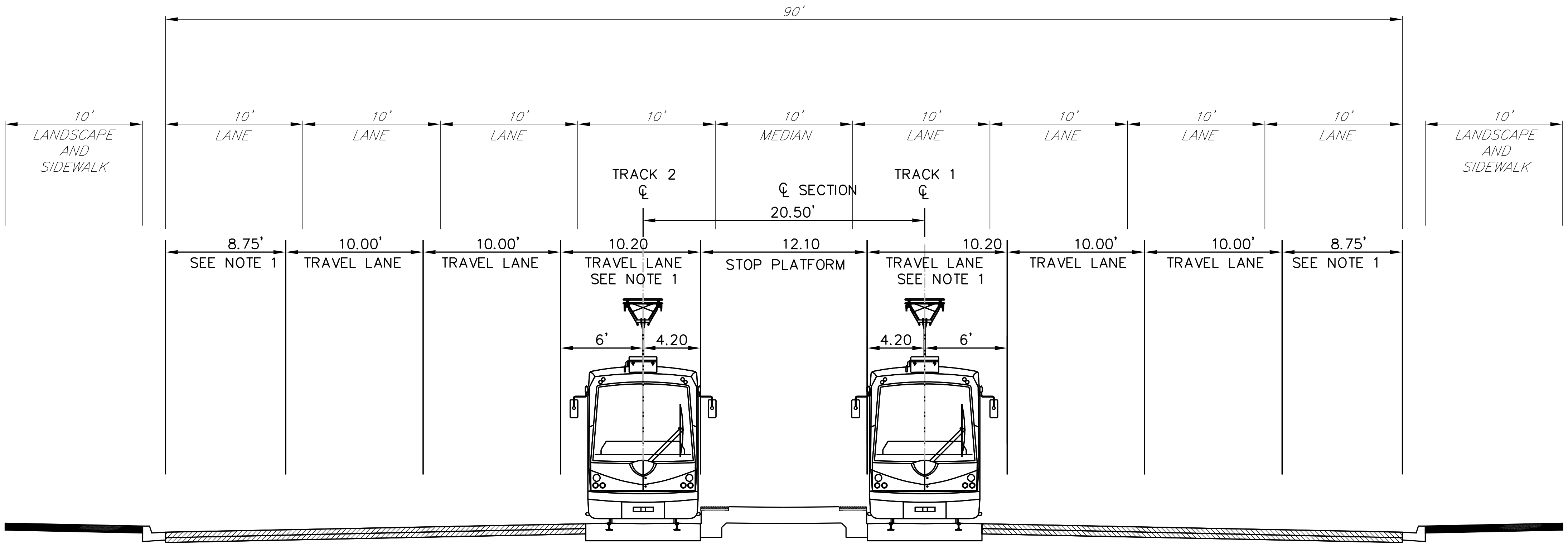
DRAFT / NOT FOR DESIGN / FOR ILLUSTRATION PURPOSES ONLY

NOTES:
1. PROPOSED TYPICAL SECTION AS SHOWN DOES NOT PROVIDE SUFFICIENT WIDTH TO ACCOMMODATE STREETCAR STOP AND 8 TRAFFIC LANES. BRIDGE DECK MODIFICATION NECESSARY TO MAINTAIN EXISTING LANE CONFIGURATION ON BRIDGE.

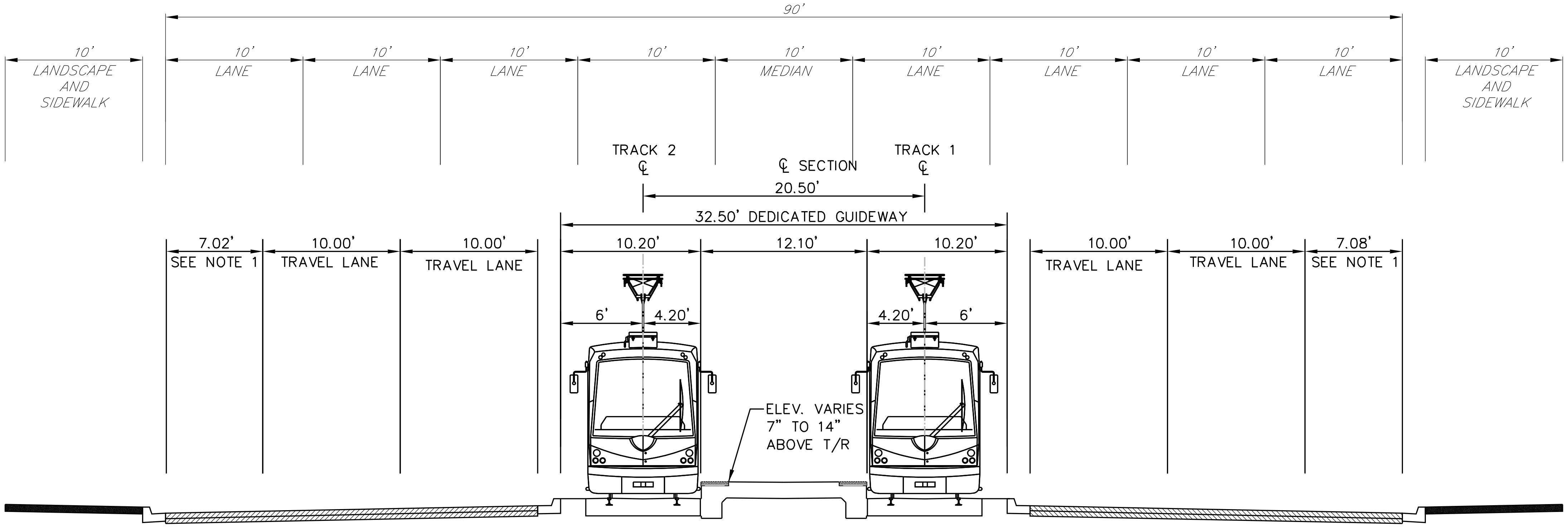
LEGEND
PROPOSED TEXT
EXISTING TEXT

BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

KINGMAN ISLAND
A.1 TYPICAL SHARED USE OPTION



TYPICAL SECTION
STREETCAR STOP
MEDIAN RUNNING WITH PLATFORM – 34th STREET –
MIXED TRAFFIC



TYPICAL SECTION
STREETCAR STOP
MEDIAN RUNNING WITH PLATFORM – 34th STREET –
DEDICATED GUIDEWAY

LEGEND
PROPOSED TEXT
EXISTING TEXT

NOTES:
1. PROPOSED TYPICAL SECTION AS SHOWN DOES NOT PROVIDE SUFFICIENT WIDTH TO ACCOMMODATE STREETCAR STOP AND 8 TRAFFIC LANES.

SCALE IN FEET
10 0 10 20

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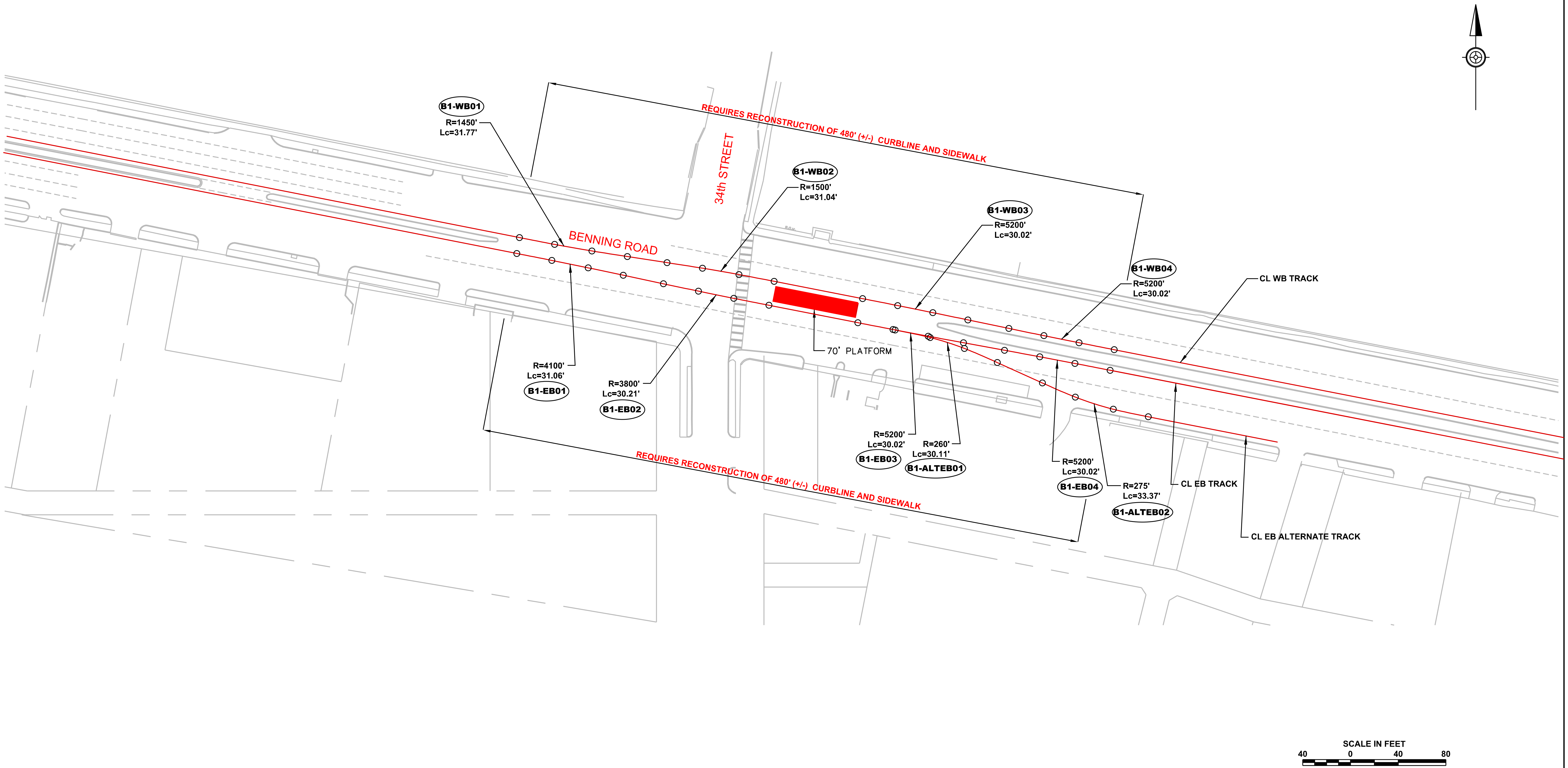
BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

34th STREET STOP LOCATION
B.1 AND B.2 TYPICAL MEDIAN STOP



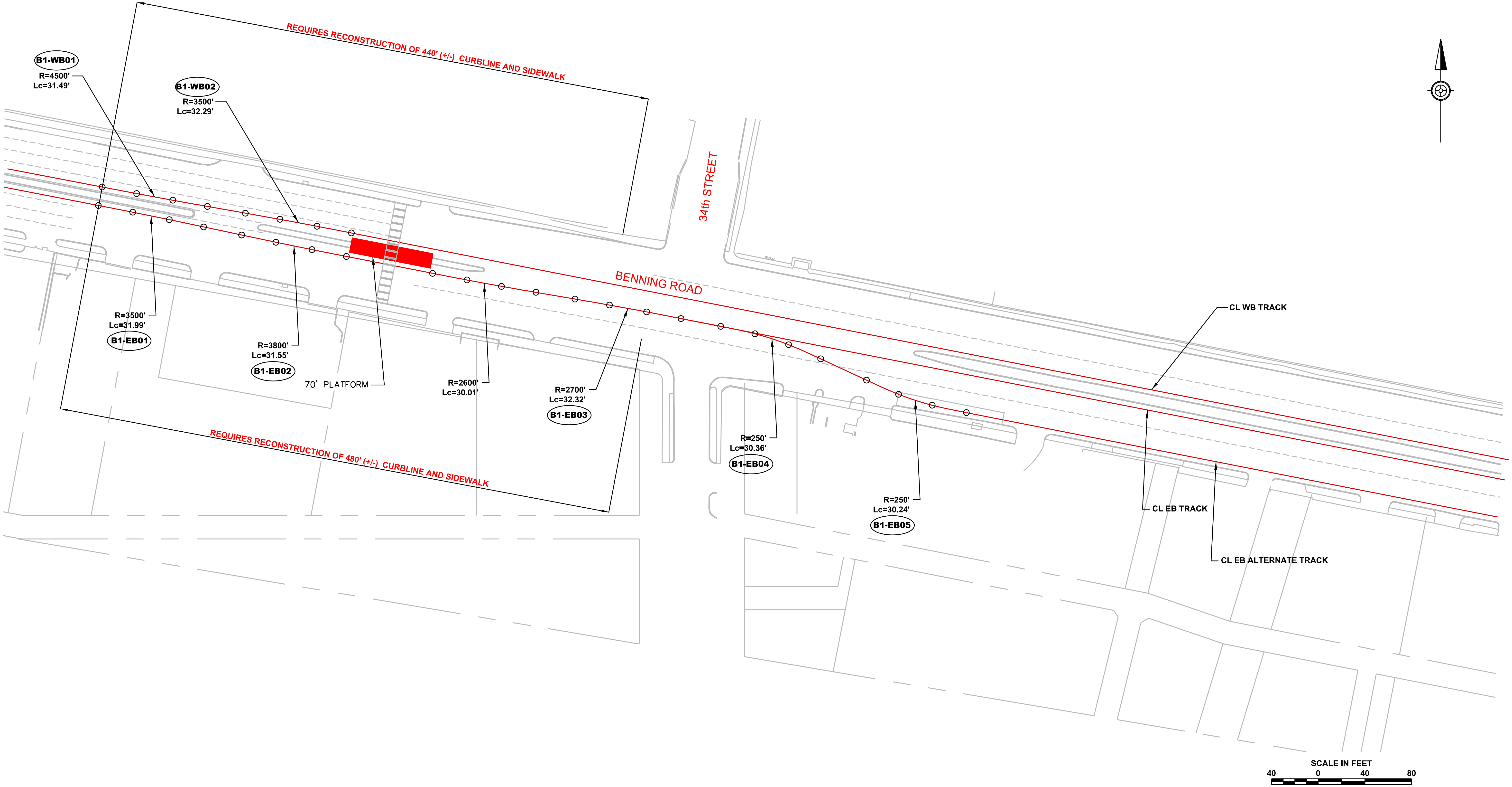
DRAFT / NOT FOR DESIGN / FOR ILLUSTRATION PURPOSES ONLY

NOTES:

1. GUIDEWAY AS SHOWN REQUIRES A 6 FOOT WIDE CLEARANCE ENVELOPE, AND WILL REQUIRE MOVING CURB LINES AS FOLLOWS:
   1.1. FOR SIDE RUNNING, 1 FOOT NOMINAL PER SIDE
   1.2. FOR CENTER RUNNING, 2 FEET NOMINAL PER SIDE

BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND TURN-AROUND
B.1 34TH STREET INTERSECTION, PLATFORM EAST OF 34TH STREET



DRAFT / NOT FOR DESIGN / FOR ILLUSTRATION PURPOSES ONLY

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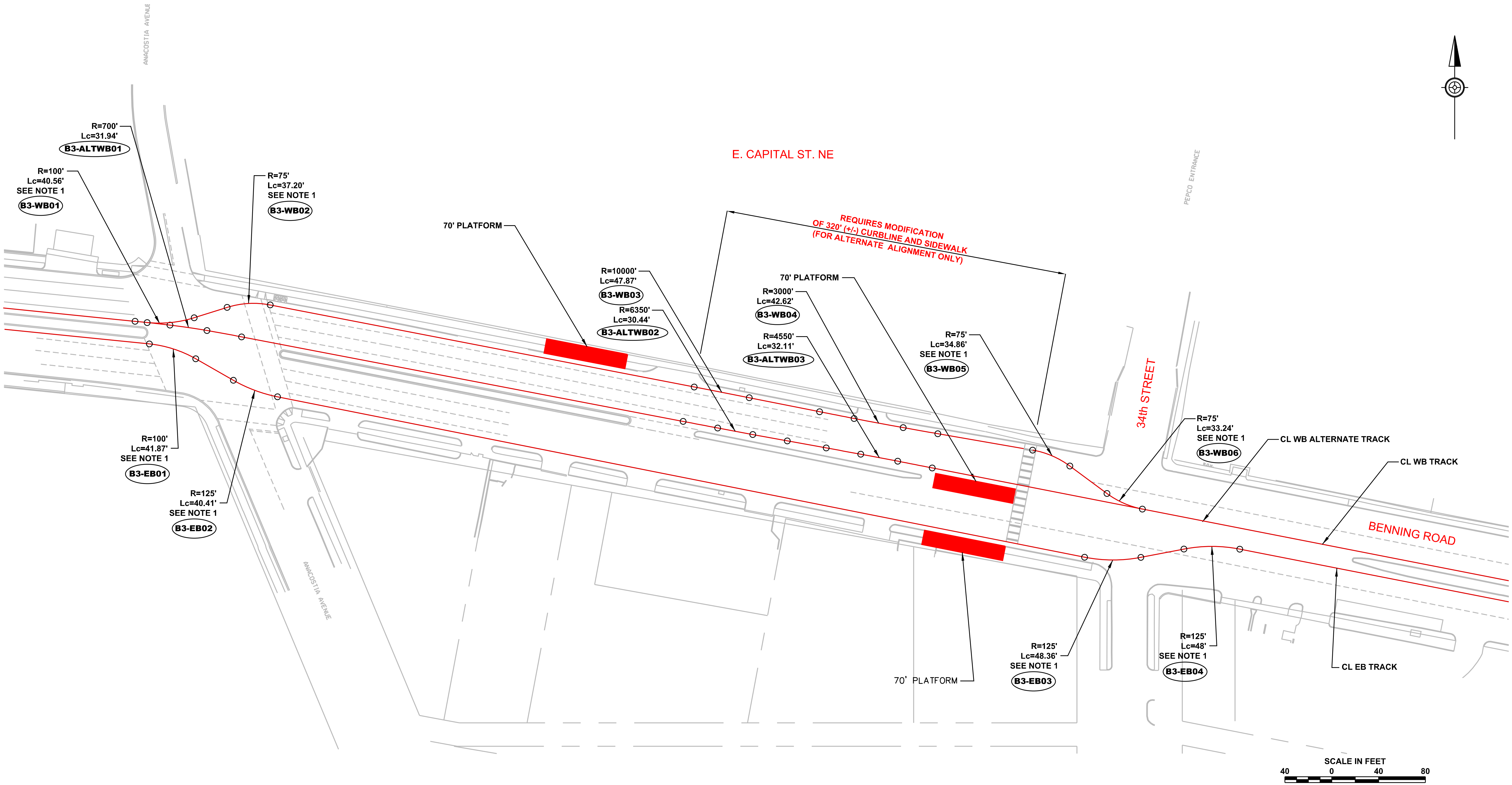
   1.1. FOR SIDE RUNNING, 1 FOOT NOMINAL PER SIDE
   1.2. FOR CENTER RUNNING, 2 FEET NOMINAL PER SIDE

BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND TURN-AROUND

B.2 34TH STREET INTERSECTION, PLATFORM WEST OF 34TH STREET



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FOR ILLUSTRATION PURPOSES ONLY

NOTES:

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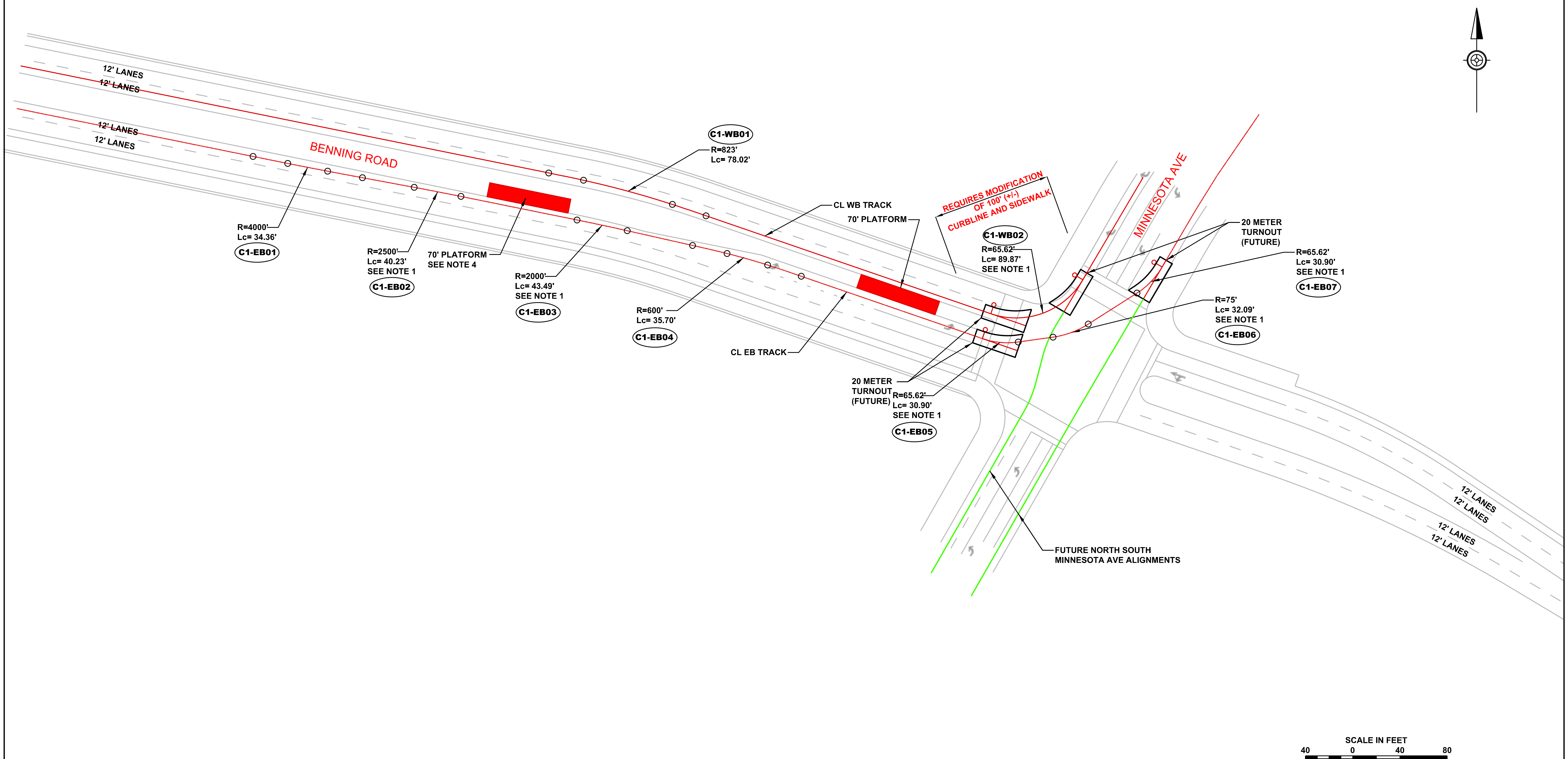
2. GUIDEWAY AS SHOWN REQUIRES A 6 FOOT WIDE CLEARANCE ENVELOPE, AND WILL REQUIRE MOVING CURB LINES AS FOLLOWS:

2.1. FOR SIDE RUNNING, 1 FOOT NOMINAL PER SIDE
2.2. FOR CENTER RUNNING, 2 FEET NOMINAL PER SIDE

BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND TURN-AROUND
B.3 34TH STREET INTERSECTION, PLATFORMS, SIDE RUNNING, WEST OF 34TH STREET



DRAFT / NOT FOR DESIGN / FOR ILLUSTRATION PURPOSES ONLY

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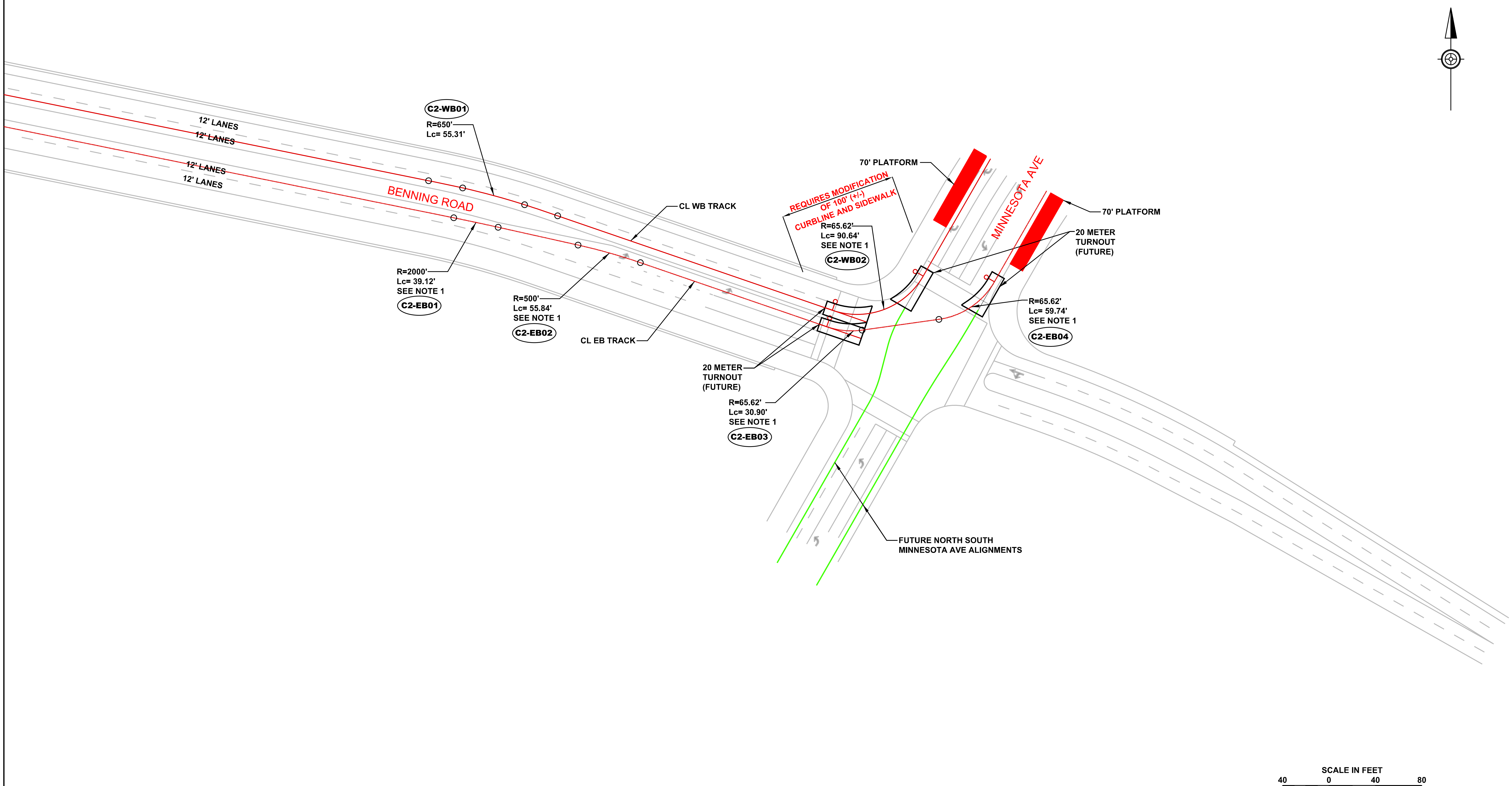
3. GUIDEWAY AS SHOWN REQUIRES A 6 FOOT WIDE CLEARANCE ENVELOPE, AND WILL REQUIRE MOVING CURB LINES AS FOLLOWS:
   3.1. FOR SIDE RUNNING, 1 FOOT NOMINAL PER SIDE (ON MINNESOTA AVE ONLY)
4. STOP PLATFORM LOCATES ON 4.8% VERTICAL.

BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND TURN-AROUND
C.1 MEDIAN STOPS ON VIADUCT
BENNING ROAD AND MINNESOTA AVE INTERSECTION



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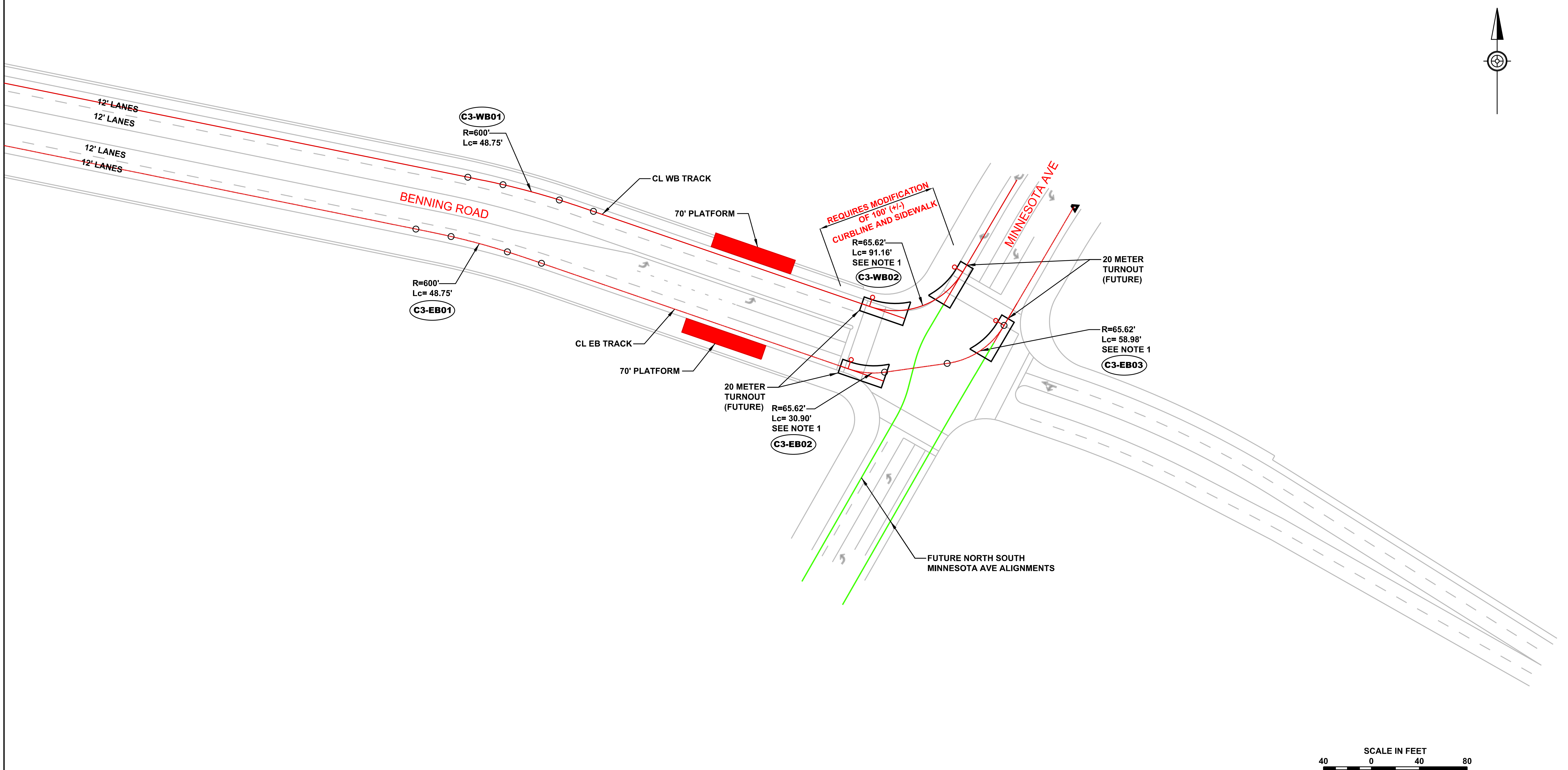
3. GUIDEWAY AS SHOWN REQUIRES A 6 FOOT WIDE CLEARANCE ENVELOPE, AND WILL REQUIRE MOVING CURB LINES AS FOLLOWS:

3.1. FOR SIDE RUNNING, 1 FOOT NOMINAL PER SIDE (ON MINNESOTA AVE ONLY)

BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND TURN-AROUND
C.2 CURBSIDE STOPS ON MINNESOTA AVENUE
BENNING ROAD AND MINNESOTA AVE INTERSECTION



DRAFT / NOT FOR DESIGN /
FOR ILLUSTRATION PURPOSES ONLY

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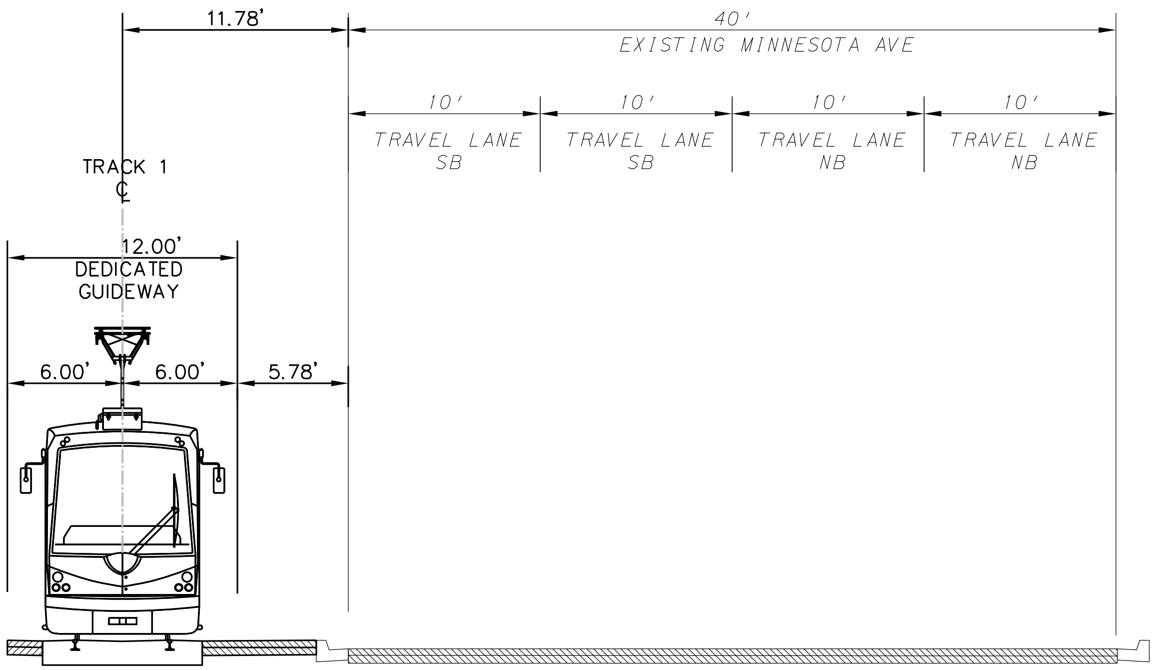
3.1. FOR SIDE RUNNING, 1 FOOT NOMINAL PER SIDE (ON MINNESOTA AVE ONLY)

BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND
TURN-AROUND
C.3 CURBSIDE STOPS ON VIADUCT
BENNING ROAD AND MINNESOTA AVE
INTERSECTION



TYPICAL SECTION – D1
DEDICATED GUIDEWAY
TURN–AROUND

LEGEND
PROPOSED TEXT
EXISTING TEXT

SCALE IN FEET
10 0 10 20

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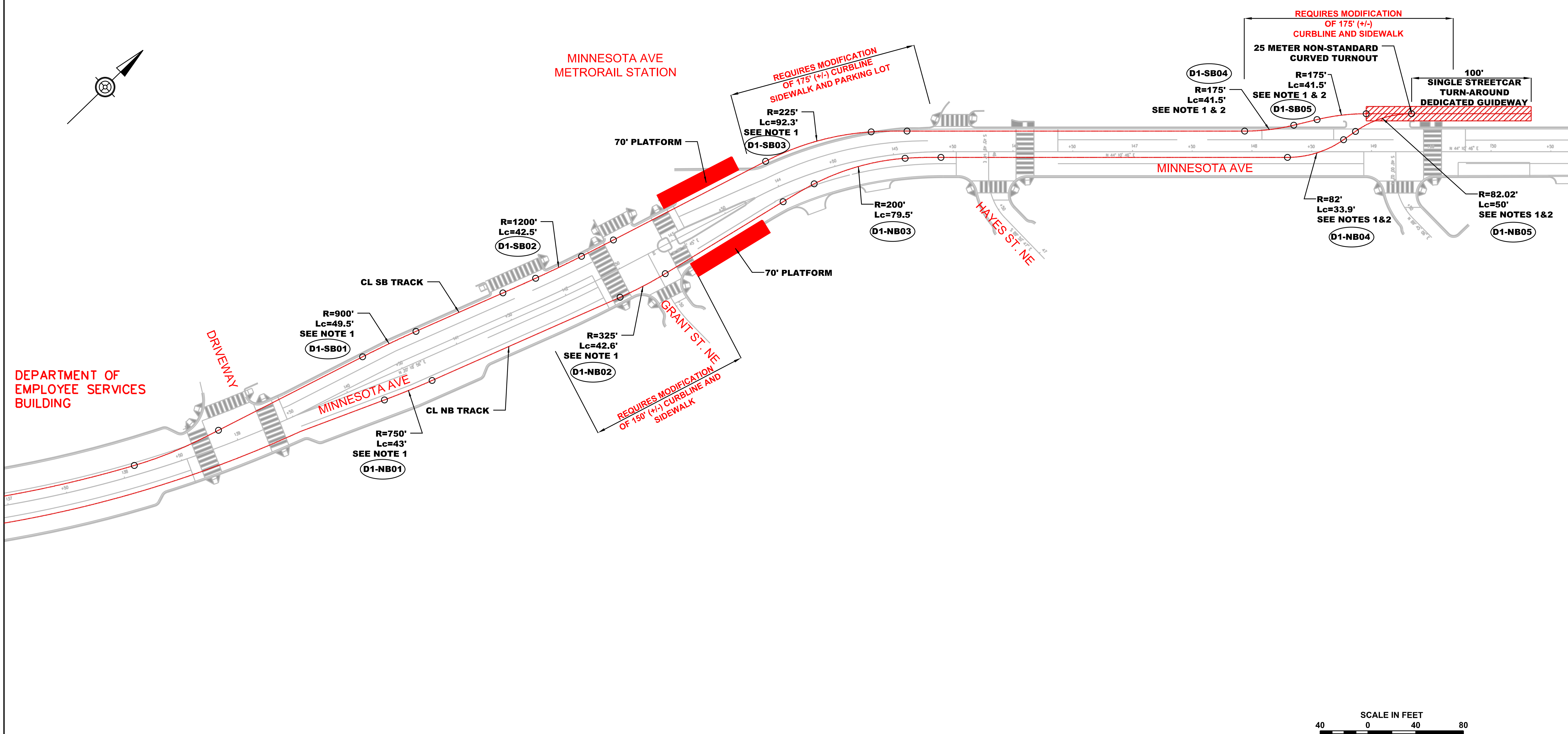
FOR ILLUSTRATION PURPOSES ONLY

BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

MINNESOTA AVE METRO STATION
D.1 STOPS BY STATION ENTRANCE,: KISS & RIDE
TURN-AROUND



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2. TANGENT LENGTH BETWEEN REVERSE CURVES DOES NOT MEET MINIMUM LENGTH OF 33' AS SET BY DESIGN CRITERIA 3.1.1.1. APPROVAL FROM AUTHORITY REQUIRED.
3. GUIDEWAY AS SHOWN REQUIRES A 12 FOOT WIDE CLEARANCE ENVELOPE, AND WILL REQUIRE MOVING CURB LINES AS FOLLOWS:
3.1. FOR SIDE RUNNING, 1 FOOT NOMINAL PER SIDE
3.2. FOR CENTER RUNNING, 2 FEET NOMINAL PER SIDE

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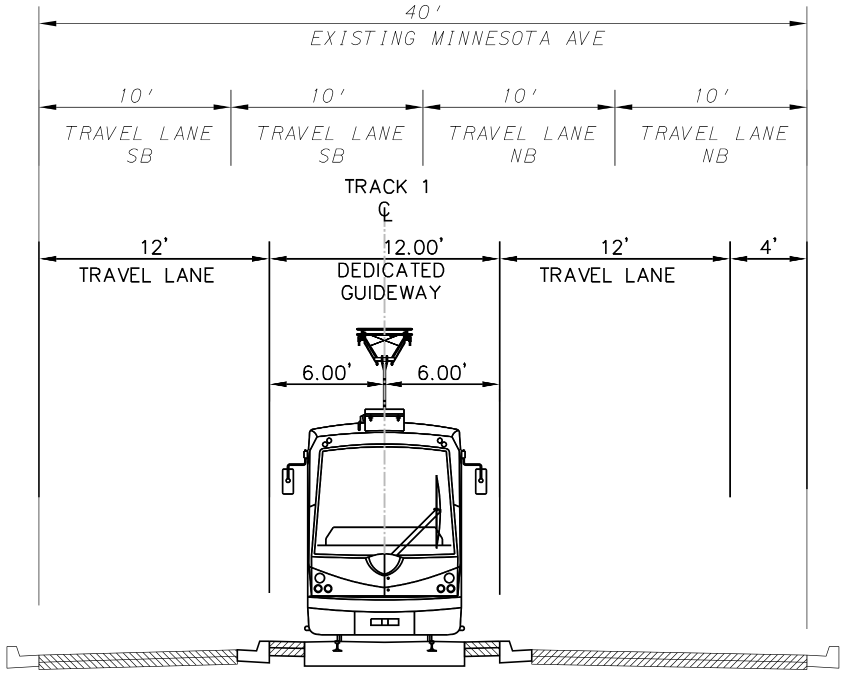
FOR ILLUSTRATION PURPOSES ONLY

BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

MINNESOTA AVE METRO STATION
D.1 STOPS BY STATION ENTRANCE,: KISS & RIDE
TURN-AROUND



TYPICAL SECTION – D2
MINNESOTA AVE
DEDICATED GUIDEWAY
TURN–AROUND

LEGEND
PROPOSED TEXT
EXISTING TEXT

SCALE IN FEET
10 0 10 20

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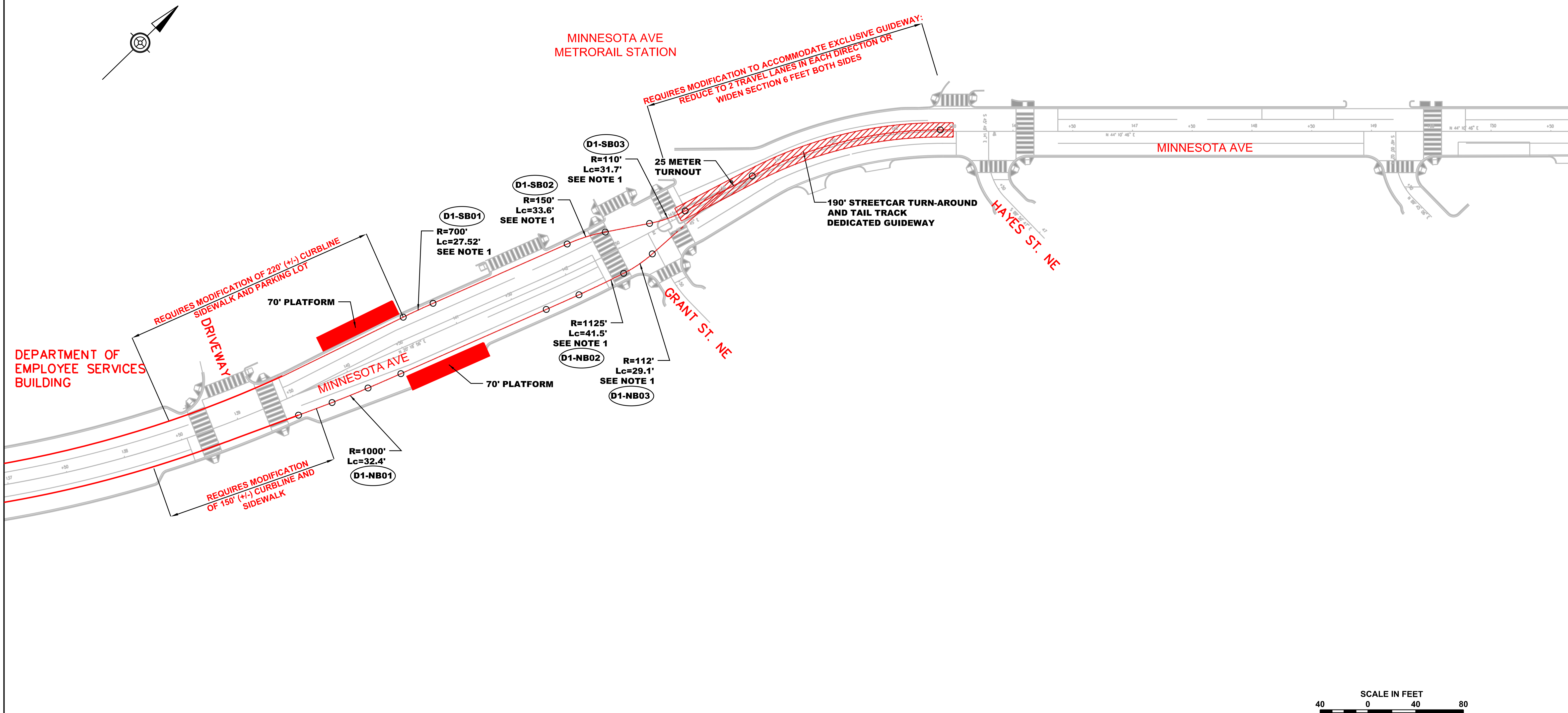
BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

MINNESOTA AVE METRO STATION
D.2 STOPS BY BUS FACILITY; MINNESOTA AVE TURN-AROUND



NOTES:

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2. TANGENT LENGTH BETWEEN REVERSE CURVES DOES NOT MEET MINIMUM LENGTH OF 33' AS SET BY DESIGN CRITERIA 3.1.1.1. APPROVAL FROM AUTHORITY REQUIRED.
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3.1. FOR SIDE RUNNING, 1 FOOT NOMINAL PER SIDE

3.2. FOR CENTER RUNNING, 2 FEET NOMINAL PER SIDE

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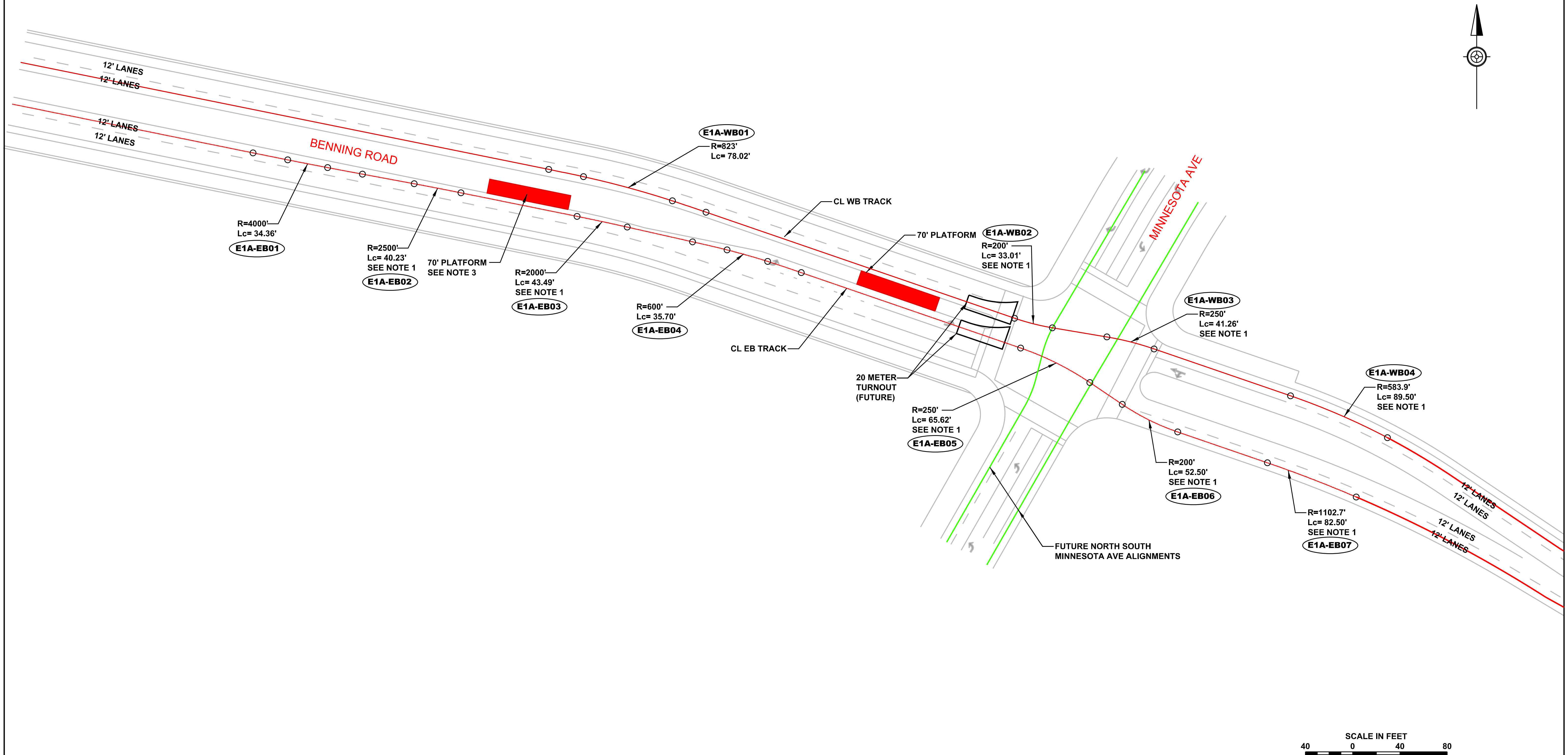
BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

MINNESOTA AVE METRO STATION
D.2 STOPS BY BUS FACILITY; MINNESOTA AVE TURN-AROUND



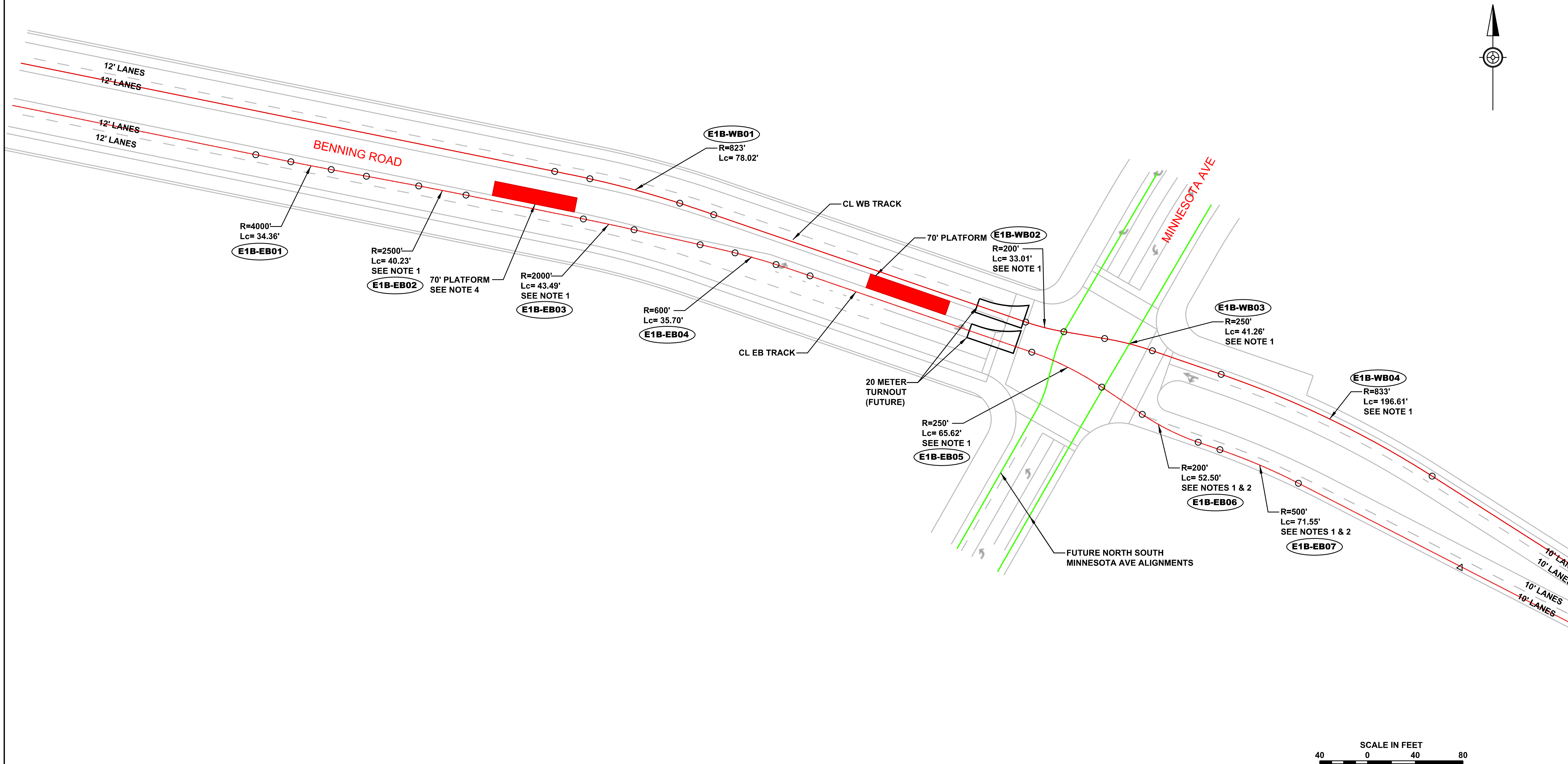
DRAFT / NOT FOR DESIGN /
FOR ILLUSTRATION PURPOSES ONLY

NOTES:

1. CURVE DOES NOT INCLUDE SPIRAL TRANSITION CURVE PER DESIGN CRITERIA 3.1.1.1. WAIVER TO DESIGN CRITERIA REQUIRED.
2. STOP PLATFORM LOCATES ON 4.85 VERTICAL.

BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND
TURN-AROUND
E.1 MEDIAN STOPS ON VIADUCT (OPTION A)
BENNING ROAD AND MINNESOTA AVE
INTERSECTION



DRAFT / NOT FOR DESIGN / FOR ILLUSTRATION PURPOSES ONLY

NOTES:

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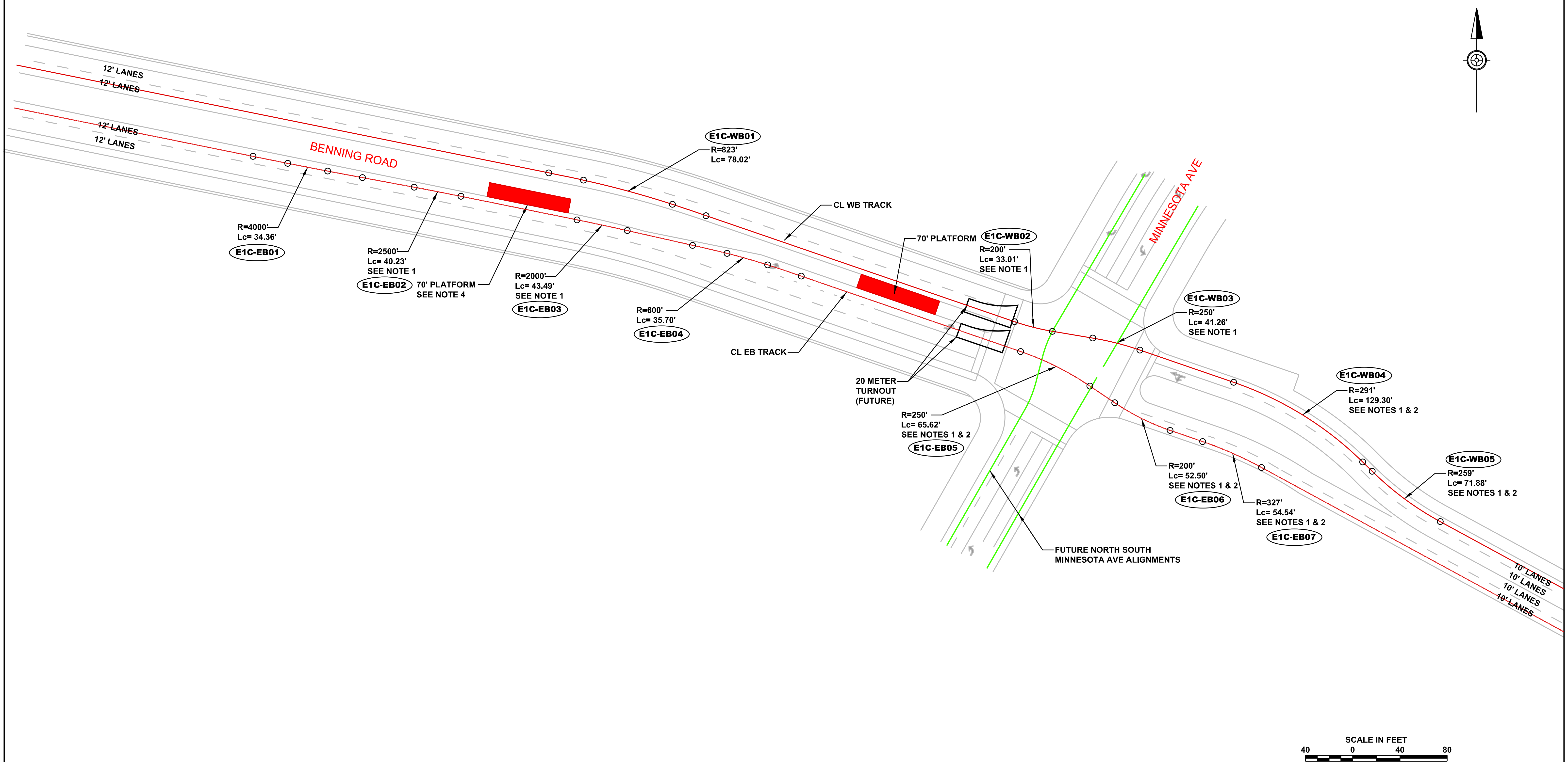
3. GUIDEWAY AS SHOWN REQUIRES A 6 FOOT WIDE CLEARANCE ENVELOPE, AND WILL REQUIRE MOVING CURB LINES AS FOLLOWS:
   3.1. FOR SIDE RUNNING, 1 FOOT NOMINAL PER SIDE (EAST OF INTERSECTION ONLY)
4. STOP PLATFORM LOCATES ON 4.8% VERTICAL.

BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND TURN-AROUND
E.1 MEDIAN STOPS ON VIADUCT (OPTION B)
BENNING ROAD AND MINNESOTA AVE INTERSECTION



DRAFT / NOT FOR DESIGN /
FOR ILLUSTRATION PURPOSES ONLY

NOTES:

1. CURVE DOES NOT INCLUDE SPIRAL TRANSITION CURVE PER DESIGN CRITERIA 3.1.1.1. WAIVER TO DESIGN CRITERIA REQUIRED.
2. TANGENT LENGTH BETWEEN REVERSE CURVES DOES NOT MEET MINIMUM LENGTH OF 33' AS SET BY DESIGN CRITERIA 3.1.1.1. APPROVAL FROM AUTHORITY REQUIRED.
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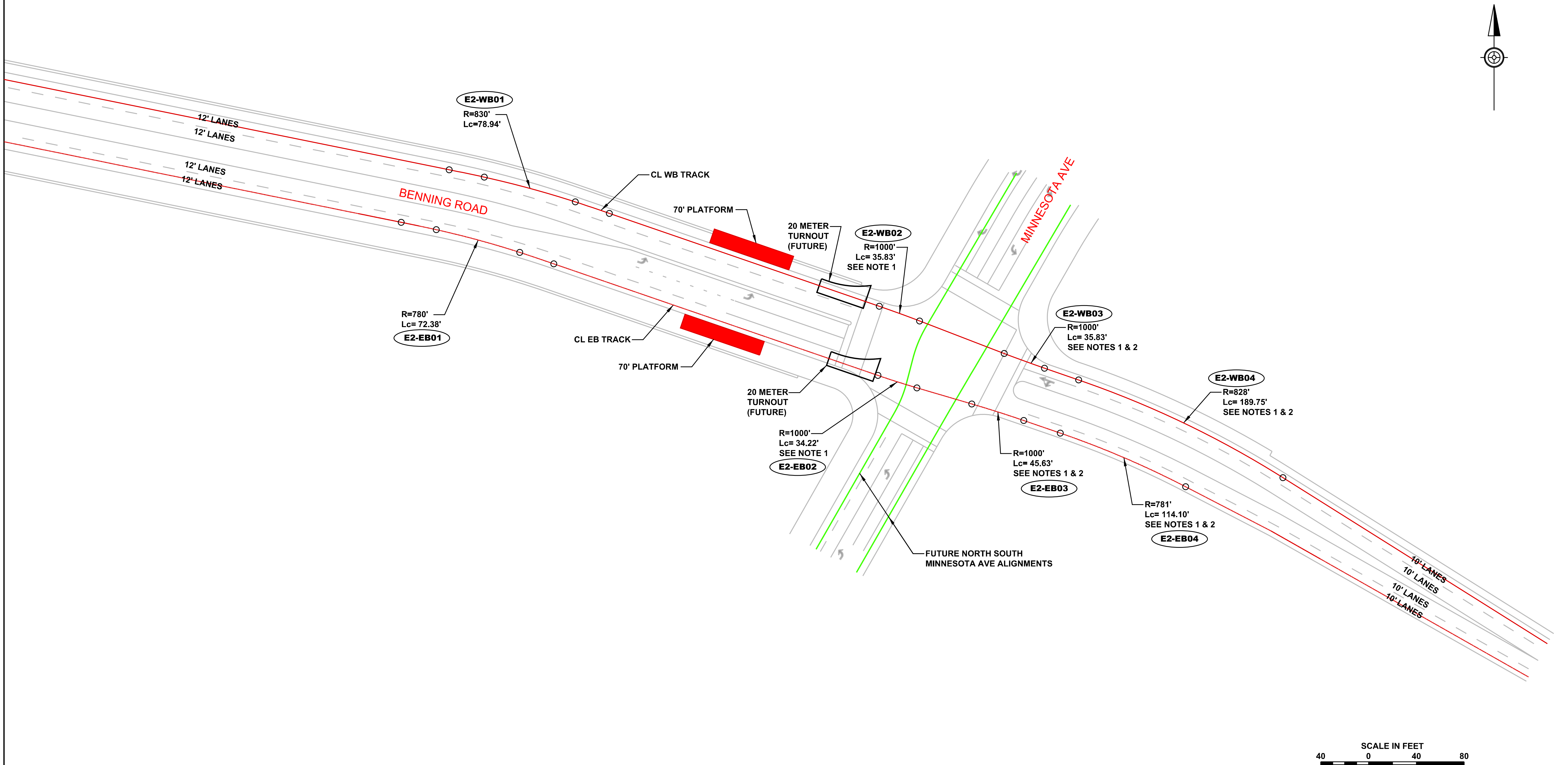
   3.1. FOR SIDE RUNNING, 1 FOOT NOMINAL PER SIDE (EAST OF INTERSECTION ONLY)
4. STOP PLATFORM LOCATES ON 4.8% VERTICAL.

BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND TURN-AROUND
E.1 MEDIAN STOPS ON VIADUCT (OPTION C)
BENNING ROAD AND MINNESOTA AVE INTERSECTION



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FOR ILLUSTRATION PURPOSES ONLY

NOTES:

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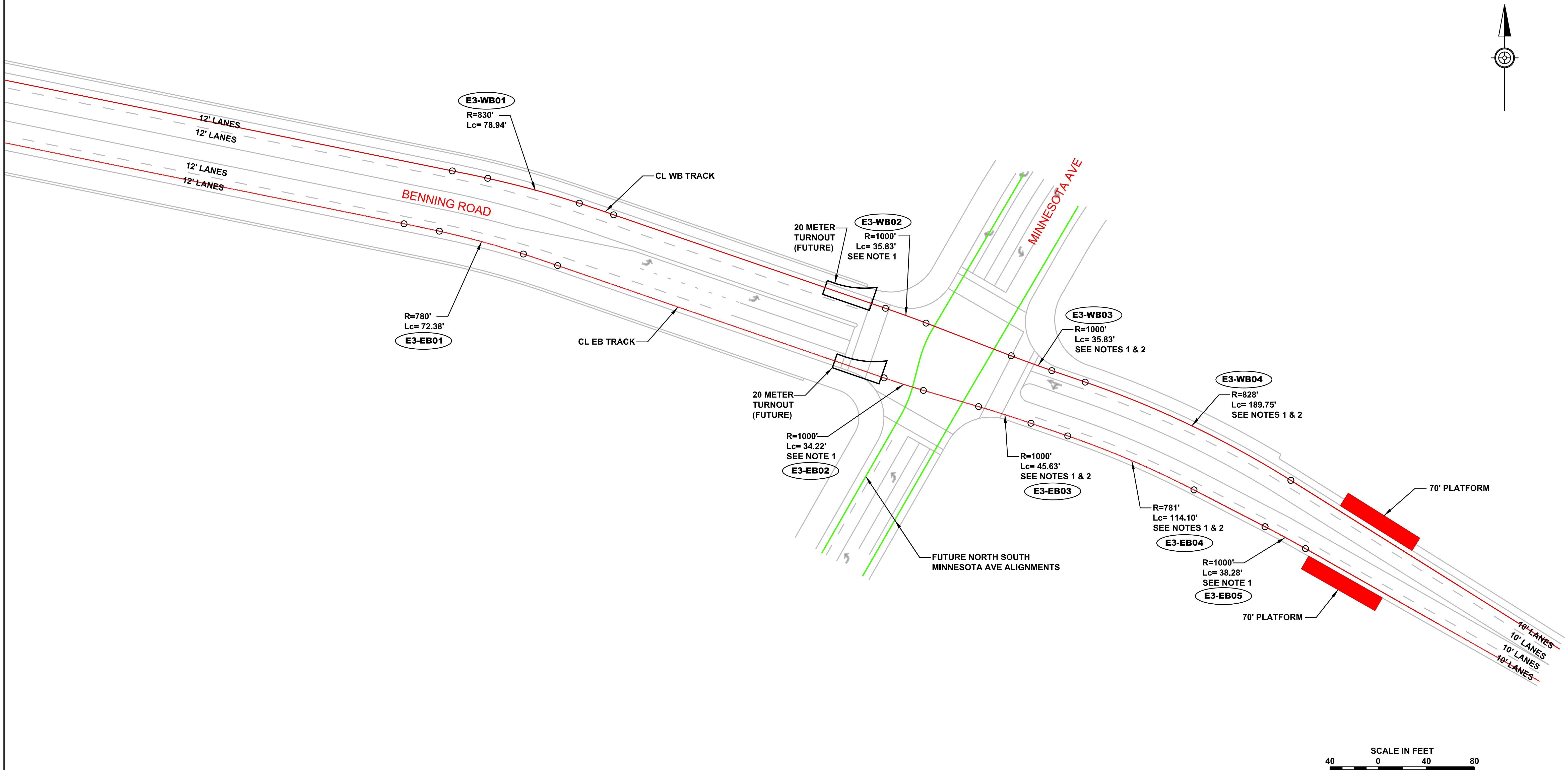
2. TANGENT LENGTH BETWEEN REVERSE CURVES DOES NOT MEET MINIMUM LENGTH OF 33' AS SET BY DESIGN CRITERIA 3.1.1.1. APPROVAL FROM AUTHORITY REQUIRED.
3. GUIDEWAY AS SHOWN REQUIRES A 6 FOOT WIDE CLEARANCE ENVELOPE, AND WILL REQUIRE MOVING CURB LINES AS FOLLOWS:
   3.1. FOR SIDE RUNNING, 1 FOOT NOMINAL PER SIDE (EAST OF INTERSECTION ONLY)

BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND
TURN-AROUND
E.2 CURBSIDE STOPS ON VIADUCT
BENNING ROAD AND MINNESOTA AVE
INTERSECTION



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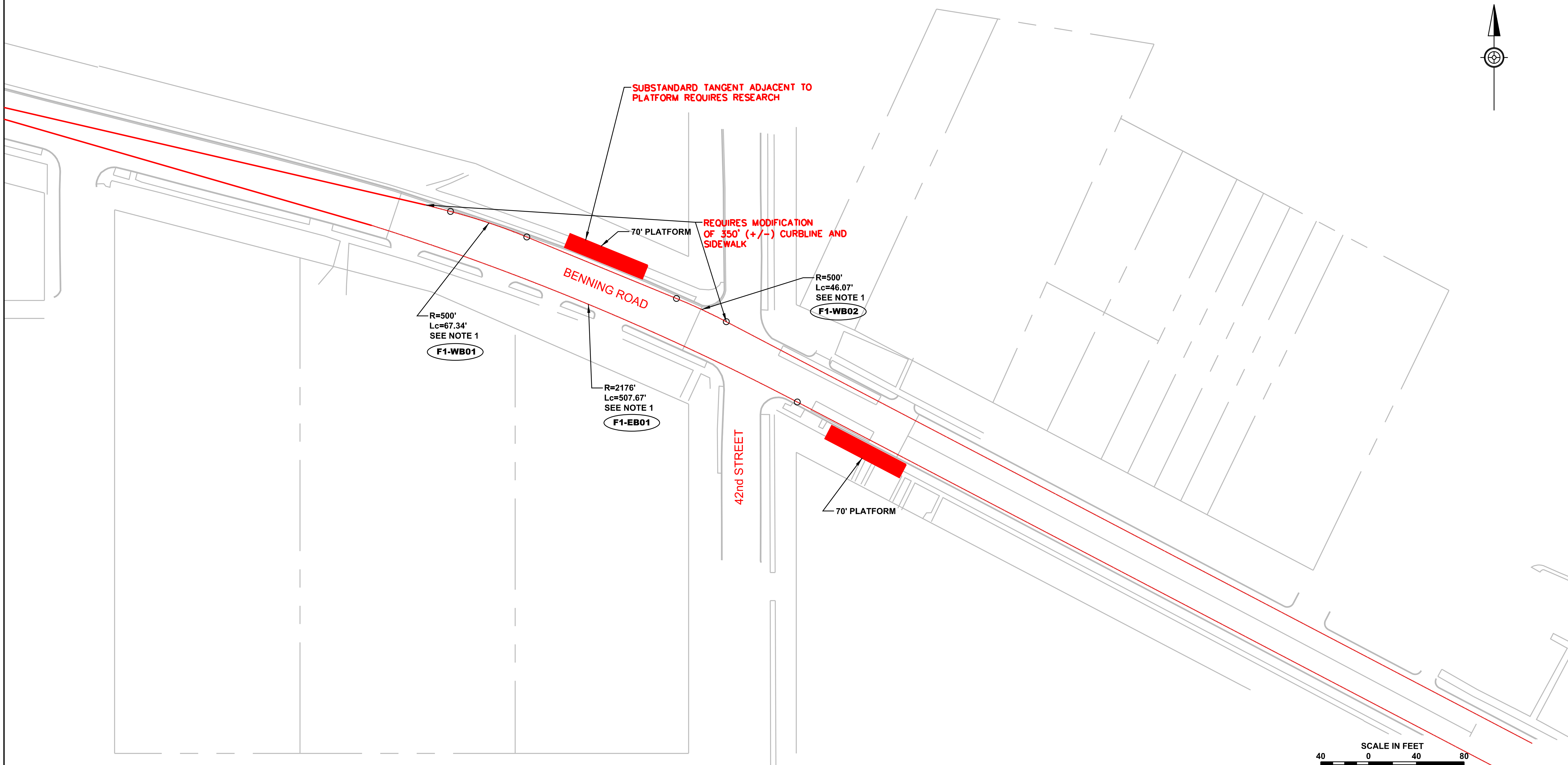
BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND TURN-AROUND
E.3 CURBSIDE STOPS EAST OF INTERSECTION
BENNING ROAD AND MINNESOTA AVE INTERSECTION



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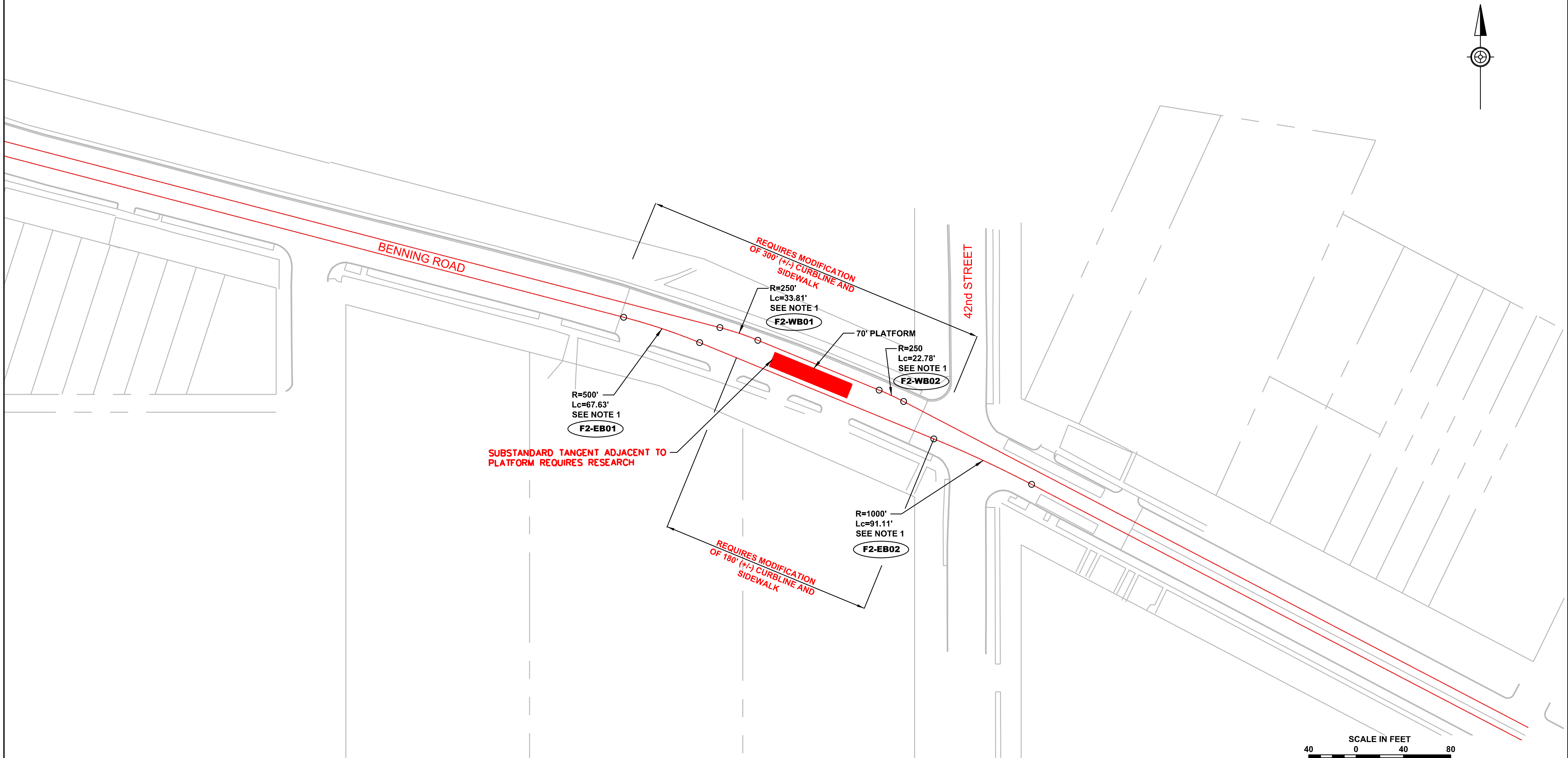
BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

42nd STREET INTERSECTION
F.1 SIDE RUNNING PLATFORMS



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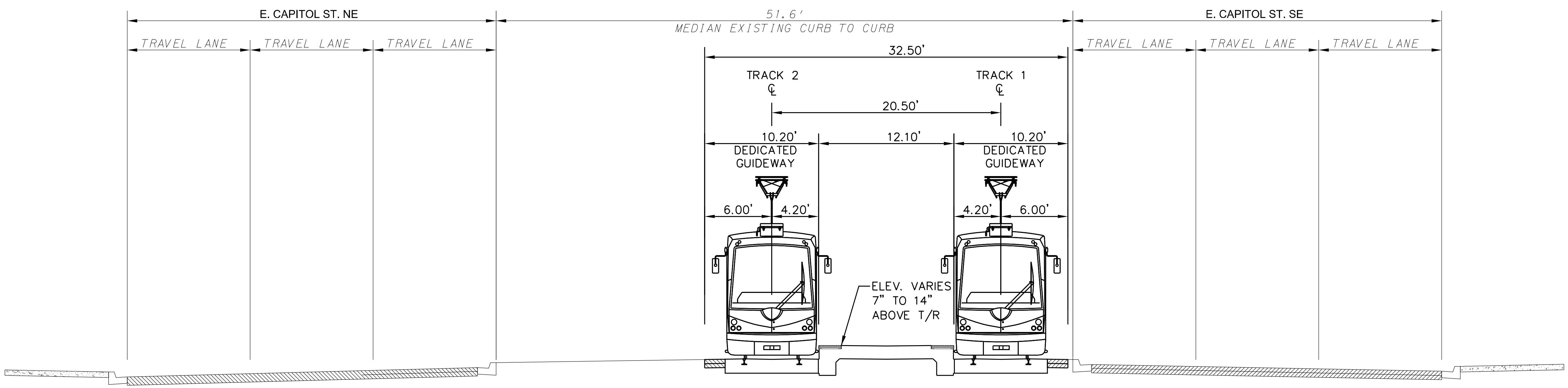
BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

42nd STREET INTERSECTION
F.2 SIDE MEDIAN PLATFORMS



TYPICAL SECTION – G1
E CAPITAL ST MEDIAN TURN–AROUND
CENTER PLATFORM

LEGEND
PROPOSED TEXT
EXISTING TEXT

SCALE IN FEET
10 0 10 20

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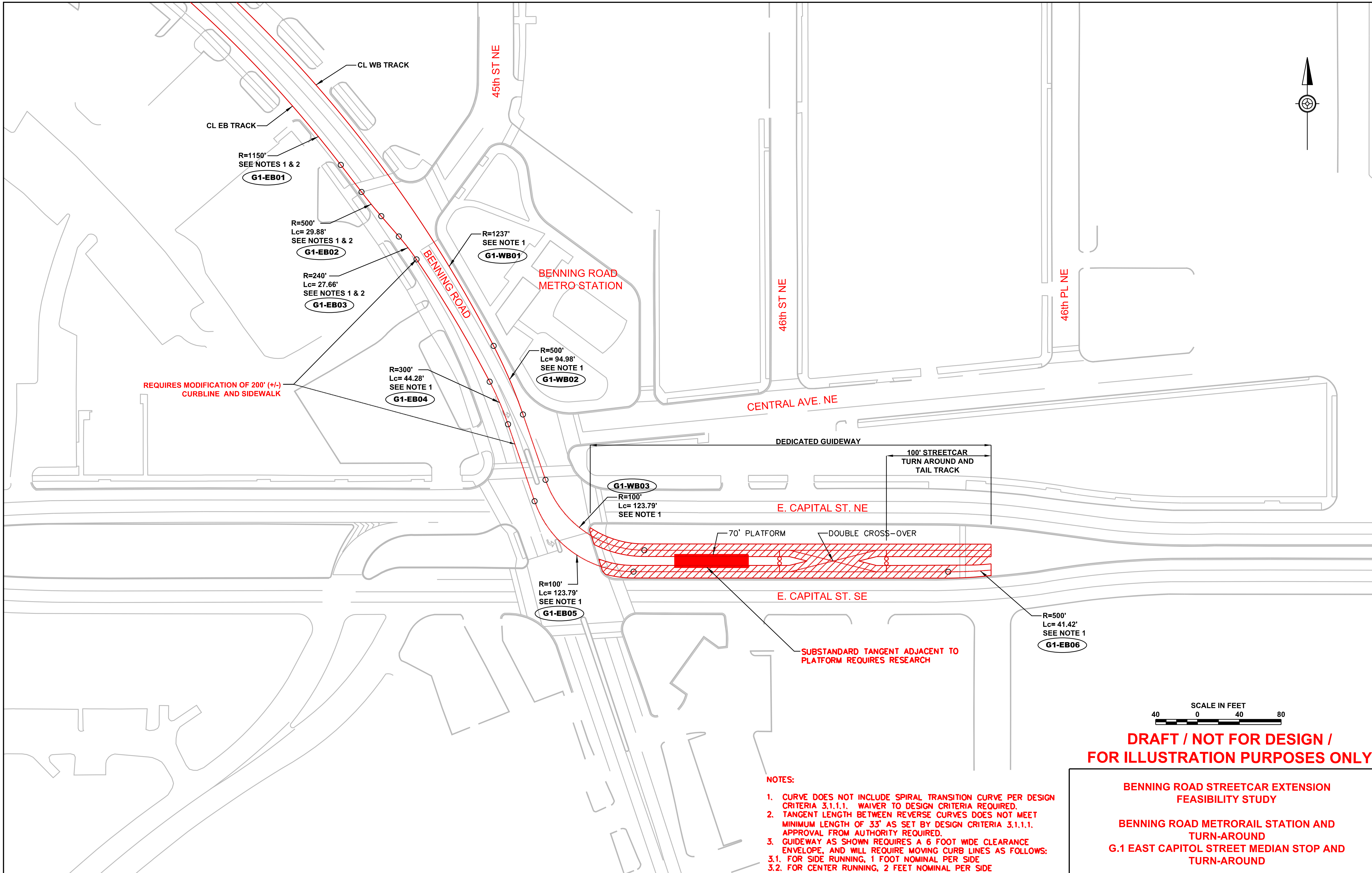
BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND TURN-AROUND
G.1 EAST CAPITOL STREET MEDIAN STOP AND TURN-AROUND



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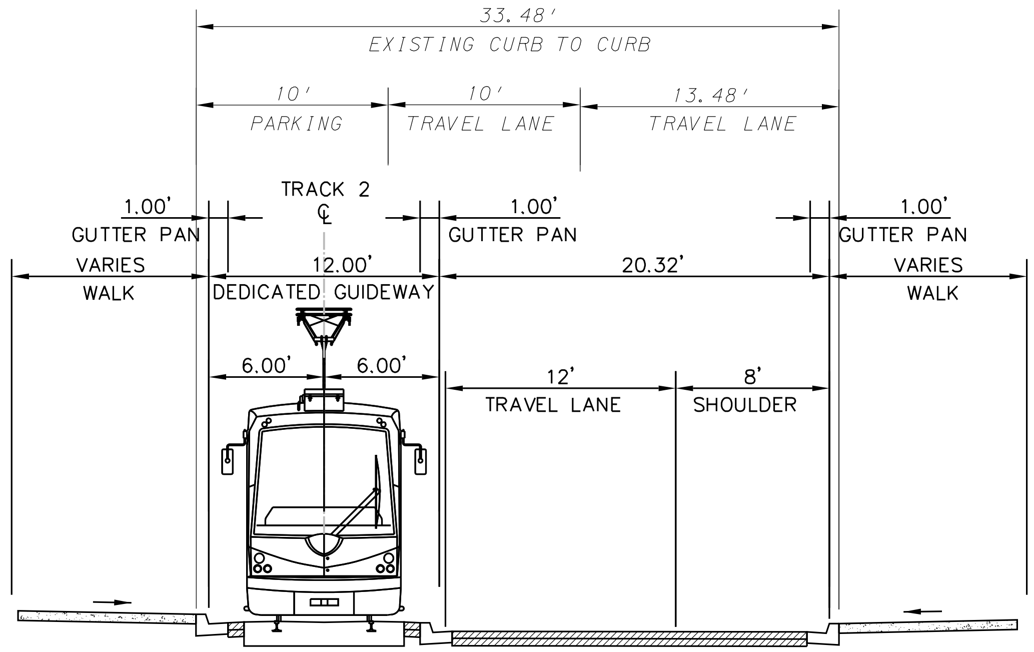
BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND TURN-AROUND
G.1 EAST CAPITOL STREET MEDIAN STOP AND TURN-AROUND



TYPICAL SECTION – G2
CENTRAL AVE
SINGLE TAIL TRACK

LEGEND
PROPOSED TEXT
EXISTING TEXT

SCALE IN FEET
10 0 10 20

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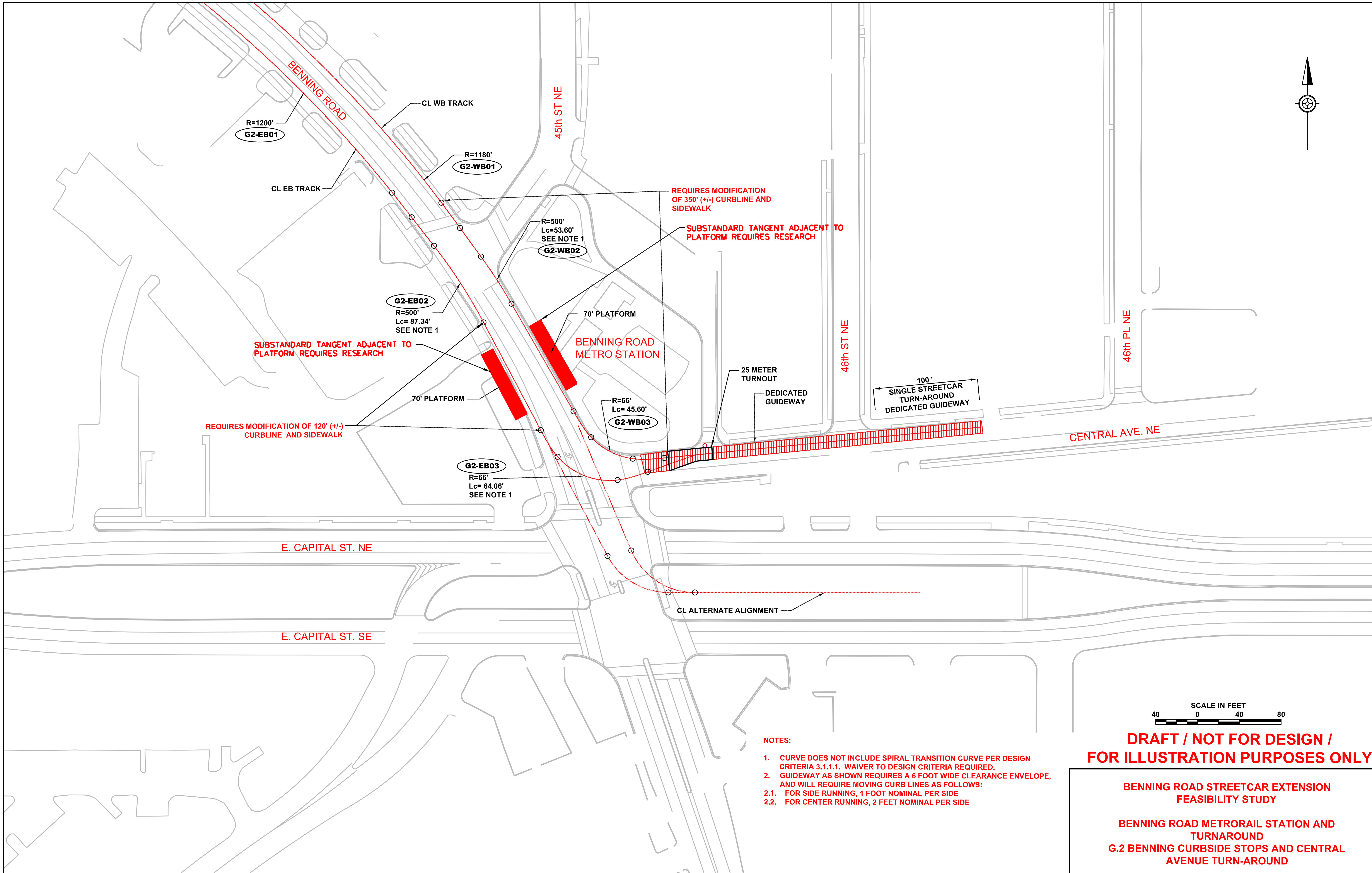
BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND TURNAROUND
G.2 BENNING CURBSIDE STOPS AND CENTRAL AVENUE TURN-AROUND



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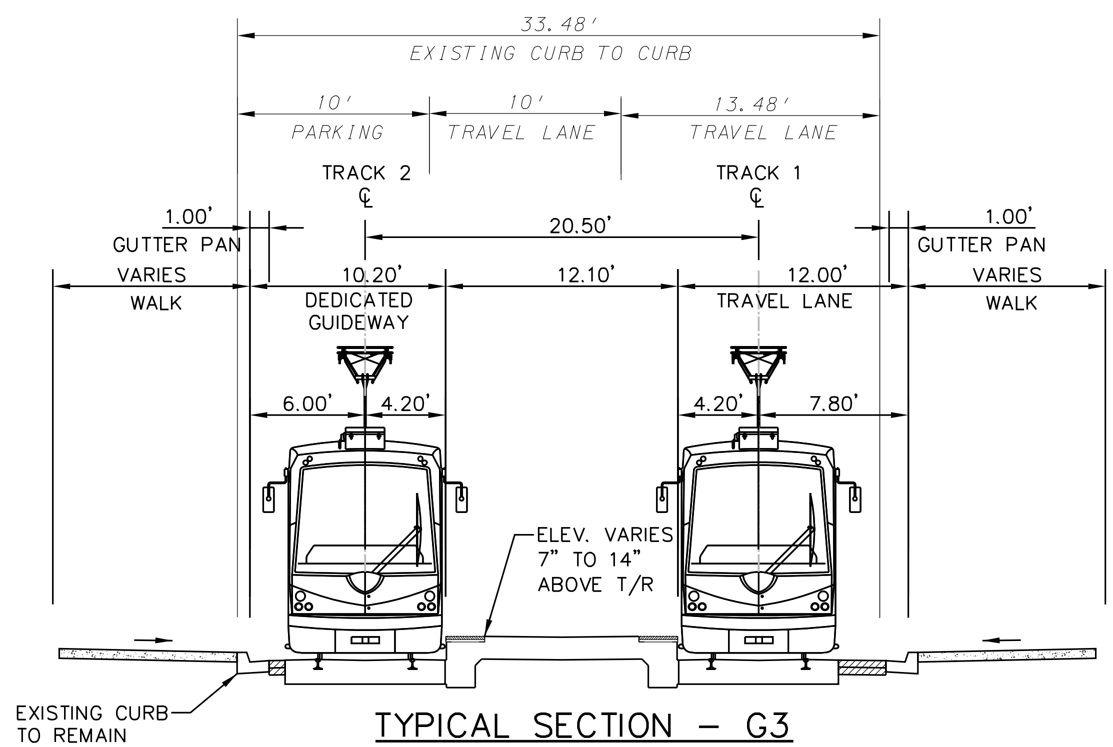
BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND TURNAROUND
G.2 BENNING CURBSIDE STOPS AND CENTRAL AVENUE TURN-AROUND



TYPICAL SECTION – G3
CENTRAL AVE NE – TERMINAL STOP
CENTER PLATFORM

LEGEND
PROPOSED TEXT
EXISTING TEXT

SCALE IN FEET
10 0 10 20

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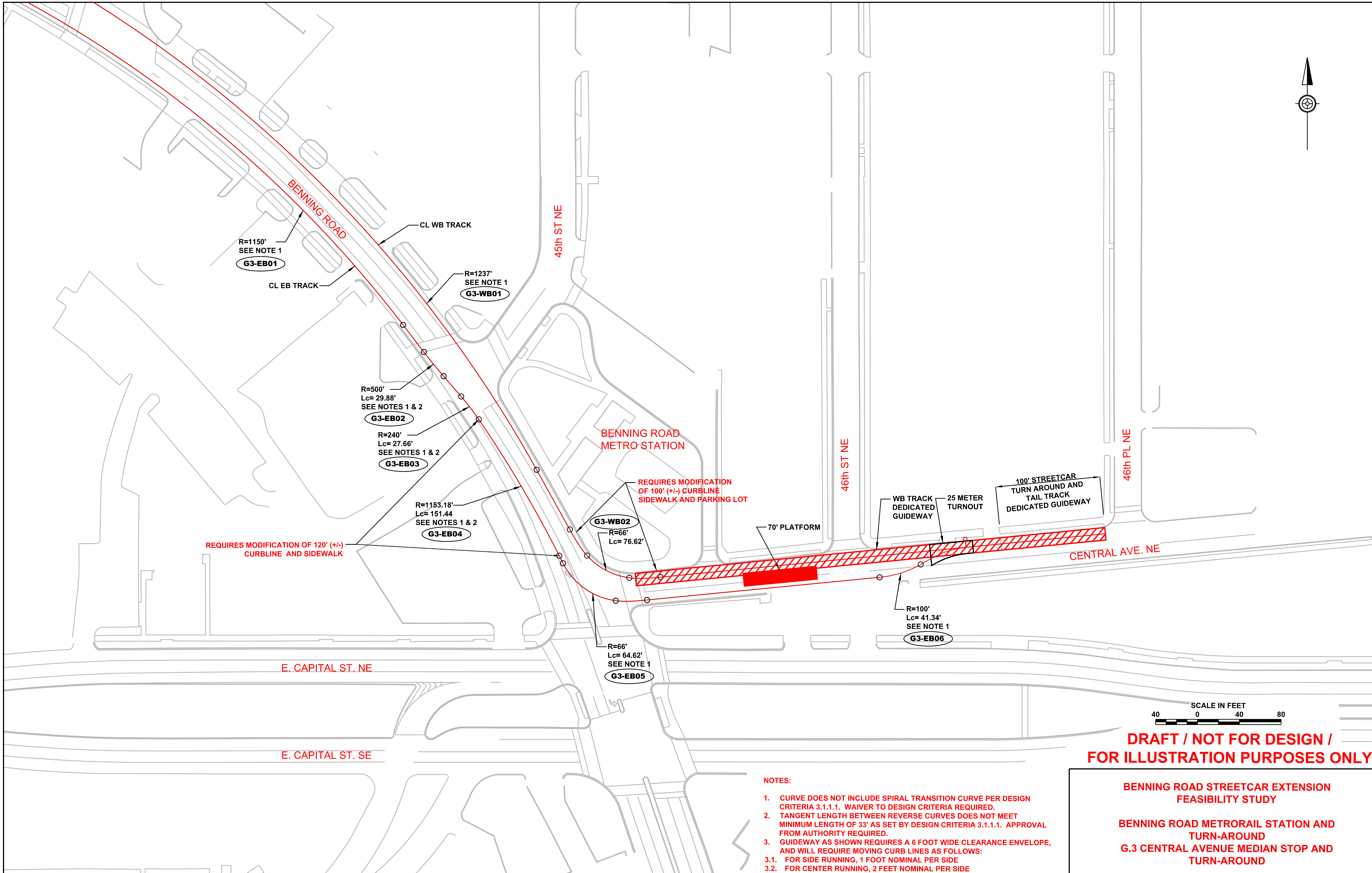
BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND
TURN-AROUND
G.3 CENTRAL AVENUE MEDIAN STOP AND
TURN-AROUND



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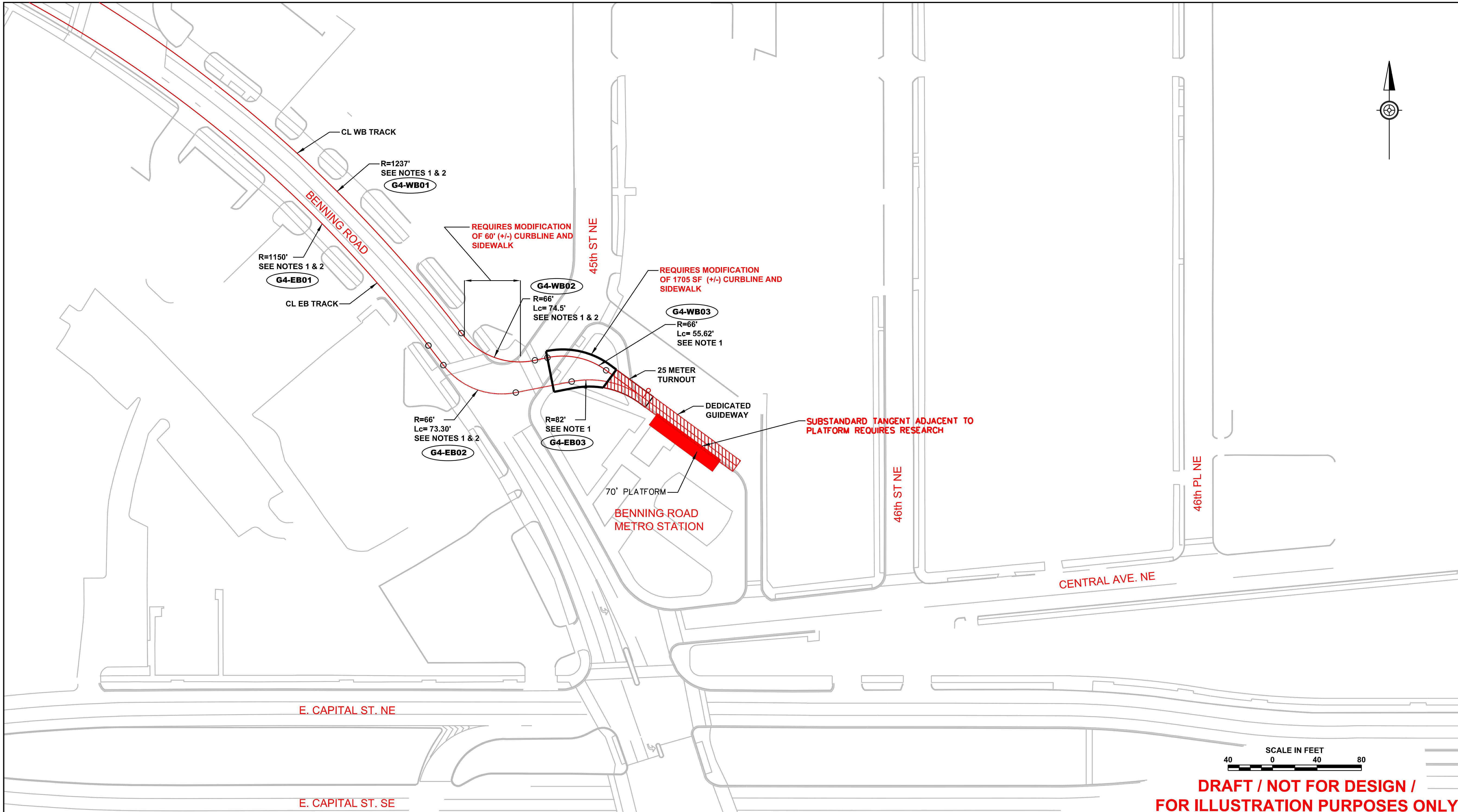
BENNING ROAD STREETCAR EXTENSION
FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND TURN-AROUND
G.3 CENTRAL AVENUE MEDIAN STOP AND TURN-AROUND



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BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

BENNING ROAD METRORAIL STATION AND TURN-AROUND
G.4 KISS AND RIDE SITE STOP AND TURN-AROUND

APPENDIX B: Track Alignment Design Exceptions Report

BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

APPENDIX B: TRACK ALIGNMENT DESIGN EXCEPTIONS

B-1: DESCRIPTION

This appendix identifies track alignment design elements which do not meet the requirements of the Design Criteria at the time of the Conceptual Definition of Alternatives Submission. The elements identified require either re-design, a formal waiver to criteria from DDOT or a combination of both prior to progressing the design to the next level of Engineering. It is recommended in a way which balances the planning needs and operational, maintenance and safety requirements.

The current alignment configurations are compared to the following Design Criteria for compliance:

DDOT Design Criteria Reference	Design Criteria
Chapter 3, Part 3.1.1.2. Curved Alignment	The desired minimum length of spiral is the greater of 31Ea, 0.82 Eu V or 1.10 Ea V. The absolute minimum spiral to be provided should be 30'.
Chapter 3, Part 3.1.1.1. Tangent Alignment	The minimum tangent length should be 33' or 3 times the design speed in mph, whichever is greater. In the instances where the absolute minimum of 0' is used, documentation needs to be prepared indicating its justification.
Chapter 3, Part 3.1.1.3. Reverse Curves	The following criteria may be used with prior approval from DDOT: Reverse curves shall have spiral transition curves that meet at the point of reverse curvature, with the rate of change of super-elevation constant through both of the spiral curves.
Chapter 3, Part 3.1.1.1. Tangent Alignment	Platforms that are adjacent to curves sharper than 650', the tangent track through the platform shall be extended beyond both ends of the platform so that the streetcar clearance envelope does not overhang any portion of the platform as the streetcar approaches and leaves the stop. (Approximately 35'). For a radius of less than 650' the vehicle clearance overhang will need to be checked to ensure that the platform is not being adversely impacted.

Note 1-Suggest further refinement of the alignment at the next level of design to determine the feasibility of including spiral curves.

The following table outlines the deficiencies of each alternative:

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
Alternative X.1 Oklahoma Westbound Unsignalized Transition	X1-YL01-Spirals not provided X1-YL02-Spirals not provided X1-YL03-Spirals not provided X1-EB01-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	The geometry provided meets the minimum curve radius criteria and ties into the center running Benning Road streetcar alignment without major modifications to the Benning Road NE and 26th Street NE intersection. X1-EB01 and X1-YL03 are closure curves from 20 meter turnouts. All curves are non-revenue.
Alternative X.2 Oklahoma Westbound Signalized Transition	X2-EB01-Spirals not provided X2-EB02-Spirals not provided X2-EB03-Spirals not provided X2-WB01-Spirals not provided X2-WB02-Spirals not provided X2-WB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	The geometry provided meets the minimum curve radius criteria and ties into the center running Benning Road streetcar alignment without major modifications to the Benning Road NE and 26th Street NE intersection. X2-EB03 and X2-WB03 are closure curves from 20 meter turnouts. All curves are non-revenue.
	Substandard Tangent Length of 8.15’ between the 20 meter turnout and X2-EB01 Substandard Tangent Length of 19.24’ between X2-WB02 and X2-WB03	Chapter 3, Part 3.1.1.1. Tangent Alignment	The tangents provided between the curves is driven by the required radius for a 20 meter turnout in addition to keeping the lane configuration the same on 26th Street NE.
Alternative B.1 34th Street Intersection, Platform East of 34th Street	NA	NA	NA
Alternative B.2 34th Street Intersection, Platform West of 34th Street	NA	NA	NA

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
Alternative B.3 34th Street Intersection, Platforms, Side Running, West of 34th Street	B3-EB01-Spirals not provided B3-EB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	The geometry provided holds the stop bar on the west side of Benning Road at the intersection of Anacostia Avenue and transitions the streetcar as quickly as possible from center running to side running.
	B3-EB03-Spirals not provided B3-EB04-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	The geometry provided holds the stop bar on the west side of the intersection of 34th Street and Benning Avenue. These curves also transition the streetcar from side running to center running as quickly as possible.
	B3-WB01-Spirals not provided B3-WB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	The geometry provided holds the stop bar on the east side of Benning Road at the intersection of Anacostia Avenue and transitions the streetcar from side running to center running as quickly as possible.
	B3-WB05-Spirals not provided B3-WB06-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	The geometry provided holds the stop bar on the west side of the intersection of 34th Street and Benning Avenue. These curves also transition the streetcar from center running to side running as quickly as possible.

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
	C1-EB02-Spirals not provided C1-EB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided in order to keep the project defined platform location in tangent as well as match the existing lane configuration along Benning Road as closely as possible.
	C1-EB05-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided so as not to preclude the future construction of a 20 meter turnout to continue streetcar east along Benning Road.
	C1-EB06-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided in order to maintain the minimum tangent lengths between curves C1-EB05 and C1-EB06 as well as curves C1-EB06 and C1-EB07.
	C1-EB07-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided so as not to preclude the future construction of a 20 meter turnout to continue streetcar access south along Minnesota Avenue.
	C1-WB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided so as not to preclude future construction of two 20 meter turnouts, one along Minnesota Avenue to continue streetcar access to the south and one along Benning Road to continue streetcar access to the east.

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
Alternative C.2 Curbside Stops on Minnesota Ave Benning Road and Minnesota Ave Intersection	C2-EB01-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided as part of this conceptual design it appears that spirals would not adversely impact the lane width for the left turn lane on Benning Road.
	C2-EB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spiral has been provided in order to keep the configuration of the left turn lane on the west side of Benning Road the same as existing.
	C2-EB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided so as not to preclude the future construction of a 20 meter turnout.
	C2-EB04-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided so as not to preclude the future construction of a 20 meter turnout.
	C2-WB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided so as not to preclude future construction of two 20 meter turnouts.

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
Alternative C.3 Curbside Stops on Viaduct Benning Road and Minnesota Ave Intersection	C3-EB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided so as not to preclude the future construction of a 20 meter turnout.
	C3-EB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided so as not to preclude the future construction of a 20 meter turnout.
	C3-WB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided so as not to preclude future construction of two 20 meter turnouts.

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
D.1 Stops by Station Entrance: KISS and Ride Turn-around	D1-NB01-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided as part of this conceptual design however, it appears that spirals would not adversely impact the lane width of Minnesota Avenue. See Note 1.
	D1-NB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	An entrance spiral has not been provided in order to maintain the stop bar on the west side of the Minnesota Avenue and Grant Street NE intersection. An exit spiral has not been provided in order to provide 35' of tangent adjacent to the project defined platform location.
	D1-NB04-Spirals not provided D1-NB05-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals have not been provided so that the 25 meter turnout will not be adversely impacted and the streetcar is transitioned as quickly as possible from center running to the dedicated guideway.
	D1-SB01-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided as part of this conceptual design however, it appears that spirals would not adversely impact the lane width of Minnesota Avenue. See Note 1.
	D1-SB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	An exit spiral was not provided in order to provide 35' of tangent adjacent to the project defined platform location.
	D1-SB04-Spirals not provided D1-SB05-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals have not been provided so that the 25 meter turnout will not be adversely impacted and the streetcar is transitioned as quickly as possible from the dedicated guideway to side running.
	Substandard Tangent Length of 12.15' between D1-NB04 and D1-NB05	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangent has been provided so that the 25 meter turnout will not be adversely impacted and the streetcar is transitioned as quickly as possible from center running to the dedicated guideway.

D.1 Stops by Station Entrance: KISS and Ride Turn-around(Cont'd)	Substandard Tangent Length between D1-SB04 and D1-SB05 of 20.03'	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangent has been provided so that the 25 meter turnout will not be adversely impacted and the streetcar is transitioned as quickly as possible from the dedicated guideway to side running.

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
D.2 Stops by Bus Facility: Minnesota Ave Turn-around	D2-NB02-Spirals not provided D2-NB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No exit spiral has been provided in order to keep the stop bar, on the west side of the Minnesota Avenue and Grant Street NE intersection, in place and transition the streetcar from side running to the dedicated guideway as quickly as possible.
	D2-SB0-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided so that the project defined platform location remains in tangent.
	D2-SB02-Spirals not provided D2-SB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided for these curves in order to keep the stop bar, on the east side of the Minnesota Avenue and Grant Street NE intersection, in pace as well as transition the streetcar as quickly as possible from dedicated guideway to side running.

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
Alternative E.1 Median Stops on Viaduct (Option A) Benning Road and Minnesota Ave Intersection	E1A-EB02-Spirals not provided E1A-EB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided in order to maintain the project defined platform location in tangent.
	E1A-EB05-Spirals not provided E1A-EB06-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided in order to maintain the stop bar location on the west side of the Benning Road and Minnesota Avenue intersection as well as not to preclude future construction of a 20 meter turnout that would connect streetcar access to Minnesota Avenue.
	E1A-EB07-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided as part of this conceptual design however, it appears that spirals would not adversely impact the lane width on Benning Road. See Note 1.
	E1A-WB02-Spirals not provided E1A-WB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided in order to maintain the stop bar location on the east side of the Benning Road and Minnesota Avenue intersection as well as not to preclude future construction of a 20 meter turnout that would connect streetcar access to Minnesota Avenue.
	E1A-WB04-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided as part of this conceptual design however, it appears that spirals would not adversely impact the lane width on Benning Road. See Note 1.

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
Alternative E.1 Median Stops on Viaduct (Option B) Benning Road and Minnesota Ave Intersection	E1B-EB02-Spirals not provided E1B-EB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided in order to maintain the project defined platform location in tangent.
	E1B-EB05-Spirals not provided E1B-EB06-Spirals not provided E1B-EB07-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided in order to maintain the stop bar location on the west side of the Benning Road and Minnesota Avenue intersection as well as not to preclude future construction of a 20 meter turnout that would connect streetcar access to Minnesota Avenue.
	E1B-WB02-Spirals not provided E1B-WB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided in order to maintain the stop bar location on the east side of the Benning Road and Minnesota Avenue intersection as well as not to preclude future construction of a 20 meter turnout that would connect streetcar access to Minnesota Avenue.
	E1B-WB04-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided as part of this conceptual design however, it appears that spirals would not adversely impact the lane width on Benning Road. See Note 1.
	Substandard Tangent Length of 19.22' between E1B-EB06 and E1B-EB07	Chapter 3, Part 3.1.1.1. Tangent Alignment	The tangents provided between the curves minimize changes necessary to the intersection of Benning Road and Minnesota Avenue as well as maintain the minimum tangent length between E1B-EB05 and E1B-EB06.

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
Alternative E.1 Median Stops on Viaduct (Option C) Benning Road and Minnesota Ave Intersection	E1C-EB02-Spirals not provided E1C-EB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided in order to maintain the project defined platform location in tangent.
	E1C-EB05-Spirals not provided E1C-EB06-Spirals not provided E1C-EB07-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided in order to maintain the stop bar location on the west side of Benning Road and Minnesota Avenue intersection as well as not to preclude future construction of a 20 meter turnout that would connect streetcar access to Minnesota Avenue.
	E1C-WB01-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided as part of this conceptual design however, it appears that spirals would not adversely impact the lane width on Benning Road. See Note 1.
	E1C-WB02-Spirals not provided E1C-WB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided in order to maintain the stop bar location on the east side of the Benning Road and Minnesota Avenue intersection as well as not to preclude future construction of a 20 meter turnout that would connect streetcar access to Minnesota Avenue.
	E1C-WB04-Spirals not provided E1C-WB05-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals were provided in order to minimize changes necessary to the Westbound lane configuration of Benning Road. See Note 1.
	Substandard Tangent Length of 25.38' between E1C-EB05 and E1C-EB06	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents were provided in order to maintain the stop bar location on the west side of Benning Road at the Minnesota Avenue intersection.
	Substandard Tangent Length of 29.09' between E1C-EB06 and E1C-EB07	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents were provided in order to maintain the lane configuration on Eastbound Benning Road east of Minnesota Avenue.
	Substandard Tangent Length of 11.31' between E1C-WB04 and E1C-WB05	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents were provided in order to maintain the lane configuration on Westbound Benning Road east of Minnesota Avenue.

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
Alternative E.2 Curbside Stops of Viaduct Benning Road Minnesota Ave Intersection	E2-EB02-Spirals not provided E2-EB03-Spirals not provided E2-EB04-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided in order to maintain the stop bar location on the west side of the Benning Road at the intersection of Minnesota Avenue, as well as not to preclude future construction of a 20 meter turnout that would connect streetcar access to Minnesota Avenue.
	E2-WB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided so as not to preclude future construction of as 20 meter turnout that would connect streetcar access to Minnesota Avenue.
	E2-WB03-Spirals not provided E2-WB04-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided in order to maintain the stop bar location on the east side of Benning Road at the intersection of Minnesota Avenue, as well as not to preclude future construction of a 20 meter turnout that would connect streetcar access to Minnesota Avenue.
	Substandard Tangent Length of 32.35’ between E2-EB03 and E2-EB04	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents were provided in order to maintain the lane configuration on Eastbound Benning Road east of Minnesota Avenue.
	Substandard Tangent Length of 30.20’ between E2-WB03 and E2-WB04	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents were provided in order to maintain the lane configuration on Westbound Benning Road east of Minnesota Avenue.

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
Alternative E.3 Curbside Stops of East of Intersection-Benning Road and Minnesota Ave Intersection	E3-EB02-Spirals not provided E3-EB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided in order to maintain the stop bar location on the west side of the Benning Road and Minnesota Avenue intersection as well as not preclude future construction of a 20 meter turnout that would provide streetcar access to Minnesota Avenue.
	E3-EB04-Spirals not provided E3-EB05-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals were provided in order to maintain the lane configuration on Eastbound Benning Road east of Minnesota Avenue as well as to keep the project define platform location in tangent.
	E3-WB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided so as not to preclude future construction of as 20 meter turnout that would connect streetcar access to Minnesota Avenue.
	E3-WB03-Spirals not provided E3-WB04-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals were provided in order to maintain the stop bar location and lane configuration on Westbound Benning Road east of Minnesota Avenue.
	Substandard Tangent Length of 32.35’ between E3-EB03 and E3-EB04	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents were provided in order to maintain the lane configuration on Eastbound Benning Road East of Minnesota Avenue as well as to keep the project defined platform in tangent.
	Substandard Tangent Length of 30.20’ between E3-WB03 and E3-WB04	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard were provided in order to maintain the lane configuration on Westbound Benning Road east of Minnesota Avenue.

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
Alternative F.1 Side Running Platforms 42nd Street Intersection	F1-EB01-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided as part of this conceptual design it appears that spirals would not adversely impact the lane width on Benning Road. See Note 1.
	F1-WB01-Spirals not provided F1-WB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals were provided in order to maintain the project defined platform location, an exit spiral to curve F1-WB01 and an entrance spiral to F1-WB02 could be provided without adversely impacting the lane widths. See Note 1.
	Platform West of 42 Street has 32.63'of tangent, instead of 35' of tangent extended at the approach and departure ends of the platform.	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents have been provided in order to ensure that the project define platform location is maintained.
Alternative F.2 Side Median Platforms 42nd Street Intersection	F2-EB01-Spirals not provided F2-EB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided as part of this conceptual design it appears that spirals would not adversely impact the lane width on Benning Road. See Note 1.
	F2-WB01-Spirals not provided F2-WB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals were provided in order to maintain the project defined platform location and minimize impacts to the typical section.
	Platform West of 42 Street has 17.55 min. of tangent, instead of 35' of tangent extended at the approach and departure ends of the platform.	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents have been provided in order to ensure that the project define platform location is maintained.

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
Alternative G.1 East Capitol Street Median Stop and Turn-around	G1-EB01-Spirals not provided G1-EB02-Spirals not provided G1-EB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals were provided in order to maintain the stop bar at the corner of 45th Street NE and Benning Road in the Eastbound direction as well as transition the streetcar from side running to center running as quickly as possible.
	G1-EB04-Spirals not provided G1-EB05-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals were provided in order to maintain the intersection configuration in addition to maintaining a minimum clearance from the oncoming traffic travelling Westbound on Benning Road.
	G1-EB06-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided in order to maintain the project defined platform and double crossover location. Alignment is non-revenue.
	G1-WB01-Spirals not provided G1-WB02-Spirals not provided G1-WB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided in order to maintain the lane configuration as closely as possible on Benning Road between E. Capital Street NE and 45th Street NE as well a maintain the project defined platform location.
	Substandard Tangent Length of 32.58’ between G1-EB01 and G1-EB02 Substandard Tangent Length of 25.70’ between G1-EB02 and G1-EB03	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents were provided in order to maintain the stop bar at the corner of 45th Street NE and Benning Road in the Eastbound direction as well as transition the streetcar from side running to center running as quickly as possible.
	Platform has 29.17’ of tangent, instead of 35' of tangent extended at the approach and departure ends of the platform.	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents have been provided in order to ensure that the project define platform location is maintained.

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
Alternative G.2 Benning Curbside Stops and Central Avenue Turn-around	G2-EB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals were provided in order to maintain the stop bar at the corner of 45th Street NE and Benning Road in the Eastbound direction as well as maintain the project defined platform in tangent.
	G2-WB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals were provided in order to maintain the project defined platform location in tangent.
	Platforms on Benning Road have 20.06’ min. of tangent, instead of 35' of tangent extended at the approach and departure ends of the platform.	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents have been provided in order to ensure that the project define platform location remains in place.

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
Alternative G.3 Central Avenue Median Stop and Turn-around	G3-EB01-Spirals not provided G3-EB02-Spirals not provided G3-EB03-Spirals not provided G3-EB04-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals were provided in order to maintain the stop bar at the corner of 45th Street NE and Benning Road in the Eastbound direction as well as to transition the streetcar as quickly as possible from side running to center running.
	G3-EB05-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No entrance spiral was provided in order to provide the minimum curve radius and maintain the lane configurations as closely as possible to the existing condition at the intersection of Benning Road and Central Avenue NE.
	G3-EB06-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided in order to maintain the platform in the project defined location as well as not to impact the 25 meter turnout. Alignment is non-revenue.
	G3-WB01-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals have been provided as part of this conceptual design it appears that spirals would not adversely impact the lane width on Benning Road. See Note 1.
	Substandard Tangent Length of 25.70’ between G3-EB02 and G3-EB03	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents were provided in order to maintain the stop bar at the corner of 45th Street NE and Benning Road in the Eastbound direction as well as to transition the streetcar as quickly as possible from side running to center running.
	Substandard Tangent Length of 8.06’ between G3-EB04 and G3-EB05	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents were provided in order to provide the minimum curve radius and maintain the lane configurations as closely as possible to the existing condition at the intersection of Benning Road and Central Avenue NE.

