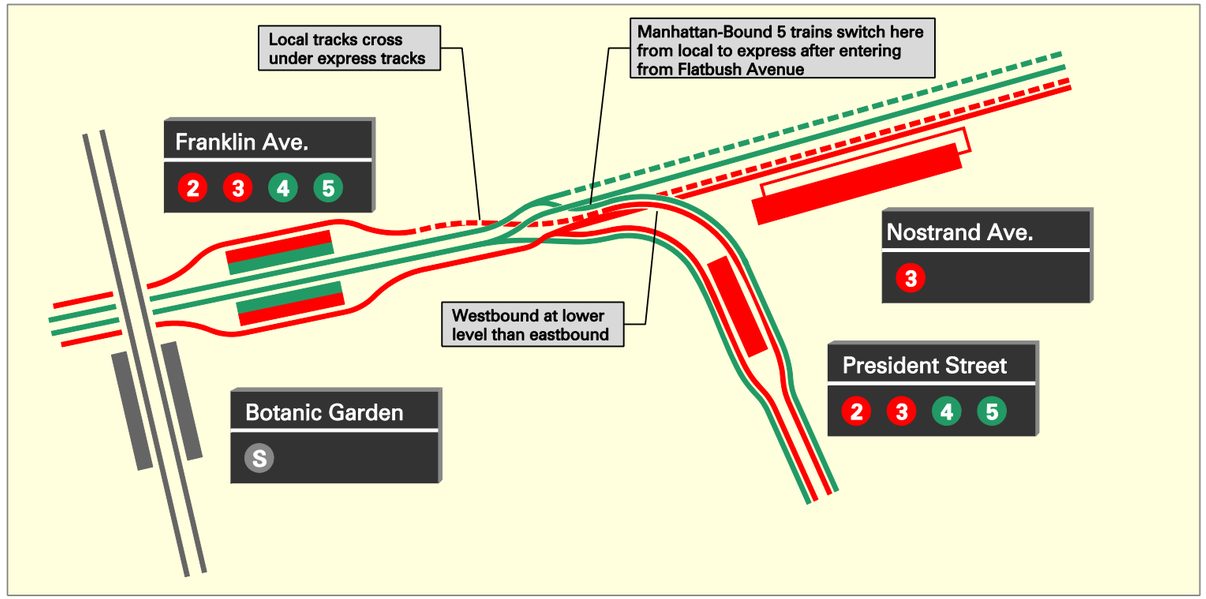
FINAL REPORT

CONCEPTUAL ENGINEERING DESIGN STUDY FOR RECONFIGURATION OF THE NOSTRAND JUNCTION IN BROOKLYN

CM-1335, TASK ORDER No. 2

JANUARY 2009



New York City Transit
Office of the Executive Vice President
Capital Planning and Budget

Table of Contents

EXECUTIVE SUMMARY ..... **I**
STUDY PURPOSE I
BACKGROUND AND PRIOR STUDIES I
ALTERNATIVES I
FINDINGS II

1.0 STUDY PURPOSE **1**
1.1 THE BOTTLENECK 1
1.2 UNPLUGGING THE BOTTLENECK 1

2.0 BACKGROUND AND PRIOR STUDIES **1**

3.0 EXISTING CONDITIONS AT PROPOSED CONSTRUCTION AREAS **2**
3.1 EASTERN PARKWAY 2
3.2 SUBWAY TUNNELS, TRACK & ALIGNMENT, STATION ENTRANCES 2
3.3 COMMUNITY DESCRIPTION 6
3.3.1 Land Use & Zoning *6*
3.3.2 Socioeconomics *6*
3.3.3 Community Facilities *7*
3.3.4 Historic Resources *7*
3.3.5 Visual Resources *7*
3.3.6 Parklands and Boulevard Landscaping *7*
3.4 TRANSIT SIGNAL/COMMUNICATIONS/POWER SYSTEMS 8
3.5 EXISTING UTILITIES UNDER EASTERN PARKWAY & CROSS STREETS WITHIN AREA OF CONSTRUCTION 8
3.5.1 Washington Avenue to Classon Avenue *8*
3.5.2 Classon Avenue to Franklin Avenue *8*
3.5.3 Franklin Avenue to Bedford Avenue *9*
3.5.4 Bedford Avenue to Rogers Avenue *9*
3.5.5 Rogers Avenue to Nostrand Avenue *9*

4.0 CONCEPTUAL ENGINEERING PLANS, IMPACTS, COSTS **10**
4.1 ALTERNATIVE 4: NEW CROSSOVERS NORTH OF NOSTRAND AVENUE .. 10
4.1.1 Track and Alignment *10*
4.1.2 Structural Plans and Sections *10*
4.1.3 Ventilation Requirements *13*
4.1.4 Construction Staging and Scheduling *13*
4.1.5 Service Impacts, Outages and Mitigation *14*
4.1.6 Subway Signal, Communications and Traction Power Issues *19*
4.1.7 Private Property Issues *19*
4.1.8 Environmental Issues *20*
4.1.9 Utility Impacts *21*
4.1.10 Construction Cost Estimate *21*
4.1.11 Conceptual Construction Schedule *21*
4.2 ALTERNATIVE 6: NEW FULLY-FLEXED GRADE-SEPARATED JUNCTION 23
4.2.1 Track and Alignment *23*
4.2.2 Structural Plans and Sections *24*
4.2.3 Ventilation Requirements *24*
4.2.4 Construction Staging and Scheduling *25*
4.2.5 Service Impacts, Outages and Mitigation *30*
4.2.6 Subway Signal, Communications and Traction Power Issues *35*
4.2.7 Private Property Issues *36*
4.2.8 Environmental Issues *36*
4.2.9 Utility Impacts *38*
4.2.10 Construction Cost Estimate *38*
4.2.11 Conceptual Construction Schedule *38*

List of Tables

TABLE ES-1: COMPARISON OF ALTERNATIVES 4 AND 6 III
TABLE ES-2: NUMBER OF GENERAL ORDERS III
TABLE 1: CONCEPTUAL CONSTRUCTION COST ESTIMATE SUMMARY – ALTERNATIVE 4 21
TABLE 2: DISTINCT TRACK CONFIGURATION ZONES 23
TABLE 3: LENGTH OF TRACKWORK FOR ALTERNATIVE 6 23
TABLE 4: STATIONING, BENT AND SECTION CROSS REFERENCE – WEST OF FRANKLIN AVENUE STATION 29
TABLE 5: STATIONING, BENT AND SECTION CROSS REFERENCE – EAST OF FRANKLIN AVENUE STATION 30
TABLE 6: CONCEPTUAL CONSTRUCTION COST ESTIMATE SUMMARY – ALTERNATIVE 6 38

List of Figures

FIGURE 1: ALTERNATIVE 4 (1993) 3
FIGURE 2: ALTERNATIVE 6 (1993) 4
FIGURE 3: ALTERNATIVE 4 PROPOSED TRACK ALIGNMENT (APPENDIX H, FIGURE 430) 11
FIGURE 4: ALTERNATIVE 4 PROPOSED TRACK PROFILE (APPENDIX H, FIGURE 431) 12
FIGURE 5: ALTERNATIVE 4 - TRACK #1 SECTION B OUTAGE 17
FIGURE 6: ALTERNATIVE 4 - TRACK #2 OUTAGE 17
FIGURE 7: ALTERNATIVE 4 - TRACK #2A / #1 SECTION A OUTAGE 17
FIGURE 8: ALTERNATIVE 4 - TRACK #3 OUTAGE 17
FIGURE 9: ALTERNATIVE - TRACKS #3A AND #4 SECTION A OUTAGE 18
FIGURE 10: ALTERNATIVE 4 - TRACK #4 SECTION B OUTAGE 18
FIGURE 11: ALTERNATIVE 4 - TRACKS #1 AND #2 SECTION B OUTAGE 18
FIGURE 12: ALTERNATIVE 4 - TRACKS #1, #2, #2A SECTION A OUTAGE 18
FIGURE 13: ALTERNATIVE 4 - CONSTRUCTION SCHEDULE 22
FIGURE 14: ALTERNATIVE 6: TRACK PLAN AND PROFILE (WASHINGTON AVENUE TO FRANKLIN AVENUE) 26
FIGURE 15: ALTERNATIVE 6: TRACK PLAN AND PROFILE (FRANKLIN AVENUE TO NOSTRAND AVENUE) 27
FIGURE 16: ALTERNATIVE 6 – TRACK #1 OUTAGE BETWEEN FRANKLIN AVENUE STATION AND NOSTRAND JUNCTION 32
FIGURE 18: ALTERNATIVE 6 – TRACK #3 OUTAGE BETWEEN FRANKLIN AVENUE STATION AND NOSTRAND JUNCTION 32
FIGURE 17: ALTERNATIVE 6 – TRACK #2 OUTAGE BETWEEN FRANKLIN AVENUE STATION AND NOSTRAND JUNCTION 32
FIGURE 19: ALTERNATIVE 6 – TRACK #3 OUTAGE BETWEEN EASTERN PARKWAY AND FRANKLIN AVENUE STATION 32
FIGURE 20: ALTERNATIVE 6 – TRACK #4 OUTAGE BETWEEN EASTERN PARKWAY AND FRANKLIN AVENUE STATION 33
FIGURE 21: ALTERNATIVE 6 – TRACK #4 OUTAGE BETWEEN FRANKLIN AVENUE STATION AND NOSTRAND JUNCTION 33
FIGURE 22: ALTERNATIVE 6 – TRACK #4 OUTAGE BETWEEN NOSTRAND JUNCTION AND NOSTRAND AVENUE STATION 33
FIGURE 23: ALTERNATIVE 6 – TRACK #2A OUTAGE SOUTH OF NOSTRAND JUNCTION AT NEW CONNECTION 33
FIGURE 24: ALTERNATIVE 6 – TRACK #3A OUTAGE SOUTH OF NOSTRAND JUNCTION AT NEW CONNECTION 34
FIGURE 25: ALTERNATIVE 6 - CONSTRUCTION SCHEDULE 39

APPENDICES

APPENDIX A: EXISTING UTILITY PLANS AND IMPACTS
APPENDIX B: ENVIRONMENTAL FIGURES
APPENDIX C: SOCIOECONOMIC DATA
APPENDIX D: COMMUNITY FACILITIES
APPENDIX E: MPT STAGING PLANS
APPENDIX F: TREE & MAP SURVEY FOR CONCEPTUAL ENGINEERING STUDY OF NOSTRAND JUNCTION
APPENDIX G: CAPITAL COST ESTIMATES AND CONSTRUCTION SCHEDULES
APPENDIX H: CONCEPTUAL ENGINEERING PLANS AND SECTIONS, TRACK OUTAGE PLANS
APPENDIX I: VENTILATION PLANT PLANS AND SECTIONS, ALTERNATIVE 6
APPENDIX J: EXISTING AND NEW SIGNAL EQUIPMENT PLANS
APPENDIX K: CONCEPTUAL STRUCTURAL DESIGN ASSUMPTIONS AND CALCULATIONS

Note: See separate Appendices Report for detailed list of figures.

EXECUTIVE SUMMARY

STUDY PURPOSE

The Bottleneck

Nostrand Junction is a bottleneck that constrains line capacity and delays trains approaching and entering the junction. These capacity constraints and delays cascade and ripple back through both the former East Side IRT and West Side IRT lines (Lexington Avenue Line and the Broadway-7th Avenue Line, respectively) in Manhattan and are severe enough that they prevent the New Lots Avenue and Nostrand Avenue Lines from operating at their maximum capacity (40 trains per hour).

Nostrand Junction comprises a section of the Brooklyn IRT of approximately 1,600 feet long, located between the east end of Franklin Avenue Station and the west end of Nostrand Avenue Station.

Although the northbound (to Manhattan) and southbound (from Manhattan) directions are stacked and segregated on two levels (the northbound direction is on the lower level; the southbound direction is on the upper level) between Utica Avenue and north of the junction, both levels were built as "flat junctions" meaning that southbound trains from the express track must cross at grade over the southbound local track to enter the Nostrand Avenue Line. In the northbound direction, Nostrand Avenue Line trains entering the New Lots Avenue Line must first cross at grade over the northbound local track.

Whenever a train must cross another mainline track at grade, there is the potential – particularly during peak periods – to delay through trains on the mainline being crossed.

Unplugging the Bottleneck

This study undertakes a conceptual engineering design and feasibility review addressing two alternatives for a proposed reconfiguration of Nostrand Junction on the IRT New Lots and Nostrand Avenue Lines in the Borough of Brooklyn. The objective of the proposed reconfiguration is to improve subway operations on the IRT 2, 3, 4 and 5 services by increasing service capacity through Nostrand Junction. These alternative improvement concepts were previously[1] short listed options for unplugging the Nostrand Junction bottleneck, Alternative 4 involves constructing new crossovers while Alternative 6 involves constructing new grade-separated flyovers.

Specifically, the objectives of this study are to: 1) prepare conceptual (less than 10% design level) engineering-design study drawings and provide narratives confirming and documenting the engineering feasibility of the two alternatives; 2) develop conceptual constructability/phasing plans, drawings and schedules for each of the two alternatives; 3) identify the types and magnitude of temporary subway service impacts resulting from reconstructing Nostrand Junction under both alternatives (i.e., service shutdowns, diversions, slow speed orders); 4) identify potential significant environmental/community impacts (which would then be further addressed as part of a separate, subsequent Environmental Impact Statement); and 5) prepare construction cost estimates for both alternatives within a reasonable degree of confidence.

BACKGROUND AND PRIOR STUDIES

Nostrand Junction has long been recognized as a source of delay that cascades up the Lexington Avenue and Broadway-7th Avenue lines. This problem was documented over 40 years ago and Nostrand Junction has been the subject of at least four prior studies. They are:

- A 1967 report titled *Transportation Studies for Southeast Brooklyn* authored by the Study Group for Southeastern Brooklyn Transportation. This study recommended that priority should be placed on improving the existing rapid transit lines instead of system expansion, and that such improvements should aim at increasing operating capacity and reducing operating delays. Nostrand Junction was specifically identified as a location in need of urgent improvements.
- The Metropolitan Transportation Authority's 1968 report *Program for Action*, which proposed extending the Nostrand Avenue Line, as well as other new subway lines such as the Utica Avenue Line.
- The 1972 study by the former Planning Division of the Authority's Engineering Department. Two options were analyzed:
  - A. Install a crossover east of Nostrand Avenue Station to eliminate the grade crossing at Nostrand Junction.
  - B. Provide a fully-flexed, grade-separated junction to improve operations at Nostrand Avenue, to provide Broadway-7th Avenue Line service to New Lots Avenue and to enable an extended Lexington Avenue Line service to the then proposed Utica Avenue Line.

  Option A, above, was less expensive than Option B, but Option A did not provide as much operational flexibility as Option B. Option B was proposed as a method for providing Lexington Avenue Line service to the then proposed Utica Avenue Line. With New York City's financial crisis in the mid-1970s, these two schemes were not pursued.
- During the Third Five Year Capital Program (1992-1996), the reconfiguration of Nostrand Junction re-emerged as a study topic. The 1993 New York City Transit report *A Report on Nostrand Avenue Junction Study; New Lots and Nostrand Avenue Lines* provided the latest (before this study) analysis on how best to cost effectively improve throughput and minimize conflicts through Nostrand Junction. The study examined seven alternatives with three groupings of alternatives:
  - Three alternatives proposed grade separating the flat junction.
  - Two alternatives proposed additional crossovers.
  - Two alternatives proposed new station platforms at Kingston Avenue Station and Nostrand Avenue Station.

  After considering construction costs, operational impacts during construction, and operational benefits, the 1993 study recommended two alternatives for further study – Alternatives 4 and 6.

ALTERNATIVES

Alternative 4: New Crossovers North of Nostrand Avenue

Overview of Alternative 4

Under this alternative, a pair of crossovers is proposed railroad south (compass east) of the junction. These new crossovers would allow trains currently changing tracks north of the junction to do so in parallel with trains merging to or diverging from the Nostrand Avenue Line.

Proposed Alignment

The proposed trackwork modifications are limited to roughly 200 feet of each track located between 65 feet south of Nostrand Junction and 75 feet north of Nostrand Avenue Station. Two, right hand, tangential Number 10 crossovers are to be installed with one on each level. The structural, signal, communication and traction power modifications required to operate these crossovers and the construction staging required are discussed in subsequent sections of this report.

[1] 1993 NYCT report *A Report On Nostrand Avenue Junction Study; New Lots and Nostrand Avenue Lines*

By direction from NYCT, the alignment presented here differs in several ways from the alignment proposed earlier in the 1993 NYCT feasibility study of this alternative concept.

First, the new Alternative 4 crossovers are located further north such that on Tracks 1 and 4 the distance from the point of switch (PS) to the point of vertical curvature (PVC) near station 260+60 is 20 feet compared to 6 feet provided by the earlier study.

Second, the latest NYCT standard tangential turnouts are used, which are approximately three feet longer than those considered in the 1993 study. Also, these crossovers are to be of 115 RE rail. Assuming that the existing track is built from rail 100 ARA-B rails (smaller cross-section), the base-of-rail elevation should be stepped down to provide the same top-of-rail elevation and therefore the same minimum vertical clearance.

To accommodate these alignment improvements without significantly impacting the limits of the structural modifications, NYCT has accepted a reduced minimum lateral clearance from the diverging route of the crossover to existing center columns. While NYCT A Division Standards normally requires 6 feet 3 inches of lateral clearance, this alternative provides 5 feet 5 inches lateral clearance from track centerline to center columns (in addition to clearance excesses required due to curvature). The limits of center column removal are based on this minimum clearance and the structural plans from the original construction of the line.

If this alternative is selected for further investigation, the limits of column removal should be further refined, and should be based on a more detailed field survey of the track and structure.

Alternative 6: New Fully-Flexed Grade-Separated Junction

Overview of Alternative 6

Under this alternative, a series of new grade separated tracks and track connections are proposed between Eastern Parkway Station and the Nostrand Junction. This would create a new set of flyovers to replace the existing “flat junction” on both the upper and lower level tunnel tracks.

Proposed Alignment

The proposed trackwork modifications cover 3,300 feet of the existing subway (See Section 4.2.1, Track and Alignment) from south of Eastern Parkway Station to north of Franklin Avenue Station. Three-thousand three-hundred (3,300) feet of new tracks would be realigned or reprofiled and 885 track feet of existing track and two existing No. 8 turnouts would be removed. The structural, signal, communication and traction power modifications required to operate these crossovers and the construction staging required are discussed in subsequent sections of this report.

For this study, an alignment and profile of Alternative 6 was created based upon the alignment proposed in the 1993 study of this alternative. Where the 1993 study alignment and profile were found to violate MW-1 and NYCT geometry criteria, an attempt was made to eliminate or reduce the severity of the deviation without significantly expanding the limits or changing the concept. Those deviations have been addressed in the proposed alignment with equilateral turnouts, additional Track 3 and 4 reprofiling and additional Track 4 realignment.

For the purposes of this study, a clearance envelope was defined along the length of all new and realigned tracks that provides a minimum of 6 feet 6 inches of lateral clearance plus car excesses along curves and turnouts. This clearance envelope was provided to the structural engineer and used to define the limits of structural modifications.

The proposed Alternative 6 alignment is based on the 1993 study, with the above-mentioned modifications.

FINDINGS

A summary comparison of the Characteristics of Alternatives 4 and 6 is provided in Table ES-1.

TABLE ES-1: COMPARISON OF ALTERNATIVES 4 AND 6

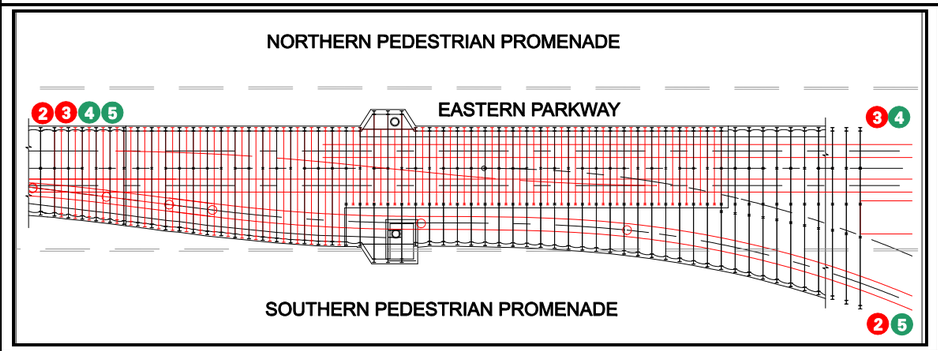
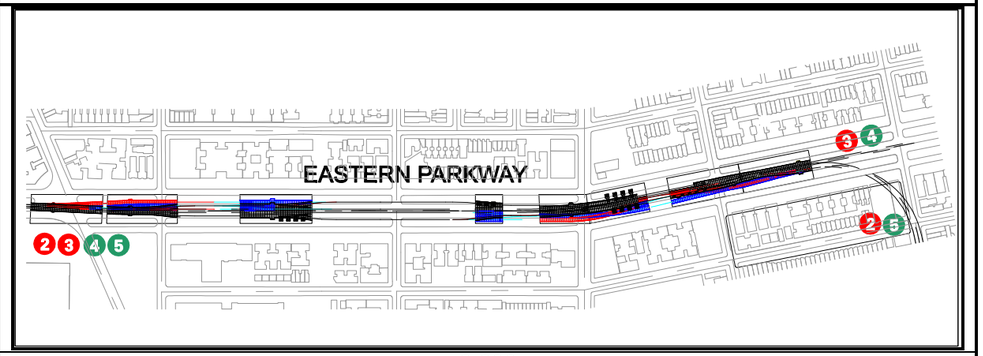
Characteristics	Alternative 4	Alternative 6
		
Length of Construction (ft)	200	3,300
Construction Cost ($Ms)	$343	$1,594
Construction Duration (Years)	3.25	6
Number of General Orders	50	200
Full Environmental Impact Statement Required	No - Assessment	Yes
Other Environmental Impacts During Construction	Traffic Detours	Traffic Detours, Air Quality Conformity Analysis Required (>5 year construction period)
Construction Impacts to Medians	Limited	Medium – 3 Ventilation Plants
Impacts on Landmark Medians	2 Trees	56 Trees, 6 World War I Plaques, 22 Lamp Posts
New Ventilation Plants Required	No	Yes
Property Acquisition	No	No

TABLE ES-2: NUMBER OF GENERAL ORDERS

General Orders	Alternative 4	Alternative 6
Weeknights Without Shuttle Bus	50	178
Weeknights With Shuttle Bus	0	134
Weekends Without Shuttle Bus	49	66
Weekends With Shuttle Bus	1	134

1.0 STUDY PURPOSE

1.1 THE BOTTLENECK

Nostrand Junction is a bottleneck that constrains line capacity and delays trains approaching and entering the junction. These capacity constraints and delays cascade and ripple back through both the former East Side IRT and West Side IRT lines (Lexington Avenue Line and the Broadway-7th Avenue Line, respectively) in Manhattan and are severe enough that they prevent the New Lots Avenue and Nostrand Avenue Lines from operating at their maximum capacity (as measured in trains per hour or TPH).

The configuration of Nostrand Junction dates back to approximately 1920 during the original construction of these two lines (it is the merging and diverging point for two subway lines): 1) the New Lots Avenue Line and 2) the Nostrand Avenue Line. Nostrand Junction comprises a section of the Brooklyn IRT of approximately 1,600 feet long, located between the east end of Franklin Avenue Station and the west end of Nostrand Avenue Station.

Although the northbound (to Manhattan) and southbound (from Manhattan) directions are stacked and segregated on two levels (the northbound direction is on the lower level; the southbound direction is on the upper level), between Utica Avenue and north of the junction, both levels were built as “flat junctions” meaning that southbound trains from the express track must cross at grade over the southbound local track to enter the Nostrand Avenue Line. In the northbound direction, Nostrand Avenue Line trains entering the New Lots Avenue Line must first cross at grade over the northbound local track.

Whenever a train must cross another mainline track at grade, there is the potential – particularly during peak periods – to delay through trains on the mainline being crossed. Indeed, New York City Transit’s (NYCT) 1993 report *A Report On Nostrand Avenue Junction Study; New Lots and Nostrand Avenue Lines* noted that during AM peak periods, 41 percent of the Nostrand Avenue services (2 and 5 trains) between President Street Station and Franklin Avenue Station are delayed an average of 1.65 minutes/train. 35 percent of the New Lots Avenue trains (3, 4 and previously 5 trains) were delayed during AM peak periods, between Nostrand Avenue Station and Franklin Avenue Station, with an average delay of 1.1 minutes/train. The 1993 report attributes the majority of the train delays to the current flat junction configuration of Nostrand Junction, with other contributing factors being terminal capacity at both Flatbush Avenue and Utica Avenue, plus train operations within the Atlantic Avenue area.

These delays not only annoy and inconvenience customers and staff alike, but they also decrease equipment utilization and extend train running times – increasing operating and even capital costs (as additional train sets may be required to protect the roster of timetabled services when running times are severely lengthened).

1.2 UNPLUGGING THE BOTTLENECK

The purpose of this study is to develop in greater detail the two previously short listed options for unplugging the Nostrand Junction bottleneck, based upon recommendations from the 1993 NYCT report *A Report On Nostrand Avenue Junction Study; New Lots and Nostrand Avenue Lines.* This report proposed six alternatives and suggested two possible recommended alternatives – Alternative 4 (constructing new crossovers) and Alternative 6 (constructing new grade-separated flyovers using cut-and-cover tunnel construction methods).

This study analyzes and refines Alternatives 4 and 6 as recommended from that prior report and undertakes a conceptual engineering design review addressing two separate alternatives for a proposed reconfiguration of Nostrand Junction on the IRT New Lots and Nostrand Avenue Lines in the Borough of Brooklyn. The objective of the proposed reconfiguration is to improve subway operations on the IRT 2, 3, 4 and 5 services by increasing service capacity through Nostrand Junction.

