Field Operations

Fresh Kills Park

Road Alternatives Report

ARUP

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Evaluation of Three Alternatives

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Prepared for:

New York City Department of Parks and Recreation

Prepared by:

ARUP
155 Avenue of the Americas
New York NY 10013

HDR/ Daniel Frankfurt
500 Seventh Avenue
New York, NY 10018

Field Operations
475 Tenth Avenue
New York< NY 10018

Geosyntec Consultants
10015 Old Columbia Road, Suite A 200
Columbia, MD 21046

AKRF, Inc.
117 East 29th Street
New York, NY 10016

Job number 131730

Ove Arup & Partners Consulting Engineers PC
155 Avenue of the Americas,
New York NY 10013
Tel +1 212 229 2669 Fax +1 212 229 1056
www.arup.com

ARUP

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Contents

1 Introduction

1.1 Background

The City's aim is to introduce a park road system that provides access for visitors to the new Fresh Kills Park and responds to the transportation needs of Staten Island residents, while respecting the uniqueness of the setting as a former landfill undergoing closure. The design must address the constraints of landfill engineering, maintain the integrity of landfill environmental protection controls, protect the natural resources on the site, and meet environmental regulations, The conceptual design phase for the Fresh Kills Park primary roadway system began in May 2007 with the exploration of alternative approaches to integration of the road system into the park design.

The scope for the conceptual design phase called for the development of six (6) roadway alternatives in the conceptual phase, to be narrowed to three (3) alternatives that would be further studied in the schematic phase, in keeping with the Generic Environmental Impact Statement (GEIS) scoping process. The GEIS calls for the assessment of: (A) a Four-Lane Alternative; (B) a Two-Lane Alternative, and (C) a Hybrid Alternative that would combine favorable elements of (A) and (B).

Rather than selecting 6 alternatives to investigate, the road design team reviewed a more comprehensive range of alignment and width options in the conceptual design phase —18 in all—to provide the broadest possible base of information for the selection of 3 alternatives for further development, in accordance with the GEIS. The results of this process were presented and discussed with New York State Department of Environmental Conservation (NYSDEC) in August 2007, as well as with City agencies, and the process was summarized in the Conceptual Roads Report, issued on September 6, 2007.

The three alternatives selected by the City have since been advanced through schematic design and are the subject of this Road Alternatives Report.

1.2 Purpose

The purpose of this report is to provide policymakers with the information necessary to evaluate the three (3) alternatives in conjunction with the GEIS, and to select a single preferred alternative for detailed design and implementation. Because some portions of roadway site preparation will have to be coordinated with the timing of landfill closure, as it progresses from the northern to the southern half of east mound (section 6/7), selection of a preferred alternative must be made quickly to avoid subsequent breaching and reconstruction of the cover system and to take advantage of cost-saving measures.

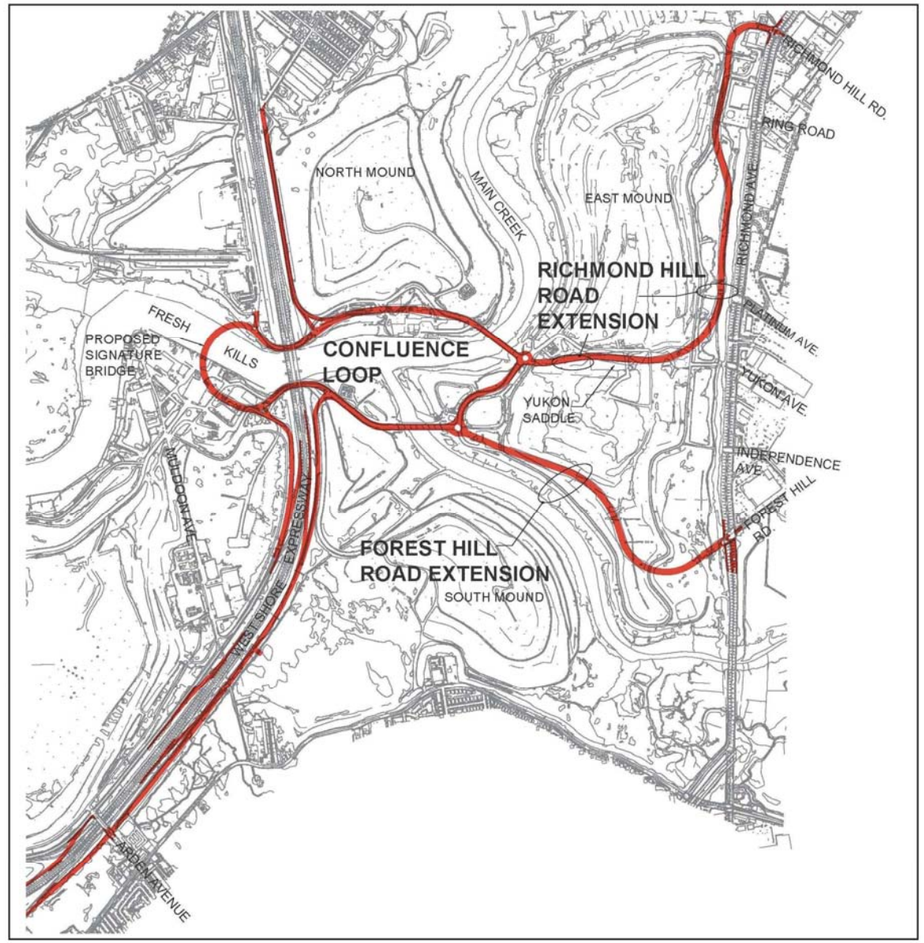
To support the selection of a single alternative to carry forward into the preliminary design investigation (PDI) phase of design, this report presents and discusses the implications of:

- The Four–Lane Alternative, including the Confluence Loop, Forest Hill Road (FHR) Extension and Richmond Hill Road (RHR) Extension.
- The Two-Lane Alternative, including the Loop and the FHR and RHR Extensions.
- The Hybrid Alternative, which combines elements of both the four and two lane versions.

A crucial element of the park roadway system that does not affect the choice between Four-Lane, Two-Lane, or Hybrid Alternatives is the proposed access improvements along the West Shore Expressway (WSE). The service road extensions and ramp additions and modifications along the WSE are identical for all three roadway alternatives.

In addition, given that roadway system, along with the whole of Fresh Kills Park, will be constructed in stages over an extended period, all three alternatives are illustrated in the report figures at two points in their implementation: in the year 2016, and the year 2036, corresponding to the GEIS analysis years.

The schematic level design described in this report focuses on the geometric alignment, landfill interface issues, environmental consequences, and park related aspects that affect the relative merits of the three road alternatives. Traffic and cost are also addressed. The report describes the basis of engineering solutions to address the identified issues. In the preliminary design phase that will follow, the investigations necessary to support those solutions will be performed.



Primary Park Road System

Figure R-1

1.3 Report Format/Data Sources

This report presents the principles and criteria that guided the design in section 2, additional considerations that will be factors in the selection of a preferred alternative in section 3, descriptions of

the three alternatives under consideration and their impacts in section 4, and a comparative evaluation in section 5.

The discussion is followed by a comprehensive set of corroborating exhibits, including Plans, Profiles, and indicative Cross Sections for each of the alternatives for both the complete 2036 and partial 2016 stages of implementation. The exhibits also include three different options for configuring the east leg of the confluence loop and its two intersections with the Forest Hill Road and Richmond Hill Road Extensions. In addition, the exhibits include possible modifications to existing bridges and initial proposals for new bridges. A discussion of the bridge options has been provided in a separate, more extensive Conceptual Bridge Report, issued in November 2007.

The plan view figures presented in this report show the existing site topography obtained between December 2006 and March 2007, and for the majority of the locations along each presented alignment the existing topography is not anticipated to change. However, at the east mound (section 6/7) the grades into which the roads design will need to tie into are those shown in the drawing package titled, Initial Working Drawings, Final Cover at Landfill Section 6/7, prepared by Tully Construction, Inc. of Flushing, New York, and dated 19 December 2006. This distinction is identified with a note included on each of the plan view drawings that show the east mound (section 6/7). In addition, although the proposed final landfill cover grades are not shown on the plan view figures, the design of the roadway vertical alignment at the east mound (section 6/7) was created using them, as illustrated in the profiles and sections. Plan view presentation of the road design in relationship to the proposed final closure grades will be made as part of the PDI design drawings.

Wetland impact was calculated based on two sources of information: Currently undefined, unregulated wetlands to the east of the East Mound and along the West Shore Expressway were delineated in a September 2007 field visit, using Army Corps of Engineers site investigation standards. The preliminary wetland boundaries have not been reviewed by US Army Corps of Engineers, however, and are therefore not considered to be federally jurisdictional (and are subject to change). They are used for guidance only, and will be confirmed before construction. The second source of information is the NYSDEC, which established the boundary of regulated tidal wetlands on site in 1978. [http://www.dec.ny.gov/imsmaps/ERM/viewer.htm] As with all construction near tidal wetlands, DEC has jurisdictional review of projects in “adjacent areas”. Therefore, this boundary, used for preliminary calculations in this report, is subject to change as the design progresses.

2 Design Principles and Criteria

The Fresh Kills site imposes unusual restrictions on road design. Extensive landfill infrastructure underlies most of the site. Wide and valuable expanses of wetland line nearly all potential circulation corridors.

The City and State will use the three sets of design criteria—1) park and environmental design, 2) road design, and 3) landfill design and maintenance criteria—to evaluate the three road alternatives described in this schematic design report. No road can be built that does not preserve the integrity of the landfill's environmental protection features and allow for the rigorous maintenance regime required to protect public health. A range of other criteria, including enhancement of natural resources; park experience; and safety of motorists, cyclists and pedestrians; will also be weighed to choose the best alternative.

The principles and criteria that have guided design work, and that will guide decision making, are outlined in this section of the report. The consultant team's assessment of each segment of the three alternative roadways according to the major criteria is presented in section 4, and summarized in section 5. Together with traffic analysis and order of magnitude cost comparisons (summarized in section 5), these criteria will be determining factors in the City's selection of the preferred alternative.

2.1 Park and Environmental Goals for Roadways

Roads at Fresh Kills Park should be designed to provide access to park features, as well as to enhance the natural setting. In the spirit of U.S. National Parks and Scenic Byways, Fresh Kills Park roads are designed to be an integral feature of the park experience – an attraction in and of themselves. Distinctive materials and a broad landscape corridor should differentiate park drives from standard city streets and cue motorists that they have entered into the park. Sensitive siting within the topography and a graceful layout will enable drivers to appreciate the scenic views and the topographic variability. The establishment of a wide planted corridor will integrate the roads into the landscape, preserve the dramatic scale of the site, and ensure that the park is a calm refuge. Fresh Kills Park roads should also offer the opportunity to enhance the ecological quality of the site.

The Fresh Kills Park circulation system is also expected to create a new critical east-west traffic relief link between Richmond Avenue and the West Shore Expressway (WSE) without dominating the park. Roads should maximize connectivity with minimal infrastructure. The road design and materials should also be as sustainable as possible and the latest technologies should be incorporated to use sustainable materials, manage stormwater, minimize ecological impact and provide a safe, durable road.

To the extent possible, Fresh Kills roads should meet the following goals:

- Provide access to park features.
- Place roads above flood level and the wetland buffer wherever possible. Avoid negative impact on wetlands, mature trees, and other ecological resources.
- Provide scenic views of park natural features while limiting the visual and physical intrusion of the road in the landscape.
- Create an extensive system of healthy wetland systems that more than compensate for any impacts on existing wetland.
- Design a landscape corridor as a robust habitat and stormwater treatment system.
- Incorporate grade separations wherever possible and buffer pedestrian paths and bikeways with native plantings integrated with the stormwater management design.
- Enhance the movement experience with curvilinear layouts, graceful ascents and descents, and smooth passage through the park.
- Create a consistent, legible system – in terms of geometries, widths, materials, edging, lighting, signage and markings – that identifies the road as a park feature.
- Provide an orienting devise and visual cues for wayfinding.
- Improve traffic flow and reduce potential for pollution from start-stop activity.
- Coordinate the installation of landscape corridors with road segments construction schedule to eliminate adverse habitat effects.
- Use sustainable and durable materials.

As the design of the Fresh Kills Park drives considers engineering constraints, it must also embrace ecological, sustainability and aesthetic goals.

2.2 Road Design Criteria

Project specific road standards are developed for the particular context in which the project will operate, while adhering and exceeding established safety standards. Consequently, separate design criteria are presented for the WSE Service Roads and Ramps, the proposed Park Roads, and affected Landfill Service Roads, as follows.

- **West Shore Expressway Service Roads and Ramps**

Design Speed	45 mph
Lane Width – Service Roads	2@ 12'
Lane Width – Ramps	15'
Shoulder Width – Service Roads	4' left, 10' right
Shoulder Width – Ramps	3.5' left, 6.5' right
Grade	6.0% maximum, 0.5% minimum
Horizontal Curvature	711' minimum radius (e = 4%)
Superelevation	4% maximum
Stopping Sight Distance	360' minimum (horizontal and vertical)
Lateral Clearance	1'-6" minimum
Vertical Clearance	14'-6" minimum
Travel Lane Cross Slope	1.5% minimum, 2.0% maximum
Rollover	4% maximum between travel lanes 8% maximum at edge of travel way
Control of Access	Maintain full access control to the West Shore Expressway

The WSE service roads and ramps are being designed in accordance with the AASHTO Policy on Geometric Design of Highways and Streets, 2004 version (Green Book) with regard to spacing, and the 2006 edition of New York State Department of Transportation's (NYSDOT) Highway Design Manual (HDM) with regard to geometry. The ramp terminals are the tapered type shown in Figures 6M through 6N of the NYSDOT 2006 HDM.

The typical sections are shown on Figure TS-1. Side slopes of 1 on 4 or flatter are adopted wherever possible, increasing to no steeper than 1 on 2 where necessary due to high embankments or local constraints.

- Park Roads

Design Speed	35 mph
Lane Width	11’ for four-lane one lane operation 12’ minimum for two-lane operation, provide for bypass
Shoulder Width	2’ minimum, 6’ desirable
Median width	0’ minimum, 4’ desirable
Bridge Roadway Width	Same as approach roadway on new bridges Reduced median and shoulders on existing bridges
Grade	8.0% maximum, 0.5% minimum
Horizontal Curvature	371’ minimum radius (e = 4%)
Superelevation	4% maximum
Stopping Sight Distance	250’ minimum (horizontal and vertical)
Lateral Clearance	1’-6” minimum
Vertical Clearance	14’-6” minimum
Travel Lane Cross Slope	1.5% minimum, 2.0% maximum
Rollover	4% maximum between travel lanes 8% maximum at edge of travel way

The typical sections for the four-lane and two-lane roads are shown on Figure TS-1. The four-lane section includes 11 foot lanes, a flush four foot textured median, and 6 foot shoulders which may also be textured. The two-lane section includes 12 foot lanes, a four foot textured median, and six foot shoulders. The combination of median, lane and shoulder widths on the two-lane road allows for bypassing of a stalled vehicles, such that a single stopped vehicle does not block an entire direction of travel. The shoulders will also contribute to improved sight distance along the inside of curved roadway segments and help keep the roadside clear of hazards. Along the confluence loop, the median and shoulders are narrowed to fit in the constrained width of the existing haul bridges and the passages beneath the West Shore Expressway, as shown on the plans.