Alternative	Design Criteria Deficiency	Design Criteria Reference	Design Criteria Discussion
Alternative G.4 KISS and Ride Site Stop and Turn-around	G4-EB01-Spirals not provided G4-EB02-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	No spirals were provided in order to maintain the stop bar at the corner of 45th Street NE and Benning Road in the Eastbound direction as well as meet the minimum required curve radii.
	G4-EB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided in order to maintain the minimum tangent length entering the curve as well as not to impact the 25 meter turnout exiting the curve.
	G4-WB01-Spirals not provided G4-WB02-Spirals not provided G4-WB03-Spirals not provided	Chapter 3, Part 3.1.1.2. Curved Alignment	Spirals were not provided in order to provide minimum curve radii as well as not impact the 25 meter turnout and maintain the project defined platform location.
	Substandard Tangent Length of 22.24’ between G4-EB01 and G4-EB02	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents were provided in order to best match the existing roadway geometry and provide the minimum required curve radii.
	Substandard Tangent Length of 11.48’ between G4-WB02 and G4-WB03	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents were provided in order to maintain minimum required curve radii.
	No Tangent is provided between Reverse Curves, G3-WB01 and G3-WB02	Chapter 3, Part 3.1.1.3. Reverse Curves	NO tangents have been provided between reverse curves in order to maintain the existing geometry on Benning Road as closely as possible. G3-WB01 R=1237’ and G3-WB02 R=66’.
	Platform has 19.17’ min, instead of 35' of tangent extended at the approach and departure ends of the platform.	Chapter 3, Part 3.1.1.1. Tangent Alignment	Substandard tangents have been provided in order to ensure that the project define platform location remains in place.

END OF APPENDIX A

Appendix D:

Bridge Impact Analysis for Anacostia River

and Kingman Lake Bridges Technical Memorandum

District Department of Transportation

BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

BRIDGE IMPACT ANALYSIS FOR ANACOSTIA RIVER AND KINGMAN LAKE BRIDGES TECHNICAL MEMORANDUM

October 2012

District Department of Transportation

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1.0 INTRODUCTION

1.1 Background

The District of Columbia Department of Transportation (DDOT), developed the *DC's Transit Future System Plan (2010)* to address the mobility, accessibility, economic and community development needs of District residents. The recommended plan has an integrated system of streetcar, limited-stop bus, and circulator bus services that will connect residents and neighborhoods to employment centers, commercial areas, recreational facilities, and multimodal transportation hubs within the District.

The planned streetcar system consists of eight lines and includes Georgetown to Benning Road Metrorail Station Line (see **Figure 1**). The initial implementation of the line is the H Street/Benning Road Streetcar that will run between Union Station and Oklahoma Avenue just west of the Anacostia River. Subsequent phases of the Streetcar System Plan will extend the line H/Benning Line across the Anacostia River, which is referred to as the "Benning Road Streetcar Extension." The final phase of the system plan includes a line from Bolling Air Force Base (AFB) to the Minnesota Avenue Metrorail Station that will intersect the Benning Road Streetcar Extension at Minnesota Avenue.

1.2 Benning Road Streetcar Extension Feasibility Study

The current study investigates options for extending the H Street/Benning Road streetcar line east of the river in the near term within the context of other ongoing and planned infrastructure projects along the corridor as well as ongoing redevelopment projects and planning studies. The study also assesses the engineering challenges of extending the line to the east, including the following issues:

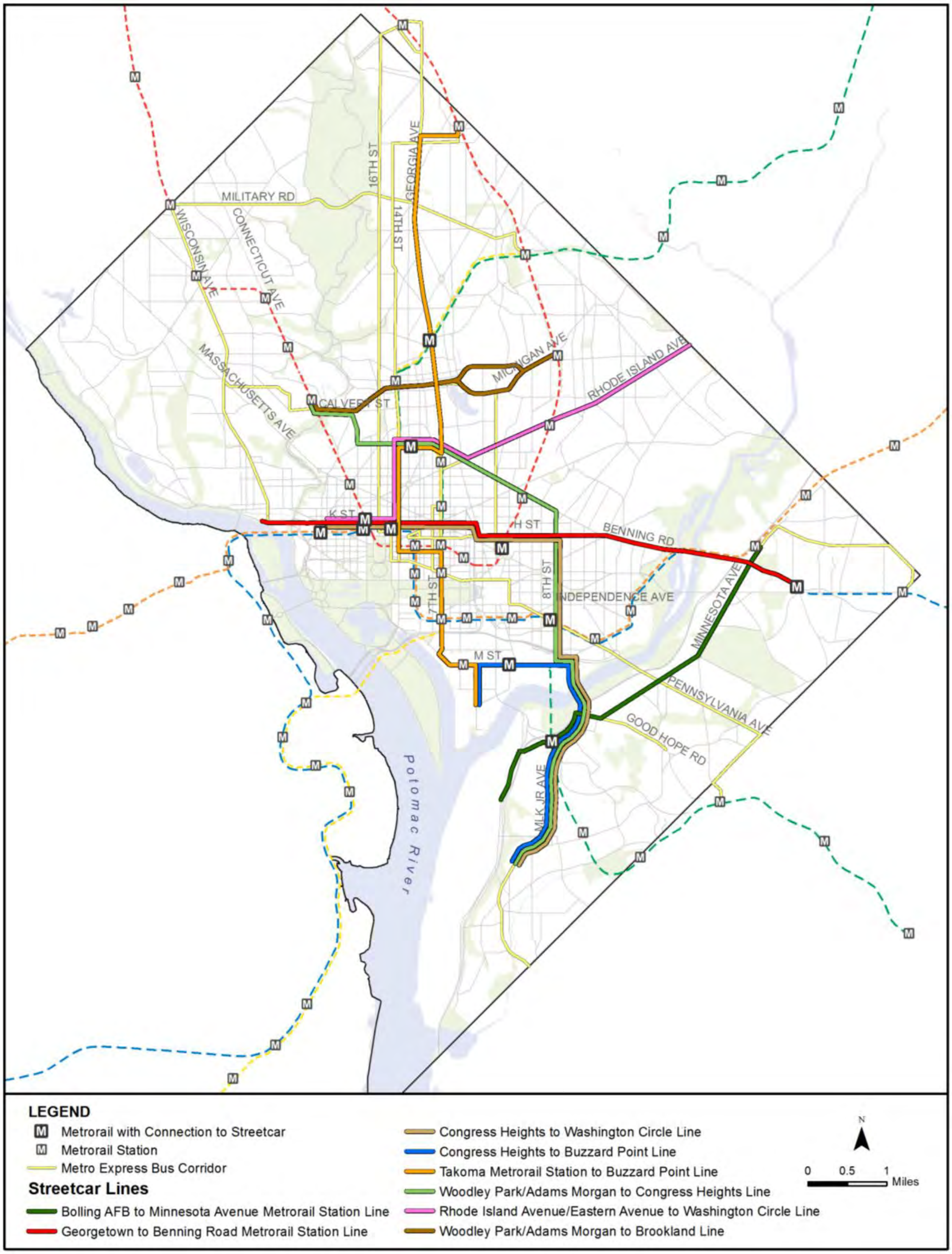
- Crossing the Anacostia River via the two bridges east and west of Kingman Island;
- Crossing Kenilworth Avenue and the CSXT railroad tracks via the eastbound and westbound Benning Road viaducts, which will require reconstruction independent of the streetcar project;
- Addressing the intersection of Benning Road and Minnesota Avenue, which is a high-volume intersection and important activity center;
- Serving both the Minnesota Avenue and Benning Road Metrorail Station areas, which have limited capacity to accommodate the operational needs of a streetcar system; and
- Minimizing potential impacts to right-of-way, driveway access, and on-street parking along the corridor.

1.3 Conceptual Definition of Alternatives

The purpose of this technical memorandum is to document the preliminary alternatives developed for the Benning Road Streetcar Extension. The memorandum is organized as follows:

- Section 2: Definition of the Corridor
    - Terminus Options
    - Planning Context
    - Engineering Context
- Section 3: Conceptual Alternatives
- Section 4: General Operating Strategies

Figure 1: DC Streetcar System Plan



2.0 Definition of the Corridor

The study corridor extends along Benning Road from the Oklahoma Avenue, NE intersection on the west (current terminus of the H/Benning Streetcar Line) to the East Capitol Street intersection on the east. The corridor includes Minnesota Avenue from Benning Road up to the Minnesota Avenue Metrorail station Kiss & Ride area.

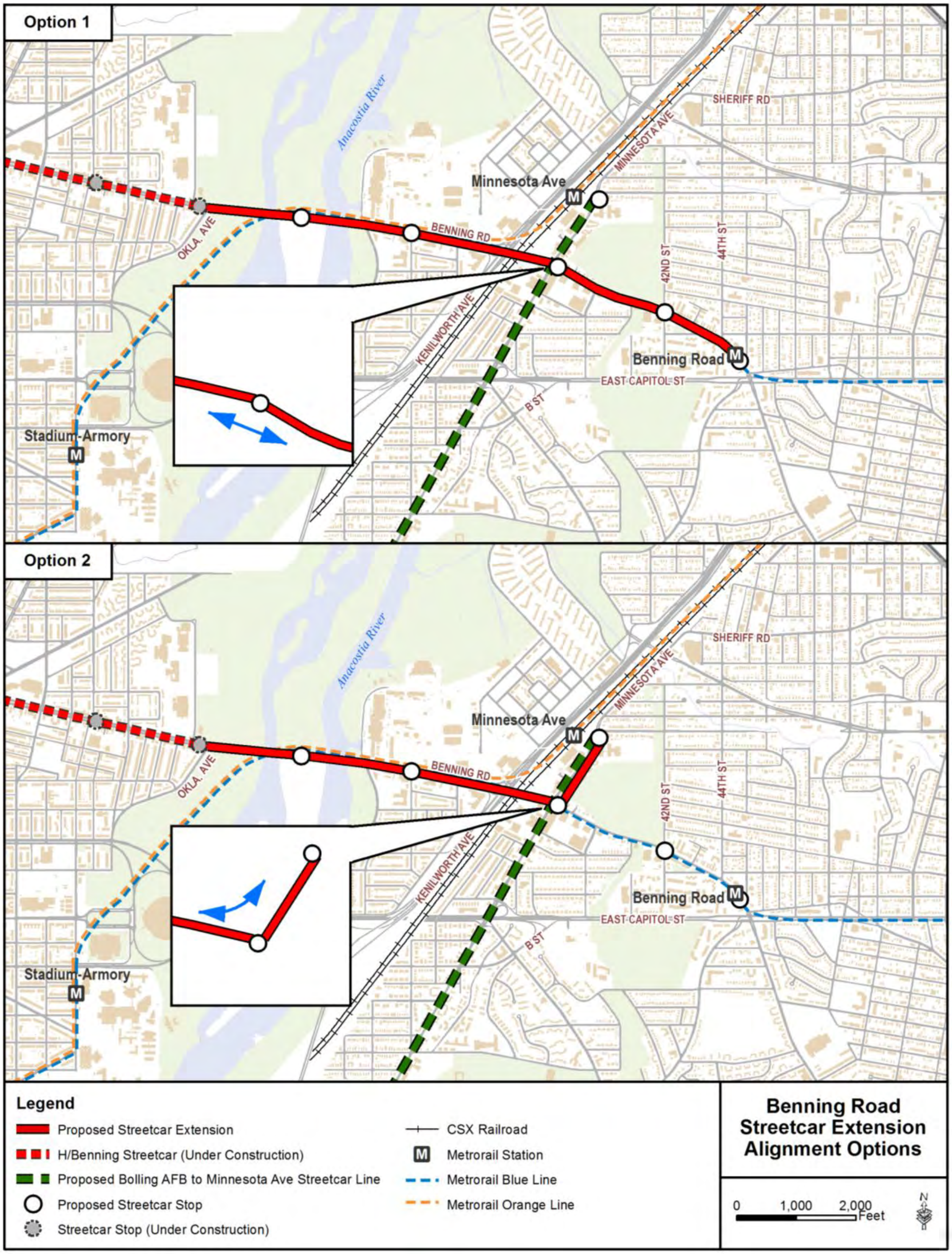
2. 1 Terminus Options

Consistent with the *DC Streetcar System Plan*, two terminus options, Benning Road Metrorail Station and Minnesota Avenue Metrorail station, for the initial extension of the H/Benning Streetcar across the Anacostia River are being considered in the feasibility study (see **Figure 2**). These terminus options guide the streetcar extension alignment alternatives, including where initial service areas, potential stop locations, and curbside or median-running track segments and transition locations. Potential stop locations for the two options are listed in **Table 1**.

Table 1: Potential Streetcar Stop Areas for the Two Terminus Options

Minnesota Ave Metrorail Station Terminus Option	Benning Rd Metrorail Station Terminus Option
A. Kingman Island	A. Kingman Island
B. Benning Road & 34th Street NE	B. Benning Road & 34th Street NE
C. Benning Road & Minnesota Avenue NE	
D. Minnesota Avenue Metrorail Station (Orange Line) / Department of Employment Services (DOES)	
	E. Benning Road & Minnesota Avenue NE / Benning Library
	F. Benning Road & 42nd Street NE
	G. Benning Road Metrorail Station (Blue Line)

Figure 2: Initial Terminus Options



2.2 Planning Context

There are several background projects and studies in the area related to this study:

Far Northeast Livability Study (DDOT, study ongoing)

The study has found that many intersections and roadways in the Far Northeast portion of the District of Columbia, including East Capitol Street, Benning Road and Sheriff Road, have been designed primarily to accommodate vehicular commuter traffic. Wide roadways with long green-phase signals encourage speeding, provide few pedestrian crossings, and discourage pedestrian use of marked crossing locations and control devices. Initial recommendations along the Benning Road Streetcar Extension corridor include:

- Full signal and crosswalks of Benning Road at the Benning Branch Library;
- Improvements at the intersection of East Capitol Street, Benning Road, Texas Avenue, and Central Avenue;
- Removal of the southbound left-turn movement at the Grant Street/Minnesota Avenue intersection;
- Provision of a southbound left-turn phase at the Minnesota Avenue/Benning Road intersection; and
- Pedestrian accommodation enhancements along 42nd Street and 44th Street.

Minnesota Avenue SE Great Streets Framework Plan (DDOT, 2005)

The plan identifies the Minnesota Avenue/Benning Road intersection area as a key mixed-use activity center. Several developments are planned at this location. The *Far Northeast Livability Study* refers to the Minnesota Avenue Great Streets Plan, which proposed realignment of the intersection approaches to eliminate the current skewed intersection angle, reconstruct all curbs to provide shorter turning radii, expand pedestrian refuge medians on the Benning Road approaches, eliminate the westbound left-turning movement, consolidate driveways near the intersection, and relocate the existing bus stops. DDOT is currently undertaking a design study that will produce engineering drawings for the corridor following the recommendations of the Great Streets Plan.

H Street NE/Benning Road Great Streets Framework Plan (DDOT, 2006)

This study covers the H Street NE/Benning Road corridor from North Capitol Street to Southern Avenue SE. The plan recommends landscape treatments, such as new sidewalks, medians, curb and gutter realignments, public art, pedestrian-scaled lighting, and street trees along the corridor. It also identified major reconstruction of Benning Road from Minnesota Avenue to 42nd Street NE, which has recently been completed and open to public use. The pedestrian facilities on the bridge over Kenilworth Avenue were recommended to be improved as part of the Kenilworth Avenue Corridor Study.

Deanwood/Great Streets – Nannie Helen Burroughs Ave and Minnesota Ave NE Strategic Development Plan (DCOP, 2008)

Similar to the *Minnesota Avenue Great Streets Plan*, the *Strategic Development Plan* identifies the Minnesota Avenue/Benning Road intersection area as a key mixed-use activity center and includes concept sketches of new commercial and residential development at the intersection and extending to the Minnesota Avenue Metrorail station.

Minnesota Avenue Metrorail Station Access Improvement Study (WMATA, 2006)

WMATA conducted the study to assess multimodal access to the Minnesota Avenue Metrorail station within the context of new developments along Minnesota Avenue, increased transit ridership, and increased vehicular traffic on area roadways. The study examined future streetcar service to the station along Minnesota Avenue; stops at the station would be located on-street, rather than within the station site. The study also examined using the northern portion of the Kiss & Ride facility as an off-street streetcar crossover track.

X1, X2, X3 Metrobus Benning Road-H Street Line Study (WMATA, 2010)
This study was undertaken by WMATA as part of its ongoing Priority Corridor Network (PCN) studies. The PCN is comprised of the highest ridership bus routes serving the most significant corridors of surface travel in the Washington metropolitan area. The PCN studies examine each corridor individually and propose strategies to increase the efficiency and effectiveness of the services along those corridors, primarily by reducing travel time while increasing ridership.

For the study of the Benning Road-H Street Line, Metrobus Route X2 was carefully examined, as were the two services that comprise the Benning Road Line (i.e., Metrobus Routes X1 and X3). The study recommended a phased-in approach for the introduction of a new service – the MetroExtra Route X9 – which would provide limited stop service between central Washington and the Capitol Heights Metrorail station, thus enlarging the service area covered by the X-series of Metrobus routes. The new MetroExtra Route X9 was first implemented every 15 minutes during the weekday peak periods, and will eventually be followed by gradual increases in its span of service and improvements in the frequency of service. The study also recommended minor adjustments to Metrobus Route X2 and X1, and the consistent use of articulated buses on Metrobus Route X2. Finally, the study recommended that – due to the existence of other duplicative bus routes – Metrobus Route X3 be eliminated. However, WMATA did not eliminate this bus route, preferring to wait until the proposed MetroExtra Route 99 (proposed in another PCN study) is implemented so that it could then re-evaluate this recommendation.

Kenilworth Avenue Corridor Study (DDOT, 2007)
The study explored options for improving Kenilworth Avenue between Pennsylvania Avenue and Eastern Avenue to provide safer and more pedestrian friendly environment, create a more pleasing urban setting, and improve access for local neighborhoods. The study recommended roadway design and pedestrian safety improvements to the Benning Road and Kenilworth Avenue interchange.

2.3 Engineering Context

The following engineering factors affect the development and initial screening of alignment options:

- Bridge structures
- Roadway geometry
- Utilities
- Right-of-way
- Multimodal traffic
- On-street parking effects

Bridge Structures

Within the study limits, Benning Road includes three bridge structures; two bridge structures over the Anacostia River, and one bridge (two parallel structures for eastbound and westbound traffic) over Kenilworth Avenue and the CSXT tracks. The proposed streetcar guideway track section is a full depth embedded track slab. An embedded track slab consists of a skeletonized track section, including rail, leveling ties, and a rail/concrete isolation material embedded in a reinforced concrete slab, with the top of rail elevation matching the top of slab elevation. The slab is nominally eight feet wide. The depth varies depending on design requirements but is typically not less than 11 inches nominal, nor greater than 18 inches. As the slab was not required to provide bridging capacity, the absolute minimum slab depth of 11 inches nominal was assumed. When considering introduction of the track slab to the undergrade structures for the bridge crossings in the corridor, two methods will be evaluated further as potential options; a build-up concept and a build-down concept.

Build-Up Concept

The build-up concept constructs the track slab on top of the existing pavement. As this method increases the elevation of an existing travel lane by 11 inches, it is necessary to develop techniques to mitigate the loss of cross-section lane / elevation inconsistency on the bridge and at the bridge approaches. Within the bridge cross section, the elevation difference can be mitigated by establishing the roadway lane as a transit-exclusive guideway, which requires separating the guideway from the general-purpose travel lanes by a concrete curb barrier. Another option would be to increase the top of pavement elevation of the adjacent travel lanes by 11 inches to match the track guideway, thus maintaining a shared guideway.

For either of these options, the existing roadway approach profiles must be adjusted at both ends of the bridge structure to accommodate the 11 inch increase in top of pavement elevation. A drawback of the build-up option from a structural engineering perspective is that it adds considerable dead load to the structure, which typically requires strengthening or re-constructing the structure. Therefore, for the purposes of this study, only the build-up with exclusive guideway option is carried forward for use in the build-up concept.

Because the existing streetcar track west of the Anacostia River is median-running, the track on the bridges connecting Kingman Island is also proposed to be median-running.

Build-Down Concept

The build-down concept maintains the top of pavement elevation and insets the track slab within the existing bridge deck cross section. This method requires demolition of the existing pavement section in the area of the track slab and construction of a track slab that is integral with the deck structure.

This method is desirable in that it does not modify the roadway cross section, does not add significant dead load to the structure, and does not require modification to the existing roadway approaches. However, the build-down method requires that the structural elements provide enough depth to accommodate the slab, new structural elements to support the slab, and potential relocation of utilities. When this method is utilized, it is sometimes desirable to design and construct a track slab with structural bridging capacity to address increased capacity of the existing bridge structure.

As in the build-up concept, the track on the Kingman Island and Anacostia River bridges is proposed to be median-running to allow for easy transition to the existing track west of Oklahoma Avenue.

Roadway Geometry Considerations: Benning Road / Minnesota Avenue Intersection

The roadway geometry and traffic constraints on potential streetcar alignments are typically localized at key study intersections, where the streetcar makes a transition or requires roadway space for a median station platform or special trackwork. The Benning Road/Minnesota Avenue intersection is one of these key constraint areas since two proposed streetcar lines intersect.

The *DC Streetcar System Plan* proposes a north-south streetcar alignment along Minnesota Avenue as well as an east-west alignment along Benning Road. This scenario would require the east-west alignment to cross and potentially connect to the north-south alignment within the limits of the Benning Road\Minnesota Avenue intersection. Providing options to connect the two lines in the future would be desirable for either revenue service or non-revenue service needs.

Where track alignments cross or connect, they do so through the use of physical elements known as special trackwork. Alignments which cross at grade do so using crossing diamond special trackwork, while alignments which join do so using turnout special track work. The physical elements of special trackwork extend beyond the limits of alignment intersection, by varying distances depending on the complexity of the casting processes, and guarding requirements prescribed by industry standards. Special trackwork fabrication constraints require that both alignments within the special trackwork element be at the same profile grade and cross-slope. As the roadway grade must match the proposed top of rail elevations and cross slope, roadway grading at special trackwork locations must be modified to accommodate the track alignment needs.

The Benning Road/Minnesota Avenue intersection (see photo in **Figure 3**) presents several challenges from a track alignment perspective. The Minnesota Avenue horizontal alignment crosses Benning Road at about a 90 degree angle, but veers to the east immediately north of the intersection. The Benning Road horizontal alignment veers to the south immediately west of the intersection and has reverse curves, for both east and west travel lanes at the west limits of the intersection to accommodate turn lanes. As such, designing the horizontal alignment to closely match the existing travel lane horizontal alignment geometry, including the special trackwork elements for track crossings and connections, presents challenges.

Figure 3: Benning Road/Minnesota Avenue Intersection

The vertical geometry at the intersection creates challenges as well. The existing grade along the centerline of Minnesota Avenue appears consistent, and the cross section is typically crowned about the centerline of road through the intersection. The existing grade along Benning Road is sloped downward from west to east as the viaduct descends and flattens out at the west side of the intersection. East of the intersection, the grade is consistent. As described previously, converging track alignments must maintain the same grades and elevations and hold a flat cross-slope relative to top of rail at all special trackwork elements. Because of the close proximity of special trackwork elements due to the tight horizontal constraints of the intersection, the vertical geometry of all of the track alignments would need to be identical. This constraint coupled with the requirement to maintain a flat cross-slope normal to the centerline of track slab would create an un-even or sawtooth profile and cross section relative to the existing roadway pavement within the intersection. This type of condition would be undesirable as it can create driver safety and drainage issues.

Uneven pavement creates vehicular safety concerns as the change in pavement elevations reduces the contact between rubber tires and the pavement, reducing the driver's control of the vehicle. Introducing a flat track slab to the existing intersection would impair the ability of the intersection to effectively drain stormwater away from the driving surface, which would also create driving hazards associated with pooling water.

Because of these concerns, it would be necessary to re-grade the entire intersection and its approaches to accommodate track crossings or connections due to the special trackwork. This re-grading could require re-setting existing curb and gutter and sidewalk elevations to maintain the minimum curb line reveal. Enhanced pedestrian accommodations that are appropriate for increased pedestrian traffic associated with the planned mixed-use development of the surrounding area should be incorporated in redesign of the intersection.

Utilities

As explained earlier, the proposed streetcar guideway track section is a full-depth embedded track slab, which consists of a skeletonized track section, including rail, leveling ties, and a rail/concrete isolation material embedded in a reinforced concrete slab. The slab is typically between 11 and 18 inches deep. Therefore, any utility line underneath the streetcar slab within the required depth will be in direct conflict with the slab. Additionally, a deeper utility line that is running parallel to the streetcar slab will have functionally less access, when a maintenance need arises.

Right-of-Way

Because the streetcar line would generally operate in mixed traffic, the need for potential right-of-way is limited to maintenance and storage facilities, substations, crossover areas that require special trackwork and any median stop platforms that would require roadway widening. Additional right-of-way might be required to achieve the minimum turning radius at certain locations. Typically, existing sidewalks can be used for curbside stop platforms and may not require additional right-of-way.

Multimodal Traffic

Implementation of the streetcar would require an assessment of potential impacts to other modes such as pedestrians, bicycle, and automobiles. When in mixed traffic, streetcar operates similar to a public transit bus. However, at certain locations, it may need to transition from a curbside to a median-running configuration. This transition typically happens at a signalized intersection through the use of a transit-only signal phase. During this phase, which could last between 5 to 15 seconds, the concurrent traffic flow is stopped to allow the streetcar movement. Therefore, depending on the streetcar frequency, there is some potential impact to general traffic.

Furthermore, due to the large radius requirement of the streetcar (minimum radius is generally around 70 feet), some turning movements may impact the location of the intersection stop bar at certain intersections if the turning path of the streetcar would be in conflict with stopped vehicles. Even with stop bar adjustments, motorists unfamiliar with this configuration, may still pull up closer to the intersection and be in conflict with the streetcar, although this would not occur frequently.

Additionally, median streetcar stops would require a safe crossing environment for pedestrians. Therefore, adequate median space with a safe and accessible walking environment should be provided for median stops. Finally, streetcar track can potentially be hazardous for bicyclists as the wheels can get caught in the track. An option is to relocate bicycle accommodations to parallel roadways or off-street facilities.

On-Street Parking

If on-street parking is provided along a roadway segment that is proposed for a curbside-running streetcar track lane, the parking would need to be eliminated. For example, off-peak on-street parking is provided along segments of Benning Road east of Minnesota Avenue; however, it would not be possible to maintain on-street parking during any periods of the day along roadway segments with curbside-running streetcar tracks.

3.0 Conceptual Alternatives

The following conceptual alternatives for the Benning Road Streetcar Extension were developed based on the planning and engineering contexts described above as well as the project purpose and need, goals and objectives (included in a separate technical memorandum). **Concept Alternative Plans** for the Minnesota Avenue Metrorail Station Terminus Option and the Benning Road Metrorail Station Terminus Option are attached at the end of the document.

3.1 Minnesota Avenue Metrorail Station Terminus Alignment Alternatives

The alignment option would serve the Minnesota Avenue Metrorail Station (the station is about 1,500 feet to the north of the Benning Road and Minnesota Avenue intersection). The **Concept Alternative Plan** for the Minnesota Avenue Metrorail Station Terminus Option at the end of the document shows the alignment, potential stop locations, and alignment transition areas under consideration for this option. The following areas from east to west along the corridor have different options under consideration:

- Oklahoma Avenue tie-in to existing streetcar track;
- Stop location and track alignment options at 34th Street;
- Potential streetcar transition on Benning Road at the Kenilworth Avenue southbound off-ramp;
- Stop location and track alignment options at the Minnesota Avenue intersection; and
- Stop location and special trackwork options at the Minnesota Avenue Metrorail station area.

Oklahoma Avenue Tie-in

The connection of the Benning Road Streetcar Extension to the recently constructed H Street/Benning Road Streetcar segment involves two options for the car barn spur and westbound transition (see **Figure 4**). The existing embedded tracks currently terminate immediately east of Oklahoma Avenue near the driveway to the RFK Stadium parking lot.

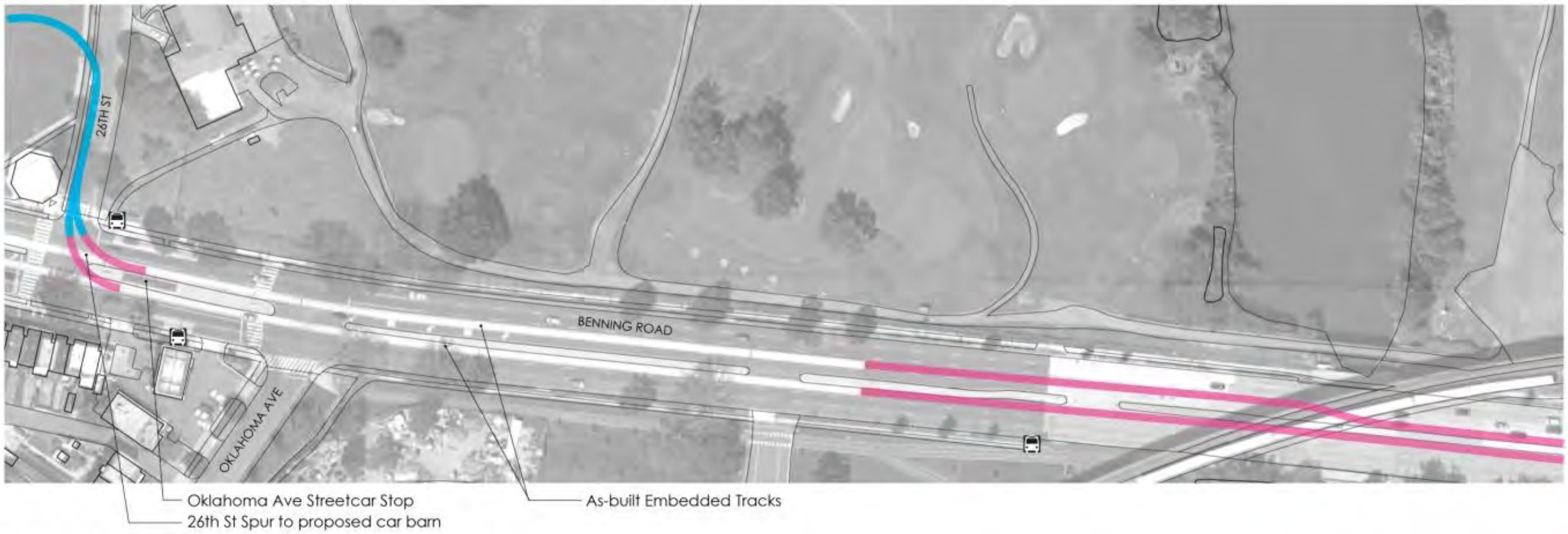
X.1 Oklahoma West Bound Unsignalized Transition

The westbound tracks east of the Oklahoma Avenue intersection are located to the north of the left turn lane on Benning Road to allow for westbound traffic to turn onto southbound Oklahoma Avenue. To connect to the existing tracks, westbound streetcars must transition from the inner median lane on the Benning Bridge (Anacostia River Bridge) to one lane north. In this option, westbound vehicular traffic merges from three lanes to two lanes when approaching the end of the bridge to allow the streetcar to transition. Eastbound streetcars remain in the inner median lane as constructed. The spur to the proposed car barn in this option has eastbound and westbound streetcars merging to a single curbside track as they turn onto 26th Street from Benning Road. This spur option would require a dedicated lane on 26th Street and narrowing of the existing roadway.

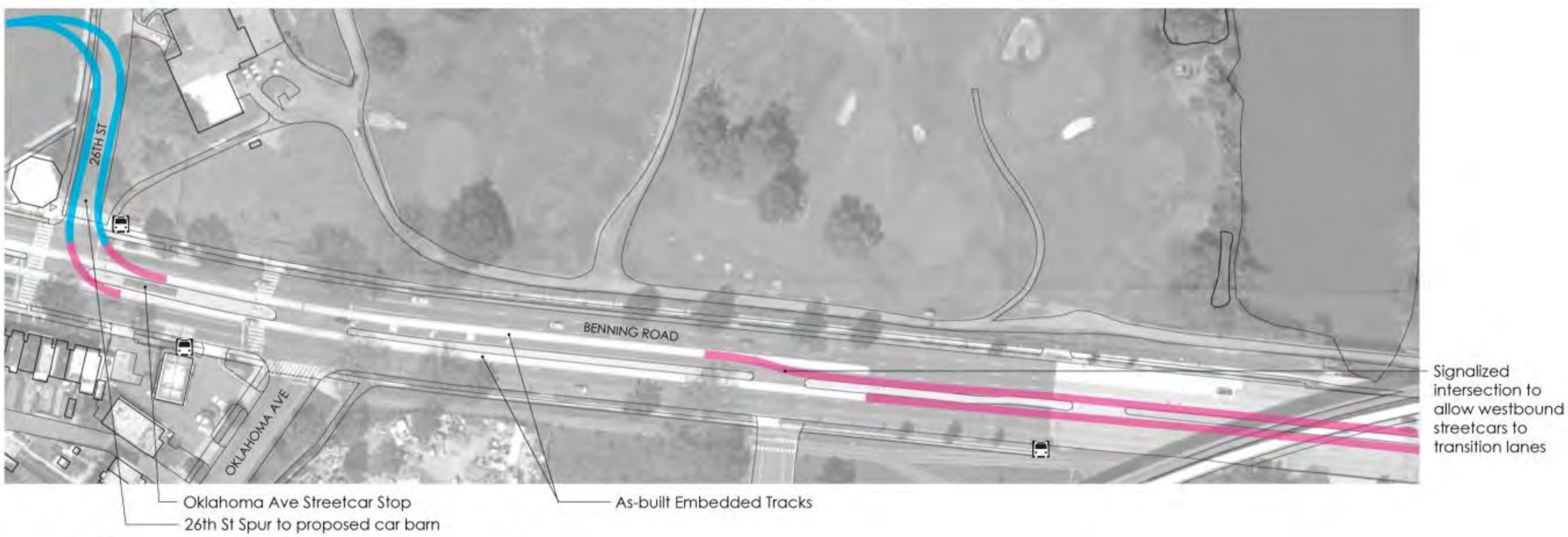
X.2 Oklahoma West Bound Signalized Transition

To avoid the westbound traffic merge after the bridge in option X1, westbound streetcars in this option transition from the inner median lane to one lane north at a signalized intersection at the RFK stadium parking driveway east of Oklahoma Avenue. Eastbound streetcars remain in the inner median lane as constructed. The spur to the proposed car barn in this option has both eastbound and westbound streetcars transitioning from the median lane on Benning Road to their own curb lanes on 26th Street at the intersection and then merging to a single track as they turn off of 26th Street into the car barn. Traffic would have to be stopped on 26th Street to allow the streetcars to turn into the car barn, but all traffic lanes could be shared. The westbound turn would require additional right-of-way to make the turn onto 26th Street and could impact the existing bus stop and streetcar stop.

Figure 4: Oklahoma Avenue Transition Options



X.1 Oklahoma Westbound Transition



X.2 Oklahoma Westbound Transition

Kingman Island

A streetcar stop on Kingman Island will offer access to the Kingman and Heritage Islands Park, future environmental center, Langston Golf Course and Driving Range, and the various events and celebrations held on the island.

A.1 West Median Stop

Both east and westbound streetcars are in the center median lane over the Benning Bridge. A median stop west of the entrance to the driving range and Kingman Island provide direct access to these destinations. A pedestrian crosswalk is required to the median stop and eastbound left turns would be permitted to the right of the streetcar track from the through lane. The streetcar track slab under the "build-up" option would gradually descend and become level at the intersection to allow for use of the lane by mixed traffic.

A.2 East Median Stop

Both eastbound and westbound streetcars are in the center median lane over the Benning Bridge. A median stop east of the entrance to the driving range and Kingman Island trail would provide direct access to these destinations. A pedestrian crosswalk is required to the median stop. The streetcar track slab under the "build-up" option would gradually descend and become level at the intersection to allow for use of the lane by mixed traffic.

34th Street Stop Location and Alignment Options

Major destinations in the River Terrace neighborhood include the Pepco plant directly north of Benning Road, and mixed commercial uses south of Benning Road. Beyond the commercial strip to the south is the River Terrace Elementary School and River Terrace residential neighborhood. The Benning Road Corridor Redevelopment Framework Plan identified a number of parcels recommended for long-term redevelopment, including retail, small office, and recreational uses. A streetcar stop near the intersection of 34th Street would provide the most direct access to the Pepco plant entrance and would serve the existing commercial area and potential future development.

B.1 East Median Stop

A median stop east of 34th Street provides direct access to the intersection but conflicts with westbound left pocket onto 34th Street, which needs to be eliminated. U-turns for westbound traffic could be permitted after the median west of the intersection to still allow this movement. Also, the westbound left-turns can be provided from the streetcar track lane with a protected green arrow. Streetcars are in the center median lane as they travel from or approach the Benning Bridge. Eastbound streetcars could remain in center median lane after the east median stop or transition after the stop one lane to the south, which would direct them onto the curb lane of the viaduct. Westbound streetcars are in the center median lane from the viaduct or would have to transition from the curb lane to the median lane at the ramp merge point (see B1) east of 36th street.

B.2 West Median Stop

A median stop west of 34th street must be setback enough to allow for eastbound left turns into the Pepco plant. A mid-block pedestrian crosswalk would be required to the station platform. Streetcars are in the center median lane as they travel from or approach the Benning Bridge. Eastbound streetcars could transition on lane to the south at the 34th street intersection to be in the curb lane of the viaduct. Westbound streetcars are in the center median lane from the viaduct or would have to transition from the curb lane to the median lane at the ramp merge point (see B1) east of 36th Street.

B.3 Curbside Stops
Curbside stops can also be accommodated at the sidewalks for both directions. This arrangement requires two transitions: at Anacostia Avenue and 34th Street. The eastbound transition could connect to the median or curb lanes of the eastbound viaduct similar to the other options.

Optional Benning Road Westbound Transition at Kenilworth Off-Ramp
Westbound track could transition from curb lane to the central median lane at the ramp merge area on Benning Road. Only Benning Road westbound traffic would be stopped to allow the streetcars to make this transition. Eastbound streetcars travel in either the median or curb lane.

Minnesota Avenue Intersection

The intersection of Minnesota Avenue and Benning Road is the gateway to a major retail and community services hub for Ward 7, including the existing the Department of Employee Services, East River Park Shopping Center and the Benning Library, as well as planned new uses. The *Deanwood/Great Streets – Nannie Helen Burroughs Ave NE & Minnesota Ave NE Strategic Development Plan* identifies this node as a high priority redevelopment area. A civic plaza and entrance to Fort Mahan Park is proposed east of the intersection. A destination commercial center and mixed-use redevelopment of existing retail areas are proposed south and west of the intersection. In addition to redevelopment, improvements to the Minnesota Avenue streetscape are being planned as part of the Minnesota Great Streets initiative. A streetcar stop at or close to the intersection of Minnesota Avenue and Benning Road is crucial to provide riders convenient access to this activity center. However, locating streetcar stops at the intersection presents challenges due to the constraints of the viaduct immediately to the west, intersection geometry, high traffic volumes, existing bus stops, and special trackwork requirements.

C.1 Median Stops on Viaduct
A median stop on the viaduct is proposed to be split, with staggered stops to allow for eastbound left turns onto Minnesota Avenue by a dedicated left-turn lane without a streetcar stop right at the intersection. This requires an eastbound stop set back from the intersection, a mid-block pedestrian crossing, and a relatively level area for the streetcars to stop on a vertical tangent as the viaduct descends to meet the grade of Minnesota Avenue. Eastbound streetcars transition at the intersection from the eastbound left-turn lane to the curb lane of Minnesota Avenue. Westbound streetcars transition from the curb or median lane of Minnesota Avenue at the intersection to the median lane of the viaduct.

C.2 Curbside Stops on Minnesota Avenue
Curbside stops on Minnesota Avenue avoid conflicts with the eastbound left turn on the viaduct but are somewhat removed from the intersection and conflict with existing heavily used bus stops. Eastbound and westbound streetcars transition from the median lanes of the viaduct to the curb lanes of Minnesota Avenue at the intersection.

C.3 Curbside Stops on Viaduct
Curbside stops on the viaduct allow the stops to be close to the destinations south of the intersection and avoid impacting eastbound left turns. Platforms must be relatively level for the streetcars to stop on a vertical tangent as the viaduct descends to meet the grade of Minnesota Ave. Eastbound streetcars remain in the curb lane after the intersection. A pedestrian refuge island can be created to accommodate the southbound Minnesota Avenue onto westbound Benning Road curb to curb turning radius. Alternatively, the westbound streetcar could transition from the curb lane on Minnesota Avenue to the median lane of the viaduct to avoid a potential encroachment at the corner, but a westbound curbside stop here is no longer possible.

Minnesota Avenue Metrorail Station

A stop in this area would provide direct access to the Metrorail system and to the residential areas to the east and across the Kenilworth corridor to the west. A large residential, office and retail development, Parkside, is planned northwest of the Metrorail station that will significantly increase the development intensity and population in the neighborhood. As this would be a terminus stop, track crossover and tail track would need to be provided in the vicinity.

D.1 Stops by Station Entrance; Kiss & Ride Turnaround

The northbound stop is located close to the Metrorail station entrance on the curbside of Minnesota Avenue north of the Grant Street intersection. The southbound stop is located at the existing entrance to the bus terminal for buses traveling southbound on Minnesota Avenue, which would require closure of this driveway and redesign of the bus terminal entrance to accommodate southbound buses. The closure of the driveway would have the benefit of consolidating driveway curbcuts, improving the pedestrian environment, but would result in a loss of one of the bus bays/layover spaces in the station bus terminal.

An alternative southbound stop is located south of the bus facility exit by the northeast corner of the Department of Employee Services (DOES) building. The southbound stop would not require pedestrians exiting the station to cross traffic lanes to reach the platform and would be conveniently located for customers and employees of the DOES building.

Northbound track is curbside-running and transitions to the special trackwork for the crossover and tail track beginning at the intersection of Hayes Street and extending onto the WMATA Kiss & Ride site. Southbound streetcars exit the turnaround near the Hayes Street intersection and transition to the curb lane of Minnesota Avenue. This turnaround would require a reduction in Kiss & Ride spaces. Southbound streetcars could alternatively transition to the median lane on Minnesota Avenue after the bus terminal exit near the DOES building.

D.2 Stops by Bus Facility; Minnesota Avenue Turnaround

Northbound and southbound stops are located on the curbsides of Minnesota Avenue between the Friendship Public Charter School and the Metrorail station bus terminal. The southbound stop may require a reduction in bus layover spaces depending on the width of the proposed sidewalk in this area. Northbound streetcars transition to a turnaround track from the curbside of Minnesota Avenue to the median of Minnesota Avenue at the intersection of Grant Street. Southbound streetcars transition from the median turnaround on Minnesota Avenue to the curbside after the Grant Street intersection. This turnaround may require the widening of Minnesota Avenue or the reduction of vehicular lanes to one lane in each direction on Minnesota Avenue. Southbound streetcars could alternatively transition from the curbside to the median lane on Minnesota Avenue at a new traffic signal located at the bus facility exit to the south.

3.2 Benning Road Metrorail Station Terminus Alignment Alternatives

The option would terminate at the Benning Road Metrorail station. In addition to stop locations A, B and C described above, this alternative route would include stops at 42nd Street and the Benning Road Metrorail Station. Because there is limited right-of-way along Benning Road, a median stop at the intersection with 42nd Street would require the elimination of one through lane in each direction on Benning Road. Therefore, the alignment options along Benning Road east of Minnesota Avenue generally consider curbside-running tracks in both directions, which would eliminate existing on-street parking allowed during off-peak hours along Benning Road. The **Concept Alternative Plan** for the Benning Road Metrorail Station Terminus Option at the end of the document shows the alignment, potential stop locations, and alignment transition areas under consideration for this option.

Minnesota Avenue Intersection

Different stop locations and alignments are possible with the streetcar continuing east on Benning Road rather than turning north onto Minnesota Avenue. It should be noted that the Minnesota Avenue intersection is approximately 0.28 miles, or a 5-minute walk from the Minnesota Avenue Metrorail Station, so it would still be possible for streetcar riders to access the Minnesota Avenue Metrorail station from a streetcar stop in this location, although it would not be as convenient.

E.1 Median Stops on Viaduct

A median stop on the viaduct is proposed to be split with staggered stops to allow for eastbound left turns onto Minnesota Avenue by a dedicated left-turn lane without the influence of a streetcar right at the intersection. This arrangement requires an eastbound stop set back from the intersection, a mid-block pedestrian crossing, and a relatively level area for the streetcars to stop on a vertical tangent as the viaduct descends to meet the grade of Minnesota Avenue. This option would require both the eastbound and the westbound transition occur at the intersection, which will have an effect on traffic operations.

E.2 Curbside Stops on Viaduct

Curbside stops on the viaduct allow the stops to be close to the destinations south of the intersection and avoid impacting eastbound left turns. Platforms must be relatively level for the streetcars to stop on a vertical tangent as the viaduct descends to meet the grade of Minnesota Avenue. Eastbound and westbound streetcars remain in the curb lane on Benning Road before and after the intersection, reducing potential traffic effects.

E.3 Curbside Stops East of Intersection

Stops east of the Minnesota Avenue intersection could be located in front of the Benning Library on opposite curbs. The roadway levels out at this location, and the stops do not conflict with the existing bus stops by the intersection. However, the streetcar stops are further from uses along and west of Minnesota Avenue. The eastbound and westbound streetcars may remain in the curb lane of Benning Road or transition from the median lane of the viaduct at the intersection of Minnesota Avenue depending on the preferred configuration to the west.

42nd Street

The intersection of 42nd Street would serve the residential neighborhoods north and east of Benning Road. The *Benning Road Corridor Redevelopment Framework Plan* identified two parcels for redevelopment surrounding the intersection. Recommended future development here includes a community center, moderate-density residential uses and/or neighborhood retail.

F.1 Curbside Stops

Curbside stops on the far side of the intersection serve both eastbound and westbound streetcars with curbside-running alignments.

F.2 Median Stop

A median stop is located west of the intersection with both eastbound and westbound streetcars remaining in the median lane from the Minnesota Avenue intersection. A median stop would conflict with eastbound left turns onto 42nd Street. This configuration would also require eliminating one general travel lane in each direction along Benning Road to accommodate the stop.

Benning Road Metrorail Station and Turnaround

Extending the Benning Road Streetcar to the Benning Road Metrorail Station would provide direct access to the Metrorail system, East Capitol Street, and the neighborhoods to the south and east. Additionally, the *Benning Road Corridor Redevelopment Framework Plan* identified several parcels for long-term transit-oriented redevelopment potential, with mixed retail, residential and small office uses.

G.1 East Capitol Street Median Stop and Turnaround

A median stop is located in the median of East Capitol Street. This locates the stop out of vehicular traffic lanes and closer to uses south and east of the intersection but further from the Metrorail station entrance. This stop location conflicts with the *Far Northeast Livability Study* proposal to eliminate the East Capitol Street median and replace it with left turn lanes. Eastbound and westbound streetcars transition from curb lanes on Benning Road to the median at the East Capitol Street intersection. The streetcars would turn around in a tail track within the median east of the stop.

G.2 Benning Curbside Stops and Central Avenue Turnaround

Opposing streetcar stops are located curbside directly outside of the Metro station entrance. Eastbound stop may require additional right-of-way on private property, while the westbound turn could encroach into the Metro Station area. East and westbound streetcars converge to a shared turnaround track after the stops on the westbound lane of Central Avenue. This turnaround will impact the vehicular traffic of Central Avenue as it required dedicated right-of-way for operations.

G.3 Central Avenue Median Stop and Turnaround

A median stop is located east of the metro station entrance on Central Avenue. A midblock pedestrian crosswalk is required to provide safe access to the proposed stop. East and westbound streetcars remain in median from Benning Road to Central Avenue and converge to a shared turnaround track after the stop at the intersection of 46th Street. This turnaround requires vehicular traffic to transition from two-way between Benning Road and 46th Street to one way east after 46th Street.

G.4 Kiss & Ride Site Stop and Turnaround

An off-street single platform stop is located on the site of the existing Benning Road Metrorail station Kiss & Ride facility. The location would provide direct access to the Metrorail station but would eliminate the Kiss & Ride facility and impact the intersection with 45th Street. A new traffic signal would be required at the intersection with 45th Street with a special signal phase to allow the eastbound and westbound streetcars to cross to/from the curb lanes of Benning Road in and out of the Metrorail station site. The turning radius requirement for the westbound track may require redesign of the intersection of 45th Street.

4.0 General Operating Strategy

Frequency of Service

The proposed frequency of service for the line is every 10 minutes in both directions of service throughout the entire service day.

Span of Service

The proposed span of service is as follows:

- Monday through Thursday: 6:00 AM to 12:00 AM
- Friday: 6:00 AM to 2:00 AM
- Saturday: 8:00 AM to 2:00 AM
- Sunday: 8:00 AM to 10:00 PM

Fare Structure

DDOT's proposed fare structure for the streetcar service would be similar to the DC Circulator service. Based on the existing fare structure, the streetcar service would have the following fares:

- Cash = $1.00
- SmarTrip Card = $1.00
- Senior/Disabled = $0.50
- Transfers to/from Metrobus, DC Circulator = Free (SmarTrip Card only)
- Transfers to/from Metrorail = $0.50 (SmarTrip Card only)

Background Bus Service

[*Currently under review by WMATA and DDOT and will be incorporated in the subsequent versions*]

Concept Alternative Plans

Executive Summary

AECOM was contracted by Washington Metropolitan Area Transit Authority (WMATA) in partnership with the District of Columbia Department of Transportation (DDOT) to evaluate the feasibility of extending the H/Benning Streetcar east of Oklahoma Avenue across the Anacostia River to Ward 7. As part of the evaluations of alternatives, this technical memorandum assesses impacts and major considerations to accommodate fixed rail streetcar service on the Benning Road Bridge over the Anacostia River (Bridge No. 52) and Benning Road Bridge over Kingman Lake (Bridge No. 77). This memorandum outlines the assumptions made in the bridge assessment, describes and analyzes two options for accommodating streetcar service on the bridges, reports the results of the analysis, and estimates rough order of magnitude costs for the options analyzed.

It is important to note that this assessment memorandum is focused solely on structural issues and is independent from other considerations that may affect the ultimate recommendation on how to proceed with accommodating the DC Streetcar on Benning Road east of Oklahoma Avenue. Of the two options analyzed, this memorandum recommends the “Build Up” option from a structural engineering perspective. The Build Up option has a dedicated lane in each direction for the streetcar guideway and reduces the general travel lanes by one lane in each direction. This recommendation is based on cost, constructability, and structural capacity.

The rest of the memorandum describes the assessment in detail.

Descriptions of Existing Bridges

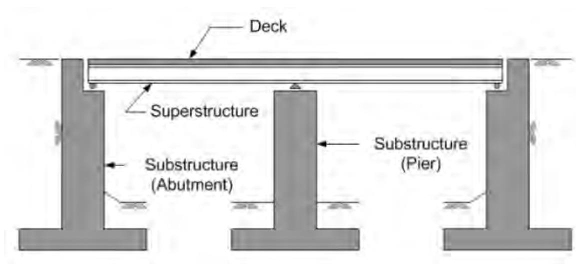
The two bridges assessed in the study are:

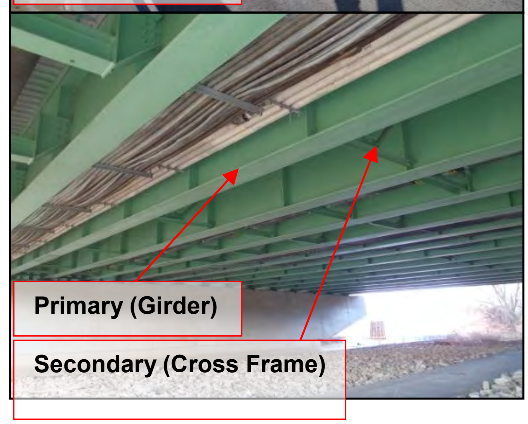
- Benning Road Bridge over the Anacostia River (Bridge No. 52)
- Benning Road Bridge over Kingman Lake (Bridge No. 77)

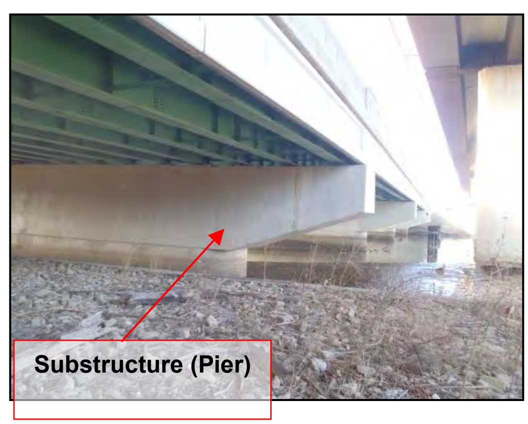
Refer to Appendix Page A1 for a location map of the existing bridges.

Major Bridge Components

The bridges being assessed can be divided into three basic parts or components, which are defined below: deck, superstructure, and the substructure (see diagram below).







Deck:
The purpose of the deck is to provide a smooth and safe riding surface for the traffic utilizing the bridge. Each of the bridges in this study has a concrete deck.

Superstructure:
The basic purpose of the superstructure is to carry loads from the deck across the span and to the bridge supports, or substructure. The primary members that make up the superstructure for the study bridges consist of steel girders. The secondary members that make up the superstructure are Steel Diaphragms for Bridge No. 77 and Steel Cross Bracing for Bridge No. 52.

Substructure:
The purpose of the substructure is to transfer the loads from the superstructure to the foundation soil or rock. Typically the substructure includes all elements below the superstructure. The loads are then distributed to the earth. Each of the bridges in this study is made up of concrete substructures.

Bridge No. 52

Bridge No. 52 is a five-span continuous steel multi-girder structure with a reinforced concrete deck supported on reinforced concrete abutments and piers. The bridge was constructed in 2004 and carries eight lanes of divided two-way Benning Road over the Anacostia River. The structure is approximately 556 ft long with a curb-to-curb width of approximately 87 ft and an out-to-out width of approximately 119 ft. The bridge has a 7.9-ft wide concrete median in the middle and 10.8-ft wide sidewalks on each side. The bridge is oriented east-west. The bridge is not currently posted for any weight restrictions.

Bridge Dimensions (Per Contract Plans*[1]):

- Deck Thickness = 8.66 in
- Number of Girders = 17
- Girder Spacing = Sta. Ahead (5 spaces at 7.12 ft, 6 spaces at 6.66 ft, and 5 spaces at 7.12 ft)
- Bridge Width = 118.8 ft
- Sidewalk Widths = 2 at 10.83 ft
- Lane Width = 10.83 ft
- Median Width = 7.9 ft
- No. Spans = 5
- Span Lengths = 110.24 ft

Refer to Appendix Pages A2 and A3 for General Plan & Elevation and Typical Section.

[1] *Note: Plans for Bridge No. 52 are not demarcated as "As-built" and have not been verified in the field.

Bridge No. 77

Bridge No. 77 is a single-span steel multi-girder structure. The bridge carries eight lanes of divided two-way Benning Road traffic over Kingman Lake. Kingman Lake is a tidal overflow reservoir for the Anacostia River with no navigational traffic. The structure is 62.0 ft in length with an out-to-out width of 114 ft. The structure was replaced in 2000 with modified reinforced concrete abutments. The new abutments are set back from the old abutments. The old abutments function as channel walls and were reinforced at the top. The bridge is also oriented east-west. The bridge is not currently posted for any weight restrictions.

Bridge No. 77 Elevation View

Bridge Dimensions (Per Contract Plans[2]):

- Deck Thickness = 8.5 in
- Number of Girders = 15
- Girder Spacing = 14 spaces at 7.5 ft
- Bridge Width = 114 ft
- Sidewalk (with Barrier) Width = 13 ft
- Lane Width = 10 ft
- Median Width = 8 ft
- No. Spans = 1
- Span Length = 58.5 ft

Refer to Appendix Pages A7 and A8 for General Plan & Elevation and Typical Section.

[2] *Note: Plans for Bridge No. 77 are not demarcated as "As-built" and have not been verified in the field.

Streetcar and Bridge Loading Assumptions

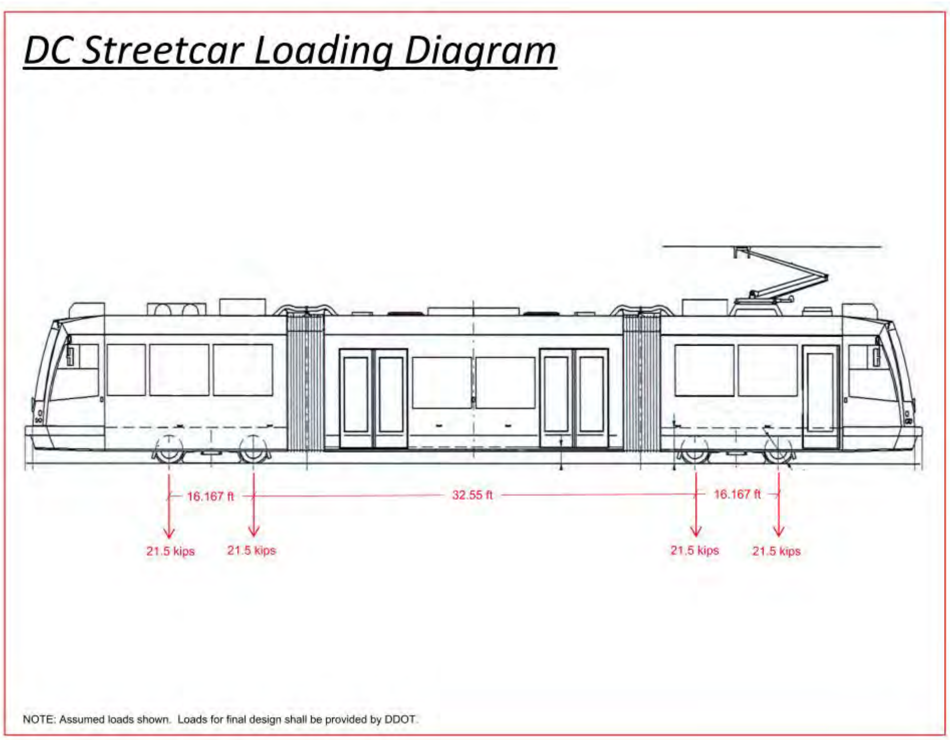
In advancing the concept of incorporating the proposed DC Streetcar track and service onto the existing bridge structures, the following assumptions were made:

Design Vehicle (refer to Appendix Page A11 for diagram)

- The proposed DC Streetcar vehicle for assessment is similar to the Inekon Trio Type 12 WMATA Vehicle;
- The gross vehicle weight is assumed to be 86,000 lbs (note that the precise weight would need to be verified for final design);
- The proposed DC Streetcar vehicle has two (2) trucks and four (4) axles (see diagram below);
- The total tram vehicle load is equally distributed to both trucks: 21.5 kips on each axle;
- Only one DC Streetcar vehicle occupies one lane on the bridge at one time (based on anticipated operating headway between vehicles);
- DC Streetcar vehicles are not anticipated to be coupled (i.e., only one DC Streetcar vehicle per train, with the axle configuration discussed above); and
- The existing bridges design vehicles are HS-20 (maximum axle 32,000 lbs) or the Alternate Military Vehicle with two 24,000 lbs per axles, spaced at 4 ft.

