May 2014

Final Environmental Impact Statement
& Section 4(f) Evaluation

VIRGINIA AVENUE TUNNEL RECONSTRUCTION

Appendices B to K

Federal Highway Administration

District Department of Transportation

Appendix B

Concepts Evaluation Technical Report

July 17, 2012

Virginia Avenue Tunnel Reconstruction Project

Concepts Evaluation Technical Report

Version 2

DRAFT

Submitted to: District Department of Transportation

Submitted by: Parsons Brinckerhoff

CSX How tomorrow moves

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1 Introduction

The Federal Highway Administration (FHWA), in cooperation with the District of Columbia Department of Transportation (DDOT) and CSX Transportation, Inc. (CSX), are preparing an Environmental Impact Statement EIS) in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended, for CSX's proposal to replace the existing Virginia Avenue Tunnel, located in the Capitol Hill neighborhood of the District of Columbia (District or DC). The Virginia Avenue Tunnel is wholly owned and operated by CSX.

The purpose of the Project is to replace the aging Virginia Avenue Tunnel with a facility that would provide for the long-term freight transportation needs of the rail network in the District and throughout the I-95 corridor. The existing Virginia Avenue Tunnel is deficient for the following reasons:

- With a single-track, the tunnel is a major chokepoint in CSX's rail network in the District, which is part of CSX's national network along the east coast;
- The tunnel has insufficient vertical clearance for CSX to operate double-stack intermodal freight trains; and
- At over 100 years old, the tunnel is nearing the end of its useful life and is subject to an ever increasing level of maintenance and repairs.

The following needs and objectives for the Project have been identified:

- Correct Deficiencies of Virginia Avenue Tunnel
- Address Freight Transportation Demand and Need for Additional Capacity
- Maintain Freight Traffic During Construction
- Minimize Construction Duration and Impacts to Community, Including Impacts to Traffic, Pedestrians and Cyclists
- Keep Communication Open Throughout NEPA and Construction

This project also intends to accomplish its goals in a manner that provides community enhancements to improve the aesthetic condition of Virginia Avenue. The purpose of this report documents the concept development and evaluation process, and introduces a range of concepts that could be eligible for consideration as alternatives for inclusion in the EIS in accordance with the NEPA. This report also describes the screening process used to identify those concepts that would be recommended for retention and further evaluation, as well as those concepts recommended for elimination because they would not qualify as "reasonable" alternatives for the proposed project.

Version 1 of this report was submitted to DDOT on March 26, 2012. The current version of this report (Version2) reflects DDOT's decision to carry three of the concepts identified in this report in the upcoming EIS as project alternatives.

2 Project Concepts

In order to develop reasonable alternative concepts that would address the Project's Purpose and Need, a preliminary assessment of the engineering and physical constraints was conducted along the alignment of the existing tunnel. In addition, DDOT and FHWA sought input from Federal and District agencies, interested parties and the general public. From these activities, 12 preliminary alternative concepts were developed. Concept 1 is the no action or no build condition. Concepts 2 to 7 involve the "rebuilding" of the Virginia Avenue Tunnel. Concepts 8 to 11 involve "rerouting" CSX's mainline rail line outside of the Virginia Avenue SE corridor. Concepts 9 and 10 were taken from a study conducted by the National Capital Planning Commission (NCPC) in 2007 titled, the Railroad Realignment Feasibility Study. The NCPC study identified alternative routes for CSX to relocate its I-95 corridor away from the District, but still within the Washington Metropolitan Area. Concept 3A was developed after development of the 11 original preliminary concepts.