The pavement structure has not been designed, but is expected to include of flexible asphaltic surface, binder and base layers over a granular subbase course, founded on a suitably prepared subgrade. Based on the historic placement of unclassified fill throughout the site and placement of municipal solid waste within the delineated landfill boundaries, subgrade preparation may include foundation improvement techniques such as, surcharge fill placement, undercutting, and use of geosynthetic reinforcing materials. Side slopes of 1 on 4 are provided wherever possible; however, site conditions necessitate fairly extensive use of 1 on 3 (33%) slopes to minimize intrusion into wetlands and the landfill. Slopes of 1 on 2 may be eventually be introduced in combination with guide rail where they would result in significant impact reductions. Swales and ditches will be incorporated to prevent landfill and other site runoff from encroaching on the roadway pavement.

2.3 Landfill Criteria for Roads

The New York State Subpart 360 Landfill Regulations do not contain either design criteria or a required methodology for design of roadways over landfills. Nonetheless, it is the design team’s understanding that the design of the Fresh Kills Park roads cannot compromise the function or integrity of the existing landfill environmental protection systems and the design must maintain the level of protection provided under existing permit and permit equivalent requirements for the landfill.

Consequently, the final design will include a plan for the systematic monitoring of construction activities, to document that construction is consistent with the design, and a plan for post-construction monitoring to document the long-term integrity of the landfill environmental protection systems that may be influenced by the presence of the roadway. Investigations, including field demonstrations and measurements to verify the validity of the design concepts and material parameters that will be used, will be recommended as part of the design process.

The design team understands that to meet the performance standard described, the road design permit application documents must suitably demonstrate the ability of the design to maintain the integrity of the landfill environmental protection systems. The most critical issues to be addressed are:

- The cut-off wall and leachate collection trench, which contain and collect leachate (i.e., water that has come in contact with waste), must not be damaged and their function must not be compromised.
- The continuity of the geosynthetic landfill cap and natural soil liner, which control infiltration of rainwater into the waste mass from above and exfiltration of leachate through the base of the landfill, must be maintained to prevent generation of additional leachate or release of leachate into the creeks, basins or groundwater.
- The stability of the landfill and the stability of the roadway embankments that will be constructed on the landfill cover system must be evaluated and assured.
- Landfill infrastructure such as landfill gas header or lateral collection pipes, which may settle due to surcharge fill placement will need to be monitored (and, if needed, repaired) during and following surcharge to insure integrity of the system. .
- Settlement of the roadway due to municipal solid waste decomposition must be analyzed and the roadways must be designed to accommodate future settlement of the waste.
- The dynamic loading of the landfill by vehicles traveling on the roadway must be considered in the design analyses.
- A specific plan for monitoring the landfill environmental protection features following construction must be prepared.
- Portions of active landfill service roads, if any, that need to be modified, relocated, or reconstructed to accommodate Park roads will be designed to be continuous and consistent with the adjoining undisturbed segments and to be satisfactory to the New York City Department of Sanitation (DSNY) and New York State Department of Environmental Conservation (NYSDEC).
- In areas where final landfill closure has not been completed, such as the east mound (Section 6/7), the road alignment and vertical profile design will be prepared in relationship to the proposed final cover design grades.

The Fresh Kills Park road design permit application documents will be supported by reports and analyses presented in a manner similar to that required for a landfill permit application (i.e., New York State Regulations, Subpart 360-2.3). These supporting materials are anticipated to include the following documents.

- A Geotechnical Investigation Report, to establish the basis of geotechnical parameters used for road foundation design and analysis.
- A Report of Field Demonstration of Pile and Natural Soil Liner Compatibility, to demonstrate that penetration of the landfill natural soil liner by piles will not decrease the effectiveness of the natural soil liner in containing leachate.
- An Engineering Design Report, to present engineering analyses that demonstrate conformance with the requirements of applicable permit and permit equivalent documents.
- A Construction Quality Assurance Plan, to describe systematic procedures for monitoring and documentation that will be performed during construction of the roadway features.
- An Operations and Maintenance Plan to establish systematic procedures for the post-construction monitoring of the roadway and landfill environmental protection systems, which is consistent with the operations currently performed as part of the on-going post-closure care and maintenance of the site.

3 Other Criteria for Selection of the Preferred Alternative

Traffic analysis and order of magnitude cost estimates for each of the three roadway alternatives will also be determining factors in the selection of the preferred alternative. A comprehensive traffic analysis that evaluates the impact of the roadway alternatives on traffic patterns is being prepared as part of the Generic Environmental Impact Statement. The findings of this analysis are summarized in this section of the report.

A preliminary order of magnitude cost comparison is also summarized in this section. Predictably, two-lane roadways are more expensive than two-lane roadways. The estimate of the marginal cost of additional lanes will be used by policymakers to evaluate other trade-offs among criteria. Development of more precise cost estimates may be required if policy makers find, after reviewing the roadway alternatives against all criteria, that cost might be a decisive factor.

3.1 Traffic Analysis

Traffic congestion is one of the major challenges affecting Staten Island today, and is therefore one of the most important criteria to consider in the decision on the number of lanes for park roadways. It is critical to build a road system that can handle the traffic volumes projected to enter and traverse the park. It is a goal to alleviate congestion in the road network outside of the park as well.

As part of the Fresh Kills Park Generic Environmental Impact Statement (GEIS) analysis, a Traffic Impact Study has been conducted (concurrently with the development of the road alternatives) to assess the potential traffic impacts from the proposed project on the study area intersections and the surrounding road network. The environmental review process requires that the model use conservative traffic assumptions that tend to overestimate future traffic, particularly given the long-term schedule associated with the project. The assumptions used in this study have been coordinated with the New York City Department of Transportation and other interested agencies.

Approximately seven miles of new park roadways will be constructed. For practical reasons, these roadways will be constructed in phases. The Forest Hill Road Extension, South Loop, East Loop, North Loop, and West Shore Expressway access improvements are assumed to be completed by 2016 and the Richmond Hill Road Extension to be added by 2036. Future traffic conditions were therefore analyzed for each of these two construction phases.

In addition, traffic was analyzed according to three scenarios:

1. Baseline existing conditions (2007). Based on data collected in May and July 2007.

2. Future Without the Proposed Project (No-Build). These are the baseline conditions that are modified to incorporate background growth at 2% per year from 2007 through 2016, then 1% per year from 2017 to 2036 and other projects and various roadway improvements that are expected to occur in the study area independent of the proposed project.

3. Future with the Proposed Project (Build). This analysis examines conditions when park trip generation rates are layered onto the No-Build conditions described above. This analysis is performed to analyze the incremental impacts of the proposed park.

In total, 30 intersections abutting the project area and along principal arterials were selected for analysis.

A general description of the methodology and a brief synopsis of the findings are presented below. For a full explanation of the Traffic Impact Study's methodology and findings, please consult the draft Traffic and Parking Chapter of the Preliminary Draft Generic Environmental Impact Statement.

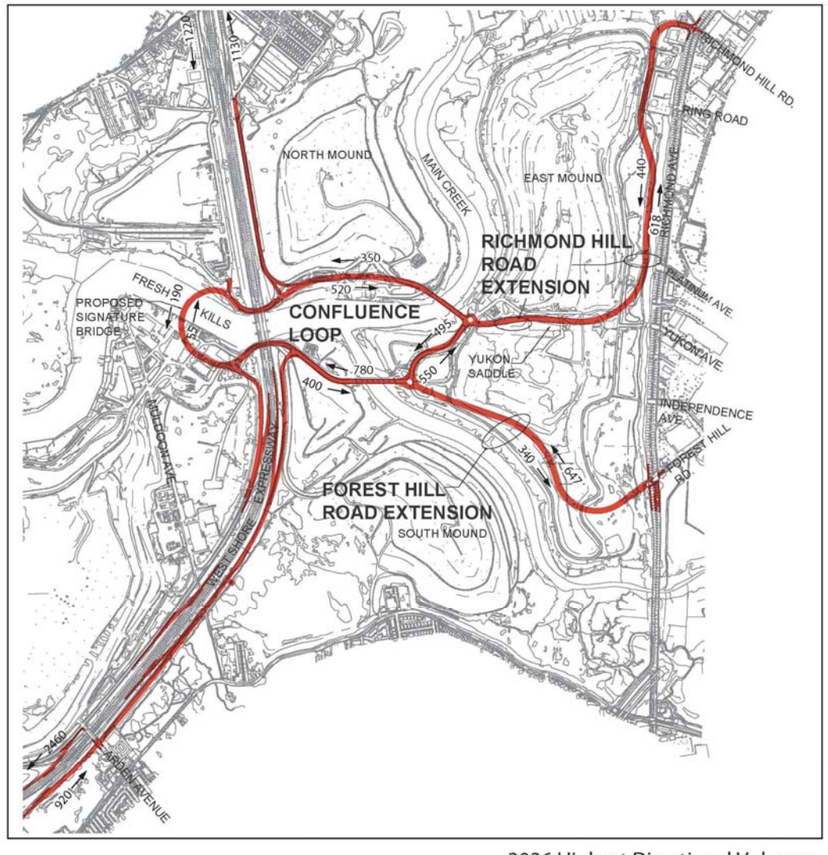
3.1.1 Existing Conditions

Existing study area traffic volumes for the weekday and weekend conditions were collected in May 2007 and supplemented by a summer data collection program in July 2007. Data were collected during the weekday (peak hours in the AM, midday, and PM) and Saturday (peak hours in the midday and PM).

Traffic congestion is prevalent at major intersections in the study area. In general, most intersections experience congested conditions in most hours studied. Richmond Avenue and other large arterials carry high traffic volumes (more than 6,000 vehicles per hour in both directions) during the weekday and weekend.

3.1.2 Future Without the Proposed Project

Current traffic conditions are very poor in Staten Island, and the traffic analysis predicts they will worsen in the future without the proposed park and roads (the No-Build Scenario). The Levels of Service (LOS) at many major intersections in the study area are unsatisfactory in the future without the park.



2036 Highest Directional Volumes

Figure R-2

3.1.3 Future With the Proposed Project

Based on the traffic levels expected on park roads, two-lane roads (one lane in each direction) are shown to be adequate to serve projected volumes within the park, as seen in Figure R-3. The newly created west legs at the major intersections on Richmond Avenue at Richmond Hill Road and Forest Hill Road would operate acceptably.

The traffic analysis shows that park drives will have little impact – positive or negative – on the functionality of the surrounding street network. The analysis suggests that park roads cannot solve Staten Island's traffic problem. The new direct connection provided between Richmond Avenue and the West Shore Expressway will alleviate congestion on Arthur Kill Road, the current major east-west connector, resulting in up to 360 fewer vehicles at the intersection of Arthur Kill Road and Woodrow Road during 5 peak analysis periods. In addition, at other intersections, such as Richmond Avenue at Yukon Avenue and Richmond Avenue at Drumgoole Road there will be approximately 450 fewer vehicles in the future weekend PM peak hour, as these vehicles would use the new park roads in the future conditions.

Some intersections (especially those in the close vicinity of Fresh Kills Landfill), however, will experience increased traffic levels due to traffic diversions and park generated traffic volumes. For example, the intersections of Richmond Avenue and Forest Hill Road and Richmond Avenue and Richmond Hill Road will experience a net increase in traffic volumes by up to 500 vph during the five analysis peak periods. These intersections would experience an overall deterioration in the traffic operating conditions.

More to the point of this report, the Traffic Study demonstrates that the number of lanes has no effect on projected traffic volumes. The travel demand projections were done based on a consideration of the size of the different components of the park. The trips, thus generated, were assigned to the roadway network based on prevailing origin and destination patterns in the study area. The diverted traffic calculations were based upon general guidelines from available traffic planning studies in the area and supplemented by pertinent assumptions, wherever necessary, as explained in greater detail in the Traffic and Parking chapter of Fresh Kills Park GEIS.

As outlined in the Highway Capacity Manual (HCM 2000), published by the Transportation Research Board, a two-lane road system has a capacity of 3200 vehicles per hour for both directions of travel combined. Based on the combination of traffic diversions and project generated trips, the levels of traffic activity anticipated on the new park roads could be accommodated by a two-lane road system.

Figure R-2 presents the highest projected 2036 volume for each direction at each leg, regardless of which analysis hour it occurs in. Since these maximums are generally not concurrent, adding the two directions together overstates the actual total bi-directional volumes in most cases. Nonetheless, even using these overstated totals, no single leg of the park road system takes up to even half of a two-lane road's capacity.

3.2 Cost

A cost estimate was performed based on the 90% Schematic Design drawing set, dated January 4, 2008. The estimate evaluates the cost of each road alternative (Four-Lane, Two-Lane, and Hybrid) by individual road segment (West Shore Expressway Corridor, FHR Extension, RHR Extension, East Loop, South Loop, and North Loop). The West Loop Signature Bridge was not analyzed because it is the longest-term feature of the park roadway network, the least well defined, and open to a broad range of potential treatments. (Wetland impacts for the West Loop were, however, included in order to fully understand the environmental implications of the environmental impact that the Signature Bridge causes.)

Costs are divided into five major categories: Preloading, Bridges & Viaducts, Standard Roadworks, Site Specific Roadworks, and Fire Department Water Lines. Because of their uniqueness and magnitude, costs associated with the landfill are accounted fro in two ways: under Preloading, to account for the measures needed to mitigate landfill settlement (primarily by inducing and accelerating settlement ahead of road construction, by placing a wider, taller, and heavier mound of material over the roadbed), and under the Site Specific portion of each estimate to allow for adjustments to landfill infrastructure. The cost of park-specific features, such as the landscape / stormwater corridor, were taken into account as well, and included as line-items in the Site Specific portion.

Unit costs were used for items such as leachate management, wetland mitigation, trees and planting. The amount of wetland mitigation acreage required was calculated based on the assumption of a 3 to 1 ratio of mitigation to impact. As stated in the introduction of this report, wetland impact was calculated based on two sources of information: Currently undefined, unregulated wetlands to the east of the East Mound and along the West Shore Expressway were delineated in a September 2007 field visit, using Army Corps of Engineers site investigation standards, but as yet not reviewed. The second source of information is the NYSDEC, which established the boundary of regulated tidal wetlands on site in 1978 and also subject to DEC review and change.