Loadings and Structural Configuration

- Dead and live loads per AASHTO Standard Specification for Highway Bridges, 17th Edition, and per FTA Transit Cooperative Research Program Report 57;
- The effects of rocking and wind on the streetcar were not included in the evaluation. This assumption was based on past research that has shown that light rail vehicles behave like highway vehicles(due to their axle spacing, loading, and suspension), which are not subject to these forces. Alternatively, AASHTO impact factors were used similar to highway vehicles;
- Distribution factors for the streetcar track were conservatively assumed in locations to provide the maximum stress in a girder, allowing for flexibility during future track location studies;
- Wheel load distribution factors were calculated assuming the worst case position for both HS-20 and DC Streetcar vehicles. This is a conservative assumption, since the streetcar loading would be in a fixed position and would likely not develop the load distributions used in the analysis. However, for planning and preliminary study purposes, this assumption is commensurate with the level and detail of analysis conducted to date;



- Streetcar track position was investigated adjacent to the median ("median-running" alignment) because the existing track alignment to the west of the bridge is located adjacent to the median. The track position was not investigated along the outside of the structure adjacent to the sidewalk ("curbside-running" alignment); and
- Load Factor Methodology was used for comparisons of the DC Streetcar loading with the AASHTO HS20 Design Loading. The AASHTO Standard Specifications for Bridges, Strength Design Methodology (LFD) were used based on the original design methodology and to provide compatibility between the existing bridge design criteria and the proposed criteria.

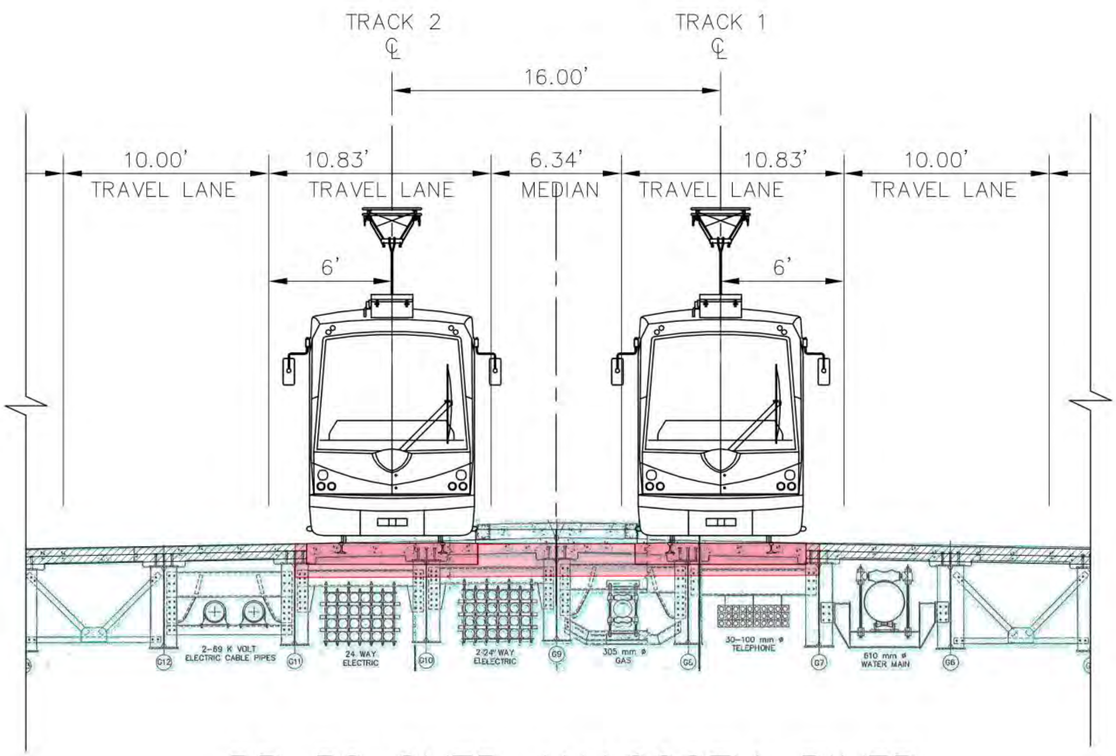
Analyses

The structural analysis assessed the controlling vehicle in a shared-use lane (i.e., HS-20 or DC Streetcar vehicle) and determined the sufficiency of superstructure and substructure for the proposed geometry and loadings. Conceptual recommendations for improvements were made as needed. Below is a discussion of the options assessed and the conclusions that resulted.

For the analysis, two options for both bridges were evaluated. Build Down Option 1 for mixed-traffic lanes, and Build Up Option 2 for dedicated streetcar lanes. The Build Down Option 1 involves reconstructing a portion of the existing bridge deck to accommodate streetcar rails which remain nearly flush (within approximately ¼") with the existing bridge deck surface. The Build Up Option 2 involves constructing a dedicated streetcar lane approximately 11 ½" above the existing bridge deck.

Build Down - Mixed Traffic Lane (Option 1)

The existing bridge structures were reviewed for accommodating a Build Down track configuration. The existing bridges' deck thicknesses are a minimum of 8.5". The existing bridge deck does not provide the required thickness. The 6.5" rail is a continuous longitudinal break in the structural slab, and only 2" of concrete and reinforcing would remain for structural support. The analysis assumed a 16" total deck thickness would be used in the bay where the proposed Build Down track alignment would occur. The 16" is assumed to have adequate thickness for a structural slab to support the rails, considering a 6.5" rail and a 9.5" deck thickness. Based on a review of the typical cross section, it was determined that positioning the rails between two girders, as opposed to straddling a beam, would provide the most beneficial location for the girders to not be overstressed and require strengthening. This position allows the girders to maintain half the strength provided by the existing concrete deck on the opposite side of the girder web. Additionally, it would be the most efficient method of constructing the Build Down track by isolating the proposed improvements to one bay, limiting utility impacts and required reconstructed deck forming.

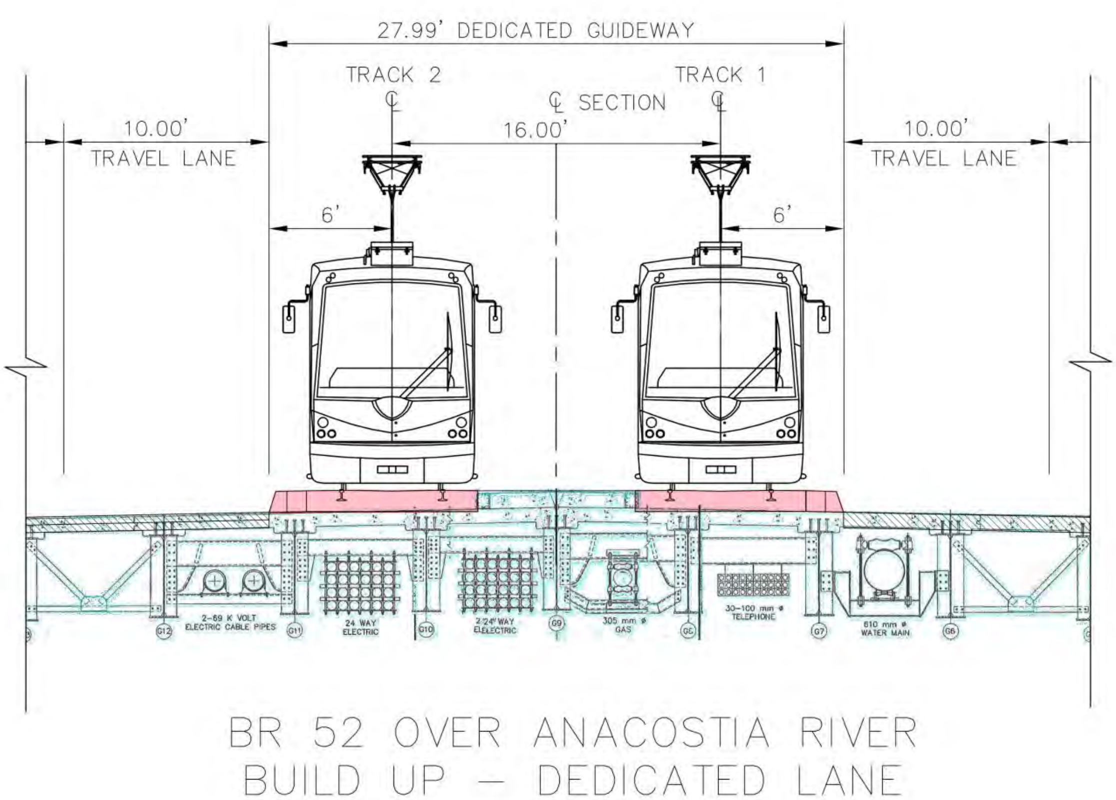


BR 52 OVER ANACOSTIA RIVER
BUILD DOWN – MIXED TRAFFIC LANE

Note: Bridge No. 77 section similar. Refer to Appendix Pages A5 and A9 for proposed Build Down Typical Sections.

Build Up - Dedicated Lane (Option 2)

An alternate structural configuration was assessed which utilizes an 11 ½" cast-in-place non- composite concrete deck topping (similar to a raised median), constructed on top of the existing bridge deck. This built-up deck would be a raised deck that extends from the existing raised concrete median and would only be used by streetcar traffic. Variations of this option can include reducing the median to allow the centerline of tracks to be 14 feet from each other. Track engineers have concluded that 14 feet is the minimum offset that allows room for the Overhead Catenary System (OCS) poles to be placed between streetcars while maximizing the roadway width for highway vehicles.



Note: Bridge No. 77 section similar. Refer to Appendix Pages A6 and A10 for proposed Build Down Typical Sections

Results

Bridge No. 52

For the Anacostia River Bridge No. 52, the interior Girder 7 was analyzed for both options. This beam was chosen due to it having greater loads applied directly to it from the adjacent water line and telephone lines and being adjacent to the streetcar location. For the Build Up option, the structure was analyzed with both the DC Streetcar loading and the HS-20 loading, and the additional dead load. The analysis indicated that the two vehicles had nearly the same results for moment, while the streetcar had greater influence for shear at the supports than the HS-20. It should be noted that conservative assumptions were made, and, with refined analysis, the loads may result in less influence for moment and shear. For the Build Up option the analysis indicated it would be possible to accommodate the DC Streetcar vehicles and track with potential minimal strengthening to the girders.

For the Build Down option on Anacostia River Bridge No. 52, the results indicated that the beams can accommodate the additional loading from a streetcar and appurtenances if the centerline of the track is placed between two beams. If the rails are to be shifted in toward the median, causing the rails to straddle an existing beam, the beam may become overstressed and require strengthening. From the analysis it can be deduced that loads need to be reduced for this option to be feasible. In lieu of reducing the loads, beams could be temporarily shored; however, this could be difficult and costly over a waterway.

Alternatives for further investigation could include an assessment of strengthening the existing girders, adding girders, or relocating existing utilities away from controlling girders. Although difficult, there are techniques that can be employed to make the Build Down option constructible; however, it may be cost prohibitive in comparison to other available options, such as the Build Up option.

Bridge No. 77

For the Kingman Lake Bridge No. 77, an interior girder was analyzed with the additional dead load for both the Build Up and Build Down options. A separate assessment was performed to evaluate the governing load between the HS-20 truck and the DC Streetcar. The assessment indicated that the force-effects were comparable. Therefore, the analysis was simplified to a dead load investigation. Results indicated that for both options there would be adequate structural capacity in the superstructure to accommodate the DC Streetcar vehicle and deck modifications.

Conclusions

From analyzing both bridges superstructures, it has been concluded that the DC Streetcar loading is very similar to the HS-20 highway design loading for which the bridges were originally designed. The options can be evaluated independent of the live load forces produced by the DC Streetcar. It should be noted that if DDOT requires the structures to support different design vehicles than what was analyzed within this investigation, additional analysis will be needed.

Substructure Evaluation

The general notes on the existing drawings for both bridges indicate that the existing structure (superstructure and substructure piers/abutments) was designed for HS-20 and Alternate Military Vehicle Loadings. As such, preliminary pier and abutment reactions generated from the superstructure analysis for the Bridge No. 52 Build Up option are less than the design load reactions for the HS-20 as noted (Unfactored):

HS-20	Pier Reaction 309 K
DC Streetcar	Pier Reaction 294 K
HS-20	Abutment Reaction 124 K
DC Streetcar	Abutment Reaction 122 K

Bridge No. 77 abutment reactions for the two vehicles were not available for comparison because a line girder analysis was not performed as part of the superstructure analysis. Using engineering judgment the difference between HS-20 and DC Streetcar reactions are expected to be similar to Bridge No. 52 as noted above.

Based on the above data and by engineering judgment, AECOM concludes the existing substructures and their foundations for both Bridge No. 52 and Bridge No. 77 are capable of carrying the additional loading for the DC Streetcar vehicles and track.

The piers for Bridge No. 52 are wide wall/hammerhead piers with small cantilevers for exterior beams. The end supports for both bridges are conventional reinforced concrete abutments. Reactions from deadloads would slightly increase from the as-detailed condition due to OCS loads, and additional concrete for both track configurations. However, given the construction of the piers (heavy mass) and abutments, it is anticipated that the additional load would redistribute without a significant effect on the substructures and their foundations.

Rough Order-of-Magnitude Cost Estimate

Based on the options considered, a rough order-of-magnitude construction cost estimate (ROM) in 2012 dollars was developed for each proposed configuration, which includes the following:

- Partial structure demolition of existing deck or concrete median;
- Superstructure strengthening;
- Utility relocations;
- Diaphragm modifications;
- Build Down concrete deck;
- Non-composite cast-in-place dedicated track, and median modifications; and
- Modifications to superstructure to support OCS poles.

Refer to Appendix Page A2 for the construction cost estimate.

APPENDIX A

- A1 – LOCATION MAP
- A2 – CONSTRUCTION COST ESTIMATE
- A3 – BRIDGE NO. 52 – EXISTING GPE
- A4 – BRIDGE NO. 52 – EXISTING TYPICAL SECTION
- A5 – BRIDGE NO. 52 – TYPICAL SECTION FOR BUILD DOWN OPTION
- A6 – BRIDGE NO. 52 – TYPICAL SECTION FOR BUILD UP OPTION
- A7 – BRIDGE NO. 77 – EXISTING GPE
- A8 – BRIDGE NO. 77 – EXISTING TYPICAL SECTION
- A9 – BRIDGE NO. 77 – TYPICAL SECTION FOR BUILD DOWN OPTION
- A10 – BRIDGE NO. 77 – TYPICAL SECTION FOR BUILD UP OPTION
- A11 – DC STREETCAR LOADING DIAGRAM

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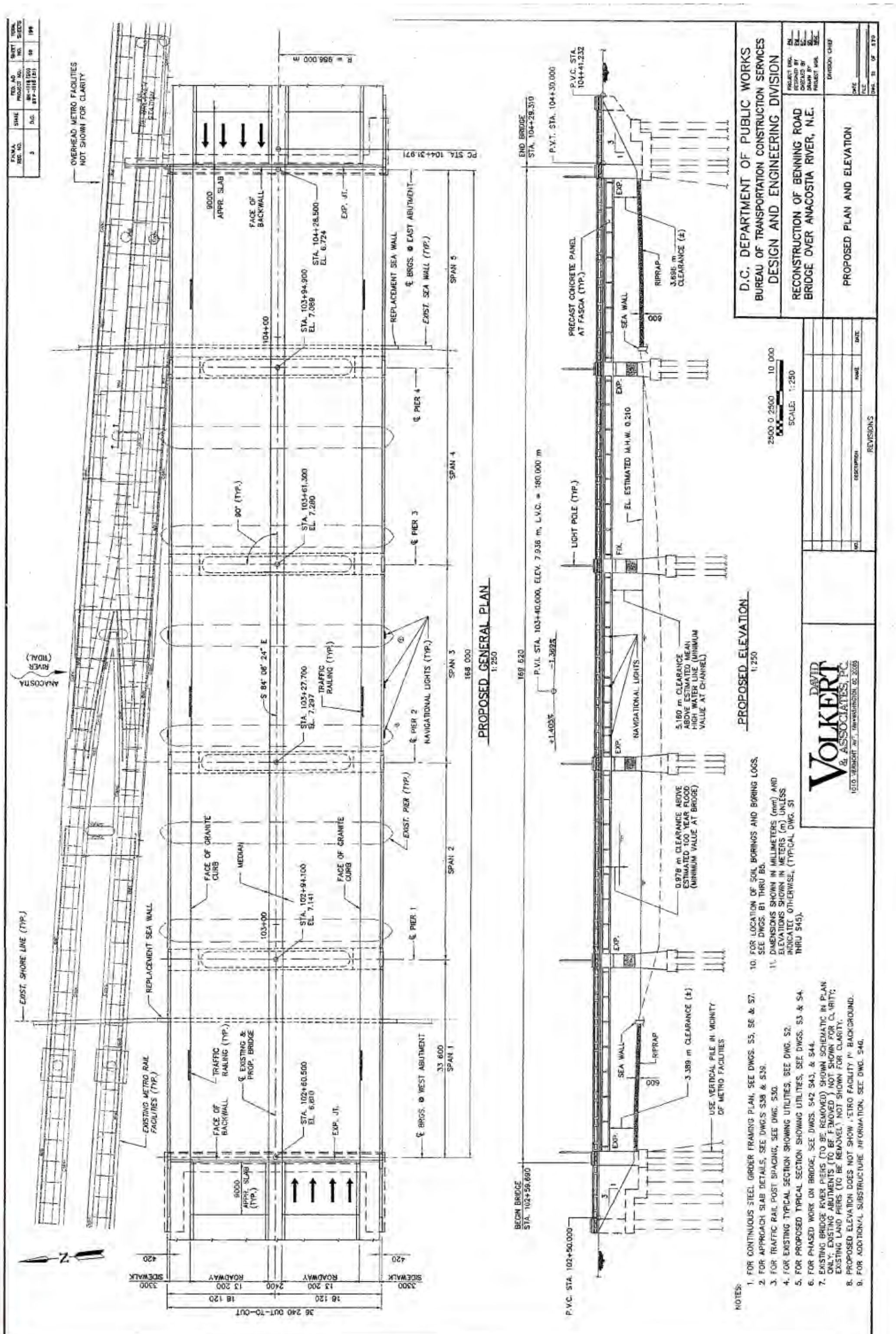
LOCATION MAP

Source: Google Maps, copyright 2012

AECOM Benning Road Streetcar Feasibility Study - Construction Cost Estimate

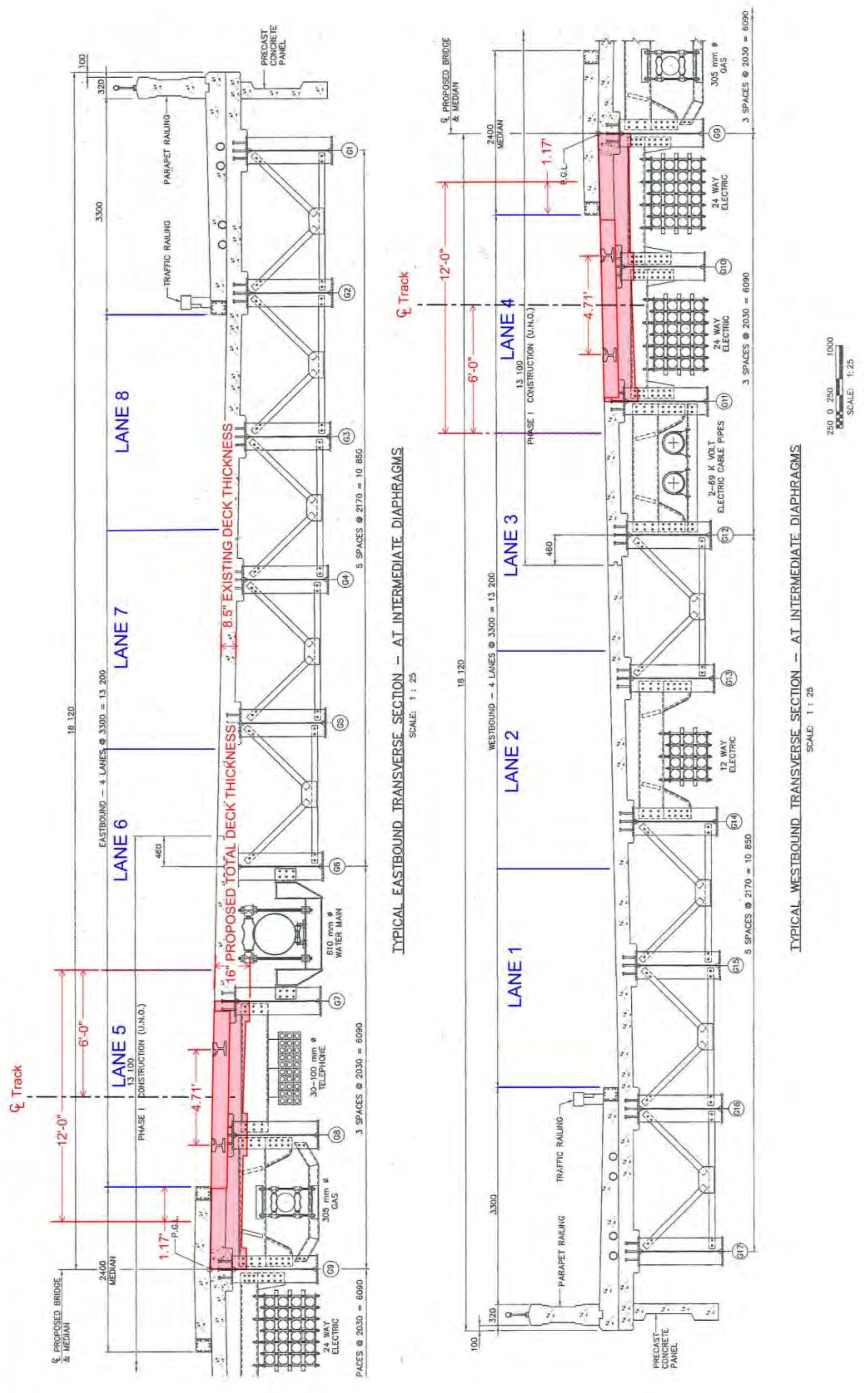
DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	COST
BR No. 77 - Build Down Option:				
Removal of Concrete:	SY	207	$ 100.00	$ 20,700.00
Deck Concrete:	CY	95	$ 1,000.00	$ 95,000.00
Duct Bank Relocation:	LS	1	$ 50,000.00	$ 50,000.00
Water Main Relocation:	LS	1	$ 50,000.00	$ 50,000.00
Hardware and Diaph. Modifications:		33% utility relocation		$ 33,000.00
Maintenance of Traffic:	LS	1	$ 15,000.00	$ 15,000.00
				$ 263,700.00
BR No. 77 - Build Up Option:				
Removal of Concrete:	SY	28	$ 100.00	$ 2,800.00
Deck Concrete:	CY	36	$ 750.00	$ 27,000.00
Maintenance of Traffic:	LS	1	$ 6,000.00	$ 6,000.00
				$ 35,800.00
BR No. 52 - Build Down Option:				
Removal of Concrete:	SY	1634	$ 100.00	$ 163,400.00
Deck Concrete:	CY	750	$ 1,000.00	$ 750,000.00
Duct Bank Relocation:	LS	1	$ 187,500.00	$ 187,500.00
Gas Main Relocation:	LS	1	$ 87,500.00	$ 87,500.00
Hardware and Diaph. Modifications:		33% utility relocation		$ 90,750.00
Maintenance of Traffic:	LS	1	$ 90,000.00	$ 90,000.00
				$ 1,369,150.00
BR No. 52 - Build Up Option:				
Removal of Concrete:	SY	246	$ 100.00	$ 24,600.00
Deck Concrete:	CY	314	$ 750.00	$ 235,500.00
Maintenance of Traffic:	LS	1	$ 20,000.00	$ 20,000.00
				$ 280,100.00

Construction Cost in 2012 Dollars

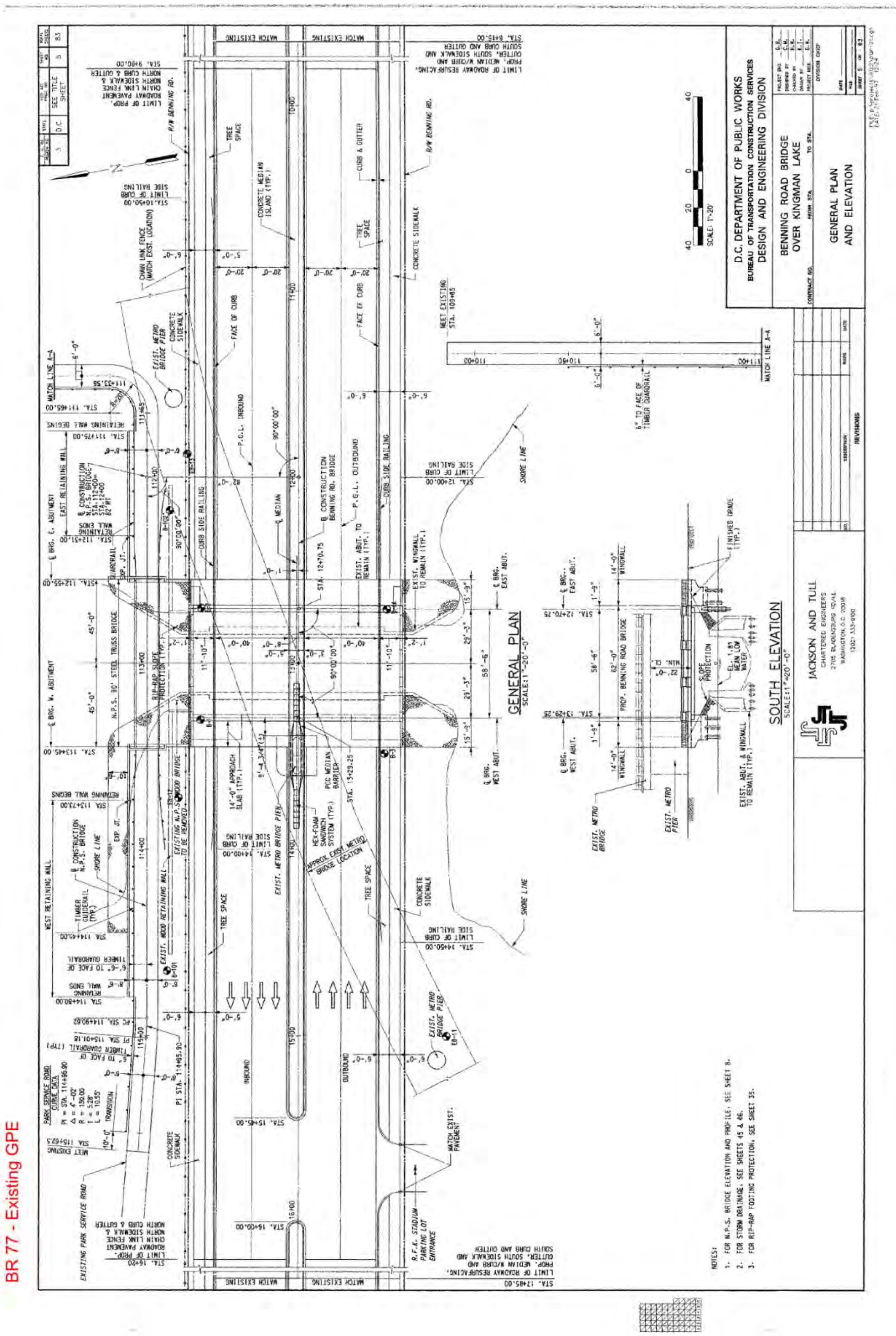


BR 52 - Existing GPE

BR No. 52 Typical Section - Build Down Option (Not to Scale)

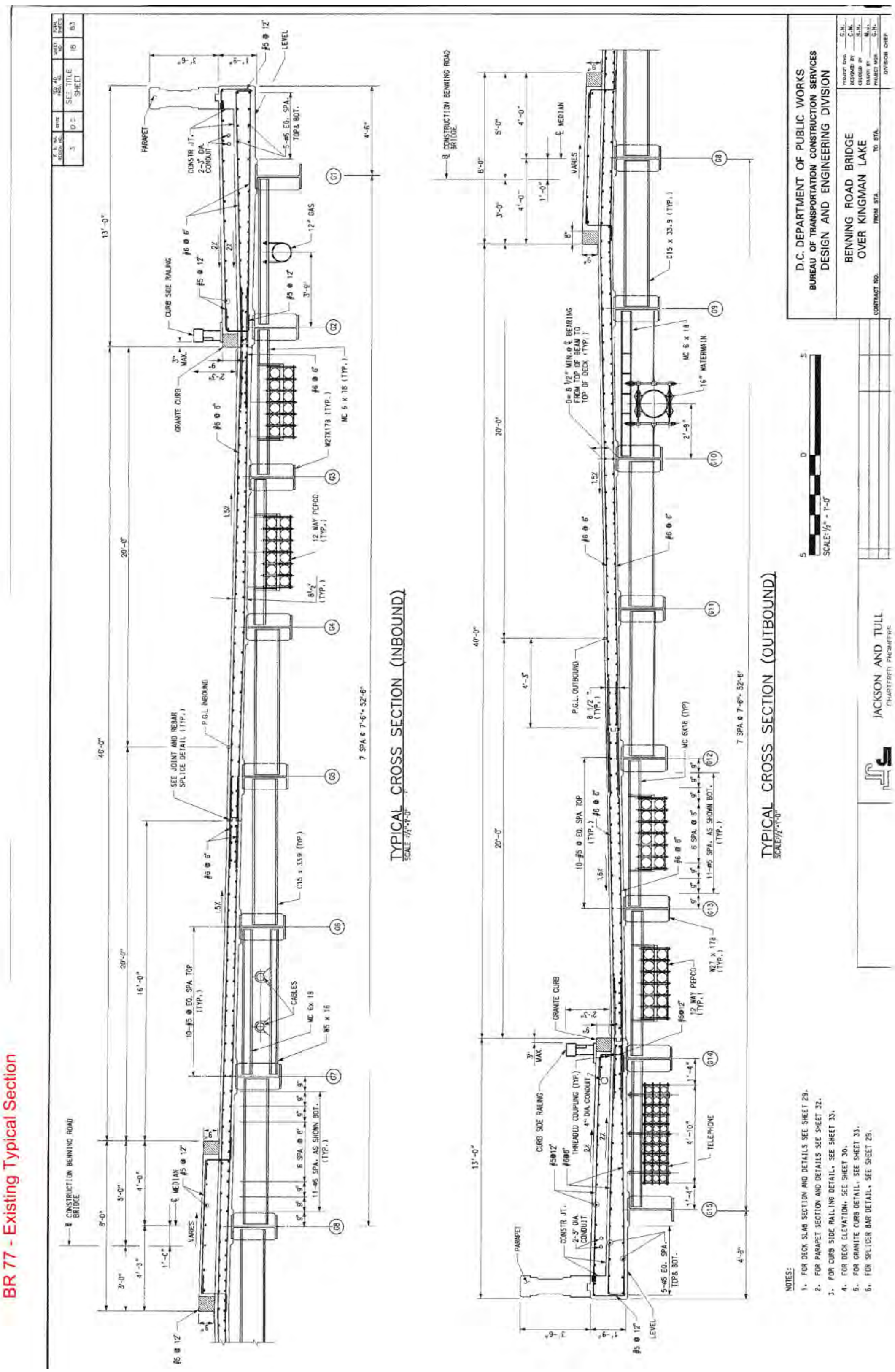


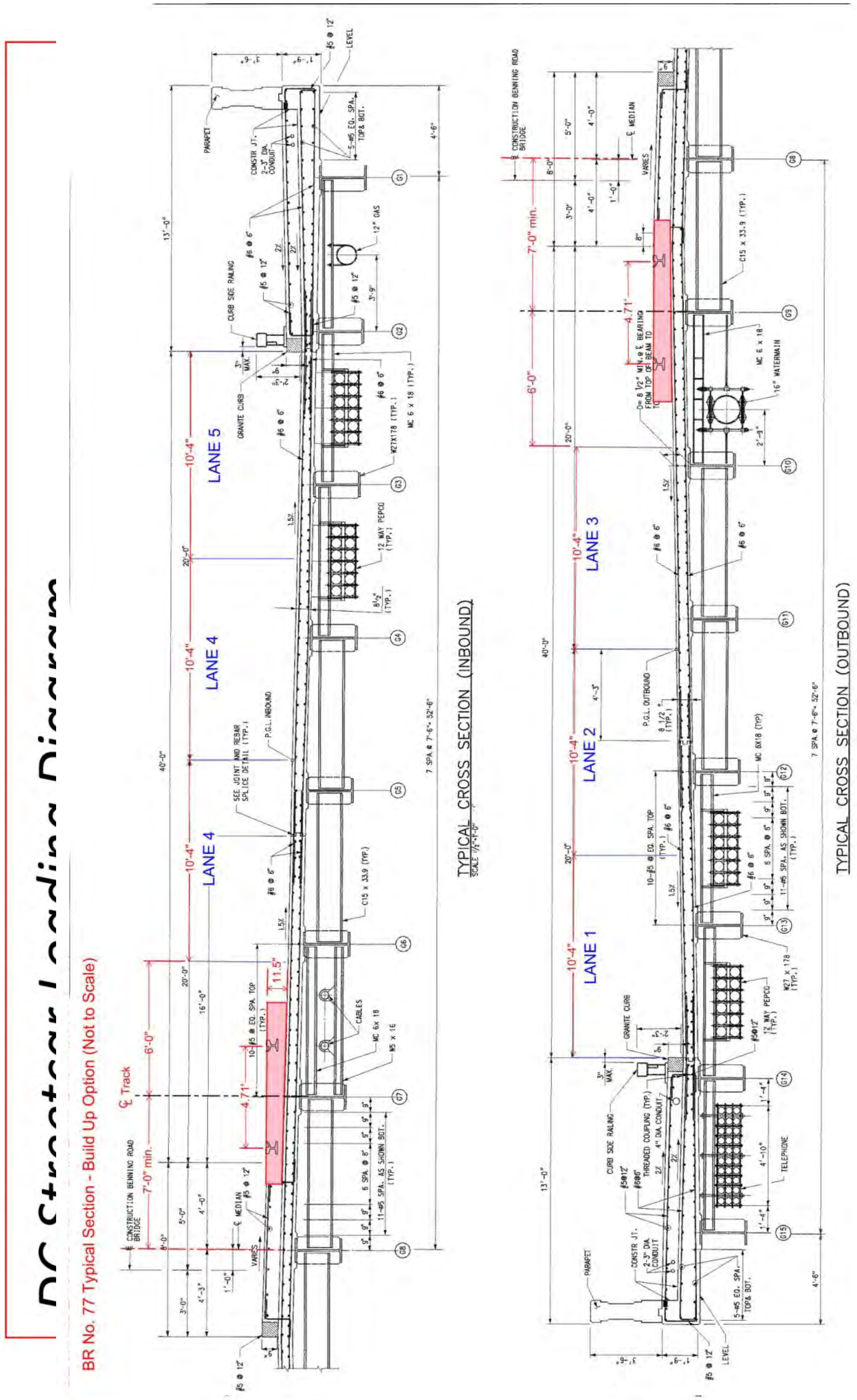
Appendix A-4



BR 77 - Existing GPE

BR 77 - Existing Typical Section




DC Streetcar Loading Diagram
BR No. 77 Typical Section - Build Up Option (Not to Scale)
℄ Track
LANE 1
LANE 2
LANE 3
LANE 4
LANE 5
TYPICAL CROSS SECTION (INBOUND)
TYPICAL CROSS SECTION (OUTBOUND)

Appendix E:

Traffic Analysis Technical Memorandum

District Department of Transportation

BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

TRAFFIC ANALYSIS TECHNICAL MEMORANDUM

November 2012

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AECOM was contracted by Washington Metropolitan Area Transit Authority (WMATA) in partnership with the District of Columbia Department of Transportation (DDOT) to evaluate the feasibility of extending the H/Benning Streetcar east of Oklahoma Avenue across the Anacostia River to Ward 7. This technical memorandum documents the existing and 2040 traffic operation conditions at key intersections along Benning Road, between 26th Street, NE and East Capitol Street, and along Minnesota Avenue, NE in the vicinity of the Minnesota Avenue Metro Station. The study also investigates potential traffic impacts from the proposed Benning Road streetcar extension - from the as-built track at Oklahoma Avenue, NE to the Minnesota Avenue Metro Station and to the Benning Road Metro Station in the year 2040.

Existing Conditions

Study Area

The study area encompasses Benning Road from 26th Street, NE on the west to East Capitol Street on the east, and Minnesota Avenue from Benning Road on the south to Hayes Street on the north. The study intersections along Benning Road and Minnesota Avenue include eight (8) signalized intersections and four (4) unsignalized intersections, listed below and shown in Figure 1.

Signalized Intersections:

- Benning Road and 26th Street, NE
- Benning Road and Oklahoma Avenue, NE
- Benning Road and Anacostia Avenue, NE
- Benning Road and 34th Street, NE
- Benning Road and Minnesota Avenue, NE
- Benning Road and 42nd Street, NE
- Benning Road and East Capital Street, NE
- Minnesota Avenue, NE and Grant Street, NE

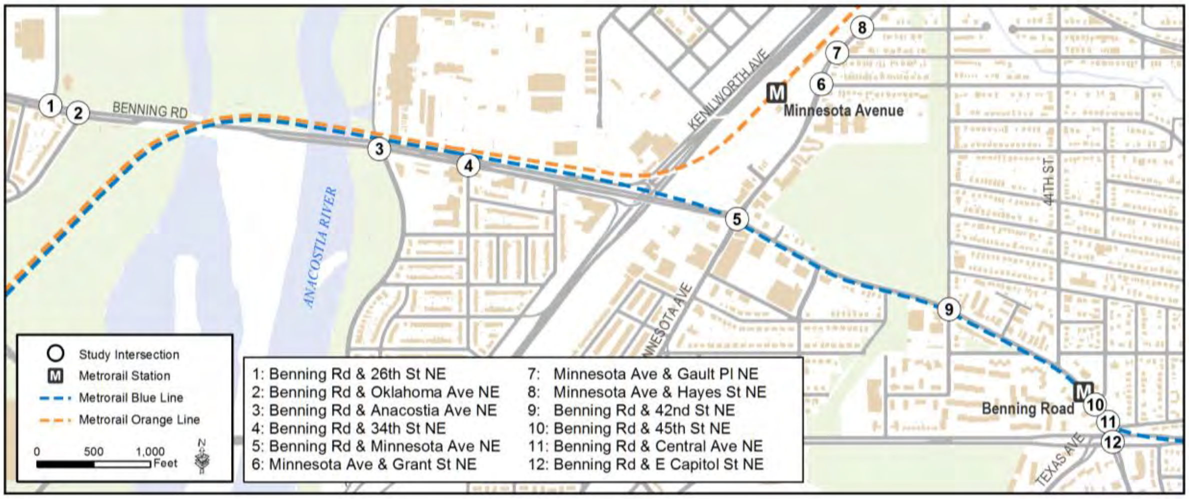
Unsignalized Intersections:

- Benning Road and Central Avenue, NE
- Benning Road and 45th Street, NE
- Minnesota Avenue, NE and Gault Place, NE
- Minnesota Avenue, NE and Hayes Street, NE

Benning Road is a major east-west arterial street that links downtown DC to suburban neighborhoods in the District as well as in Maryland. The Average Annual Daily Volume on the Benning Road Bridge segment is estimated to be 44,400 vehicles (Source: DDOT Traffic Volume Map 2010.

Minnesota Avenue is a northeast-southwest arterial street that runs parallel to I-295/DC-295 and crosses major intersections such as Massachusetts Avenue, SE, East Capitol Street, Benning Road and Eastern Avenue on the north.

Figure 1: Study Intersections on Benning Road and Minnesota Avenue



Methodology

The methodology adopted for the traffic operations study and corridor analysis is summarized below.

Accident Analysis – Accident data was provided by DDOT in the study area from the year 2009 through the year 2011. The data were analyzed to determine safety conditions at the intersections through review of accident type, pattern, severity, and concentration. Table 1 shows a summary of accident data at major study intersections.

Table 1: Accident Data at Major Study Intersections (2009-2011)

Intersection[2]	Number of Crashes (3 years)	Crash Rate (Crashes/Million Vehicles)	Collision Type[1] Rear-end	Collision Type[1] Sideswipe	Collision Type[1] Angle	Crashes Resulting in Injury	Crashes Resulting in Fatality
1. Benning Rd and 26th St	18	0.37	38.9%	5.6%	5.6%	5	0
2. Benning Rd and Oklahoma Ave	20	0.40	30.0%	15.0%	10.0%	7	0
3. Benning Rd and Anacostia Ave	24	0.48	54.2%	16.7%	8.3%	10	1
4. Benning Rd and 34th St	36	0.69	30.6%	36.1%	5.6%	15	0
5. Benning Rd and Minnesota Ave	134	**2.77**	26.9%	24.6%	7.5%	53	0
6. Minnesota Ave and Grant St	27	**1.22**	18.5%	22.2%	7.4%	10	0
7. Minnesota Ave and Gault Pl	4	0.21	25.0%	25.0%	25.0%	2	0
8. Minnesota Ave and Hayes St	4	0.22	25.0%	25.0%	0.0%	0	0
9. Benning Rd and 42nd St	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10. Benning Rd and 45th St	9	0.37	33.3%	22.2%	22.2%	4	0
11. Benning Rd and Central Ave	18	0.77	44.4%	22.2%	5.6%	6	0
12. Benning Rd and East Capital St	113	**1.90**	25.7%	26.5%	11.5%	40	0

N/A = Not Available
Notes:
1. DDOT Traffic Accident Reporting and Analysis System includes 14 types of collisions. Other types not reflected in Table 1 include left turn, right turn, head on, parked, fixed object, ran off road, pedestrian involved, backing, non collision, under/over ride and unspecified.
2. Accident data at the intersection of Benning Road and 42nd Street is not available.

Field observations – Field observations were performed at the project location and its vicinity to determine the existing roadway and geometric conditions, lane assignments, traffic control and operations, speed limits, signing and pavement markings, and other site characteristics that could affect the traffic operations and safety at the study intersections.

Data Collection – Peak period turning movement counts were performed at the study intersections on Wednesday, September 15, 2010 and Tuesday, June 12, 2012. The AM peak hour and PM peak hour along the Benning Road and Minnesota Avenue corridors at the study intersections were determined as 7:30 a.m. to 8:30 a.m. and 5:00 p.m. to 6:00 p.m., respectively.

Alternatives Development – Several potential alternatives were developed for the proposed Benning Road streetcar extension from the existing track terminus at Oklahoma Avenue to Minnesota Avenue Metro Station/Benning Road Metro Station. These alternatives were developed to provide concurrent and safe multi-modal operations along the study corridor.

Traffic Analysis – A traffic operations analysis was performed for the study intersections using Synchro 8.0 and VISSIM based on the methodology outlined in the 2010 edition of the Highway Capacity Manual (HCM). The analysis examined the AM and PM peak hour operational conditions at the corridor intersections for the existing year 2012 conditions, no-build year 2040 conditions, and proposed build alternatives for the year 2040. Impacts to peak hour operations were assessed using Measures of Effectiveness (MOEs), including Delay expressed as seconds per vehicle (sec/veh) and Level of Service (LOS), for the existing condition and proposed conditions at the study intersections.

Intersection LOS analysis provides a measure of delay and service condition for all approaches to the intersection. The HCM 2010 edition uses LOS as a qualitative measure to describe the operating conditions at signalized and unsignalized intersections based on control delay per vehicle (seconds). The LOS range of A through F represents driving conditions from best to worst, respectively. LOS A represents free-flow conditions with no congestion, and LOS F represents severe congestion, significant delays, queues, and stop-go conditions. For the purpose of this study, LOS D or better was assumed as an acceptable LOS at intersections for urban conditions. Table 2 presents the LOS thresholds for signalized and unsignalized intersections per the HCM 2010.

Table 2: LOS Thresholds for Signalized and Unsignalized Intersections

Control Delay at Signalized Intersections		Control Delay at Unsignalized Intersections	
Delay (sec/veh)	**LOS**	**Delay (sec/veh)**	**LOS**
<= 10	A	<= 10	A
> 10 – 20	B	> 10 – 15	B
> 20 – 35	C	> 15 – 25	C
> 35 – 55	D	> 25 – 35	D
> 55 – 80	E	> 35 – 50	E
> 80	F	> 50	F

Source: HCM 2010.

The AM and PM peak hour traffic conditions at each intersection were initially analyzed using Synchro 8.0 to generate preliminary delays and LOS results. Synchro 8.0 is a macroscopic traffic analysis software which is commonly used to analyze vehicular and pedestrian traffic flows and operations at isolated intersections, arterial corridors, and roundabouts. It is widely used for macroscopic traffic analysis, signal timing optimization, and evaluation. Synchro 8.0 enables engineers to analyze existing conditions and several geometric and signal timing alternatives effectively and efficiently with relative ease.

A VISSIM microscopic traffic analysis and simulation was later performed to discretely model automobile, transit and pedestrian interaction and operations at each study intersection. VISSIM is a microscopic stochastic, time-step based simulation model where each vehicle in the system is modeled discretely to assess traffic performance and its impact on traffic flow and operations. The models contains a car following and lane changing algorithm which enables modeling of complex driver, vehicle, and traffic system behavior for longitudinal and lateral vehicular movements under various conditions in the system. For this study, the existing lane configuration, peak hour turning movement counts, and signal timings were coded in Synchro and VISSIM at each study intersection. The existing field implemented signal timings were coded in the model using the DDOT field timing sheets. The existing MOE results were generated in Synchro based on the HCM 2010 edition guidelines. The existing conditions VISSIM models were run 10 times and the average output results were tabulated and analyzed to determine the overall conditions at the study intersections during the AM and PM peak hours. In order to replicate the existing peak hour traffic conditions at study intersections, the AM and PM peak hour models were calibrated based on field data and observations.

Analysis Results

This section summarizes the delay and LOS results from Synchro and VISSIM at each study intersection during AM and PM peak hours. Table 3 and Table 4 present the MOE summary for the existing AM peak hour conditions from Synchro and VISSIM analysis, respectively. Tables 5 and 6 present the MOE summary for the PM peak hour conditions from Synchro and VISSIM analysis, respectively. Detailed discussions for each intersection are presented later in the memorandum. Please note that there are some differences between VISSIM and Synchro results at several intersections due to the differences in the underlying assumptions and calculations used in these tools. The traffic analysis for this study is based on the VISSIM model due its capability in modeling vehicles, pedestrians, buses, streetcars, and other traffic system behaviors under various conditions. Synchro results are presented for reference purposes.

Table 3: Existing AM Peak Hour Delay and LOS Conditions (Synchro)

No.	Intersection	Traffic Control	Intersection Delay	Intersection LOS	Northbound Delay	Northbound LOS	Southbound Delay	Southbound LOS	Westbound Delay	Westbound LOS	Eastbound Delay	Eastbound LOS
1	Benning Rd and 26th St	Signalized	9.9	A	-	-	30.9	C	10.0	A	6.0	A
2	Benning Rd and Oklahoma Ave	Signalized	7.3	A	31.7	C	-	-	7.1	A	4.8	A
3	Benning Rd and Anacostia Ave	Signalized	4.2	A	37.1	D	36.2	D	3.3	A	1.7	A
4	Benning Rd and 34th St	Signalized	23.5	C	38.2	D	40.5	D	25.8	C	11.6	B
5	Benning Rd and Minnesota Ave	Signalized	94.2	F	90.7	F	54.6	D	181.5	F	29.6	C
6	Minnesota Ave and Grant St	Signalized	11.9	B	8.4	A	9.1	A	33.7	C	-	-
7	Minnesota Ave and Gault Pl	Unsignalized	22.3	C	0.0	A	0.3	A	20.5	C	22.3	C
8	Minnesota Ave and Hayes St	Unsignalized	13.9	B	0.2	A	0.0	A	13.9	B	-	-
9	Benning Rd and 42nd St	Signalized	13.7	B	23.2	C	25.0	C	11.9	B	10.6	B
10	Benning Rd at 45th St	Unsignalized	82.1	F	0.0	A	1.3	A	82.1	F	19.9	C
11	Benning Rd at Central Ave	Unsignalized	286.7	F	0.0	A	0.0	A	286.7	F	-	-
12	Benning Rd and E Capitol St	Signalized	121.7	F	48.3	D	58.5	E	195.3	F	67.9	E

The Synchro results indicate acceptable LOS D or better conditions at six signalized and two unsignalized intersections in the study area during the AM peak hour. The results at the signalized intersections of Benning Road and East Capitol Street, and Benning Road and Minnesota Avenue show unacceptable LOS F with intersection delays of 121.7 sec/veh and 94.2 sec/veh, respectively. This can be attributed to the heavy approach volumes at the intersection, limited capacity and available green time to service the volumes within the 120 sec cycle length. The vehicles at the unsignalized intersections of Benning Road and 45th Street, and Benning Road and Central Avenue experience LOS F during the AM peak hour. The long delays for the side street can be attributed to heavy traffic volumes along Benning Road. All the other intersections and their approach show acceptable LOS D or better conditions with delays less than 55 sec/veh at signalized intersections and 50 sec/veh at unsignalized intersections.

Table 4: Existing AM Peak Hour Delay and LOS Conditions (VISSIM)

No.	Intersection	Traffic Control	Intersection		Northbound		Southbound		Westbound		Eastbound	
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
1	Benning Rd and 26th St	Signalized	7.1	A	-	-	33.0	C	5.7	A	8.3	A
2	Benning Rd and Oklahoma Ave	Signalized	9.4	A	23.5	C	-	-	10.4	B	4.5	A
3	Benning Rd and Anacostia Ave	Signalized	3.4	A	33.2	C	23.2	C	1.8	A	3.9	A
4	Benning Rd and 34th St	Signalized	17.6	B	18.4	B	18.2	B	19.4	B	11.6	B
5	Benning Rd and Minnesota Ave	Signalized	48.2	D	30.0	C	41.8	D	83.7	F	33.1	C
6	Minnesota Ave and Grant St	Signalized	14.6	B	9.2	A	9.1	A	52.2	D	-	-
7	Minnesota Ave and Gault Pl	Unsignalized	6.9	A	0.1	A	0.5	A	6.5	A	6.9	A
8	Minnesota Ave and Hayes St	Unsignalized	7.6	A	0.2	A	0.1	A	7.6	A	-	-
9	Benning Rd and 42nd St	Signalized	10.0	B	35.0	D	32.3	C	5.1	A	5.4	A
10	Benning Rd and 45th St	Unsignalized	8.3	A	0.3	A	1.7	A	8.3	A	7.8	A
11	Benning Rd and Central Ave	Unsignalized	44.7	D	0.0	A	0.0	A	44.7	D	-	-
12	Benning Rd and E Capitol St	Signalized	60.2	E	76.3	E	61.5	E	50.8	D	62.4	E

The VISSIM results indicate acceptable LOS D or better conditions at seven signalized and four unsignalized intersections in the study area during the AM peak hour. The results at Benning Road and East Capitol Street intersection show unacceptable LOS E results with 60.2 sec/veh overall intersection delay. The intersection is operating under split phases for all approaches in the existing condition due to the limitation of the roadway geometry. Due to this inefficient signal operation as well as the heavy approach volumes at the intersection, northbound, southbound and eastbound vehicles experience long delays with LOS E during the AM peak hour. In addition, the westbound approach along Benning Road at the Minnesota Avenue intersection shows unacceptable LOS F conditions due to insufficient green time provided to service the high hourly vehicular demand as well as frequent bus service at the near side bus stop in the westbound approach. All the other intersections and their approach show acceptable LOS D or better conditions with delays less than 55 sec/veh at signalized intersections and 50 sec/veh at unsignalized intersections.

Table 5: Existing PM Peak Hour Delay and LOS Conditions (Synchro)

No.	Intersection	Traffic Control	Intersection Delay	Intersection LOS	Northbound Delay	Northbound LOS	Southbound Delay	Southbound LOS	Westbound Delay	Westbound LOS	Eastbound Delay	Eastbound LOS
1	Benning Rd and 26th St	Signalized	4.9	A	-	-	38.8	D	1.2	A	4.1	A
2	Benning Rd and Oklahoma Ave	Signalized	11.8	B	26.7	C	-	-	11.5	B	10.9	B
3	Benning Rd and Anacostia Ave	Signalized	1.8	A	37.7	D	36.8	D	2.7	A	0.3	A
4	Benning Rd and 34th St	Signalized	14.4	B	38.4	D	35.9	D	14.5	B	12.7	B
5	Benning Rd and Minnesota Ave	Signalized	39.9	D	26.6	C	34.0	C	59.0	E	44.0	D
6	Minnesota Ave and Grant St	Signalized	10.0	A	10.0	A	7.7	A	27.0	C	-	-
7	Minnesota Ave and Gault Pl	Unsignalized	42.4	E	0.0	A	0.3	A	21.1	C	42.4	E
8	Minnesota Ave and Hayes St	Unsignalized	9.6	A	0.0	A	0.3	A	12.4	B	-	-
9	Benning Rd and 42nd St	Signalized	13.9	B	23.6	C	24.4	C	10.2	B	12.6	B
10	Benning Rd at 45th St	Unsignalized	28.4	D	0.6	A	0.1	A	28.4	D	20.1	C
11	Benning Rd at Central Ave	Unsignalized	21.0	C	0.0	A	0.5	A	21.0	C	-	-
12	Benning Rd and E Capitol St	Signalized	118.6	F	47.3	D	49.6	D	267.5	F	93.0	F

The Synchro results indicate acceptable LOS D or better conditions at seven signalized and four unsignalized intersections in the study area during the PM peak hour. The results at the Benning Road and East Capitol Street intersection show unacceptable LOS F results with 118.6 sec/veh. This can be attributed to the heavy approach volumes at the intersection, limited capacity and available green time to service the volumes within the 120 sec cycle length. The delay at Benning Road and Minnesota Avenue intersection is 59.0 sec/veh in the westbound direction. At the intersection of Minnesota Avenue and Gault Place intersection, the delay on the stop controlled eastbound approach is 42.4 sec/veh which results in LOS E result at the intersection. All the other intersections and their approach show acceptable LOS D or better conditions with delays less than 55 sec/veh at signalized intersections and 50 sec/veh at unsignalized intersections.

Table 6: Existing PM Peak Hour Delay and LOS Conditions (VISSIM)

No.	Intersection	Traffic Control	Intersection Delay	Intersection LOS	Northbound Delay	Northbound LOS	Southbound Delay	Southbound LOS	Westbound Delay	Westbound LOS	Eastbound Delay	Eastbound LOS
1	Benning Rd and 26th St	Signalized	6.5	A	-	-	43.1	D	2.4	A	5.9	A
2	Benning Rd and Oklahoma Ave	Signalized	4.1	A	17.5	B	-	-	5.1	A	2.8	A
3	Benning Rd and Anacostia Ave	Signalized	3.9	A	24.1	C	25.2	C	3.0	A	3.6	A
4	Benning Rd and 34th St	Signalized	15.9	B	19.4	B	30.2	C	16.3	B	15.2	B
5	Benning Rd and Minnesota Ave	Signalized	34.9	C	29.4	C	30.8	C	55.2	E	34.0	C
6	Minnesota Ave and Grant St	Signalized	10.4	B	0.0	A	8.8	A	36.9	D	-	-
7	Minnesota Ave and Gault Pl	Unsignalized	8.4	A	0.4	A	0.4	A	6.7	A	8.4	A
8	Minnesota Ave and Hayes St	Unsignalized	9.0	A	0.2	A	0.2	A	9.0	A	-	-
9	Benning Rd and 42nd St	Signalized	9.8	A	35.4	D	28.9	C	4.2	A	5.9	A
10	Benning Rd and 45th St	Unsignalized	7.7	A	0.1	A	1.0	A	7.7	A	7.1	A
11	Benning Rd and Central Ave	Unsignalized	5.3	A	0.0	A	0.0	A	5.3	A	-	-
12	Benning Rd and E Capitol St	Signalized	61.2	E	56.3	E	120.6	F	63.3	E	38.6	D

The VISSIM PM peak hour results indicate acceptable LOS D or better conditions at seven signalized and four unsignalized intersections in the study area. The results at Benning Road and East Capitol Street intersection show unacceptable LOS E with 61.2 sec/veh overall intersection delay. The intersection is operating under split phases for all approaches in the existing condition due to the limitation of the roadway geometry. Due to this inefficient signal operation as well as the heavy approach volumes at the intersection during the PM peak hour, northbound and westbound vehicles experience LOS E and southbound vehicles experience LOS F. In addition, the westbound approach along Benning Road at the Minnesota Avenue intersection shows LOS E with 55.2 veh/sec approach delay. This can be attributed to the heavy approach volumes at the intersection especially in the eastbound approach, constraining the green time available for the westbound approach within the 120 sec cycle length to service the demand. All the other intersections and their approach show acceptable LOS D or better conditions with delays less than 55 sec/veh at signalized intersections and 50 sec/veh at unsignalized intersections.