Specifically, the objectives of this study are to: 1) prepare conceptual (less than 10 percent design level) engineering design study drawings and provide narratives confirming and documenting the engineering feasibility of the two aforementioned Nostrand Junction alternatives; 2) develop conceptual constructability/phasing plans, drawings and schedules for each of the two alternatives; 3) identify the types and magnitude of temporary subway service impacts resulting from reconstructing Nostrand Junction under both alternatives (i.e., service shutdowns, diversions, slow speed orders); 4) identify potential significant environmental/community impacts (which would then be further addressed as part of a separate, subsequent Environmental Impact Statement); and 5) prepare construction cost estimates for both alternatives within a reasonable degree of confidence.

The NYCT has not assigned a construction completion date or target date for beneficial use. Cost estimates will be made using mid-2008 construction cost factors escalated to an estimated mid-point of construction. While the completion timeframe has not been determined, the purpose of this study is to complete a number of the intermediate steps needed to advance either Alternative 4 or 6. This includes verifying the practicality of the two alternatives, creating the phasing plan, identifying significant environmental issues (if any), and estimating construction costs. This will allow NYCT to advance this project when funding opportunities permit.

2.0 BACKGROUND AND PRIOR STUDIES

Nostrand Junction has long been recognized as a source of delay that not only affects local train movements through the junction, but also as a conflict point that cascades further up the line on the Lexington Avenue and Broadway-7th Avenue lines. This recognition was documented over 40 years ago and Nostrand Junction has been the subject of at least four prior studies. They are:

- A 1967 report titled *Transportation Studies for Southeast Brooklyn* authored by the Study Group for Southeastern Brooklyn Transportation. This study recommended that priority should be placed on improving the existing rapid transit lines instead of system expansion, and that such improvements should aim at increasing operating capacity and reducing operating delays. Nostrand Junction was specifically identified as a location in need of urgent improvements.

  This study proposed constructing additional track and switches east of Franklin Avenue Station to provide a fully flexed junction that eliminated the capacity bottleneck for $12.3 million (1966 dollars). Those proposed improvements would enable the full line capacity of 60 TPH to be attained and allow both the Lexington Avenue Line and the Broadway-7th Avenue Line express services to operate at full capacity.
- The Metropolitan Transportation Authority’s 1968 report *Program for Action*, which proposed extending the Nostrand Avenue Line, as well as other new subway lines such as the proposed Utica Avenue Line.
- The 1972 study by the former Planning Division of the Authority's Engineering Department. Two options were analyzed:

  A. Install a crossover east of Nostrand Avenue Station to eliminate the grade crossing at Nostrand Junction.

  B. Provide a fully-flexed, grade-separated junction to improve operations at Nostrand Avenue, to provide Broadway-7th Avenue Line service to New Lots Avenue and to enable an

extended Lexington Avenue Line service to the then proposed Utica Avenue Line.

Option A, above, was less expensive than Option B, but Option A did not provide as much operational flexibility as Option B. Option B was proposed as a method for providing Lexington Avenue Line service to the then proposed Utica Avenue Line. This extension could have maximized the junction's capacity without modifying the then existing service plan which consisted of one Broadway-7th Avenue Line route and one Lexington Avenue Line route to both Flatbush Avenue Terminal and New Lots Terminal. With New York City's financial crisis in the mid-1970s, these two schemes were not pursued, and have remained dormant until recently.

- During the Third Five Year Capital Program (1992-1996), the reconfiguration of Nostrand Junction re-emerged as a study topic. The 1993 NYCT report *A Report On Nostrand Avenue Junction Study; New Lots and Nostrand Avenue Lines* provided the latest (before this study) analysis on how best to cost effectively improve throughput and minimize conflicts through Nostrand Junction. The study examined seven alternatives with three groupings of alternatives:
  - Three alternatives proposed grade separating the flat junction.
  - Two alternatives proposed additional crossovers.
  - Two alternatives proposed new station platforms at Kingston Avenue Station and Nostrand Avenue Station.

After considering construction costs, operational impacts during construction, and operational benefits, the 1993 study recommended two alternatives for further study – Alternatives 4 and 6 (see Figures 1 and 2).

Alternative 4 added new crossovers north of Nostrand Avenue to eliminate a three-line merge, was deemed efficient with no potential conflicts, and increased the line capacity from 44 TPH to 57 TPH.

However, the disadvantage with Alternative 4 is that it no longer provides both Lexington Avenue Line and Broadway-7th Avenue Line services from both Flatbush Avenue Terminal and the New Lots Avenue Terminal. Alternative 4 only provides Lexington Avenue Line service from New Lots Avenue, while Broadway-7 Avenue Line service is served only from Flatbush Avenue Terminal under this alternative. As the customers have become used to a choice of both the Lexington Avenue Line and Broadway-7th Avenue Line services from both the Nostrand Avenue Line and the New Lots Avenue Line, if Alternative 4 is implemented, they would be required to transfer at common interchange stations (i.e., Franklin Avenue, Atlantic Avenue, Nevins Street or Borough Hall stations) to access the desired line. As some customers board either the Nostrand Avenue Line or the New Lots Line by first transferring from another mode such as a bus, requiring customers to transfer once more may be politically difficult. Also, customers boarding at terminal stations where they may be able to claim a seat may be annoyed at an intermediate transfer that will require them to relinquish their seat as they board another train.

Alternative 6 added a new grade separated set of flyovers on both the upper and lower level tunnel tracks between the Eastern Parkway Station and the Nostrand Avenue Junction to eliminate a three line merge, was deemed efficient with no potential conflicts, and increased the line capacity from 44 TPH to 56 TPH.

The advantages of Alternative 6 are that it maintains the present train service and does not require passengers to transfer, resolves the three (3) line merge bottleneck, and increases speeds through the new tracks.

However, the disadvantage with Alternative 6 is that it requires increasing the capacity of the Flatbush Avenue Terminal for the additional traffic generated with three (3) lines merging, one to the south and two spread to the north of Franklin Avenue. Alternative 6 was also estimated to be in the middle of the cost range of the most expensive alternatives.

This current study effort builds upon the two recommended alternatives (Alternatives 4 and 6) from the 1993 NYCT report and forms the basis of work for this study.

3.0 EXISTING CONDITIONS AT PROPOSED CONSTRUCTION AREAS

The existing physical conditions, as noted in the 1993 NYCT *Nostrand Avenue Junction Study* report, remain essentially unchanged and still apply today.

3.1 EASTERN PARKWAY

Nostrand Junction is located underneath Eastern Parkway between the easterly end of the Franklin Avenue Station and the westerly end of the Nostrand Avenue Station. The junction is approximately 1,600 feet long, bounded by the building lines north and south of Eastern Parkway. Nostrand Junction has a practical capacity of 44 TPH during the AM peak.

The Eastern Parkway itself is a combined roadway (with outer service lanes and central express lanes) and the park consists of two wide, tree lined medians, each bisected by a pedestrian walkway. The linear parklands are designated as historic resources and link Lincoln Park to Prospect Park.

3.2 SUBWAY TUNNELS, TRACK & ALIGNMENT, STATION ENTRANCES

Within Nostrand Junction, the existing New Lots Avenue Line underground structure starts as a four track single level structure at Franklin Avenue and transitions to a four track bi-level structure at the Nostrand Avenue Station, with northbound local and express tracks below and the southbound local and express tracks above. A 16 feet 2 inch grade separation is maintained throughout the train tracks.

In the vicinity of Rogers Avenue, two tracks from the Nostrand Avenue Line coverage and connect with the bi-level structure approximately 300 feet west of the Nostrand Avenue Station. The southbound Nostrand Avenue line track connects to the upper level southbound local track with a No. 8 special turnout. The northbound Nostrand Avenue line track connects to the lower level northbound local track with a No. 8 special turnout.

Additionally, directly north of the connections, crossovers are provided on both levels between the local and express tracks. In the vicinity of Franklin Avenue, the existing New Lots Avenue line tracks converge to one common level to permit the four tracks, two island platform express/local transfer at the Franklin Avenue Station.

Approximately 1,200 feet west of Franklin Avenue in the vicinity of Classon Avenue, the existing structure is a bi-level, four tracks, steel and concrete bent subway structure. The two upper level tracks carry local service (both northbound and southbound) and the two lower level tracks carry the express service (both northbound and southbound).

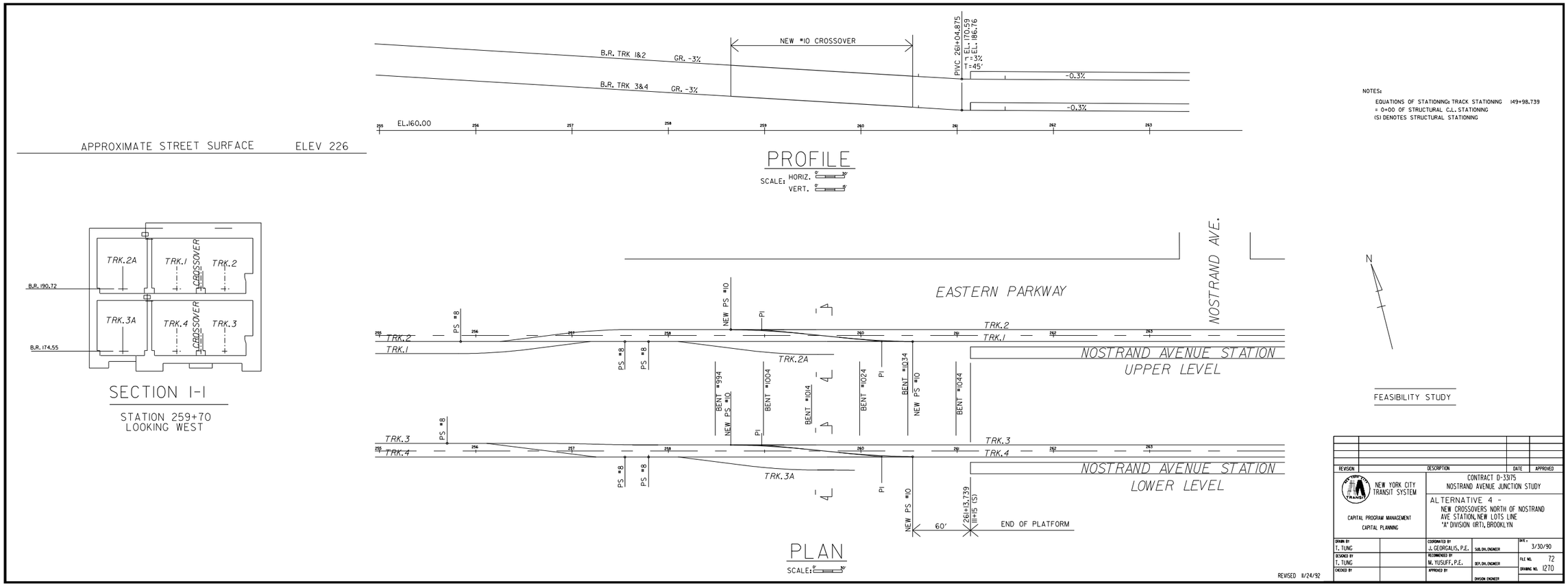


Figure 1: Alternative 4 (1993)

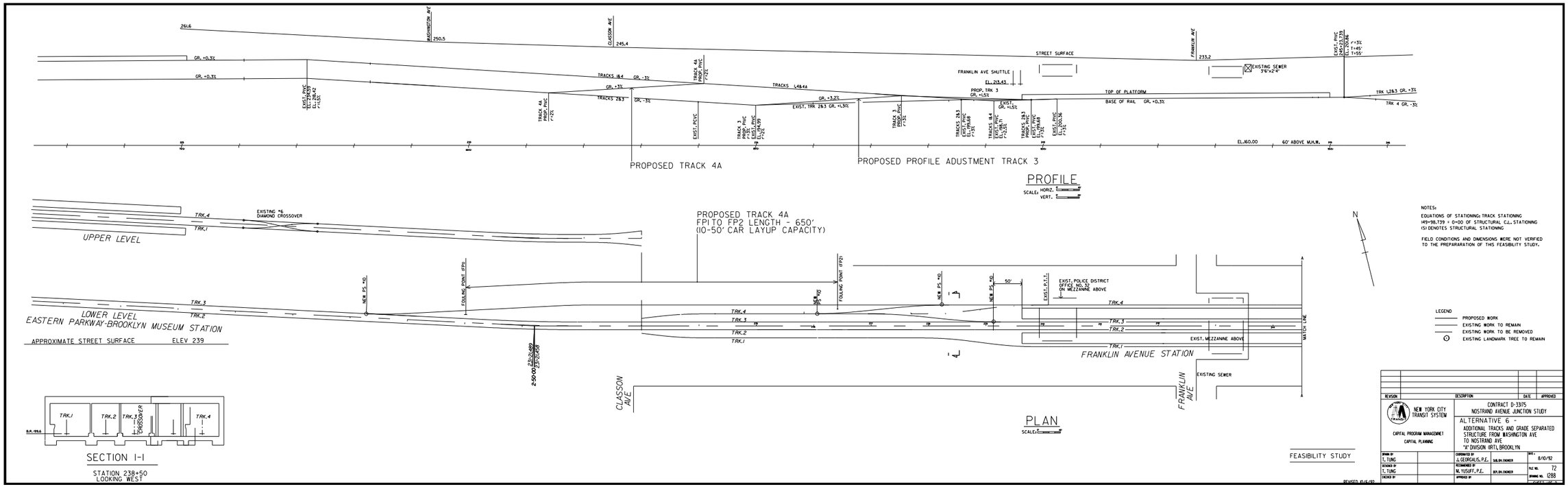


Figure 2: Alternative 6 (1993)

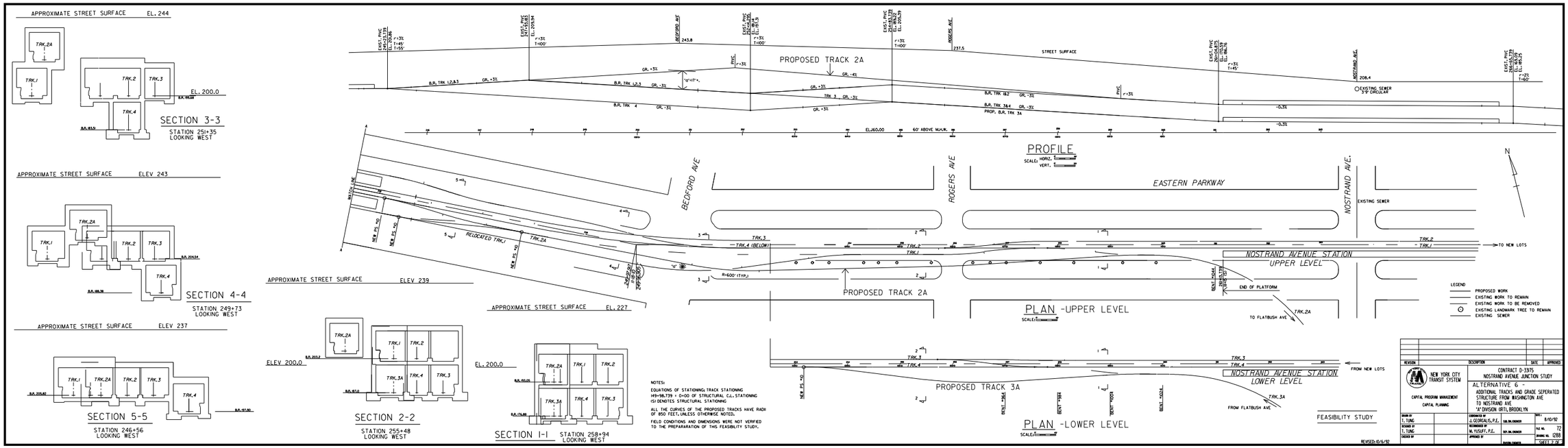


Figure 2: Alternative 6 (1993) (continued)

At the westerly end of Franklin Avenue Station, the structure is located approximately 36 feet below Eastern Parkway and 17 feet below the Franklin Avenue Shuttle tracks (which cross Eastern Parkway at right angles). The structure is 33 feet wide at Classon Avenue and flairs to 90 feet at the Franklin Avenue Station. At the Franklin Avenue Station, the structural envelope accommodates two 525 feet-long, 20 feet 4 inch-wide platforms with the two express tracks in the middle and the two local tracks on the sides. At each platform, two rows of columns, 15 feet on center and 4 feet 9 inches from the platform edge, support the roof structure. The station is served by an overhead mezzanine at Franklin Avenue, which provides access from the street above. The westerly end of the existing mezzanine is used by the Police Department as a district office. Since the 1993 Report was written, a new free transfer from the Franklin Avenue Station to the adjacent Botanic Garden Station (on the Franklin Avenue Shuttle) has been open to the public.

3.3 COMMUNITY DESCRIPTION

This section presents a brief description of the community surrounding the proposed Nostrand Junction project area. This summary provides a baseline of environmental conditions that will be considered in the environmental issues screening that follows in later project studies.

A 33-block study area was defined to screen potential issues from the two alternatives under evaluation on existing conditions and potentially sensitive elements found there including: land use and zoning, demographic and socioeconomic composition, community facilities, historic and visual resources, and parks and open spaces. These features of the study area are presented narratively and graphically on the following pages.

3.3.1 Land Use & Zoning

Land Use

Nostrand Junction is located in the residential Crown Heights section of Brooklyn and is situated beneath Eastern Parkway between Nostrand Avenue and Franklin Avenue. The underground Nostrand Avenue and Franklin Avenue Stations on the New Lots Line have station entrances on Eastern Parkway in the project site, the latter of which also connects to the Franklin Avenue Shuttle line.

The project area consists of six rectangular-shaped blocks that line Eastern Parkway, typical of the symmetrical form of the historic Crown Heights neighborhood. Eastern Parkway, the main thoroughfare of Crown Heights and the project site, is divided into three separate roadways – the main roadway (two-way traffic) and two local service roads (one-way traffic) – located directly north and south of it and bordered by tree-lined malls.

The existing land-use pattern in the project area is characterized by a mix of three- and four-story brownstone/brick homes that occupy the middle lots of the block and are setback 20-feet from the sidewalk along the northern and southern service roads of Eastern Parkway (see Land Use Figure in Appendix B). Higher density five- and six-story apartment buildings are primarily located on the corner lots and transition into mixed residential and commercial uses along the main avenues. Local retail stores, fresh produce markets, commercial/professional offices spaces, small eateries and restaurants line the north-south streets that cross Eastern Parkway: Nostrand, Rogers, Bedford, and Franklin Avenues.

The immediate project area features four churches: Shiloh Seventh Day Adventist, First Baptist Church, Philadelphian Sabbath Cathedral, and Evangelical Lutheran.

Automobile related uses (car wash and gas station) and a mixed commercial/office building with a ground floor Washington Mutual Bank location are found along Bedford Avenue north and south of Eastern Parkway. Nearby churches are located along the parkway service roads.

The study area is characterized by a variety of single and multi-family homes located along the mid-block sections of Union Street, Lincoln Place, St. John's Place, and Sterling Place. A mix of transportation, commercial, institutional, and multi-family buildings are located along Bedford Avenue. Ground floor retail and residential buildings line the commercial corridors of Franklin and Nostrand Avenues within the study area, providing a full variety of local services and amenities. There are also a number of religious, cultural, and public institutions including schools, churches, synagogues, City and State institutions, and health facilities.

Zoning

The project site is located primarily in an R6 zoning district (see Zoning Map figure in Appendix B). The R6 zoning district is for medium density residential development allowing a varied housing stock ranging from row houses to small apartment buildings. There are several blocks throughout the study area (mainly in the northwest and southeast) that are zoned R7-1. An R7-1 zoning allows for medium density apartments, which corresponds to the mix of one- and two-family, attached housing found along Eastern Parkway. Nostrand and Franklin Avenues have a C1-3 commercial overlay that extends through the study area. Bedford Avenue, between President Street and Lincoln Place, incorporates a C8-2 commercial district allowing for automotive and heavy commercial uses such as gas stations and car washes. The northwest, northeast, and southwest corners at the intersection of Eastern Parkway and Rogers Avenue have a C2-1 commercial overlay. Portions of Franklin Avenue, between Carroll Street and Eastern Parkway, are zoned R6A which is compatible with the surrounding R6 zoning. Existing buildings within the study area appear to comply with the current applicable zoning bulk regulations.

3.3.2 Socioeconomics

The study area extends into Community District 8 (Census Tracts 217, 219, and 317.02) north of Eastern Parkway and Community District 9 (Census Tracts 213, 319, 321, 323, and 325) south of Eastern Parkway. Statistics for the census tracts were included because 50 percent or more of the census tracts fell within the boundaries of the study area. Detailed information on these tracts is provided below. (See Appendix C)

According to 2000 U.S. Census, New York City had a total population of 8,008,278, which is comprised of 35 percent White/non-Hispanic, 24.5 percent Black/African American, 9.7 percent Asian, and 27 percent of Hispanic Origin. In Brooklyn, the population totaled 2,465,326: 34.7 percent White/non-Hispanic, 34.4 percent Black/African American, 7.5 percent Asian, and 19.8 percent of Hispanic Origin.

In the city as a whole, 69 percent of housing units were renter-occupied compared to 72.9 percent renter-occupied units in Brooklyn. The citywide median annual household income was $38,293, slightly higher than Brooklyn's median household income of $32,135. Within New York City, the median age of residents was 34.2 years and slightly younger in Brooklyn - 33.1 years.

In the portion of study area located in Community District 8 (Census Tracts 217, 219 and 317.06) (see Appendix C), most of the population are Black/African American, followed by people of Hispanic Origin. Black/African Americans are predominately represented in this neighborhood to a greater degree than in other parts of the borough and city at large. Households within these census tracts are primarily renter-occupied with only 5 to 17.8 percent owner-occupancy within all three census tracts. The median household income for the area ranges between $26,780 and $31,317 for an average of $29,415, which is significantly less (-$8,878) than

the City and slightly lower than the borough. The median age of neighborhood residents is also lower than the citywide and borough median ages.

In the portion of study area located in Community District 9 (Census Tracts 213, 319, 321, 323, and 325) (see Appendix C), the majority of residents are Black/African American, followed by Hispanic Origin residents. Within Census Tract 319, a significant percentage of residents are White/non-Hispanic. Households within these tracts are primarily renter-occupied and to a significantly greater degree than the borough and City. The median household income in the area ranges between $28,091 and $33,480 for an average of $29,706, which is a significantly less (-$8,586.8) than the City and slightly lower than the borough. The median age of neighborhood residents is slightly lower than the City and typical of Brooklyn residents.

3.3.3 Community Facilities

Police Services. The study area is serviced by the 71st and 77th Police Precincts. The 71st Precinct house is situated at 421 Empire Boulevard, about one mile southeast of the center of the project site. The 77th precinct house is situated at 127 Utica Avenue, about one and a half miles northeast of the secondary study area.

Fire Services. The unit serving the site is Engine Company 280 Ladder Company 132, located at 489 St. John's Place, less than half a mile away from the secondary study area.

Health Care Services. The study area is served by the Empire Center Central Brooklyn Medical Group, a local medical center located at 546 Eastern Parkway.

Public Schools. There is one primary school and three secondary schools located within the secondary study area. Public School 241 is located at 925 Carroll Street; the Prospect Heights and Clara Barton Secondary Schools are located at 883 Classon Avenue and the W.E.B. Du Bois Secondary school is located at 402 Eastern Parkway.

(See Appendix D for a detailed community facilities listing.)

3.3.4 Historic Resources

Eastern Parkway

Eastern Parkway was designated a historic scenic landmark in 1978 by the New York City Landmarks Preservation Commission (NYCLPC) and listed in the National Register of Historic Places (NRHP) in 1983. It is situated in the center of the project area and spans three miles between Ralph Avenue and Grand Army Plaza (see Historic Map). Designed by the renowned landscape architects Frederick Law Olmsted and Calvert Vaux, construction of the parkway began in 1870 and was completed in 1874.

Eastern Parkway is divided into three roadways by two broad, tree-line malls. Olmsted envisioned the parkway as a means to providing "a new kind of roadway incorporating central malls with trees, pleasure drives, walkways, and service roads in order to draw the character of Prospect Park, with its attendant benefits, through Brooklyn" [2]. The development of the parkway during the early 20th century fostered the settlement of middle and upper class professionals in the areas surrounding the parkway. The establishment of upper classes along the parkway ushered in "an assortment of architectural forms, including one and two-family row houses, semi-detached residences, and freestanding mansions"[3], some of which are still seen present-day. Significant features of the parkway include the varied species of trees that line the malls including: Elms, Norway Maples, Silver Maples, Red Oaks, and Pin Oaks, paved octagonal asphalt tiles of the mall, and concrete and wooden-slate park benches[4].

Additional Historic Resources

The Studebaker Building is located at 1469 Bedford Avenue on the corner of Sterling Place and Bedford Avenue, a half block outside of the study area. Tooker and Marsh architects built the automobile showroom in 1920. The historic five-story building has a brick and white terra cotta façade with the Studebaker logo. In 2000, the Studebaker Building was designated by the NYCLPC for its neo-gothic structure. Two years ago, a developer bought the 1920 building, which in recent years was home to artists' studios on the upper floors and a church in the walled-over showroom. Since then, with the help of financing from the City, the structure was converted into 27 low-income rental apartments.[5]

The monumental Brooklyn Museum is located at the intersection of Washington Avenue and Eastern Parkway, a half block outside of the study area. The L-shaped museum was built between 1895 and 1906 by the architectural firm of McKim, Mead and White. The historic building stands four stories tall on four and half acres of land. The museum was designated a historic landmark in 1976 by the National Register of Historic Places (NYRHP) and is regarded for its "architectural significance, as an example of the American neo-classical style and its importance as a historic cultural institution"[6]. Significant features of the Brooklyn Museum include the projecting pavilions located at the center and ends of the building, the central pavilion, the dome, the hexastyle portico, and sculptured figures adorned on the portico[7] (see Historic Resources figure in Appendix B).

The Crown Heights North Historic District located approximately three blocks north of the study area was designated by the NYCLPC on April 24, 2007. The historic district showcases Crown Heights' detailed row houses, attached houses, freestanding residences, churches, flats buildings, and elevator apartment houses dating from the middle of the nineteenth century to the 1930s[8].