The estimate reflects construction costs based on regular working hours (without overtime). It excludes engineering and other soft costs. Escalation is assumed to be 5% per annum to the midpoint of construction, presumed as 2016. Refer to the cost estimate for further information about methodology and assumptions. Findings will be summarized in the Alternatives Evaluation section (Section 5) of this report.

4 Description of Alternatives

4.1 West Shore Expressway Corridor

The West Shore Expressway (WSE) is the primary regional access route. The project proposes changes and additions within the WSE corridor between Arthur Kill Road and Victory Boulevard to improve access to and from the proposed park. The proposed changes include new and extended service roads, additional ramps, and ramp relocations. The WSE through lanes would not be affected, with mainline modifications limited to those needed to accommodate new or adjusted entrance and exit ramp terminals. The proposed access modifications are the same under all three alternatives. Consequently, they are described separately from the remainder of the alternatives.

The West Shore Expressway Corridor improvements are shown on Figures WSE1 through WSE5 in the drawing set. The corresponding profiles are presented in Figures WSE-P1 and WSE-P2.

For clarity and ease of reference, the proposed northbound and southbound improvements are presented individually.

4.1.1 Northbound

The proposed improvements begin at Arthur Kill Road and include the addition of a new service road to Fresh Kills. New intersections would be created with Arden Avenue and the south leg of new Confluence Loop, referred to herein (and defined in section 4.2.1) as South Loop Road. The service road will be two-lane and operate one way, northbound.

A new exit ramp affords northbound WSE traffic direct access to the Park, both in proximity to the future South Park sports fields and the Confluence area. A new entrance ramp offers park visitors the means to efficiently reach the northbound WSE. The entrance ramp also provides an additional access point for local traffic and some relief to the entrance at Arthur Kill Road.

North of Fresh Kills, an existing DSNY egress road is replaced by a new two-lane one-way northbound service road constructed to current NYSDOT standards. The service road begins at the intersection with the north leg of Confluence Loop, referred to herein as North Loop Road, and match into the existing WSE northbound service road at Wild Avenue. The new service road provides access to North Park, Wild Avenue, Victory Boulevard, and to northbound WSE at an existing entrance ramp just beyond Victory Boulevard. It also continues to accommodate vehicles exiting DSNY facilities.

- ***Geometry.*** By paralleling the mainline, the proposed service roads generally provide large sweeping curves and ample tangents, both horizontally and vertically, that are well within the design criteria, as are the new ramps that link them. The only anticipated non-standard feature is at the approach to the South Loop Road intersection, where a smaller than standard radius of 349 ft provides a better angle of entry, and a slightly reduced design speed of ~34 mph is deemed acceptable given that the service road terminates at this location.

- ***Infrastructure.*** The proposed northbound service roads south of Fresh Kills introduces embankments that will interrupt some of the existing drainage patters. However, addition of the service road was foreseen in the original design, and the changes can be accommodated with common measures that guide the flows toward existing outlets. North of Fresh Kills, the proposed drainage adheres closely to the existing patterns except in the vicinity of Wild Avenue. There the new road will pass over an open ditch that runs from a closed system to the north into a culvert to the west. The project proposes to extend closed pipe system through the area served by the ditch.

  Electrical transmission lines run adjacent to the proposed service road for most of its length, both north and south of the Kills. A gas line runs beneath the service road north of the Kills. These facilities are not expected to impede the proposed project, but will have to be protected during construction.

- ***Landfill.*** The proposed service road borders landfill section 2/8 south of Fresh Kills, and landfill section 3/4 north of Fresh Kills. Both segments are predominately located within the NYSDOT right-of-way and entirely outside the respective landfill solid waste management unit boundaries. .

  South of Fresh Kills, the northbound service road runs parallel to an existing access road serving section 2/8, before intersecting with the access road at the intersection of the landfill access road with the proposed South Loop Road. A new connection between the northbound service road and the existing landfill access road will be provided at this location.

  The proposed service road will be partially located over of the existing landfill gas interceptor vent system located directly west of the landfill section 2/8. To maintain the function of the vent system, to minimize lateral subsurface migration of landfill gas away from DSNY property, the roadway foundation design will include construction of lateral venting layer keyed into the existing vent system trench. The lateral venting layer will consist of a permeable aggregate within a geotextile filter fabric. Perforated venting pipes that connect the existing vent trench to the surface will be located at 200-ft intervals. A typical section showing the proposed design to accommodate the landfill gas venting system is shown on Figure DT-1 in the drawing set. To supplement the collection and transmission capacity of the lateral vent layer system, additional vent trenches may also be installed parallel to the existing system.

  North of Fresh Kills, the reconstructed service road would be located in the bed of an existing landfill access service road. The proposed service road will include protected pullouts along the eastern side of the roadway to provide access to six existing groundwater monitoring wells and one leachate collection drain cleanout manhole.

- ***Environmental.*** South of Fresh Kills, construction of the service road immediately south of the proposed north bound entrance ramp onto the West Shore Expressway will require partial backfilling of drainage swale and wetland area. This portion of the WSE service road network will result in an impact to an unregulated freshwater stream and wetland system corresponding to approximately 0.21acres. Approximately 0.10 acres of these impacts are associated with five minor wetlands crossings, and 0.11 acres are impacts to a larger parallel roadway drainage system wetland. Most impacts were avoided by placing the new service road largely to the west of the existing wetland corridor.

  The realignment of the service road north of Fresh Kills Creek, immediately prior to the point where the service road leaves the DSNY property, will require backfilling of an unregulated drainage swale and wetland area west of the existing DSNY haul road. The associated freshwater wetland impact is approximately 0.02 acres. This realignment would, however, increase the buffer between road traffic and a high-value, maturing wet forest just east of the roadway.

  Impacts were avoided by utilizing the existing DSNY haul road alignment as much as possible, up to a point where its straightening was necessary to form a well-aligned intersection with Wild Avenue. In addition, the proposed straightening allows for the protection of a nearby existing higher-value forested wetland that lies east of the existing haul road.

  The stormwater flow carried within the drainage channel will be placed into a culvert to accommodate the design. Drainage from the new service road will require stormwater management facilities in compliance with NYSDEC SPDES requirements. Construction activities will require the development of an Erosion and Sediment Control Plan and a Stormwater Pollution Prevention Plan.

  The unavoidable wetland impacts to the stream system wetlands will be mitigated as a part of comprehensive wetland mitigation strategy for wetland creation and restoration that will maximize restored wetland functions and values to compensate for losses.

As with all sections of the road, efforts will be made during construction to preserve existing mature trees or valuable habitat, where found.

- ***Park.*** The proposed northbound service road provides direct ingress to South Park near Muldoon Avenue and access to all other park areas by way of its link to South Loop Road. By staying within the WSE Right-of-Way, the service road avoids intrusion into South Park habitat and program areas. The entrance near Muldoon Avenue will lead to a large parking area located along the WSE in the vicinity of the future sports fields. The road also provides egress from the park, with a direct link to the northbound WSE.

  North of Fresh Kills, the reconstructed service road provides egress from the park towards Wild Avenue, Victory Blvd. and the northbound WSE, and access to north park facilities near Wild Avenue.

  Except for the short segments at the approaches to the confluence loop, the service road and ramps lie outside proposed park land.

  These entrances to the 2,200 acre park are critical for park visitors from other parts of Staten Island and the region. They provide sufficient flow and legibility to service the planned event venues in the park. Service road improvements also make it possible for park circulation to function prior to (or without) the construction of the signature bridge.

4.1.2 Southbound

A southbound WSE service road is already in place north of Fresh Kills, and for most of the length between the Kills and Arthur Kill Road. It is two lanes wide and operates one-way, southbound.

North of Fresh Kills, the existing service road is presently only open to the public from Victory Boulevard to Wild Avenue, with the remainder running within DSNY property, under DSNY control, and limited to authorized vehicles. It serves the DSNY concrete and rubble crushing facility, the DSNY compost facility, and the DSNY Staten Island Waste Transfer Station. This section of the service road will continue to serve these facilities throughout park development and construction. However, to accommodate park development, the team proposes to open this entire length of service road to public use as a park entry road for visitors coming from the north. It connects with the proposed Confluence Loop at an intersection with both North Loop Road and West Loop Road, providing access to Creek Landing and the Point, and all other park destinations.

South of Fresh Kills, the park development project includes a new segment of service road that extends the existing service road northward from its current terminus at the existing southbound WSE exit ramp to a proposed new intersection with the proposed South Loop Road.

The existing exit ramp provides access to DSNY's District 3 Garage, the regional repair shop, and the main landfill site entrance at Muldoon Avenue. However, in the area where this ramp meets the service road the sight distance and merging geometry of the roadway are deficient, and when combined with an active service road extension as proposed at this location, would become unacceptable. Consequently, the reconstruction of the existing exist ramp, at a position immediately north of its current location is proposed.

A new entrance ramp on to WSE is proposed south of Arden Avenue. A new entrance ramp at this location offers park visitors an efficient means to reach the southbound WSE. The proposed configuration also allows use of Arden Avenue as an additional WSE access point for local traffic and provide some relief to the southbound entrance at Arthur Kill Road. To make room for the new entrance, the existing exit ramp to Arthur Kill Road is relocated to a position north of Arden Avenue.

- ***Geometry.*** The proposed service road extension and existing road generally provide sweeping curves and ample tangents, both horizontally and vertically, that are within the design criteria. One exception, located at the north end of the service road, is the short segment of roadway immediately south of Wild Avenue, where the service road makes an abrupt "S" curve. This abrupt transition is located at the entrance to DSNY property, where the existing road transitions from a WSE service road within the expressway right-of-way, to a DSNY access road. The current design retains this alignment as a traffic calming feature.

  Another exception is anticipated at the intersection of the service road with South Loop Road, where a design that uses a smaller than standard radius (250 ft) that allows the alignment to avoid encroaching into landfill section 1/9 and minimize encroachment into drainage basin K1.

- ***Infrastructure.*** The proposed southbound service road extension just south of the Kills alters the topography and interrupts some existing drainage. The project will continue the pattern of combined closed and open systems in use on the existing service road. The systems eventually outlet to the east of the expressway.

  Electrical transmission and a gas main run beneath the proposed service road extension. These facilities will have to be protected during construction. The gas line may have shallow cover and may influence the profile of the new ramps. If too shallow, portions of the gas main may need to be lowered in order to achieve ramp profiles that meet vertical sight distance design criteria.

- ***Landfill.*** The service road extension borders landfill section 1/9. However, it is located inside the NYSDOT right-of-way for most of its length and entirely outside the landfill access road and landfill solid waste management unit boundary. The roadway foundation parallels the existing landfill cover system, located coincident with the solid waste management unit boundary. The maximum embankment fill thickness to be placed in this area is 4 ft. The proposed offset between the service road and cutoff wall is consistent with the general offset distances that currently exist between the cutoff wall and existing portion of the southbound service road. The design avoids hydraulic monitoring wells and groundwater monitoring wells located along the eastern side of landfill Section 1/9. The proposed service road partially covers an existing segment of landfill gas interceptor venting trench that is located along the alignment. Engineering controls to maintain the effectiveness of the landfill gas interceptor venting trench will be the same as those proposed for services roads associated with the northbound the service road.

- ***Environmental.*** The Southbound service road and associated ramps do not appear to directly impact any wetlands. No jurisdictional wetlands are in the area. Before construction, it is recommended that preliminary field-based wetland delineation be performed for the project to confirm no impact.

- ***Park.*** Conversion of the north segment to joint DSNY and public use provides access to the park for visitors coming from the north along the WSE. Extension of the south segment provides southbound visitors efficient means of exiting the park. The proposed ramps facilitate both park ingress and egress for visitors from other parts of the island and the region. Except for the short segment at the departure from South Loop Road, the service road and ramps lie outside proposed park land. They provide sufficient flow and legibility to service the planned event venues in the park, and make it possible for park circulation to function prior to (or without) the construction of the signature bridge.

4.1.3 Traffic Operations

As indicated on Figure R-3, the northbound service road is projected to carry traffic volumes up to approximately 920 vehicles per hour (vph) south of Fresh Kills in 2036. The new exit ramp is expected to carry approximately 450 vph and the new entrance ramp is expected to carry approximately 460 vph. The southbound service road is projected to carry traffic volumes up to approximately 2150 vph.

The traffic operating conditions at the WSE service road as well as the mainline WSE are to be evaluated using CORSIM simulation as part of the Fresh Kills Park DGEIS analysis. That work is not yet complete.

4.1.4 Cost

The cost of the West Shore Expressway access improvements is estimated as $58 Million (in 2016 dollars). Given that the proposed changes are the same under all alternatives under consideration, this cost is to be added to the cost of each road alternative within the park to arrive at the total estimated cost of the park's primary road network.

4.2 Four-Lane Alternative

The Four-Lane Alternative proposes to construct four-lane roadways along the entire primary road system, including the whole Confluence Loop, the Forest Hill Road Extension and the Richmond Hill Road Extension. The West Shore Expressway corridor improvements would be as described in section 4.1.

The typical four-lane park road section consists of two 11' travel lanes in each direction, separated by a 4' wide flush textured median, supplemented by 6' wide flush outside shoulders, and bordered by landscaped roadsides that include drainage swales. The typical section is shown on Figure TS-1.

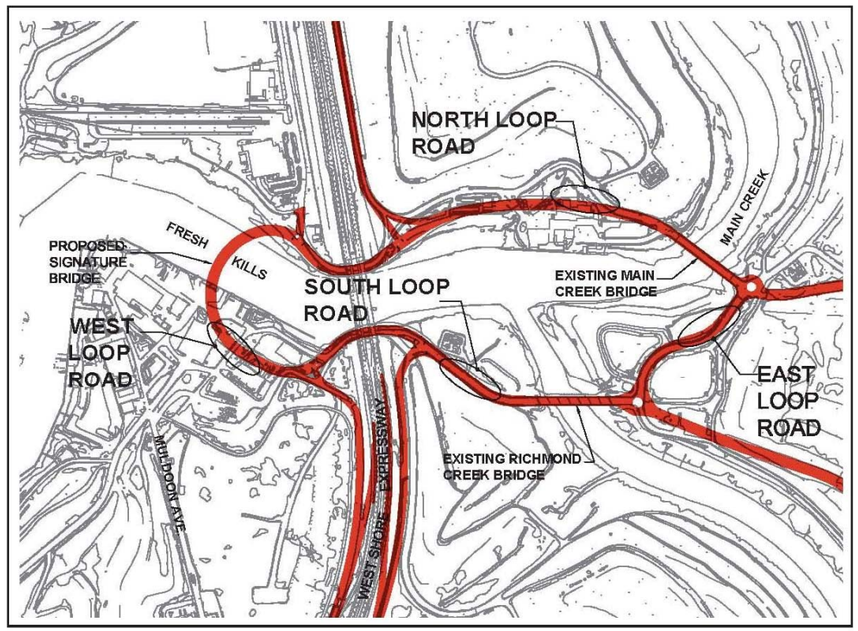
4.2.1 Confluence Loop

The proposed confluence loop drive is the primary hub and vehicular circulation organizing element within the park. It links the entire system, providing the means to cross from North Park to South Park, from East Park to West Park, from Richmond Avenue to the West Shore Expressway. The proposed configuration is dictated by both natural and manmade conditions. The Confluence Loop is shown on Figures L1-2036-4 and L2-2036-4 in the report's drawing set. For clarity and ease of reference, its component legs are discussed in individually.