Existing Conditions Intersection Analysis Summary

1. Benning Road and 26th Street, NE

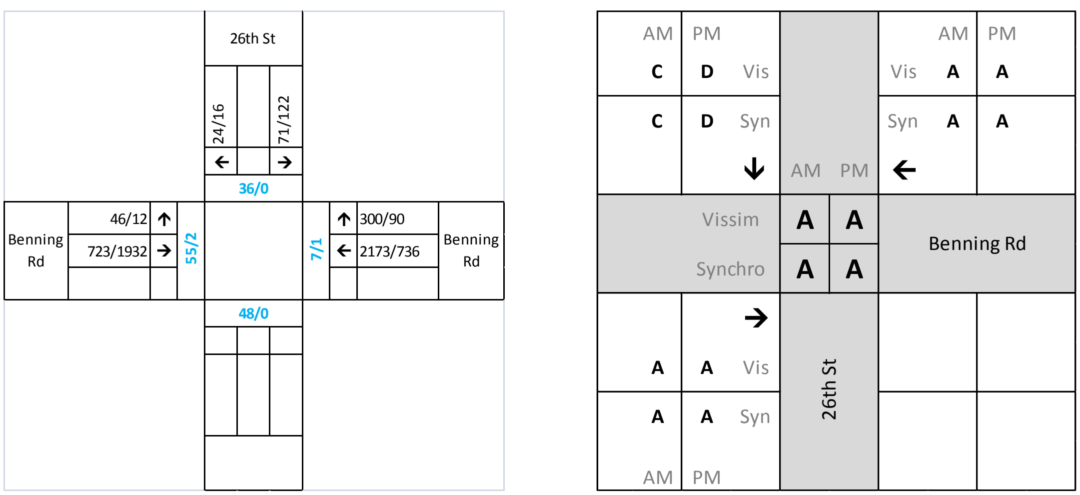
The intersection is signalized and operates as three phase traffic movements. Pedestrians cross Benning Road on the west side of the intersection. The pedestrian ramps on the northwest and southwest corner of the intersection were recently constructed.. At the intersection, 146 pedestrians and 3 pedestrians were counted in the morning and afternoon peak hours, respectively.

For the last three years, the accident rate at the intersection was 0.37 crashes per million vehicles, where 39% (7 accidents) were rear-end, 5% (1 accident) were sideswipe, 5% (1 accident) were right angle, and 5% (1 accident) were head on accidents. There were 5 crashes that resulted in injury at the intersection.

The existing turning movement counts and LOS results from Synchro and VISSIM at the intersection of Benning Road and 26th Street are shown in Figure 2 below. The traffic analysis indicates the intersection operates at acceptable level of service A with current traffic demand during the AM and PM peak hours.

Figure 2: Existing Turning Movement Counts and Pedestrian Volumes (Left), and Traffic Analysis Results (Right) at Benning Road and 26th Street

(XX/YY: AM Peak Hour Volume/PM Peak Hour Volume)



2. Benning Road and Oklahoma Avenue, NE

The intersection is controlled by a traffic signal and operates as three traffic signal phase with the left turn signal from Benning Road to Oklahoma Avenue as a leading phase movement. Pedestrians are only allowed to cross on the west side of the intersection where the left turning vehicles from Oklahoma Avenue yield to pedestrians while crossing Benning Road.

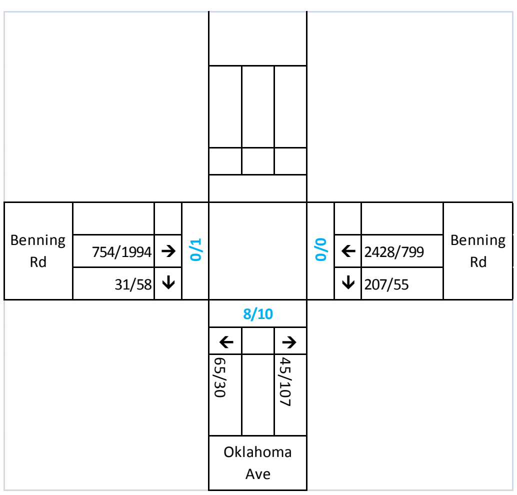
At the intersection, 8 pedestrians and 11 pedestrians were counted crossing the intersection in the morning and afternoon peak periods, respectively.

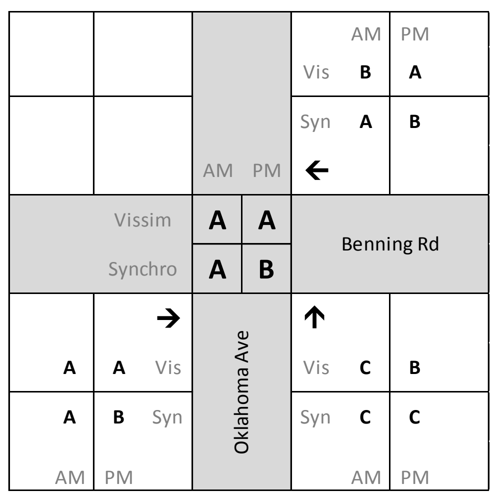
For the last three years, the accident rate at the intersection was 0.40 crashes per million vehicles, where 30% (6 accidents) were rear-end, 15% (3 accidents) were sideswipe, 10% (2 accidents) were right angle, 20% (4 accidents) were left turn and 5% (1 accident) were head on accidents. There were 7 crashes that resulted in injury at the intersection.

The existing turning movement counts and LOS results from Synchro and VISSIM at the intersection of Benning Road and Oklahoma Avenue are shown in Figure 3 below. The VISSIM results indicate the intersection operates at acceptable level of service A with current traffic demand during the AM and PM peak hours.

Figure 3: Existing Turning Movement Counts and Pedestrian Volumes (Left), and Traffic Analysis Results (Right) at Benning Road and Oklahoma Avenue

(XX/YY: AM Peak Hour Volume/PM Peak Hour Volume)





Parking restriction for eastbound and westbound Benning Road in the immediate vicinity of the intersection is between 7:00 – 9:30 AM (Monday - Friday) and 4:00 – 6:30 PM (Monday - Friday) in the morning and afternoon peak hours, respectively. See Table 7 for further information.

According to the *Far Northeast Livability Study Existing Conditions technical memorandum* dated August 26, 2010, an older bicycle route from Oklahoma Avenue to the Benning Road Metro station has been neglected, and way-finding signs are in disrepair.

3. Benning Road and Anacostia Avenue, NE

The intersection is controlled by a traffic signal and operates as two traffic signal phases: northbound/southbound Anacostia Avenue and westbound/eastbound Benning Road. No left-turn lanes or left-turn signal phases are provided for all approaches. Pedestrians are only allowed to cross Benning Road on the east side of the intersection.

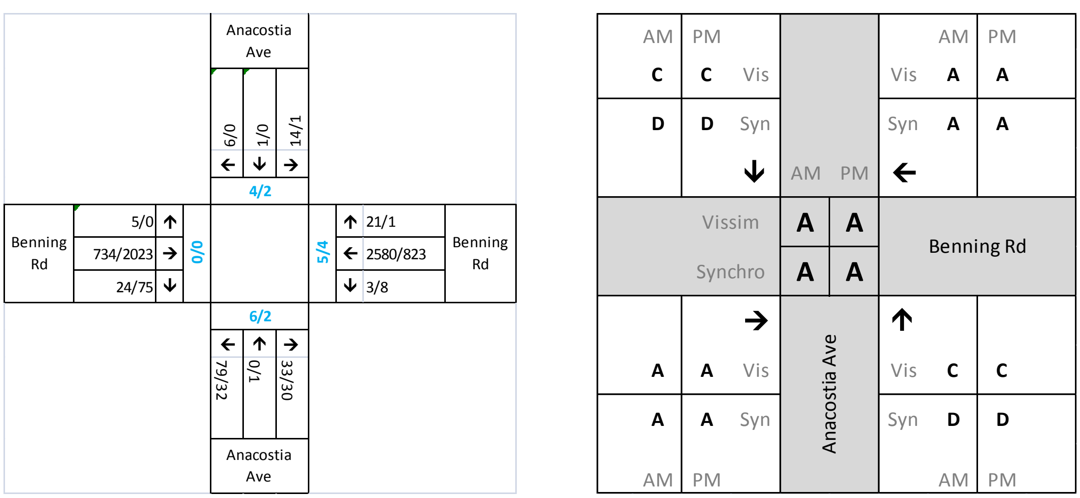
There are minor pedestrian activities observed at this intersection. Only 5 pedestrians and 4 pedestrians were counted crossing Benning Road in the morning and afternoon peak periods, respectively.

For the last three years, the accident rate at the intersection was 0.48 crashes per million vehicles, where 54.2% (13 accidents) were rear-end, 16.7% (4 accidents) were sideswipe, 8.3% (2 accidents) were right angle, 4.2% (1 accidents) were left turn and 4.2% (1 accident) were pedestrian involved. There were 1 crash that resulted in fatality and 10 crashes that resulted in injury at the intersection.

The existing turning movement counts and LOS results from Synchro and VISSIM at the intersection of Benning Road and Anacostia Avenue are shown in Figure 4 below. The VISSIM results indicate the intersection operates at acceptable level of service A with current traffic demand during the AM and PM peak hours.

Figure 4: Existing Turning Movement Counts and Pedestrian Volumes (Left), and Traffic Analysis Results (Right) at Benning Road and Anacostia Avenue

(XX/YY: AM Peak Hour Volume/PM Peak Hour Volume)



4. Benning Road and 34th Street , NE

The intersection is controlled by a traffic signal with left turning phases from west and east side of Benning Road serving the turning traffic to 34th Street. It follows with the main street and side street phases. The pedestrians are allowed to cross on the east side of the intersection while the side street phases are green.

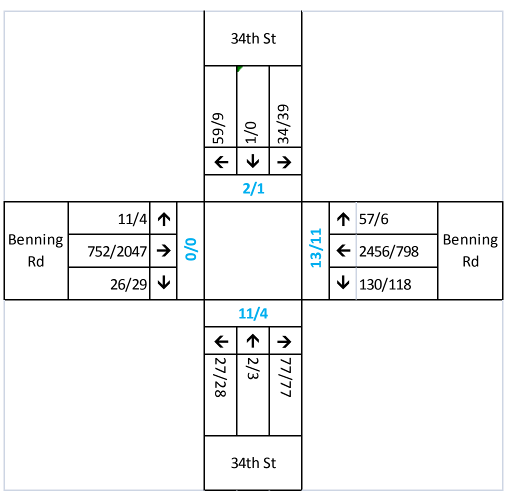
At the intersection, 26 pedestrians and 12 pedestrians were counted crossing the intersection in the morning and afternoon peak, respectively.

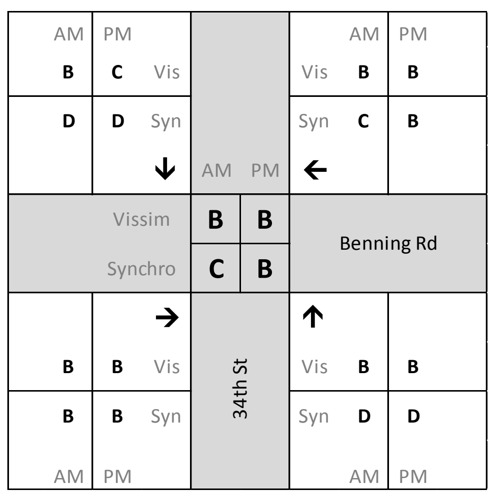
For the last 3 years, the accident rate at the intersection was 0.69 crashes per million vehicles, where 30% (11 accidents) were rear-end, 36% (13 accidents) were sideswipe and 5% (2 accidents) were right angle accidents. There was one (1) pedestrian and two bicyclists involved in accidents and there were 15 crashes that resulted injury at the intersection.

The existing turning movement counts and LOS results from Synchro and VISSIM at the intersection of Benning Road and 34th Street are shown in Figure 5 below. The VISSIM results indicate the intersection operates at acceptable level of service B with current traffic demand during the AM and PM peak hours.

Figure 5: Existing Turning Movement Counts and Pedestrian Volumes (Left), and Traffic Analysis Results (Right) at Benning Road and 34th Street

(XX/YY: AM Peak Hour Volume/PM Peak Hour Volume)





Parking restriction for eastbound and westbound Benning Road in the immediate vicinity of the intersection is between 7:00 – 9:30 AM (M-F) and 4:00 – 6:30 PM (M-F) in the morning and afternoon peak respectively. See Table 7 for further information.

5. Benning Road and Minnesota Avenue, NE

The Benning Road/Minnesota Avenue intersection is at the junction of major east-west and north-south corridors.

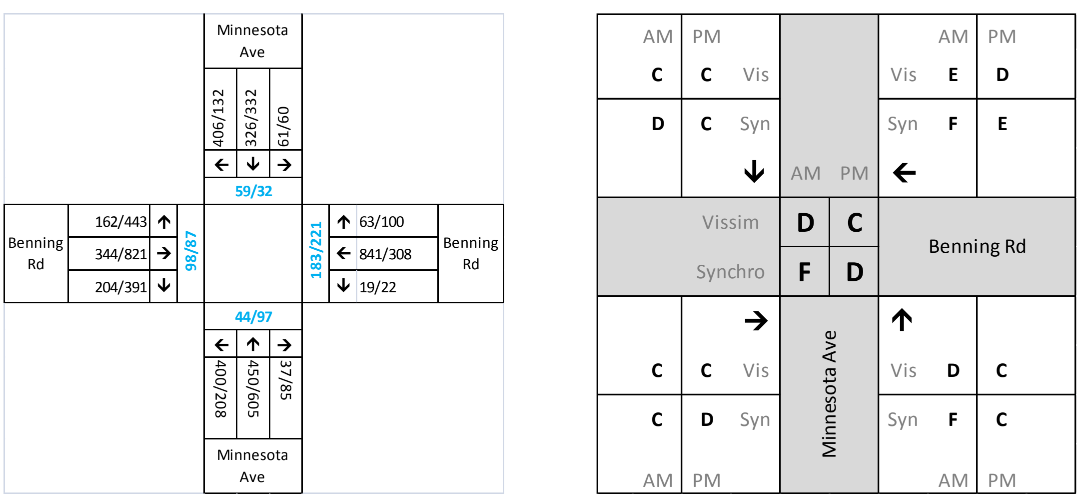
Pedestrian phases are running in concurrent with vehicular phase movement on all side of the approaches. At the intersection, there are total of 384 pedestrians and 6 bicyclists were counted in the morning peak. In the afternoon peak, 437 pedestrians were counted crossing the intersection. The west and east side of Benning Road crossings have 98 pedestrians and 183 pedestrians per hour during the morning and afternoon peak hours, respectively. In the afternoon peak period, the pedestrians per hour were counted 87 and 221, respectively.

The intersection is one of the highest accident locations in the District. For the last 3 years, the accident rate at the intersection was 2.77 crashes per million vehicles where 27% (36 accidents) were rear-end, 25% (33 accidents) were sideswipe and 7.5% (10 accidents) were right angle accidents. There were four (4) pedestrians and two (2) bicyclists involved in accidents, and there were 53 crashes that resulted in injury at the intersection.

The existing turning movement counts and LOS results from Synchro and VISSIM at the intersection of Benning Road and Minnesota Avenue are shown in Figure 6. The VISSIM results indicate that the intersection operates at LOS D and LOS C during the AM and PM peak hour, respectively. As shown in Table 3, the westbound approach along Benning Road experiences LOS E at the Minnesota Avenue during the AM peak hour. The green time provided for this approach is not sufficient to process the traffic demand of 841 vehicles per hour.

Figure 6: Existing Turning Movement Counts and Pedestrian Volumes (Left), and Traffic Analysis Results (Right) at Benning Road and Minnesota Avenue

(XX/YY: AM Peak Hour Volume/PM Peak Hour Volume)



Parking restriction for eastbound and westbound Benning Road in the immediate vicinity of the intersection is no standing/parking anytime.

6. Minnesota Avenue and Grant Street, NE

The intersection is located close to Minnesota Avenue Metro Station. Field observation indicates that pedestrians are crossing Minnesota Avenue at midblock to access the Metro Station and transit facility. As per the *Far Northeast Livability Study*, the intersection through the Great Streets program to include the following upgrades:

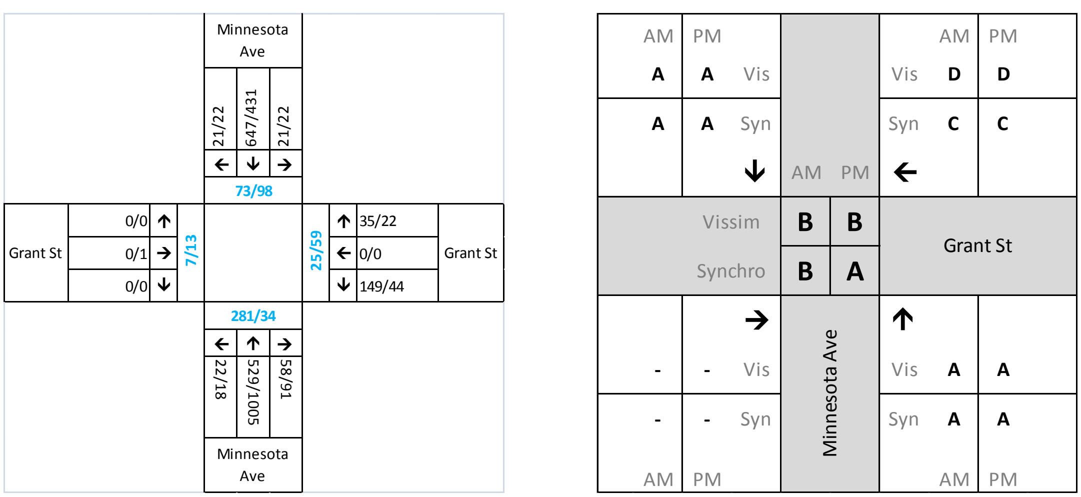
- Provide curb extensions on Grant Street to reduce the existing turning radii and reduce the pedestrian crossing distance across Grant Street
- Reconstruct the existing pedestrian refuge median on the north approach of Minnesota Avenue
- Provide crosswalks on all four approaches

386 pedestrians and 204 pedestrians crossing the intersection in the morning and afternoon peak hours were counted, respectively. For the last 3 years, the accident rate at the intersection is 1.22 crashes per million vehicles where 18.5% (5 accidents) were rear-end, 22.2% (6 accidents) were sideswipe and 7.4% (2 accidents) were right angle accidents. There were three (3) pedestrians were involved in the accident and there were 10 crashes that resulted injury at the intersection.

The existing turning movement counts and LOS results from Synchro and VISSIM at the intersection of Minnesota Avenue and Grant Street are shown in Figure 7 below. The VISSIM results indicate the intersection operates at acceptable LOS B with current traffic demand during the peak hours.

Figure 7: Existing Turning Movement Counts and Pedestrian Volumes (Left), and Traffic Analysis Results (Right) at Minnesota Avenue and Grant Street

(XX/YY: AM Peak Hour Volume/PM Peak Hour Volume)



Parking for northbound Minnesota Avenue between School zone and Grant Street is allowed between 9:30 AM to 4 PM with 2-hour parking limit. There is no parking between 7 AM to 9:30 AM (M-F). No standing/parking is allowed anytime between Grant Street and Hayes Street. In the southbound direction, no standing/parking is allowed anytime between Hayes Street and Gault Street. Between Gault Street and Bus Entrance, no parking is allowed between 9:30 AM to 4:00 PM. Between the bus entrance and exit, except Sundays no standing/parking is allowed. Between the bus exit and garage entrance, 4-hour meter parking is allowed between 7:00 AM and 6:30 PM (M-F). Between the Garage entrance and Benning Road, no parking is allowed except Sundays.

7. Minnesota Avenue and Gault Place , NE

The intersection is unsignalized and is controlled by a stop sign. Pedestrian crossing is marked on the east side of Minnesota Avenue crossing Gault Place.

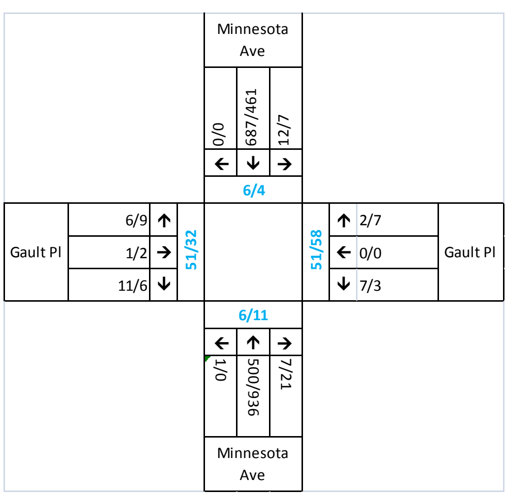
At the intersection, 114 pedestrians and 115 pedestrians were counted crossing the intersection in the morning and afternoon peak hours, respectively.

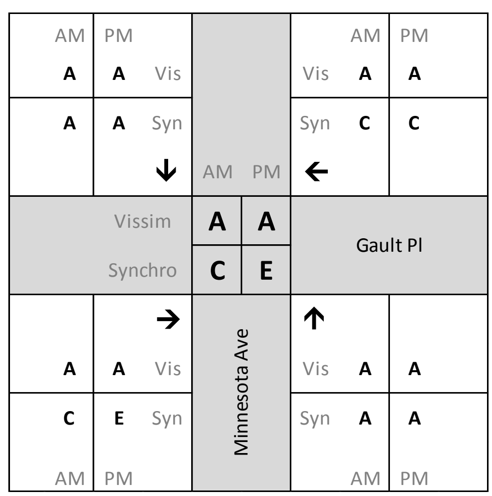
For the last 3 years, the accident rate at the intersection was 0.21 crashes per million vehicles, where 25% (1 accident) were rear-end, 25% (1 accident) were sideswipe and 25% (1 accident) were right angle accident. There was one (1) pedestrian involved in accident and there were 2 crashes that resulted injury at the intersection.

The existing turning movement counts and LOS results from Synchro and VISSIM at the intersection of Minnesota Avenue and Gault Place are shown in Figure 8 below. The VISSIM results indicate the intersection operates at LOS A with current traffic demand during the AM and PM peak hour.

Figure 8: Existing Turning Movement Counts and Pedestrian Volumes (Left), and Traffic Analysis Results (Right) at Benning Road and Central Avenue

(XX/YY: AM Peak Hour Volume/PM Peak Hour Volume)





Parking restriction for northbound and southbound Minnesota Avenue in the immediate vicinity of the intersection is No Standing/Parking anytime. See Table 7 below for further information.

8. Minnesota Avenue and Hayes Street, NE

The intersection is unsignalized and is controlled by a stop sign. Pedestrian crossing is marked for crossing Hayes Street where ramps are located on the northeast and southeast corners.

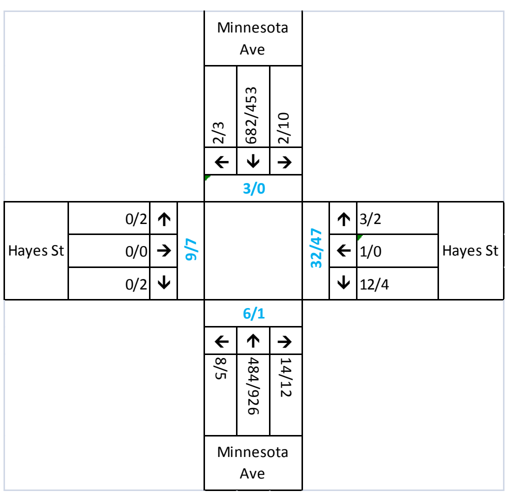
At the intersection, 50 pedestrians and 55 pedestrians were counted crossing the intersection in the morning and afternoon peak hours, respectively.

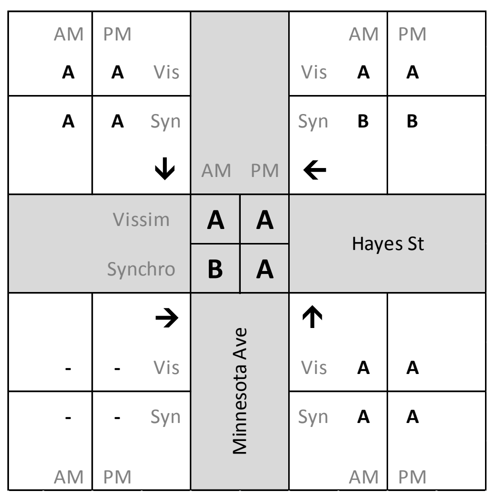
For the last 3 years, the accident rate at the intersection was 0.22 crashes per million vehicles, where 25% (1 accident) were rear-end, 25% (1 accident) were sideswipe, and 50% (2 accidents) fixed object accidents. There was no pedestrian involved in an accident, and there were no crashes that resulted injury at the intersection.

The existing turning movement counts and LOS results from Synchro and VISSIM at the intersection of Minnesota Avenue and Hayes Street are shown in Figure 9 below. The VISSIM results indicate the intersection operates at acceptable LOS A with current traffic demand during the peak hours.

Figure 9: Existing Turning Movement Counts and Pedestrian Volumes (Left), and Traffic Analysis Results (Right) at Minnesota Avenue and Hayes Street

(XX/YY: AM Peak Hour Volume/PM Peak Hour Volume)

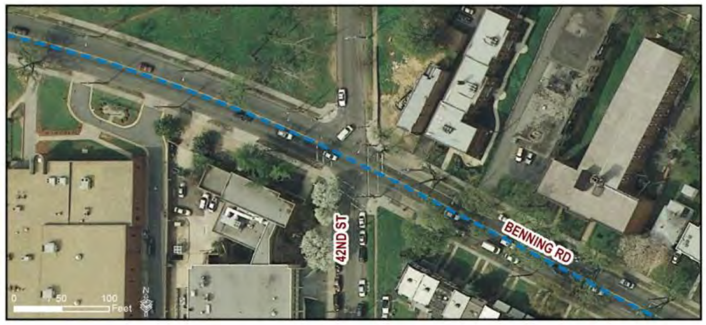




Parking restriction for northbound and southbound Minnesota Avenue in the immediate vicinity of the intersection is No Standing/Parking anytime.

9. Benning Road and 42nd Street, NE

The intersection is controlled by a traffic signal and operates as two traffic signal phases: northbound/southbound 42nd Street and westbound/eastbound Benning Road. No left-turn lanes or left-turn signal phases are provided for all approaches. Pedestrian cross-walks are provided for all legs.

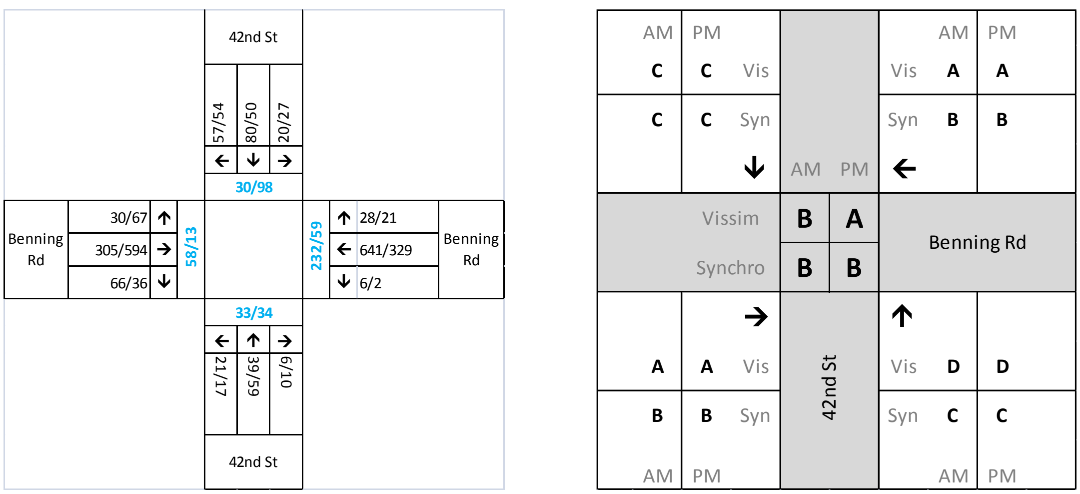


There are 290 pedestrians and 72 pedestrians counted crossing Benning Road, and 63 pedestrians and 132 pedestrians counted crossing 42nd Street during the AM and PM peak hour, respectively.

The existing turning movement counts and LOS results from Synchro and VISSIM at the intersection of Benning Road and 42nd Street are shown in Figure 10 below. The VISSIM results indicate the intersection operates at acceptable level of service B and A with current traffic demand during the AM and PM peak hours, respectively.

Figure 10: Existing Turning Movement Counts and Pedestrian Volumes (Left), and Traffic Analysis Results (Right) at Benning Road and 42nd Street

(XX/YY: AM Peak Hour Volume/PM Peak Hour Volume)



10. Benning Road and 45th Street, NE

The intersection is unsignalized and is controlled by a stop sign. Pedestrian crossing is marked on the west side of Benning Road where ramps are located on the northwest and southwest corner.

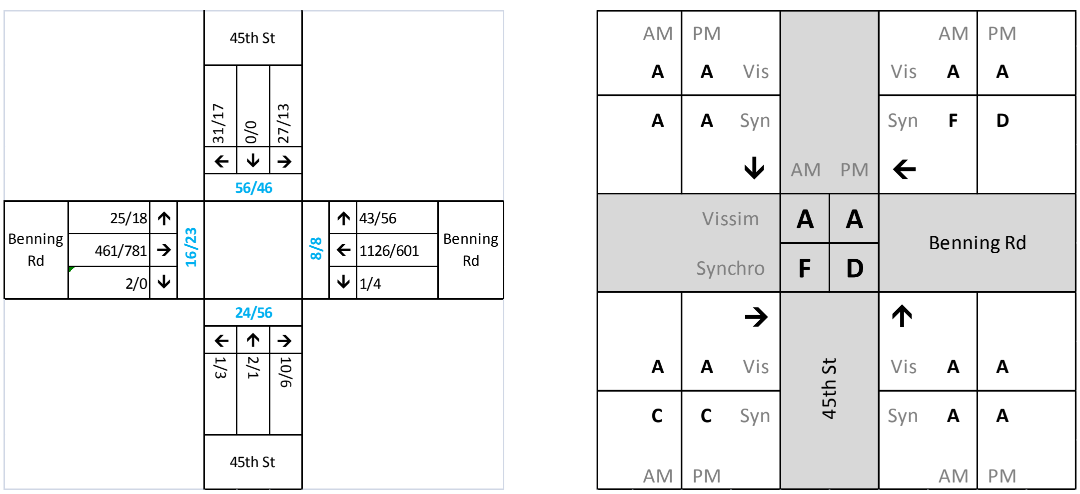
At the intersection, 104 pedestrians and 133 pedestrians were counted crossing the intersection in the morning and afternoon peak hours, respectively.

For the last 3 years, the accident rate at the intersection was 0.37 crashes per million vehicles, where 33% (3 accidents) were rear-end, 22% (2 accidents) were sideswipe and 22% (2 accidents) were right angle accidents. There was one (1) pedestrian involved in an accident, and there were 4 crashes that resulted in injury at the intersection.

The existing turning movement counts and LOS results from Synchro and VISSIM at the intersection of Benning Road and 45th Street are shown in Figure 11 below. The VISSIM results indicate the intersection operates at acceptable level of service A during the AM and PM peak hour.

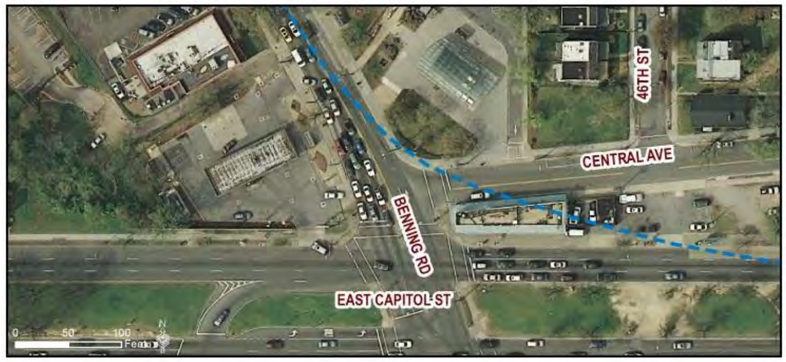
Figure 11: Existing Turning Movement Counts and Pedestrian Volumes (Left), and Traffic Analysis Results (Right) at Benning Road and 45th Street

(XX/YY: AM Peak Hour Volume/PM Peak Hour Volume)



On westbound Benning Road, no standing/parking is allowed between 7:00 – 9:30 AM and 4:00 – 6:30 PM (M-F) in the immediate vicinity of the intersection. No standing/parking is allowed anytime in the eastbound direction.

11. Benning Road and Central Avenue, NE



The intersection is located close to East Capitol Street intersection and is controlled by a stop sign. The proximity of the Central Avenue approach to the next major intersection has challenges for right turning vehicles to safely turn onto Benning Road.

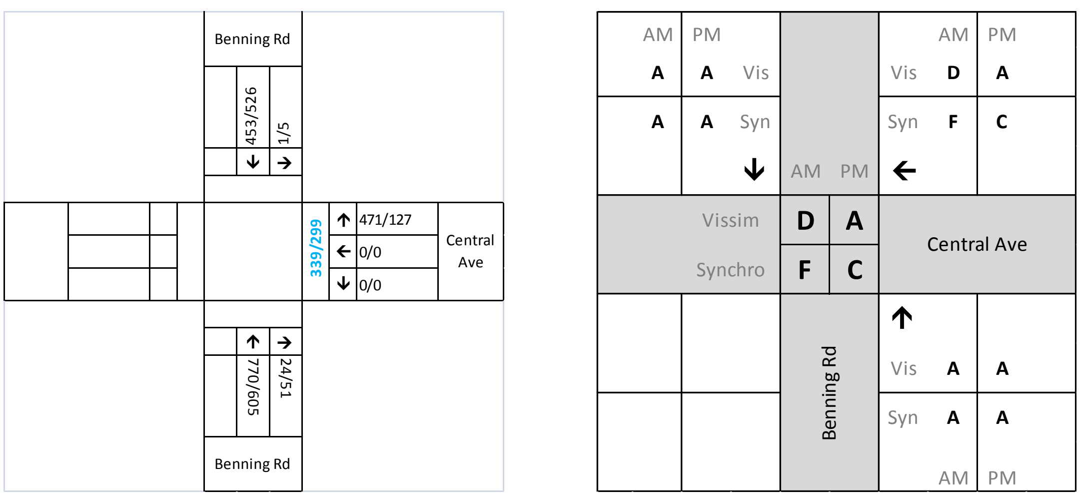
Due to the proximity of the intersection to the Benning Road Metro station, a higher volume of pedestrians were counted; 339 pedestrians and 299 pedestrians crossing the intersection in the morning and afternoon peak hours, respectively.

For the last 3 years, the accident rate at the intersection was 0.77 crashes per million vehicles, where 44% (8 accidents) were rear-end, 22% (4 accidents) were sideswipe and 5% (1 accident) were right angle accidents. There were three (3) pedestrians involved in accident and there were 6 crashes that resulted injury at the intersection.

The existing turning movement counts and LOS results from Synchro and VISSIM at the intersection of Benning Road and Central Avenue are shown in Figure 12 below. The VISSIM results indicate the intersection operates at acceptable LOS D and LOS A with current traffic demand during the AM and PM peak hour.

Figure 12: Existing Turning Movement Counts and Pedestrian Volumes (Left), and Traffic Analysis Results (Right) at Benning Road and Central Avenue

(XX/YY: AM Peak Hour Volume/PM Peak Hour Volume)



Parking restriction for eastbound and westbound Benning Road and in the immediate vicinity of the intersection is No Standing/Parking anytime. On Central Avenue between 47th and 46th Street, 2 Hour Parking is allowed between 7:00 – 8:30 PM (M-F) and there are Zipcar spaces between 46th Street and Benning Road.

12. Benning Road and East Capitol Street, NE

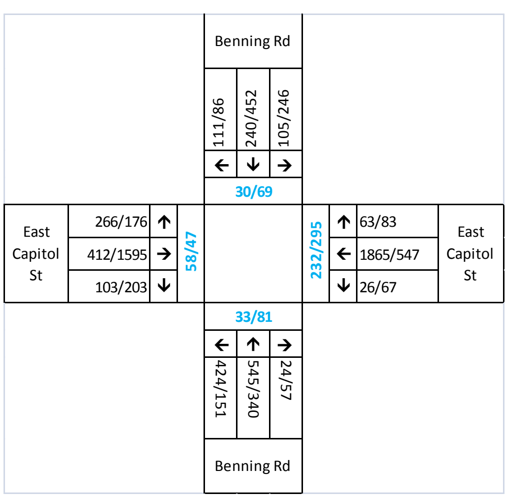
The intersection is controlled by a traffic signal and is operating under interval control with split phase operation. The metro station entrance and exit is located at the corner of Benning Road, East Capitol Street and Central Avenue intersection. The intersection is controlled by a traffic signal allowing overlaps and pedestrian movements at various interval operation. 353 pedestrians and 492 pedestrians in the morning and afternoon peak hours were counted crossing the intersection, respectively.

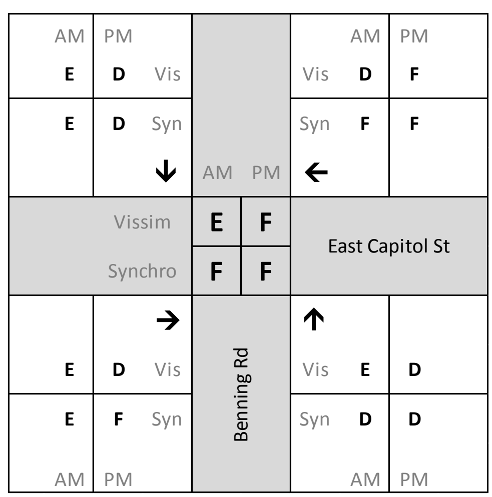
The intersection is one of the highest accident locations in the District. For the last 3 years, the accident rate at the intersection was 1.9 crashes per million vehicles where 26% (29 accidents) were rear-end, 26% (30 accidents) were sideswipe and 11% (13 accidents) were right angle accidents. There were nine (9) pedestrians and one (1) bicyclist was involved in the accident and there were 40 crashes that resulted injury at the intersection.

The existing turning movement counts and LOS results from Synchro and VISSIM at the intersection of Benning Road and Central Avenue are shown in Figure 13. The traffic analysis indicates the intersection fails with current traffic demand during peak hours. The intersection is currently operating with LOS E and LOS F during the AM and PM peak hour, respectively. High delays can be attributed to the heavy approach volumes at the intersection particularly in the westbound direction during the AM peak hour and eastbound during the PM peak hour. The existing lane configuration and signal timing is not optimal for traffic operation at the intersection. As shown in Table 3 and Table 5, westbound East Capitol Street experiences significant delays over 7 minutes during the PM peak hour due to the insufficient green time provided to this approach.

Figure 13: Existing Turning Movement Counts and Pedestrian Volumes (Left), and Traffic Analysis Results (Right) at Benning Road and East Capitol Street

(XX/YY: AM Peak Hour Volume/PM Peak Hour Volume)





Parking restriction for northbound and southbound Benning Road in the immediate vicinity of the intersection is No Standing/Parking anytime. See Table 7 below for more information. Figure 14 shows the on-street parking configuration in the study area.

Table 7: Summary of On-Street Parking Benning Road

From	To	Parking Restrictions	# Parking Spaces	Notes
East Bound				
Oklahoma Ave	Anacostia Ave	No Standing/Parking 4:00 – 6:30 PM (M-F)		
Anacostia Ave	Bridge Start	No Standing/Parking 4:00 – 6:30 PM (M-F)		
Bridge Start	Minnesota Ave	No Standing/Parking Anytime		
Minnesota Ave	39th Street	No Standing/Parking Anytime		
39th Street	42nd Street	No Standing/Parking 4:00 – 6:30 PM (M-F)	Approx 50 Spaces (assuming 20 feet/space)	Approx 1,000 Feet of available curb to use as parking during non-restricted time periods
42nd Street	Blaine Street	No Standing/Parking 4:00 – 6:30 PM (M-F)	22 Spaces	Sign for "Metrobus Loading Zone" but no bus stop flag. Took approximately 6 parking spaces on curb.
Blaine Street	44th Street	No Standing/Parking 7:00 – 9:30 AM; 4:00 – 6:30 PM (M-F)	5 Spaces	
44th Street	2nd Driveway	No Standing/Parking 7:00 – 9:30 AM; 4:00 – 6:30 PM (M-F)	3 Spaces	
2nd Driveway	East Capitol Street	No Standing/Parking Anytime		
West Bound				
East Capitol Street	Central Ave	No Standing/Parking Anytime		
Central Ave	45th Street	No Standing/Parking 7:00 – 9:30 AM; 4:00 – 6:30 PM (M-F)	6 Spaces	
45th Street	44th Street	No Standing/Parking 7:00 – 9:30 AM; 4:00 – 6:30 PM (M-F)	4 Spaces	
44th Street	42nd Street	No Standing/Parking 7:00 – 9:30 AM (M-F)	28 Spaces	
42nd Street	39th Street	No Standing/Parking 7:00 – 9:30 AM (M-F)	Approx 75 Spaces (assuming 20 feet/space)	Approx 1,500 Feet of available curb to use as parking during non-restricted time periods
39th Street	Minnesota Ave	No Standing/Parking Anytime		
Minnesota Ave	Bridge End	No Standing/Parking Anytime		
Bridge End	Oklahoma Ave	No Standing/Parking 7:00 – 9:30 AM (M-F)		

Central Avenue

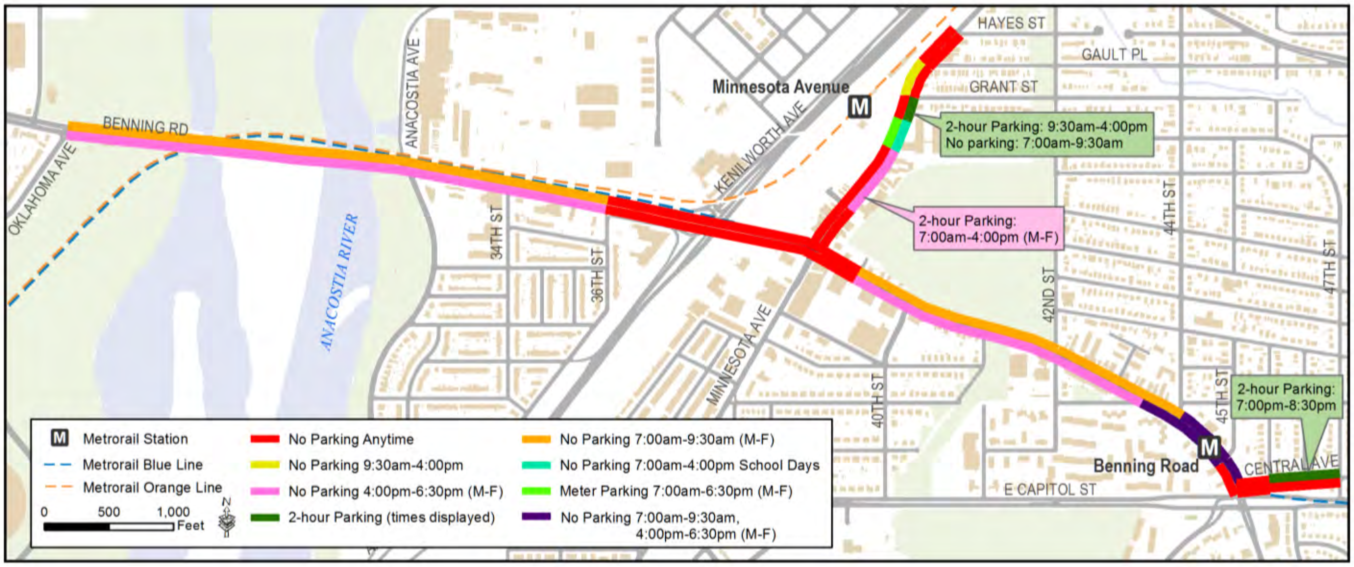
From	To	Parking Restrictions	# Parking Spaces	Notes
East Bound				
Benning Road	47th Street	No Standing/Parking Anytime		
West Bound				

From	To	Parking Restrictions	# Parking Spaces	Notes
47th Street	46th Street	2 Hour Parking 7:00 – 8:30 PM (M-F)	12 Spaces	
46th Street	Benning Road	Zip Car Parking Only	2 Spaces	

Minnesota Avenue

From	To	Parking Restrictions	# Parking Spaces	Notes
North Bound				
Benning Road	AutoZone Parking Lot	No Standing/Parking Anytime		
AutoZone Parking Lot	Strip Mall Parking Lot	2 Hour Meter Parking; No Parking 7:30 – 9:30 AM, 4:00 – 6:30 PM (M-F)	2 Spaces	
Strip Mall Parking Lot	School Zone	No Standing/Parking 4:00 – 6:30 PM (M-F); 2 Hour Parking 7 AM – 4 PM (M-F)	18 Spaces	
School Zone (approx bus exit)	School Zone (approx bus entrance)	No Parking 7 AM – 4 PM School Days	12 Spaces	
School Zone	Grant Street	2 Hour Parking Limit; 9:30 AM – 4 PM; No Parking 7 AM – 9:30 AM (M-F)	6 Spaces	
Grant Street	Hayes Street	No Standing/Parking Anytime		
South Bound				
Hayes Street	Gault Street	No Standing/Parking Anytime		No On-Street Parking;; Off Street Parking Lot for Metro Station
Gault Street	Bus Entrance	No Parking 9:30 AM – 4:00 PM	6 Spaces	
Bus Entrance	Bus Exit	No Standing/Parking Except Sundays	6 Spaces	
Bus Exit	Garage Entrance	4 Hour Meter Parking; 7:00 AM – 6:30 PM (M-F)	18 Spaces	
Garage Entrance	Benning Road	No Parking Except Sundays	6 Spaces	Large Scale Development Project

Figure 14: On-Street Parking Conditions



2040 No-Build Conditions

Traffic Demand Forecast

The Metropolitan Washington Council of Governments (MWCOG) Version 2.3 Model was used to compare and generate traffic volumes between the years 2012 and 2040 in order to analyze the regional traffic growth patterns. The results from the MWCOG Model show an average 0.86 percent annual growth rate along Benning Road and East Capitol Street between 2012 and 2040. This annual growth rate results in a total growth of 27 percent of existing traffic volumes from 2012 to 2040.

Field collected AM and PM peak hour turning movement counts were projected to the year 2040 based on an average annual growth rate of 0.86 percent. Signal timing was optimized for the intersection of Minnesota Avenue and Grant Street during the AM peak hour to provide better traffic operation in the 2040 No-Build condition. At the intersection of Benning Road and Minnesota Avenue, the following changes were made in the 2040 No-Build models:

- Changed the intersection from pre-timed signal control to actuated-coordinated signal control;
- Provided an exclusive right-turn lane on southbound Minnesota Avenue at Benning Road according to Minnesota Avenue, N.E. revitalization Project from A Street to Sheriff Road; and
- Restricted westbound left turns from Benning Road onto Minnesota Avenue to provide better traffic operation.

Analysis for the remaining intersections assumed the same geometries and traffic signal timings as the existing conditions to determine the 2040 No-Build peak hour conditions in the study area.

Figure 15 shows the projected turning movement volumes for 2040 No-Build conditions at each study intersection.

2040 No-Build Analysis Results

Table 8 and Table 9 present the MOE results for the 2040 No-Build AM peak hour conditions from Synchro and VISSIM, respectively. Table 10 and Table 11 present the MOE results for the 2040 No-Build PM peak hour conditions from Synchro and VISSIM, respectively. The average delay and LOS for each approach and for the intersection overall are provided for each study intersection. Detailed discussions of traffic operations at major intersections are presented in the subsequent sections.

Figure 15: Project Traffic Counts and Pedestrian Volumes in 2040 No-Build Condition (XX/YY: AM Peak Hour Volumes/PM Peak Hour Volumes)

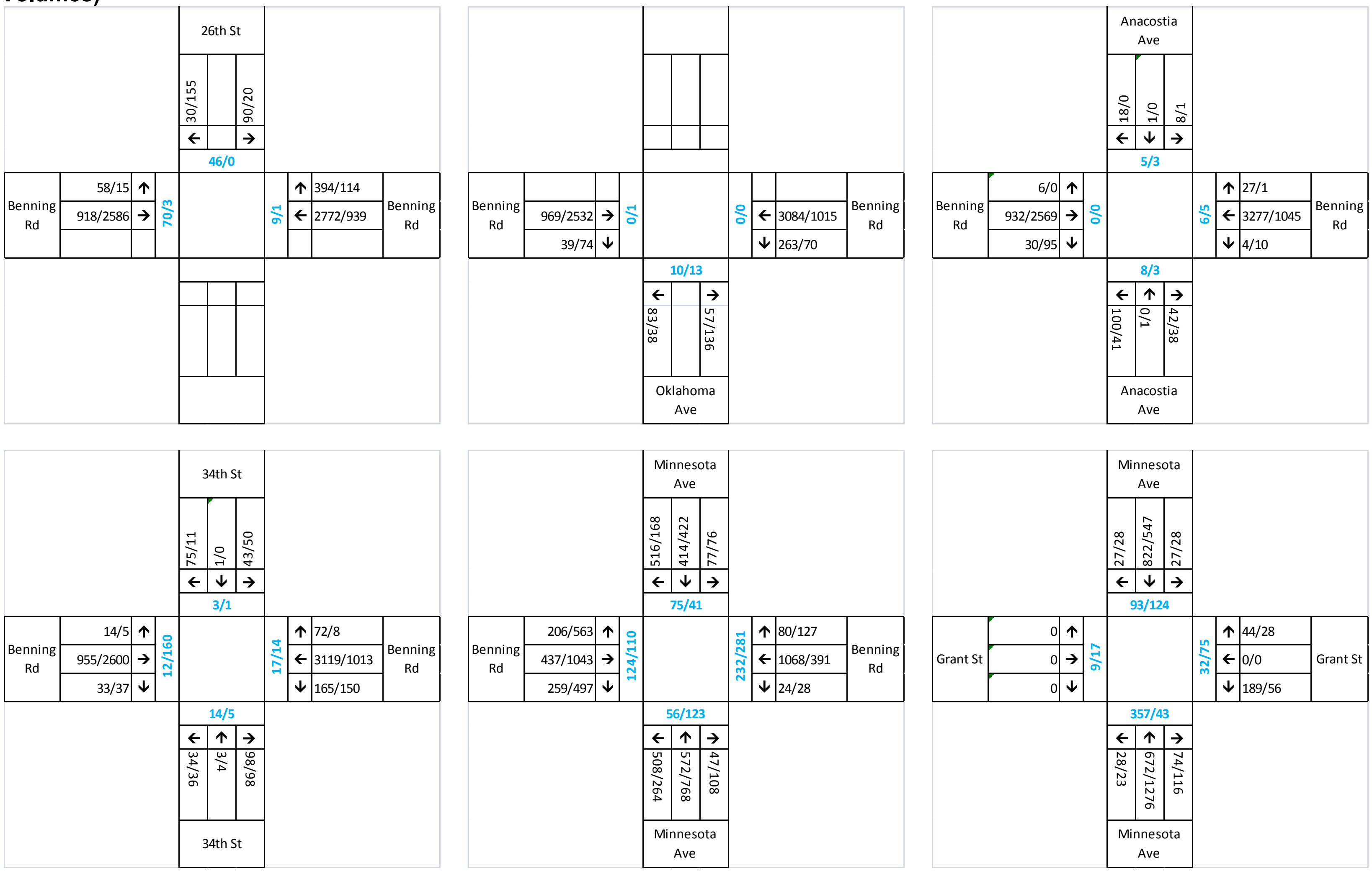


Figure 15: Project Traffic Counts and Pedestrian Volumes in 2040 No-Build Condition (XX/YY: AM Peak Hour Volumes/PM Peak Hour Volumes) (continued)

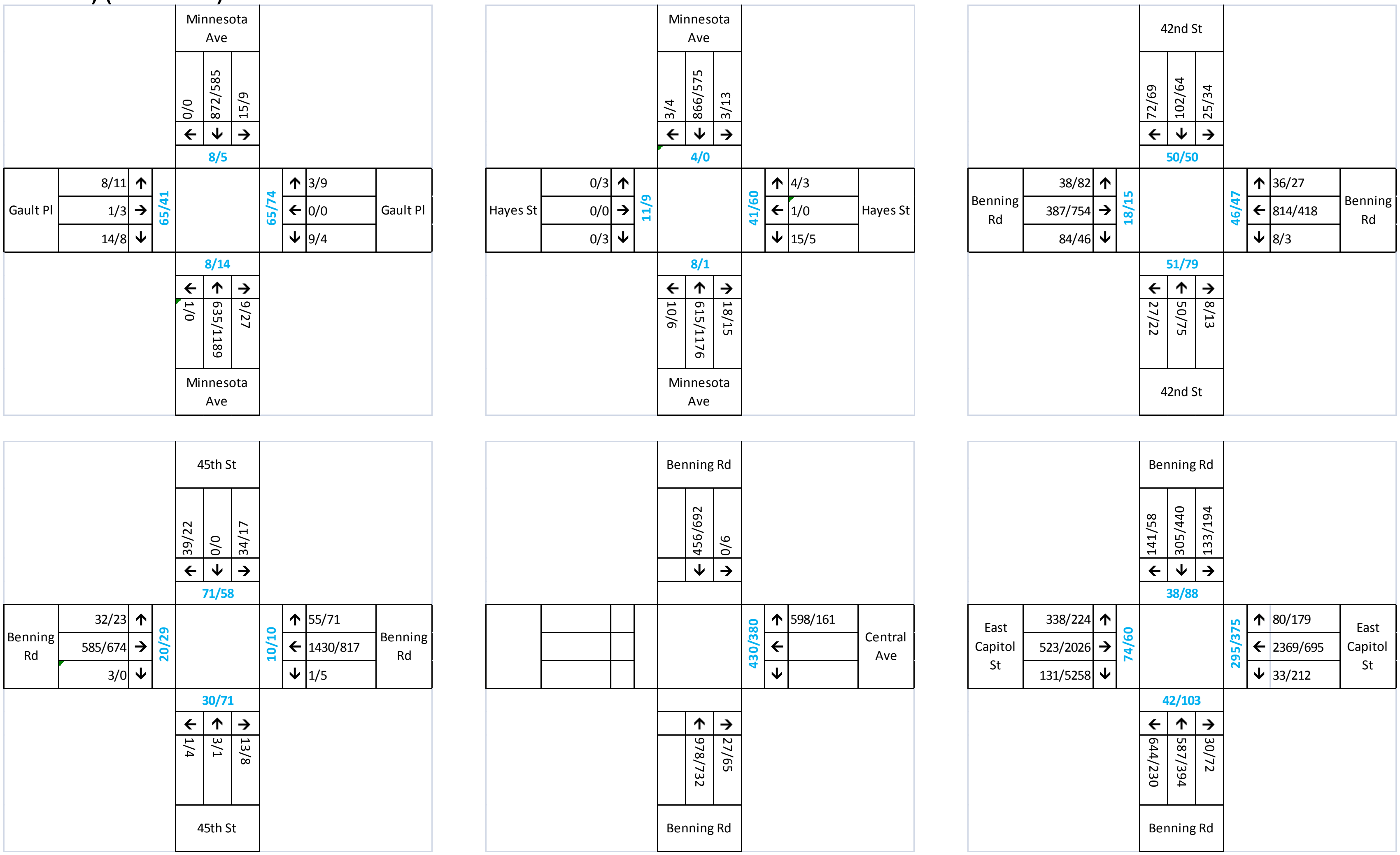


Table 8: 2040 No-Build AM Peak Hour Delay and LOS Conditions (Synchro)

No.	Intersection	Traffic Control	Intersection		Northbound		Southbound		Westbound		Eastbound	
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
1	Benning Road and 26th Street	Signalized	68.3	E	-	-	7.3	A	88.6	F	7.3	A
2	Benning Road and Oklahoma Avenue	Signalized	8.7	A	31.3	C	-	-	8.5	A	6.3	A
3	Benning Road and Anacostia Avenue	Signalized	8.5	A	37.4	D	36.6	D	9.0	A	1.7	A
4	Benning Road and 34th Street	Signalized	63.2	E	39.5	D	45.0	D	79.4	E	14.5	B
5	Benning Road and Minnesota Avenue	Signalized	191.7	F	218.2	F	124.9	F	342.6	F	37.0	D
6	Minnesota Avenue and Grant Street	Signalized	12.5	B	9.2	A	10.3	B	32.0	C	-	-
7	Minnesota Avenue and Gault Place	Unsignalized	46.1	E	0.0	A	0.3	A	36.5	E	46.1	E
8	Minnesota Avenue and Hayes Street	Unsignalized	32.6	D	0.2	A	0.0	A	32.6	D	-	-
9	Benning Road and 42nd Street	Signalized	14.8	B	23.7	C	26.4	C	13.2	B	11.5	B
10	Benning Road and 45th Street	Unsignalized	574.8	F	0.0	A	2.2	A	574.8	F	32.3	D
11	Benning Road and Central Avenue	Unsignalized	571.2	F	0.0	A	0.0	A	571.2	F	-	-
12	Benning Road and E Capitol Street	Signalized	216.6	F	90.3	F	84.2	F	356.1	F	105.5	F

The Synchro results indicate acceptable LOS D or better conditions at four signalized and one unsignalized intersection in the study area during the year 2040 AM peak hour. The LOS at the intersections of Benning Road and 26th street, Benning Road and 34th street, and Minnesota Avenue and Gault Place downgrade from LOS A and LOS C, respectively, in the existing condition to LOS E for both in the 2040 No-Build condition due to the regional traffic growth during the AM peak hour. Westbound Benning Road experiences long delays at 26th Street and 34th Street. The intersection of Benning Road and Minnesota Avenue continues to operate under LOS F, with 191.7 sec/veh intersection delay in the 2040 No-Build condition. Northbound, southbound and westbound approaches at the intersection all experience delays more than two minutes. The three adjacent intersections along Benning Road – 45th Street, Central Avenue and East Capitol Street – all operate with LOS F during the AM peak hour. The westbound approach along East Capitol Street experiences the highest delays of approximately six minutes at the intersection of Benning Road and East Capitol Street.

All the other intersections and their approaches show acceptable LOS D or better conditions with delays less than 55 sec/veh at signalized intersections and 50 sec/veh at unsignalized intersections.