3.3.5 Visual Resources

Within the project area, Eastern Parkway, a designated scenic landmark, is the main visual resource in the vicinity of the project. The parkway's canopy of trees along the pedestrian promenade offers shaded seating on the benches of the mall. The park-like qualities of the mall offer a recreational space for local residents. View corridors of the historic parkway are available along the parallel streets and along the avenues that intersect it.

At the very western edge of study area is the Dr. Ronald McNair Park, located on Washington Avenue and Eastern Parkway. Views of the park are visible from the street and sidewalks along Eastern Parkway between Washington and Classon Avenues.

Additionally, there are splendid vistas of the Manhattan skyline within the study area from Washington Avenue, looking north.

3.3.6 Parklands and Boulevard Landscaping

The Eastern Parkway pedestrian malls, a designated scenic landmark, are the primary open spaces and recreational areas in the study area, spanning three miles between Grand Army Plaza and Ralph Avenues (see Historic Resources Section). The historic parkway is comprised

[2] National Register of Historic Places Designation Report, Eastern Parkway 90NR01317 (August 4, 1983), p5
[3] National Register of Historic Places Designation Report, Eastern Parkway 90NR01317 (August 4, 1983), p3
[4] National Register of Historic Places Designation Report, Eastern Parkway 90NR01317 (August 4, 1983), p3
[5] New York City Landmarks, 3rd Edition , New York City Landmarks Preservation Commission (2004) p 254-256

[6] National Register of Historic Places Designation Report, The Brooklyn Museum 90NR01296 (November 11,1976), p2
[7] National Register of Historic Places Designation Report, The Brooklyn Museum 90NR01296 (November 11,1976), p2-3
[8] Crown Heights North Historic Designation Report, New York City Landmarks Preservation Commission (2007) p 4

of two broad tree-lined malls on the northern and southern sides of Eastern Parkway and is adorned with concrete and wooden park benches that line the mall walkway offering pedestrians and residents a peaceful sitting area[9]. The pedestrian promenade offers active uses for local residents who walk, run, or bike along the open space. Passive uses of the parkway include sitting on the shaded benches and general leisurely enjoyment of the open space; a valuable resource for local residents in the dense urban community.

In the study area, there is one open space: the Dr. Ronald McNair Park, which was named after the distinguished physicist and African-American astronaut. It is located on the western edge of the study area on a triangular-shaped parcel of land. According to the New York City Department of Parks, the 1.36 acre park underwent a capital renovation project in 1994 and now features bluestone paving, fencing, game tables, World's Fair benches, and a bronze portrait sculpture of Dr. Ronald McNair[10].

3.4 TRANSIT SIGNAL/COMMUNICATIONS/POWER SYSTEMS

The existing signal plan layout within the project area is provided in Appendix J; see Figures S-1 thru S-6. NYCT controls subway service through the Rail Control Center (RCC) located in Manhattan via PLC modbus plus communications with PLC located in the field. Backup control of Eastern Parkway and Nostrand Avenue are handled at the Utica Avenue Master Tower. The current system capacity for this junction is 40 TPH and the design headway capacity supports 90-second headways. However, those headways are not achievable due to the track configuration with the three lines that merge at Nostrand Junction. The signal system on the Eastern Parkway Line is bi-directional on Tracks 1 and 4 and single direction running on Tracks 2 (southbound) and 3 (northbound). On the Nostrand Avenue Line, Tracks 2A and 3A are both signaled for bi-directional operation. On the New Lots Avenue Line, only single direction traffic is provided where Tracks 1 and 2 are southbound and Tracks 3 and 4 are northbound.

The Franklin Avenue Station does not contain interlocking control for approximately 1800' on either side of the station. The signaling within this particular area is Automatic Block signaling.

The Nostrand Avenue relay room is an all relay controlled Interlocking located approximately 40 feet north of the end of the Nostrand Avenue Station platform. This room is already over utilized with train control equipment and there is no spare space available to install additional new equipment. Within the control limits of the relay room, there are 17 controlled signals with associated train stops and 6 switch machines.

The signal system on the Eastern Parkway Line is bi-directional on Tracks 1 and 4 and single direction running on Tracks 2 (southbound) and 3 (northbound). On the Nostrand Avenue Line, Tracks 2A and 3A are both signaled for bi-directional operation. On the New Lots Avenue Line, only single direction traffic is provided where Tracks 1 and 2 are southbound and Tracks 3 and 4 are northbound. (See Figure S-1 to S-6 in Appendix J)

3.5 EXISTING UTILITIES UNDER EASTERN PARKWAY & CROSS STREETS WITHIN AREA OF CONSTRUCTION

The utilities found within Eastern Parkway between the major intersections from Washington Avenue to Nostrand Avenue, as further detailed below, are combined sanitary sewer and stormwater sewer mains; water mains; National Grid gas mains; electrical duct banks; signal and roadway lighting duct banks, and Empire City Subway (Telephone) duct banks.

3.5.1 Washington Avenue to Classon Avenue

Washington Avenue

The documented existing utilities are multiple 4-inch Con Edison electrical conduit ducts, a traffic signal conduit, several Empire City Subway duct banks of 4 to 24 pipes with pipe sizes and type varying. There is a 22-inch VIT (vitrified clay pipe) combined sanitary sewer crossing over the subway at Eastern Parkway and combining with a 12-inch VIT combined sanitary sewer to a manhole and continuing downstream through an 18-inch by 12-inch sewer main. Crossing Washington Avenue there is an active 12" and 6" steel National Grid gas main and retired 6" cast iron gas main with various Con Edison, Empire City and traffic conduits with light poles located on either side of the roadway at the street intersections.

Northern Roadway

The documented existing utilities are a traffic signal conduit running approximately 7 feet from the northern curb line, an Empire City Subway duct bank of 12 PVC telecommunication pipes, a 12-inch DIP and 48-inch DIP water main, a 4" steel active National Grid gas main, and a 12-inch VIT combined sanitary sewer running under the cartway of the road. Light poles are located on either side of the roadway at the street intersections.

Main Roadway

The documented existing utilities are two 3.5-inch Con Edison electrical conduits running approximately 11 feet from the northern curb line within the median. A 12" retired cast iron National Grid gas main approximately 8' from the northern curbline within the main roadway. Traffic control lights are located on either side of the roadway at the street intersections.

Southern Roadway

The documented existing utilities are a 12-inch DIP water main, a 12" active cast iron National Grid gas main, a 6" retired cast iron National Grid gas main, and 12-inch VIT combined sanitary sewer running under the cartway of the road. Light poles are located on either side of the roadway at the street intersections.

3.5.2 Classon Avenue to Franklin Avenue

Classon Avenue

The documented existing utilities are multiple 4-inch Con Edison electrical conduit ducts, a 6" active steel and 6" retired cast iron National Grid gas mains, a 22-inch VIT combined sanitary sewer crossing over the subway at Eastern Parkway and changing to a 22.5-inch by 15-inch combined sanitary sewer, traffic signal conduit, an Empire City Subway duct bank of 12 PVC pipes, and a 12-inch DIP water main along Classon Avenue. Crossing Classon Avenue there are two 12-inch DIP and one 24-inch DIP water mains, two 4" active steel with two 6" and one 12" retired cast iron National Grid gas mains, and 12" and 18"x12" combined sewer mains connecting to the 22" VIT within Classes Avenue with various Con Edison, Empire City and traffic conduits with light poles located on either side of the roadway at the street intersections.

Northern Roadway

The documented existing utilities are two 3-inch and two 4-inch Con Edison electrical conduit ducts, a traffic signal conduit running approximately 7 feet from the northern curb line, a 12-inch DIP and 48-inch DIP water main, a 4" active steel and 6" retired cast iron National Grid gas main, and a 12-inch VIT combined sanitary sewer running under the cartway of the road and storm inlets at Franklin Avenue intersection. Light poles are located on either side of the roadway at the street intersections.

Main Roadway

The documented existing utilities are two 4-inch Con Edison electrical conduit ducts running approximately 12 feet from the

[9] National Register of Historic Places Designation Report, Eastern Parkway 90NR01317 (August 4, 1983)
[10] NYC Department of Parks and Recreation http://www.nycgovparks.org/parks/B044/highlights/202

northern curb line within the median. A 12” abandoned steel National Grid gas main approximately 8’ from the northern curb line within the main roadway. A 15-inch VIT combined sewer main is located approximately 15 feet from the northern curb line within the median and is approximately 89 feet along the median where a 15-inch VIT combined sewer main crossing Eastern Parkway joins at a manhole. There is a pump room noted as PR #3247 located approximately 240 feet east from the Classon Avenue intersection that discharges a force main of two 8-inch lines at cartway centerline, which has approximately 4 feet of cover. Traffic control lights are located on either side of the roadway at the street intersections.

Southern Roadway

The documented existing utilities are two 4-inch Con Edison electrical conduit ducts, a 12-inch DIP water main, an active 4” steel and retired 6” cast iron National Grid gas main with the active 4” main terminating and an active 6” main starting at approximately 470’ from Classon Avenue, and a 12-inch VIT combined sanitary sewer running under the cartway of the road. Light poles are located on either side of the roadway at the street intersections.

3.5.3 Franklin Avenue to Bedford Avenue

Franklin Avenue

The documented existing utilities are multiple 0.5-inch to 6-inch Con Edison electrical conduit ducts, various Empire City Subway telecommunications duct banks, an active 6” steel with retired 4” cast iron National Grid gas main along Franklin Avenue from Union to Eastern Parkway service road north, an active 12” cast iron National Grid gas main along Franklin Avenue from Eastern Parkway service road north to Lincoln Place, traffic signal conduit, a 12-inch DIP water main along Franklin Avenue. Crossing Franklin Avenue there are two 12-inch DIP and one 24-inch DIP water mains, two 16” cast iron combined sanitary sewer main connecting into a 24-inch VIT main along Franklin Avenue crossing over the subway at Eastern Parkway and changing to a 3-foot 2-inch by 2-foot 0-inch combined sanitary sewer. The force main running down Eastern Parkway discharges into the combined sewer system along Franklin Avenue. There are two 6” active steel National Grid gas mains also crossing Franklin Avenue with various Con Edison, Empire City and traffic conduits with light poles located on either side of the roadway at the street intersections.

Northern Roadway

The documented existing utilities are two 3-inch Con Edison electrical conduit ducts, a traffic signal conduit running approximately 7 feet from the northern curb line, a 12-inch DIP and 48-inch DIP water main, an active 4” steel and retired 6” cast iron National Grid gas mains, and a 12-inch VIT combined sanitary sewer running under the cartway of the road and storm inlets at Franklin Avenue intersection. Light poles are located on either side of the roadway at the street intersections.

Main Roadway

The documented existing utilities are fourteen 3.5-inch and eight 4-inch Con Edison electrical conduit ducts running approximately 24 feet from the northern curb and reduces to 2-foot 3.5-inch and 2-foot 4-inch conduits approximately 347 feet up Eastern Parkway at a utility manhole and 560 feet where further reductions and a crossing is located. There is a 12” abandoned steel National Grid gas main approximately 8’ from the northern curb line within the main roadway. Traffic control lights are located on either side of the roadway at the street intersections.

Southern Roadway

The documented existing utilities are two 3-inch and two 4-inch Con Edison electrical conduit ducts, a 12-inch DIP water main, an active 6” steel and retired 6” cast iron National Grid gas mains, and a 12-inch VIT combined sanitary sewer running under the cartway of the road. Light poles are located on either side of the roadway at the street intersections.

3.5.4 Bedford Avenue to Rogers Avenue

Bedford Avenue

The documented existing utilities are multiple 3-inch to 4-inch Con Edison electrical conduit ducts, traffic signal conduits, a 20-inch DIP as well as portions of a 12 inch DIP water main to the north and south of Eastern Parkway, an active 6” steel National Grid gas main, and various Empire City Subway conduit duct banks. Crossing Bedford Avenue there are two 12-inch DIP and one 24-inch DIP water main, a 12 inch VIT combined sanitary sewer, two 6” and one 12” retired cast iron National Grid gas mains with two active 6” steel gas mains with various Con Edison, Empire City and traffic conduits with light poles located on either side of the roadway at the street intersections.

Northern Roadway

The documented existing utilities are two 3-inch Con Edison electrical conduit ducts, an active 6” steel and retired 6” cast iron National Grid gas main, a traffic signal conduit running approximately 7 feet from the northern curb line, a 12-inch DIP and 48-inch DIP water main, and a 12-inch VIT combined sanitary sewer east and west of Bedford Avenue with various Con Edison, Empire City and traffic conduits with light poles located on either side of the roadway at the street intersections.

Main Roadway

The documented existing utilities are fourteen 3.5-inch Con Edison electrical conduit ducts running approximately 22 feet from the northern curb line within the median. There is a 12” abandoned steel National Grid gas main approximately 8’ from the northern curb line within the main roadway. There is a pump room noted as PR #3248 located approximately 175 feet east from the Bedford Avenue intersection that discharges a force main of a 10-inch line at a cartway centerline that has approximately 4 feet of cover. Traffic control lights are located on either side of the roadway at the street intersections.

Southern Roadway

The documented existing utilities are two 4-inch and two 3.5-inch Con Edison electrical conduit ducts, a 12-inch DIP water main, an active 6” steel and retired 6” cast iron National Grid gas main, and a 12-inch VIT combined sanitary sewer running under the cartway of the road. Light poles are located on either side of the roadway at the street intersections.

3.5.5 Rogers Avenue to Nostrand Avenue

Rogers Avenue

The documented existing utilities are multiple 4-inch Con Edison electrical conduit ducts, an active 16” welded steel and a retired 6” and 16” cast iron National Grid gas mains, traffic signal conduits, Empire City Subway conduit duct banks, and a 12-inch DIP water main along Rogers Avenue. Crossing Rogers Avenue there are two 12-inch DIP and one 24-inch DIP water mains, two active 6” steel and two retired 6” cast iron with one retired 12” cast iron National Grid gas mains, two 12” VIT combined sewer mains and a 10” force main with various Con Edison, Empire City and traffic conduits with light poles located on either side of the roadway at the street intersections.

Northern Roadway

The documented existing utilities are two 3- to 3.5-inch Con Edison electrical conduit ducts, traffic signal conduit running approximately 7 feet from the northern curb line, a 12-inch DIP and 48-inch DIP water main, a 12” steel increasing to a 16” steel National Grid gas main, and a 12-inch VIT combined sanitary sewer running under the

cartway of the road. Light poles are located on either side of the roadway at the street intersections.

Main Roadway

The documented existing utilities are fourteen 3.5-inch Con Edison electrical conduit ducts running approximately 22 feet from the northern curb line within the median, a 12" abandoned steel National Grid gas main approximately 8' from the northern curb line within the main roadway, and a force main of 10" at cartway centerline which has approximately 4 feet of cover that discharges into a 3-foot 9-inch by 3-foot 9-inch combined sewer system along Nostrand Avenue. Traffic control lights are located on either side of the roadway at the street intersections.

Southern Roadway

The documented existing utilities are two 3-inch Con Edison electrical conduit ducts, a 12-inch DIP water main, an active 6" cast iron National Grid gas main, and a 12-inch VIT combined sanitary sewer running under the cartway of the road. Light poles are located on either side of the roadway at the street intersections.

4.0 CONCEPTUAL ENGINEERING PLANS, IMPACTS, COSTS

Existing Alignment

The study area consists of the four tracks of the Eastern Parkway Line from Nostrand Junction to Nostrand Avenue Station. These tracks are located in a bi-level subway structure and are tangent with 12 feet 6 inch track centers within the study area. The southbound Tracks 1 and 2 are located on the upper level, directly above northbound Tracks 4 and 3, respectively, with a 16 feet 2 inch vertical separation.

All tracks in the study area are Modified Type II. The existing vertical clearance, from the top of new 100 lb/yd rail to the bottom of the overhead structure, is 12 feet 8-3/8 inches, which is also the NYCT A Division minimum standard vertical clearance for vertically tangent track. Tracks on both levels are on a 3.00 percent grade descending southbound, from several hundred feet north of the junction until 50 feet north of the Nostrand Avenue Station.

4.1 ALTERNATIVE 4: NEW CROSSOVERS NORTH OF NOSTRAND AVENUE

4.1.1 Track and Alignment

Overview of Alternative 4

To alleviate congestion on the Eastern Parkway Line caused by the three-line merge at Nostrand Junction, a pair of crossovers is proposed railroad south (compass east) of the junction. These new crossovers would allow trains currently changing tracks north of the junction to do so in parallel with trains merging to or diverging from the Nostrand Avenue Line.

Proposed Alignment

The proposed trackwork modifications are limited to roughly 200 feet of each track located between 65 feet south of Nostrand Junction and 75 feet north of the Nostrand Avenue Station. Two, right hand, tangential Number 10 crossovers are to be installed with one on each level, as shown in Figures 3 and 4 (Figures 430 and 431, Appendix H). The structural, signal, communication and traction power modifications required to operate these crossovers and the construction staging required to construct the same are discussed elsewhere in this report.

By direction from NYCT, the alignment presented here differs in several ways from the alignment proposed earlier in the 1993 NYCT feasibility study of this alternative concept (see Figure 1).

First, the new Alternative 4 crossovers are located further north such that on Tracks 1 and 4 the distance from the PS to the PVC near station 260+60 is 20 feet compared to 6 feet provided by the earlier study.

Second, the latest NYCT standard tangential turnouts are used, which are approximately three feet longer than those considered for the previous study. Also, these crossovers are to be of 115 RE rail. If the existing track is built from rail of a shorter cross-section, the base-of-rail elevation should be stepped down to provide the same top-of-rail elevation and therefore the same minimum vertical clearance.

To accommodate these alignment improvements without significantly impacting the limits of the structural modifications, NYCT has accepted a reduced minimum lateral clearance from the diverging route of the crossover to existing center columns. While NYCT A Division Standards normally require 6 feet 3 inches feet of lateral clearance, this alternative provides 5 feet 5 inches lateral clearance from track centerline to center columns (in addition to clearance excesses required due to curvature). The limits of center column removal shown on Appendix H, Figure 404 are based on this minimum clearance and the structural plans from the original construction of the line.

If this alternative is selected for further investigation, the limits of column removal should be further refined, and should be based upon a more detailed field survey of the track and structure.

4.1.2 Structural Plans and Sections

The new Nostrand Junction crossovers are located on both the upper and lower levels of the existing subway tunnel structure. Construction of these new crossovers will affect the existing tunnel structure and will require structural modifications and reconstruction.

Within the proposed limits of the crossover, the existing structure consists of two distinct sections – Section A, and Section B (see Plan Figure Numbers 401, 405 and 406 in Appendix H).

- Section A (Figure 405 in Appendix H) consists of a two level structure with two simple spans at each level.
- Section B (Figure 406 in Appendix H) consists of a two level structure with three simple spans at each level.

The proposed crossovers will require removing the interior columns on both levels along the center line of the tunnel. As a result, within Section A the center columns will be removed, and within Section B one line of interior columns will be removed.

Structural Design Objective

Eliminating the interior columns will require extensive structural modifications that include replacing the existing roof beams, replacing the track floor beams and adding new exterior columns. The proposed design takes into consideration the necessary constructability and structural feasibility issues.

Structural Design Criteria

The structural design criteria used in this study is based upon NYCT's Structural Design Guidelines, upon the available existing structure drawings, and miscellaneous information.

The primary objective of these design criteria is to establish reasonable structural design parameters and design criteria to be used during this conceptual design effort of Alternative 4 (as defined in the NYCT Study Report dated January 15, 1993).

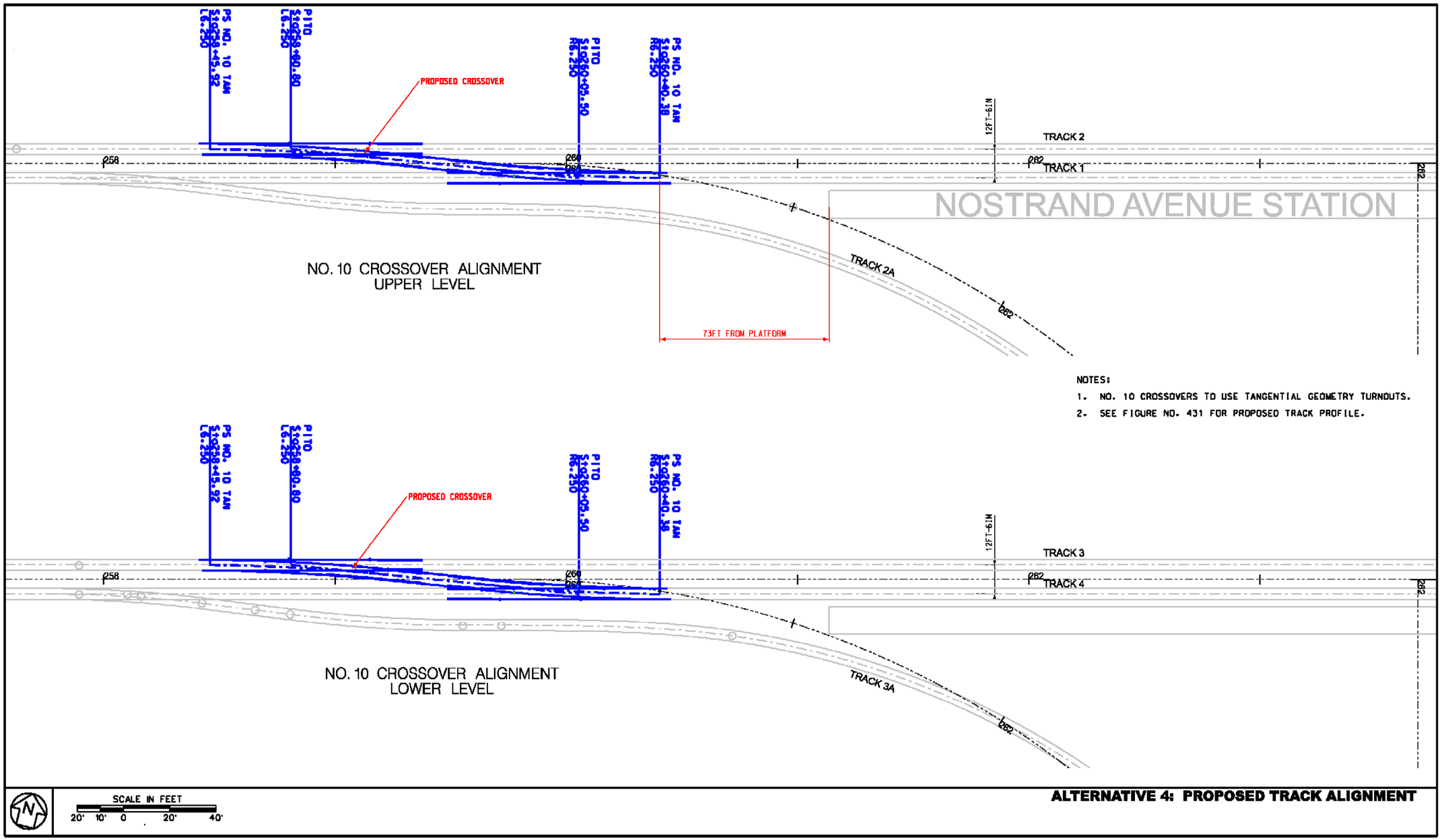


Figure 3: Alternative 4 Proposed Track Alignment (Appendix H, Figure 430)

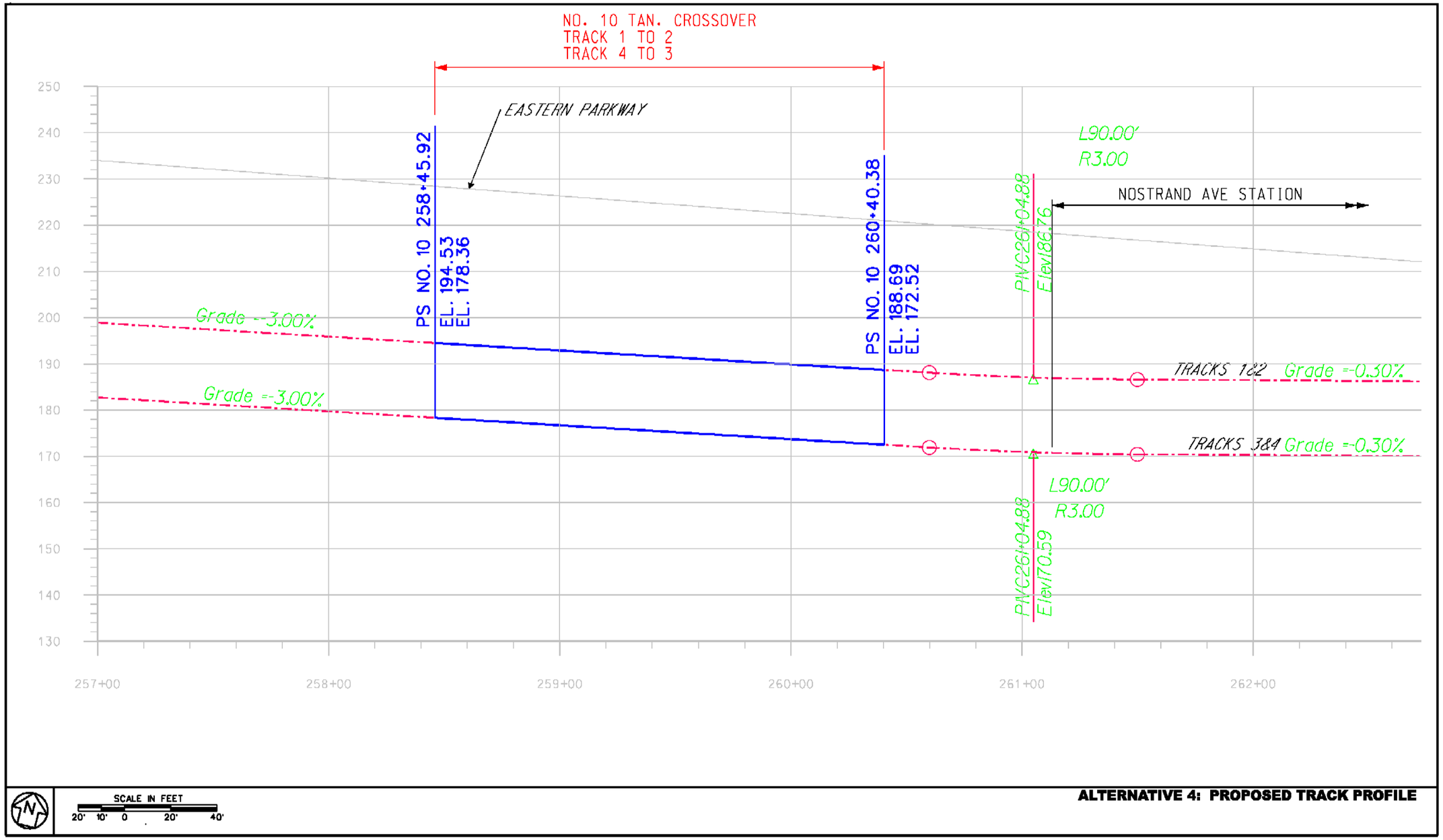


Figure 4: Alternative 4 Proposed Track Profile (Appendix H, Figure 431)

Design Specifications:

- AISC
- AREMA
- ACI 318
- NYCT DG-452
- NYCT DG-453

The existing structure was analyzed using the ASD method, while the new structure was analyzed and designed according to the same ASD method.