South Loop Road

South Loop Road generally parallesl the south shore of Fresh Kills, beginning at its intersection with the proposed southbound service road extension, and ending at the intersection with East Loop Road, where it also abuts the Forest Hill Road Extension. It occupies the bed of an existing DSNY access and haul road for its entire length, crossing beneath existing bridges that carry the WSE mainline over Fresh Kills, passing between landfill section 2/8 and its flare station, and across an existing haul bridge over Richmond Creek. The roadway, slightly more than ½ mile long, would be reconstructed to park road design standards, and the bridge converted for park use, as discussed in the Bridge Alternatives Report and shown in Figures RC-1and RC-3.

- ***Geometry.*** The proposed South Loop Road winds its way through the site with a curvilinear alignment that meets park road design criteria. As it passes beneath the WSE bridges and across the Richmond Creek Bridge, the typical cross section is narrowed by eliminating the 4' median and by reducing the 6' shoulders to 2' on each side. This will allow the four lanes to fit alongside a pedestrian path underneath the WSE, and within the existing footprint of the Richmond Creek Bridge. The four-lane roadway occupies the entire width of the Richmond Creek Bridge, requiring that the pedestrian path be taken across the Creek on a new, separate bridge. Potential treatments at the bridges are discussed in greater detail in the Bridge Alternatives Report. The South Loop Road profile is presented on Figure SL-2036-4P1 in the drawings set.
- ***Infrastructure.*** It does not appear that the proposed roadway affects submarine electrical cables and a gas line that cross Fresh Kills in the vicinity of the WSE.



Confluence Loop

Figure R-3

- ***Landfill.*** The existing DSNY haul road is fenced on both sides as it passes between landfill section 2/8 and the flare station and reaches Richmond Creek. In tracing the same path, the proposed four-lane roadway generally fits within the current fence lines. The proposed road is placed at a slightly higher elevation than existing to take better advantage of the existing roadside drainage system.

  The proposed road passes over several landfill utilities that lay below the existing roadbed, including a water line, a leachate force main, a landfill gas transmission line and electrical lines that are each expected to remain active. Manhole and valves covers and related hardware are to be raised to be flush with the new surface. At the existing location of the Section 2/8 landfill gas flare station, an entrance/exit point form South Loop Road is to be provided.

  The landfill gas main and its electrical line rise out of the ground and are carried across Richmond Creek respectively along the north fascia of the haul bridge, and the leachate main along the south fascia.

  The four-lane roadway alignment projects into Fresh Kills as it passes under the WSE. Consequently, the outfall from landfill stormwater management basin K1 needs to be extended to the new shoreline.
- ***Environmental.*** The four-lane South Loop Road intrudes into the tidal waters of Fresh Kills Creek in the area under the WSE bridges. This area is steep-sided and the water is both deep and shaded; the area is therefore of relatively lower habitat value, and impacts could be offset elsewhere. Some impacts have been avoided by reducing the width of the roadway in this area,

as described in the *Geometry* section. The alignment's impact is a relatively short segment of approximately 550 linear feet along the shoreline under the WSE, projecting into Fresh Kills Creek approximately 39 feet out from the existing shoreline. This results in approximately 0.37 acres of DEC-regulated tidal open water impacts, which will be mitigated by tidal wetland restoration elsewhere on site.

As discussed in detail in the bridge report, a four-lane road necessitates the construction of a new pedestrian and cycle bridge parallel to the existing Richmond Creek Bridge. This non-vehicular bridge is 18ft wide and approximately 725ft long, as seen in Figure RC-3. Its construction results in an impact of approximately 0.38 acres. The total impact for the South Loop is therefore approximately 0.75 acres. The loss and shading of open water cannot be recouped.

- ***Park.*** The loop drive is the primary hub and organizing element for circulation within the park. South Loop Road will provide direct access to the Terrace and the Point. Public transportation will also be concentrated in the loop.

  Due to space constraints, bikeways run adjacent to roadways in the loop and separation for the motorized and non-motorized systems must be carefully designed. Parking areas are concentrated in the Point and Creek Landing both to service programming and to serve as point of interchange between cars and non-motorized movement through the park on foot, by bike and by boat.

  Wider roadways impinge on design options for creating safe passage and a good park experience for pedestrians and cyclists. The width of the four-lane road causes it to intrude into what would otherwise be the waterfront activity and habitat area of the Terrace, and it crowds bikeways. The four-lane roadway is significantly more difficult for pedestrians and cyclists to cross safely away from signals. The cost of creating a pedestrian and bicycle bridge over the creek is significant and therefore presents an opportunity cost for the park.

West Loop Road

West Loop Road extends from the intersection between the proposed southbound service road extension and South Loop Road, across Fresh Kills, to the intersection of the southbound service road with North Loop Road. It would advance the regional goal of improving the continuity of the WSE service roads. It is approximately 0.4 miles long.

The Fresh Kills crossing, the prime component of West Loop Road, is programmed in the Draft Master Plan as an appealing iconic element featuring a Signature Bridge, intended to bring added attention to The Point and the whole of the park. Many opportunities will be explored for fulfilling the iconic goals. Three initial possibilities are presented in the conceptual Bridge Alternatives Report, one of which is included in this report, as Figure SB-5.

- ***Geometry.*** The proposed road is curved nearly throughout, featuring a 525' radius across Fresh Kills, except at the north end where it reduces to 315'. The latter non-standard curve is necessitated by the constrained space and short distance to the WSE underpass. Vertically, the bridge rises at 3.5% on from the south and 4.7% from the north to provide at least 30' of vertical clearance to over the Fresh Kills navigation channel. The entire West Loop Road profile is shown on Figure WEL-2036-4P1.

  West Loop Road meets the southbound park entrance road with a skewed intersection.

- ***Infrastructure.*** It does not appear that the proposed roadway affects submarine electrical cables and a gas line that cross Fresh Kills in the vicinity of the WSE.

- ***Landfill.*** South of Fresh Kills, the West Loop Road traverses land presently occupied by DSNY landfill management and maintenance facilities. However those facilities are scheduled for future abandonment and are not expected to conflict with the park's implementation. In the same area, the alignment passes over a water line, a landfill gas transmission main, and an underground electrical line. No special protection of the utility crossings is envisioned at this location. Along the West Loop road an access point to landfill Section 1/9 services roads and Basin K1 will be provided.

- ***Environmental.*** Construction of the proposed Signature Bridge will impact a significant area of DEC-regulated tidal open water and a limited area of DEC-regulated tidal wetlands. The Signature Bridge impacts approximately 1.69 acres, 1.57 acres of which is open water way and 0.12 acres of which is tidal wetlands, including fill impacts for embankments and pier support structures, as well as ancillary impacts include the shading of tidal waters by bridge shadows. Impacts have been avoided by designing a bridge that would stay out of the water as much as possible. A bridge carrying the standard four-lane roadway section and a 15' pedestrian and bike path would be 75' to 80'wide, as shown in Figure SB-5. Mitigation for the loss of tidal wetland could be provided elsewhere in the park, but open water can not be recouped.

- ***Park.*** West Loop Road and Signature Bridge are intended to serve as an iconic marker, a recognizable access point for the largest concentration of destination programs in Fresh Kills Park, a source of unique vistas and new relationships to the water, and an architectural feature to be explored. A number of striking contemporary pedestrian and vehicular bridges, like those designed by Santiago Calatrava, Wilkinson Eyre Architects, Ove Arup and others in cities around the world but particularly in Europe, demonstrate the potential of a bridge to activate and reconnect people to water bodies. If the signature bridge is to have these effects, the design of the non-motorized portion of the bridge is particularly important.

  One of the interesting aspects of the Fresh Kills site is the way the creek fork and expressway establish four distinct sectors of the park. Existing bridges, retrofitted to serve park needs, can accommodate basic needs for access, but a purpose-built feature bridge would enhance park identity and offer a gateway and hinge between sectors. While the park circulation system is designed to function without the signature bridge, the bridge supports the full build-out of Point attractions and improves circulation, particularly for pedestrians.

North Loop Road

North Loop Road would generally parallel the north shore of Fresh Kills and extend from its intersection with the existing DSNY service road, where it would also abut West Loop Road, to its intersection with East Loop Road, where it would also abut the Richmond Hill Road Extension. It utilizes the bed of an existing DSNY access and haul road beneath the WSE and across the Main Creek Bridge but veers off in between, to form crescent that will host Creek Landing. It is approximately ¾ miles long. The existing haul bridge will be converted for park use, as discussed in the Bridge Alternatives Report and shown in Figures MC-1and MC-3.

- ***Geometry***. The constrained space along the shoreline and the need to minimize intrusion into Fresh Kills result in the use of a 300' radius rather than the standard 371' as North Loop Road passes beneath the WSE bridges. As with South Loop Road, under the WSE and across the Main Creek Bridge, the typical cross section is narrowed by eliminating the 4' median and by reducing the 6' shoulders to 2' on each side, to allow the four lanes to fit alongside a pedestrian path underneath the WSE, and within the existing footprint of the Main Creek Bridge. The four-lane roadway occupies the entire width of the Main Creek Bridge, requiring that the pedestrian path be taken across the Creek on a new, separate bridge, as discussed in the Bridge Alternatives Report. The North Loop Road profile is shown on Figure NL-2036-4P1.

- ***Infrastructure.*** It does not appear that the proposed roadway affects submarine electrical cables and a gas line that cross Fresh Kills west of the WSE. However, the road sits over a multi-opening chamber that houses submarine electrical cables to the east of the WSE. In the same area, a drainage outfall serving the WSE needs to be extended or replaced.

- ***Landfill.*** The proposed alignment passes close to but is designed to avoid intruding into landfill section 3/4 and affecting its completed closure system. However, the alignment is proposed to traverse landfill stormwater management basins Q and F, essentially vacating the former, and reducing the storage volume of the latter. To maintain the functionality of the stormwater management control system, Basin Q could be reconstructed in a location north and east of its current position, without encroaching into the existing landfill gas condensate tank located near the eastern edge of the basin. The outfall location of the new basin would likely be relocated from the current position. The revised basin will be designed to meet landfill regulations for stormwater management control. At stormwater management Basin F, the storage capacity and control function of the basin will be analyzed to determine if modification to the basin is necessary to accommodate the storage volume displaced by North Loop Road. Should analysis suggest that additional capacity is required, the existing basin could be expanded towards the north.

  At the location of Basin Q and Basin F an entrance/exit point to the North Loop Road is to be provided to accommodate landfill post-closure operation and maintenance activities. Access to the Section 3/4 landfill gas flare station is to be provided from the existing landfill service road located along the south of the Section 3/4. This section of service road is not encroached upon by the North Loop Road alignment.

  North Loop Road also traverses land presently occupied by DSNY landfill construction and maintenance facilities. However those facilities are scheduled for abandonment upon completion of east mound landfill closure (approximately 2011) and are not expected to conflict with the creation of Creek Landing and North Park.

- ***Environmental.*** With regard to impact on landfill stormwater basins, the basins impacted are rip rap lined and most often dry and therefore do not currently provide substantial habitat.

  The Creek Landing area is bulk-headed and paved and industrial in character, but a thin neck of mapped tidal wetland extends into the area. The four-lane North Loop Road crosses this narrow corridor of mapped wetland. Approximately 0.05 acres of wetland is impacted by the crossing.

  The North Loop also intrudes into the creek in the area under the WSE bridges. Under the WSE, the North Loop alignment impacts Fresh Kills Creek for a short segment of approximately 430 linear feet, projecting approximately 27 feet out from the existing shoreline corresponding to approximately 0.20 acres of tidal waterway impacts, of which 0.06 acres are DEC-regulated tidal wetlands and 0.14 acres are DEC-regulated tidal open water. This area is steep-sided and the water is both deep and shaded, so impacts could be offset elsewhere. Tidal wetland impacts will be mitigated by tidal wetland restoration on site. The North Loop road does not directly impact any freshwater wetlands identified as potentially being jurisdictional in the research and delineation efforts performed to date.

  As discussed in detail in the bridge report, a four-lane road necessitates the construction of a new pedestrian and bicycle bridge parallel to the existing Main Creek Bridge. This pedestrian bridge is 18ft wide and approximately 650ft long, as seen in Figure MC-3. Its construction would result in an impact of 0.32 acres of DEC-regulated tidal waters. The loss and shading of open water cannot be recouped.

  The total impact caused by the North Loop is approximately 0.56 acres.

- ***Park.*** North Loop Road will provide direct access to Creek Landing and its concentration of waterfront and cultural activities, as well as the North Park path system***.*** The roadway segment is critical to provide access not only to the Confluence but to the almost entirely non-motorized North Park. The width of the four-lane road is not optimal from a park standpoint, because it intrudes into what would otherwise be the waterfront activity area of the Creek Landing, and crowds out bikeways. The four-lane roadway is significantly more difficult for pedestrians and cyclists to cross safely away from signals. The cost of creating a pedestrian and bicycle bridge over the creek is significant and therefore presents an opportunity cost for the park.

East Loop Road

East Loop Road completes the confluence ring road system, and provides essential linkages among the Forest Hill Road Extension, the Richmond Hill Road Extension, and the remainder of the Confluence Loop. It begins at the intersection with South Loop Road and the Forest Hill Road Extension, and terminates at the intersection with North Loop Road and the Richmond Hill Road Extension. The road is approximately ¼ mile long. In consideration of its essential role and the importance of the achieving satisfactory performance at its intersections, two separate options have been developed for East Loop Road:

Option 1 introduces a split signalized intersection at the south end in the form of a circle that results in separate two-lane northbound and southbound roadways.

Option 2 features roundabouts at both intersections and a four-lane roadway aligned with the bed of an existing landfill haul road between Basins C1 and C2, and generally avoids encroaching upon the landfill Section 6/7 solid waste management unit boundary.

In each Option, the southern portion of the East Loop Road at the connection with South Loop Road with the Forest Hill Road Extension is aligned to pass south and clear of the leachate management system pumping station located south of Basin C2. This critical landfill management system element pumps leachate collected from leachate collection drains located around landfill Section 3/4, Section 2/8 and Section 6/7 to the Fresh Kills Landfill Leachate Treatment Plant, located at the southern tip of the landfill Section 1/9, more than 2 miles away.