Table 9: 2040 No-Build AM Peak Hour Delay and LOS Conditions (VISSIM)

No.	Intersection	Traffic Control	Intersection Delay	Intersection LOS	Northbound Delay	Northbound LOS	Southbound Delay	Southbound LOS	Westbound Delay	Westbound LOS	Eastbound Delay	Eastbound LOS
1	Benning Road and 26th Street	Signalized	7.2	A	-	-	32.3	C	5.6	A	9.1	A
2	Benning Road and Oklahoma Avenue	Signalized	15.3	B	26.7	C	-	-	18.2	B	4.7	A
3	Benning Road and Anacostia Avenue	Signalized	4.2	A	34.5	C	24.0	C	2.6	A	4.4	A
4	Benning Road and 34th Street	Signalized	20.4	C	19.3	B	22.1	C	22.8	C	12.1	B
5	Benning Road and Minnesota Avenue	Signalized	123.0	F	37.9	D	213.1	F	117.4	F	139.2	F
6	Minnesota Avenue and Grant Street	Signalized	16.9	B	11.8	B	12.2	B	51.4	D	-	-
7	Minnesota Avenue and Gault Place	Unsignalized	6.7	A	0.2	A	1.0	A	6.7	A	6.4	A
8	Minnesota Avenue and Hayes Street	Unsignalized	7.6	A	0.4	A	0.1	A	7.6	A	-	-
9	Benning Road and 42nd Street	Signalized	11.3	B	36.1	D	33.9	C	6.2	A	6.6	A
10	Benning Road and 45th Street	Unsignalized	254.9	F	0.3	A	254.9	F	28.9	D	43.6	E
11	Benning Road and Central Avenue	Unsignalized	73.7	F	0.0	A	99.1	F	73.7	F	-	-
12	Benning Road and E Capitol Street	Signalized	203.6	F	228.7	F	709.3	F	147.9	F	126.2	F

The VISSIM results indicate acceptable LOS D or better conditions at six signalized and two unsignalized intersections in the study area during the year 2040 AM peak hour. The traffic operation at Benning Road and East Capitol Street intersection downgrades from LOS E in the existing condition to LOS F, with 203.6 sec/veh intersection delay in the 2040 No-Build condition. All the approaches at this intersection experience significant delays while southbound traffic experiences the highest delay of 11.8 minutes. The southbound queue backs up beyond 45th Street and impacts the traffic operation at 45th Street and Central Avenue. As a result, both of the intersections operated at LOS F during the AM peak hour. Due to the restrictions of the geometry at the intersection of Benning Road and East Capitol Street, all approaches are assumed to operate under split phases in the future condition, same as in the existing condition. The inefficient signal operations as well as the regional demand growth result in the operational failure at the intersection of Benning Road and East Capitol Street in the 2040 No-Build condition.

Benning Road at its intersection with Minnesota Avenue also shows unacceptable LOS F, with 123.0 sec/veh intersection delay. This delay can be attributed to the limited capacity of the existing lane configuration, which is not capable of handling the future demand growth during the AM peak hour in the 2040 No-Build condition.

All the other intersections and their approaches show acceptable LOS D or better conditions, with delays less than 55 sec/veh at signalized intersections and 50 sec/veh at unsignalized intersections.

Table 10: 2040 No-Build PM Peak Hour Delay and LOS Conditions (Synchro)

No.	Intersection	Traffic Control	Intersection Delay	Intersection LOS	Northbound Delay	Northbound LOS	Southbound Delay	Southbound LOS	Westbound Delay	Westbound LOS	Eastbound Delay	Eastbound LOS
1	Benning Road and 26th Street	Signalized	5.9	A	-	-	39.0	D	1.4	A	5.5	A
2	Benning Road and Oklahoma Avenue	Signalized	15.6	B	27.1	C	-	-	12.1	B	16.2	B
3	Benning Road and Anacostia Avenue	Signalized	1.9	A	38.0	D	36.8	D	3.0	A	0.3	A
4	Benning Road and 34th Street	Signalized	17.2	B	39.5	D	36.3	D	15.8	B	16.3	B
5	Benning Road and Minnesota Avenue	Signalized	100.7	F	38.2	D	39.3	D	202.0	F	127.6	F
6	Minnesota Avenue and Grant Street	Signalized	11.6	B	12.1	B	8.3	A	27.4	C	-	-
7	Minnesota Avenue and Gault Place	Unsignalized	278.8	F	0.0	A	0.4	A	73.5	F	278.8	F
8	Minnesota Avenue and Hayes Street	Unsignalized	50.5	F	0.1	A	0.4	A	50.5	F	23.1	C
9	Benning Road and 42nd Street	Signalized	15.3	B	24.2	C	25.5	C	10.7	B	14.7	B
10	Benning Road and 45th Street	Unsignalized	52.6	F	0.2	A	0.7	A	52.6	F	27.1	D
11	Benning Road and Central Avenue	Unsignalized	23.7	C	0.0	A	0.2	A	23.7	C	-	-
12	Benning Road and E Capitol Street	Signalized	158.6	F	116.6	F	122.0	F	196.0	F	164.8	F

The Synchro results indicate acceptable LOS D or better conditions at seven signalized and one unsignalized intersection in the study area during the PM peak hour in the year 2040 No-Build condition. The traffic operation at the intersection of Benning Road and Minnesota Avenue downgrades from LOS D in the existing condition to LOS F in the 2040 No-Build condition due to the regional traffic growth and limited roadway capacity. The results at the stop controlled intersections of Minnesota Ave and Gault Place, and Minnesota Avenue and Hayes Street show unacceptable LOS F conditions, with 278.8 sec/veh and 50.5 sec/veh delay, respectively, along the stop controlled approaches. The intersection of Benning Road and East Capitol Street continues to operate at LOS F during the PM peak hour, and all approaches experience delays more than 100 seconds. At the intersection of Benning Road and 45th street, the delays for the stop controlled approach exceeds the capacity due to heavy vehicular demand on Benning Road as well as limited availability of acceptable gaps for vehicles on 45th street to enter Benning Road.

All the other intersections and their approaches show acceptable LOS D or better conditions, with delays less than 55 sec/veh at signalized intersections and 50 sec/veh at unsignalized intersections.

Table 11: 2040 No-Build PM Peak Hour Delay and LOS Conditions (VISSIM)

No.	Intersection	Traffic Control	Intersection Delay	Intersection LOS	Northbound Delay	Northbound LOS	Southbound Delay	Southbound LOS	Westbound Delay	Westbound LOS	Eastbound Delay	Eastbound LOS
1	Benning Road and 26th Street	Signalized	8.1	A	-	-	42.3	D	2.8	A	8.1	A
2	Benning Road and Oklahoma Avenue	Signalized	4.5	A	21.6	C	-	-	5.9	A	2.8	A
3	Benning Road and Anacostia Avenue	Signalized	4.5	A	23.0	C	35.0	D	3.5	A	4.4	A
4	Benning Road and 34th Street	Signalized	16.8	B	25.2	C	31.9	C	16.8	B	16.1	B
5	Benning Road and Minnesota Avenue	Signalized	42.7	D	39.9	D	37.9	D	42.2	D	45.8	D
6	Minnesota Avenue and Grant Street	Signalized	11.2	B	0.0	A	10.2	B	38.2	D	-	-
7	Minnesota Avenue and Gault Place	Unsignalized	6.7	A	0.7	A	0.6	A	6.4	A	6.7	A
8	Minnesota Avenue and Hayes Street	Unsignalized	5.9	A	0.4	A	0.2	A	5.9	A	-	-
9	Benning Road and 42nd Street	Signalized	11.0	B	34.8	C	31.7	C	5.1	A	7.1	A
10	Benning Road and 45th Street	Unsignalized	257.9	F	0.3	A	257.9	F	29.1	D	43.2	E
11	Benning Road and Central Avenue	Unsignalized	95.6	F	0.0	A	95.6	F	3.9	A	-	-
12	Benning Road and E Capitol Street	Signalized	237.4	F	157.3	F	342.2	F	469.7	F	158.1	F

The VISSIM results indicate acceptable LOS D or better conditions at seven signalized and two unsignalized intersections in the study area during the year 2040 PM peak hour. The traffic operation at the Benning Road and East Capitol Street intersection downgrades from LOS E in the existing condition to LOS F during the PM peak hour in the 2040 No-Build condition. All the approaches at this intersection experience significant delays while westbound traffic experiences the highest delay of 7.8 minutes (469.7 seconds). The southbound queue backs up beyond 45th Street and impacts the traffic operation at 45th Street and Central Avenue. As a result, both of the intersections operate at LOS F during the PM peak hour. Due to the restrictions of the geometry at the intersection of Benning Road and East Capitol Street, all approaches are assumed to operate under split phases in the future condition, same as in the existing condition. The inefficient signal operations as well as the regional demand growth result in the operational failure at the intersection of Benning Road and East Capitol Street in the 2040 No-Build condition.

All the other intersections and their approaches show acceptable LOS D or better conditions, with delays less than 55 sec/veh at signalized intersections and 50 sec/veh at unsignalized intersections.

2040 No-Build Conditions Analysis Summary

1. Benning Road and Minnesota Avenue, NE

During the AM peak hour, the intersection of Benning Road and Minnesota Avenue is projected to operate at LOS F, with the overall intersection delay of 123.0 seconds. Delays in the AM are attributed to the high traffic demand going westbound into downtown and limited existing roadway capacity during the AM peak hour.

2. Benning Road and East Capitol Street, NE

The intersection of Benning Road and East Capitol Street is projected to experience long delays during both AM and PM peak hours. These delays can mainly be attributed to inefficient traffic operations at the intersection. The existing geometry restricts the possibility of running the eastbound and westbound traffic on East Capitol Street concurrently and the northbound and southbound traffic on Benning Road concurrently, resulting in long wait times for all vehicles at the intersection. The congestion at this intersection also impacts the traffic operation at Central Avenue and 45th Street, which experiences LOS F during both AM and PM peak hours.

The remaining intersections operate under acceptable LOS D or better during the AM and PM peak hours in the 2040 No-Build condition.

Potential Mitigations

Minnesota Avenue and Benning Road

Improvements that could potentially mitigate the delays and improve the traffic operation at the Benning Road and Minnesota Avenue intersection in 2040 are as follows:

- Add an additional left-turn lane for northbound approach;
- Add an exclusive right-turn lane on westbound Benning Road (bus stop will be relocated on the right-turn lane); and
- Broader consideration of the transportation network, including creating new links and travel patterns.

Based on the 2040 No-Build analysis results and understanding of projected future intersection failure, the technical memorandum recommends that DDOT conduct further study to improve the operations of the intersection. Operational improvements would be needed to accommodate 2040 traffic demand as well as proposed streetcar operations and stop location at the intersection of Benning Road and Minnesota Avenue.

Benning Road and East Capitol Street

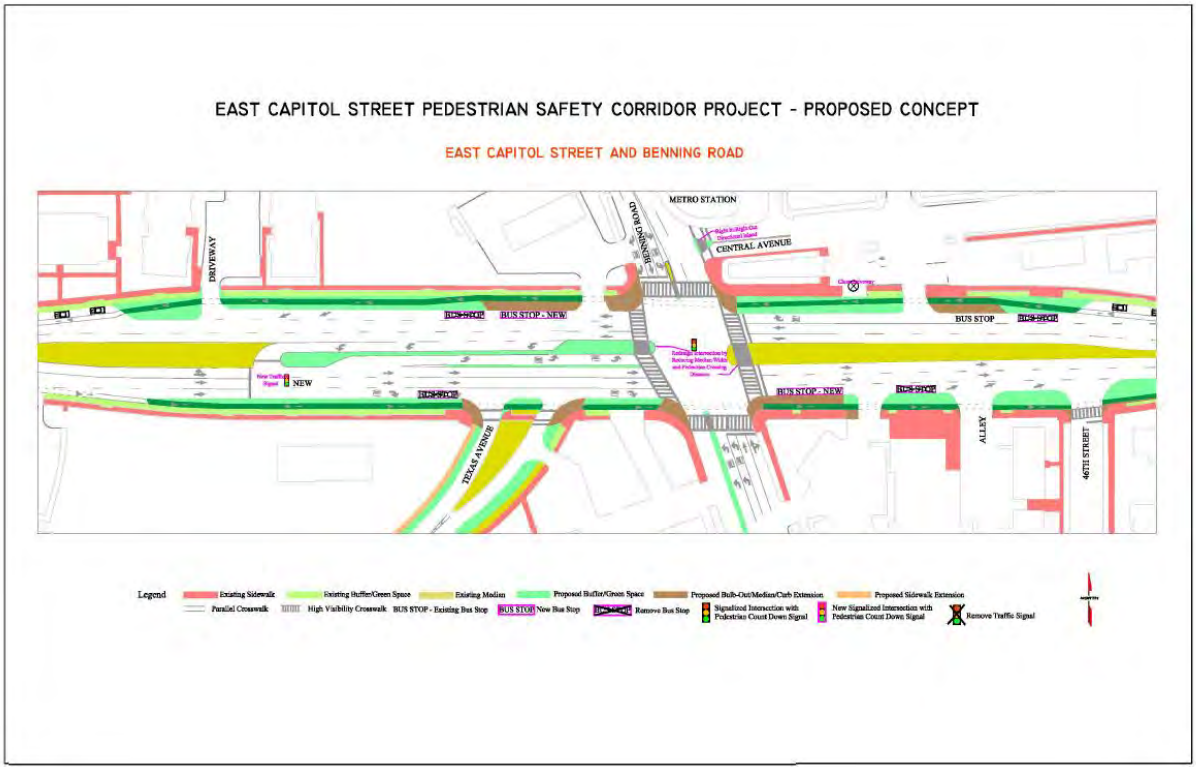
Improvements that could potentially mitigate delays and improve traffic operation at the Benning Road and East Capitol Street intersection in 2040 are as follows:

- Change the intersection from pre-timed signal control to actuated signal control;
- Change the diamond operations with overlaps to a concurrent standard four-legged signalized intersection phase operation;
- Remove part of the median by pulling back the East Capitol Street stop bar to provide sufficient radius for opposing left-turning vehicles to run concurrently;

- Remove the left turn from East Capitol Street to Texas Avenue;
- For the northbound Benning Road approach, increase the left turn storage length to 350 feet and add an additional left-turn lane;
- For the eastbound East Capitol Street approach, increase the left-turn lane storage length to 250 feet and add an additional left-turn lane; and
- For the westbound East Capitol Street approach, add a left-turn lane with storage length of 250 feet.

As part of East Capitol Pedestrian Safety Corridor study, DDOT developed a concept plan to improve the intersection operation (see Figure 16).

Figure 16: Proposed Lane Configurations at Benning Road and East Capitol Street (DDOT)



Source: *East Capitol Street Pedestrian Safety Project – Proposed Concept for East Capitol Street between Stoddert Place and Southern Avenue* (DDOT 2012).

Based on the analysis results and understanding of the projected future intersection failure, the technical memorandum recommends that DDOT conduct further study and coordination to improve the capacity of the intersection. The improvements are needed to accommodate 2040 traffic demand as well as proposed streetcar operations and stop location at the intersection of Benning Road and East Capitol Street.

2040 Build Condition

This section discusses potential traffic impacts from operations of the proposed Benning Road Streetcar Extension for each of the terminus alternatives under consideration.

Minnesota Avenue Metro Terminus Alternative

The Minnesota Avenue Metro Station terminus alternative has four proposed stop locations: Kingman Island, the 34th Street Intersection, the Minnesota Avenue Intersection, and the Minnesota Avenue Metro Station.

26th Street and Oklahoma Avenue (X1 and X2 Options)

The connection of the Benning Road Streetcar Extension to the H/Benning Streetcar Line under construction has two options for the car barn spur and westbound transition. The existing embedded tracks currently terminate east of Oklahoma Avenue near the entrance to the RFK Stadium parking lot, with the final stop in the median between 26th Street and Oklahoma Avenue.

X.1 Oklahoma Westbound Transition

X.2 Oklahoma Westbound Transition

Option X1 uses an unsignalized transition between the existing tracks and extended tracks along westbound Benning Road. The westbound existing tracks east of the Oklahoma Avenue intersection are located to the north of the left-turn lane on Benning Road to allow for westbound traffic to turn onto Oklahoma Avenue. To reach the existing tracks, westbound streetcars on the Benning Road Streetcar Extension segment must transition from the inner median lane on the Benning Bridge (Anacostia River Bridge) to one lane north. In this option, westbound traffic on Benning Road would merge from three lanes to two lanes when approaching the end of the bridge to allow the streetcar to transition. Eastbound streetcars remain in the inner median lane as constructed. The spur to the proposed car barn in this option has eastbound and westbound streetcars merging to a single curbside track as they turn onto 26th Street from Benning Road. This configuration would require a dedicated lane on 26th Street, narrowing the existing roadway. This option does not require additional signal controls on 26th Street to protect the streetcar transition.

In **Option X2**, westbound streetcars transition from the inner median lane to one lane north at a signalized intersection at the RFK stadium parking entrance east of Oklahoma Avenue to avoid the westbound traffic merge after the bridge. Eastbound streetcars remain in the inner median lane as constructed. The spur to the proposed car barn in this option has both eastbound and westbound streetcars transitioning from the median lane on Benning Road to their own curb lanes on 26th Street at the intersection and then merging to a single track as they turn off of 26th Street into the car barn. Traffic would have to be stopped on 26th Street to allow the streetcars to turn into the car barn, but all traffic lanes could be shared. The westbound turn would require additional right-of-way to make the turn onto 26th Street and could impact the existing bus stop and streetcar stop.

For both Options X1 and X2, the westbound stop bar on Benning Road at 26th Street intersection would need to be relocated upstream to allow the proposed streetcar westbound track alignment from Benning Road to northbound 34th Street to access the car barn. A transit phase would be needed to protect this streetcar transition and all the vehicular traffic would be stopped at the intersection when the streetcars make the turns. As the streetcar transition into the car barn would generally occur during the off-peak hours, the traffic impacts from the streetcar transition at 26th Street are not analyzed in this study. During regular operations, the eastbound and westbound streetcars would continue through the intersection along Benning Road, and there would be no need for an additional transit phase, as streetcars would share the general traffic phase.

Tables 12, 13 and 14 show the projected delays and LOS at the intersections of 26th Street and Benning Road, and Oklahoma Avenue and Benning Road, and at the new intersection of Benning Road and the RFK stadium parking driveway for Options X1 and X2. Tables 12 and 13 include existing and 2040 No-Build results for comparison purposes.

The results indicate that vehicles experience similar delays in Option X1 and Option X2 during the AM and PM peak hours. The maximum traffic volume that can be processed at the bottleneck, where three through lanes reduce to two through lanes in Option X1, is approximately 3,500 vehicles per hour based on the sensitivity analysis in the VISSIM simulation. If the traffic demand continues to grow with the same growth rate (0.86 percent), the traffic in Option X1 is likely to fail in 2045 during the AM peak hour.

Table 12: Delay and LOS at the Intersection of Oklahoma Avenue and Benning Road

		AM									
		Intersection		Northbound		Southbound		Westbound		Eastbound	
Option		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing		9.4	A	23.5	C	-	-	10.4	B	4.5	A
2040 No Build		13.6	B	26.4	C	-	-	15.9	B	4.7	A
2040 Build	X1	13.8	B	27.1	C	-	-	16.1	B	4.7	A
	X2	11.3	B	27.3	C	-	-	12.8	B	4.6	A
		PM									
		Intersection		Northbound		Southbound		Westbound		Eastbound	
Option		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing		4.1	A	17.5	B	-	-	5.1	A	2.8	A
2040 No Build		4.6	A	21.8	C	-	-	6.1	A	2.8	A
2040 Build	X1	4.5	A	21.6	C	-	-	6.1	A	2.7	A
	X2	5.7	A	29.0	C	-	-	6.3	A	3.9	A

Table 13: Delay and LOS at the Intersection of 26th Street and Benning Road

Option		Intersection Delay	Intersection LOS	Northbound Delay	Northbound LOS	Southbound Delay	Southbound LOS	Westbound Delay	Westbound LOS	Eastbound Delay	Eastbound LOS
AM											
Existing		7.1	A	-	-	33.0	C	5.7	A	8.3	A
2040 No Build		7.2	A	-	-	32.3	C	5.6	A	9.1	A
2040 Build	X1	7.3	A	-	-	31.9	C	5.7	A	9.5	A
	X2	7.1	A	-	-	32.1	C	5.3	A	9.7	A
PM											
Existing		6.5	A	-	-	43.1	D	2.4	A	5.9	A
2040 No Build		8.1	A	-	-	42.3	D	2.8	A	8.1	A
2040 Build	X1	8.3	A	-	-	42.0	D	2.8	A	8.4	A
	X2	9.2	A	-	-	42.5	D	3.7	A	9.5	A

Table 14: Delay and LOS at the New Signalized Intersection at the RFK Stadium Parking Driveway

Option		Intersection Delay	Intersection LOS	Northbound Delay	Northbound LOS	Southbound Delay	Southbound LOS	Westbound Delay	Westbound LOS	Eastbound Delay	Eastbound LOS
AM											
2040 Build	X2	8.0	A	39.9	D	-	-	8.8	A	1.7	A
PM											
2040 Build	X2	4.7	A	39.9	D	-	-	5.4	A	2.5	A

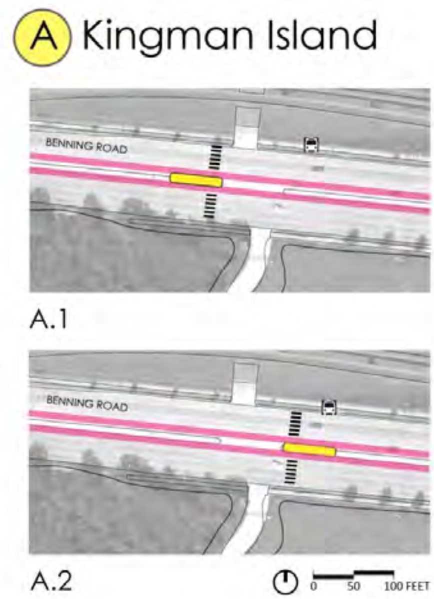
Table 15 below lists the pros and cons for each build option.

Table 15: Pros and Cons of Build Options X1 and X2

Build Option	Pros	Cons
X1	• Does not require signalizing a new intersection at the RFK Stadium Parking entrance for streetcar transition, which would reduce operating and maintenance costs of streetcar operations.	• Reduces the number of general traffic lanes from three to two on westbound Benning Road, creating a bottleneck for traffic. The bottleneck would result in delays and queues when the traffic volumes reach 3,500 vehicles per hour.
X2	• Maintains the existing three through lanes along westbound Benning Road, providing higher roadway capacity than in Option X1.	• Requires signalizing a new intersection at the RFK Stadium Parking entrance for the streetcar transition, which would increase the operating and maintenance costs of streetcar operations.

Kingman Island (A1 and A2 Options)

A streetcar stop on Kingman Island will offer access to the Langston Golf Course Driving Range, the future environmental education center, and the various events held on the island.



Both eastbound and westbound streetcars would be in the dedicated median lane over the Benning Bridge. **Option A1** assumes a median stop west of the entrances to the driving range and Kingman Island trail, providing direct access to these destinations. **Option A2** assumes the stop to be located east of the entrance to the driving range and Kingman Island trail. A pedestrian crosswalk and pedestrian signals are required to serve the median stop. During both the AM and PM peak hours, the pedestrian signal would operate with a 100-second cycle length to be coordinated with the intersections at Oklahoma Avenue and 26th Street. Eastbound left turns into the golf range and westbound left turns would be prohibited and the access to the driving range would be restricted to right-in/right-out movements.

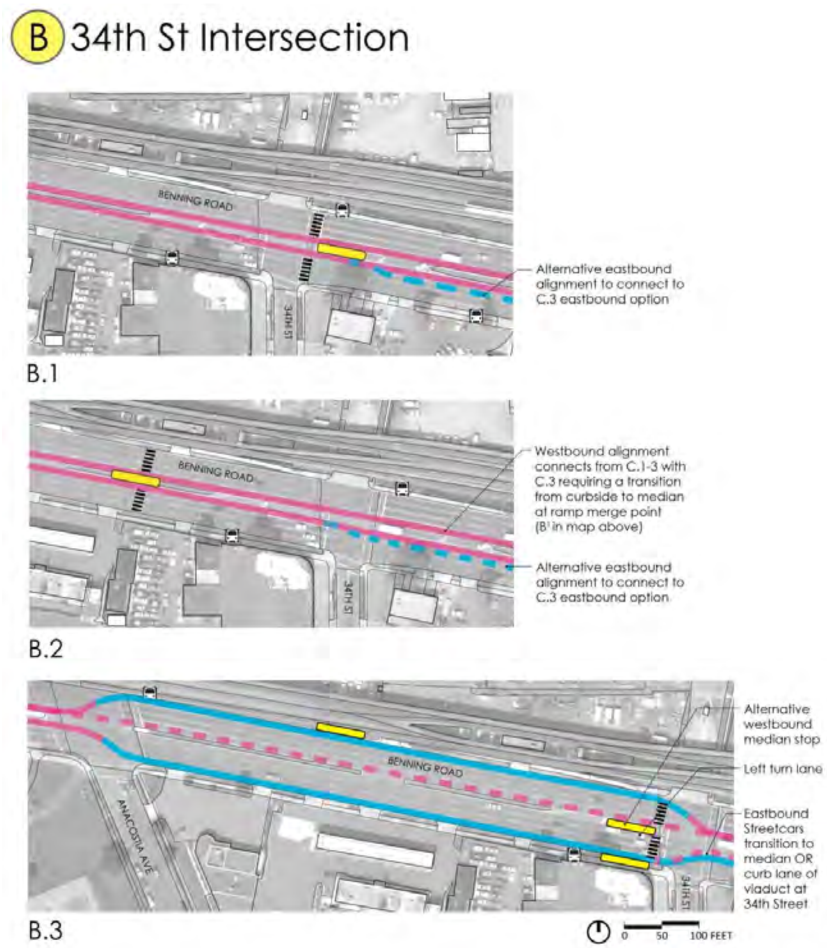
Table 16 lists vehicle delays and LOS for the proposed intersection at Kingman Island under the 2040 Build conditions. The results indicate that vehicles would experience similar delays in Option A1 and Option A2. Option A1 might be slightly more preferred than Option A2 as the streetcar stop is staggered with the curb-side bus stop.

Table 16: Delays and LOS at New Signalized Intersection of Kingman Island Access

Option		Intersection Delay	Intersection LOS	Northbound Delay	Northbound LOS	Southbound Delay	Southbound LOS	Westbound Delay	Westbound LOS	Eastbound Delay	Eastbound LOS
AM											
2040 Build	A1	16.7	B	-	-	-	-	19.4	B	8.3	A
	A2	13.3	B	-	-	-	-	9.5	A	14.8	B
PM											
2040 Build	A1	16.8	B	-	-	-	-	19.6	B	8.5	A
	A2	13.3	B	-	-	-	-	9.4	A	14.8	B

34th Street Intersection (B1, B2 and B3 Options)

Major destinations in the River Terrace neighborhood include the Pepco plant directly north of Benning Road and mixed commercial uses along the south side of Benning Road. Beyond the commercial strip to the south is the River Terrace Elementary School and River Terrace residential neighborhood. The *Benning Road Corridor Redevelopment Framework Plan* identified a number of parcels for redevelopment in the long term to include retail, small office, and potentially an inter-generational recreation center. A streetcar stop around the intersection of 34th Street would provide the most direct access to the Pepco Plant, the existing commercial area, and potential future development.



The streetcars would run in mixed traffic along Benning Road east of Anacostia Avenue.

Option B1 assumes a median stop east of 34th Street which would provide direct access to the intersection. Streetcars would be in the center median lanes as they travel from or approach the Benning Viaduct. Eastbound streetcars could remain in center median lane after the east median stop or transition after the stop one lane to the south to put them on the curb lane of the viaduct. The transition would require stopping all eastbound through traffic at 34th Street. Westbound streetcars would be in the center median lane from the viaduct or would have transitioned from the curb lane to the median lane at the ramp merge point (see Diagram B^1 on the following page) east of 36th street.

The following assumptions were applied in the VISSIM models for Build Option B1 at the intersection of 34th Street and Benning Road:

- Eliminate the westbound left-turn bay to accommodate the streetcar stop;
- Modify the lane configuration on the westbound approach to have the westbound left turn shared with the through lane;
- Retain the protected westbound left turn phase which runs concurrently with the eastbound left turn phase;
- Retain the pre-timed traffic control while optimizing the signal timing; and
- Provide a transit phase of 10-seconds for the eastbound streetcar transition after the stop.

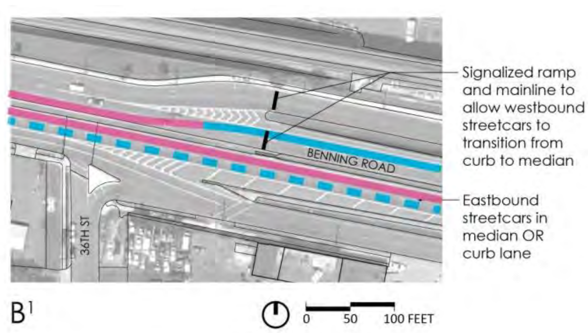
The advantage of Option B1 is that no additional cross-walk would need to be provided to serve the transit stop. Pedestrians could access the transit stop using the existing pedestrian cross-walk. The disadvantage of Option B1 is that the westbound traffic would be delayed due to the revised lane configuration and streetcar operations. As the westbound left turn would share the through lane, the leading protected left turn phase for the westbound approach might not be utilized if the first vehicle at the stop bar is a through vehicle when the protected left-turn phase is active. The westbound left turn vehicle would also block the through traffic and streetcars while waiting at the intersection to make the turn. The other option of the signal operation is to make the intersection operate under lead-lag left turn operation; that is, westbound through and left turn phases starting at the same time and followed by a lagging eastbound left turn phase. This signal operation could effectively reduce the traffic and streetcar delays for the westbound approach. However, it would create the “yellow-trap” for the westbound left-turning vehicles, which could be addressed by the flashing yellow treatment.

Option B2 assumes a median stop located approximately 250 feet west of 34th Street. A mid-block pedestrian crosswalk and pedestrian signals would be required to provide access to the station platform. The pedestrian signal is coordinated with the 34th Street and Benning Road intersection. Streetcars would be in the center median lane as they travel from or approach the Benning Viaduct. Eastbound streetcars could transition one lane to the south at the 34th street intersection to be on the curb lane of the viaduct. A 10-second transit phase would be provided to allow for eastbound streetcar transition. Westbound streetcars would be in the center median lane from the viaduct or would have transitioned from the curb lane to the median lane at the ramp merge point east of 36th street (see B^1).

Option B3 assumes curb-side streetcar stops between Anacostia Avenue and 34th Street in both directions along Benning Road. The westbound streetcar stop is located in the midblock between 34th Street and Anacostia Avenue, and the eastbound stop is located west of 34th Street. To serve the curb stops, streetcars in both directions require a transition at Anacostia Avenue and 34th Street. The transition distance and time should be long enough for streetcars to transition across three lanes. A transition distance of 200 feet is assumed in the simulation model based on the streetcar transition speed of 5 mph. A transit phase of 20 seconds is provided for each transition. The streetcar transition causes conflicts with traffic in the same direction and does not conflict with traffic in the opposing direction. Option B3 also requires moving the westbound stop bar further east by 70 feet at the intersection of Anacostia Avenue and Benning Road. This would provide sufficient distance for the streetcars to complete the transitions before reaching the elevated and dedicated transit-way on the Benning Viaduct; however, this configuration would require longer clearance time for the westbound vehicular traffic. In Option B3, streetcars and vehicles would experience more delays due to the streetcar transition, and the midblock stop in the westbound direction would increase the walk time of pedestrians to cross Benning Road.

Alternatively, the westbound streetcar would remain in the median lane along Benning Road between 34th Street and Anacostia Avenue. The alternative alignment assumes a median stop west of 34th Street for the westbound streetcars. This option would effectively reduce streetcar and vehicle delays on the westbound approach, reduce the pedestrian walk time from the stop to the 34th Street intersection, and retain the existing location of westbound stop bars at Anacostia Avenue. However, this option requires removing the eastbound left turn bay at 34th Street to accommodate the streetcar stop. The eastbound left turn would share the through lane while the protected phase for the left turn would be retained. The left turning vehicles would block streetcars and eastbound through traffic while waiting to turn. A new pedestrian crosswalk would be required to provide access to the westbound median stop. The pedestrian phase would run concurrently with northbound traffic phase while the left-turning vehicles yield to pedestrians.

At the ramp merge point (see Diagram B^1), westbound streetcars transition from the curb lane to the center median lane on Benning Road. Both the ramp and mainline are signalized to allow the streetcars to make this transition. A transit phase of 10-second should be provided for the westbound streetcar to complete the transition, which would cause extra delays for the through traffic along Benning Road. Eastbound streetcars could travel in either the median or curb lane.



B^1

Tables 17 and 18 show the vehicle delays and LOS results for the intersections of 34th Street and Benning Road, and Anacostia Avenue and Benning Road, respectively, for all Build options. The tables include results relevant to Existing, 2040 No Build and 2040 Build conditions.

The intersection of 34th Street and Benning Road would experience the highest delays during the AM peak hour in Option B1 due to the removal of the westbound left-turn bay and streetcar stop. The streetcar operation in Option B3 would create the least traffic impacts during the AM peak hour. However, the delay for the streetcar to traverse the segment is much shorter in Options B1 and B2 when compared to Option B3.

Table 17: Delays and LOS at the Intersection of 34th Street and Benning Road

		AM									
		Intersection		Northbound		Southbound		Westbound		Eastbound	
Option		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing		18.5	B	14.8	B	17.0	B	20.7	C	11.6	B
2040 No Build		22.4	C	15.8	B	19.9	B	26.0	C	11.7	B
2040 Build	B1	41.5	D	16.6	B	22.5	C	52.9	D	9.7	A
	B2	32.1	C	17.7	B	24.0	C	38.3	D	14.5	B
	B3-1	26.8	C	18.7	B	21.6	C	32.2	C	10.6	B
	B3-2	19.6	B	17.3	B	20.8	C	22.3	C	10.9	B
		PM									
		Intersection		Northbound		Southbound		Westbound		Eastbound	
Option		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing		16.0	B	18.3	B	25.4	C	17.6	B	15.0	B
2040 No Build		17.1	B	22.9	C	27.9	C	18.8	B	15.9	B
2040 Build	B1	15.1	B	24.5	C	26.8	C	20.4	C	12.1	B
	B2	16.5	B	24.4	C	27.2	C	16.1	B	16.0	B
	B3-1	16.1	B	23.7	C	29.1	C	20.0	C	13.7	B
	B3-2	16.2	B	24.4	C	28.3	C	17.5	B	14.9	B

Table 18: Delays and LOS at the intersection of Anacostia Avenue and Benning Road

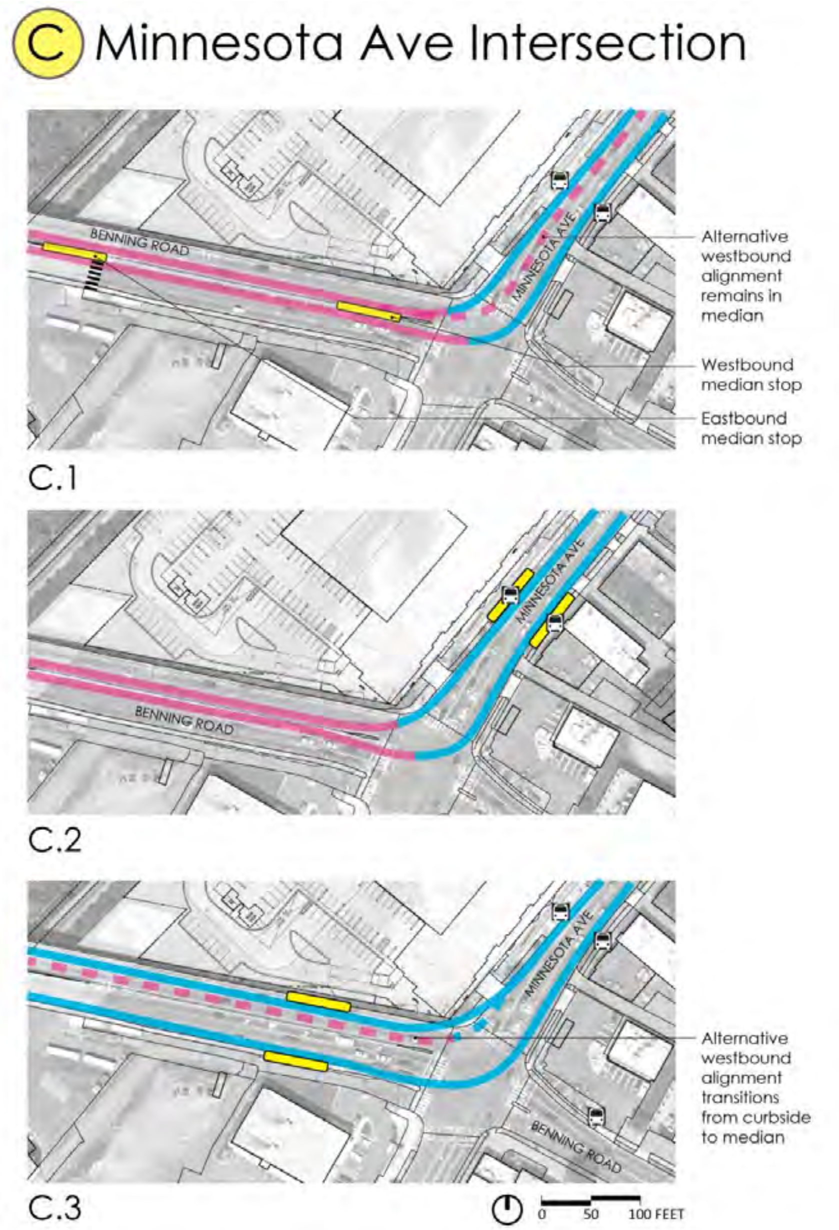
		AM									
		Intersection		Northbound		Southbound		Westbound		Eastbound	
Option		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing		3.9	A	33.2	C	23.0	C	2.4	A	3.8	A
2040 No Build		5.3	A	34.4	C	24.4	C	4.1	A	4.4	A
2040 Build	B1	8.5	A	34.4	C	24.4	C	8.4	A	4.5	A
	B2	14.4	B	34.5	C	24.5	C	16.4	B	4.6	A
	B3-1	16.5	B	35.0	D	25.0	C	18.8	B	6.0	A
	B3-2	14.9	B	34.8	C	24.7	C	16.8	B	5.5	A
		PM									
		Intersection		Northbound		Southbound		Westbound		Eastbound	
Option		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing		3.9	A	24.0	C	35.9	C	3.0	A	3.6	A
2040 No Build		4.6	A	23.1	C	39.4	D	3.8	A	4.4	A
2040 Build	B1	5.4	A	23.2	C	39.3	D	4.3	A	5.2	A
	B2	6.7	A	23.3	C	39.5	D	8.3	A	5.5	A
	B3-1	6.6	A	23.9	C	42.9	D	5.2	A	6.6	A
	B3-2	5.9	A	22.5	C	37.4	D	4.0	A	6.2	A

Table 19 lists the pros and cons for each build option.

Table 19: B1, B2, and B3 Build Options Pros and Cons

Build Option	Pros	Cons
B1	• Pedestrians could use existing cross-walk to access the transit stop.	• Westbound left-turn bay at 34th Street would be removed and left-turn vehicles would share a lane with through traffic. As such, the through vehicle would be delayed by left-turn vehicles and left-turn vehicles would be delayed by a streetcar when it dwells at the stop.
B2	• Retains the eastbound and westbound left-turn bays at 34th Street.	• A new signalized pedestrian cross-walk should be provided between 34th Street and Anacostia Avenue to serve the transit stop, which would increase the operating and maintenance costs of the streetcar operations.
B3	• This option retains the eastbound and westbound left-turn bays at 34th Street.	• The streetcars in both directions need to transition twice which would increase the traffic delays of streetcars and vehicles. • No Right-Turn-on-Red is used for westbound traffic at Anacostia Avenue. • As the streetcars need to change three lanes during every transition, longer transition distance and longer transit phase would be provided – further increasing the vehicle delay. • The streetcar transition on westbound Benning Road at Anacostia Avenue requires moving the westbound stop bar further east. Right-turn-on-red will not be allowed for westbound right-turning vehicles. • The mid-block stop in the westbound direction would increase the walk time of pedestrians crossing Benning Road.
B3-Alt.	• No transition is needed for the westbound streetcars, which reduces streetcar running time and vehicle delays.	• This option requires removing the eastbound left-turn bay at 34th Street. • A new pedestrian crosswalk would need to be provided across the west leg of the 34th Street intersection, creating potential conflicts with northbound left-tuning vehicles.

Minnesota Avenue Intersection (C1, C2 and C3 Options)



The intersection of Minnesota Avenue and Benning Road is the gateway to a major retail hub in Ward 7 including the destinations of the Department of Employee Services, East River Park Shopping Center, and the Benning Library. The *Deanwood / Great Streets – Nannie Helen Burroughs Ave NE & Minnesota Ave NE Strategic Development Plan* identified this node as a high-priority redevelopment area. In addition, improvements to the Minnesota Avenue streetscape are planned as part of the Minnesota Great Streets initiative. A streetcar stop at or near the intersection of Minnesota Avenue and Benning Road is crucial to providing transit riders with access to this activity center but challenging due to the constraints of the Benning Viaduct, busy intersection, and active bus stops.

Option C1 shows a median stop on the viaduct which must be split with staggered stops to allow for eastbound left turns onto Minnesota Avenue. This option requires that the eastbound stop be set back from the intersection, include a mid-block pedestrian crossing, and have a relatively level area for the streetcars to stop on a vertical tangent as the viaduct descends to meet the grade of Minnesota Avenue. Eastbound streetcars transition at the intersection from the center median lane to the northbound curb lane of Minnesota Avenue. Westbound streetcars transition from the curb or median lane of southbound Minnesota Ave at the intersection to the westbound median lane of the viaduct. Alternatively, the westbound streetcar transitions from the southbound median lane on Minnesota Avenue to the westbound median lane on Benning Road.

Option C2 assumes curbside streetcar stops located on Minnesota Avenue. The locations avoid conflicts with the eastbound left turn at base of the viaduct but conflict with existing heavily used bus stops.

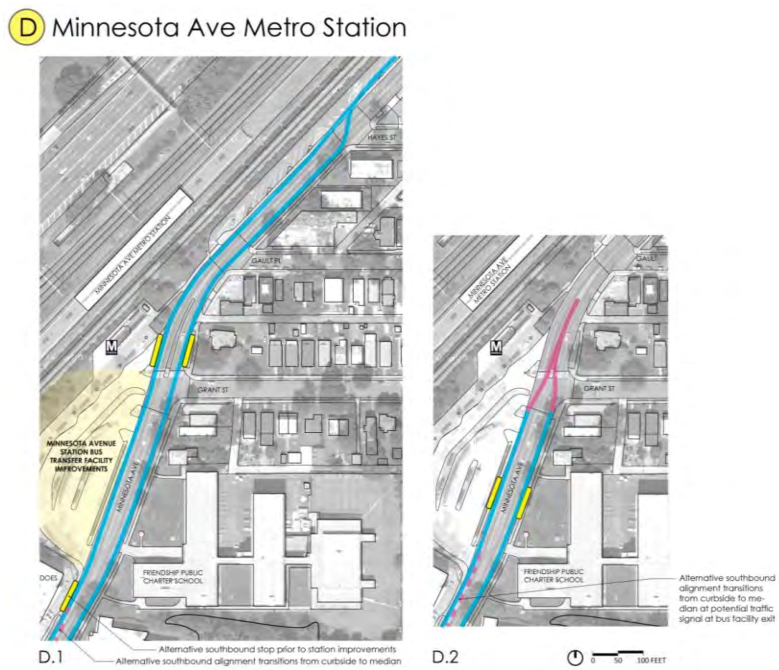
Eastbound and westbound streetcars transition from the median lanes of the viaduct to the curb lanes on Minnesota Ave at the intersection.

Option C3 assumes curbside bus stops on the viaduct, which allow the stops to be close to the destinations south of the intersection and avoid impacting eastbound left turns. Platforms must be relatively level for the streetcars to stop on a vertical tangent as the viaduct descends to meet the grade of Minnesota Avenue. Eastbound streetcars remain in the curb lane after the intersection. The westbound streetcar guideway would require additional right-of-way to continue running in the curb lane from southbound Minnesota Avenue to the curb lane of westbound Benning Road. Alternatively, the westbound streetcar could transition from the curb lane on Minnesota Avenue to the median lane of the viaduct to avoid the need for additional right-of-way, but a westbound curbside stop at this location would no longer be possible.

The intersection is projected to experience significant delays in the 2040 No-Build condition due to regional traffic growth. Based on the 2040 No-Build traffic condition and understanding the intersection failure in future years, the technical memorandum recommends that DDOT conduct further study and coordination to improve the capacity of the intersection to handle the 2040 traffic volume as well as the streetcar operations and stops.

Minnesota Avenue Metro Station (D)

Extending the Benning Road Streetcar to the Minnesota Avenue Metro Station in the short term would provide direct access to the Metrorail system and to the residential areas east of Minnesota Avenue and west of Kenilworth Avenue. Additionally, a large residential, office and retail development, Parkside, is planned northwest of the Metro station that will significantly increase the development intensity and population in the neighborhood.



In **Option D1**, the northbound stop is located close to the Metro station entrance on the curbside of Minnesota Avenue, just north of the Grant Street intersection. The southbound stop is located south of the bus facility exit by the northeast corner of the Department of Employee Services (DOES) building. The southbound stop does not require pedestrians from the Metro station to cross traffic lanes to reach the platform and is conveniently located for DOES employees. North of the stop, the northbound streetcars continue in the curb lane and transition to the shared track around the intersection of Hayes Street, continuing onto the WMATA Kiss & Ride property. Southbound streetcars exit the tail track near the Hayes Street intersection and transition to the curb lane of Minnesota Avenue. The intersection of Hayes Street and Minnesota Avenue would be signalized and a transit phase of 10 seconds would be provided to protect this transition. The tail track would require a reduction in the number of Kiss & Ride short-term parking spaces. Southbound streetcars could alternatively transition to the center median lane on Minnesota Avenue after the southbound Metro station stop.

In **Option D2**, northbound and southbound stops are located on the curbside of Minnesota Avenue between the Friendship Public Charter School and the Metro station bus loop. The southbound stop would require a reduction in bus layover spaces. Northbound streetcars transition to a tail track from the curbside of Minnesota Avenue to the median of Minnesota Avenue at the intersection of Grant Street. Southbound streetcars transition from the median tail track on Minnesota Avenue to the curbside after the Grant Street intersection. This turnaround may require the widening of Minnesota Avenue or the reduction of vehicular lanes. Southbound streetcars could alternatively transition from the curbside to the center median lane on Minnesota Avenue at a new traffic signal at the bus facility exit. The traffic lanes on Minnesota Avenue reduce to one lane in each direction north of Grant Street. For safety traffic operations concerns, the southbound left turn at Grant Street would need to be restricted. Left-turning vehicles could reroute via Gault Place or Hayes Street.

Tables 20, 21 and 22 list the delays and LOS at the intersections of Grant Street, Gault Place, and Hayes Street with Minnesota Avenue, respectively, for all Build options. The tables also include the existing and 2040 No-Build results for comparison purposes. Please note that the intersection of Minnesota Avenue and Hayes Street is signalized in Build Option D1 and unsignalized in the existing, 2040 No-Build and Build Option D2 conditions. For unsignalized intersections, the highest approach delay at the intersection is used to represent intersection delay. For signalized intersections, intersection delay is the weighted average delay for all vehicles approaching the intersection.

Results indicate that vehicles experience similar delays at the intersection of Grant Street and Minnesota Avenue in Build Options D1 and D2. However, in Option D2, the roadway capacity reduces to half between Grant Street and Gault Place on Minnesota Avenue, which would potentially cause traffic operations failure due to traffic growth in future years. Although this failure is not projected by 2040, it is likely to occur by 2045. As shown in Table 22, vehicles from all approaches experience higher delays in Option D1 than in the other scenarios due to the signal control and streetcar operation at the intersection of Hayes Street and Minnesota Avenue. Westbound vehicles experience higher delays in Option D1 than in Option D2, because the headway of vehicles on Minnesota Avenue becomes shorter in Option D2 due to the lane reduction and longer wait times for side street vehicles to find a gap.

Table 20: Delays and LOS at the Intersection of Grant Street and Minnesota Avenue

		AM									
		Intersection		Northbound		Southbound		Westbound		Eastbound	
Option		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing		14.6	B	9.2	A	9.1	A	52.3	D	-	-
2040 No Build		16.0	B	12.5	B	12.4	B	40.8	D	-	-
2040 Build	D1	17.1	B	12.6	B	14.7	B	40.8	D	-	-
	D2	17.8	B	14.3	B	9.9	A	43.3	D	-	-
		PM									
		Intersection		Northbound		Southbound		Westbound		Eastbound	
Option		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing		10.6	B	9.7	A	9.0	A	35.8	D	-	-
2040 No Build		12.1	B	11.1	B	11.0	B	34.2	C	-	-
2040 Build	D1	13.0	B	12.3	B	11.5	B	34.3	C	-	-
	D2	18.6	B	19.6	B	8.0	A	47.1	D	-	-

Table 21: Delays and LOS at the Intersection of Gault Place and Minnesota Avenue

Option		Intersection Delay	Intersection LOS	Northbound Delay	Northbound LOS	Southbound Delay	Southbound LOS	Westbound Delay	Westbound LOS	Eastbound Delay	Eastbound LOS
AM											
Existing		7.0	A	0.1	A	0.5	A	7.0	A	6.5	A
2040 No Build		8.9	A	0.2	A	0.9	A	8.1	A	8.9	A
2040 Build	D1	11.0	B	0.6	A	1.3	A	8.7	A	11.0	B
	D2	9.4	A	0.3	A	0.8	A	9.3	A	9.4	A
PM											
Existing		9.1	A	0.4	A	0.5	A	9.1	A	5.6	A
2040 No Build		9.9	A	0.8	A	0.7	A	9.8	A	9.9	A
2040 Build	D1	16.1	B	1.0	A	0.7	A	8.4	A	16.1	B
	D2	21.8	C	0.3	A	2.0	A	21.8	C	10.4	B

Table 22: Delays and LOS at the Intersection of Hayes Street and Minnesota Avenue

Option		Intersection Delay	Intersection LOS	Northbound Delay	Northbound LOS	Southbound Delay	Southbound LOS	Westbound Delay	Westbound LOS	Eastbound Delay	Eastbound LOS
AM											
Existing		8.2	A	0.3	A	0.1	A	8.2	A	-	-
2040 No Build		9.6	A	0.6	A	0.2	A	9.6	A	-	-
2040 Build	D1	4.2	A	5.2	A	2.2	A	36.9	D	-	-
	D2	10.8	B	0.4	A	0.2	A	10.8	B	-	-
PM											
Existing		9.0	A	0.3	A	0.3	A	9.0	A	-	-
2040 No Build		12.6	A	0.5	A	0.4	A	12.6	A	-	-
2040 Build	D1	4.4	A	4.5	A	3.8	A	32.3	C	-	-
	D2	22.2	C	0.3	A	0.5	A	22.2	C	-	-

Note: The intersection of Minnesota Avenue and Hayes Street is signalized in Build Option D1 and unsignalized in the existing, 2040 No-Build, and Build Option D2 conditions.

Table 23 shows the pros and cons for each of the D build options.

Table 23: D1 and D2 Build Options Pros and Cons

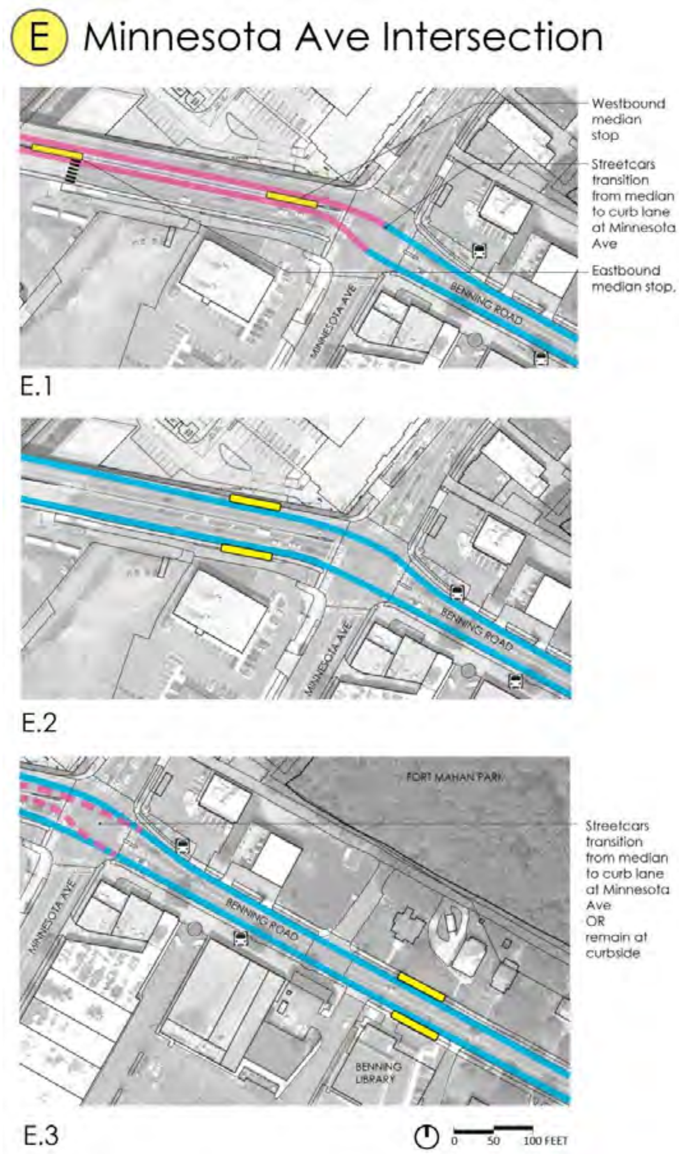
Option	Pros	Cons
D1	• Crossover operation occurring in dedicated right-of-way and not interfering with traffic on Minnesota Avenue	• Impact on the Kiss & Ride spaces and operations • Longer travel distance for streetcar to reach its terminal
D2	• Shorter travel distance for streetcar to reach its terminal	• The roadway capacity is reduced to half between Grant Street and Gault Place on Minnesota Avenue, which would potentially cause capacity deficiencies due to future year traffic growth

Benning Road Streetcar – Benning Road Metro Terminus Alternative

The alternative would extend the Benning Road Streetcar line to a terminus at the Benning Road Metro Station. In addition to stop locations A and B described above, this alternative requires different configuration options for the intersection of Benning Road at Minnesota Avenue and has two additional stops: Benning Road at 42nd Street and the Benning Road Metro Station.

Minnesota Avenue Intersection (E1, E2, and E3 Options)

Different stop locations and alignments are considered with the streetcar continuing east on Benning Road rather than turning north onto Minnesota Avenue. The Minnesota Avenue intersection is approximately 0.28 miles, or a 5-minute walk, from the Minnesota Avenue Metro Station, so some streetcar riders could access the Minnesota Avenue Metro station from a streetcar stop in this location.



Option E1 proposes the same streetcar stop locations on the viaduct as Option C1. A median stop on the viaduct must be split with staggered stops to allow for eastbound left turns onto Minnesota Avenue. This requires an eastbound stop set back from the intersection, a mid-block pedestrian crossing, and a relatively level area for the streetcars to stop on a vertical tangent as the viaduct descends to meet the grade of Minnesota Avenue. Eastbound streetcars would transition at the intersection from the center median lane to the curb lane of Benning Road. Westbound streetcars would transition from the curb lane of Benning Road at the intersection to the median lane of the viaduct.

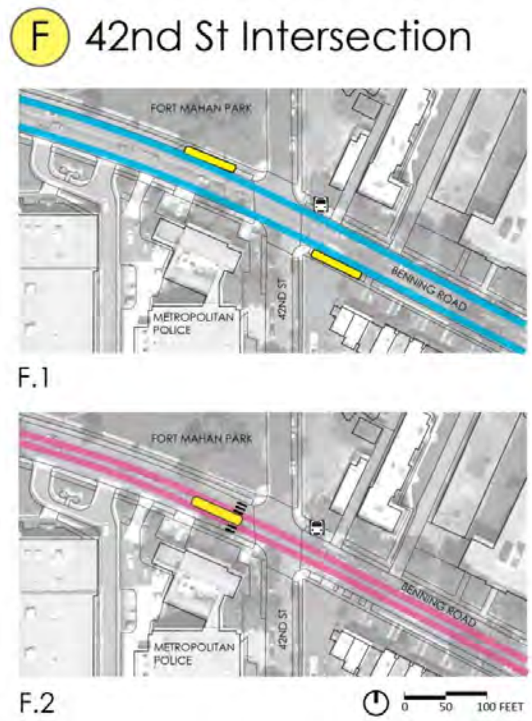
Option E2 proposes curbside stops on the viaduct, which allows the stops to be closer to the destinations south of the intersection and avoid impacting eastbound left turns. Platforms must be relatively level for the streetcars to stop on a vertical tangent as the viaduct descends to meet the grade of Minnesota Avenue. Eastbound and westbound streetcars remain in the curb lanes on Benning Road before and after the intersection.

In **Option E3**, the streetcar stops are located east of Minnesota Avenue, which could be placed in front of the Benning Library on opposite sites. The roadway levels out at this location; however, the stops are further from the destinations north of the intersection. The eastbound and westbound streetcars may remain in the curb lanes of Benning Road or transition to the median lanes of the viaduct at the intersection of Minnesota Avenue.

The intersection would experience significant delays in 2040 due to regional traffic growth. Based on the analysis results for 2040 No-Build traffic condition and understanding of the intersection failure in future years, the technical memorandum recommends that DDOT conduct further study and coordination to improve the capacity of the intersection to handle the 2040 traffic volume as well as the streetcar operations.

42nd Street, NE Intersection (F1 and F2 Options)

The intersection of 42nd Street and Benning Road is a gateway to the residential neighborhoods north and south. The *Benning Road Corridor Redevelopment Framework Plan* identified two parcels for redevelopment surrounding the intersection. Future proposed development here includes a community center and residential or neighborhood retail. With the future development in the area as well as the existing residential neighborhoods, a transit stop is proposed at the intersection.



In **Option F1**, curbside stops on the far side of the intersection are proposed for both eastbound and westbound streetcars remaining in the curb lanes. The buses could potentially share the stops with streetcars. **Option F2** proposes a median stop located west of the intersection with both eastbound and westbound streetcars remaining in the center median lanes. To accommodate a median streetcar stop, Benning Road would need to be widened at 42nd Street. A pedestrian cross-walk on the west side of the intersection may need to be redesigned to better serve the streetcar stop. The traffic concern for Option F2 is that the median streetcar stop would delay eastbound left turns onto 42nd Street.