Construction Materials

Unless specific information is found on the drawings, all existing structural materials are assumed to be per NYCT DG-452.

All new structural concrete shall have compressive strength f'c = 4000 PSI Min.

All new structural steel shall be ASTM A992 and ASTM A36, unless noted otherwise.

Structural Clearances

Minimum Structural Clearances are provided in accordance with NYCT DG-452.

Wherever the existing structural clearances from center lines of tracks to the existing columns are less than required by DG-452, the modified structure shall provide clearances that are equal or better than the existing clearances.

Allowable Stresses

Allowable stresses shall be as specified in NYCT DG-452.

Live Load Deflection

The Live Load deflection of the track supporting structure shall be designed in accordance with the requirements specified in AREMA.

Intermediate track floors shall be so designed that the computed Live Load deflection shall not exceed 1/640 of the span length center to center of bearings for simple spans.

Lateral Pressure on Subway Structure

Lateral pressure on subway structure shall be computed according to NYCT DG-452.

In earth above water level, the lateral pressure is computed as one-third the vertical pressure, assuming the weight of earth as 100 PCF.

Footing Bearing Pressure on Soil

Maximum allowable soil bearing pressure at the bottom elevation of the existing footings shall be 8 TSF (16 KSF).

Structural Design Challenges

One of the major and obvious challenges associated with constructing Alternative 4 is the need to perform significant structural modifications within the subway tunnels, all while seeking to minimize track outages and service disruptions.

Eliminating the interior columns at the lower level requires replacing the existing track supporting floor beams. The depth of the new floor beams must match the depth of the existing beams because of the controlling track profiles at both levels. The structural challenge is to design a new floor beam that is almost two times longer than the existing floor beams, and yet to keep the depth of the beam the same as the existing beams, and to also control Live Load deflections.

Design Concept

The structural design concept for Alternative 4 has been developed to address the above mentioned constructability, feasibility and structural design challenges.

Structural modifications include adding new steel framing that is inserted and positioned between the existing steel bents. This concept results in reducing the bent spacing from the existing 5-foot 0-inch spacing to new 2-foot 6-inch spacing. As a result, the existing exterior columns within Section A, and the exterior and remaining interior columns within Section B can be saved and reused for supporting the new roof and track beam as shown in Modified Section A (Figure 410 in Appendix H) and Modified Section B (Figure 411 in Appendix H). The significance of this design concept is that it is possible to re-use the existing footings with some modifications, and to also control the track floor beam Live Load deflections.

Reusing the existing footings will save money and reduce construction impacts upon revenue subway service.

Structural Design Calculations

See Appendix K for the conceptual structural design calculations for Alternative 4.

4.1.3 Ventilation Requirements

The 1994 NYCT Authority-wide Ventilation System Strategy Study was used as the source document for this project with the understanding that NYCT ventilation design has evolved since 1994. The study found that, for the existing tunnel configuration between the three adjacent stations (Nostrand Avenue, President Street and Franklin Avenue), in order to meet NFPA 130 requirements, three (3) new Ventilation Plants would be required. Of these, two plants, at Classon and Nostrand Avenues, would each require 300 kcfm fan capacity and the third, at Rogers Avenue, would require 800 kcfm fan capacity. Under the 1994 Ventilation Study this tunnel section has a priority Index of 21 which means that it most likely will be proposed for capital projects within the next couple of 5 Year Capital Programs, depending upon funding levels.

Under Alternative 4, as the proposed construction only entails removal of columns within the upper and lower tunnels, additional ventilation has not been proposed. Future consideration of the addition of ventilation plants is not precluded.

4.1.4 Construction Staging and Scheduling

Alternative 4: New Crossovers North of Nostrand Avenue Station

NYCT is one of the few subway systems in the world that operates "24/7" without shutting down. As a result, there is no normal "down time" in which to construct the proposed Alternative 4 crossovers without somehow affecting revenue service at some particular time.

The proposed construction staging plan recognizes the importance of maintaining revenue service and minimizing service disruptions and inconvenience to subway customers. Therefore, this staging plan represents the best attempt to keep needed construction related service outages and reroutes to a minimum.

A specific construction staging sequence, along with accompanying track maps and other figures, can be found in Appendix H.

Recognizing the importance of maintaining subway service – and especially during the critical peak periods – three guiding principles were used:

- Plan and sequence construction in a manner such that the bulk of the construction can take place without affecting subway service on the lines that pass through Nostrand Junction.

- For those instances where construction must close down a track(s), schedule such construction during the overnight hours (between 12:00 to 5:00 AM) and/or confine them to weekends (53 hours).
- Minimize impacts upon the community at street level, to the extent practical.

Adding the proposed new crossovers involves reconfiguring the tunnel structure so that it can accommodate the new crossovers (one for the upper level, a second one for the lower level). Cut and cover construction is proposed, with an emphasis on quickly restoring the street surface to allow vehicular traffic to use the street (via temporary decking) while construction proceeds below. At selected locations, access shafts may be required to permit material, equipment and spoils to enter and leave the construction area.

Summarized, and greatly simplified, the construction staging sequence consists of the following steps:

- Constructing the new support walls and temporary street decking to permit restoration of the street surface. This would allow Nostrand Junction construction work to proceed below the decking, and also help to minimize community impacts.
- Reconfiguring the column lines between the upper level tracks by reconstructing the upper level of the tunnel. This will enable the new upper level crossover to be inserted.
- Reconfiguring the column lines between the lower level tracks by reconstructing the lower level of the tunnel. This will enable the new lower level crossover to be inserted.
- Finish work including new or relocated signals, communications, rails and roadbed as well as street and landscaping restoration.

These steps are illustrated by the four construction phases and sections shown in Appendix H, Figures 421 to 424. These figures illustrate the work to be done in Section B. Work to be done in Section A will be similar, although not illustrated. The phases are:

- PHASE I: General Site Preparation
- PHASE II: Excavation and Support
- PHASE III: Upper Level Reconstruction
- PHASE IV: Lower Level Reconstruction

To accomplish this construction work, no weekday daytime service outages or track closures are proposed. Where tracks must be closed and trains rerouted (or in certain cases, bus substitution required), weekday overnight hours and weekend days are proposed. The staging plan represents a rigorous attempt to minimize such track closures.

4.1.5 Service Impacts, Outages and Mitigation

NYCT is one of the few transit systems in the world to operate subway service 24 hours a day and customers rely upon the subway for transportation not only for traditional peak period trips, but also for trips outside of peak periods. As a vital transportation lifeline, it is critical that disruptions are kept to a minimum.

The construction staging plan, as summarized in Section 4.1.4 and as detailed in Appendix H, describes the attempt to construct as much of the new Nostrand Junction crossovers "under traffic" as is safely practical. The construction techniques proposed are in response to working within limited construction "windows" and reflect innovative ideas to perform the construction work in a manner that reduces track outages and tunnel closures.

However, during the estimated 3.25 year construction duration, some track closures will be required, and these translate into service changes or in severe cases, line closures requiring bus substitutions. To minimize inconvenience, these service disruptions are proposed for weekday overnight hours and weekends when fewer trains operate and fewer customers ride. Fifty (50) General Orders (GOs) are estimated at this conceptual stage of work.

A public outreach campaign, combined with NYCT's service awareness efforts (i.e., posting service disruption notices at stations, on the Internet, in the neighborhood, and even in local newspapers, etc.) could help alert and inform customers of scheduled (and unavoidable) service changes. On the day of major disruptions, such as when complete line closures are required and service replaced with buses, extra NYCT staff on site at affected stations could help guide customers.

From a broader perspective, the community and customers should also be informed of the benefits of Alternative 4 and how that will translate into more frequent peak period train service. This could be done via a proactive public outreach process as used on other similar NYCT projects.

Construction of Alternative 4 would require 14 different alternate service patterns at various times over the 3.25 year construction period. These are described below and lettered from Type A1 through Type H. Approximately 50 of these outages are estimated at this conceptual stage of work.

- **Type A1:** Closure of Track 1 (see Figure 5).
  - **Recommended time of service outage:** Weekday overnight: 12:00 AM to 5:00 AM track possession.
  - **Train operation impact:** Southbound 4 trains must operate on Track 2 to Utica Avenue.
  - **Customer impact:** Nostrand Avenue and Kingston Avenue stations bypassed.
    - Southbound customers must ride past to Utica Avenue station and transfer to northbound train to reach bypassed stations.
    - Customers seeking to travel southbound from the two bypassed stations must first travel to Franklin Avenue and transfer to a southbound train.
- **Type A2:** Closure of Track 1 (see Figure 5).
  - **Recommended time of service outage:** Weekends: 53 hour track possession.
  - **Train operation impact:** Southbound 3 and 4 trains must operate on Track 2 to Utica Avenue.
  - **Customer impact:** Nostrand Avenue and Kingston Avenue stations bypassed.
    - Southbound customers must ride past to Utica Avenue station and transfer to northbound train to reach bypassed stations.
    - Customers seeking to travel southbound from the two bypassed stations must first travel to Franklin Avenue and transfer to a southbound train.
- **Type B1:** Closure of Track 2 (see Figure 6)
  - **Recommended time of service outage:** Weekday overnight: 12:00 AM to 5:00 AM track possession.
  - **Train operation impact:** Southbound 4 trains must divert to Track 1 at Nostrand Junction.
  - **Customer impact:** None.
- **Type B2:** Closure of Track 2 (see Figure 6)
  - **Recommended time of service outage:** Weekends: 53 hour track possession.

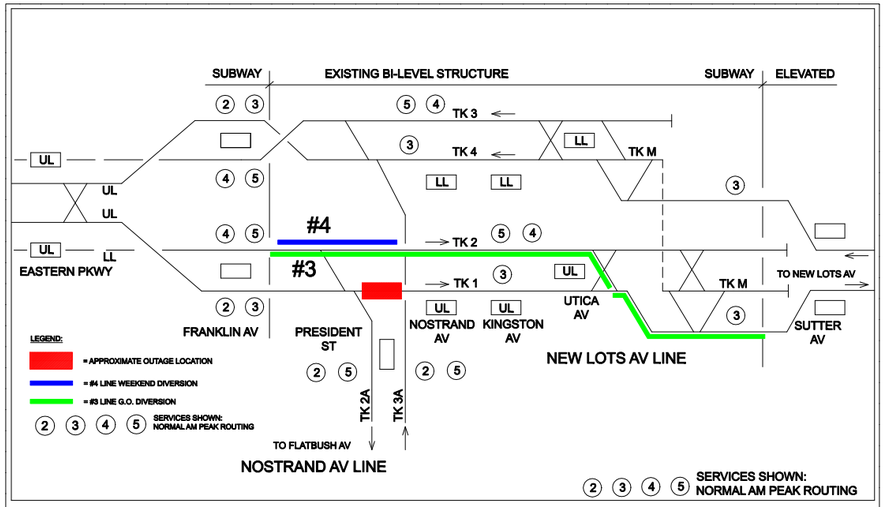
- **Train operation impact:** Southbound 4 trains must divert to Track 1 at Nostrand Junction.
- **Customer impact:** None.

- **Type C1:** Closure of Track 1 at junction of Track 2A to Nostrand Avenue Line (see Figure 7)
  - **Recommended time of service outage:** Weekday overnight: 12:00 AM to 5:00 AM track possession.
  - **Train operation impact:** Track 2A inaccessible.
    - Southbound 2 trains operate via Track 2 from Atlantic Avenue to Franklin Avenue station, and then diverted to terminate at Utica Avenue Station.
    - Southbound 4 trains operate via Track 2 through Utica Avenue to terminate at New Lots Avenue Station.
    - Single track shuttle train service provide on the Nostrand Avenue Line using Track 3A in both directions from Flatbush Avenue to Franklin Avenue Station.
  - **Customer impact:** Southbound local stations between Atlantic Avenue and Utica Avenue stations are bypassed.
    - Single track shuttle train will require transfers at Franklin Avenue Station and will extend headways on the Nostrand Avenue Line.
    - Southbound Eastern Parkway Line customers must ride past to either Franklin Avenue or Utica Avenue station and transfer to northbound train to reach bypassed stations.
    - Northbound Eastern Parkway Line customers must travel south to either Franklin Avenue or Utica Avenue, to transfer to northbound trains.
- **Type C2:** Closure of Track 1 at junction of Track 2A to Nostrand Avenue Line (see Figure 7)
  - **Recommended time of service outage:** Weekends: 53 hour track possession.
  - **Train operation impact:** Track 2A inaccessible.
    - Southbound 2 train terminates at Atlantic Avenue Station.
    - Southbound 3 trains operate via Track 2 to Utica Avenue Station then crosses over to Track 1 to New Lots Avenue Station.
    - Southbound 4 train operates via Track 2 to Utica Avenue Station.
  - **Customer impact:**
    - Nostrand Avenue Line closed. Bus substitute required to Franklin Avenue Station.
    - Southbound Eastern Parkway Line customers must ride past to either Franklin Avenue or Utica Avenue station and transfer to northbound train to reach bypassed stations.
    - Northbound Eastern Parkway Line customers must travel south to either Franklin Avenue or Utica Avenue, to transfer to northbound trains.
- **Type D1:** Closure of Track 3 (see Figure 8)
  - **Recommended time of service outage:** Weekday overnight: 12:00 AM to 5:00 AM track possession.
  - **Train operation impact:** Northbound 4 trains operate via Track 4 to Nostrand Junction, then cross over to Track 3 and continue northbound.
  - **Customer impact:** None.
- **Type D2:** Closure of Track 3 (see Figure 8)
  - **Recommended time of service outage:** Weekends: 53 hour track possession.
  - **Train operation impact:** Southbound 4 trains switch from Track 2 to Track 1 via 4 to Nostrand Junction, then cross over to Track 3 and continue northbound.
  - **Customer impact:** None.
- **Type E1:** Closure of Track 4 at junction of Track 3A (see Figure 9)
  - **Recommended time of service outage:** Weekday overnight: 12:00 AM to 5:00 AM track possession.
  - **Train operation impact:**
    - No train service on the Nostrand Avenue Line.
    - Southbound 4 train operates via Track 2 to Track 1 at Nostrand Junction.
    - Southbound 2 train operates via Track 2 from Atlantic Avenue to Franklin Avenue Station, then deadheads to Utica Avenue Station where turns to become a northbound train (using Track 3 to Atlantic Avenue Station).
  - **Customer impact:**
    - Substitute bus service required for the Nostrand Avenue Line (both directions).
    - Substitute bus service required on the Eastern Parkway Line (both directions) for Bergen Street, Grand Army Plaza and Eastern Parkway stations. Through train service provided on the express tracks.
    - At Nostrand Avenue and Kingston Avenue stations, only southbound service is provided. Northbound customers must travel to Utica and transfer to a northbound train. Northbound customer for these two stations must travel to Franklin Avenue Station and transfer to a southbound train stopping at these two stations.
- **Type E2:** Closure of Track 4 at junction of Track 3A (see Figure 9)
  - **Recommended time of service outage:** Weekends: 53 hour track possession.
  - **Train operation impact:**
    - No train service on the Nostrand Avenue Line. Need to identify location to turn back 2 trains.
    - Northbound 3 and 4 trains operate via Track 3 to Atlantic Avenue Station, where 3 trains switch back to Track 4.
    - Southbound 2 train operates via Track 2 from Atlantic Avenue to Franklin Avenue Station, then deadheads to Utica Avenue Station where turns to become a northbound train (using Track 3 to Atlantic Avenue Station).
  - **Customer impact:**
    - Substitute bus service required for the Nostrand Avenue Line (both directions).
    - Substitute bus service required on the Eastern Parkway Line (both directions) for Bergen Street, Grand Army Plaza and Eastern Parkway stations. Through train service provided on the express tracks.
    - At Nostrand Avenue and Kingston Avenue stations, only southbound service is provided. Northbound customers must travel to Utica and transfer to a northbound train. Northbound customer for these two stations must travel to Franklin Avenue Station and transfer to a southbound train stopping at these two stations.
- **Type F1:** Closure of Track 4 (see Figure 10)
  - **Recommended time of service outage:** Weekday overnight: 12:00 AM to 5:00 AM track possession.
  - **Train operation impact:** Northbound 4 train on Track 3 from Utica Avenue Station.

- **Customer impact:** Kingston Avenue and Nostrand Avenue stations bypassed in the northbound direction. Northbound customers from these stations must travel south to Utica Avenue Station, then transfer to a northbound train. Northbound customers going to these stations must travel to Franklin Avenue Station, then transfer to a southbound train.

- **Type F2:** Closure of Track 4 (see Figure 10)
  - **Recommended time of service outage:** Weekends: 53 hour track possession.
  - **Train operation impact:** Northbound 3 trains operate via Track 3 from Utica Avenue to Atlantic Avenue Station, and then switch back to Track 4.
  - **Customer impact:** Customers to/from Kingston Avenue, Nostrand Avenue, Eastern Parkway, Grand Army Plaza and Bergen Street stations are served by southbound trains only. Northbound customers from these stations must first travel south to the next express station to transfer to northbound trains. Northbound customers going to these stations must first travel north to the next express station, then transfer to southbound trains.
- **Type G:** Closure of Tracks 1 and 2 (see Figure 11)
  - **Recommended time of service outage:** Weekends: 53 hour track possession.
  - **Train operation impact:**
    - Both northbound and southbound 3 and 4 trains are suspended south of Franklin Avenue Station.
    - 2 trains operate normally throughout.
  - **Customer impact:** Substitute bus service required for the New Lots Avenue Line, perhaps as far north as Atlantic Avenue.
- **Type H:** Closure of Tracks 1 and 2 (see Figure 12)
  - **Recommended time of service outage:** Weekends: 53 hour track possession.
  - **Train operation impact:** 2, 3 and 4 train service in both directions south of Franklin Avenue Station is suspended. No service on the Nostrand Avenue Line.
  - **Customer impact:**
    - Substitute bus service required for the Nostrand Avenue Line.
    - Substitute bus service required for the New Lots Avenue Line, with the limits to be determined.

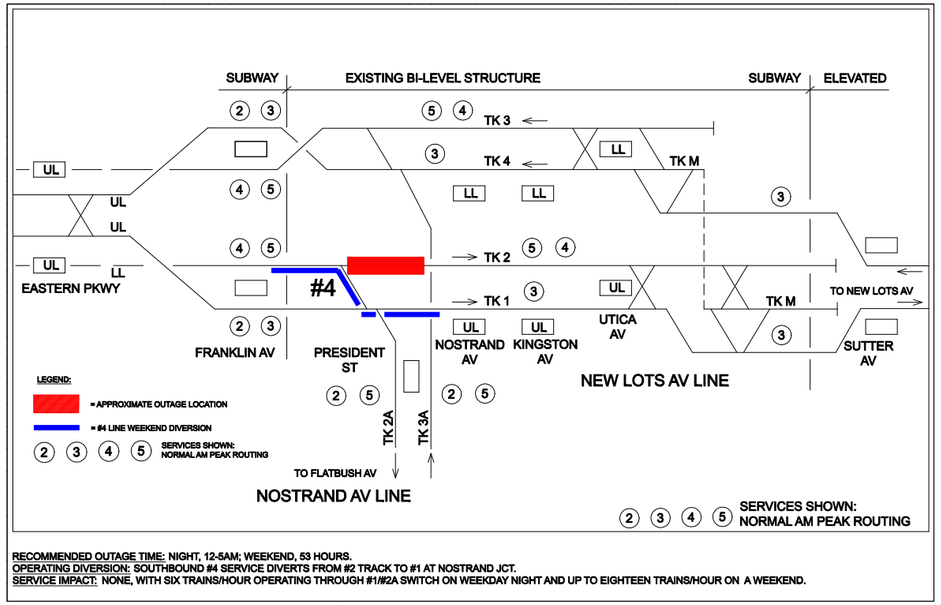
For more matching graphical information depicting these track closures, see Figures 5 through 12 following this page.



RECOMMENDED OUTAGE TIME: NIGHT, 12-5AM.
OPERATING DIVERSION: #4 SERVICE MUST OPERATE SOUTHBOUND ON #2 TRACK TO UTICA AVE.
SERVICE IMPACT: SOUTHBOUND CUSTOMERS TO NOSTRAND AVE. AND KINGSTON AVE. STATIONS MUST GO TO UTICA AVE. AND BACK.

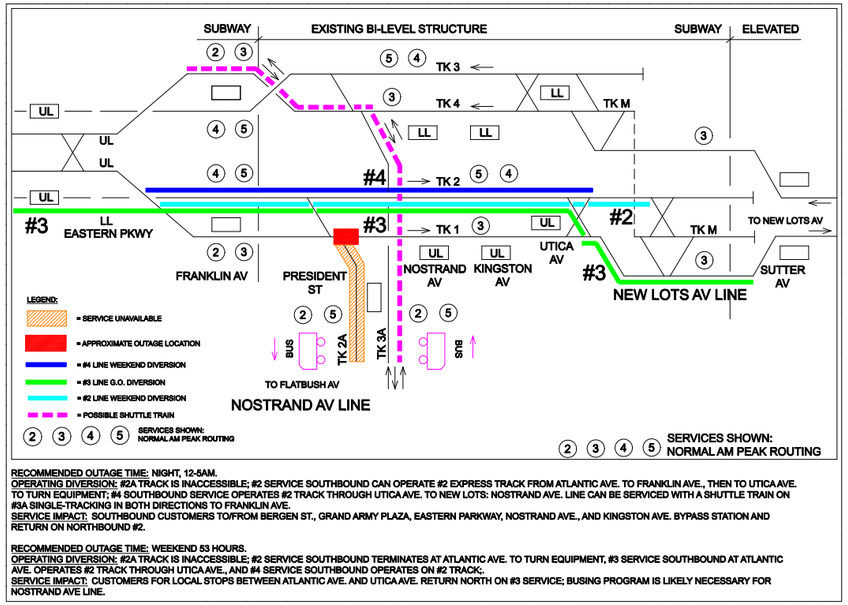
RECOMMENDED OUTAGE TIME: WEEKEND 53 HOURS.
OPERATING DIVERSION: #3 AND #4 SERVICE MUST OPERATE ON #2 EXPRESS TRACK FROM ATLANTIC AVE. TO UTICA AVE.
SERVICE IMPACT: SAME AS NIGHT OUTAGE.

Figure 5: Alternative 4 - Track #1 Section B Outage



RECOMMENDED OUTAGE TIME: NIGHT, 12-5AM; WEEKEND, 53 HOURS.
OPERATING DIVERSION: SOUTHBOUND #4 SERVICE DIVERTS FROM #2 TRACK TO #1 AT NOSTRAND JCT.
SERVICE IMPACT: NONE, WITH SIX TRAINS/HOUR OPERATING THROUGH #1/#2A SWITCH ON WEEKDAY NIGHT AND UP TO EIGHTEEN TRAINS/HOUR ON A WEEKEND.

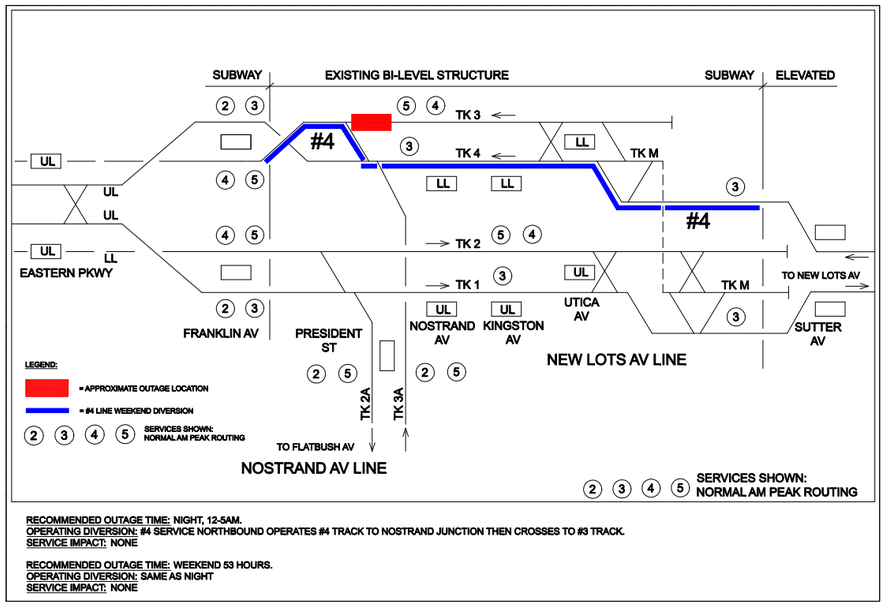
Figure 6: Alternative 4 - Track #2 Outage



RECOMMENDED OUTAGE TIME: NIGHT, 12-5AM.
OPERATING DIVERSION: #2A TRACK IS INACCESSIBLE; #2 SERVICE SOUTHBOUND CAN OPERATE #2 EXPRESS TRACK FROM ATLANTIC AVE. TO FRANKLIN AVE., THEN TO UTICA AVE. TO TURN EQUIPMENT; #4 SOUTHBOUND SERVICE OPERATES #2 TRACK THROUGH UTICA AVE. TO NEW LOTS: NOSTRAND AVE. LINE CAN BE SERVICED WITH A SHUTTLE TRAIN ON #3A SINGLE-TRACKING IN BOTH DIRECTIONS TO FRANKLIN AVE.
SERVICE IMPACT: SOUTHBOUND CUSTOMERS TO/FROM BERGEN ST., GRAND ARMY PLAZA, EASTERN PARKWAY, NOSTRAND AVE., AND KINGSTON AVE. BYPASS STATION AND RETURN ON NORTHBOUND #2.