Each option requires construction of multiple access points to landfill infrastructure located along the East Loop Road. Specific facilities that will have access provided include: (i) Basin C1; (ii) a combined entrance to Basin C2 and the leachate collection system pumping station; and (iii) access to southern perimeter landfill service road.

Option 1 is shown on Figure L2-2036-4.1, and Option 2 on Figure L2-2036-4.2. A profile based on Option 1 appears on Figure WEL-2036-4P1. The profile for Option 2 would be expected to be similar.

- ***Geometry.***

  Option 1. The northbound and southbound roadways form a circular semi-symmetrical pair around Basin C2 and its upstream channel, that create a distinctive, readily identifiable center for the roadway network, to help orient and guide visitors the various park venues. To achieve a good fit, a smaller than standard radius of 275’ is proposed for the curved road segments around basin C2. The split configuration results in a split signalized intersection shaped to adhere to the overall geometric concept theme and to facilitate unopposed right turn movements. The circular effect is completed by a turnaround at the north end of Basin C2. At the north end of the leg, a different application of the concept results in a compact signalized intersection. Left turn bays are proposed from eastbound to northbound at the south intersection, and from westbound to southbound at the north intersection, to avoid disruption to through traffic.

  Option 2. The proposed alignment avoids east mound landfill infrastructure by following an existing path to the west of Basin C2. It is made to meet minimum curvature by veering as necessary off the existing DSNY roadbed. The intersections are served by modern roundabouts. The extensive infrastructure and constrained space require that compact roundabouts be adopted, with diameters in the lower range for four lane operation. The north roundabout is particularly constrained, and forced further north that the desirable location by the presence of massive outfall system leading to Basin C2. Due to the nature of roundabouts, no auxiliary bays are necessary on any of the approach roadways.

- ***Infrastructure.*** There are no known infrastructure elements unrelated to the landfill in the vicinity of East Loop Road Option 1 or Option 2.
- ***Landfill.***

  Option 1. The west leg occupies the bed of an existing DSNY haul road, under which a landfill gas transmission main and its associated electrical line are buried. In general, the manhole covers need to be raised to the new surface elevation. At the East Loop Road intersection with the North Loop Road, landfill gas transmission line manholes are located within the intersection.

  The east leg is located parallel to landfill Section 6/7, with the southern part of the leg outside of the leachate cutoff wall (i.e., landfill solid waste unit boundary) and the northern part inside of the leachate cutoff wall. At the transition location from inside to outside of the leachate cutoff wall a concrete protective slab, similar to the slab at the Muldoon Ave entrance to Landfill Section 1/9, is to be constructed to span the relatively soft cutoff wall. The concrete slab is to be placed at an elevation above the landfill geomembrane cover, and separated from the geomembrane by a minimum 12 inches of soil. A detail of the proposed protective slab cover is shown in Figure DT-1.

  Reduced storage capacity of the Basin C2 can be managed by extending the basin footprint to the south, or potentially modifying the existing culvert connection between Basin C1 and C2 to allow for use of additional storage within basin C1.

  Option 2. Despite veering slightly from the existing DSNY haul roadbed, Option 2 encounters no more challenges than does the west leg of Option 1, other than at the north roundabout. The north roundabout sits over the cutoff wall and leachate trench as well as a landfill gas transmission main. Construction of protective concrete slabs above the leachate cutoff wall, as described for Option 1 is proposed.

- ***Environmental.*** This road alignment will require filling within Basin C2 (as discussed above), which is rip rap lined and does not currently provide substantial habitat. Neither intersection Option impacts regulated wetlands.
- ***Park.*** East Loop Road provides essential linkages among park roads, serves as a principal orienting element to visitors of the park, and offers direct access to the Marsh, Creek Landing, and then Sunken Forest.

  Option 1. The circular configuration best fulfils the intention of the Draft Master Plan, enabling the creation of the Sunken Forest with a strongly delineated edge. The circular configuration is a distinctive orienting device for park visitors, and enables a smooth passage through the park.

  Option 2. This configuration reduces the overall pavement footprint, minimizing impermeable surfaces. Fewer pedestrian and bicycle crossings are necessary to move from the shoreline to East Mound and around the basins. The routing of the road between the two basins connects Basin C2 to the mound, providing potential for future ecological connectivity between a restored water body and nearby upland habitats.

4.2.2 Forest Hill Road Extension

As suggested by its designation, the Forest Hill Road Extension connects the park roadway system with Richmond Avenue at Forest Hill Road (FHR) by adding the fourth leg to the existing intersection at the south end of the Staten Island Mall. The modified intersection will become a principal gateway into the park. By providing a continuous alignment, the FHR Extension together with South Loop Road forms a direct link between the West Shore Expressway and Richmond Avenue.

From East Loop, the alignment climbs onto landfill section 6/ 7 (East Mound) and traverses the mound along its southern end. It descends from the landfill with a grade separated crossing over the existing landfill service road (and proposed pedestrian and bicycle path) and continues on a viaduct, skimming over existing wetlands, touching down at the approach to Richmond Avenue. This portion of the section 6/7 is scheduled for final closure in 2009 and 2010. It is intended that construction of the FHR Extension be phased in conjunction with that of the final landfill cap such as to maximize efficiency and cost, and minimize duplication and disruption.

Widening of Forest Hill Road east of Richmond Avenue to four lanes by the New York City Department of Transportation is intended at some point in the future. However, the widening has not yet been specifically programmed and consequently is not included in the GEIS 2036 No-Build condition. For consistency with the GEIS it is therefore assumed that the widening will not be in place in this report as well. The project proposes to approach Richmond Avenue by splaying the eastbound roadway from two to three lanes, widening including an eastbound to northbound left turn bay, a through lane to Forest Hill Road, and a right turn lane. It proposes to re-stripe the lanes on Richmond Avenue to add new turn bays into the new FHR extension. The modifications on Richmond Avenue would be accommodated within the existing right-of-way. The intersection's signalization would be modified accordingly.

The proposed Forest Hill Road Extension is shown on Figures L2-2036-4.1 and FH1-2036-4.

- ***Geometry***. The alignment was conceived to be sweeping and curvilinear while minimizing interference with landfill infrastructure elements. It surpasses the design criteria throughout.
- ***Infrastructure.*** There are no known infrastructure elements unrelated to the landfill in the path of the FHR Extension.
- ***Landfill.*** The proposed alignment passes over the landfill and must account for the unusual roadbed conditions, and its influence needs to be accounted for with regard to maintaining the function of the landfill environmental protection features. The specific features and systems that may be influenced by the road alignment include: final cover system and foundation support properties of the waste, landfill gas management system, stormwater management system, and leachate management system.

To accommodate the different construction requirements of the roadway and cover system, each feature is intended to be constructed separately. In cross section each of the features consists of multiple layers of engineered soil, aggregate, or geosynthetic material. A typical cross section of the roadway over the landfill cover system is provided in Figure DT-1. From top to bottom the layers include:

- Pavement structure (i.e., asphalt wearing, binder, and base courses, and subbase, among others);
- Select granular subgrade (2 to 3 ft-thick);
- Embankment fill (variable thickness, minimum 0 ft-thick);
- Barrier protection layer 2 ft-thick;
- Geosynthetic drainage layer; and
- Geosynthetic barrier layer.

As described, the minimum separation between the bottom of the roadway pavement structure and top of the landfill geomembrane barrier layer will be 4-ft. The typical pavement structure thickness is expected to be on the order of 18 to 24 inches. Consequently, the separation of the between the asphalt surface and the top of geomembrane would be 5.5 to 6 ft. This separation distance exceeds the recommended minimum distance of 4-ft between waste and top of pavement surface, as described in Chapter 9 of the New York State Department of Transportation Highway Design Manual (2007). This separation distance is also estimated to provide a greater than 75 percent reduction in bearing pressure transmitted from wheel loads to the geomembrane surface (assuming a 2V:1H load spread angle and vertical separation distance of 6 ft).

The design of the roadway pavement structure will be based on the subgrade resilient modulus, which is a measurement of the capacity of the landfill cover system barrier soil and underlying waste (collectively subgrade materials) to support the roadway pavement structure. According to chapter 4 of the New York State Department of Transportation Comprehensive Pavement Design Manual (2002), the minimum required subgrade resilient modulus for construction is 28 Mega-Pascal (MPa). It is anticipated that during the prelimainary design phase of work, resilient modulus of the existing landfill cover soil and waste along the proposed alignment will be measured in situ using an instrument known as a falling weight deflectometer (FWD). Barrier protection soil used for construction of the landfill cover system is an engineered fill which is required to meet a rigid set of material specifications, described in the landfill closure construction contract documents. Consequently, laboratory measurements of resilient modulus of the barrier protection material are anticipated to be performed during preliminary design. Finally, finite element modeling of the combined subgrade and pavement structure, which incorporate the field and laboratory measurements of resilient modulus and other soil parameters, will be used to evaluate the overall composite reaction of the final design.

The placement of the road over the landfill final cover system requires evaluation of potential sliding of the roadway embankment along the interface between the landfill geosynthetic drainage layer and geosynthetic barrier layer. Calculations to verify stability along this interface are commonly prepared for landfill permit design. Due to the increased loads that will be imposed on this interface by construction of the roadway, evaluation of the roadway embankment stability will be performed as part of preliminary design. Similarly, the imposed load of the roadway embankment on the landfill could induce global instability of the waste mass beneath the road. Global stability analysis of the final configuration will also be performed.

To minimize the thickness and cost of the roadway section and to minimize future maintenance and repair costs, the waste and soils materials beneath the roadway will need to be densified before roadway construction. To densify the soils, a large mound of soil will be temporarily placed over the future roadway alignment until the underlying waste and soils compress; the compression will be monitored carefully to verify that the soil densities and strength needed to support the roadway have been achieved.

The alignment skirts much of the landfill gas collection system, but cannot avoid it entirely. It crosses the southern landfill gas collection header ring at two locations, crosses, eight lateral landfill gas collection pipes and passes over three landfill gas extraction wells. At the locations where the roadway passes over the header ring, the landfill gas lines will be rerouted through a protective carrier pipe that will protect the pipes from crushing, and allow access to flush the pipes, remove condensate, or if needed remove and replace the pipes. The protective carrier pipe should be constructed prior to landfill cover construction, in order to permit the pipes to remain at the current elevation and thereby maintain a positive gradient to drain condensate to existing collection points. The protective carrier pipes will terminate at HDPE manholes designed to penetrate the landfill cover system. The manhole design and seal to the cover system geomembrane will be equivalent to the landfill gas well vault configuration being used for Landfill Section 6/7 closure construction. Details of the landfill gas pipe protection are shown in Figure DT-1. In addition, wells that are located in the proposed roadway alignment will be either decommissioned and reinstalled outside of the alignment, or, where that distance is too far from the current well location, a lateral header will be connected to the well so that it can be accessed from outside of the roadway alignment.

The road over landfill design will also include placement of lateral vent channels perpendicular to the road alignment at a one vent per 200-ft spacing. The vent channels will consist of shallow gravel trenches with embedded perforated pipe wrapped in a protective geotextile filer fabric. The vents will provide a means for sampling the soil vapor beneath the road alignment and above the cover, thereby providing a means to monitor the landfill cover surface for release of landfill gas. A detail of the landfill vent channels is provided in Figure DT-1.

To maintain safe operations, the roadway must be drained as quickly as possible and no roadside runoff can be taken across the pavement. As a consequence, swales and ditches must be introduced to intercept runoff that would otherwise flow onto the road. This occurs at several points on the mound. Swales would be introduced along much of the north edge of the road to intercept mound runoff on the uphill side. A culvert would be added under the roadway on the west side to convey flows westward toward Basin C2, and on the east side to the mound to carry flows southward towards Basin R. In general, stormwater flow controls are designed to maintain the flow patterns and discharge locations provided in the NYSDEC approved Landfill Section 6/7 Closure Plan.

As the roadway descends from the mound onto the viaduct, the alignment spans over the leachate collection trench and cut-off wall. This requires that one end of the span be placed within the landfill, inside of the leachate trench. The schematic design proposal is to use a mechanically stabilized earth wall over the geomembrane to retain the roadway embankment, and to cantilever the west end of the structure from a pier founded on reliable strata, below the waste. The latter necessitates penetration of the landfill final cover, and the lower natural soil liner. A schematic detail that addresses the connection between the final cover geomembrane and bridge pier as well as allowing inspection of the connection is included on Figure FC-1.1.

With regard to the penetration of the natural soil liner, a field demonstration project would be performed at a nearby location outside of the landfill solid waste management unit boundary. In general the test would include advancement of an oversized steel casing through the soil strata that composes the landfill natural soil liner, and then advancing a support pile consistent with the type that would be used during construction through the oversized steel casing and through the natural soil liner. Water placed within the annulus between the pile and casing would be measured over period of time and the vertical percolation rate calculated. The results of the test would be used to support or contradict the anticipated self-sealing (i.e., low-permeability) connection between the soil liner and support pile.

- ***Environmental.*** The Forest Hill Road Extension extends into the park from Richmond Avenue by crossing over an existing unregulated freshwater wetlands area. In order to avoid impact, a viaduct approximately 900ft long has been proposed. This results in approximately 1.08 acres of wetland disturbance due to the construction of piles and shading. The affected area is dominated by *Phragmites communis* which would be replaced by native marsh plant communities with higher habitat value once construction of the viaduct was complete. Significant wetland creation will be required to compensate for the encroachment, and new stormwater management controls are necessary in this section of the road.
- ***Park.*** The Forest Hill Extension serves as the southeastern gateway into the park. This roadway is a relatively short and direct route to the loop program areas, and as such does not have as significant a physical presence in the park as other east-west road alignments. The viaduct and views from this roadway could be very beautiful, offering a contemporary park drive experience. However, the greater width of the four lane road occupies more of the space that would otherwise be dedicated to park use. The cost of creating a two-lane bridge is significantly more than a two-lane, and therefore presents an opportunity cost for the park.

4.2.3 Richmond Hill Road Extension

The Richmond Hill Road Extension connects the park roadway system with Richmond Avenue at Richmond Hill Road (RHR). The modified intersection, just north of the Staten Island Mall, would become the northeast gateway into the park. The RHR Extension begins at the intersection with East Loop Road, crosses over the middle of landfill section 6/7 generally in line with Yukon Avenue, and

descends with a grade separated crossing over the existing landfill service road (and proposed pedestrian and bicycle path). The central band of landfill section 6/7 traversed by the alignment, herein referred to as the Yukon saddle, is scheduled for landfill final closure construction in 2009 and 2010. As with the Forest Hill Road Extension, it is intended that construction of the road be phased in conjunction with that of the final landfill cap such as to maximize efficiency and cost, and minimize duplication and disruption.