Table 24 lists vehicle delays and LOS at the intersection of 42nd Street and Benning Road in the 2040 Build conditions. For comparison purposes, the table also includes the existing and 2040 No-Build results. Both build options would have negligible traffic impacts on the traffic operations at the intersection.

Table 24: Delays and LOS at the intersection of 42nd Street and Benning Road

						AM					
		Intersection		Northbound		Southbound		Westbound		Eastbound	
Option		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing		10.0	B	35.0	D	32.3	C	5.1	A	5.4	A
2040 No Build		11.7	B	33.0	C	31.4	C	7.2	A	7.9	A
2040 Build	F1	11.9	B	33.0	C	31.4	C	7.5	A	8.1	A
	F2	12.0	B	33.2	C	31.4	C	7.5	A	8.4	A
						PM					
		Intersection		Northbound		Southbound		Westbound		Eastbound	
Option		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing		9.8	A	35.4	D	28.9	C	4.2	A	5.9	A
2040 No Build		11.6	B	32.9	C	28.7	C	6.0	A	8.4	A
2040 Build	F1	11.9	B	33.0	C	28.7	C	6.2	A	9.0	A
	F2	11.8	B	33.0	C	31.4	C	7.2	A	7.9	A

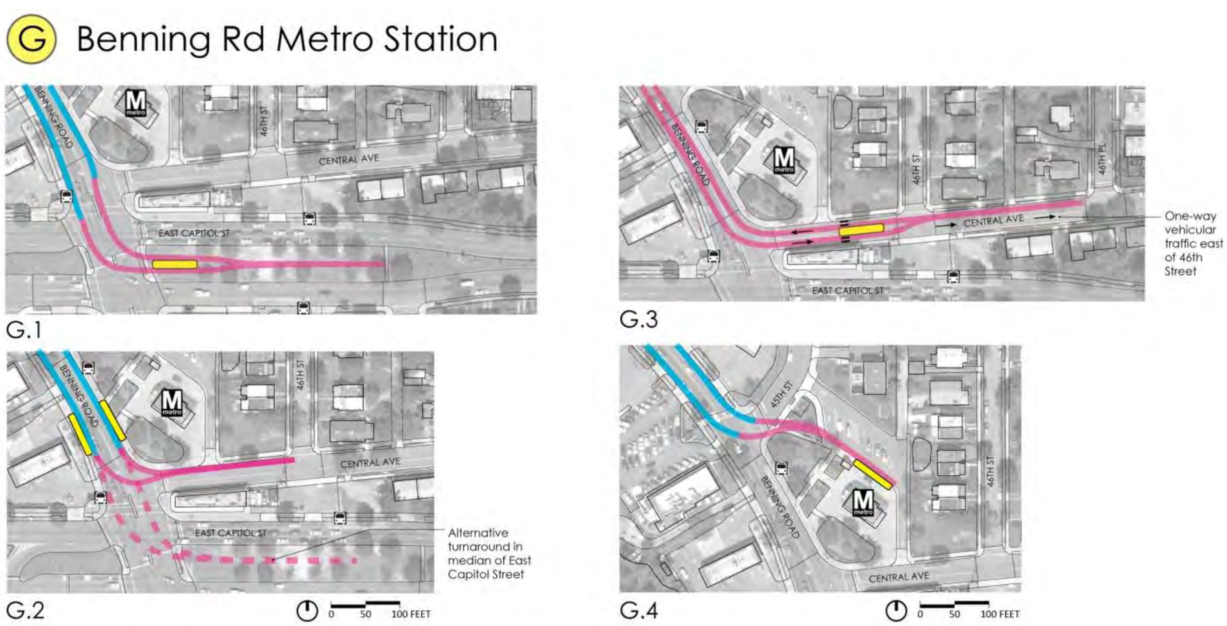
Table 25 lists the pros and cons for each of the F build options.

Table 25: F1 and F2 Build Options Pros and Cons

Option	Pros	Cons
F1	• Does not require additional right-of-way	• Sidewalk space may be constrained in front of Fort Mahan Park.
F2	• Median running alignment would have fewer on-street parking impacts.	• Requires widening the road to accommodate the median streetcar stop, which would require additional right-of-way. • Requires redesign of the pedestrian cross-walk

Benning Road Metro Station (G1, G2, G3, and G4 Options)

Extending the Benning Road Streetcar to the Benning Road Metro Station would provide direct access to the Metrorail system, East Capitol Street, and the neighborhoods to the south and east. Additionally, the Benning Road Corridor Redevelopment Framework Plan identified several parcels with long-term transit-oriented redevelopment potential to include mixed-use retail, residential and small office uses.



In **Option G1**, the stop is located in the median of East Capitol Street. This option locates the stop out of vehicular traffic and closer to destinations south and east but further from the Metro station entrance. This stop location conflicts with the proposal to eliminate the East Capitol Street median in the *Far Northeast Livability Study.* Eastbound and westbound streetcars transition from curb lanes on Benning Road to the median at the East Capitol Street westbound intersection. The streetcar tail track would be within the median east of the stop.

In **Option G2**, opposing streetcar stops are located curbside directly outside of the Metro station entrance. The eastbound stop may require additional right-of-way on private property. Eastbound and westbound streetcars converge to a shared tail track after the stops on the westbound lane of Central Avenue. This tail track would impact the vehicular traffic of Central Avenue. A mid-block pedestrian crosswalk for the stop would be required on Central Avenue.

In **Option G3**, a median stop is located east of the Metro station entrance on Central Avenue. A mid-block pedestrian crosswalk would be required to access the stop. Eastbound and westbound streetcars remain in median from Benning Road to Central Avenue and the tracks converge to a shared tail track after the stop at the intersection of 46th Street. This tail track would require vehicular traffic to transition from two-way operations between Benning Road and 46th Street to one-way operations east of 46th Street.

In **Option G4**, a streetcar stop is located in the existing Kiss & Ride facility, directly outside of the Metro station entrance. Eastbound and westbound streetcars remain in the curb lane on Benning Road and transition into a crossover at the intersection of 45th Street.

The intersection would experience significant delays in the 2040 No-Build condition with the existing lane configuration and signal operation. Based on the analysis results and understanding of the intersection failure in future years, the technical memorandum recommends that DDOT conduct further study and coordination to improve the capacity of the intersection to handle the 2040 traffic volume as well as the streetcar operations.

Appendix F:

Utilities Technical Memorandum

District Department of Transportation

BENNING ROAD STREETCAR EXTENSION FEASIBILITY STUDY

UTILITIES TECHNICAL MEMORANDUM

October 2012

District Department of Transportation

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Utilities

To accommodate the proposed embedded track slab and streetcar system infrastructure, it is important that existing utilities are identified and accounted for early in the design. This report outlines the methodology used to assess existing utilities; classifies utility conflicts; discusses impacted utilities; provides an overview of utility relocations as well as new utilities required for streetcar operation; and provides an appendix containing tabulation of utilities that are in conflict. This report section examines utilities along Benning Road and Minnesota Avenue within the project area for the two proposed streetcar terminus alternatives – Minnesota Avenue Metro Terminus and Benning Road Metro Terminus.

Existing Utilities

Being located in a fully developed and urbanized location, numerous existing utilities, both aerial and subsurface, are found within the project limits. This inventory of existing surface and subsurface utilities was performed using available documentation and observation. Topographical survey and/or geophysical prospecting techniques were not employed at this time but are strongly recommended for design activities; it is believed that some of the utility documentation collected previously was based on physical determination. It should also be noted that the provided data contains discrepancies and contradictory information. As such, there is no guarantee that all utilities within the project area are accurately represented or located, including any undisclosed government utilities. In addition, any recent or ongoing utility relocation work by the utility companies may not be included in this discussion. Underground electric, telephone, and communication facilities are assumed to be contained within ductwork.

Based on available documents provided by DDOT, existing utilities may include but are not limited to those listed in **Table 1**:

Table 1: Existing Utilities

Utility Type	Utility Owner	Description
Gas	Washington Gas	Underground distribution lines and service connections; size and locations varies.
Water	DC Water (WASA)	Underground distribution lines and service connections; size and locations vary (4” to 30”). Fire hydrants are located throughout corridor.
Electric	Potomac Electric and Power Company (PEPCO)	Aerial – Overhead wires mounted typically to wooden poles are found throughout the project area along both sides of the roadways; size and type unknown. Subsurface – Underground facilities throughout project. Extensive underground transmission and distribution facilities from the western project limit to the Benning Road Viaduct, typically in the westbound roadway, including twin 69kv electric cable pipes and several multi-way duct banks ranging in size from 4-way(W) to 24W ductbanks. Although information is not available for the eastern project area, it is believed that transmission lines are present in and around East Capitol Street. Along Minnesota Avenue, underground electric is typically beneath the southbound lanes except for limited areas between grant and Hayes Streets.

Telephone	Verizon Communications	Aerial – Overhead wires mounted typically to wooden poles are found throughout the project area along both sides of the roadways; size and type unknown. Subsurface – Underground facilities present throughout corridor. Along Benning Road, west of Minnesota Avenue, underground facilities are typically found beneath the eastbound roadway. East of Minnesota Avenue, underground telephone facilities are typically beneath the westbound lane of Benning Road. For the area along Minnesota Avenue, underground facilities are beneath the northbound lanes.
Communication/ CATV	TBD	Aerial – Overhead communication wires mounted typically to wooden poles are observed throughout the project area along both sides of the roadways; size and type unknown. Subsurface – Unknown
Street Lighting	District Department of Transportation	Street lighting is throughout the project limits including bridge mounted lights. Luminaires are typically cobra-head style mounted on aluminum poles or wooden utility poles. Along Benning Road and Minnesota Avenue, lighting mounted to wooden poles are fed from an overhead power source, whereas bridge-mounted street lights are on dedicated aluminum poles and fed via underground service.
Traffic Signals/ Enforcement	District Department of Transportation and Metropolitan Police Department	DDOT standard traffic signals, control cabinets, and cameras and devices are throughout the project and are typically surface mounted on a standalone pole or foundation. DDOT cameras are typically for traffic surveillance while the MPD owned facilities are for red light and speed enforcement. Underground facilities including manholes, hand holes, and conduit are also present to services the aboveground equipment. Size and location of underground facilities are unknown.
Sanitary Sewer	DC Water (WASA)	Underground service connections and trunk lines located throughout the project limits, primarily along Minnesota Avenue and along Benning Road east of Minnesota Avenue; size and locations varies.
Storm Drainage	DC Water (WASA)	Storm runoff is conveyed by gutters to catch basins; size and location of drainage piping varies.
Rail	Washington Metropolitan Transportation Authority (WMATA) and CSX	Project is adjacent to WMATA and CSX facilities. As such, underground utilities may be present. Project crosses beneath and over existing rail facilities.

As stated, this inventory of existing utilities is limited and as such all utilities may not be accurately accounted. It is recommended that coordination with facility owners occur as the design advances.

Based on District guidelines, where existing utility information is not available or is incomplete, the following minimum depths to top of utility have been used:

Table 2: Utility Depth

Utility Type	Minimum Depth
Gas	3 feet
Water	4 feet
Sanitary Sewer	10.5 feet
Storm Drainage	5.5 feet

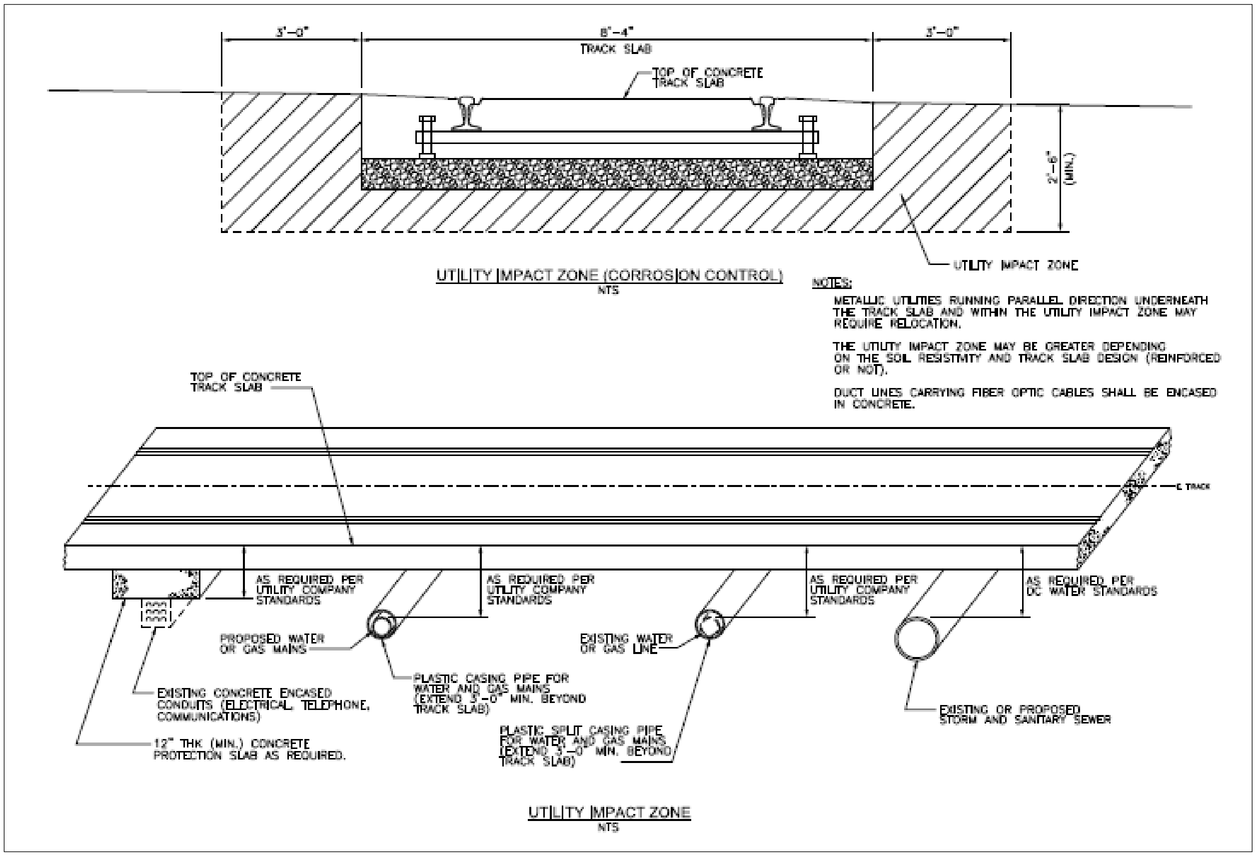
Conflict Assessment

To minimize future disturbance to the streetcar line, a utility-free envelope is used in this study for the identification of conflicts with existing utilities and the placement of proposed utilities. This utility-free envelope is the width of track slab and has nominal depth of 30 inches (see **Figure 1**). Existing utilities that cross beneath this envelope in a perpendicular-like fashion are typically considered to not be in conflict for this purpose of this feasibility study. However, significant cost would be borne if a utility does not permit their facility to perpendicularly cross beneath the track slab because construction of a new separate main to eliminate crossing laterals would be required; such action is not considered by this study at this time.

Pending direction from utility owners, or results of subsurface investigation to occur in future design phases, existing utilities are considered to be in conflict if any of the following criteria are met:

- Located underneath the streetcar alignment within the required depth running in any horizontal direction.
- Deeper than the 30 inch envelope depth but running parallel and beneath the slab as this would limit access to the utility for future maintenance or repair of the utility line.
- As directed by utility company standards and minimum offsets.

Figure 1: Utility Impact Zone *(Source: DDOT Streetcar Standards)*



In addition to conflicts associated with the above mentioned slab envelope, conflicts with existing utilities will also occur as a result of required changes to curb lines and medians, proposed platforms, dedicated guideway infrastructure, and other streetcar facilities such as specialized trackwork.

For those existing utilities that are not in direct conflict, and/or for proposed utilities, protection measures are required within a three-foot buffer surrounding the track slab (see **Figure 1**). One reason for this measure is to provide corrosion control. For existing and proposed water and gas lines, a plastic casing pipe (split pipe for existing utilities) is recommended beneath and extending three-feet beyond the slab. For utilities in encased conduits (underground electric, telephone and communication) a one-foot thick concrete slab is recommend to be placed above the ductbank.

Utility Conflicts

Based on the assessment of existing utilities through review of available information, the two proposed streetcar terminus alternatives (Minnesota Avenue Metro Terminus and Benning Road Metro Terminus), as well as the individual alignment options, were used to identify potential conflicts. Generally, numerous underground utilities are in conflict with the proposed streetcar throughout the corridor and above ground utilities are impacted at select locations, typically where side running options are proposed. For purposes of this study, additional conflict length was assumed at locations where the streetcar alignment transitions from center to side running, or vice versa, to account for design refinements or utility work zones. Conflicts have been grouped by alignment option and utility type for ease of comparison and assembly of terminus alternative layouts; a complete tabular listing is located in the **Appendix**. **Table 3** below is a summation of key conflicts between existing utilities and proposed streetcar alignments.

Table 3: Summary of Key Utility Conflicts by Project Segment

Project Segment	Terminus Alternative(s)	Alignment Option(s)	Key Utility Conflicts
Benning Road from 26th Street to Benning Road Viaduct	Minnesota Avenue Metro Terminus and Benning Road Metro Terminus	X1 and X2 A1 and A2 B1, B2, and B3	• Extensive underground electric, water, and gas lines run parallel and beneath slab of center running and side running alignments. Electric facilities include transmission and distribution feeders. • Numerous utilities including gas, water, electric, and telephone carried beneath Bridge 52 and Bridge 77. Selection of build-up or build-down concept will determine impacts and relocation strategy. • Utility poles with aerial facilities, street lights, and traffic signals impacted with side running option B3 between Anacostia Avenue and 34th Street.
Benning Road from Benning Road Viaduct to Minnesota Avenue Intersection	Minnesota Avenue Metro Terminus and Benning Road Metro Terminus	Mainline C1, C2, and C3 E1, E2, and E3	• Underground gas and electric impacted by center running alignment in vicinity of viaduct. • Extensive above and below ground conflicts at Minnesota Avenue intersection for all options. • Utility poles with aerial facilities, street lights, and traffic signals impacted with side running options.
Minnesota Avenue from Benning Road to Hayes Street	Minnesota Avenue Metro Terminus	C1, C2, and C3 D1 and D2	• Underground water, gas and telephone facilities conflict with side running options. • Limited impacts to utility poles with aerial facilities and street lights with side running options along southbound roadway in vicinity of Grant Street to Hayes Street.

Benning Road from Minnesota Avenue to East Capitol Street	Benning Road Metro Terminus	E1, E2, and E3 F1 and F2 G1, G2, G3, and G4	• Impacts to aboveground facilities along westbound Benning Road associated with E series, and along both sides of roadway with F and G alignment options. • Underground water and telephone conflicts. • Full extent of utility impacts is unknown in the vicinity of Benning Road Metro Station and East Capitol Street due to lack of available data.

To facilitate the streetcar line, structural work is required to the bridges within the project limits; this work will impact existing utilities. Within the study limits, Benning Road includes three bridge structures: Bridge 77 over Kingman Lake, Bridge 52 over the Anacostia River, and the Benning Road Viaduct (two parallel structures for eastbound and westbound traffic) over Kenilworth Avenue, Anacostia Freeway and the CSXT tracks. Bridges 52 and 77 will be modified to accept proposed streetcar infrastructure but the viaduct will be replaced in its entirety (work being designed by others) and will require utility relocations to accept embedded track slab. Impacts to utilities carried by bridges 52 and 77 will greatly depend on whether the streetcar track is placed in a shared lane with vehicular traffic, or has its own dedicated lane that is raised similar to a median. At this time, selection of the shared use option will affect existing utilities mounted to the underside of the existing deck slab. Extent of impacts will require further coordination but at a minimum, existing utilities will require temporary support and reattachment as the deck is replaced to accommodate embedded track.

Similarly, additional utility conflicts may arise where specialized trackwork is required at the Minnesota Avenue intersection. Because intersecting track alignments must maintain the same grades, and hold a flat cross-slope relative to top of rail at all special trackwork elements, re-grading the entire intersection and its approaches may be necessary. This would affect additional utilities that are beyond the track slab conflict zone and may entail resetting of valves, manholes, fire hydrants, traffic signal equipment, and utility poles and street lights; these related grading conflicts are not itemized in the utility **Appendix**.

Relocated and New Utilities

As a result of the conflict assessment, extensive utility relocation may be required pending selection of preferred alignment options, advancement of engineering design, collection of accurate utility data, and further coordination with effected utility owners. Relocations shall conform to the standards and specifications of the respective utility owners, including WMATA and DDOT. Relocation activities will also have to be factored into construction programming. The **Appendix** lists approximate lengths of utility relocation, based on the conflict methodology previously discussed, to aid in determining order of magnitude construction cost estimates. It should be noted that for relocation quantities listed in the **Appendix**, total relocation should be based solely on those alignment options selected as part of a preferred alternative; this study presented utility conflicts and relocations associated with all options to assist in determining a preferred alternative. Also note that for those utilities that cross perpendicular and beneath the track slab utilities, and are listed as protect in place in the **Appendix**, protection measures are required (see **Figure 1**); these measures are not quantified at this stage of design. Likewise, further relocation may be required if a utility company does not permit their existing facilities that perpendicularly cross beneath the track slab to be protected in place. As such construction of new mains would be required. Similarly, street lighting infrastructure and underground conduits may be required to replace existing lights mounted to shared wooden utility poles pending selection of a preferred alternative.

In addition to relocating existing utilities to make room for the streetcar, new utilities are needed to support streetcar system operations. To facilitate these new utilities, existing utilities may be in conflict or will require connection to proposed streetcar infrastructure. Utilities ranging from train control, signals, communication, power, drainage, and lighting are necessary. It is anticipated that proposed track drainage will connect to existing infrastructure by possibly relocating existing inlets and/or by constructing new inlets and manholes to tie to existing lines; drainage design will be advanced during subsequent design phases. Likewise, systemwide electrical high voltage power requires ductbanks and manholes. Regardless of alternative selected, two substations will be installed, one at either end. These facilities, approximately 20' x 13' in size, may necessitate additional existing utility relocations so the structure can be sited, as well as new utilities routed to and from the substation. Refer to bridge structures and streetcar sections of this report for additional discussion on new utilities and facilities required for streetcar system operations.

Utility relocations should also consider *The DC Transit Future System Plan*. Based on the future plan, streetcar service would be provided along both Benning Road and Minnesota Avenue. To accommodate any future connection or specialized track work through the intersection, all utility relocations at this intersection should be performed at the time the Benning Road Streetcar Extension is constructed. This would prevent future disruptions, allow for cost savings by performing all work simultaneously, and facilitate future streetcar construction.

Appendix

Benning Road Streetcar
Composite Utility Layout
AECOM 10-24-2012

Not for Construction - In-progress Working Drawing

Benning Road Street Car
Existing Utilities

Utility	Owner
Stormwater	DC Water
Sanitary Sewer	DC Water
Water	DC Water
Gas	Washington Gas
Electric	Potomac Electric and Power Company (PEPCO)
Street Lighting	District Department of Transportation (DDOT)
Traffic Signals	District Department of Transportation (DDOT)
Telephone	Verizon Communications
Communication	To be determined
Rail	Washington Metropolitan Transportation Authority (WMATA)
	CSX

Notes:

1. This inventory of existing surface and subsurface utilities was performed using available documentation and observation.
2. Utility companies were not contacted as part of this assessment.
3. There is no guarantee that all utilities within the project area are represented, or accurately located.
4. Traffic signal equipment is not specifically accounted for in the following tables. Based on available data, some facilities labeled as underground electric may be related to traffic signals; further investigation required.

5. Existing utilities on bridges, that are identified to be relocated, are subject to selection of slab construction method as this will determine true utility impact.

Alignment Option
A1
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Water	16" Existing	(-)17+0.68	(-)13+30.92	11.63' R, 11.63'R	422.18	Relocate
Water	24" Existing	(-)13+30.92	(-)07+13.43	11.63' R, 18.75'R	567.84	Relocate
Gas	12" Existing	(-)12+38.78	(-)07+14.50	31.83'L, 6.35' L	490.58	Relocate
Gas	12" Existing	(-)07+14.50	(-)01+07.31	6.35'L, 3.78' R	592.85	Relocate
Gas	12" Existing	(-)18+00	(-)16+58.16	8.22'L, 21.89' L	257.08	Relocate
Telephone	30W Existing	(-)08+77.03	(-)07+14.62	35.75'R,12.48'R	47.15	Relocate
Telephone	30W Existing	(-)07+14.62	(-)01+7.35	12.48'R,12.34'R	592.81	Relocate
Electric	Existing	(-)18+00	(-)17+64.24	13.44' L, 12.82' L	164.28	Relocate
Electric	Two 69KV Elec Line	(-)17+64.24	(-)7+14.11	12.98' L, 13.18' L	1114.85	Relocate
Electric	Two 69KV Elec Line	(-)7+14.11	(-)1+07.26	13.18' L, 15.76' L	426.98	Relocate
Electric	Existing	(-)13+07.95	(-)13+35.25	18.36' R, 13.75' L	39.94	Perpendicular to tracks - Protect in place
Electric	Existing	(-)13+40.00	(-)13+19.74	16.78' R, 13.59' L	42.74	Perpendicular to tracks - Protect in place
Electric	8" Existing	(-)13+36.42	(-)07+14.37	13.24' R, 17.88' L	588.54	Relocate
Electric	24" Existing	(-)07+14.37	(-)01+06.69	17.88' L, 0.00' L	584.27	Relocate
Electric	16" Existing	(-)08+18.37	(-)07+14.43	18.83'L,0.38'L	93.62	Relocate
Electric	24" Existing	(-)06+62.97	(-)07+14.28	21.69'L,0.37'L	53.72	Relocate
Electric	24" Existing	(-)07+14.28	(-)02+19.82	0.37'L,9.36	505.56	Relocate
Electric	Existing	(-)18+96.90		14.84' L, 15.24 'R	30.68	Perpendicular to tracks - Protect in place
Electric	Existing	(-)08+09.05		14.92' L, 18.04 'R	32.95	Perpendicular to tracks - Protect in place
Electric	Existing	(-)08+52.11		15.08' L, 18.29'R	33.3	Perpendicular to tracks - Protect in place

Alignment Option
A1
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Electric	One 4" Existing Electric Steel Conduit	(-)02+56.71		16.64' L, 18.66'R	33.72	Perpendicular to tracks - Protect in place
Stormwater	Existing 18" RCP Class III	(-)08+43.58		14.89' L, 17.98' R	43.03	Perpendicular to tracks - Protect in place
Stormwater	Existing 18" RCP Class IV	(-)13+38.09	(-)13+78.86	2.16' L, 1.93' L	43.03	Relocate
Stormwater	Existing 15" RCP Class III	(-)13+31.72	(-)13+37.42	3.37' L, 15.36' L	13.45	Perpendicular to tracks - Protect in place
Stormwater	Existing 15" RCP Class III	(-)13+81.59	(-)13+37.42	0.00' , 15.58' R	18.78	Perpendicular to tracks - Protect in place

Alignment Option
A2
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Water	16" Existing	(-)17+0.68	(-)13+30.92	11.63' R, 11.63'R	422.18	Relocate
Water	24" Existing	(-)13+30.92	(-)07+13.43	11.63' R, 18.75'R	567.84	Relocate
Gas	12" Existing	(-)12+38.78	(-)07+14.50	31.83'L, 6.35' L	490.58	Relocate
Gas	12" Existing	(-)07+14.50	(-)01+07.31	6.35'L, 3.78' R	592.85	Relocate
Gas	12" Existing	(-)18+00	(-)16+58.16	8.22'L, 21.89' L	257.08	Relocate
Telephone	30W Existing	(-)08+77.03	(-)07+14.62	35.75'R,12.48'R	47.15	Relocate
Telephone	30W Existing	(-)07+14.62	(-)01+7.35	12.48'R,12.34'R	592.81	Relocate
Electric	Existing	(-)18+00	(-)17+64.24	13.44' L, 12.82' L	164.28	Relocate
Electric	Two 69KV Elec Line	(-)17+64.24	(-)7+14.11	12.98' L, 13.18' L	1114.85	Relocate
Electric	Two 69KV Elec Line	(-)7+14.11	(-)1+07.26	13.18' L, 15.76' L	426.98	Relocate
Electric	Existing	(-)13+07.95	(-)13+35.25	18.36' R, 13.75' L	39.94	Perpendicular to tracks - Protect in place
Electric	Existing	(-)13+40.00	(-)13+19.74	16.78' R, 13.59' L	42.74	Perpendicular to tracks - Protect in place
Electric	8" Existing	(-)13+36.42	(-)07+14.37	13.24' R, 17.88' L	588.54	Relocate
Electric	24" Existing	(-)07+14.37	(-)01+06.69	17.88' L, 0.00' L	584.27	Relocate
Electric	16" Existing	(-)08+18.37	(-)07+14.43	18.83'L,0.38'L	93.62	Relocate
Electric	24" Existing	(-)06+62.97	(-)07+14.28	21.69'L,0.37'L	53.72	Relocate
Electric	24" Existing	(-)07+14.28	(-)02+19.82	0.37'L,9.36	505.56	Relocate
Electric	Existing	(-)18+96.90		14.84' L, 15.24 'R	30.68	Perpendicular to tracks - Protect in place
Electric	Existing	(-)08+09.05		14.92' L, 18.04 'R	32.95	Perpendicular to tracks - Protect in place
Electric	Existing	(-)08+52.11		15.08' L, 18.29'R	33.3	Perpendicular to tracks - Protect in place

Alignment Option
A2
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Electric	One 4" Existing Electric Steel Conduit	(-)02+56.71		16.64' L, 18.66'R	33.72	Perpendicular to tracks - Protect in place
Stormwater	Existing 18" RCP Class III	(-)08+43.58		14.89' L, 17.98' R	43.03	Perpendicular to tracks - Protect in place
Stormwater	Existing 18" RCP Class IV	(-)13+38.09	(-)13+78.86	2.16' L, 1.93' L	43.03	Relocate
Stormwater	Existing 15" RCP Class III	(-)13+31.72	(-)13+37.42	3.37' L, 15.36' L	13.45	Perpendicular to tracks - Protect in place
Stormwater	Existing 15" RCP Class III	(-)13+81.59	(-)13+37.42	0.00' , 15.58' R	18.78	Perpendicular to tracks - Protect in place

Alignment Option
B1
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Electric	Existing	(-)01+07.02	0.00+15.33	1.95' L, 15.21' L	103.35	Relocate
Electric	Existing	(-)01+08.48	0.00+51.67	1.14' L, 13.55' L	145.89	Relocate
Electric	Existing	(-)13+09.42	(-)13+35.25	18.36' R, 13.75' L	115.69	Perpendicular to tracks - Protect in place
Electric	24" Existing	(-01+07.32	(-)01+68.16	1.46' L, 17.16' R	66.07	Perpendicular to tracks - Protect in place
Electric	8" Existing	00+33.72	00+73.13	16.97' R, 13.55' L	50.21	Perpendicular to tracks - Protect in place
Electric	24" Existing	00+83.66	02+42.65	0.82' L, 0.71' L	159.35	Relocate
Electric	Existing	02+73.05	08+52.67	15.54' R, 15.75 'L	587.39	Perpendicular to tracks - Protect in place
Electric	Existing	(-)08+09.05	14+48.38	1.81' L, 18.04 'R	32.95	Perpendicular to tracks - Protect in place
Gas	Existing	(-)01+07.32	14+50.56	6.34' R, 8.29' L	1549.49	Perpendicular to tracks - Protect in place
Stormwater	Existing	(-)01+58.24		15.44'L, 17.19'R	32.8	Perpendicular to tracks - Protect in place
Electric	Existing	(-)01+77.93		15.49' L, 17.02' R	43.03	Perpendicular to tracks - Protect in place
Water	Existing	00+23.00		14.89' L, 14.68' R	32.56	Perpendicular to tracks - Protect in place
Water	Existing	01+86.46		13.43' L, 15.31' R	28.76	Perpendicular to tracks - Protect in place
Water	Existing	03+38.43		13.29' L, 15.71' R	29.01	Perpendicular to tracks - Protect in place
Sanitary	3" Existing	01+06.85		13.49'L,15.36'R	36.69	Perpendicular to tracks - Protect in place
Stormwater	Existing	03+64.82		13.29'L, 15.77'R	29.49	Perpendicular to tracks - Protect in place
Electric	Existing	04+00.00		13.06'L , 15.62' R	31.79	Perpendicular to tracks - Protect in place
Water	Existing	04+17.04		13.22' L, 15.93' R	29.18	Perpendicular to tracks - Protect in place
Stormwater	Existing	04+92.53		13.12'L, 16.10'R	29.27	Perpendicular to tracks - Protect in place
Stormwater	Existing	12+71.18		15.58'L, 44.98'R	70.02	Perpendicular to tracks - Protect in place

Alignment Option
B1
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Telephone	Existing	03+62.47		13.28'L,15.83'r	29.73	Perpendicular to tracks - Protect in place
Electric	Existing	06+35.27		46.86'R	11.49	Perpendicular to tracks - Protect in place
Water	Existing	07+81.51		13.72'L,18.3'R	32.52	Perpendicular to tracks - Protect in place
Electric	Existing	07+90.11		13.96'L,18.92'R	33.14	Perpendicular to tracks - Protect in place
Stormwater	Existing	07+57.99		15.76'L,19.18'R	37.84	Perpendicular to tracks - Protect in place
Electric	Existing	08+73.51		2.97'L,19.07'R	21.99	Perpendicular to tracks - Protect in place
Telephone	Existing	10+91.38	11+59.09	31.01'R	66.08	Relocate
Sanitary	24" Existing	10+50.93	11+20.61	22.71'R	67.78	Relocate
Water	Exsiting	10+42.059	14+56.64	42.58' R	312.73	Relocate

Alignment Option
B2
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Electric	Existing	(-)01+07.02	0.00+15.33	1.95' L, 15.21' L	103.35	Relocate
Electric	Existing	(-)01+08.48	0.00+51.67	1.14' L, 13.55' L	145.89	Relocate
Electric	Existing	(-)13+09.42	(-)13+35.25	18.36' R, 13.75' L	115.69	Perpendicular to tracks - Protect in place
Electric	24" Existing	(-01+07.32	(-)01+68.16	1.46' L, 17.16' R	66.07	Perpendicular to tracks - Protect in place
Electric	8" Existing	00+33.72	00+73.13	16.97' R, 13.55' L	50.21	Perpendicular to tracks - Protect in place
Electric	24" Existing	00+83.66	02+42.65	0.82' L, 0.71' L	159.35	Relocate
Electric	Existing	02+73.05	08+52.67	15.54' R, 15.75 'L	587.39	Perpendicular to tracks - Protect in place
Electric	Existing	(-)08+09.05	14+48.38	1.81' L, 18.04 'R	32.95	Perpendicular to tracks - Protect in place
Gas	Existing	(-)01+07.32	14+50.56	6.34' R, 8.29' L	1549.49	Perpendicular to tracks - Protect in place
Stormwater	Existing	(-)01+58.24		15.44'L, 17.19'R	32.8	Perpendicular to tracks - Protect in place
Electric	Existing	(-)01+77.93		15.49' L, 17.02' R	43.03	Perpendicular to tracks - Protect in place
Water	Existing	00+23.00		14.89' L, 14.68' R	32.56	Perpendicular to tracks - Protect in place
Water	Existing	01+86.46		13.43' L, 15.31' R	28.76	Perpendicular to tracks - Protect in place
Water	Existing	03+38.43		13.29' L, 15.71' R	29.01	Perpendicular to tracks - Protect in place
Sanitary	Existing	01+06.85		13.49'L,15.36'R	36.69	Perpendicular to tracks - Protect in place
Stormwater	Existing	03+64.82		13.29'L, 15.77'R	29.49	Perpendicular to tracks - Protect in place
Electric	Existing	04+00.00		13.06'L , 15.62' R	31.79	Perpendicular to tracks - Protect in place
Water	Existing	04+17.04		13.22' L, 15.93' R	29.18	Perpendicular to tracks - Protect in place
Stormwater	Existing	04+92.53		13.12'L, 16.10'R	29.27	Perpendicular to tracks - Protect in place
Stormwater	Existing	12+71.18		15.58'L, 44.98'R	70.02	Perpendicular to tracks - Protect in place

Alignment Option
B2
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Telephone	Existing	03+62.47		13.28'L,15.83'r	29.73	Perpendicular to tracks - Protect in place
Electric	Existing	06+35.27		46.86'R	11.49	Perpendicular to tracks - Protect in place
Water	Existing	07+81.51		13.72'L,18.3'R	32.52	Perpendicular to tracks - Protect in place
Electric	Existing	07+90.11		13.96'L,18.92'R	33.14	Perpendicular to tracks - Protect in place
Stormwater	Existing	07+57.99		15.76'L,19.18'R	37.84	Perpendicular to tracks - Protect in place
Electric	Existing	08+73.51		2.97'L,19.07'R	21.99	Perpendicular to tracks - Protect in place
Electric	Existing	09+00	10+00	20.93'R	100.11	Relocate
Sanitary	24" Existing	09+00	10+00	22.13'R	100	Relocate
Telephone	Existing	09+25	10+25	31.36	100	Relocate
Water	Exsiting	09+50	11+50	42.63'R	200	Relocate
Sanitary	Exsiting	09+50	11+50	44.40'R	200	Relocate
Electric	Exsiting	09+50	11+50	47.17'R	200	Relocate

Alignment Option
B3
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Electric	24" Existing	(-)01+7.29	(-)7+37.36	1.68' L, 46.05'L	843.088	Relocate
Electric	24" Existing	(-)01+8.60	00+43.87	0.63' L, 13.14'L	136.7	Relocate
Electric	24" Existing	(-)01+7.30	01+00.00	1.46' L,19.68'L	198.85	Relocate
Electric	Existing	(-)01+7.34	00+22.97	9.42' R,22.62'L	127.04	Protect in place
Electric	Existing	(-)01+89.07	00+32.90	21.21' R,17.32'R	79.51	Protect in place
Electric	Existing	(-)01+12.11	05+33.99	42.08' L,49.99'L	622.58	Relocate
Electric	Existing	07+63.33	09+00	46.31' L,34.16'L	141.46	Relocate
Electric	Existing	02+50.00	08+51.95	1.02' R,31.27'L	660.15	Protect in place
Electric	Existing	00+57.32	00+72.40	1.02' R,31.27'L	20.27	Protect in place
Electric	Existing	06+54.03	14+48.42	1.21' L,1.26'L	794.16	Protect in place
Electric	Existing	(-)01+4.25	00+43.54	21.71' R,12.58'R	90.04	Perpendicular to tracks - Protect in place
Electric	Existing	00+50	02+32.10	46.41' R,44.75'R	192.73	Relocate
Gas	Existing	(-)01+7.31	00+40.88	3.63' R, 8.41' R	132.46	Relocate
Gas	12" Existing	08+50.00	14+49.31	9.64' R, 8.12' L	591.76	Relocate
Stormwater	Existing	(-)01+58.28		17.19' L, 17.62' R	34.85	Perpendicular to tracks - Protect in place
Electric	Existing	(-)01+78.32		19.32' L, 17.54' R	37.53	Perpendicular to tracks - Protect in place
Water	Existing	00+22.98		27.68' L, 30.86' R	59.73	Perpendicular to tracks - Protect in place
Electric	Existing	00+99.24		39.31'L, 28.85'L	10.58	Perpendicular to tracks - Protect in place
Electric	Existing	01+12.42		43.97'L, 29.32'L	14.97	Perpendicular to tracks - Protect in place
Electric	Existing	01+16.52		44.03'L, 29.40'L	14.87	Perpendicular to tracks - Protect in place

Alignment Option
B3
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Electric	Existing	08+73.09	09+92.34	20.63'R,21.56'R	118.12	Relocate
Electric	Existing	07+93.63	08+82.56	36.58'R,36.45'R	89.11	Relocate
Electric	Existing	08+73.05		19.79'R,35.11'R	15.4	Perpendicular to tracks - Protect in place
Electric	Existing	03+14.31	08+91.45	45.91'R,52.74'R	578.53	Relocate
Sanitary Sewer	18" Existing	01+36.34		41.82'L, 29.43'L	38.31	Perpendicular to tracks - Protect in place
Sanitary Sewer	Existing 3'Sanitary Sewer	01+36.34		12.62'L, 44.45'L	64.41	Perpendicular to tracks - Protect in place
Stormwater	Existing	07+63.68	08+61.54	24.24'L,23.60'L	197.71	Relocate
Sanitary Sewer	Existing 24"	08+31.09	09+43.57	21.17'R,21.65'R	116.51	Relocate
Sanitary Sewer	Existing 4'-6"	03+53.25	03+64.77	41.17'R	19.13	Perpendicular to tracks - Protect in place
Telephone	Existing	(-)01+78.94	01+58.83	33.66'R, 38.86'R	178.48	Relocate
Telephone	Existing	00+37.61	08+58.75	40.52'R, 45.21'R	821.04	Relocate
Telephone	Existing	07+76.44	08+35.59	31.23'R,31.61'R	159.83	Relocate
Water	Existing	01+36.45		44.27' L, 46.69' R	90.97	Perpendicular to tracks - Protect in place

Alignment Option
C1
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Gas	Existing	25+66.99	25+82.85	15.65' L, 15.49' L	123.76	Relocate
Water	Existing	25+01.78	25+28.98	16.81'R, 30.17' L	54.28	perpendicular to tracks - Protect in place
Stormwater	10" Existing	28+03.82	28+31.82	0.66'R, 11.72' L	55.83	perpendicular to tracks - Protect in place
Stormwater	18" Existing	29+00	32+25.49	19.32'R, 4.74'R	309.51	Relocate
Telephone	Existing	30+47.46	32+73.01	32.64'R,47.15'L	219.05	Relocate
Telephone	Existing	32+2.29		33.38'R,43.11'R	9.93	perpendicular to tracks - Protect in place
Telephone	Existing	32+3.12		33.38'R,43.11'R	9.18	perpendicular to tracks - Protect in place
Telephone	Existing	32+00	32+27.29	29.98'R	24.05	perpendicular to tracks - Protect in place
Electric	Existing	30+77.12	32+31.63	36.44'R, 28.14'R	143.3	Relocate
Water	16" Water Line Abandoned	31+15.00	31+82.72	7.35'R,1.64'R	69.36	Remove Abandoned Facility
Stormwater	Existing	31+69.62		12.72'R,25.83'R	13.29	perpendicular to tracks - Protect in place
Stormwater	21" Existing	32+11.60	32+50.29	2.87'L,12.26'R	44.62	perpendicular to tracks - Protect in place
Sanitary Sewer	21" Existing	32+42.08	32+65.19	1.64'R,0.399'R	23.36	perpendicular to tracks - Protect in place
Stormwater	24" Existing	32+70.94	32+62.97	25.64'L,2.49'R	27.71	perpendicular to tracks - Protect in place
Sanitary Sewer	24" Existing	31+55.66	31+85.29	46.71'R,46.48'R	32.29	Relocate
Sanitary Sewer	3'-9" Existing	128+32.39	130+35.02	40.32'L,27.61'L	205.72	Relocate
Sanitary Sewer	Existing	128+69.21	128+98.52	10.75'R,8.98'R	29.73	perpendicular to tracks - Protect in place
Stormwater	15" Existing	129+22.47	129+43.62	35.43'L,28.33'R	71.27	perpendicular to tracks - Protect in place
Electric	Existing	30+97.46	32+71.19	26.12'R,10.67'R	172.32	Relocate
Electric	Existing	32+13.03	32+8.48	3.41'L,39.53'R	43.18	Protect in place

Alignment Option
C1
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Electric	Existing	129+5.89	129+25.05	38.80'L,14.35'R	56.87	perpendicular to tracks - Protect in place
Electric	Existing (OVH)	128+98.43		38.82'L,23.17'R	62.8	perpendicular to tracks - Protect in place
Electric	Existing	129+18.60	129+8.01	13.54'R,26.61'R	17.06	perpendicular to tracks - Protect in place
Electric	Existing	129+10.02	129+32.42	38.84'L,28.53'R	71.08	perpendicular to tracks - Protect in place
Water	20" Existing	32+25.72		116.63'L,36.39'R	150.83	perpendicular to tracks - Protect in place
Water	12" Existing	32+42.92	32+41	1.08'R,21.33'R	20.75	perpendicular to tracks - Protect in place
Water	Existing	130+28.56	130+27.28	12.06'R,25.76'R	13.91	perpendicular to tracks - Protect in place
Sanitary Sewer	12" Existing	32+36.65	32+29.85	5.19'R,25.59'R	20.91	perpendicular to tracks - Protect in place
Sanitary Sewer	Existing	128+72.87	128+74.14	45.22'L,13.93'R	59.12	perpendicular to tracks - Protect in place
Gas	Existing	129+46.01	130+67.16	38.82'L,27.77'L	124.96	Relocate
Gas	Existing	130+6.29	130+0.64	29.96'L,27.85'R	58.07	Relocate
Telephone	Existing	130+14.60	130+90.37	12.96'R,11.99'R	76.32	Relocate
Telephone	Existing	31+92.53	33+00	63.62'R,4.22'L	149.63	Relocate
Stormwater	Existing	30+18.16		3.07'R,31.90'R	29.23	perpendicular to tracks - Protect in place

Alignment Option
C2
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Gas	Existing	25+66.99	25+82.85	15.65' L, 15.49' L	123.76	Relocate
Water	Existing	25+01.78	25+28.98	16.81'R, 30.17' L	54.28	perpendicular to tracks - Protect in place
Stormwater	10" Existing	28+03.82	28+31.82	0.66'R, 11.72' L	55.83	perpendicular to tracks - Protect in place
Stormwater	18" Existing	29+00	32+25.49	19.32'R, 4.74'R	309.51	Relocate
Telephone	Existing	30+47.46	32+73.01	32.64'R,47.15'L	219.05	Relocate
Telephone	Existing	32+2.29		33.38'R,43.11'R	9.93	perpendicular to tracks - Protect in place
Telephone	Existing	32+3.12		33.38'R,43.11'R	9.18	perpendicular to tracks - Protect in place
Telephone	Existing	32+00	32+27.29	29.98'R	24.05	perpendicular to tracks - Protect in place
Telephone	Existing	30+29.79	32+53.52	13'R, 7.2' L	173.81	Relocate
Electric	Existing	30+77.12	32+31.63	36.44'R, 28.14'R	143.3	Relocate
Water	16" Water Line Abandoned	31+15.00	31+82.72	7.35'R,1.64'R	106.02	Remove Abandoned Facility
Stormwater	21" Existing	32+11.60	32+50.29	2.87'L,12.26'R	44.62	perpendicular to tracks - Protect in place
Stormwater	21" Existing	32+33.27	32+50.43	7.4'R,12.23'R	18.86	perpendicular to tracks - Protect in place
Sanitary Sewer	21" Existing	32+33.39	32+60.26	2.01'R,0.66'R	27.24	perpendicular to tracks - Protect in place
Stormwater	24" Existing	32+70.94	32+62.97	25.64'L,2.49'R	27.71	perpendicular to tracks - Protect in place
Sanitary Sewer	24" Existing	31+55.66	31+85.29	46.71'R,46.48'R	32.29	Relocate
Sanitary Sewer	3'-9" Existing	128+32.39	130+35.02	40.32'L,27.61'L	205.72	Relocate
Sanitary Sewer	Existing	128+69.21	128+98.52	10.75'R,8.98'R	29.73	perpendicular to tracks - Protect in place
Electric	Existing	30+97.46	32+71.19	26.12'R,10.67'R	172.32	Relocate
Electric	Existing	30+97.38	32+42.91	26.17'R,11.97'R	94.43	Relocate

Alignment Option
C2
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Electric	Existing	32+13.03	32+8.48	3.41'L,39.53'R	43.18	Protect in place
Electric	Existing	129+5.89	129+25.05	38.80'L,14.35'R	56.87	perpendicular to tracks - Protect in place
Electric	Existing (OVH)	128+98.43		38.82'L,23.17'R	62.8	perpendicular to tracks - Protect in place
Electric	Existing	129+18.60	129+8.01	13.54'R,26.61'R	17.06	perpendicular to tracks - Protect in place
Electric	Existing (OVH)	129+10.02	129+32.42	38.84'L,28.53'R	71.08	perpendicular to tracks - Protect in place
Water	20" Existing	32+25.72		101.12'L,29.81'R	132.27	perpendicular to tracks - Protect in place
Water	12" Existing	32+44.68	32+37.94	5.27'L,15.06'R	20.59	perpendicular to tracks - Protect in place
Water	Existing	130+28.56	130+27.28	12.06'R,25.76'R	13.91	perpendicular to tracks - Protect in place
Sanitary Sewer	12" Existing	32+38.93	32+38.07	1.52'L,18.77'R	20.68	perpendicular to tracks - Protect in place
Sanitary Sewer	Existing	128+72.87	128+74.14	45.22'L,13.93'R	59.12	perpendicular to tracks - Protect in place
Gas	2" Existing	129+46.01	130+67.16	38.82'L,27.77'L	124.96	Relocate
Gas	12" Existing	130+6.29	130+0.64	29.96'L,27.85'R	58.07	Relocate
Telephone	Existing	130+14.60	130+90.37	12.96'R,11.99'R	76.32	Relocate
Telephone	Existing	31+92.53	33+00	63.62'R,4.22'L	149.63	Relocate
Stormwater	Existing	30+18.16		3.07'R,31.90'R	29.23	perpendicular to tracks - Protect in place

Alignment Option
C3
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Water	Existing	25+01.78	25+28.98	16.81'R, 30.17' L	54.28	perpendicular to tracks - Protect in place
Gas	Existing	25+70.14	25+62.49	6.57'R,20.47'R	16.14	perpendicular to tracks - Protect in place
Stormwater	18" Existing	25+68.79	29+89.57	25.01'R,18.89'R	431.82	Relocate
Sanitary Sewer	10" Existing	28+36.20	27+97.86	37.77'L,28.04'R	77.01	perpendicular to tracks - Protect in place
Sanitary Sewer	Existing	32+80.07		2.88'L,31.61'R	34.61	perpendicular to tracks - Protect in place
Stormwater	18" Existing	31+45.52	32+10.21	7.33'R,8.32'R	64.29	Relocate
Stormwater	Existing	31+70.48		17.25'R,28.29'R	17.78	perpendicular to tracks - Protect in place
Stormwater	Existing	32+78.87	32+99.38	1.82'L,32.47'L	34.52	Relocate
Sanitary Sewer	24" Existing	30+00	31+6.45	47.82'R,47.11'R	106.46	Relocate
Sanitary Sewer	15" Existing	32+44.99	32+62.19	41.11'R,44.29'R	18.37	perpendicular to tracks - Protect in place
Sanitary Sewer	10" Existing	32+23.28	32+97.46	17.86'L,20.88'L	75.02	perpendicular to tracks - Protect in place
Sanitary Sewer	Existing	32+30.28	32+34.85	49.77'R,62.69'R	14.73	perpendicular to tracks - Protect in place
Stormwater	Existing	32+14.16	32+15.84	31.12'R,49.69'R	19.26	perpendicular to tracks - Protect in place
Sanitary Sewer	3'-9" Existing	128+73.32	130+59.23	29.88'L,27.61'L	184.75	Relocate
Stormwater	15" Existing	129+22.47	129+43.62	35.43'L,28.33'R	71.27	perpendicular to tracks - Protect in place
Stormwater	21" Existing	32+71.61	32+88.77	12.21'R,8.85'R	17.29	perpendicular to tracks - Protect in place
Stormwater	21" Existing	32+5.40	32+16.20	8.39'L,0.87'R	16.19	perpendicular to tracks - Protect in place
Water	30" Existing	28+82.95	29+87.85	50.03'R,51.50'R	303.75	Relocate
Water	4" Existing	31+38.99	32+3.92	66.18'R,72.52'R	55.3	Relocate
Water	8" Existing	32+25.69		51.05'R,67.18'R	16.32	perpendicular to tracks - Protect in place

Alignment Option
C3
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Water	16" Existing	32+27.99	32+51.69	53.04'R,52.74'R	23.45	Relocate
Water	20" Existing	128+66.38	129+66.82	40.74'L,24.35'L	101.6	Relocate
Water	Existing	32+12.18		56.05'R,70.72'R	15.01	perpendicular to tracks - Protect in place
Water	Existing	32+19.46		69.53'R,63.07'R	11.05	perpendicular to tracks - Protect in place
Gas	4" Gas Line Abandoned	30+75.05	31+98.89	57.79'R,73.94'R	139.27	Remove Abandoned Facility
Gas	2" Existing	129+46.01	130+67.16	38.82'L,27.77'L	124.96	Relocate
Gas	12" Existing	129+10.72	130+90.35	45.17'L,27.86'L	183.63	Relocate
Telephone	Existing	32+1.12	31+91.14	57.69'R,70.01'R	18.17	perpendicular to tracks - Protect in place
Telephone	Existing	32+61.47	32+79.48	26.10'R,24.64'R	18.28	perpendicular to tracks - Protect in place
Telephone	Existing	32+78.97	32+93.71	3.26'L,3.97'L	14.89	perpendicular to tracks - Protect in place
Telephone	Existing	32+3.82	32+4.28	57.14'R,71.66'R	14.66	perpendicular to tracks - Protect in place
Telephone	Existing	30+29.79	32+53.52	13'R, 7.2' L	183.43	Relocate
Telephone	Existing	129+23.48	129+90.39	2.78'R,11.98'R	163.39	Relocate
Electric	Existing	28+50.00	31+15.35	19.14'L,20.79'L	263.17	Relocate
Electric	Existing	29+11.45	30+58.54	36.13'R,36.43'R	120.82	Relocate
Electric	Existing	31+87.69	31+79.82	70.71'R,57.83'R	14.96	perpendicular to tracks - Protect in place
Electric	Existing	32+19.78	32+21.45	42.68'R,57.30'R	15.66	perpendicular to tracks - Protect in place
Electric	Existing	32+23.39	32+47.09	56.68'R,55.87'R	24.05	Relocate
Electric	Existing	32+72.50	32+88.16	10.49'R,9.79'R	15.87	perpendicular to tracks - Protect in place
Electric	Existing	32+14.68	32+12.35	16.36'L,3.74'R	20.17	perpendicular to tracks - Protect in place

Alignment Option
C3
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Electric	Existing	128+93.09	128+69.76	43.25'L,27.68'R	74.78	perpendicular to tracks - Protect in place
electric	Existing (OVH)	128+98.43		38.82'L,23.17'R	68.8	perpendicular to tracks - Protect in place
electric	Existing (OVH)	129+10.02	129+32.42	38.84'L,28.53'R	70.82	perpendicular to tracks - Protect in place
electric	Existing	129+19.03	129+7.18	13.22'R,27.73'R	18.77	perpendicular to tracks - Protect in place

Alignment Option
D1
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Gas	12" Wrapped	148+14.77	150+33.55	17.15'L, 26.89'L	210.5	Relocate
Water	16" RCP Existing	145+17.71	145+54.44	12.58'L, 12.05'R	47.51	Relocate
Telephone	Existing	145+04.17	145+24.98	26.77'L, 11.74'R	47.34'	perpendicular to tracks - Protect in place
Stormwater	42" RCP Existing	148+33.49	150+33.55	31.12L, 31.09 L	200.05	Relocate
Electric	Existing	148+45.48	150+33.55	32.26L, 32.59' L	188.07	Relocate
Stormwater	15" Existing	148+87.82	148+93.88	38.95'L, 12.28'L	27.9'	perpendicular to tracks - Protect in place
Stormwater	15" Existing	148+62.41	148+71.27	23.29'L, 37.49L	16.7	perpendicular to tracks - Protect in place
Electric	Existing	148+63.54	148+89.04	46.74' L, 9.78'L	36.78'	perpendicular to tracks - Protect in place
Stormwater	Existing	145+72.21	145+78.96	24.61' L, 12.05' R	37.28'	perpendicular to tracks - Protect in place
Electric	Existing	144+86.18	146+01.88	4.58'R, 12.05'R	115.04	Relocate
Water	8" Existing	148+72.9	148+80.92	16.39' L, 4.11'L	15.38'	Relocate
Water	Existing	145+16.39	145+27.76	11.47' R, 12.43' L	24.09'	perpendicular to tracks - Protect in place
Electric	Existing	145+06.48	145+08.46	26.33'L, 11.23' R	37.63'	perpendicular to tracks - Protect in place
Water	Existing	144+21.01	145+42	2.41'R, 16.78'L	126.51	Relocate
Electric	Existing	144+86.28	144+95.04	4.58'R,27.92'L	31.68	Relocate
Electric	Existing	143+00.11	145+37.19	27.49' R, 12.02' R	240.27	Relocate
Telephone	Existing	133+59.95	144+90.88	13.05'R, 11.25' R	1136.93'	Relocate
Electric	Existing	143+57.92	144+84.89	30.29'L,0.63'	133.91	perpendicular to tracks - Protect in place
Stormwater	15" Existing	144+71.83	144+85.26	30.5'L, 22.84' L	16.38'	perpendicular to tracks - Protect in place
Electric	Existing	143+91.71	144+94.17	30.75'L, 27.98' L	110.96'	perpendicular to tracks - Protect in place