RECOMMENDED OUTAGE TIME: WEEKEND 53 HOURS.
OPERATING DIVERSION: #2A TRACK IS INACCESSIBLE; #2 SERVICE SOUTHBOUND TERMINATES AT ATLANTIC AVE. TO TURN EQUIPMENT, #3 SERVICE SOUTHBOUND AT ATLANTIC AVE. OPERATES #2 TRACK THROUGH UTICA AVE., AND #4 SERVICE SOUTHBOUND OPERATES ON #2 TRACK.
SERVICE IMPACT: CUSTOMERS FOR LOCAL STOPS BETWEEN ATLANTIC AVE. AND UTICA AVE. RETURN NORTH ON #3 SERVICE; BUSING PROGRAM IS LIKELY NECESSARY FOR NOSTRAND AVE LINE.

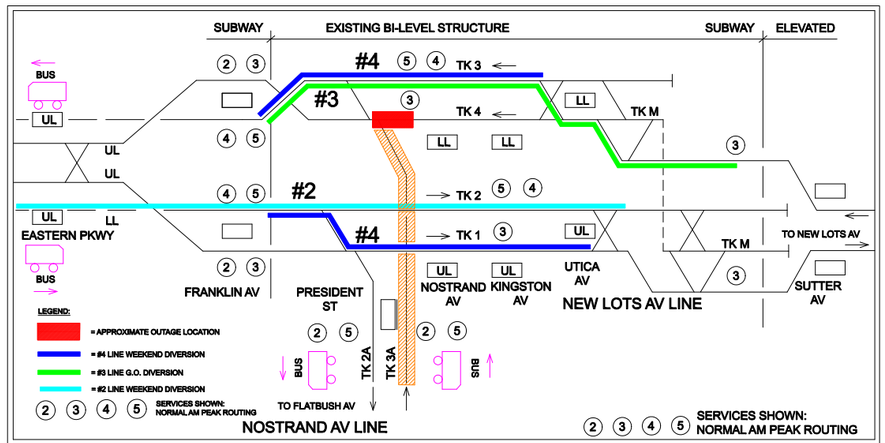
Figure 7: Alternative 4 - Track #2A / #1 Section A Outage



RECOMMENDED OUTAGE TIME: NIGHT, 12-5AM.
OPERATING DIVERSION: #4 SERVICE NORTHBOUND OPERATES #4 TRACK TO NOSTRAND JUNCTION THEN CROSSES TO #3 TRACK.
SERVICE IMPACT: NONE

RECOMMENDED OUTAGE TIME: WEEKEND 53 HOURS.
OPERATING DIVERSION: SAME AS NIGHT
SERVICE IMPACT: NONE

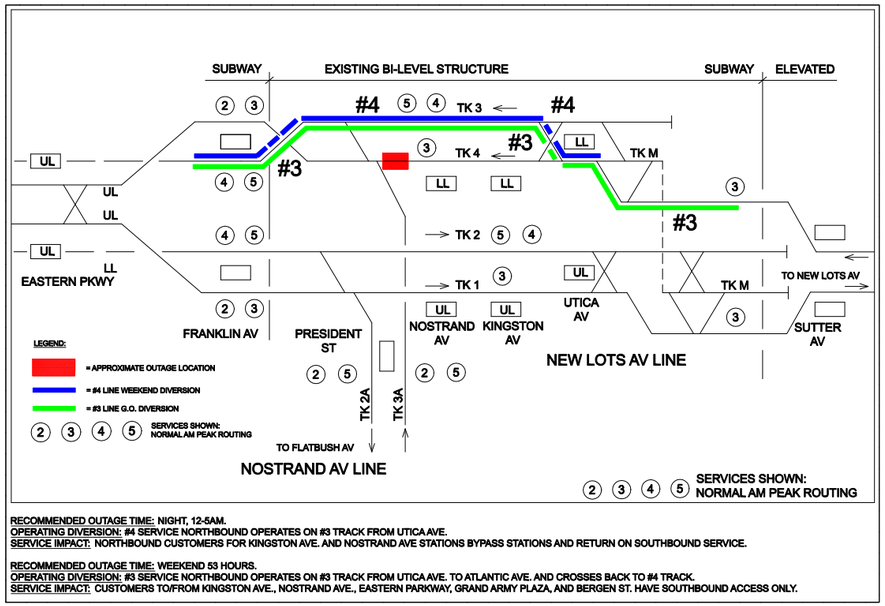
Figure 8: Alternative 4 - Track #3 Outage



RECOMMENDED OUTAGE TIME: NIGHT, 12-5AM.
OPERATING DIVERSION: #4 SERVICE OPERATES #2 TRACK TO #1 TRACK AT NOSTRAND JUNCTION; #2 SERVICE SOUTHBOUND OPERATES #2 TRACK FROM ATLANTIC AVE. TO FRANKLIN AVE. THEN OPERATES EQUIPMENT TO UTICA AV. TO TURN FOR NORTHBOUND SERVICE ON #3 TRACK (EXPRESS) TO ATLANTIC AVE.; NO TRAIN SERVICE ON NOSTRAND AVE. LINE.
SERVICE IMPACT: BUSING IS REQUIRED FOR THE NOSTRAND AVE. LINE AND EASTERN PARKWAY, GRAND ARMY PLAZA, BERGEN ST. IN BOTH DIRECTIONS; KINGSTON AVE. AND NOSTRAND AVE. CUSTOMERS ACCESS ALL SERVICE THROUGH SOUTHBOUND TRAINS.

RECOMMENDED OUTAGE TIME: WEEKEND 53 HOURS.
OPERATING DIVERSION: #3 AND #4 NORTHBOUND SERVICE OPERATES ON #3 TRACK TO ATLANTIC AVE. WITH #3CROSSING BACK TO #4 TRACK; #2 SERVICE IS SUSPENDED TO AND FROM THE NOSTRAND AVE. LINE AND AN APPROPRIATE LOCATION MUST BE IDENTIFIED TO SHORT-TURN #2 EQUIPMENT FOR NORTHBOUND SERVICE.
SERVICE IMPACT: BUSING IS REQUIRED FOR EASTERN PARKWAY, GRAND ARMY PLAZA, BERGEN ST., AND THE NOSTRAND AVE. LINE.

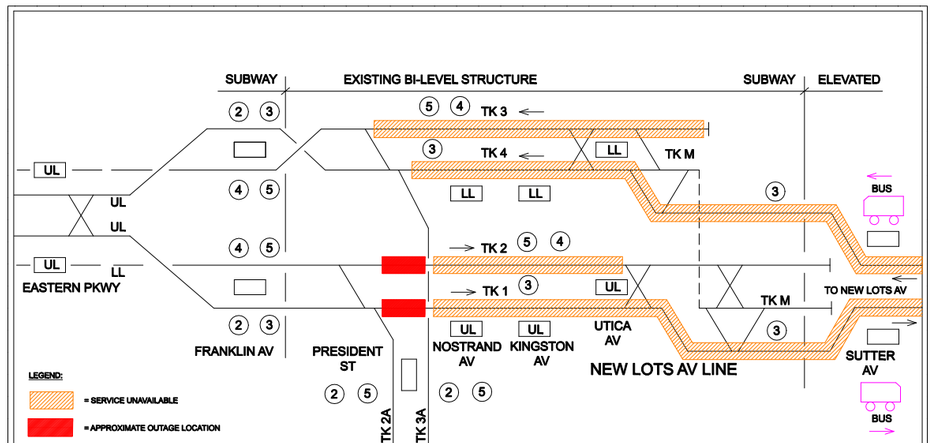
Figure 9: Alternative - Tracks #3A and #4 Section A Outage



RECOMMENDED OUTAGE TIME: NIGHT, 12-5AM.
OPERATING DIVERSION: #4 SERVICE NORTHBOUND OPERATES ON #3 TRACK FROM UTICA AVE.
SERVICE IMPACT: NORTHBOUND CUSTOMERS FOR KINGSTON AVE. AND NOSTRAND AVE STATIONS BYPASS STATIONS AND RETURN ON SOUTHBOUND SERVICE.

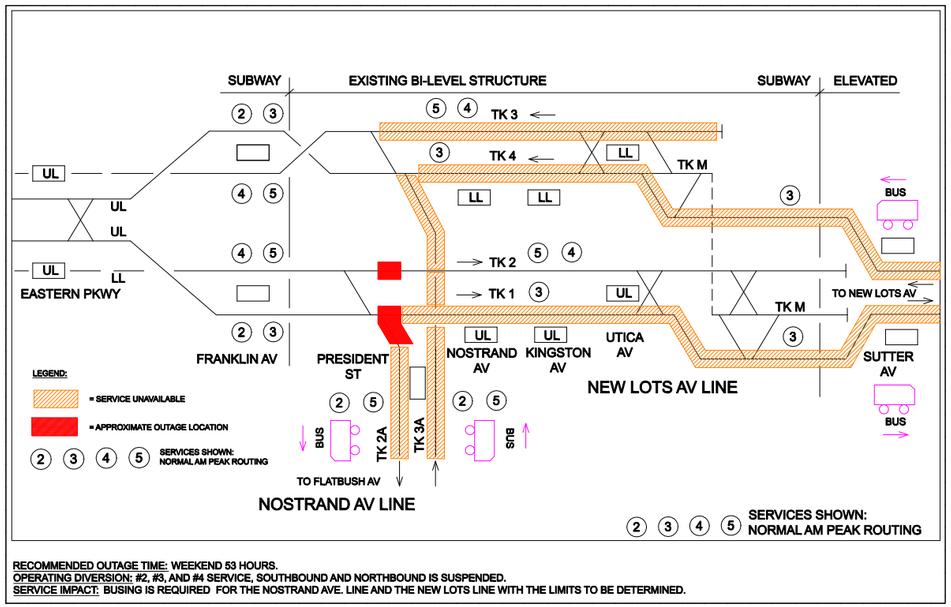
RECOMMENDED OUTAGE TIME: WEEKEND 53 HOURS.
OPERATING DIVERSION: #3 SERVICE NORTHBOUND OPERATES ON #3 TRACK FROM UTICA AVE. TO ATLANTIC AVE. AND CROSSES BACK TO #4 TRACK.
SERVICE IMPACT: CUSTOMERS TO/FROM KINGSTON AVE., NOSTRAND AVE., EASTERN PARKWAY, GRAND ARMY PLAZA, AND BERGEN ST. HAVE SOUTHBOUND ACCESS ONLY.

Figure 10: Alternative 4 - Track #4 Section B Outage



RECOMMENDED OUTAGE TIME: WEEKEND 53 HOURS.
OPERATING DIVERSION: #3 AND #4 SERVICE, SOUTHBOUND AND NORTHBOUND, IS SUSPENDED; SERVICE CAN BE MAINTAINED TO ATLANTIC AVE; #2 SERVICE OPERATES NORMALLY.
SERVICE IMPACT: BUSING IS REQUIRED FOR THE NEW LOTS LINE NORTH TO PERHAPS AS FAR AS ATLANTIC AVE.

Figure 11: Alternative 4 - Tracks #1 and #2 Section B Outage



RECOMMENDED OUTAGE TIME: WEEKEND 53 HOURS.
OPERATING DIVERSION: #2, #3, AND #4 SERVICE, SOUTHBOUND AND NORTHBOUND IS SUSPENDED.
SERVICE IMPACT: BUSING IS REQUIRED FOR THE NOSTRAND AVE. LINE AND THE NEW LOTS LINE WITH THE LIMITS TO BE DETERMINED.

Figure 12: Alternative 4 - Tracks #1, #2, #2A Section A Outage

4.1.6 Subway Signal, Communications and Traction Power Issues

Reference Drawing Illustrations are provided in Appendix J and are as follows:

Figures No. 450 thru 454 Staging Plans: Illustrate Impacts to the Signaling System.

Figures No. 455 thru 459 Signaling Outages: Illustrate Track Outage Impacts.

Signal Equipment to be Removed/Replaced

The Alternative 4 tunnel construction area for the reconfiguration of the upper and lower level tunnel support system (for the new crossover switches) is located between Track/Signal Stationing 258+50 and 260+50 (see Figure Number 450 in Appendix J). All existing signal equipment and cables located between these stationing parameters will need to be relocated to the outside of the construction envelope. This work must be performed prior to beginning tunnel track-level construction.

A block signal design, to provide optimized block signal placements for the required relocated signals, would be conducted at a subsequent engineering design stage.

Construction Signaling Staging

There are three (3) Signal Construction Stages. Each stage is described as Signal Stage1 (S-1) through Signal Stage 3 (S-3).

Signal Stage 1 (S-1 Early Work)

The S-1 Signal Construction Stage consists of relocating the signals, train stops, insulated rail joints, communications cables and signal local and express cables (see Figure Numbers 451 and 452 in Appendix J) to clear the construction area and to avoid damage during construction. Signal relocations are to be made reusing the existing wayside control equipment and the existing Nostrand Relay Room when it is permitted. This early work is critically necessary to allow the clearing out of all signaling equipment obstacles prior to starting tunnel construction. The construction lead time for the new relay control room is too long to wait for receipt of the new equipment.

Rerouting of the new and existing cables needs to be further investigated, with the possibility of designing and installing a new duct bank system. Since the tunnel construction involves removing the center column beams and reinforcing the outer wall beams with new beams (installed between existing beams), any existing cables on the cable messenger system on all tracks (Tracks 1, 2, 3 and 4) will need to be rerouted to avoid the tunnel construction zone. Another alternative could be to reroute these cables through Tracks 2A and 3A to clear the construction area.

As trains will continue to run during the duration of construction, relocated signal and communications cables must remain operational.

Marker Signals 416X (Track 1 STA 259+80) and 422X (Track 2 STA 260+60) should be moved to the south of their current location to clear the construction area. Additionally, these signals should be modified during the cutover of the new system to become new home signals with trip stops for the new interlocking, if reverse running train operation is required in the future. (Note that the above-noted Appendix figures show these signals as marker signals.)

Track 1 Automatic GT Signal (STA 259+40) associated insulated joints and train stop would all need to be moved to the south out of the construction area. The effectiveness of moving this signal needs to be investigated during the block design.

Track 4 Controlled Signal B440 (STA 259+10) associated insulated joints and train stop would all need to be moved to the south. The effects of moving this signal needs to be investigated during the block design.

It is assumed that several approach signals with GT and ST will require changes to their stationing locations and time values. Their new, actual locations and timer settings will be unknown until the block design has been performed.

Signaling Installation/Test Track Outages are shown on Appendix J, Figures No.455 and 456, Illustrations 1-1 thru 1-8.

Stage 2 (S-2)

Once Signal Stage S-1 has been completed, construction within the tunnel portions can begin.

Using contract documents, and in parallel to this stage and the previous S-1 stage, signal contractors can design, manufacture and factory test the signal equipment for the new interlocking control.

The new Relay Room will be located above the upper level Tracks 1 and 2, within the area used for construction staging, which is the entire length of the construction area (200 feet). A 16-foot by 110-foot area will be dedicated for the Relay Room, along with a UPS Room and a Fire Suppression Room. As mentioned earlier, cable routing for this new equipment must be planned in coordination with the relocation of the existing signal equipment in order to add the new cables to the already relocated cables.

During the tunnel construction and when available, the new crossover special track work can be installed. The new switch points will need to be spiked, clamped and indicated prior to resuming revenue operation. The existing signal system will be required to indicate the status of the points and shall interface with the exiting control system. This modification will be used until the new signal interlocking control equipment is placed into service. It will be critical to ensure that the wayside cables for this function are adequately protected from damage and the work areas coordinated while the tunnel construction is still in process.

Modifications to the Tower Control can also be designed, installed and staged for future cutovers during this stage. Once the new Signal Room equipment has been installed and within the new Relay Room, non-invasive testing and power up tests can be conducted.

Coordinated with construction, the installation contractor can pull new cables. With use of a duct bank system installed in advance, these cables can be readily installed. During this stage, new wayside equipment (see Figure Number 453 in Appendix J) including, Switch Machines, Home Signals and Train Stops will be installed.

Signaling Installation/Test Track Outages are shown on Appendix J, Figure No.457 and 458, Illustration 2-1 thru 2-6.

Stage 3 (S-3 Final Test and Cutover)

After all signal and communications equipment has been installed and non-invasive testing completed, safety testing of the complete Signal System can now be performed in preparation of a cutover (see Figure No. 454, Appendix J).

Signaling Installation/Test Track Outages are shown in Appendix J, Figure No.458, Illustrations 2-7 and 2-8.

4.1.7 Private Property Issues

The construction of Alternative 4 and the subsequent subway operations associated with this alternative does not create any private property issues as the construction zone is located under the wide parkway median and away from existing private buildings.

No private property acquisition or relocation is required under this alternative.

4.1.8 Environmental Issues

Potential project issues to the community would be limited to construction period inconveniences and no long-term or permanent issues. Since the project does not include construction of a fan plant, no significant community issues would result.

As a result, construction issues within the project area may include and are not limited to: temporary lane closures, construction staging, limited street parking spaces, and disruption to normal train service and access to subway stations (See Service Impacts, Outages & Mitigations Section for further clarification).

Additionally, the removal of street trees and furniture along the parkway may be required but these would be replaced in kind at the end of construction, in consultation with the NYC Department of Parks and Recreation.

Trees and Other Street Landscape Factors

Construction work related to Alternative 4 would create only limited impact upon the existing street trees. Trees on the north side of the street should not be affected by Alternative 4 construction. The only possible affect on the trees is if any of the tree roots on the north side extend into the construction area, which is impossible to know without excavating the street. If this is the case, any trees that fall within that area will need to be removed. The largest tree on the north end of the block is approximately 5 feet 6 inches in circumference.

The worst case scenario on the south side of the street would involve the removal of two large trees, including the roots and possibly the pruning of roots of smaller trees, if their roots extend into the construction area. The removal of the large trees for replanting would cost approximately $20,000 per tree. To remove and dispose of any of the trees on either side would cost approximately $1,500 each. Pruning the tree roots will probably cost in the $600–800 range per tree.

According to a *Draft Tree and Map Survey for Conceptual Engineering Study of Nostrand Avenue Junction* conducted by Jablonski Building Conservation Inc. in May 2008, few of the original historic trees that were planted during the construction of the parkway remain, and as a result no historic elements would be permanently affected.

Air Quality During Construction

Air pollutant emissions during construction are from two types of sources: mobile source emissions on roadways off-site (i.e., worker vehicles and trucks on roadways) and on-site emissions from engine emissions and fugitive dust (i.e., tailpipe emissions from construction equipment and trucks, and fugitive dust).

During construction of the proposed project whose duration is projected to be 3.25 years, pollutant levels will not be affected by mobile source emissions since no major detours or diversions are anticipated to occur during peak traffic periods. Travel lanes on Eastern Parkway will remain open during peak periods when congestion occurs and the majority of the construction activities aboveground will occur during the off-peak period at night. In addition, the number of construction generated truck and worker trips is anticipated to be below the significant trip threshold cited in New York City's CEQR Technical Manual and in NYCDEP's PM2.5 Interim Threshold Guidelines.

No emissions will be generated from underground activities since diesel-powered work trains will not be used in the construction process. On site emissions from aboveground activities will be minimized though NYCT's "green" specification commitment that requires contractors to incorporate non-road construction equipment PM mitigation measures prior to significant construction work commencing on the contract.

The NYCT's "green" specifications include measures to control airborne particulate matter and other pollutants (CO, NO_x and hydrocarbons), implemented to the maximum extent practicable, to include:

- All on-road vehicles and diesel-powered heavy equipment (stationary and mobile) used on the site for 40 hours or more during the execution of this Contract will use ultra low-sulfur diesel fuels (15ppm sulfur content);
- Idling time will be limited to three consecutive minutes for delivery and dump trucks and all other diesel powered equipment;
- Ensure that diesel emissions do not cause harmful effects to adjacent sensitive receptors. Sensitive receptors include but are not limited to hospitals, schools, daycare facilities, elderly housing, and convalescent facilities;
- Ensure that diesel powered engines are located away from fresh air intakes, air conditioners, and windows.
- Establish truck-staging zones for vehicles waiting to load or unload material at the Work Site. Such zones will be located where diesel emissions have the least impact on abutters and the general public;
- All Contractor non-road vehicles with auxiliary power source and construction equipment powered by an internal combustion engine with gross engine horse power rating of 50hp and above that are on the Project or are assigned to the Contract and operate more than 160 hours shall be fitted with retrofit technology such as Diesel Particulate Filter (DPF) or better that removes greater than 90 percent particulate matter without increasing NO_x, and uses Ultra Low Sulfur diesel fuel with 15 parts per million (ppm) maximum of sulfur;
- The retrofit technology / retrofit emission control device shall be included on the US Environmental Protection Agency (EPA) Verified Retrofit Technology List (VERT), or Certified by the US EPA, or Certified by California Air Resources Board (CARB), or have satisfactorily met all the criteria of VERT and recommended for use on construction equipment;
- The reduction of emissions of carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_x), and particulate matter (PM) will be accomplished by installing retrofit technology. Retrofit technology can be:
  - Diesel oxidation catalysts or diesel particulate filter;
  - Engine upgrade;
  - Early engine replacement; or
  - Combination of above.
- The retrofit technology/retrofit emission control device for non-road equipment will be included on the EPA VERT or Certified by the EPA to achieve emission reduction of 50- to 90-percent HC, 40- to 90-percent CO, and 20- to 50-percent PM without increasing NO_x.

MPT Staging

In order to maintain access to the Nostrand Avenue and Franklin Avenue Lines during construction the use of a MPT plan will be utilized.

During construction, right lanes on the eastern and western portions of Eastern Parkway (work zone) will be closed. The two middle lanes of the parkway (ten feet each) will be open to the traffic on the

easterly and westerly directions of Eastern Parkway. (See Figure No. MPT-01 in Appendix E)

An excavation of the project site will be conducted on the southern side of the site and piles will be able to be installed by the contractor on the northern and southern portions of the site. (See Figure No. MPT-03 in Appendix E)

Night Work

During night-time construction, Eastern Parkway will be closed to traffic within the construction area and diverted to the local service roads on the parkway. (See Figure No. MPT-02 in Appendix E)

Contractor can install Decking and Decking supports in sections. (See Figure No. MPT-03 in Appendix E)

Daytime Work

During daytime construction, three lanes of traffic in the easterly and westerly directions of Eastern Parkway will be open. Lanes within five feet of the work zone and piles will be closed. (See Figure No. MPT-03 in Appendix E)

Train operation continues until Decking installation is finished.

During construction of the under side of the Deck, the closure of one or two lanes may be required.

Public Safety

Construction during the Nostrand Junction reconfiguration would be implemented in compliance with relevant Federal, State, and City codes, policies and guidelines, including those of the MTA NYCT intended to protect safety and security for construction workers, patrons and the general public. Key elements in these codes and policies are guidelines on safety in the event of a fire or other threat, security from crime, and safe construction practices.

4.1.9 Utility Impacts

As described in Section 3.5, and identified in Appendix A, the distribution of existing utilities within the Eastern Parkway corridor mainly consists of electrical conduits, street lighting, traffic signals and associated electrical conduits, waterlines, National Grid gas main, and storm drainage sewers located below the Eastern Parkway service roadways. Within the medians, utility distribution consists primarily of electrical ducts, and street lighting; these will have minimal issues, if any, upon fan plant construction. The utilities to be impacted by Alternative 4 are identified in Appendix A, Table U-1

4.1.10 Construction Cost Estimate

(Please see Appendix G for the detailed Construction Cost Estimate.)

TABLE 1: CONCEPTUAL CONSTRUCTION COST ESTIMATE SUMMARY – ALTERNATIVE 4

Description		Amount
Bid/Procurement Cost		$236,302,000
Total Construction Costs		*$236,302,000*
Property Acquisition		NA
Utilities (Other than Bid Contractor)		$3,000,000
Construction Contingency	5.00%	$11,815,000
Design	10.00%	$23,630,000
Inspection/Engineering Force Account	12.00%	$28,356,000
TA Labor including Busing		$40,000,000
Subtotal		*$343,103,000*
TOTAL PROJECT COST		**$343,103,000**

4.1.11 Conceptual Construction Schedule

A conceptual construction schedule has been prepared, by project section, construction stages, and major work activities, as shown in Appendix G. A summarized schedule is provided in Figure 13. The total construction duration is estimated at 3 years, 3 months, excluding the time required for design, bid process, and equipment procurement.

TASK	Year 1				Year 2				Year 3				Year 4
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
PHASE 1 General Site Preparation													
PHASE 2 Excavation and Support													
PHASE 3 Upper Level Reconstruction													
PHASE 4 Lower Level Reconstruction													

Figure 13: Alternative 4 - Construction Schedule

4.2 ALTERNATIVE 6: NEW FULLY-FLEXED GRADE-SEPARATED JUNCTION

4.2.1 Track and Alignment

Overview of Alternative 6

To alleviate train congestion on the Eastern Parkway Line caused by the three-line merge at Nostrand Avenue Junction, a series of new grade separated tracks and track connections are proposed between Eastern Parkway Station and the Junction. Alternative 6 creates a new grade separated set of flyovers to replace the existing "flat junction" on both the upper and lower level tunnel tracks.