Continuing past the landfill, the roadway crosses over stormwater management basin B1 on an earthen embankment, turning north to run generally parallel to Richmond Avenue alongside an earthen berm. Continuing northward, the road crosses a tributary pond to Springville Creek, runs adjacent to DSNY's District 2 Garage and behind the Duane Reade building, and turns east again toward Richmond Hill Road. The embankment elevations along this section of the roadway are intended to keep the road above the 100 year flood level.

At the Richmond Avenue and Richmond Hill Road intersection, the existing western leg of the intersection consists of a 200' long stub that operates as a driveway into the Duane Reade parking lot. The proposed alignment veers approximately 10 degrees from the existing alignment to help maximize the radius of the curve to the west, and reduce the skew with Richmond Hill Road to the east. The project also proposes to include an eastbound to northbound left turn bay in addition to the four basic lanes, and to re-stripe the southbound approach on Richmond Avenue to make room for a right turn bay into the park. The signal timing would be modified to reflect the changed condition.

The proposed Richmond Hill Road Extension is shown on Figures RH1-2036-4 and RH2-2036-4.

- ***Geometry***. The proposed alignment balances the desire for sweeping curves with the constraints imposed by the the landfill, the environment, existing structures, and private property. The alignment succeeds in exceeding the criteria for most of its run, but proposes a 300±' radius at the last turn towards Richmond Hill Road, to fit into the narrow band between the DSNY Garage, Basin A, and Duane Reade on the east, and landfill section 6/7 on the west. This is deemed an acceptable compromise since the curve is approaching or departing from a signalized intersection. The shoulders are omitted from the last 200±' of the approach to Richmond Avenue in favor of sidewalks. Even with these adjustments, the intersection approach is a tight fit that results in some awkward eastbound to northbound and westbound through movements.

- ***Infrastructure.*** All utilities within the site pertain to the landfill, except for the western stub of Richmond Hill Road at the intersection with Richmond Avenue. A water line, two storm sewers, a major sanitary sewer, and overhead and underground electrical lines serve the Richmond Hill Pumping Station, located at the northwestern corner of this intersection. These are to be protected in place during construction. Some power poles and catch basins need to be relocated and several manhole and valve covers adjusted vertically to accommodate the proposed alignment.

  Portions of the Richmond Avenue drainage network release their flows into an unnamed tributary of Springville Creek where they commingle with mound runoff.

- ***Landfill***

  Yukon Saddle. The proposed alignment passes over the landfill along the Yukon saddle, an alley extending across the middle of the mound that has been used over the years to accommodate haul roads, stockpiles, and an organized utility corridor supporting the section 6/7 landfill gas flare station. In this area, the depth of waste deposits since 1994 is limited to approximately 20 ft, based on review of annual surface topography between 1994 and 2007. Further, based on conversations with DSNY personnel, it is understood that slag material was used as fill in some locations along this alignment. The road has been positioned within this favorable corridor. In general, roadway foundation design and analysis of the few landfill related impacts are similar to those described along the Forest Hill Road segment. Some of the specific interactions anticipated along this alignment are described below.

  The design will need to account for the unusual roadbed conditions, as well as the road's influence on continuing landfill operations. In general, the roadway foundation design and analysis of landfill related impacts are similar to those described along the Forest Hill Road segment, with the exceptions noted above.

  While the saddle is much freer of active landfill infrastructure than the mound areas to the north and south, the alignment passes over several elements that will require protection or adjustment. Among the affected elements are two landfill gas collection laterals, crossing of landfill gas collection headers at both ends the saddle which would be realigned inside protective sleeves, covering of a leachate stone trench and a water line.

  The new roadway also interferes with several existing and post closure mound drainage ditches. Culverts are to be introduced to maintain drainage conveyance patterns that are consistent with the NYSDEC approved closure plans for landfill Section 6/7.

  As it descends from the mound, the alignment spans over the leachate collection trench and cut-off wall. This requires that one end of the span be placed within the landfill, similar to the crossing along the Forest Hill Road Extension. The proposal for this location is the same: a mechanically stabilized earth wall over the geomembrane to retain the roadway embankment, and a short section of cantilever bridge supported on an abutment founded on piles supported by reliable strata, below the waste. The schematic detail for providing visual and physical access to around the penetration, to assure the long term integrity of the seal is also the same. Here too, the pile would be placed at the base of the mound, through shallow waste. The crossing and detail are shown on Figure YC-1.1.

  Northern Leg. The road traverses Basin B1 as it continues its run towards the north and its embankment severs the southern portion of the southern end of the basin. According to hydrology modeling conducted by the design team, Basin B1 is over-dimensioned for the amount of stormwater received. Preliminary analysis indicates that the function of the basin can be maintained with some grading and outlet reconfiguration modifications. A culvert beneath the embankment is to be introduced to maintain a hydraulic connection within the divided the basin. North of basin B1, the roadway embankment crosses a pond tributary of Springville creek. A pair of multi-barrel culverts is proposed to maintain that hydraulic connection. In between, the alignment takes up the space of an existing gravel access road leading to groundwater and landfill gas monitoring wells. Protected pullouts is to be provided at each monitoring well. The landfill gas interceptor venting system is also affected along this segment of roadway. Interventions as described for the West Shore Expressway ramps are to be implemented here.

  As it negotiates the narrow passage between the DSNY District 2 Garage and the landfill, the alignment covers a section of the unnamed tributary to Springville creek. A portion of the alignment overlaps the cutoff wall. As it turns towards Richmond Hill Road it overlaps a second portion of the cut-off wall. Protective slabs are proposed to shield the cut-off wall from the influence of roadway loads, as described for protection at other similarly affected locations. The loss of the stream requires that a closed drainage system be introduced to convey flow into Springville Creek.

  This road alignment would require filling of approximately 50 percent of Basin B1. Several culverts will be required under the road to transmit water between the wetland to the east and the west of this road alignment. A portion of Basin A requires modification to support this road alignment. A small amount of tidal wetlands may be impacted on the most northern portion of this alignment. Finally, wetland mitigation will be required for the loss of existing freshwater and possibly tidal wetlands.

- ***Environmental.*** Basins B1 and B2, which were constructed in approximately 1987 as Fresh Kills Landfill stormwater retention basins, are not regulated wetlands. However field work conducted in September 2007 per the Army Corps of Engineers wetland identification guidelines suggests that Basin B1 and Basin B2 would receive a jurisdictional designation. Intrusion upon these presumed wetlands is therefore considered an impact. (As described in the Introduction, impact quantities quoted below should be considered preliminary until the ACOE has confirmed the design team's presumed wetland boundary.)

  Basin B1 is significantly impacted by the Richmond Hill Road four-lane road alignment, as is the area adjacent to the DSNY garage, where approximately 600 linear feet of an un-named stream tributary to Springville Creek will be covered over. In between, the four-lane embankment spills into the unnamed pond that feeds the stream. In total, the Four-lane Alternative results in approximately 4.26 acres of unregulated freshwater wetland impacts.

  The design team believes that these engineered freshwater basins provide relatively little habitat value, as compared to the tidal wetland areas along the north and west sides of east mound. Impact of these higher quality wetlands has been avoided by the proposed alignment along the Richmond Avenue berm. Existing vegetation and aquatic life in Basin B1 and the un-named tributary is not of high quality. It would be replaced by native marsh plant communities with higher habitat value once construction of the road was complete. The loss of potential habitat in this area could be compensated for elsewhere on site.

- ***Park.*** The Richmond Hill Road Extension serves as the northeastern gateway into the park. From a park experience standpoint, this alignment is not ideal for the motorist. Horizontal and vertical alignments are not as smooth or scenic as those in other road locations. The RHR Extension is a relatively long, indirect route to the Confluence and therefore has somewhat greater physical presence. While this presence is confined to areas that have somewhat less park potential, the road would become the dominant and nearly exclusive feature along its path north of Yukon Avenue. The two-lane roadway occupies practically all of the space between the DSNY District 2 garage and landfill, and nearly all of the land between the berm and Basin B1, causing those areas to be lost to other park uses. The alignment does avoid major impact on the berm and the thick vegetation it supports, which create a much needed buffer between the park interior and the mall and 8-lane Richmond Avenue roadway.

4.2.4 Traffic Operations

A summary of the traffic analysis performed for the proposed project is presented in section 3.1 and the projected traffic conditions for the project as a whole in section 3.1.3. The analysis indicates that traffic levels within the park will be low, at less than half the capacity of two-lane roads on all park roads, and therefore well below the capacity of four-lane roads. The volumes are also well below those that can be efficiently processed by signalized intersections within the park, or by the roundabouts proposed under Option 2 for East Loop Road.

Normal traffic operations on the Four-Lane Alternative are expected to be satisfactory.

Considerable spare capacity will be available throughout the park road network. The spare capacity will provide added flexibility in dealing with incidents, major events, and roadway maintenance. An important consideration is whether the added flexibility is a sufficient benefit to justify a larger investment.

4.2.5 Cost

The cost of the park roads as proposed under the Four-Lane Alternative is estimated at approximately $243 Million (in 2016 dollars). Adding the $58 Million cost of the WSE access improvements results in an estimated road system cost of $301 Million.

A significant portion of the cost, $51 Million, is attributed to the proposed viaduct over the wetlands traversed by the Forest Hill Road Extension. The viaduct structure minimizes impact on the wetlands, whereas the less expensive option of placing the road on an embankment across the wetlands is unlikely to receive the necessary DEC approval. However, a combination of embankment and strategically placed structures may result in acceptable impact on the wetlands and substantial cost savings, and this opportunity will be explored in the preliminary design phase.

4.3 Two-Lane Alternative

The typical two-lane Park Road section consists of one 12' travel lane in each direction, separated by a 4' wide flush textured median, supplemented by 6' wide flush outside shoulders, and bordered by landscaped roadsides that include drainage swales where needed. Lane widths are 1' wider for the Two-Lane than for the Four-Lane Alternative to improve driver comfort and to provide sufficient width - together with the median and shoulder - for passing stalled vehicles without having to encroach into the opposite direction of travel. The typical section is shown in Figure TS-1.

4.3.1 Confluence Loop

The Two-Lane Alternative threads its way through the physical constraints imposed by the narrow passages under the West Shore Expressway and over the existing creek bridges in a manner similar to that of the Four-Lane Alternative. Consequently, it follows the same curvilinear horizontal alignment and profile. However, its narrower footprint provides some additional flexibility, as described below. The Two-Lane Alternative is shown on Figures L1-2036-2 and L2-2036-2.1. Individual components are discussed below.

South Loop Road

The footprint of the Two-Lane Alternative is such that the two-lane roadway width, in addition to the full width path for pedestrians and bicyclists, falls within the paved width as the Four-Lane Alternative.

- ***Geometry.*** The South Loop profile is presented in Fig. SL-2036-2P1. The Two-Lane Alternative differs from the Four-Lane Alternative at the crossing beneath the WSE Bridge and at Richmond Creek Bridge, where the Two-Lane Alternative maintains its typical cross section.

  The narrower Two-Lane Alternative requires less roadway extension beyond the existing shoreline. It may be possible to reduce the width under the WSE by eliminating the median and reducing the shoulders, as with the Four-Lane Alternative, to further reduce the impact on the Kills, but this would expose it to the risk that a stalled vehicle could block travel in that direction. The Two-Lane Alternative allows for both the roadway and the path for pedestrians and bicyclists to be located on the existing Richmond Creek Bridge. A scheme for the two-lane Richmond Creek Bridge treatment is shown on Figures RC-1 and RC-2.

- ***Infrastructure.*** It does not appear that the proposed roadway affects submarine electrical cables and a gas line that cross Fresh Kills in the vicinity of the WSE.

- ***Landfill.*** The outfall from Basin K1 serving landfill section 1/9 needs to be extended, though a shorter distance than with the Four-Lane Alternative. In the vicinity of landfill section 2/8, the proposed roadway fits comfortably within the footprint of the existing DSNY haul road. As with the Four-Lane, the landfill utilities that lay below the existing roadbed need to be protected and their manhole and valve covers and related hardware raised to be flush with the new surface. An entrance/exit point form South Loop Road is to be provided at the section 2/8 Flare Station.

- ***Environmental.*** The two-lane South Loop Road extends 31' into the Fresh Kills shoreline under the West Shore Expressway. The tidal wetland impacts for the Two-Lane Alternative totals approximately 0.31 acres of regulated tidal open water. This area is currently degraded, steep-sided and the water is both deep and shaded. Its impacts could be offset elsewhere. The two-lane road has minimal impact elsewhere as it occupies more of less the space of existing DSNY haul roads.

- ***Park.*** Pedestrians and cycles can share the existing Richmond Creek bridge, which is wide enough to allow for physical separation of cars and buses from non-motorized lanes. The small program area at the Terrace would not be compromised by a narrower South Loop Road.

West Loop Road

The Fresh Kills crossing would feature an appealing iconic bridge as the main component of West Loop Road. One possible concept for a two-lane signature bridge is included in this report, as Figure SB-5.

- ***Geometry.*** The roadway horizontal curvature is very similar to that of the Four-Lane Alternative, with a slight improvement in radius at the north end, to 325'. The profile, also similar, is provided in Figure NWL-2036-2P1.
- ***Infrastructure.*** It does not appear that the proposed roadway affects existing utilities.
- ***Landfill.*** South of Fresh Kills, the West Loop Road traverses land presently occupied by DSNY landfill management and maintenance facilities. However those facilities are scheduled for future abandonment and are not expected to conflict with the park's implementation. In the same area, the alignment passes over a water line, a landfill gas transmission main, and an underground electrical line. No special protection of the utility crossings is envisioned at this location for the Two-Lane Alternative.
- ***Environmental.*** The tidal wetland impacts for the Two-Lane Alternative totals approximately 1.06 acres – 0.11 acres of DEC mapped tidal wetlands and approximately 0.95 acres of regulated tidal open water.
- ***Park.*** A two-lane West Loop Road and signature bridge would serve the purposes described under the Four-Lane Alternative—iconic marker, gateway to the largest concentration of destination programs, hinge between park sectors, architectural feature with unique vistas of the water—with less impact on the waterway.

North Loop Road

The overall layout of North Loop Road is described in Section 4.2.1.

- ***Geometry.*** The roadway alignment includes curves of 300' radius at the WSE Bridge crossing, and profile is identical to that of the Four-Lane Alternative. The West Loop Road profile is provided in Figure NWL-2036-2P1. The Two-Lane Alternative differs from the Four-Lane Alternative at the crossing beneath the WSE Bridge and at Main Creek Bridge.

  As for South Loop Road, the Two-Lane Alternative maintains the typical cross section, but still requires less roadway extension into the shoreline relative to the Four-Lane Alternative. Additionally, the Two-Lane Alternative allows for a full width path for pedestrians and bicyclists to be located on the existing Main Creek Bridge. A scheme for the two-lane Main Creek Bridge treatment is provided in Figures MC-1 and MC-2.
- ***Infrastructure.*** The road sits over a multi-opening submarine electrical cable chamber. A drainage outfall serving the WSE needs to be extended or replaced.
- ***Landfill.*** The proposed two-lane alignment passes close to but is designed to avoid intruding into landfill section 3/4 and affecting its completed closure system. However, the alignment traverses landfill stormwater management basins Q and F. The loss of necessary storage volume and its compensation would be the same as for the Four-Lane Alternative.