Alignment Option
D1
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Sanitary sewer	12" Existing	143+84.6	144+35.75	7.10R, 15.22'R	51.27	perpendicular to tracks - Protect in place
Gas	Existing	138+67.24	144+30.40	25.75'L, 31.98' L	566.2	Relocate
Stormwater	42" Existing	142+60.51	143+81.95	19.23'L, 30.50'L	95.2	Relocate
electric	existing	142+89.61	143+01.51	30.89' L, 27.42' R	59.56'	perpendicular to tracks - Protect in place
Stormwater	21" Existing	142+89.28	142+89.98	30.89' L, 28.17' R	59.27'	perpendicular to tracks - Protect in place
Stormwater	15" Existing	142+12.5	142+87.42	29.19'L,19.23'L	76.17	Relocate
Sanitary sewer	12" Existing	142+62.47	142+68.13	10.72' R, 29.31' R	16	perpendicular to tracks - Protect in place
Water	Existing	142+66.23	142+71.07	14.68'R, 29.23'R	15.34	perpendicular to tracks - Protect in place
Water	Existing	142+40	142+47	29.5'L, 16.4'L	14.56	perpendicular to tracks - Protect in place
Gas	3" Wrapped	142+24	142+24	13.16'L, 27.84'L	14.67	perpendicular to tracks - Protect in place
Water	12" Existing	141+81.96	141+90.71	31.42'L, 29.57' L	56.98'	Relocate
Electric	Existing	129+67.64	138+76	18.18' L, 19.59'L	903.42	Relocate
Gas	6" Gas Line Abandoned	137+40.03	138+21.49	0.76'L, 0.98'L	82	Remove Abandoned Facility
Sanitary sewer	10" Existing	135+33.54	136+69.69	2.39' L, 1.13' L	136.02	Relocate
abandoned (DATR)		135+59.89	136+19.44	1.06'L, 1.03'L	59.53	Relocate
Stormwater	15" Existing	133+72.56	133+73.93	22.76'L, 15.13'R	38.22'	perpendicular to tracks - Protect in place
Stormwater	15" Existing	133+40	133+72.5	21.81'L, 22.76'L	32.41	Relocate
Water	Existing	134+03.17	134+03.17	25.05'L, 14.89'L	10	perpendicular to tracks - Protect in place
Water	8" Existing	133+80	133+80	16' R, 1.2'R	15	perpendicular to tracks - Protect in place
Electric	Existing	133+08.79	133+09.19	10.98'L, 24.79'L	13.81'	perpendicular to tracks - Protect in place

Alignment Option
D1
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Stormwater	21" Existing	128+89.31	133+71.71	1.08'R, 7.63'L	481.97	Relocate
Sanitary Sewer	Existing	130+63.25	133+56.37	2.02'L, 2.05'L	293.12	Relocate
Electric	Existing OVERHEAD	131+46.53	131+60.07	11.8' R, 24.79	39.33	perpendicular to tracks - leave in place
Water	12" Existing	131+30.29	131+45.39	1.97'R, 24.79' L	30.72'	perpendicular to tracks - Protect in place
Water	12" Existing	128+74.07	131+30.29	20.83' L, 1.97' R	258.05	Relocate
Water	Existing	130+29.1	130.29.47	14.24'R, 4.51'R	9.73	perpendicular to tracks - Protect in place
Telephone	Existing	128+53	130+59.02	20.83'L, 12.87'R	209.24	perpendicular to tracks - Protect in place
Electric	Existing	129+16.64	129+67.52	17.92' L, 15.62' R	61.29	perpendicular to tracks - Protect in place
Water	Existing	129+80	139+60	21.22'L, 12'L	964'	Relocate
Electric	Existing	129+34.42	129+67.52	15.53'R, 17.92'L	46.38	perpendicular to tracks - Protect in place
Sanitary sewer	12" Existing	129+00.27	129+86.12	20.83'L, 6.35' L	87.46	Relocate
Sanitary sewer	Existing	129+35.05	129+66.32	20.83L, 18.31'L	31.62	Protect in place
Stormwater	Existing	129+68.74	130+51.79	17.94'L, 15.18' L	85.51	Remove Abandoned Facility
Water	Existing	129+48.68	130+54.89	20.83'L, 11.37'L	109.19	Remove Abandoned Facility
Gas	12" wrapped	130+01.97	130+05.26	15.04'R, 21.41'L	36.59	perpendicular to tracks - Protect in place
Stormwater	Existing	126+60.39	130+12.01	15.34' R, 11.86'R	351.05	Relocate
Stormwater	Existing	126+83.78	127+88.29	6.17'L, 20.83'L	107.14	Relocate
Stormwater	45" Existing	126+60.33	126+98.02	3.21' R, 1.99' R	37.71	Relocate
Electric	Existing (OVH)	131+46.53	131+60.07	11.8' R, 24.79	39.33	perpendicular to tracks - Protect in place
Electric	Existing (OVH)	130+28.09	131+57.45	22.23' L,21.89'L	130.49	Relocate

Alignment Option
D1
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Electric	Existing	127+98.34	127+98.65	20.83L, 16.17' R	37.01	perpendicular to tracks - Protect in place
Water	Existing	128+00.68	128+01.49	16.17'R, 20.83'L	37.01	perpendicular to tracks - Protect in place
Cable line	Existing	128+17.05	128+20.03	20.83'L, 16.08' R	37.03	perpendicular to tracks - Protect in place
Sanitary sewer	15" Existing	128+06.82	128+14.29	16.14'R, 20.83'L	37.72	perpendicular to tracks - Protect in place
Telephone	Existing	128+76.87	128+78.99	20.83'L, 16.03'R	36.93	perpendicular to tracks - Protect in place
Electric	Existing	128+32.15	128+40.39	20.83'L, 15.98' R	38.02	perpendicular to tracks - Protect in place
Stormwater	21" Existing	128+43.53	128+43.86	15.97'R, 20.83'L	37.83	perpendicular to tracks - Protect in place
Electric	Existing	128+42.65	128+43.56	20.83'L, 15.96'R	36.81	perpendicular to tracks - Protect in place
Stormwater	21" Existing	128+53.13	128+54.43	20.83'L, 15.19'R	36.77	perpendicular to tracks - Protect in place
Cable line	Existing	128+56.21	128+57.13	20.83'L, 15.9'R	36.75	perpendicular to tracks - Protect in place
Electric	Existing	128+60.5	128+67.13	20.83'L, 15.86'R	37.25	perpendicular to tracks - Protect in place
Sanitary sewer	10" Existing	128+73.16	128+73.47	20.83'L, 15.82'R	36.66	perpendicular to tracks - Protect in place
Electric	Existing	128+74.48	128+87.72	15.82'R, 20.83'L	38.97	perpendicular to tracks - Protect in place
Electric	Existing	128+95.94	129+01.63	20.83'L, 15.72'R	36.9	perpendicular to tracks - Protect in place
Stormwater	Existing	128+48.81	128+69.62	1.27'R, 15.84'L	25.41	perpendicular to tracks - Protect in place

Alignment Option
D2
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Water	Existing	145+33.38	145+48	8.56'L, 6.054'R	20.9	perpendicular to tracks - Protect in place
Water	Existing	145+16.7	145+17.5	6.06'R, 8.78'L	14.86	perpendicular to tracks - Protect in place
Gas	2" Wrapped	145+06.79	145+07.59	5.81'R, 8.85'L	14.68	perpendicular to tracks - Protect in place
Telephone	Existing	145+05.3	145+24.98	8.86'L, 11.74'R	29.11	perpendicular to tracks - Protect in place
Water	Existing	144+20.92	144+85.48	2.42'R, 9'L	65.1	Relocate
Electric	Existing	144+11.62	144+86.28	9.45'L, 8.96'L	87.12	Relocate
Sanitary sewer	12" Existing	142+81.09	143+50	0.55'R, 4.97'R	69.05	Relocate
Gas	6" Steel Gas Line Abandoned	142+82.56	144+07.52	3.21'R, 9.46'L	116.17	Remove Abandoned Facility
Stormwater	21" Existing	142+87.78	142+89.55	12.83'L,20.06'R	32.94	Relocate
Electric	Existing	142+92.86	142+99.12	11.66'L, 17.69'R	30	Relocate
Gas	Existing	138+50.00	143+00.00	25.75'L, 16.16' L	445.68	Relocate
Stormwater	15" Existing	142+12.5	142+60.3	29.19'L,20.90'L	49.17	Relocate
Sanitary sewer	Existing	142+62.47	142+66.78	10.72'R,24.89'R	14.8	perpendicular to tracks - Protect in place
Water	Existing	142+64.78	142+69.47	10.72'R,24.41'R	14.8	perpendicular to tracks - Protect in place
Water	20" Existing	412+28.18	146+43.50	7.74'L,16.85'L	319.23	Relocate
Telephone	Existing	133+59.95	142+15.6	13.05'R,25.08' R	915.93	Relocate
Gas	3" Wrapped	142+24	142+24	13.16'L, 27.84'L	14.67	perpendicular to tracks - Protect in place
Gas	2" Wrapped	136+31.32		25.09'L,21.83'R	47.91	perpendicular to tracks - Protect in place
Water	Existing	129+80	139+40	20.22'L, 11.50'L	946	Relocate
Electric	Existing	129+67.64	138+76	18.18' L, 19.59'L	903.42	Relocate
Stormwater	15" Existing	133+72.56	133+73.93	22.76'L, 15.13'R	38.22	perpendicular to tracks - Protect in place

Alignment Option
D2
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Stormwater	15" Existing	133+40	133+72.5	21.81'L, 22.76'L	32.41	
Water	Existing	134+03.17	134+03.17	25.05'L, 14.89'L	10	perpendicular to tracks - Protect in place
Water	8" Existing	133+80	133+80	16' R, 1.2'R	15	perpendicular to tracks - Protect in place
Electric	Existing	133+08.79	133+09.19	10.98'L, 24.79'L	13.81	perpendicular to tracks - Protect in place
Stormwater	21" Existing	128+89.31	133+71.71	1.08'R, 7.63'L	481.97	Relocate
Sanitary Sewer	Existing	130+63.25	133+56.37	2.02'L, 2.05'L	293.12	Relocate
Electric	Existing (OVH)	131+46.53	131+60.07	11.8' R, 24.79R	39.33	perpendicular to tracks - leave in place
Water	12" Existing	131+30.29	131+45.39	1.97'R, 24.79' L	30.72'	perpendicular to tracks - Protect in place
Water	12" Existing	128+74.07	131+30.29	20.83' L, 1.97' R	258.05	Relocate
Water	Existing	130+29.1	130.29.47	14.24'R, 4.51'R	9.73	perpendicular to tracks - Protect in place
Telephone	Existing	128+53	130+59.02	20.83'L, 12.87'R	209.24	crosses both tracks
Electric	Existing	129+16.64	129+67.52	17.92' L, 15.62' R	61.29	perpendicular to tracks - Protect in place
Water	Existing	129+80	139+60	21.22'L, 12'L	964'	Relocate
Electric	Existing	129+34.42	129+67.52	15.53'R, 17.92'L	46.38	perpendicular to tracks - Protect in place
Sanitary sewer	12" Existing	129+00.27	129+86.12	20.83'L, 6.35' L	87.46	Relocate
Sanitary sewer	Existing	129+35.05	129+66.32	20.83L, 18.31'L	31.62	protect in place
Stormwater	Stormwater Line Abandoned	129+68.74	130+51.79	17.94'L, 15.18' L	85.51	Remove Abandoned Facility
Water	Water Line Abandoned	129+48.68	130+54.89	20.83'L, 11.37'L	109.19	Remove Abandoned Facility
Gas	12" Wrapped	130+01.97	130+05.26	15.04'R, 21.41'L	36.59	perpendicular to tracks - Protect in place
Stormwater	Existing	126+60.39	130+12.01	15.34' R, 11.86'R	351.05	Relocate
Stormwater	Existing	126+83.78	127+88.29	6.17'L, 20.83'L	107.14	Relocate

Alignment Option
D2
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Stormwater	45" Existing	126+60.33	126+98.02	3.21' R, 1.99' R	37.71	Relocate
Electric	Existing (OVH)	131+46.53	131+60.07	11.8' R, 24.79	39.33	perpendicular to tracks - protect in place
Electric	Existing (OVH)	130+28.09	131+57.45	22.23' L,21.89'L	130.49	Relocate
Electric	Existing	127+98.34	127+98.65	20.83L, 16.17' R	37.01	perpendicular to tracks - Protect in place
Water	Existing	128+00.68	128+01.49	16.17'R, 20.83'L	37.01	perpendicular to tracks - Protect in place
Cable line	Existing	128+17.05	128+20.03	20.83'L, 16.08' R	37.03	perpendicular to tracks - Protect in place
Sanitary sewer	15" Existing	128+06.82	128+14.29	16.14'R, 20.83'L	37.72	perpendicular to tracks - Protect in place
Telephone	Existing	128+76.87	128+78.99	20.83'L, 16.03'R	36.93	perpendicular to tracks - Protect in place
Electric	Existing	128+32.15	128+40.39	20.83'L, 15.98' R	38.02	perpendicular to tracks - Protect in place
Stormwater	21" Existing	128+43.53	128+43.86	15.97'R, 20.83'L	37.83	perpendicular to tracks - Protect in place
Electric	Existing	128+42.65	128+43.56	20.83'L, 15.96'R	36.81	perpendicular to tracks - Protect in place
Stormwater	21" Existing	128+53.13	128+54.43	20.83'L, 15.19'R	36.77	perpendicular to tracks - Protect in place
Cable line	Existing	128+56.21	128+57.13	20.83'L, 15.9'R	36.75	perpendicular to tracks - Protect in place
Electric	Existing	128+60.5	128+67.13	20.83'L, 15.86'R	37.25	perpendicular to tracks - Protect in place
Sanitary sewer	10" Existing	128+73.16	128+73.47	20.83'L, 15.82'R	36.66	perpendicular to tracks - Protect in place
Electric	Existing	128+74.48	128+87.72	15.82'R, 20.83'L	38.97	perpendicular to tracks - Protect in place
Electric	Existing	128+95.94	129+01.63	20.83'L, 15.72'R	36.9	perpendicular to tracks - Protect in place
Stormwater	Existing	128+48.81	128+69.62	1.27'R, 15.84'L	25.41	perpendicular to tracks - Protect in place
Gas	Existing	127+65.47		20.75'L,16.54'R	37.76	perpendicular to tracks - Protect in place

Alignment Option
E1A
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Gas	Existing	24+56.44	25+70.80	4.193'L,5.14'R	114.78	Relocate
Gas	Existing	25+70.46		1.55'L,13.18'R	16.91	Perpendicular to tracks - Protect in place
Water	Existing	25+11.51		29.93'L,11.42'R	47.71	Perpendicular to tracks - Protect in place
Sewer Line	10" Existing	28+16.24		29.49'L,11.41'R	47.65	Perpendicular to tracks - Protect in place
Sewer Line	18" Existing	29+00	32+17.75	20.60'R,3.07'R	354.25	Relocate
Sewer Line	Existing	30+16.54		3.04'R,17.24'R	12.35	Perpendicular to tracks - Protect in place
Water	16" Water Line Abandoned	30+76.84	31+82.80	18.55'R,19.46'R	105.98	Remove Abandoned Facility
Sewer Line	Existing	30+16.54		3.04'R,17.24'R	12.35	Perpendicular to tracks - Protect in place
Sewer Line	Existing	31+69.86		12.64'R,33.04'R	21	Perpendicular to tracks - Protect in place
Electric	Existing	30+97.31	32+57.57	26.16'R,11.26'R	157.46	Relocate
Telephone	Existing	30+91.43	32+46.50	30.86'R,0.69'R	156.78	Relocate
Telephone	Existing	32+3.33	32+9.27	30.86'R,0.69'R	100.1	Relocate
Telephone	Existing	30+80.13	34+41.23	29.77'R,24.28'R	234.91	Relocate
Sanitary Sewer	Existing	32+31.38		8.27'R,24.22'R	35.64	Perpendicular to tracks - Protect in place
Sanitary Sewer	Existing	32+10.31	33+99.53	21.56'L,25.62'L	89.3	Relocate
Water	20" Existing	32+17.54		9.75'R,41.95'R	32.65	Perpendicular to tracks - Protect in place
Water	12" Existing	32+17.54		9.75'R,41.95'R	36.89	Perpendicular to tracks - Protect in place
Stormdrain	45" Existing	32+59.74		6.31'L,36.29'R	42.68	Perpendicular to tracks - Protect in place
Electric	Existing	32+85.58		21.53'R,36.26'R	14.71	Perpendicular to tracks - Protect in place
Electric	Existing	32+93.72		22.31'R,37.03'R	14.81	Perpendicular to tracks - Protect in place

Alignment Option
E1A
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Gas	12" Existing	33+15.76		21.97'L,38.06'R	60.68	Perpendicular to tracks - Protect in place
Electric	Existing	32+98.05	33+71.35	16.11'L,19.84'L	74.4	Relocate
Sanitary Sewer	Existing	32+80.12			47.93	Perpendicular to tracks - Protect in place
Water	Existing	33+22.35	33+51.32	9.75'R,41.95'R	36.89	Relocate
Water	Existing	33+27.97		33.52'R,38.24'R	4.84	Perpendicular to tracks - Protect in place
Water	Existing	33+49.29		31.83'R,37.36'R	5.53	Perpendicular to tracks - Protect in place
Water	Existing	33+49.29		31.83'R,37.36'R	5.53	Perpendicular to tracks - Protect in place
Electric	Existing	35+21.85		60.90'L,46.28'L	14.98	Perpendicular to tracks - Protect in place
Electric	Existing	33+42.31	35+22.92	36.47'L,41.34'L	178.63	Relocate
Water	8" Existing	36+41.69		52.29'L,0.37'L	51.79	Perpendicular to tracks - Protect in place
Sanitary Sewer	27" Existing	34+00	37+66.87	5.17'L,11.02'L	329.14	Relocate
Sanitary Sewer	Existing	36+91.86		13.24'L,1.05'R	15.99	Perpendicular to tracks - Protect in place
Sanitary Sewer	Existing	36+42.24		52.30'L,37.57'L	14.66	Perpendicular to tracks - Protect in place
Sanitary Sewer	Existing	36+51.61		52.30'L,37.06'L	16.41	Perpendicular to tracks - Protect in place

Alignment Option
E1B
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Refer to E1A						

Alignment Option
E1C
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Refer to E1A						

Alignment Option
E2
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Water	Existing	25+28.70	25+5.05	30.03'L,11.41'R	48.31	Perpendicular to tracks - Protect in place
Water	Existing	30+16.41	31+39.62	50.02'R,51.49'R	123.62	Relocate
Water	8" Existing	32+12.27	32+12.15	58.18'R,72.79'R	14.93	Perpendicular to tracks - Protect in place
Water	8" Existing	32+28.03	32+14.37	53.97'R,69.63'R	21.59	Perpendicular to tracks - Protect in place
Water	16" Existing	32+26.48	32+84.93	52.82'R,52.54'R	59.49	Perpendicular to tracks - Protect in place
Water	Existing	33+22.34	33+49.33	33.85'R,31.39'R	26.57	Relocate
Water	Existing	33+27.86	33+28.32	33.52'R,44.38'R	10.87	Perpendicular to tracks - Protect in place
Water	Existing	33+49.31	33+49.7	31.84'R,39.57'R	7.75	Perpendicular to tracks - Protect in place
Water	20" Existing	32+24.96	32+20.05	0.32'L,14.99'R	15.53	Perpendicular to tracks - Protect in place
Water	12" Existing	32+44.15	32+39.15	3.69'L,11.63'R	15.49	Perpendicular to tracks - Protect in place
Water	4" Existing	30+40.16	32+3.94	66.62'R,70.86'R	154.23	Relocate
Water	8" Existing	34+38.71	36+41.26	30.67'L,29.38'L	203.19	Relocate
Water	8" Existing	36+41.82	36+41.84	40.56'L,13.80'R	54.45	Perpendicular to tracks - Protect in place
Gas	Existing	25+23.05	25+15.17	1.42'R,15.57'R	16.33	Perpendicular to tracks - Protect in place
Gas	4" Gas Line Abandoned	30+75.05	31+98.89	57.79'R,73.94'R	139.27	Remove Abandoned Facility
Gas	12" Existing	33+7.17	33+79.89	49.64'R,33.09'R	83.63	Relocate
Gas	12" Existing	33+12.96	33+22.32	15.86'L,37.85'R	54.55	Perpendicular to tracks - Protect in place
Gas	2" Gas Line Abandoned	33+84.64	34+56.29	24.04'L,26.68'L	71.87	Remove Abandoned Facility
Electric	Existing	28+50	30+79.92	36.02'R,36.52'R	229.03	Relocate
Electric	Existing	29+38.87	30+50	19.31'L,21.33'L	113.83	Relocate

Alignment Option
E2
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Electric	Existing	31+87.69	31+79.82	70.71'R,57.83'R	14.96	perpendicular to tracks - Protect in place
Electric	Existing	32+19.78	32+21.45	42.68'R,57.30'R	15.66	perpendicular to tracks - Protect in place
Electric	Existing	32+23.31	32+75.36	56.62'R,54.99'R	53.79	Relocate
Electric	Existing	32+76.89	32+74.42	40.13'R,55.23'R	15.11	perpendicular to tracks - Protect in place
Electric	Existing	32+93.15	33+2.80	35.95'R,50.78'R	14.93	perpendicular to tracks - Protect in place
Electric	Existing	32+12.68	32+11.01	1.43'R,16.21'R	14.83	perpendicular to tracks - Protect in place
Electric	Existing	33+00	34+35.40	16.95'L,22.53'L	137.25	Relocate
Electric	Existing	33+72.57	34+23.24	28.43'L,22.46'L	50.62	Relocate
Electric	Existing	33+42.31	35+22.92	36.47'L,41.34'L	178.63	Relocate
Electric	Existing	34+28.55	34+23.71	9.39'R,23.88'R	15.14	perpendicular to tracks - Protect in place
Electric	Existing	34+76.89	34+79.69	24.70'L,33.12'R	59.59	perpendicular to tracks - Protect in place
Telephone	Existing	32+1.12	31+91.14	57.69'R,70.01'R	18.17	perpendicular to tracks - Protect in place
Telephone	Existing	32+3.82	32+4.28	57.14'R,71.66'R	14.66	perpendicular to tracks - Protect in place
Telephone	Existing	32+51.37	32+33.93	4.95'L,12.54'R	22.79	perpendicular to tracks - Protect in place
Telephone	Existing	32+2.05	33+38.08	17.52'R,5.99'L	139.9	Relocate
Telephone	Existing	33+00	34+41.81	23.43'R,24.25'R	143.86	Relocate
Sanitary	10" Existing	28+36.26	27+97.97	37.64'L,28.06'R	76.41	perpendicular to tracks - Protect in place
Stormwater	18" Existing	26+76.58	28+99.84	23.18'R,19.94'R	222.06	Relocate
Stormwater	18" Existing	25+50	30+00	24.68'R,18.69'R	447.16	Relocate
Sanitary	Existing	32+79.41	32+77.91	9.87'L,4.84'R	15.15	perpendicular to tracks - Protect in place

Alignment Option
E2
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Stormwater	21" Existing	32+16.48	32+44.66	1.14'R,10.68'R	28.99	Diagonal to tracks - Protect in place
Sanitary	21" Existing	32+19.54	33+19.46	2.80'R,2.21'L	98.27	Relocate
Stormwater	15" Existing	32+54.06	32+45.69	24.56'L,7.68'L	18.77	perpendicular to tracks - Protect in place
Stormwater	Existing	36+92.19	36+85.97	6.89'L,8.62'R	17.12	perpendicular to tracks - Protect in place
Stormwater	24" Existing	37+16.87	37+66.11	9.71'L,10.64'L	49.48	Relocate
Stormwater	24" Existing	32+65.65	32+61.39	7.36'L,7.73'R	15.66	perpendicular to tracks - Protect in place
Sanitary	24" Existing	30+00	31+6.34	47.79'R,47.11'R	106.34	Relocate
Sanitary	12" Existing	32+39.35	32+21.19	2.84'L,68.49'R	71.86	perpendicular to tracks - Protect in place
Sanitary	15" Existing	32+61.04	33+4.51	44.16'R,50.28'R	34.68	Diagonal to tracks - Protect in place
Sanitary	10" Existing	33+49.46	36+42.19	23.37'L,36.73'L	294.65	Relocate
Sanitary	10" Existing	36+27.10	36+41.32	41.02'L,25.79'L	17.91	Relocate

Alignment Option
E3
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Water	Existing	25+28.70	25+5.05	30.03'L,11.41'R	48.31	Perpendicular to tracks - Protect in place
Water	Existing	30+16.41	31+39.62	50.02'R,51.49'R	123.62	Relocate
Water	8" Existing	32+12.27	32+12.15	58.18'R,72.79'R	14.93	Perpendicular to tracks - Protect in place
Water	8" Existing	32+28.03	32+14.37	53.97'R,69.63'R	21.59	Perpendicular to tracks - Protect in place
Water	16" Existing	32+26.48	32+84.93	52.82'R,52.54'R	59.49	Perpendicular to tracks - Protect in place
Water	Existing	33+22.34	33+49.33	33.85'R,31.39'R	26.57	Relocate
Water	Existing	33+27.86	33+28.32	33.52'R,44.38'R	10.87	Perpendicular to tracks - Protect in place
Water	Existing	33+49.31	33+49.7	31.84'R,39.57'R	7.75	Perpendicular to tracks - Protect in place
Water	20" Existing	32+24.96	32+20.05	0.32'L,14.99'R	15.53	Perpendicular to tracks - Protect in place
Water	12" Existing	32+44.15	32+39.15	3.69'L,11.63'R	15.49	Perpendicular to tracks - Protect in place
Water	4" Existing	30+40.16	32+3.94	66.62'R,70.86'R	154.23	Relocate
Water	8" Existing	34+38.71	36+41.26	30.67'L,29.38'L	203.19	Relocate
Water	8" Existing	36+41.82	36+41.84	40.56'L,13.80'R	54.45	Perpendicular to tracks - Protect in place
Gas	Existing	25+23.05	25+15.17	1.42'R,15.57'R	16.33	Perpendicular to tracks - Protect in place
Gas	4" Gas Line Abandoned	30+75.05	31+98.89	57.79'R,73.94'R	139.27	Remove Abandoned Facility
Gas	12" Gas Line	33+7.17	33+79.89	49.64'R,33.09'R	83.63	Relocate
Gas	12" Gas Line	33+12.96	33+22.32	15.86'L,37.85'R	54.55	Perpendicular to tracks - Protect in place
Gas	2" Gas Line Abandoned	33+84.64	34+56.29	24.04'L,26.68'L	71.87	Remove Abandoned Facility
Electric	Existing	28+50	30+79.92	36.02'R,36.52'R	229.03	Relocate
Electric	Existing	29+38.87	30+50	19.31'L,21.33'L	113.83	Relocate

Alignment Option
E3
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Electric	Existing	31+87.69	31+79.82	70.71'R,57.83'R	14.96	perpendicular to tracks - Protect in place
Electric	Existing	32+19.78	32+21.45	42.68'R,57.30'R	15.66	perpendicular to tracks - Protect in place
Electric	Existing	32+23.31	32+75.36	56.62'R,54.99'R	53.79	Relocate
Electric	Existing	32+76.89	32+74.42	40.13'R,55.23'R	15.11	perpendicular to tracks - Protect in place
Electric	Existing	32+93.15	33+2.80	35.95'R,50.78'R	14.93	perpendicular to tracks - Protect in place
Electric	Existing	32+12.68	32+11.01	1.43'R,16.21'R	14.83	perpendicular to tracks - Protect in place
Electric	Existing	33+00	34+35.40	16.95'L,22.53'L	137.25	Relocate
Electric	Existing	33+72.57	34+23.24	28.43'L,22.46'L	50.62	Relocate
Electric	Existing	33+42.31	35+22.92	36.47'L,41.34'L	178.63	Relocate
Electric	Existing	34+28.55	34+23.71	9.39'R,23.88'R	15.14	perpendicular to tracks - Protect in place
Electric	Existing	34+76.89	34+79.69	24.70'L,33.12'R	59.59	perpendicular to tracks - Protect in place
Telephone	Existing	32+1.12	31+91.14	57.69'R,70.01'R	18.17	perpendicular to tracks - Protect in place
Telephone	Existing	32+3.82	32+4.28	57.14'R,71.66'R	14.66	perpendicular to tracks - Protect in place
Telephone	Existing	32+51.37	32+33.93	4.95'L,12.54'R	22.79	perpendicular to tracks - Protect in place
Telephone	Existing	32+2.05	33+38.08	17.52'R,5.99'L	139.9	Relocate
Telephone	Existing	33+00	34+41.81	23.43'R,24.25'R	143.86	Relocate
Sanitary	10" Existing	28+36.26	27+97.97	37.64'L,28.06'R	76.41	perpendicular to tracks - Protect in place
Stormwater	18" Existing	26+76.58	28+99.84	23.18'R,19.94'R	222.06	Relocate
Stormwater	18" Existing	25+50	30+00	24.68'R,18.69'R	447.16	Relocate
Sanitary	Sanitary Sewer	32+79.41	32+77.91	9.87'L,4.84'R	15.15	perpendicular to tracks - Protect in place

Alignment Option
E3
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Stormwater	21" Existing	32+16.48	32+44.66	1.14'R,10.68'R	28.99	Diagonal to tracks - Protect in place
Sanitary	21" Existing	32+19.54	33+19.46	2.80'R,2.21'L	98.27	Relocate
Stormwater	15" Existing	32+54.06	32+45.69	24.56'L,7.68'L	18.77	perpendicular to tracks - Protect in place
Stormwater	Existing	36+92.19	36+85.97	6.89'L,8.62'R	17.12	perpendicular to tracks - Protect in place
Stormwater	24" Existing	37+16.87	37+66.11	9.71'L,10.64'L	49.48	Relocate
Stormwater	24" Existing	32+65.65	32+61.39	7.36'L,7.73'R	15.66	perpendicular to tracks - Protect in place
Sanitary	24" Existing	30+00	31+6.34	47.79'R,47.11'R	106.34	Relocate
Sanitary	12" Existing	32+39.35	32+21.19	2.84'L,68.49'R	71.86	perpendicular to tracks - Protect in place
Sanitary	15" Existing	32+61.04	33+4.51	44.16'R,50.28'R	34.68	Diagonal to tracks - Protect in place
Sanitary	10" Existing	33+49.46	36+42.19	23.37'L,36.73'L	294.65	Relocate
Sanitary	10" Existing	36+27.10	36+41.32	41.02'L,25.79'L	17.91	Relocate

Alignment Option
F1
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Telephone	Existing	47+13.66	49+41.91	6.38'L,15.64'L	229.08	Relocate
Telephone	Existing	49+48.04	52+43.92	16.43'L,6.23'L	348.52	Relocate
Telephone	Existing	50+5.30	52+61.61	15.63'L,14.66'L	348.52	Relocate
Telephone	Existing	52+73.27	52+82.32	14.42'L,21.33'L	11.42	Relocate
Telephone	Existing	52+73.99	55+22.09	12.30'L,7.88'L	249.49	Relocate
Telephone	Existing	52+62.31	53+91.16	12.29'L,19.45'L	118.49	Relocate
Telephone	Existing	53+00		6.24'L,27.29'R	40.09	Perpendicular to tracks - Protect in place
Water	Existing	47+42.17	49+44.33	16.52'L,15.28'L	202.31	Relocate
Water	Existing	49+46.51		13.24'L,20.24'R	34.46	Perpendicular to tracks - Protect in place
Water	Existing	49+49.87	53+31.07	20.74'R,23.23'R	377.07	Perpendicular to tracks - Protect in place
Water	8" Existing	53+17.35	53+31.07	20.43'L,23.23'R	52.87	Perpendicular to tracks - Protect in place
Water	8" Existing	49+48.69	54+26.05	13.21'L,4.85'R	482.53	Relocate
Water	8" Existing	53+69.49	55+22.07	24.29'R,24.87'R	152.92	Relocate
Stormdrain	Existing	52+91.68		19.80'L,21.86'R	62.75	Perpendicular to tracks - Protect in place
Stormdrain	Existing	53+22.75		19.36'L,27.24'R	53.72	Perpendicular to tracks - Protect in place
Stormdrain	Existing	53+44.79		19.75'L,27.04'R	48.17	Perpendicular to tracks - Protect in place
Sanitary Sewer	Existing	53+7.97		20.74'L,27.25'R	53.02	Perpendicular to tracks - Protect in place
Electric	Existing	50+31.26		22.87'L,21.56'R	48.12	Perpendicular to tracks - Protect in place
Electric	Existing	49+00	54+00	21.91'L,22.26'L	505.87	Relocate
Electric	Existing	53+41.52		19.87'L,27.23'R	52.35	Perpendicular to tracks - Protect in place

Alignment Option
F2
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Telephone	Existing	47+13.66	49+41.91	6.38'L,15.64'L	229.08	Relocate
Telephone	Existing	49+98.84	53+10.98	13.79'L,16.74'R	326.92	Relocate
Telephone	Existing	50+35.23	52+56.29	14.63'L,14.41'L	222.4	Relocate
Telephone	Existing	52+73.99	55+22.09	12.30'L,7.88'L	249.49	Relocate
Water	Existing	49+46.51		12.23'L,14.57'R	27.03	Perpendicular to tracks - Protect in place
Water	8" Existing	53+17.41		11.88'L ,20.66'R	31.22	Perpendicular to tracks - Protect in place
Water	8" Existing	49+62.79	55+20.05	12.60'L,3.68'L	574.83	Relocate
Stormdrain	Existing	52+91.68		12.82'L,17.86'R	35.67	Perpendicular to tracks - Protect in place
Stormdrain	Existing	53+22.75		11.74'L,16.25'R	31.58	Perpendicular to tracks - Protect in place
Stormdrain	Existing	53+44.79		11.19'L,15.87'R	48.17	Perpendicular to tracks - Protect in place
Sanitary Sewer	Existing	53+7.97		12.13'L,16.59'R	31.61	Perpendicular to tracks - Protect in place
Sanitary Sewer	24" Existing	52+50.00	55+22.37	1.09'R,1.73'R	230.23	Relocate

Alignment Option
G1
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Existing utility information not available. Conflicts unknown but shall be assumed. Further investigation required prior to subsequent design phases.						

Alignment Option
G2
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Existing utility information not available. Conflicts unknown but shall be assumed. Further investigation required prior to subsequent design phases.						

Alignment Option
G3
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Existing utility information not available. Conflicts unknown but shall be assumed. Further investigation required prior to subsequent design phases.						

Alignment Option
G4
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Existing utility information not available. Conflicts unknown but shall be assumed. Further investigation required prior to subsequent design phases.						

Alignment Option
Main Line (section west of Minnesota Avenue)
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Gas	Existing	14+51.13	24+50.00	8.16'L,4.51'L	1032.67	Relocate
Electric	Existing	14+50.83	17+17.39	1.29' L, 0.44'R	265.62	Relocate
Electric	Existing	15+27.40		14.77' L,16.50'R	31.37	Perpendicular to tracks - Protect in place
Electric	Existing	16+34.59		13.39'L,17.01'R	30.42	Perpendicular to tracks - Protect in place
Electric	Existing	17+39.25		13.25'L,16.94'R	40.04	Perpendicular to tracks - Protect in place
Sanitary Sewer	Existing	17+65.01		4.14'R,12.71'R	8.59	Perpendicular to tracks - Protect in place
Sanitary Sewer	Existing	17+66.18	17+91.90	15.37'R,15.07'R	25.72	Perpendicular to tracks - Protect in place
Sanitary Sewer	Existing	17+97.18		13.49'L,3.56'L	10.48	Perpendicular to tracks - Protect in place
Sanitary Sewer	Existing	17+93.22		13.53'L,16.89'R	30.41	Perpendicular to tracks - Protect in place
Sanitary Sewer	Existing	18+7.00		13.48'L,1.44'L	13.56	Perpendicular to tracks - Protect in place
Sanitary Sewer	Existing	18+13.65		13.48'L,1.44'L	15.35	Perpendicular to tracks - Protect in place

Alignment Option
Main Line (section east of Minnesota Avenue)
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Electric	Existing	38+43.28		4.22'L,10.42'R	15.12	Perpendicular to tracks - Protect in place
Electric	Existing	40+08.06		3.36'L,11.24'R	19.27	Perpendicular to tracks - Protect in place
Electric	Existing	40+37.85		3.22'L,11.49'R	16.44	Perpendicular to tracks - Protect in place
Electric	Existing	41+8.65		2.82'L,11.77'R	20.43	Perpendicular to tracks - Protect in place
Electric	Existing	42+26.73		21.13'L,14.66'R	36.02	Perpendicular to tracks - Protect in place
Electric	Existing	43+16.06		20.52'L,17.39'R	45.6	Perpendicular to tracks - Protect in place
Electric	Existing	45+15.61		10.59'L,16.11'R	33.62	Perpendicular to tracks - Protect in place
Electric	Existing	40+50.00	44+29.99	21.09'L,22.06'R	377.49	Relocate
Sanitary Sewer	Existing	43+6.00	46+82.49	17.39'R,12.52'R	378.82	Relocate
Telephone	Existing	42+00	45+00	12.92'L,12.16'L	299.66	Relocate
Telephone	Existing	41+71.30	47+10.66	14.26'R,6.64'L	541.48	Relocate
Telephone	Existing	42+48.19	44+22.71	13.63'L,14.13'L	176.33	Relocate

Alignment Option
X1
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Existing utility information not available. Conflicts unknown but shall be assumed. Further investigation required prior to subsequent design phases.						

Alignment Option
X2
Utility Impacts

Utility	Description	Approximate Location and Disposition				
		Stationing From/To		Offset (Ft)	Length (Ft)	Action
Existing utility information not available. Conflicts unknown but shall be assumed. Further investigation required prior to subsequent design phases.						

Appendix G:

Environmental Constraints

Environmental Conditions and Potential Effects

Resource	EXISTING CONDITIONS	ALIGNMENT 1: TERMINATING AT THE BENNING ROAD METRO STATION	ALIGNMENT 2: TERMINATING AT THE MINNESOTA AVENUE METRO STATION
Conformance with Local Land Use and Zoning	Existing land uses along the corridor are a mix of commercial, low and medium residential, utility, transportation, institutional, park, and open space uses. The DC Comprehensive Plans envisions that the corridor would be developed as mixed-use, with moderate- to medium-density residential and low- to medium-density commercial uses. The parks and open spaces remain unchanged in the future land use plan.	Alignment 1 would support and enhance services to the proposed land uses along the corridor.	Alignment 2 would support and enhance services to the proposed land uses along the corridor.
Conformance with Local Plans	A number of local plans address the Benning Road Streetcar including the Benning Road Corridor Redevelopment Framework Plan (DC Office of Planning, July 2008 and the DC Streetcar System Plan (District Department of Transportation, October 2010).	The DC Streetcar System Plan and the Benning Road Corridor Redevelopment Framework Plan recommend that the streetcar extend to Benning Road Metro station (Alignment 1).	The DC Streetcar System Plan and the Benning Road Corridor Redevelopment Framework Plan recommend that the streetcar extend to Benning Road Metro station (Alignment 1) rather than to the Minnesota Avenue Metro station Alignment 2).
Neighborhoods and Community Resources	Existing neighborhoods along the corridor include: • Carver Terrace and Langston Dwellings, • River Terrace, • Mayfair, • Upper Central NE, • Lower Central NE, and • Marshall Heights/Benning	The project is not expected to negatively affect the existing neighborhoods abutting the streetcar alignment. The streetcar service would enhance transit service for the neighborhoods. Pedestrian crossings across Benning Road and Minnesota Avenue will require planning to provide continued safe access to	The project is not expected to negatively affect the existing neighborhoods abutting the streetcar alignment. The streetcar service would enhance transit service for the neighborhoods. Pedestrian crossings across Benning Road and Minnesota Avenue will require planning to

Resource	EXISTING CONDITIONS	ALIGNMENT 1: TERMINATING AT THE BENNING ROAD METRO STATION	ALIGNMENT 2: TERMINATING AT THE MINNESOTA AVENUE METRO STATION
	Heights. Community resources within the neighborhood include the Benning Road Library, the Benning U.S. Post Office, the Metropolitan Police Department Sixth District Station, and the DC Fire Department Engine 27 Station and the DC Fire Department Engine 30 Station. A number of schools – Phelps High School, Spingarn High School, River Terrace Elementary School, and Friendship Public Charter School (along Minnesota Avenue) lie within the study area. Churches along the corridor include Ward Memorial AME Church, New Grove Baptist Church, Supreme Council-House of Jacob, and Mount Vernon United Methodist Church and New Jerusalem Temple along the Minnesota Avenue corridor.	schools, churches and other community resources. Additional review of emergency access routes for the DC Fire Department Engine 30 Station is required to ensure that there is no disruption during construction or other negative effects to the service provided.	provide continued safe access to schools, churches and other community resources. Additional review of emergency access routes for the DC Fire Department Engine 27 Station is required to ensure that there is no disruption during construction or other negative effects to the service provided.
Environmental Justice	Carver Terrace and Langston Dwellings is a low-income residential area with the lowest percentage of home-ownership in the District; Benning Heights is a mix of multi-family and government subsidized housing; and Marshall Heights is a low-income African American neighborhood.	The proposed project is not expected to negatively impact low-income and minority populations in Carver Terrace and Langston Dwellings, and Benning Heights / Marshall Heights. The streetcar service would enhance transit service for the populations. Further study will be required.	The proposed project is not expected to negatively impact low-income and minority populations in Carver Terrace and Langston Dwellings. The streetcar service would enhance transit service for the populations.

Resource	EXISTING CONDITIONS	ALIGNMENT 1: TERMINATING AT THE BENNING ROAD METRO STATION	ALIGNMENT 2: TERMINATING AT THE MINNESOTA AVENUE METRO STATION
Parks and Parklands	A number of regional parks and trails exist along the Benning Road Corridor: • Anacostia Riverwalk Trail, • Kenilworth Trail, • Langston Golf Course, • Kingman and Heritage Islands Park, • Anacostia Park, and • Fort Mahan Park.	Parks and trails in the study area, specifically the Fort Mahan Park, may be affected by any roadway widening required for station locations or track geometry considerations. The streetcar service would enhance transit access to these parks. Further study will be required.	Same as Alignment 1, except that there would be no impacts to the Fort Mahan Park.
Historic and Cultural Resources	• Fort Mahan Park, one of the parks of the Fort Circle Parks System, and the Langston Golf Course are listed on the National Register of Historic Places. • The project may also require review by the US Commission of Fine Arts under the Shipstead-Luce Act.	Impacts to historic and cultural resources resulting from the proposed project require further study.	Same as Alignment 1.
Property Acquisition and Displacements	The proposed streetcar alignments generally lie within the existing public street right-of-way maintained by the District Department of Transportation.	Property acquisitions and displacements may be required as a result of this project to accommodate traction power substations, crossover areas that require special trackwork, and stop platforms. As the design advances, potential property acquisitions and displacements will be studied further.	Same as Alignment 1.
Traffic	Both Benning Road and Minnesota Avenue are heavily-used thoroughfares. Benning Road is a	Traffic impacts from streetcar facilities and operations are expected. To the extent possible, measures should be	Same as Alignment 1.

Resource	EXISTING CONDITIONS	ALIGNMENT 1: TERMINATING AT THE BENNING ROAD METRO STATION	ALIGNMENT 2: TERMINATING AT THE MINNESOTA AVENUE METRO STATION
	principal east-west arterial street that links downtown DC to suburban neighborhoods in the District as well as in Maryland. The Average Annual Daily Volume on the Benning Road Bridge segment is estimated to be 44,400 vehicles. Minnesota Avenue is a northeast-southwest minor arterial street that runs parallel to I-295/DC-295. For additional information regarding existing traffic conditions, refer to Appendix E Traffic Analysis Technical Memorandum.	integrated into the design and implementation process to minimize potential impacts.	
Hazardous and Contaminated Materials	A Recognized Environmental Conditions (REC) site along the corridor the PEPCO power plant which is a CERCLA site.	Further assessment undertaken during a detailed environmental study may identify additional REC sites and will determine how the project may affect the land uses on these sites.	Same as Alignment 1.
Air Quality	The Washington, DC Metropolitan Region is a Non-Attainment Area for Ground Level Ozone and $PM_{2.5}$ criteria pollutants.	The project is not expected to affect regional air quality in any measurable or substantial way. Further study will be required.	Same as Alignment 1.
Noise & Vibration	A number of schools and churches exist adjacent to the proposed alignment.	Potential noise and vibration impacts resulting from the proposed project require further study.	Same as Alignment 1.
Water Resources	Water resources and FEMA designated 100-year flood zones exist within the study area. Wetlands exist along the Anacostia River near the proposed alignment.	No impacts to the existing water resources or flood zones are expected. The project would add minimal impervious surfaces. No disturbances or impacts to wetlands are expected.	Same as Alignment 1.

Resource	EXISTING CONDITIONS	ALIGNMENT 1: TERMINATING AT THE BENNING ROAD METRO STATION	ALIGNMENT 2: TERMINATING AT THE MINNESOTA AVENUE METRO STATION
		Further study will be required.	
Protected Species & Habitats	Upon preliminary investigation, no federally-protected animal or plant habitat appear to exist adjacent to the streetcar alignment. This determination will need to be confirmed in writing by the U.S. Fish and Wildlife Service.	No impacts to federally-protected animal or plant habitat are expected as a result of this alignment. Further study will be required.	Same as Alignment 1.
Utilities	Being located in a fully developed and urbanized location, numerous existing utilities, both aerial and subsurface, are found within the project limits. For additional information regarding existing traffic conditions, refer to Appendix F: Utility Conflicts Technical Memorandum.	Numerous underground utilities would be impacted by the proposed streetcar throughout the corridor. Above ground utilities would be impacted at select locations, typically where side running streetcar tracks are proposed.	Same as Alignment 1.
Construction Impacts	During construction, there would be traffic, noise, and potential vibration impacts.	Construction impacts to traffic such as lane closures and detours would be addressed and mitigated with detailed Management of Traffic plans. Best management practices in construction technology and by specifying hours of construction would be required to minimize the impacts from construction noise and vibration.	Same as Alignment 1.

Appendix H:

Capital and Operating Cost Estimate Calculations

Benning Road Streetcar Extension Feasibility Study

Conceptual Level Range of Magnitude Cost Estimate

Unit Costs and Quantities Developed by DDOT

Minnesota Avenue Metro Rail Station Terminus Options

	FT	MI
Alignment Length	7680	1.454545455

Item	Low Range Cost	High Range Cost	Assumptions
Alt X Base Cost	$ 785,780	$ 903,860	
Alt A Base Cost	$ 3,318,100	$ 3,318,100	
Alt B Base Cost	$ 2,573,810	$ 2,677,810	
Alt B-C Base Cost	$ 1,388,457	$ 1,388,457	
Alt C Base Cost	$ 1,345,480	$ 1,823,090	
Alt D Base Cost	$ 2,559,325	$ 3,228,835	
Reconstruction of Benning Road / Minnesota Ave Intersection - Roadway and Drainage	$ -	$ -	
Traffic Signal Cost	$ 1,250,000	$ 1,250,000	
TPSS	$ 1,200,000	$ 1,200,000	
Utility Cost	$ 4,363,636	$ 4,363,636	
Sub Total 1	$ 18,784,588	$ 20,153,788	
Professional Services	$ 6,574,606	$ 7,053,826	35% of Sub Total 1
Right of Way	$ -	$ -	No Right of Way Costs
Vehicles	$ 20,000,000	$ 20,000,000	assumes 4 additional at $5M each
Sub Total 2	$ 45,359,194	$ 47,207,614	
Contingency	$ 22,679,597	$ 23,603,807	50% of Sub Total 2
GRAND TOTAL	**$ 68,038,791**	**$ 70,811,421**	
Cost Per MI	$ 46,776,669	$ 48,682,852	

Benning Road Streetcar Extension Feasibility Study			
Conceptual Level Range of Magnitude Cost Estimate			

Benning Road Metro Rail Station Terminus Options

	FT	MI	
Alignment Length	9500	1.80	
Item	**Low Range Cost**	**High Range Cost**	**Assumptions**
Alt X Base Cost	$ 785,780	$ 903,860	
Alt A Base Cost	$ 3,318,100	$ 3,318,100	
Alt B Base Cost	$ 2,573,810	$ 2,677,810	
Alt B-E Base Cost	$ 1,388,457	$ 1,388,457	
Alt E Base Cost	$ 1,571,485	$ 2,130,930	
Alt F Base Cost	$ 2,156,920	$ 2,275,065	
Alt G Base Cost	$ 2,636,150	$ 3,188,505	
Reconstruction of Benning Road / Minnesota Ave Intersection - Roadway and Drainage	$ -	$ -	
Traffic Signal Cost	$ 1,250,000	$ 1,250,000	
	$ 1,200,000	$ 1,200,000	
Utility Cost	$ 5,397,727	$ 5,397,727	Assume $3MM / Mile
Sub Total 1	$ 22,278,429	$ 23,730,454	
Professional Services	$ 7,797,450	$ 8,305,659	35% of Sub Total 1
Right of Way	$ -	$ -	No Right of Way Costs
Vehicles	$ 20,000,000	$ 20,000,000	assumes 4 additional at $5M each
Sub Total 2	$ 50,075,880	$ 52,036,113	
Contingency	$ 25,037,940	$ 26,018,057	50% of Sub Total 2
GRAND TOTAL	**$ 75,113,819**	**$ 78,054,170**	
Cost Per MI	$ 41,747,470	$ 43,381,686	

Unit Cost for Each Item PROVIDED BY DDOT		
Item	Unit Cost	Units
GUIDEWAY & TRACK ELEMENTS		
GUIDEWAY		
Single Track Feet Curbside Running - Standard Guideway	$ 500	RF
Single Track Feet Median Running - Standard Guideway	$ 500	RF
Single Track Feet on Aerial Structure	$ 500	RF
Single Track Feet Curbside Running - Non-Standard Guideway		RF
Single Track Feet (Intersection)	$ 450	RF
Single Track Feet (CBTC) - Dedicated Guideway	$ 450	RF
Widening for Curbside Running - Standard Guideway (1 foot nominal)	$ 50	SF
Widening for Median Running - Standard Guideway (2 foot nominal)	$ 60	SF
Other Typical Section Widening (175'X4')	$ 100	SF
Other Typical Section Widening (define)		SF
Other Typical Section Widening (define)		SF
Other Typical Section Widening (define)		SF
Other Typical Section Widening (define)		SF
TRACKWORK		
Single Track Feet Curbside Running - Standard Guideway		RF
Single Track Feet Median Running - Standard Guideway		RF
Single Track Feet on Aerial Structure		RF
Single Track Feet Curbside Running - Non-Standard Guideway		RF
Single Track Feet (Intersection)		RF
Single Track Feet (CBTC) - Dedicated Guideway		RF
SPECIAL TRACKWORK		
25 Meter Turnout	$ 170,000	EACH
20 Meter Turnout	$ 150,000	EACH
No. 4 Cross-over	$ 300,000	EACH
No.4 Double Cross-over	$ 700,000	EACH
STATIONS, STOPS, TERMINALS, INTERMODAL		
Side Platform (70'x12')	$ 200,000	EACH
CenterPlatform (70'x12.13')	$ 250,000	EACH
Fare Collection Side Platform	$ 35,000	EACH
Fare Collection Center Platform	$ 35,000	EACH
Message Board Equipment Side Platform	$ 10,000	EACH
Message Board Equipment Center Platform	$ 10,000	EACH
SITEWORK & SPECIAL CONDITIONS		
SYSTEMS		
Electrification - OCS	$ 54	RF
Communications, Line	$ 70	RF
TPSS	$ 600,000	EA

Operating & Maintenance Cost Estimate

Benning Road Metrorail Extension

Cycle Time Development

Segment	Running Time (Minutes)	Cycle Time* (Minutes)
Union Station-Oklahoma Avenue NE	17.22	
Oklahoma Avenue NE-Benning Road NE/Minnesota Avenue NE	8.92	
Benning Road NE/Minnesota Avenue NE-Benning Road Metrorail Station	6.25	
Total	**32.39**	**79.78**

** Cycle Time assumes a round trip + 7.5 minutes on each end for layover/recovery time*
assumed travel speed is 7.5 mph

Annual Revenue Hours and O&M Cost Estimate Development

Day of Service	Span Hours	Headway (Minutes)	Vehicles (Trains)	Actual Vehicles (Trains)	Daily Revenue Hours	Annual Number of Service Days	Annual Revenue Hours	Year 2012 O&M Cost per Revenue Hour**	Annual O&M Cost
Monday-Thursday	18	10	7.97818	8	144	204	29,376.00		
Friday	20	10	7.97818	8	160	52	8,320.00		
Saturday	18	10	7.97818	8	144	52	7,488.00		
Sunday/Holiday	14	10	7.97818	8	112	57	6,384.00		
Total (Union Station-Benning Road Metrorail Station)							**51,568.00**	**$ 224.09**	**$ 11,555,873.12**
Total (Union Station-Oklahoma Avenue NE ONLY)							**27,414.65**		**$ 6,143,348.21**
Total (Benning Road Metrorail Extension ONLY)							**24,153.35**		**$ 5,412,524.91**

*** Uses O&M Cost/Revenue Hour from Urban Circulator Grant Report Adjusted for Inflation 3% per Annum to Year 2012*

Operating & Maintenance Cost Estimate

Minnesota Avenue Metrorail Extension

Cycle Time Development

Segment	Running Time (Minutes)	Cycle Time* (Minutes)
Union Station-Oklahoma Avenue NE	17.22	
Oklahoma Avenue NE-Benning Road NE/Minnesota Avenue NE	8.92	
Benning Road NE/Minnesota Avenue NE-Minnesota Avenue Metrorail Station	3.47	
Total	**29.61**	**74.23**

** Cycle Time assumes a round trip + 7.5 minutes on each end for layover/recovery time*
assumed travel speed is 7.5 mph

Annual Revenue Hours and O&M Cost Estimate Development

Day of Service	Span Hours	Headway (Minutes)	Vehicles (Trains)	Actual Vehicles (Trains)	Daily Revenue Hours	Annual Number of Service Days	Annual Revenue Hours	Year 2012 O&M Cost per Revenue Hour**	Annual O&M Cost
Monday-Thursday	18	10	7.42273	8	144	204	29,376.00		
Friday	20	10	7.42273	8	160	52	8,320.00		
Saturday	18	10	7.42273	8	144	52	7,488.00		
Sunday/Holiday	14	10	7.42273	8	112	57	6,384.00		
Total (Union Station-Minnesota Avenue Metrorail Station)							**51,568.00**	**$ 224.09**	**$ 11,555,873.12**
Total (Union Station-Oklahoma Avenue NE ONLY)							**29,985.69**		**$ 6,719,493.37**
Total (Minnesota Avenue Metrorail Extension ONLY)							**21,582.31**		**$ 4,836,379.75**

*** Uses O&M Cost/Revenue Hour from Urban Circulator Grant Report Adjusted for Inflation 3% per Annum to Year 2012*

Appendix I:

Ridership Technical Memorandum

Benning Road - Travel Demand Forecasting Approach

The purpose of this document is to describe the assumptions used in developing the proposed Benning Road/Minnesota Ave Streetcar scenarios. AECOM employed the current WMATA transit post-processor (Version 2.3) for the MWCOG model, which was recently developed to support the WMATA Regional Transit System Plan (RTSP). AECOM developed the WMATA transit post-processor to work in combination with the MWCOG model to provide significantly enhanced capability to estimate transit utilization in the region.

AECOM created Year 2040 No-Build alternative and six build alternatives. The No-Build Alternative includes existing background bus service and the committed changes by the Year 2040. It has Streetcar from Benning & Oklahoma Ave to H & 1st NE. The build alternatives overlay the Streetcar extension and the modified bus service frequencies on the Year 2040 No-Build Alternative. The bus frequencies and the Streetcar station to station travel times are coded as per the Proposed Streetcar Operating Plan Assumptions. The year 2040 demographic data was taken from "MWCOG Round 8.0 3722-Zone System".

The six build alternatives include three variants of each of the Streetcar scenarios, Benning Road Streetcar scenario and Minnesota Ave Streetcar scenario. These variants have different background bus service frequencies. These alternatives are named as:
Benning Road Streetcar (Alt A) Scenarios:

- RTSP_2040_AltA_opt1
- RTSP_2040_AltA_opt2
- RTSP_2040_AltA_opt3

Minnesota Ave Streetcar (Alt B) scenarios:

- RTSP_2040_AltB_opt1
- RTSP_2040_AltB_opt2
- RTSP_2040_AltB_opt3

The stop to stop travel time for the Streetcar in the No-Build and in each of the build alternatives is presented in Table 1. The bus frequencies for the buses in the project area in each variant are tabulated in Table 2. The bus travel times are tabulated in Table 3.

Table 1: Stop-To-Stop Travel Time For Streetcar

Stop ID	Stop	Travel time to next stop (min) No-Build	Alt A Benning Rd	Alt B Minnesota Ave
10079	Minnesota Ave Metro	-	-	1.85
10080	Benning Rd Metro	-	3.11	-
10081	Benning & 42nd NE	-	2.32	-
10082	Benning and Minnesota Ave	-	4.41	4.53
10083	Benning and 34th NE	-	3.18	3.26
10084	Kingman Island	-	3.26	3.34
10085	Benning & Oklahoma Ave	1.19	1.16	1.19
10086	Benning and 19th NE	1.70	1.66	1.71
10087	H & MD Ave	2.00	1.95	2.00
10088	H & 13 th NE	2.67	2.60	2.67
10089	H & 8th NE	2.22	2.17	2.23
10090	H & 5th NE	2.22	2.17	2.23
10091	H & 1st NE	-	-	-
	Total	12.00	28.00	25.00

Table 2: Background bus service frequencies

Metrobus Route	Direction	No-Build PK	No-Build OP	Option 1 PK	Option 1 OP	Option 2 PK	Option 2 OP	Option 3 PK	Option 3 OP
X1	WB	17	-	18	-				
X2	WB	6	9	10	10	6	9	10	10
X2	EB	6	9	10	10	6	9	10	10
X3	WB	24	-	24	-	24	-	24	-
X8	WB	9	6	13	40	13	40	13	40
X8	EB	7	6	17	40	17	40	17	40
X9	WB	15	-	10	-	15	-	15	-
X9	EB	15	-	10	-	15	-	15	-

Table 3: Bus Travel Time

Metrobus Route	Direction	No-Build		Build	
		PK	OP	PK	OP
X1	WB	40	-	20	-
X2	WB	44	40	44	40
X2	EB	36	39	36	39
X3	WB	54	-	54	-
X8	WB	16	16	16	16
X8	EB	16	16	16	16
X9	WB	43	-	43	-
X9	EB	38	-	38	-

2040 Streetcar Ridership Estimates (Option 2 is carried forward)

	Option 1	**Option 2**	Option 3
Streetcar Ridership 2040 No Build	4,257	**4,257**	4,257
Streetcar Ridership Benning Rd Terminus (increase from No Build)	3,925	**3,503**	4,168
Streetcar Ridership Minnesota Ave Terminus (increase from No Build)	986	**532**	1,087
Total Transit Linked Trips - Benning Rd Change vs No Build	68	**738**	(203)
Total Transit Linked Trips - Minnesota Ave Change vs No Build	(639)	**158**	(908)

No Build - X2: 5 min, X9: 15 min, X1 from Minnesota to Downtown (17 min)
Option 1 - X2: 10 min, X9: 10 min, X1 truncated to btw Union Station & Downtown (17 min)
Option 2 - X2: 5 min, X9: 15 min, X1 truncated to btw Union Station & Downtown (17 min)
Option 3 - X2: 10 min, X9: 15 min, X1 truncated to btw Union Station & Downtown (17 min)