These improvements spread the three-line merges over a longer distance, add an additional crossover and use higher speed turnouts and crossovers to increase the capacity of the junction.

Proposed Alignment

The Alternative 6 track alignment and profile were created based on the 1993 feasibility study (see Figure 2). Where the 1993 study alignment and profile were found to violate MW-1 and NYCT geometry criteria, an attempt was made to eliminate or reduce the severity of the deviation without significantly expanding the limits or changing the concept. The following describes those deviations and how they have been addressed in the proposed alignment.

- **Equilateral turnouts:** The 1993 study shows a crossover arrangement that would require a special turnout with a curved frog at the northern end of the new Track 2A. Also, some of the crossover turnouts were located on a vertical curve with a rate of change of 3% per 100 feet. To avoid placing turnouts on vertical curves (Track 1 and 2 south of Franklin Avenue Station) and using special frogs, the proposed alignment uses a No. 10 equilateral turnout which also allows both No. 10 lateral turnouts on Track 1 and 2 to be located on vertical tangents.

  However, the PS of these turnouts on Track 1 and 2 are 12.5 feet from the PVT with a rate of change of 3% per 100 feet. This is less than the 40 foot minimum that NYCT prefers.

- **Relocated Track 3A:** The 1993 study relocated the junction between Nostrand Avenue Track 3A and Eastern Parkway Track 4 north 500 feet from the current No. 8 turnout. The proposed new No. 10 turnout was located on a 70 feet vertical tangent between two reverse vertical curves, both with a rate of change of 3% per 100 feet. This location does not provide enough room for a standard No. 10 tangential turnout to be installed on a vertical tangent. This study's revised alignment retains this location in plan view but lowers the profile of 323 track feet of existing Track 4, such that the new turnout is on a longer vertical tangent.

- **Franklin Avenue Shuttle Clearance:** Existing clearance is 12'-8 5/8" from top of rail to bottom of steel. The 1993 study reduced that clearance to 12'-2" from top of rail, in the middle of a sharp vertical curve (with a rate of change of 6% per 100 feet required to connect PVIs shown on 1990s study profile). MW-1 states minimum vertical clear to be 12'-6 3/8" plus vertical center excess (sag curve). To provide sufficient clearance without rebuilding the shuttle structure, the existing profile is maintained under the shuttle and the proposed crossovers are moved north and built on the existing Track 4 profile. This results in changes to the length of track and tunnel construction summarized in Table 3.

- **Track grades:** The 1993 study has two sections of track with grades greater than the 3% maximum allowed by MW-1 for new construction (-4%, Track 2A; +3.2%, Track 3). Also, six turnouts were located on 3% grades which are greater than the 1.5% maximum allowed by MW-1. The +3.2% grade on Track 3 was eliminated by the changes described in Number 4 above, however the other deviations from MW-1 criteria remain in the proposed plan.

TABLE 2: DISTINCT TRACK CONFIGURATION ZONES

Location	Track Configuration
Eastern Parkway Station North	Track 2 and 3, lower level; Track 1 and 4, upper level; common horizontal alignment on both levels; track centers 13 feet 6 inches; vertical separation 16 feet 2 inches.
Existing Transition	Over 800 route feet: Track centers change from 13 feet 6 inches to 14 feet 3 inches and then to 29 feet 7 inches; vertical separation changes from 16 feet 2 inches to no separation.
Franklin Avenue Station	Tracks 1, 2, 3 and 4 on single level; center island platforms between Tracks 1 and 2 and between Tracks 3 and 4.
Existing Flyover	Over 1,200 route feet: Track 4 crosses under Track 3 and 2 reaching 16 feet 2 inches of vertical separation from these tracks; Track 3 descends to the lower level and Track 1 and 2 curve to reach a common horizontal alignment with Tracks 3 and 4.
Nostrand Junction to Utica Avenue	Track 3 and 4, lower level; Track 1 and 2, upper level, common horizontal alignment on both levels; track centers 13 feet 6 inches; vertical separation 16 feet 2 inches.
Existing Junction	Nostrand Avenue Line Tracks 2A ad 3A divert from Tracks 1 and 4, respectively.

TABLE 3: LENGTH OF TRACKWORK FOR ALTERNATIVE 6

	1990s Study Track Feet	2008 Proposed Track Feet
North of Franklin Avenue Station		
New Track 4A	1,200	1,210
Rebuild Track 3 and 4 for crossovers	400	490
Reprofile Track 3 North of Franklin Avenue Station	650	820
Realign Track 4 to allow Track 3 to be reprofiled North of Franklin Avenue Station	0	450
South of Franklin Avenue Station		
Realign Track 1	905	
New Track 2A	1,395	
New Track 3A	665	
Reprofile Track 3 South of Franklin Avenue Station	0	325

The proposed trackwork modifications cover 3,300 feet of the existing subway from south of Eastern Parkway Station to north of Franklin Avenue Station as shown in Figures No. 14 and 15. Three-thousand three-hundred (3,300) feet of new tracks would be constructed including eight new No. 10 turnouts. To accommodate these new tracks, 2,500 track feet of existing track would be realigned or reprofiled and 885 track feet of existing track and two existing No. 8 turnouts would be removed. The structural, signal, communication and traction power modifications required to operate these crossovers and the construction staging required are discussed in subsequent sections of this report.

For the purposes of this study, a clearance envelope was defined along the length of all new and realigned tracks that provides a minimum of 6 feet 6 inches of lateral clearance plus car excesses along curves and turnouts. This clearance envelope was used to define the limits of structural modifications.

The resulting proposed Alternative 6 alignment is based on the 1993 study with the above mentioned modifications (see Figures 14 and 15). No field survey was used to confirm the as-built location and alignment of the existing track. The alignment was not reviewed for purposes of defining operating speeds or determining required superelevation; the radii used in the 1993 study were retained in the proposed alignment. If this alternative is selected for further investigation, the alignment and structural modifications should be further refined based on a field survey and an analysis of the required track speed.

4.2.2 Structural Plans and Sections

One of the major factors that define the complexity of Alternative 6 is the necessity of maintaining revenue and non revenue train service on all tracks all the time. Extensive structural work will be performed to the extent possible without service shut downs by using targeted weekend and nighttime track GOs and flagging.

Structural work includes:

- Construction of new tunnels.
- Modifications, reconfiguration and reconstruction of the existing tunnels to accommodate new crossovers and to integrate the new tunnels into the existing and modified structures.

Structural challenges are defined by the complex construction, tasks and diverse methods required, including extensive coordination with transit operations to limit service impacts.

The work will require underpinning of the existing subway structures and precisely defined and coordinated construction phasing and steps. The existing subway tracks affected by modifications will be skeletonized and supported on mini piles. This method enables train operations to be maintained while the existing track bed is removed and the space below is excavated, structural modifications made, and new track support structure is constructed.

Some structural modifications are similar to those proposed in Alternative 4, using similar construction methods.

Sections of the new bypass tunnels where they run alongside of the existing tunnel structure without interfering will be built as conventional cut-and-cover tunnels.

At street level, construction impacts are expected to be limited to the inner and outer Eastern Parkway roadway lanes, service roads, cross-streets and medians. There are no expected impacts to adjacent properties. The major elements of street work include utilities, which will be relocated or supported in place, or combination of both as required, installation of piles, street decking, excavation, support and bracing and providing space for construction staging. Impacts to the Parkway medians will include relocation and or replacement of trees within construction areas.

A detailed discussion of the anticipated construction activities for each stage of work, in each location, west and east of Franklin Avenue Station is presented in Section 4.2.4. The structural plans and sections are provided in Appendix H, Figures 601 to 638-2.

Structural Design Calculations

Conceptual structural design assumptions and calculations made for Alternative 4 were adopted for Alternative 6 (See Appendix K).

4.2.3 Ventilation Requirements

The 1994 NYCT Authority-wide Ventilation System Strategy Study was used as the source document for this project with the understanding that NYCT ventilation design has evolved since 1994. The Ventilation Study identified fan plant locations and capacities for the existing track configurations. Given that the Alternative 6 scheme is adding two additional tracks and the fact that the ventilation capacity of a fan plant would be individually ducted to a track (S), it is reasonable to assume for the purposes of this study that the number of fan plants would not change. The new fan plant capacities are also based on the NYCT systemwide ventilation report, but modified slightly as indicated below. Subway Environment Simulation (SES) modeling has not been performed for this conceptual engineering feasibility study. The ventilation criterion is to produce airflow rates sufficient to prevent backlayering of smoke in the path of egress within enclosed tunnel sections. Subsequent SES modeling will be required if the project advances to Preliminary Engineering to actually determine the optimum locations and capacities. Based upon this Alternative 6 tunnel configuration, the fan plant capacity at Classon and Nostrand Avenues is estimated to be 400,000 cfm and the fan plant capacity at Rogers Avenue is estimated to be the same 800 kcfm as was estimated in the 1994 study. As per current practice by NYCT, where porous walls separate tracks, the entire capacity of a proposed fan plant is directed (ducted) to the incident track (s). Therefore, the porous wall separating each trackway is assumed to be sealed wherever possible to permit the fan plants to work as designed

The tunnel section between the Eastern Parkway and Franklin Avenue Stations begins with two levels stacked atop each other (with two tracks each) and ends with four tracks on a single level. At each level the tracks are separated by porous walls with openings 2-3' wide x 7' high on 10' centers. Two existing unequipped fan plants 7231D and E connect near mid-tunnel, with each serving a different level. The entire capacity of a proposed fan plant (Classon Avenue) is directed to the incident track(s). The fan plant capacity is estimated to be 400,000 CFM. It is assumed that the porous walls separating trackways will be sealed during construction.

The tunnel section between the Franklin Avenue and Nostrand Avenue Stations begins with one level at Franklin Avenue Station and ends with two levels (with two tracks each). The tracks are separated by columns on each level. After midpoint the lower level tracks are separated by a porous wall. Two existing unequipped fan plants 7231G and F connect near mid-tunnel with each serving a different level. The entire capacity of a proposed fan plant (Rogers Avenue) is directed to the incident track(s). The fan plant capacity is estimated to be 800,000 cfm. As before, it is assumed that the existing porous walls separating trackways will be sealed as part of this construction.

The tunnel sections between Franklin Avenue and the President Street Station consists of two levels with a single track on each level. There is no existing fan chamber for this section. The entire capacity of a new fan plant (Nostrand Avenue) is directed to the incident track. The fan plant capacity is estimated to be 400,000 cfm. The existing porous wall separating each trackway is assumed to be sealed as part of this construction.

The existing fan chambers are determined to be too small to meet current fan plant design. Three ventilation plants are proposed for Alternative 6, together with the associated air supply ducts which feed air to the subway structure tracks. These plants and the numbers of tracks served by each are:

- Classon Avenue Ventilation Plant (400KCFM), located in the southern median strip of Eastern Parkway, just to the east of the Classon Avenue intersection and ducted to serve each of 5 tracks individually (Track 1, Track 2, Track 3, Track 4 and Track 4A);
- Rogers Avenue Ventilation Plant (800 KCFM), located in the northern median strip of Eastern Parkway, just to the east of the Rogers Avenue intersection and ducted to serve four sets of tracks individually (Track 1/Track 2, Track 3/Track 4, Track 2A and Track 3A);
- Nostrand Avenue Ventilation Plant (400KCFM), located in the southern median strip of Eastern Parkway, just west of the Nostrand Avenue intersection and ducted to serve two tracks individually (Track 2 and Track 3).

All proposed new Nostrand Junction ventilation plants will be located in the raised median strip between the Eastern Parkway service roads and the main Eastern Parkway roadway lanes, directly next to the intersections. The median strip locations were selected in order to create the fewest construction impacts upon traffic during construction. For each location, two options were developed and considered: 1) a three fan option and 2) a four fan option. The three fan option consists of installing three 135,000 cfm fans side by side, on one level. This level extends from the center roadway median to about one half of the width of the service road. The four fan option consists of four 100,000 cfm fans, two fans placed side by side, then stacked on two levels. The four fan plant configuration fits into the roadway median. The three fan option, being in one level, is likely the less expensive option, since it does not extend as deep as the four fan option, however it has the disadvantage that it occupies about one half of the service road and thus will at some point during construction affect the service road traffic. The four fan two level concept, which keeps the construction within the existing Eastern Parkway medians, was selected by NYCT for cost estimating purposes.

The distribution of existing utilities within the Eastern Parkway corridor is very light and mainly consists of electrical conduits for street lighting, waterlines, plus storm drainage sewers located below the Eastern Parkway service roadways. Within the medians utility distribution consists primarily of electrical ducts for street lighting; these will have minimal issues, if any, upon ventilation plant construction.

All proposed ventilation plant options are located within the park like medians and will therefore impact the trees and vegetation within the footprint of the plant. A more detailed discussion of the impacts appears elsewhere in this report. Within the ventilation plant foot print only shrubs and small trees can be located, given the presence of the proposed below grade structure. Additionally, ventilation gratings will occupy about two-thirds of the width of the median. This leaves approximately one-third of the median width as an unencumbered walkway for a length of 30 feet.

The first two plans for each plant, (except for Rogers Avenue where it is the first four plans) (Appendix I) depict the street level. The plans differ in that the first shows vegetation and the second does not. The following plan(s) for each location shows a plan view at the fan room level. The following drawing(s) for each location shows a longitudinal section through the fan plant. The last drawing(s) for each shows cross sections of the ventilation plants with respect to the subway structures and shows the duct connecting to each subway tunnel. Dampers are proposed for each track. The EDR (Electrical Distribution Room) and MCC (Motor Control Center) rooms are located on separate levels. A walled corridor was added to the fan room to border the separate EDR and MCC room. Each proposed ventilation plant has been provided with two means of egress. If necessary, an additional exit can be included from the plenum to the track tunnels.

The electrical power system for each ventilation plant will be supplied by a new Consolidated Edison (Con Ed) 120/208 volt, three phase, four wire network transformer vault via a new property line box located on the sidewalk side adjacent to the plant. The transformer vault will supply power to a new free standing, four-section 120/208 volt, three phase, four wire main electrical switchboard located in the Electrical Distribution Room (EDR). The main electrical switchboard will distribute power to four 208 volt, three phase, three wire free standing MCC located in the MCC Room below the EDR. The four MCC's will supply power to four new tunnel ventilation fan motor units via four new, non-fused, local motor disconnect switches. The fan motor units and local motor disconnect switches will be located in the Fan Room.

The main electrical switchboard will also distribute power to four new local 120/208 volt, three phase, four wire electrical Integrated Circuit (IC) panel boards in the MCC Room. The IC panel boards will supply power to local ventilation equipment. There will be two new free standing Supervisory Control Cabinets in the MCC Room for local control operations.

There will be one new miscellaneous local 120/208 volt, three phase, four wire electrical panel board in the EDR to supply power to local miscellaneous electrical equipment. New electrical power and control raceways/wiring will be included as required.

4.2.4 Construction Staging and Scheduling

This section provides a conceptual description of suggested construction activities and sequences of work required along each segment of the project. It has been prepared to support and explain the conceptual structural plans and sections provided in Appendix H, as well as to permit a reasonable level of construction cost scheduling and estimating accuracy at this conceptual engineering phase of the work.

<u>West of Franklin Avenue Station (See Appendix H, Figures 621 to 624 and 631-1 to 633-4)</u>

The existing tunnel sections west of Franklin Avenue Station transition from two tracks over two tracks (Section AA) to all four tracks at the same level at the approach to the west end of the station (Section CC). Three tracks are affected:

- Lower Track 3 - requires reprofiling;
- Upper Track 4 - requires modification to allow Track 3 reprofiling and a new "Y" turnout connecting it to reprofiled Track 3 and to a new Track 4A;
- New Track 4A on the north side of Track 3 - connects lower level Track 3 to existing Track 4 at Franklin Avenue Station.

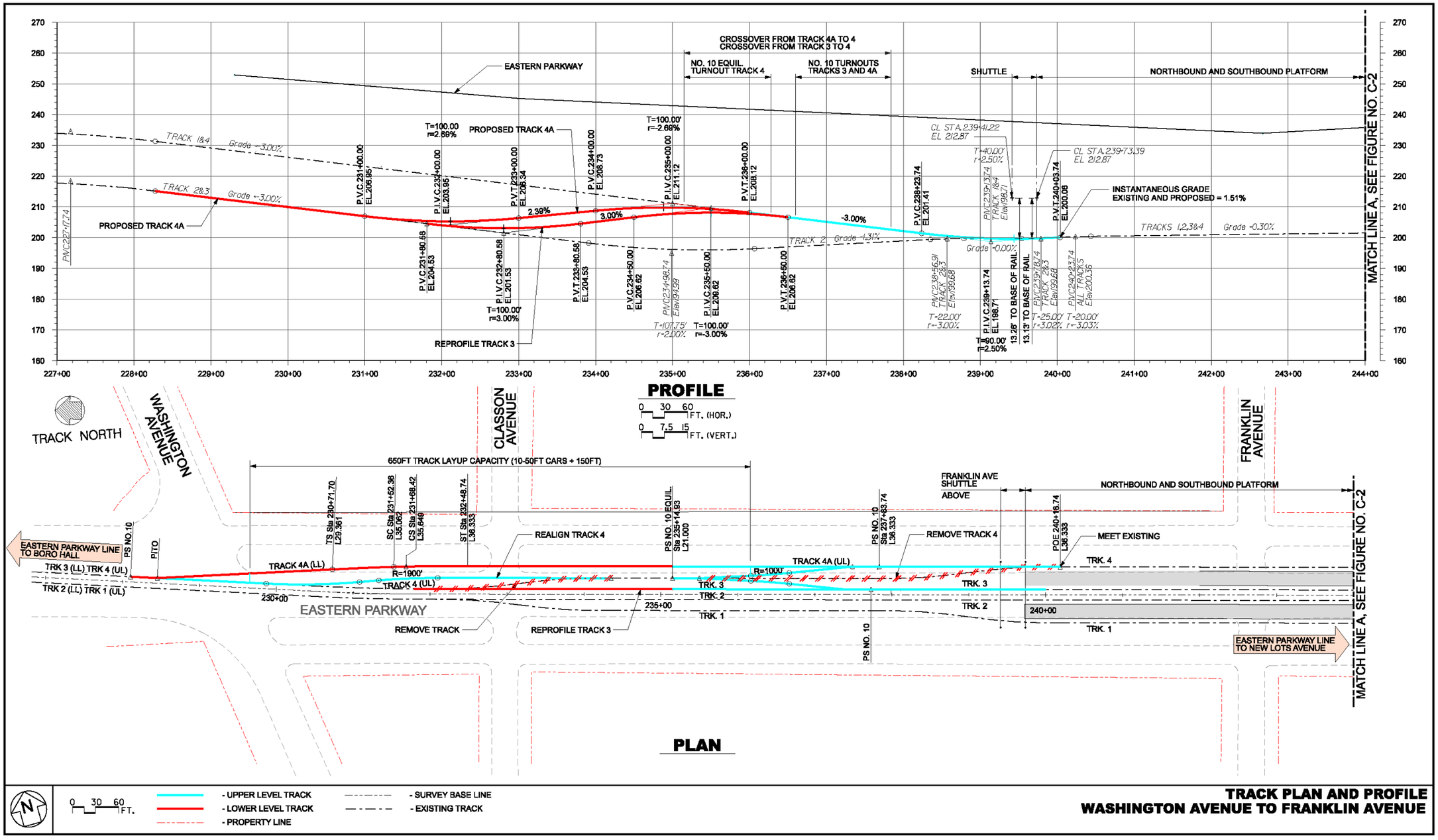


Figure 14: Alternative 6: Track Plan and Profile (Washington Avenue to Franklin Avenue)

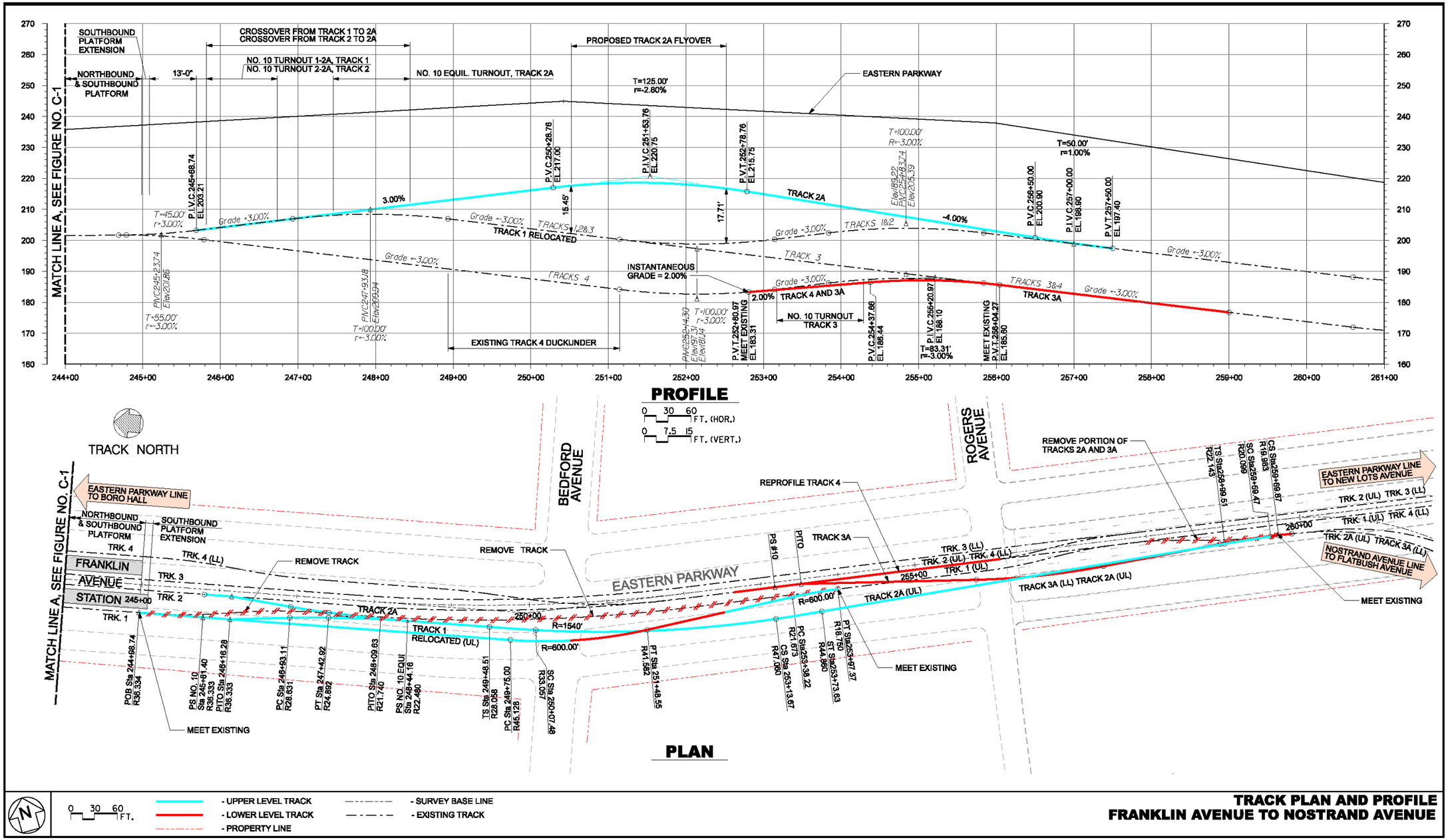
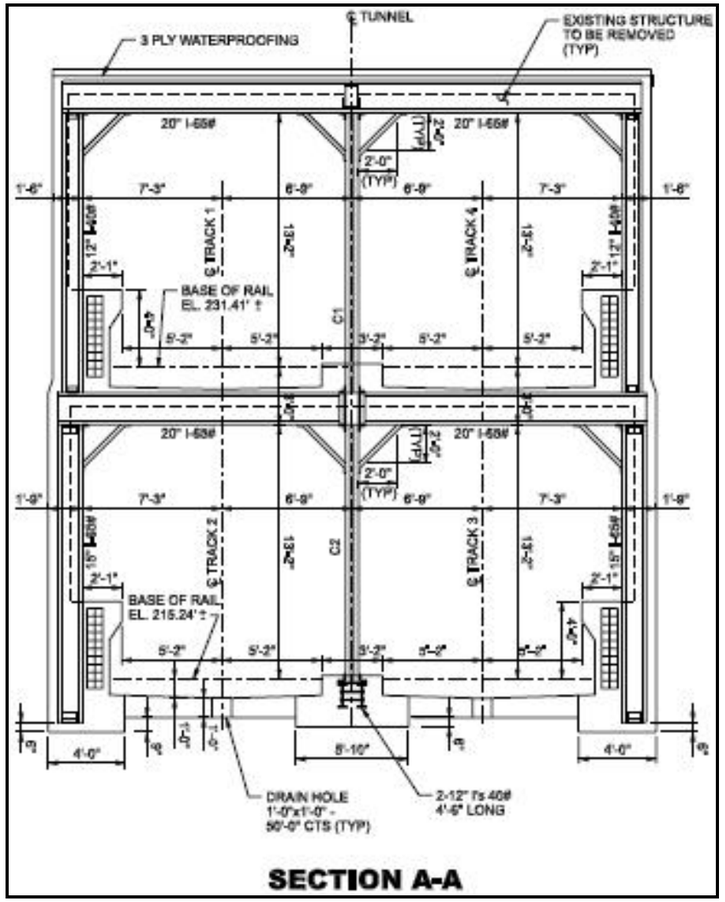
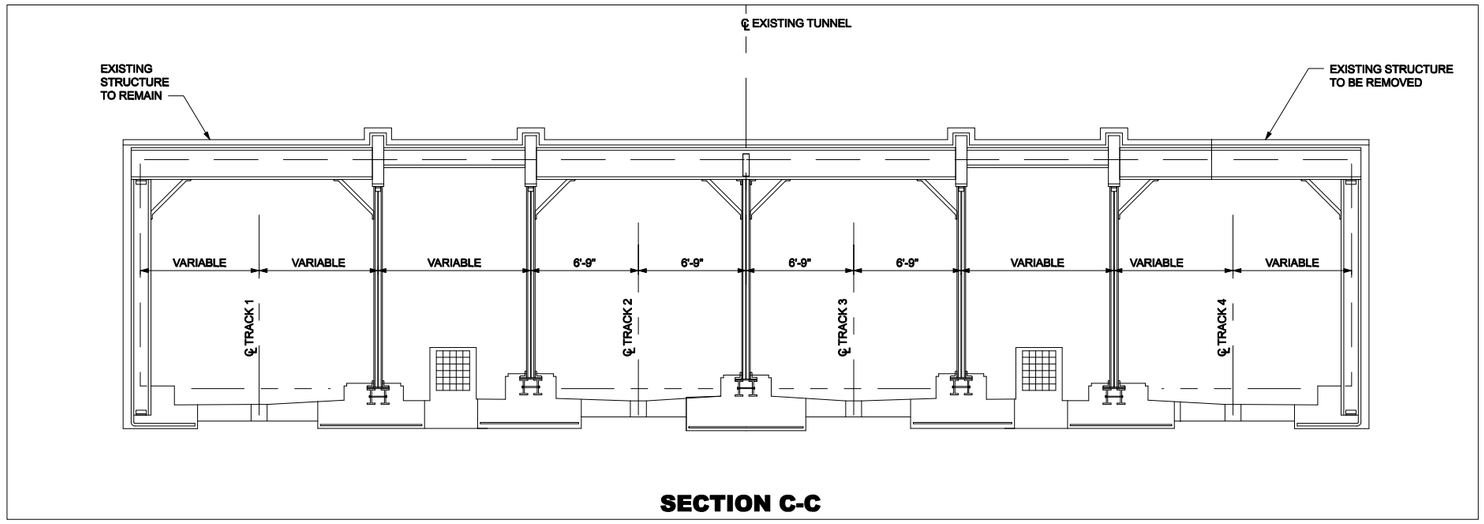


Figure 15: Alternative 6: Track Plan and Profile (Franklin Avenue to Nostrand Avenue)



SECTION A-A

Existing Tunnel Section West of Franklin Avenue Station



SECTION C-C

Existing Tunnel Section Approaching Franklin Avenue Station

The suggested construction sequence west of Franklin Avenue Station is:

- **Stage 1W:** Construct the turnout for Track 4A from Lower Track 3 at Washington Avenue (Bents #389 - #424, Sections AA and 1A).
- **Stage 2W:** Construct the Track 4A structure adjacent to the existing structure (Bents #425 - #590, Sections 2A, 2B, 2C, 3A and 3B), part of which will support Track 4.
- **Stage 3W:** Realign Track 4 so that Track 3 reprofiling can begin (Bents #424 - #511, Sections 2A, 2B and 2C). This requires modifying the existing Track 4 structure between Washington Avenue to just east of Classon Avenue and then making this a permanent diversion.
- **Stage 4W:** Construct that part of the Track 4 "Y" that connects to Track 4A (Bents #527 - #577, Sections 3A and 3B).
- **Stage 5W:** Construct the merge of Track 4 with Track 4A (Bents #578 - #609, Sections 3C and 3D). When the structure is complete, make the permanent connections of Track 4 to Track 4A at Franklin Avenue Station and just east of Classon Avenue.
- **Stage 6W:** Reprofile Track 3 (Bents #460 - #625, Sections 2C, 2D, 3A, 3B, 3C and 3D). After reprofiling of Track 3 is complete, make the permanent connection of Track 4 at the "Y" to Track 3.