  Access points are to be provided to accommodate landfill post-closure operation and maintenance activities, the section 3/4 landfill gas flare station and the basins.

  The road is not expected to conflict with the maintenance facilities in its path, since these will be abandoned on completion of east mound landfill closure
- ***Environmental.*** The two-lane North Loop Road intrudes into the creek in the area under the WSE bridges, extending the existing shoreline out into the water by 19 feet. It will cause no impact to DEC mapped tidal wetlands or regulated tidal open water. However, as with all construction near tidal wetlands, DEC may perform a jurisdictional review of projects in areas adjacent to mapped tidal wetlands, and reevaluate mapped wetland boundaries. The shoreline area is degraded and steep-sloped. The water is deep and shaded. Impacts could be mitigated elsewhere.
- ***Park.*** This roadway segment provides a graceful, arcing access road to the Creek Landing and the almost entirely non-motorized North Park. The two-lane version of this road preserves more space for waterfront and park activity in the Creek Landing, and prioritizes bike and pedestrian path alignments. No new pedestrian and cycle bridge over Main Creek is required, a significant advantage in terms of park development.

East Loop Road

Similar to the Four-Lane Alternative, the Two-Lane Alternative presents two options for East Loop Road, as described below:

Option 1: The Two-Lane Alternative follows the same alignment and incorporates similar signalized intersections as the Four-Lane Alternative Option 1. Option 1 is shown on Figure L2-2036-2.1. A profile based on Option 1, is provided in Figure EL-2036-2P1.

Option 2: The Two-Lane Alternative Option 2 follows the same alignment and avoids the same conflicts as the Four-Lane Alternative Option 2 scheme. Option 2 is shown in Figure L2-2036-2.2. Option 2 profile is similar to that of the east leg of Option 1.

- ***Geometry***.

  Option 1. The option consists of separate northbound and southbound roadways, each including two 6' wide shoulders and one 12' wide travel lane, to allow for bypass of stalled vehicles. As for the Four Lane Alternative, some curves have non-standard radii.

  Option 2. The option consists of a single roadway with 6' wide shoulders, two 12' travel lanes and a 4' median. It includes compact single lane roundabouts at both ends, which allow them to be placed in a more desirable locations based on NYSDOT and FHWA design guidelines for roundabouts. Sue to its narrower footprint, Option 2 adheres more closely to the existing DSNY roadbed in the two-lane than in the four-lane version.
- ***Infrastructure.*** There are no known infrastructure elements unrelated to the landfill in the vicinity of East Loop Road Option 1 or Option2.
- ***Landfill***

  Option 1. The west leg of the Two-Lane Alternative occupies the bed of an existing DSNY haul road. The landfill gas transmission manhole covers will need to be raised to the new surface elevation.

  Along the east leg, a concrete protective slab is to be constructed to span the cutoff wall where the road transitions from outside to inside the leachate cutoff wall. Two such slabs will be needed.

  Reduced storage capacity of the Basin C2 due to encroachment by the Two-Lane Alternative can be managed by modifying the existing culvert connection between Basin C1 and C2. The amount of encroachment associated with the Two-Lane Alternative is less than that for the Four-Lane Alternative due to the narrower roadway width.

Option 2. The north roundabout sits over the cutoff wall and leachate trench as well as a landfill gas transmission main. Construction of protective concrete slabs above the leachate cutoff wall, as described for Option 1 is proposed.

- ***Environmental.*** The Two-Lane Alternative has no wetland impacts.
- ***Park.*** Option 1 infringes less on a flat area to the northwest, enabling the construction of a larger parking lot for park use.

4.3.2 Forest Hill Road Extension

The Two-Lane Alternative for the Forest Hill Extension follows a similar horizontal alignment and profile as for the Four-Lane Alternative. At the intersection with Richmond Avenue, the two-lane approach provides an eastbound left turn bay approaching Richmond Avenue as well one through and one right turn lane, along with restriping of northbound Richmond Avenue to provide a left turn bay onto Forest Hill Extension and re-striping for a right turn bay from southbound Richmond Avenue.

The proposed Forest Hill Road Extension is described in section 4.2.2 and shown in Figures L2-2036-2.1 and FH1-2036-2.

- ***Geometry***. The Two-Lane Alternative is similar to the Four-Lane Alternative, with a sweeping and curvilinear alignment that minimizes interference with landfill infrastructure elements. It meets or exceeds the design criteria throughout. It veers no more than 20’ from the footprint of the Four-Lane Alternative.
- ***Infrastructure.*** There are no known infrastructure elements unrelated to the landfill in the path of the FHR Extension.
- ***Landfill.*** The proposed Two-Lane Alignment passes over the landfill and must account for the unusual roadbed conditions in the same manner as the Four-Lane Alternative. The specific features and systems that may be influenced by the road alignment include: final cover system and foundation support properties of the waste, landfill gas management system, stormwater management system, and leachate management system.

The field testing necessary to advance the foundation of the Two-Lane Alternative is the same as the work required for four lanes.

The placement of the road over the landfill final cover system will require evaluation of potential sliding of the roadway embankment along the interface between the landfill geosynthetic drainage layer and geosynthetic barrier layer. Due to the narrower road width, the Two-Lane Alternative is expected to apply the least load to the landfill surface. Nonetheless, it is proposed to densify the waste beneath the roadbed ahead of road construction in a similar manner as for four lanes.
The alignment crosses the southern landfill gas collection header ring at two locations, crosses, eight lateral landfill gas collection pipes and passes over one landfill gas extraction well. The landfill gas lines are to be rerouted through a protective carrier pipe that will protect the pipes from crushing, and allow access to flush the pipes, remove condensate, or if needed remove and replace the pipes. Details of the landfill gas pipe protection are shown in Figure DT-1. The landfill gas well are to be either decommissioned and reinstalled outside of the alignment or be provided with a lateral header connection from outside of the roadway.

The two-lane road over landfill design will also include placement of lateral vent channels perpendicular to the road alignment at a one vent per 200-ft spacing for sampling the soil vapor beneath the road. A detail is provided in Figure DT-1.

Swales and ditches are to be introduced to intercept runoff that would otherwise flow onto the road. Swales are to be introduced along much of the north edge of the road to intercept mound runoff on the uphill side. A culvert is to be added under the roadway on the west side to convey flows westward toward Basin C2, The length of this culvert is less than that required for the Four-Lane Alternative.

Similar to the Four-Lane Alternative, as the roadway descends from the mound onto the viaduct, the alignment spans over the leachate collection trench and cut-off wall, requiring that one end of the span be placed within the landfill. For the Two-Lane Alternative, the width of the end pier and mechanically stabilized earth wall are less than that of the Four-Lane Alternative. A schematic detail that addresses the connection between the final cover geomembrane and bridge pier as well as allowing inspection of the connection is included on Figure FC-1.1.

- ***Environmental.*** . The freshwater wetland impacts for the Two-Lane Alternative total approximately 0.70 acres. The impact calculation corresponds to the maximum amount of potential permanent footprint impacts associated with a viaduct. The viaduct roadway design option will have the opportunity to reduce the actual wetland resource impacts in several ways. The open areas under the viaduct and the hydrologic connectivity provided for the wetland area north and south of the alignment are extremely positive attributes of this option. The two-lane viaduct option will maximize the wetland area that can be retained and enhanced. The affected area is dominated by common reed *Phragmites communis*, which would be replaced by native freshwater marsh plant communities. New stormwater management controls are necessary in this section of the road.
- ***Park.*** The two-lane version of the Forest Hill Extension provides a short and direct route to the loop program areas. Views from the roadway on the viaduct and on the mound will be significant park features. A viaduct creates a relationship between the driver and the creek while reducing impact on the wetland area. The slim roadway leaves more land for park use and brings the park closer to travelers.

4.3.3 Richmond Hill Road Extension

The Two-Lane Alternative follows a similar alignment in the same footprint as the Four-Lane Alternative from East Loop Road along Yukon saddle to just south of the DSNY’s District 2 Garage. It differs from that of the four lane alternative in the vicinity of the DSNY garage, to reduce the impact on a freshwater stream.

The proposed Richmond Hill Road Extension is shown on Figures RH1-2036-2 and RH2-2036-2.

- ***Geometry***. The alignment exceeds the design criteria, except at the horizontal curve approaching the Richmond Avenue intersection, where a curve of 300’ radius is provided. Justification for retention of the non-standard horizontal curve is the same as for the Four-Lane Alternative. See Section. 4.2.3.

  The two lane alignment differs adjacent to DSNY’s District 2 Garage to allow for minimal impacts to the stream which outlets Basin B1 to the south. The alignment passes between the garage and the stream. Since the desired profile lies approximately 10’± below the elevation of the parking lot and 10’± above the elevation of the stream, a retaining wall is required on each side of the roadway along that stretch of roadway, which allows the stream to be retained.

  At Richmond Avenue, the Two-Lane Alternative incorporates an eastbound to northbound left turn bay, a through lane and combined through/right turn lane at the eastbound approach to the intersection. The narrower roadway adds some flexibility to the eastbound approach as compared to the Four-Lane Alternative, allowing for the approach angle and shoulder widths to be adjusted during detailed design to achieve the most favorable overall geometric balance.

- ***Infrastructure.*** Street utilities located at the northwestern corner of this intersection are to be protected in place during construction. Some power poles and catch basins need to be relocated and manhole and valve covers adjusted vertically.

- ***Landfill.*** The proposed two-lane alignment passes over the landfill along the Yukon saddle, in a similar manner as the Four-Lane alternative. Some of the specific two-lane road alignment and landfill infrastructure interactions anticipated along this alignment are described below.

  The design must account for the unusual roadbed conditions, as well as the road's influence on continuing landfill operations. In general, the roadway foundation design and analysis of landfill related impacts are similar to those described along the Forest Hill Road segment described in section 4.3.2 and even more extensively in section 4.2.2.

  Among the affected elements along the Yukon saddle are two landfill gas collection laterals, crossing of landfill gas collection headers, covering of a leachate stone trench and a water line.

  Culverts are to be introduced to maintain drainage conveyance patterns.

  As it descends from the mound, the alignment spans over the leachate collection trench and cut-off wall. This requires that one end of the span be placed within the landfill, similar to the crossing along the Forest Hill Road Extension. The crossing and detail are similar to that shown on Figure YC-1.1.

  As the road traverses Basin B1, its embankment severs the southern portion of the southern end of the basin, requiring a culvert beneath the embankment to maintain the hydraulic connection. Similarly, a pair of multi-barrel culverts is proposed to maintain the hydraulic connection at the north end of Basin B1. In between, the alignment takes up the space of an existing gravel access road leading to groundwater and landfill gas monitoring wells. Protected pullouts are to be provided at each monitoring well. The landfill gas interceptor venting system are also affected along this segment of roadway.

  North of the DSNY District 2 Garage a portion of the Two-Lane Alternative alignment overlaps the cutoff wall. Protective slabs are proposed to shield the cut-off wall from the influence of roadway loads.

  The Two-Lane Alternative road alignment requires filling a portion of Basin B1. The estimated encroachments into Basin B1 and the wetlands are each less than that of the Four-Lane Alternative due to the reduced road width.

- ***Environmental***. The Two-Lane Alternative impacts approximately 3.23 acres of wetlands. It is contained within retaining walls along the length of DSNY's District 2 Garage, preventing encroachment on the adjacent un-named stream tributary. Further south, the road is able to fit almost entirely on an existing DSNY service path adjacent to existing wetlands. The engineered freshwater basins are less valuable habitat resources than the tidal wetland areas along the north and west of East Mound, and the loss of potential habitat in this area could be compensated for elsewhere on site. Several culverts will be required under the road to transmit water between the wetland to the east and the west of this road alignment.

- ***Park.*** The Richmond Hill Extension serves as the northeastern gateway into the park. As noted in the Four-Lane description, the RHR Extension is a relatively long, indirect route to the Confluence and therefore has somewhat greater physical presence, but its presence is confined to areas that have somewhat less park potential.

4.3.4 Traffic Operations

The overall project summary presented in section 3.1.3 indicates that traffic levels within the park will be low, at less than half the capacity of the Two-Lane Alternative on all park roads, and below those that can be efficiently processed by signalized intersections within the park, or by the roundabouts proposed under Option 2 for East Loop Road.

Normal traffic operations on the Two-Lane Alternative are expected to be satisfactory.

4.3.5 Cost

The cost of the park roads as proposed under the Two-Lane Alternative is estimated at approximately $179 Million (in 2016 dollars). Adding the $58 Million cost of the WSE access improvements results in an estimated road system cost of $237 Million.

A significant portion of the cost, $34 Million, is attributed to the proposed viaduct along the Forest Hill Road Extension. A combination of embankment and strategically placed structures may result in acceptable impact on the wetlands and substantial cost savings. This opportunity will be explored in the preliminary design phase.

4.4 Hybrid Alternative

The hybrid road alternative provides a combination of two-lane and four-lane road segments through the park. In this alternative, Forest Hill Road Extension and South Loop Road, which form a primary link with the West Shore Expressway, are configured as four-lane roadways and the Richmond Hill Road Extension and the remainder of the Confluence Loop are configured as two-lane roadways. As a further refinement, South Loop Road is reduced to three lanes as it passes under the WSE, since the eastbound direction is only fed by a single West Loop Road lane.

Benefits associated with the Hybrid Alternative relative to the Four-Lane Alternative include a decrease in the fill placed in basin B1, reduced wetland impacts along Richmond Hill Road Extension, less intrusion into the Kills beneath the West Shore Expressway underpass, a better fit to the park setting, all the advantages attendant to a smaller footprint across Yukon saddle and proposed Creek Landing, and reduced construction and maintenance costs.

Benefits associated with the Hybrid Alternative relative to the Two-Lane Alternative include increased traffic capacity along the most direct link between Richmond Avenue and the West Shore Expressway.

The proposed Hybrid Alternative is shown in Figures L1-2036-H, L2-2036-H, FH1-2036-H, RH1-2036-H and RH2-2036-H.

4.4.1 Confluence Loop

South Loop Road

The proposed road begins at the intersection with the southbound WSE service road extension with three lanes – two westbound, to the service road and West Loop Road, and one eastbound from West Loop Road and the Point.

From its intersection with the proposed northbound WSE service road to its intersection with East Loop Road, South Loop Road is identical to the Four-Lane Alternative. Refer to the South Loop Road discussion in Section 4.2.1 of the Four-Lane Alternative for all considerations affecting this segment.

Given that only the segment under the WSE is unique, the following discussion pertains only to that portion.

- ***Geometry.*** The eastbound direction includes a 6' shoulder, 12' lane and 4' median to provide for bypass, and the westbound two 12' lanes and a 2' shoulder, resulting in an overall width of 46' compared to 48' for four lanes, and 40' for two lanes. It may be possible to reduce the width under the WSE by eliminating the median and reducing the eastbound shoulder, to reduce the impact on the Kills, but this would expose it to the risk that a stalled vehicle could block all eastbound travel.

- ***Infrastructure.*** It does not appear that the proposed roadway affects submarine electrical cables and a gas line that cross Fresh Kills in the vicinity of the WSE.

- ***Landfill.*** The outfall from Basin K1 serving landfill section 1/9 needs to be extended. The landfill utilities that lay below the existing roadbed need to be protected and their manhole and valve covers and related hardware raised to be flush with the new surface.
- ***Environmental.*** The footprint of the Hybrid Alternative results in a 37' intrusion into the Kills, which corresponds to approximately 0.35 acres of tidal open water impact. These impacts constitute relatively minor area of open water fill impact along a relatively steep sided, deep water and shaded area that can be effectively offset elsewhere onsite by tidal wetland restoration.
- ***Park.*** The difference in width under the WSE is of little significance to the park setting or its functions.

West Loop Road

The Hybrid Alternative proposes same Fresh Kills crossing as described for the Two-Lane Alternative. Refer to section 4.3.1.

North Loop Road

The Hybrid Alternative proposes same configuration as described for the Two-Lane Alternative. Refer to section 4.3.1.

East Loop Road

The Hybrid Alternative proposes same configuration as described for the Four-Lane Alternative. Refer to section 4.2.1.

4.4.2 Forest Hill Road Extension

The Hybrid Alternative proposes same configuration as described for the Four-Lane Alternative. Refer to section 4.2.2.

4.4.3 Richmond Hill Road Extension

The proposed Richmond Hill Road Extension is the same as described for the Two-Lane Alternative. Refer to section 4.3.3.

4.4.4 Traffic Operations

The overall project summary presented in section 3.1.3 indicates that traffic levels within the park will be low, at less than half the capacity of two-Lane roads on all park roads, and below those that can be efficiently processed by signalized intersections within the park, or by the roundabouts proposed under Option 2 for East Loop Road.

Normal traffic operations on the Hybrid Alternative are expected to be satisfactory.

The spare capacity and multiple lanes will provide added flexibility in dealing with incidents, major events, and roadway maintenance along the Forest Hill Road Extension, South Loop Road and East Loop Road. An important consideration is whether the added flexibility is a sufficient benefit to justify the investment in spare capacity.

4.4.5 Cost

The cost of the park roads as proposed under the Hybrid Alternative is estimated at approximately $216 Million (in 2016 dollars). Adding the $58 Million cost of the WSE access improvements results in an estimated road system cost of $274 Million.

$51 Million of the cost is attributed to the proposed viaduct along the Forest Hill Road Extension. A combination of embankment and strategically placed structures may result in acceptable impact on the wetlands and substantial cost savings.

5 Evaluation of Alternatives

5.1 Methodology

This section synthesizes the comparison of alternatives, identifying the most salient differences in road geometry and safety, and impact on landfill and external infrastructure, environmental resources, the park experience, traffic operations and cost. Elements that do not contribute to the differentiation—West Shore Expressway Corridor improvements and internal intersections at East Loop, for example—are excluded from this summary.

Implications for systems like landfill drainage, are discussed only where the differences seem significant for the selection of the preferred alternative. In the next phase of design, all issues will be studied in greater depth.

5.2 Geometry

Since the alternatives differ primarily in the number of lanes and adhere to the same paths, there are few meaningful differences in either horizontal or vertical alignment. All three alternatives meet the geometric standards except for isolated instances where smaller than standard 373' radii are utilized to negotiate constrained areas:

- All three alternatives include 315'± radius curve on the north shore of West Loop Road
- All three alternatives include a pair of 300'± radii on North Loop Road near the WSE
- Option 1 includes a pair of 275'± radii around basin C2 under of all three alternatives
- All three alternatives include a 300'± radius curve at the turn to Richmond Hill Road

The primary differences are related to the width:

- The Two-Lane Alternative maintains a consistent standard cross section throughout
- The 4' median is eliminated and shoulders reduced from 6' to 2' on South Loop Road, under the WSE and across Richmond Creek Bridge, for both the Four-Lane and Hybrid Alternatives
- The 4' median is eliminated and shoulders reduced from 6' to 2' on North Loop Road, under the WSE and across Main Creek Bridge, in the Four-Lane Alternative
- The flush shoulders are omitted to make room for curbed sidewalks at the approach to Richmond Hill Road in the Four-Lane Alternative.

On the whole, the Two-Lane Alternative makes the fewest geometric compromises.

5.3 Infrastructure

The differences in external infrastructure and utility impacts are generally minor and generally related to the width of the roadway footprint. As such, the Four-Lane Alternative will have the more extensive effect and the Two-Lane Alternative the least.

5.4 Landfill

Each of the interventions described in Section 4 of this report is considered appropriate for preserving the environmental protection systems of the landfill and the post-closure care operations. Still, a review of the three proposed options shows that there are some differences among the alternatives in terms of construction impacts to landfill infrastructure.

5.4.1 Landfill Closure Cover System

The Forest Hill Road and Richmond Hill Road Extensions traverse East Mound, landfill section 6/7, and pass over the landfill closure cover system. The lateral extent of the road embankment is greater for the Four-Lane Alternative and the Hybrid Alternative than for the Two-Lane Alternative. Consequences of the differences are explored below.

- A wider embankment results in settlement over a larger area and applies more weight to the cover system and the waste and soils beneath the road, which could result in a lower degree of stability and increased stress on the closure system's geomembrane layer. Based on preliminary analysis, none of the options results in instability and therefore none of the alternatives is expected to impact the closure cover system integrity or performance. Impacts to the closure cover system are not believed to be significantly different for the three alternatives.
- The larger lateral extent the road embankment associated with the Four-Lane Alternative and the Hybrid Alternative over the Two-lane Alternative, results in settlement over a larger area.

Although the differences in impacts to the closure cover system among alternatives are not believed to be highly significant, the Two-Lane Alternative results in the least impact.

5.4.2 Landfill Gas Management System

The landfill gas management system (i.e., gas wells, header transmission pipes, condensate traps, and the landfill gas flare stations) will be impacted by the Confluence Loop road (North, East, and South), the Richmond Hill Road Extension, and the Forest Hill Road Extension. These roads will be located over existing gas wells and transmission pipes under all three alternatives, but will not impact any flare stations.

- The Four-Lane Alternative will require upgrading approximately 960ft of header transmission pipe and 4 gas wells.
- The Two-Lane Alternative will require upgrading approximately 640 ft of header transmission pipe and 2 gas wells.
- The Hybrid Alternative will require upgrading approximately 900ft of header transmission pipe and 4 gas wells.
- The impacts of all alternatives can be mitigated using measures described earlier in the report.

The impacts from the Four-Lane Alternative are slightly greater than those of the Two-Lane and Hybrid Alternatives, but on the whole relatively minor.

5.4.3 Stormwater Management System

Each road alternative impacts several of the stormwater management basins at the site.

- The Four-Lane Alternative impacts the largest volume of stormwater management pond storage, particularly in Basin B1.
- The Two-Lane Alternative impacts the smallest volume.
- The Hybrid Alternative fares similarly to the Two-Lane Alternative.

Each of the three options requires adjustments to the stormwater management system to accommodate the loss of capacity in basins B1, C2, F, and Q. The differences in the impacts are between the two-lane and four-lane configurations are relatively minor at Basins C2. F and Q, whereas the difference is more pronounced at Basin B1.

While adequate capacity can be developed on site to provide the needed stormwater volume, the Four-Lane Alternative would require the most extensive adjustments.

5.4.4 Leachate Management System

All three alternatives cross the leachate management system four times as they traverse East Mound, landfill section 6/7, along both the RHR and FHR Extensions. All alternatives also encroach on the existing slurry cutoff wall and leachate perimeter collection trench again at the north end of the RHR Extension. By design, all leachate pump stations are avoided by all three alternatives.

- At-grade slurry cutoff wall crossings are to be protected with a concrete slab designed to transfer, distribute the dissipated load away from the wall.
- The Four-Lane Alternative affects an additional length of cutoff wall and leachate collection trench at the north end of the RHR Extension.
- The wider footprint of the Four-Lane Alternative, and of the Hybrid Alternative along the Forest Hill road Extension, cover a longer length of the leachate collection system, increasing the difficulty of gaining access should an intervention ever become necessary.
- All three alternatives propose bridges where the RHR and FHR Extensions descend the east side of the mound. The Four-Lane Alternative requires wider bridges and longer end piers within the landfill. The Hybrid Alternative requires a wider bridge and longer pier at the FHR Extension.
- East Loop Road Option 1 crosses the leachate collection system at one additional location under the Four-lane Alternative.

In sum, the Two-Lane Alternative results in the least, and the Four-Lane the most interaction with the leachate management system.

5.4.5 Environmental Monitoring System

Each road alternative minimizes impacts to hydraulic, groundwater, landfill gas monitoring wells. Each alternative preserves access to the existing network of environmental monitoring system elements.

- One landfill gas monitoring well along FHR Extension is affected by the Four-Lane Alternative.
- One groundwater monitoring well along the RHE Extension is affected by the Two-Lane and Hybrid Alternatives.

Other than the two monitoring wells identified, there are no significant differences among the three roadway alternatives in terms of impacts to the environmental monitoring system.

5.4.6 Design Considerations

It is important to note that construction of roadways over landfills is neither uncommon nor a pioneering venture. Roadways have been successfully constructed over many landfills, as documented in the September 2007, Fresh Kills Park Conceptual Roads Report. Preparation of a design for a road over a landfill requires combining well understood analysis methods and construction methodologies from geotechnical engineering, landfill engineering, and road engineering practices, in order to address the variety of issues involved. The methods proposed for mitigating the impacts of roadway construction on landfill infrastructure have been demonstrated to be reliable at many landfills. Some of these mitigation methods include:

- Analyzing settlement and impacts to landfill cover systems resulting from placement of roadway embankments, and monitoring the cover system to verify that it is accommodating landfill settlement without compromising the performance of the landfill cover system.
- Modifying landfill infrastructure features (e.g., landfill gas wells, condensate collectors, culverts, monitoring wells, etc.) without any loss in the continuous record of monitoring history or reliability.
- Incorporating post-construction monitoring systems into a design.

Each of the interventions described in Section 4 of this report is considered appropriate for preserving the environmental protection functions of the landfill's closure and post-closure care systems.

5.5 Environmental

All of the proposed roadway alignments encroach on freshwater and tidal wetlands. The design attempted to place roads above flood level and the wetland boundaries wherever possible, but landfill engineering and maintenance criteria constrain alignment options. The entire edge of the site is bounded by wetlands; in order to enter the site from Richmond Avenue, it is necessary to cross them.

While unable to avoid negative impact on wetlands, mature trees, and other ecological resources, the design proposes to offset limited habitat losses by creating an extensive system of healthy wetlands, meadows and woodland. In the preliminary design (PDI) phase, the design of the landscape corridor around the road as a robust habitat and stormwater treatment system will be developed.

- The Four-Lane Alternative results in approximately 8.56 acres of wetland impact.
- The Two-Lane Alternative results in approximately 5.55 acres of wetland impact.
- The Hybrid Alternative results in approximately 6.34 acres of wetland impact.

Clearly the Four-Lane Alternative results in the greatest impact, affecting 3.01 acres (or 54%) more than the Two-Lane Alternative, and 2.22 acres or 35% more than the Hybrid Alternative.

Wetland permitting will be required, including DEC Tidal wetlands, US Army Corps of Engineers jurisdictional freshwater wetlands and possibly new NYDEC freshwater jurisdictional wetlands (if designated and adopted by NYDEC).

5.6 Park

All of the alternatives provide access to park features and scenic views of park natural features.

- The Two-Lane Alternative succeeds to a greater degree in limiting the visual and physical intrusion of the road in the landscape.
- The Two-Lane Alternative is consistent with park design intentions to provide access to the huge site and its features, while prioritizing bike, pedestrian and boater experience over cars.
- If traffic demand does not warrant a wider roadway, there is no advantage to either the Four-Lane or Hybrid from a park perspective, and given the intention to limit the physical presence of roadways and interference with wetlands, the Four-Lane and Hybrid are less desirable from a park perspective.
- The two-lane road affords opportunities for a greater degree of grade separation between pedestrian paths and bikeways and the roads.
- The Four-Lane Alternative requires new pedestrian/bicycle bridges across Main Creek and Richmond Creek; these will be expensive to build and present an opportunity cost for the park.
- The Two-Lane Alternative provides more room on side slopes for native plantings and enhanced stormwater management design, which will provide a habitat corridor and buffer adjacent pedestrian and bike paths.

None of the roadways is optimal in terms of enhancement of movement experience with curvilinear layouts, graceful ascents and descents. Alignment options are constrained by landfill and environmental concerns

From a park perspective, the Two-Lane is the most favorable and the Four-Lane the least favorable of the alternatives.

5.7 Traffic Operations

A summary of the traffic analysis performed for the proposed project is presented in section 3.1. The analysis indicates that traffic levels within the park will be low, at less than half the capacity of two-lane roads on all park roads.

Normal traffic operations are expected to be satisfactory for all three alternatives.

The Four-Lane Alternative adds spare capacity on all legs of the primary park road network. The Hybrid alternative adds capacity along the Forest Hill Road Extension-South Loop Road link, and East Loop Road. The spare capacity will provide added flexibility in dealing with incidents, major events,

and roadway maintenance. However, as can be seen from section 5.8 below, the added flexibility comes as considerable cost.

An important consideration in selecting a preferred alternative is whether the benefit from the added flexibility is a sufficient to justify a higher cost.

5.8 Costs

The estimated costs of the proposed park roads in 2016 dollars, exclusive of the signature bridge, are $243 Million for the Four-Lane Alternative, $179 Million for the Two-Lane Alternative and $216 Million for the Hybrid Alternative.

In other words, the estimated park roads costs of the Four-Lane Alternative are $64 Million or 36% higher than the Two-Lane Alternative. The Hybrid Alternative costs are $37 Million or 21% higher than the Two-Lane alternative. The gain from the greater investment would be added flexibility in the case of incidents, major events, and road maintenance activities.

There may be opportunities for savings if the viaduct that carries the Forest Hill road Extension over wetlands, estimated at $51 Million for the Four-Lane and Hybrid Alternatives and $34 Million for the Two-Lane Alternative, can be shortened without introducing unacceptable impacts on the wetlands.

The West Shore Expressway access improvements are a fundamental part of the park primary system. Their costs are and additional $58 Million regardless of which park road alternative is selected for implementation.