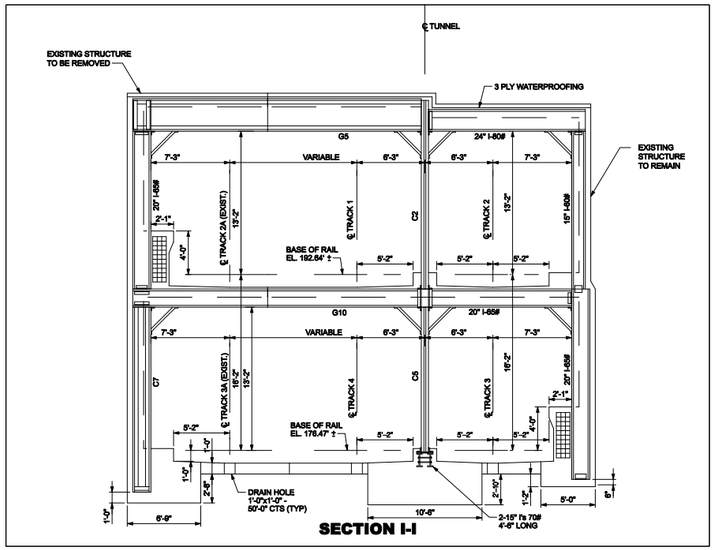
Table 4 lists the locations and stages of the proposed construction west of the Franklin Avenue station, by track and structure stations, structural bent numbers, and structural sections. Stages 1W and 2W can be concurrent, Stages 3W, 4W and 5W can be concurrent after adjacent Stages 1W and 2W are completed, as can 4W, 5W and 6W once Track 4 is realigned.

TABLE 4: STATIONING, BENT AND SECTION CROSS REFERENCE – WEST OF FRANKLIN AVENUE STATION

Track Station	Structure Station	Bent	Section	Construction Stages			
228+24	78+25	389	AA	Stage 1W: Track 4A Turnout			
228+29	78+30	390					
228+94	78+95	403					
228+99	79+00	404					
229+53	79+54	414					
229+74	79+75	419	1A				
229+99	80+00	424			Stage 3W: After Stages 1W and 2W, Realign Track 4		
230+04	80+05	425		Stage 2W: Track 4A Adjacent to Existing Structure			
230+99	81+00	444	2A				
231+09	81+10	446					
231+54	81+55	455					
231+69	81+70	458					
231+79	81+80	460					
232+34	82+35	471	2B				
232+49	82+50	474					
232+99	83+00	484	2C				
234+34	84+35	511					
234+49	84+50	514					
235+14	85+15	527			Stage 4W: Part of Track 4 "Y" to Track 4A		Stage 6W: After Stage 3W, Reprofile Track 3
235+19	85+20	528					
236+49	86+50	554	3A				
236+69	86+70	558					
236+74	86+75	559					
237+09	87+10	566	3B				
237+64	87+65	577					
237+69	87+70	578					
238+29	88+30	590			Stage 5W: Merge of Track 4 with Track 4A		
238+34	88+35	591					
238+54	88+55	595	BB, 3C				
239+04	89+05	605					
239+15	89+16	607	CC, 3D				
239+24	89+25	609					
240+04	90+05	625					

East of Franklin Avenue Station

The tunnels in this section vary from four tracks at one level (similar to Section C-C) to three tracks over three tracks (Section I-I).



There are three basic changes east of Franklin Avenue Station:

- Track 1 (upper level) is relocated outwards into a separate tunnel over some distance to allow space for a new Track 2A flyover above it.
- A new separate tunnel for Track 2A from Tracks 1 and 2 at the station flies over relocated Track 1 and joins existing Track 2A, abandoning the existing turnout from Track 2.
- A new turnout located further west for Track 3A from Track 4 emerges from the lowest level to become a separate tunnel that joins existing Track 3A, abandoning the existing turnout from Track 3. This is the most challenging part of the work, with part of the turnout from Track 4 (319 feet) being re-profiled as much as one foot lower than existing.

It should be noted that any construction to the south side of the existing train box construction will directly affect anything in the south median and may require removal of all trees in the affected area. Ventilation structures are not considered in the text below.

The suggested sequence of work needed to achieve these changes is described in the following twelve stages:

- **Stage 1E:** Construct the new turnouts for Tracks 2A and 3A at the extreme eastern end of the project, Bents #987 to #1018 (Section 8B).
- **Stage 2E:** Construct new tunnels 2A and 3A from Bents #959 to #987 (Section 8A) where they are freestanding and one above the other.
- **Stage 3E**: Construct new Tunnel 2A where it is freestanding, Bents #877 to #925 (Sections 6B and 7A).
- **Stage 4E:** Construct the new 400 feet long turnout for Track 3A (Bents #880 to #959, Sections 7B, 7A and 7B) at the location where relocated Track 1 rejoins existing Track 1. Start with Bents #880 to #903 and include Track 1 above (Section 6B), leaving off the Track 1 roof and north side columns. Lower the invert of Track 4 as required (re-profiling, Sections 6B, 7A and 7B), by up to a foot between Station 102+81 (Bent #880) and Station 106+10 (Bent #946). Track 3A is usable after the turnout track is completed once re-profiling of Track 4 is completed.
- **Stage 5E:** Construct the Track 1 turnout leaving the north side columns, roof and roof beams off (Bent #861 to Bent #880). A portion of this up to about Bent #872 will support new Track 2A above.
- **Stage 6E:** Construct relocated Track 1 from Bent #724 to Bent #741 and from Bent #786 to Bent #861.
- **Stage 7E:** Track 2A can now be constructed on top from about Bent #833 where it is clear of existing Track 1 to Bent #861 (Section 6A).
- **Stage 8E:** Construct the new "Y" junction for Tracks 1 and 2A (Bents #741 to #786, Section 4A) leaving off the roof beams and the columns between the two tracks. Divert Track 1 onto its relocated alignment, and then install the columns, roof beams and roof concrete. Install the missing north side columns, roof beams and roof concrete of Track 1, Bents #861 to #903 (Section 6B).
- **Stage 9E:** Complete Track 2A from Bents #786 to #833 (Section 5A) and Bents #861 to #877.
- **Stage 10E:** After the Track 3A turnout is finished in Stage 4E (Bent #903 to Bent #959), Track 2A can be completed above it (Bents #925 to #959, Section 7B). This completes the construction of Track 2A new tunnel including the portion with Track 3A beneath it. Track 2A traffic can now be diverted into it and the old turnout abandoned.
- **Stage 11E:** Remove existing street grating ventilation structures.

- **Stage 12E:** Construct new ventilation buildings and air supply ducts.

Table 5 lists the locations and construction stages of the proposed construction east of Franklin Avenue Station by track and structure stations, structural bent numbers, and structural sections. Apart from Stages 1E and 2E that can be constructed at any time, the other stages are very sequence dependent.

TABLE 5: STATIONING, BENT AND SECTION CROSS REFERENCE – EAST OF FRANKLIN AVENUE STATION

Track Station	Structure Station	Bent	Section	Construction Stages			
244+98.74	95+00	724		Stage 6E: Track 1			
245+81.40	95+83	740					
245+84	95+85	741		Stage 8E: Track 1	Stage 8E: Track 2A		
245+89	95+90	742					
246+36	96+37	751	DD				
246+89	96+90	762					
246+99	97+00	764	4A				
248+09.63	98+11	786		Stage 6E: Track 1	Stage 9E: Track 2A		
249+74	99+75	819	EE, 5A				
249+79	99+80	820					
250+44	100+45	833			Stage 7E: Track 2A		
250+81	100+82	840	FF, 6A				
251+84	101+85	861		Stages 5E & 8E: Track 1	Stage 9E: Track 2A		
252+39	102+40	872					
252+64	102+65	877			Stage 3E: Free-standing Tunnel Track 2A		
252+80	102+81	880		Stages 4E & 8E: Track 1		Stage 4E: Track 3A Turnout	Stage 4E: Reprofile Track 4
252+99	103+00	884	6B				
253+19	103+20	888					
253+96	103+97	903					
253+97.37	103+99	903					
254+14	104+15	907	7A				
255+04	105+05	925			Stage 10E: Track 2A		
255+39	105+40	932	GG, 7B				
256+04	106+05	945					
256+09.17	106+10	946					
256+39	106+40	952					
256+74	106+75	959	HH		Stage 2E: Tunnels Tracks 2A & 3A		
257+29	107+30	970	8A				
258+14	108+15	987			Stage 1E: Turnouts Tracks 2A & 3A		
259+09	109+10	1006	II, 8B				
259+69.87	109+71	1018					

4.2.5 Service Impacts, Outages and Mitigation

Despite the complexity of this construction project, the service objectives remain virtually the same, that is, to provide unaffected normal peak service capacity during the weekdays and to provide some level of adequate, albeit limited if necessary, service to all branches. Construction of Alternative 6 would require six different outages with related service patterns at various times between the estimated 6 year construction period. These outages are described below and lettered from Type A1 through Type E1. Approximately 200 of these outages are estimated at this conceptual stage of work.

- **Type A1:** Closure of Track 1 (see Figure 16) between Franklin Avenue Station and Nostrand Junction, affecting the use of Track 1 between Atlantic Avenue Station and Nostrand Junction.
  - **Recommended time of service outage**: Weekend 53-hour GO.
  - **Train operation impact**: Southbound 2 and 3 trains must operate on Track 2 from Atlantic Avenue to Nostrand Junction and cross back to Track 1.
  - **Customer impact**: Bergen Street, Grand Army Plaza, and Eastern Parkway southbound stations are bypassed
    1. Southbound customers to these stations proceed to Franklin Avenue and return north.
    2. Southbound customers from these stations proceed north to Atlantic Avenue then southbound to destination.
- **Type B1:** Closure of Track 2 (see Figure 17) between Franklin Avenue Station and Nostrand Junction, affecting the use of Track 2 between Atlantic Avenue Station and Utica Avenue Station.
  - **Recommended time of service outage**: Weekend 53-hour GO.
  - **Train operation impact**: Southbound 4 trains must operate on Track 1 from Atlantic Avenue to Utica Avenue.
  - **Customer impact**: None.
- **Type C1:** Closure of Track 3 (see Figures 18 and 19) between Atlantic Avenue Station and Nostrand Junction, affecting the use of Track 3 between Utica Avenue Station and Atlantic Avenue Station
  - **Recommended time of service outage**: Weekend 53-hour GO.
  - **Train operation impact**: Northbound 4 trains must operate on Track 4 from Utica Avenue to Atlantic Avenue.
  - **Customer impact**: None.
- **Type D1:** Closure of Track 4 (see Figures 20 and 21) between Eastern Parkway Station and Nostrand Junction, affecting the use

of Track 4 between Nostrand Junction and Atlantic Avenue Station
- **Recommended time of service outage**: Weekend 53-hour GO.
- **Train operation impact**: Northbound 2 and 3 trains must operate on Track 3 between Nostrand Junction and Atlantic Avenue.
- **Customer impact**: Eastern Parkway, Grand Army Plaza, and Bergen Street are bypassed
  1. Northbound customers to these stations must go to Atlantic Avenue then return southbound to destinations.
  2. Northbound customers from those stations must proceed southbound to Franklin Avenue then proceed northbound.

- **Type D2:** Closure of Track 4 (see Figure 22) between Nostrand Junction and Nostrand Avenue Station
  - **Recommended time of service outage**: Weekend 53-hour GO.
  - **Train operation impact**: Northbound 3 trains must operate on Track 3 from Utica Avenue to Atlantic Avenue.
  - **Customer impact**:
    1. Northbound customers to Kingston Avenue and Nostrand Avenue must go to Franklin Avenue and return south, and northbound customers from these stations must go southbound to Utica Avenue to proceed north.
    2. Northbound customers to Eastern Parkway, Grand Army Plaza, and Bergen Street must go to Franklin Avenue and transfer to 2 service, and northbound customers from these stations have access to 2 train service.
- **Type E1:** Closure of Tracks #2A and #3A (see Figures 23 and 24) between new tunnel structure and existing #2A/#3A tunnel south of Nostrand Junction.
  - **Recommended time of service outage**: Weekend 53-hour GO.
  - **Train operation impact**: Southbound 2 service terminates north of Franklin Avenue Station; Northbound service originates at this designated location. Southbound and Northbound service on the Nostrand Avenue line is suspended for the weekend outage. Equipment for 2 trains could turn back at Utica Avenue.
  - **Customer impact**: 2 service on the Nostrand Avenue Line is suspended. Busing program may be required for each track closure.

It is important to note that Outage Types B1 through D2 are also conducive to weekday night outages between midnight and five o'clock a.m. where the construction plan can define work tasks which can effectively be started and ended within that window of opportunity.

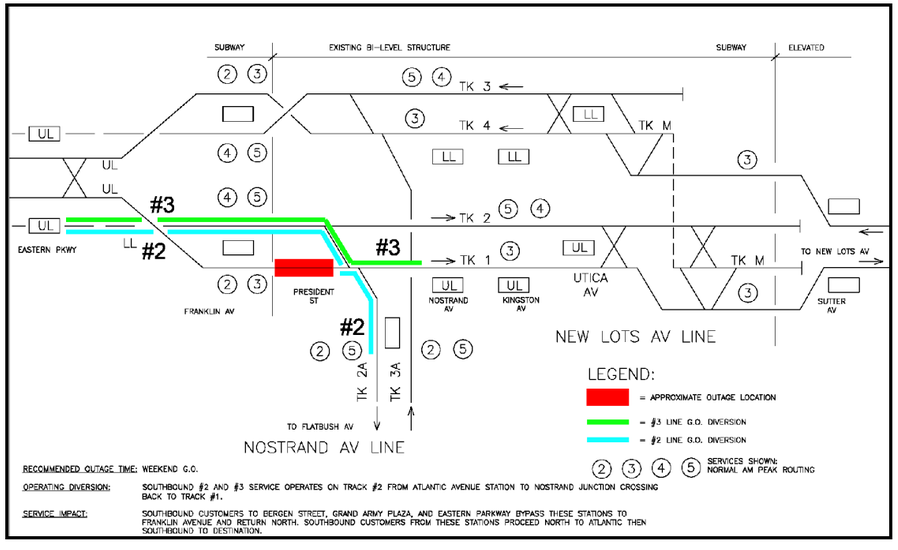


Figure 16: Alternative 6 – Track #1 Outage between Franklin Avenue Station and Nostrand Junction

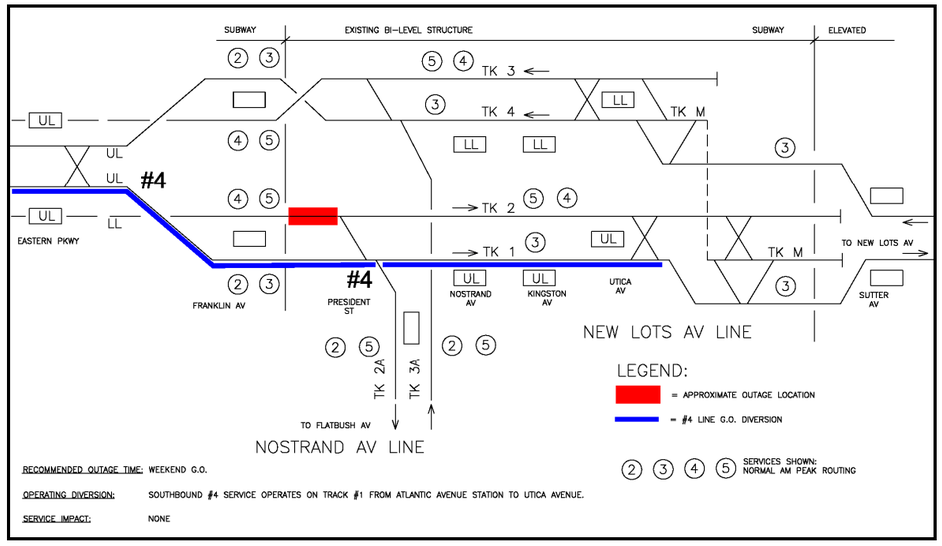


Figure 17: Alternative 6 – Track #2 Outage between Franklin Avenue Station and Nostrand Junction

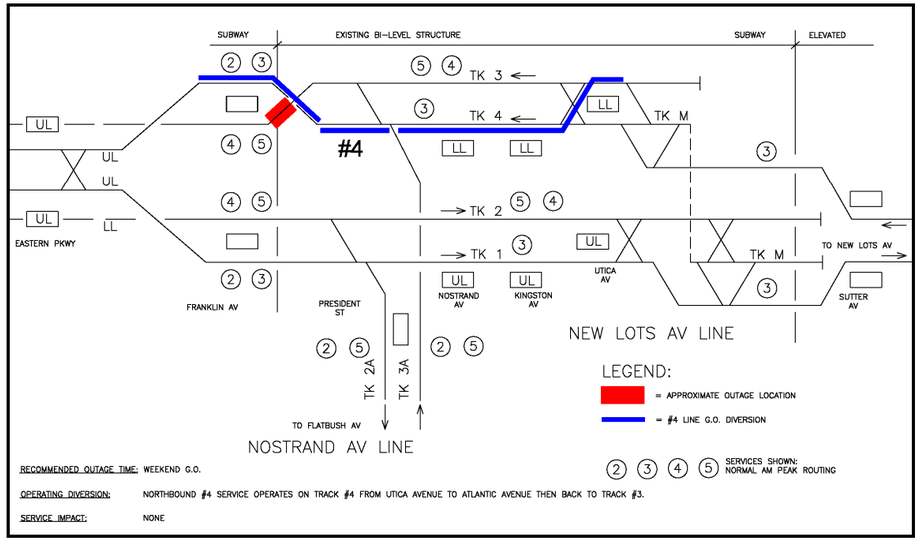


Figure 18: Alternative 6 – Track #3 Outage between Franklin Avenue Station and Nostrand Junction

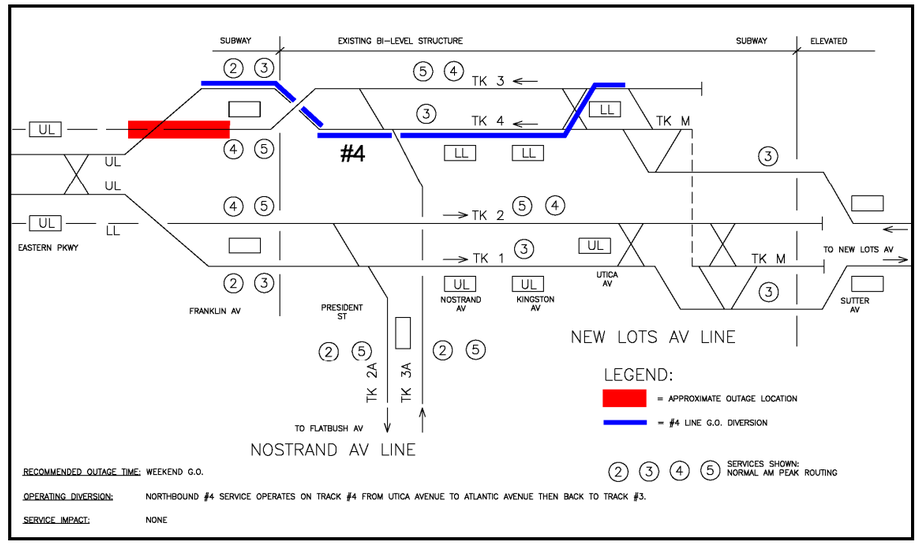


Figure 19: Alternative 6 – Track #3 Outage between Eastern Parkway and Franklin Avenue Station

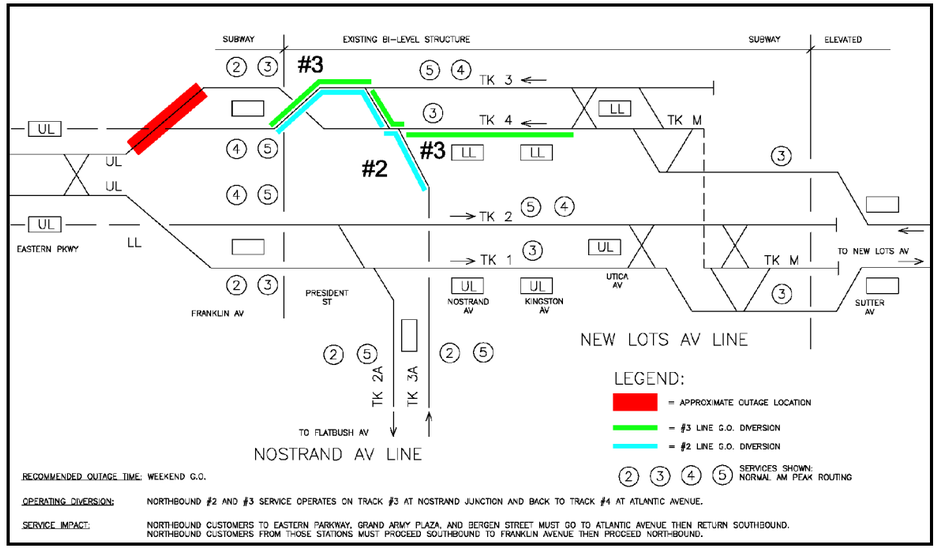


Figure 20: Alternative 6 – Track #4 Outage between Eastern Parkway and Franklin Avenue Station

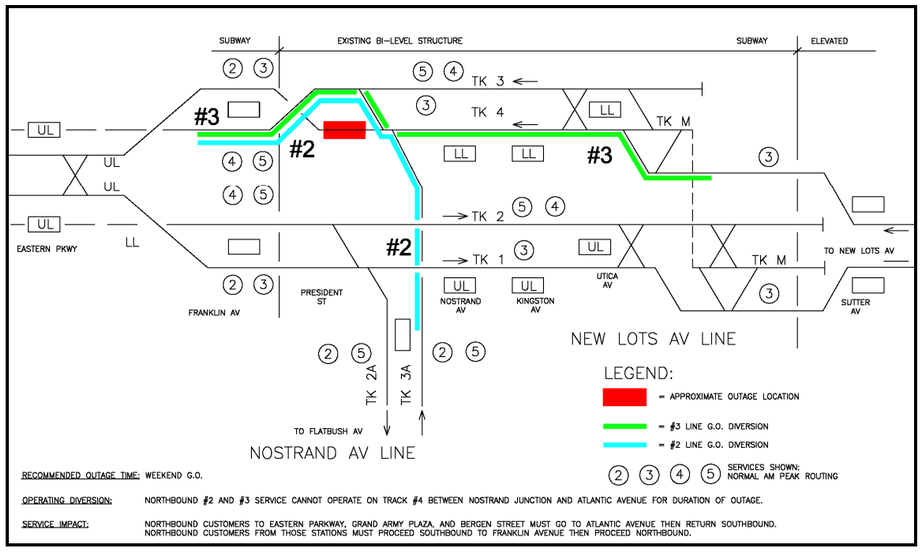


Figure 21: Alternative 6 – Track #4 Outage between Franklin Avenue Station and Nostrand Junction

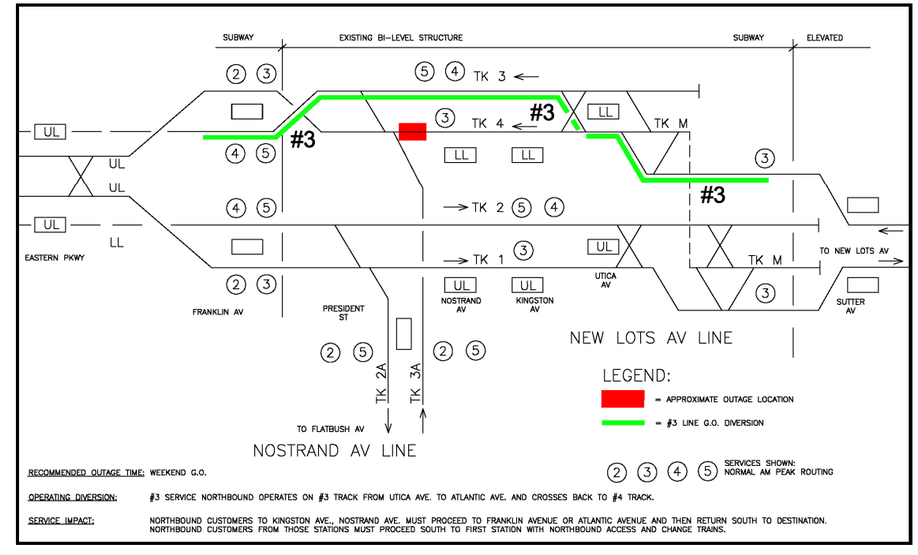


Figure 22: Alternative 6 – Track #4 Outage between Nostrand Junction and Nostrand Avenue Station

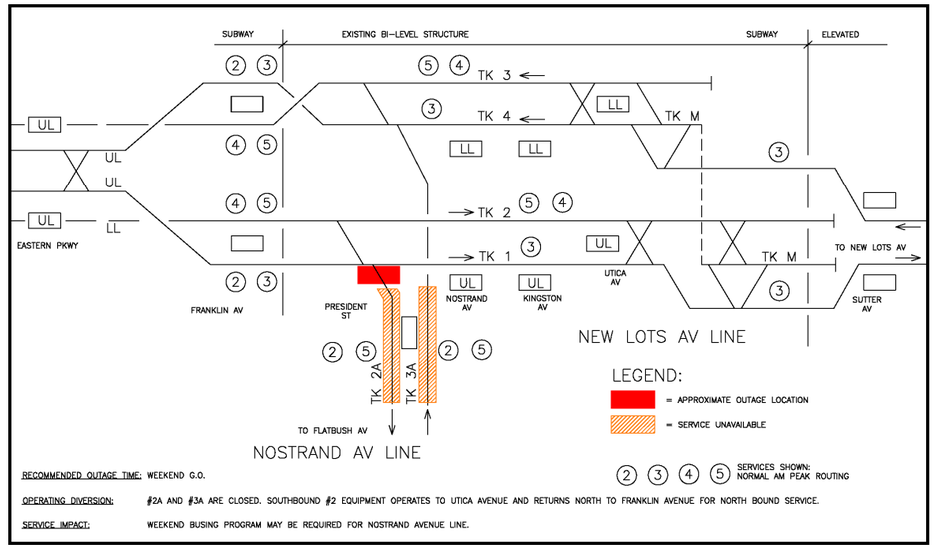


Figure 23: Alternative 6 – Track #2A Outage South of Nostrand Junction at New Connection

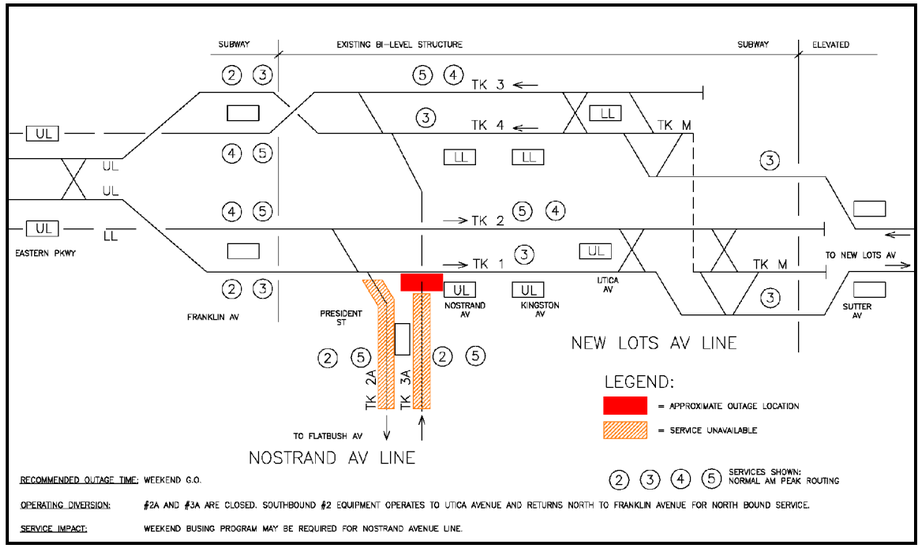


Figure 24: Alternative 6 – Track #3A Outage South of Nostrand Junction at New Connection

4.2.6 Subway Signal, Communications and Traction Power Issues

Signal Equipment to be Removed/Replaced

Under Alternative 6, there are major signaling impacts and requirements for Eastern Parkway, Franklin Avenue and Nostrand Avenue. Refer to the schematic figures below as follows:

Figures in Appendix J show the following drawings:

Figures S-1 thru S-6: Depict the existing signaling within the project area.

Figures S-7 thru S-12: Define the proposed new signaling requirements.

Figures S-13 thru S-29: Illustrate the seven Signaling Stages for implementation.

Figures S-30 thru S-34: Illustrate the Signaling Installation/Testing Track Outage Requirements.

Below is a description of the proposed new signaling requirements per interlocking:

Eastern Parkway – Additional wayside signal equipment for a new turnout switch at stationing 228+00 is required to connect the new Track 4A to existing Track 3, as well as the Associated Home Signals, Approach Signals, Track Circuits and Train Stops for protecting any train movements over the new switch, as shown in Appendix J, Figure No. S-7. An auxiliary room must be constructed to house the new equipment for the new signaling requirements. Further efforts to identify the best location for the new room will be required in subsequent design phases.

The existing equipment, both wayside and within the relay room is not intended to be replaced since it is a newer vintage interlocking. Replacement of the equipment in its entirety is not warranted. Additionally, the existing Control Panel would need to be modified for the new interlocking requirements and new signal controls and indications would need to be sent to the Utica Avenue Master Tower.

Franklin Avenue – The new signaling requirements are illustrated in Appendix J, Figures No. S-8 thru S-11. Two separate interlockings are proposed with each having relay rooms at the North Franklin Avenue Interlocking and the South Franklin Avenue Interlocking. Franklin Avenue North relay room is located within the new construction of Track 4A and the Franklin Avenue South relay room is to be located in the station platform area. Both new relay rooms are estimated to be 16’ x 110’ (see Figure S-9). Provisions for a UPS and Fire Suppression system are also required. The new signal equipment design shall allow for Future CBTC and adequate spare space must also be provided.

The control limits of the new interlockings will meet up with the existing control limits to Eastern Parkway on the north side (STA 232+00) and Nostrand Avenue control limits (STA 250+00) on the south. A significant amount of modifications will be required to the Utica Avenue Master Tower control panels to insert a new interlocking between Eastern Parkway interlocking and Nostrand Avenue interlocking. Further investigation of replacing the entire control system will be required for the Master Tower. Currently, only modifications are assumed and have been reflected in the construction cost estimate. All new controls and indications will need to be added over the existing communication line presently operating on the system

Nostrand Avenue - New signaling requirements are illustrated in Appendix J, Figures No. S-11 and S-12. The tracks from the Nostrand Avenue Line are being relocated/extended from their present connection location (see Figure S-12). The relocated Track 3A connection and new switch will remain within the Nostrand Avenue control limits, while Track 2A connection will now be implemented further north at the new South Franklin Avenue interlocking portion. The existing Nostrand Avenue Relay Room is already over-utilized with train control equipment and there is no spare space available to install additional equipment. A new room is required to include all new signal requirements and to control and indicate all existing switches, signals and train stops. The new relay room is to be 16’ x 110’, and located in the new construction areas under the new Track 1 (see Figure S-11) staging area. Provisions for an UPS and Fire Suppression system are also required.

The new signal equipment design shall allow for Future CBTC. Adequate spare space for the future additional equipment must also be provided. The new signal relay room will be designed to replace all existing equipment (including wayside) as the interlocking exists today. Additionally, all new signal requirements for the proposed modifications shall be incorporated into the design (but will not be immediately put in service until construction completion). Since the track area is impacted so heavily with construction, wayside cables would require being re-routed and replaced from the various structures. New interlocking control with all new cables would be placed in service well in advance of placing the additional interlocking equipment into service. Also with the revisions of the interlocking, modifications to the local control panel and to the Utica Avenue Master Tower control panels will be required. All new controls and indications will need to be added over the existing communication lines.

Construction Signaling Staging:

Seven (7) Signaling stages have been identified for the implementation of the proposed new signaling system. The stages are summarized below:

Stage 1 Nostrand Avenue in Service (No new Track for this stage)

New Signal Room for Nostrand Avenue. (located under new Track 1). This new room will replace the existing relay room and wayside equipment with the interlocking as it exists today.

Stage 1A in Service (North of Franklin Avenue)

New Track 4A and Realign Track 4

Stage 2 in Service (South of Franklin Avenue)

New Track 1

Stage 3 in Service (North of Franklin Avenue)

Track 3 Reprofile

Stage 4 (North of Franklin Avenue)

Crossover to Track 3 and Track 4

Stage 5 (South of Franklin Avenue)

New Track 3A

Stage 6 (South of Franklin Avenue)

New Track 2A

The following describes the Construction Signaling Staging in more detail:

Stage 1 Nostrand Avenue in Service (No new Track for this stage)

See Appendix J, Figures S-13 and S-14.

As an early construction stage of the project, the Nostrand Avenue relay room and wayside will require complete replacement. The proposed location of the new relay room is located under the new Track 1 (see Appendix J, Figure No. S-11). The new relay room requires replacement due to equipment age and lack of adequate spare space to support the new requirements.

Of all of the signal work for the proposed design, this stage is the most aggressive for installation, test and cutover. The signal design will require supporting interim signal designs along with the final configuration. A block design performed for the future design shall identify the best approach for the interim signaling and final proposed design.

Separate cutovers of Nostrand shall be performed with Tracks 1 and 2 together, and Tracks 3 and 4 together. This is selected due to the separation between the pair of tracks. It also minimizes the actual time required for a weekend track outage cutover to ensure a successful cutover. See Figures S-30 and S-31 (all illustrations) for Signal Track Outages for the installation and cutovers.

Stage 1A in Service (North of Franklin Avenue and Eastern Parkway)

New Track 4A and Realign Track 4

See Appendix J, Figures S-15 thru S-17.

In order to re-profile Track 3, the realignment of Track 4 will be required. The realigned Track 4 will now occupy the newly constructed Track 4A. The re-profiling of Track 3 and realignment of Track 4 also is required to allow the equilateral crossover to be installed at Signal Stage 4.

North Franklin Avenue will require a new relay room located within the staging area in the new 4A Track. When the new relay room is completed for Franklin Avenue, the signaling equipment can be installed along with all new cable requirements, wayside signals, track circuits, train and stops, and pre-testing can be performed.

Additionally, a new auxiliary relay room will be required to be added at Eastern Parkway station area to contain the additional equipment for the proposed design. The existing room and wayside is to remain since the age of this equipment is acceptable. The new room will need to interface with the existing room located within the station platform area. It should be noted that the new turnout being added on 3 Track is a separate interlocking and is currently located within the automatic block signal area.

Signaling Installation/Testing Track Outages are shown on Appendix J, Figure S-32, Illustration 1A-1 and 1A-2.

Stage 2 in Service (South of Franklin Avenue)

New Track 1

See Appendix J, Figures S-18 thru S-20.

In order to construct part of the new Track 2A, the existing Track 1 realignment will be required. At this stage, no Controlled Signals are required from the new South Franklin Avenue relay room. This signal stage work only involves modifications to the block signal system.

Signaling Installation/Test Track Outages are shown on Appendix J, Figure S-32, Illustration 2-1.

Stage 3 in Service (North of Franklin Avenue)

Track 3 Reprofile

See Appendix J, Figures S-21 and S-22.

As described above in Stage 1A, the associated signal work is related to re-profiling of Track 3 in preparation for the installation of the equilateral crossover that connects Track 3 and Track 4.

Additionally, the special track work switch points shall also be installed during this stage. Switch indication/protection must also be temporarily provided until the switch crossover is placed into service.

Signaling Installation/Test Track Outages are shown on Appendix J, Figure S-32, Illustration 3-1.

Stage 4 (North of Franklin Avenue)

Crossover to Track 3 and Track 4

See Appendix J, Figures S-23 and S-24.

Signal Stages 1A, 2 and 3 are all in preparation for the equilateral crossover between Track 3 and Track 4 to be placed into service. The new equipment required for this stage is to be controlled from the new North Franklin Avenue relay room (previously provided under Signal Stage 1A, above).

Signaling Installation/Test Track Outages are shown on Appendix J, Figure S-33, Illustration 4-1 thru 4-3.

Stage 5 (South of Franklin Avenue)

New Track 3A

See Appendix J, Figures S-25 and S-26.

This stage extends Track 3A to bypass Nostrand Avenue existing crossovers, however, the new turnout remains within the limits of Nostrand Avenue control from the new relay room previously installed in Stage 1, above.

Signaling Installation/Test Track Outages are shown on Appendix J, Figure S-33, Illustration 5-1.

Stage 6 (South of Franklin Avenue)

New Track 2A

See Appendix J, Figures S-27 thru S-29.

This stage extends Track 2A to bypass Nostrand Avenue existing crossovers, however, the new turnout now becomes under the control of South Franklin Avenue relay room previously installed in Stage 2, above.

Signaling Installation/Test Track Outages are shown on Appendix J, Figure S-34, Illustration 6-1 thru 6-3.

4.2.7 Private Property Issues

The construction of Alternative 6 and the subsequent subway operations associated with this alternative do not create any private property issues as the construction zone is located under the wide parkway median and service roads, and away from existing private buildings.

No private property acquisition or relocation is required under Alternative 6.

4.2.8 Environmental Issues

Construction of Alternative 6 will take place at three locations, primarily within the Eastern Parkway medians that separate the

mainline from the service roads near Nostrand Avenue, Rogers Avenue, and Classon Avenue. These medians feature pedestrian walkways that parallel the parkway and are lined on both sides with benches and dense rows of street trees. The proposed installation of three underground fan plants and underground auxiliary structures will require the temporary closure of the medians and portions of the mainline and service road at these locations during which time, access will be restricted.

Classon Avenue. Ventilation plant construction work will take place on a portion of the northern and southern medians between Classon Avenue and Franklin Avenue (near Classon Avenue) and will also entail construction on the mainline roadway near its intersection with Classon Avenue. An L-shaped area will be excavated that includes a section approximately 22 feet wide on the northern median, 140 feet long and 26 feet wide on the southern median, and 22 feet wide on the mainline roadway (see Appendix I, Classon Figure 001). When construction is complete two parallel at-grade gratings will be installed within the southern median measuring approximately 30 feet by 10 feet, as well as one equipment hatch 10 feet by 10 feet and two personnel manholes at the east and west portions of the construction area in the southern median.

Rogers Avenue. Ventilation plant construction work will take place on the western end of the northern median between Rogers Avenue and Nostrand Avenue (near Rogers Avenue) and also will entail construction within the mainline roadway and a small portion of the southern median. A T-shaped area will be excavated, approximately 268 feet and 10 inches long and 24 feet wide on the northern median, 48 feet on the main-line roadway, and 48 feet wide on the southeastern median (see Appendix I, Rogers Figures 001 and 002). When construction is complete, four at-grade gratings will be installed within the northern median measuring approximately 30 feet by 10 feet (two parallel gratings), as well as two equipment hatches 10 feet by 10 feet, and two personnel manholes – all at either end of the construction area.

Nostrand Avenue. Ventilation plant construction work will take place on the eastern end of the southern median between Nostrand Avenue and Rogers Avenue (near Nostrand Avenue) and will also entail construction within a small area in the eastbound service road. Most of the construction will occur in the median requiring the excavation of an area approximately 175 feet long and 7 feet wide and approximately 24 feet wide in the eastbound service road (see Appendix I, Nostrand Avenue Figure 001). When construction is complete, two parallel at-grade gratings 30 feet by 10 feet will be installed on the eastern portion of the median, one equipment hatch 10 feet by 10 feet will be centrally located on the median, and two personnel manholes will be installed on the eastern and western portions of the construction area in the median.

Trees and Other Street Landscape Factors

Construction work related to Alternative 6 will include both temporary and permanent issues on existing street trees. While street trees in the medians will be affected in the construction areas, they will be replaced after construction is completed to the maximum extent possible, either in soil or planters. These landscaping plans will be coordinated with the NYC Department of Parks and Recreation. Given the extensive excavation in certain locations to accommodate underground ventilation equipment and the consequent reduction in soil depth, some street trees will be removed and not replaced.

According to the Jablonski Tree and Map Survey (see Appendix F), construction activities at the western end of the southern median between Classon and Franklin Avenues would require the removal of approximately 20 trees, 4 World War I plaques and 8 lamp posts. Eleven of these trees have a circumference greater than five feet (measured at four and a half feet above ground), with the largest measuring approximately 7'-9" in circumference. The proposed work at the eastern end of the southern median would require the removal of approximately sixteen trees and six lamp posts. The affected western end of the northern median between Rogers and Nostrand Avenues would include the removal of approximately twenty trees, (one tree with a circumference greater than five feet), two World War I plaques, and eight lamp posts.

The overall total number of items affected by Alternative 6 would include 56 trees, six World War I plaques, and twenty-two lamp posts. Plaques and lamp posts removed for construction would be re-installed in the medians afterward. The removal of large trees for replanting would cost approximately $20,000 per tree, while the removal and replanting of small trees approximately $13,000. The removal and disposal of the trees on affected medians would cost $1,500 each, and pruning of tree roots approximately $600-800 per tree. The estimated total cost to remove and replant all the trees in the affected areas is approximately $850,000. Only World War I plaques above ground are accounted for in these numbers. It is highly possible that other plaques exist below ground but further excavation would be required to determine if they exist.

Air Quality During Construction

Air pollutant emissions during construction of Alternative 6 will be similar to those described for Alternative 4, except that the estimated construction period is longer (6 years). The funding source for the proposed project is not known at this time. In the event that federal funding is involved, an air quality conformity determination will need to be conducted since construction is anticipated to occur for more than five years.

MPT Staging

Assumptions. Project will be awarded to two independent contractors. One contractor starts at the east end and the other contractor starts at the west end of the project. Their work must be coordinated prior to construction. In order to have less impact on traffic, construction at intersections must be performed at nights.

MPT Sequence. The following is a description of suggested MPT sequence (see MPT Key Plan drawing Figure MPT-01 in Appendix E, Alternative 6):

- **MPT – 1** (Section 1M): Close two westbound right lanes to traffic on Eastern Parkway. Dedicate two right lanes to eastbound traffic and one lane at left to westbound traffic on south side of the Eastern Parkway. Total of two westbound and two eastbound of traffic lanes. Contractor to install complete support system (piles and decking). Please see Figures MPT-02 and MPT-10.
- **MPT – 2** (Section 2M): Close westbound and 20 feet of the sidewalk to traffic on north side of Eastern Parkway. Provide two traffic lanes one for east and one for westbound on south side of the Eastern Parkway. Please see Figures MPT-03 and MPT-11.
- **MPT – 3** (Section 3M): From station 86+25 to station 89+25 close west bound and 22 feet of the sidewalk to traffic on north side. Provide two 10 feet traffic lanes on south side for west and eastbound directions.
- **MPT - 8** (Sections 8M1 and 8M2): Close eastbound and 16 feet of the sidewalk to traffic on south side of Eastern Parkway. Provide two 10 feet traffic lanes on north side for east and westbound traffic on Eastern Parkway. Contractor to construct support system and decking for the roadway. Section 8M2 similar to 8M1 except only 2 feet of south sidewalk/bike path will be closed. Please see Figures MPT-09, MPT-18 and MPT-19.
- **MPT – 7** (section 7M1): Close eastbound and 27 feet of the sidewalk to traffic on south side of the Eastern Parkway. Provide

two 11 feet of traffic lanes on north side for east and westbound directions. Please see Figures MPT-08 and MPT-16.

- **MPT – 6** (section 6M): Close eastbound and 30 feet of the sidewalk to traffic on south side of the Eastern Parkway. Provide two 11 feet of traffic lanes on north side for east and westbound directions. Please see Figures MPT-07 and MPT-15.
- **MPT – 5** (section 5M): Close eastbound and 35 feet of the sidewalk to traffic on south side of the Eastern Parkway. Provide two 11 feet of traffic lanes on north side for east and westbound directions. Please see Figures MPT-06 and MPT-14.
- **MPT – 4** (section 4M): Close eastbound and 20 feet of the south sidewalk to traffic on Eastern Parkway. Provide two 10 feet traffic lanes on north side for west and east directions. Please see Figures MPT-05 and MPT-13.

Detour Plan. Washington Avenue is the only intersection with traffic in both directions. It is suggested that southbound traffic on Washington Avenue be directed through and that northbound traffic diverted east through the south service road and directed north through Classon Avenue and then left on north service road (west) back to north on Washington Avenue. The other intersections can be detoured similarly.

Ventilation Fans.

- Classon Avenue close south side sidewalk/bike path.
- Construct Fan structures.
- Close eastbound on Eastern Parkway.
- Divert eastbound traffic to westbound (north side).
- Build fan structure.
- Close westbound of eastern Parkway.
- Divert traffic to eastbound.
- Build rest of the fan structure.
- The other ventilation plants may be constructed in a similar fashion.

Visual Resources

As a scenic landmark, Eastern Parkway will be adversely affected by the loss of street trees – some of which are decades old - during the construction of Alternative 6. Tree removal and replacement or replanting, within the medians and permanent removal of those at the median ends, as described above, will fragment the symmetrical canopy along the median malls and impair the overall aesthetic quality of the historic parkway in the construction areas where trees may not be replaced. The extent of this impact and suitable mitigation will be defined in later stages of project design.

Other potential visual issues related to Alternative 6 construction will be temporary in nature, affecting pedestrian spaces and circulation on Eastern Parkway and the affected medians. Temporary issues may include the complete closure of the median intersections, portions of the mainline and service roads as excavation occurs below ground. Other open spaces and community facilities in the study area will remain unaffected by Alternative 6 during construction and operation of the proposed ventilation plants.

Public Safety

Construction during the Nostrand Junction reconfiguration would be implemented in compliance with relevant Federal, State, and City codes, policies and guidelines, including those of the MTA NYCT intended to protect safety and security for construction workers, patrons and the general public. Key elements in these codes and policies are guidelines on safety in the event of a fire or other threat, security from crime, and safe construction practices.

4.2.9 Utility Impacts

As described in Section 3.5, and identified in Appendix A, the distribution of existing utilities within the Eastern Parkway corridor mainly consists of electrical conduits, street lighting, traffic signals and associated electrical conduits, waterlines, gas mains with storm drainage sewers located below the Eastern Parkway service roadways. Within the medians, utility distribution consists primarily of electrical ducts, and street lighting; these will have minimal issues, if any, upon fan plant construction. The utilities to be impacted by Alternative 6 are identified in Appendix A, Table U-2.

4.2.10 Construction Cost Estimate

(Please see Appendix G for the detailed Construction Cost Estimate.)

TABLE 6: CONCEPTUAL CONSTRUCTION COST ESTIMATE SUMMARY – ALTERNATIVE 6

Description		Amount
Bid/Procurement Cost		$1,191,911,000
Total Construction Costs		*$1,191,911,000*
Property Acquisition		NA
Utilities (Other than Bid Contractor)		$10,000,000
Construction Contingency	5.00%	$59,596,000
Design	10.00%	$119,191,000
Inspection/Engineering Force Account	12.00%	$143,029,000
TA Labor including Busing		$70,000,000
Subtotal		*$1,593,727,000*
TOTAL PROJECT COST		**$1,593,727,000**

4.2.11 Conceptual Construction Schedule

A conceptual construction schedule has been prepared, by project section, construction stages, and major work activities, as shown in Appendix G. A summarized schedule is provided in Figure 25. The total construction duration is estimated at 6 years, excluding the time required for design, bid process, and equipment procurement.

TASK	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
STAGE 1W Construct Track 4A Turnout																								
STAGE 2W Construct Track 4A Structure																								
STAGE 3W Realign Track 4																								
STAGE 4W Construct Track 4 "Y" to Connect to Track 4A																								
STAGE 5W Construct Track 4 and Track 4A Merge																								
STAGE 6W Reprofile Track 3																								
STAGE 1E Construct Tracks 2A and 3A New Turnouts																								
STAGE 2E Construct Tracks 2A and 3A New Tunnels																								
STAGE 3E Construct Track 2A New Tunnel where it is Freestanding																								
STAGE 4E Construct Track 3A New Turnout																								
STAGE 5E Construct Track 1 Turnout																								
STAGE 6E Construct Relocated Track 1																								
STAGE 7E Construct Track 2A																								
STAGE 8E Construct Tracks 1 and 2A New "Y" Junction																								
STAGE 9E Complete Track 2A																								
STAGE 10E Complete Track 2A New Tunnel																								

Figure 25: Alternative 6 - Construction Schedule