2.1 Concept 1: No Build

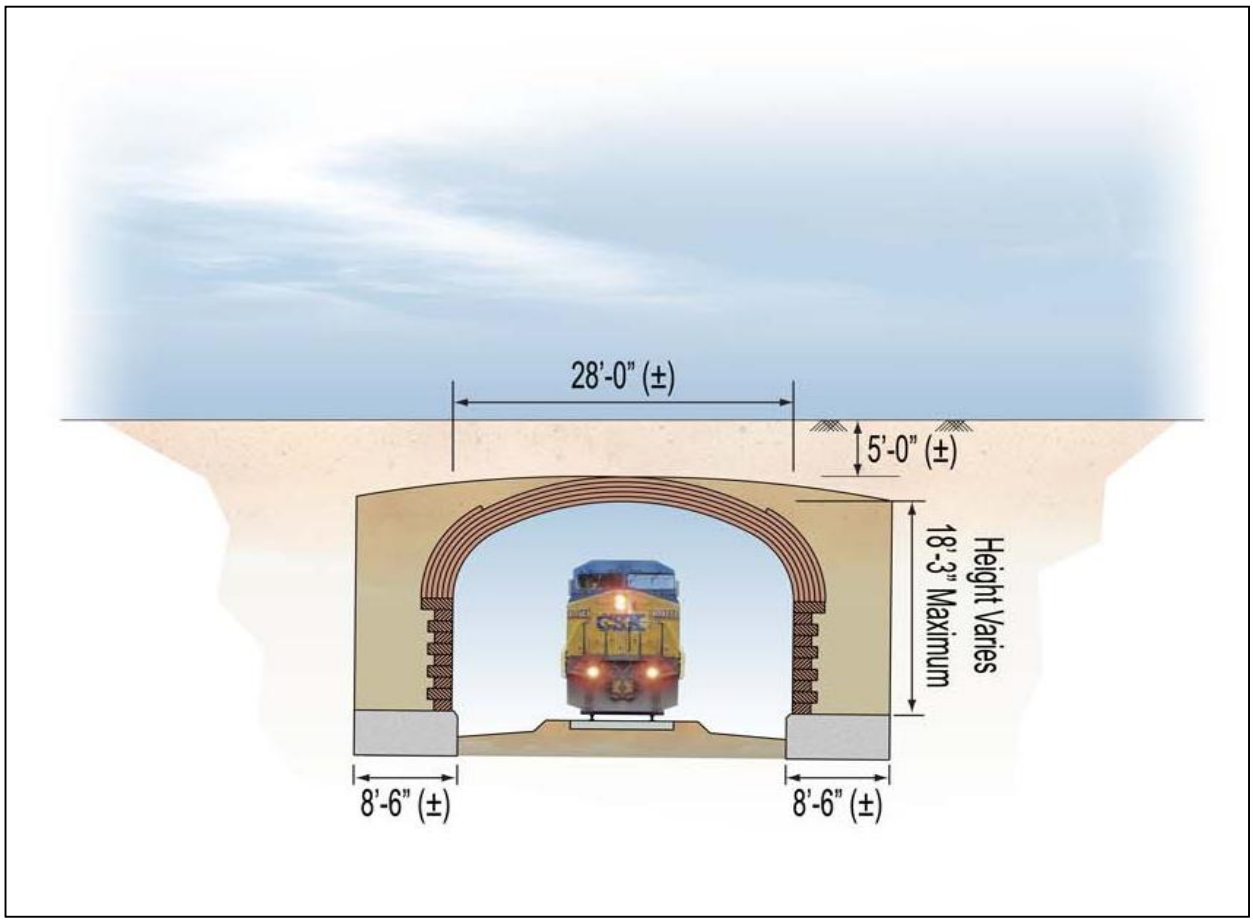
Because the EIS must include a "no action" alternative, the "no build" concept will be considered as an alternative that is carried throughout the NEPA environmental review process and is used as a point of comparison against the project's "build" alternatives (Figure 1). Under Concept 1, the existing single-track, single-stack tunnel would remain. Because the no action alternative preserves the use of the Tunnel for local rail customers, and rail operations would continue through the Virginia Avenue Tunnel, Concept 1 may involve emergency or unplanned repairs of the tunnel at some point in the future, which may require closure of at least part of Virginia Avenue SE in order for CSX to make the repairs. In addition, the tunnel would eventually require rehabilitation or replacement.

2.2 Concepts 2 to 7: Rebuild Virginia Avenue Tunnel

Concepts 2 to 7 involve the replacement of the existing Virginia Avenue Tunnel generally along its current alignment. Regardless of the "rebuild" concept (2 through 7), the new tunnel(s) would be constructed using a "cut-and-cover" methodology that would require excavation beneath and along Virginia Avenue SE to expose the existing tunnel from the top. Concepts 2, 3, 4 and 7 would involve constructing a new permanent tunnel. Concepts 2, 3 and 4 would involve construction of a temporary open trench along the side of the tunnel to maintain freight operations during construction. Concept 7 would not involve construction of an adjacent temporary open trench, but instead would temporarily detour freight trains through Union Station and other rail routes outside the District. Cut-and-cover (for Concepts 2, 3, 4, and 7) would involve excavating a trench adjacent to and over the existing tunnel; removing portions of or all of the existing tunnel; reconstructing a new tunnel floor (including permanent tracks), walls, and roof, and backfilling the trench, burying the new tunnel. Concepts 3A and 5 involve construction of new permanent twin tunnels. Concept 6 would involve construction of a new permanent tunnel in stages while maintaining freight rail traffic in one half of the tunnel at all times, and would involve installing support of excavation at the outside face of the existing

tunnel walls then rebuilding the new tunnel elements in two stages each, floor, walls and roof. All work for Concept 6 would be done within the existing tunnel footprint. Concepts 3A, 5 and 6 would not involve construction of a temporary open trench.

Figure 1: Concept 1: No Build



Upon completion of tunnel construction, the street and other affected areas would be restored. The restored roadway configuration of Virginia Avenue may change. The number of lanes may change and new pedestrian, parking and cycling amenities could be provided, regardless of the concept selected. Construction work hours would be the same for all concepts, and would allow work during weekday, daylight hours through project completion.

The construction area under all the rebuild concepts would be within the Virginia Avenue SE right-of-way, with the exception of the U.S. Marine Corps recreation facility located between 6th and 7th Streets SE and Virginia Avenue Park located near the east end of the tunnel.

The rebuild concepts would differ in how each would maintain freight operations during construction. Concepts 2, 3 and 4 would provide a temporary detour or "runaround" track in

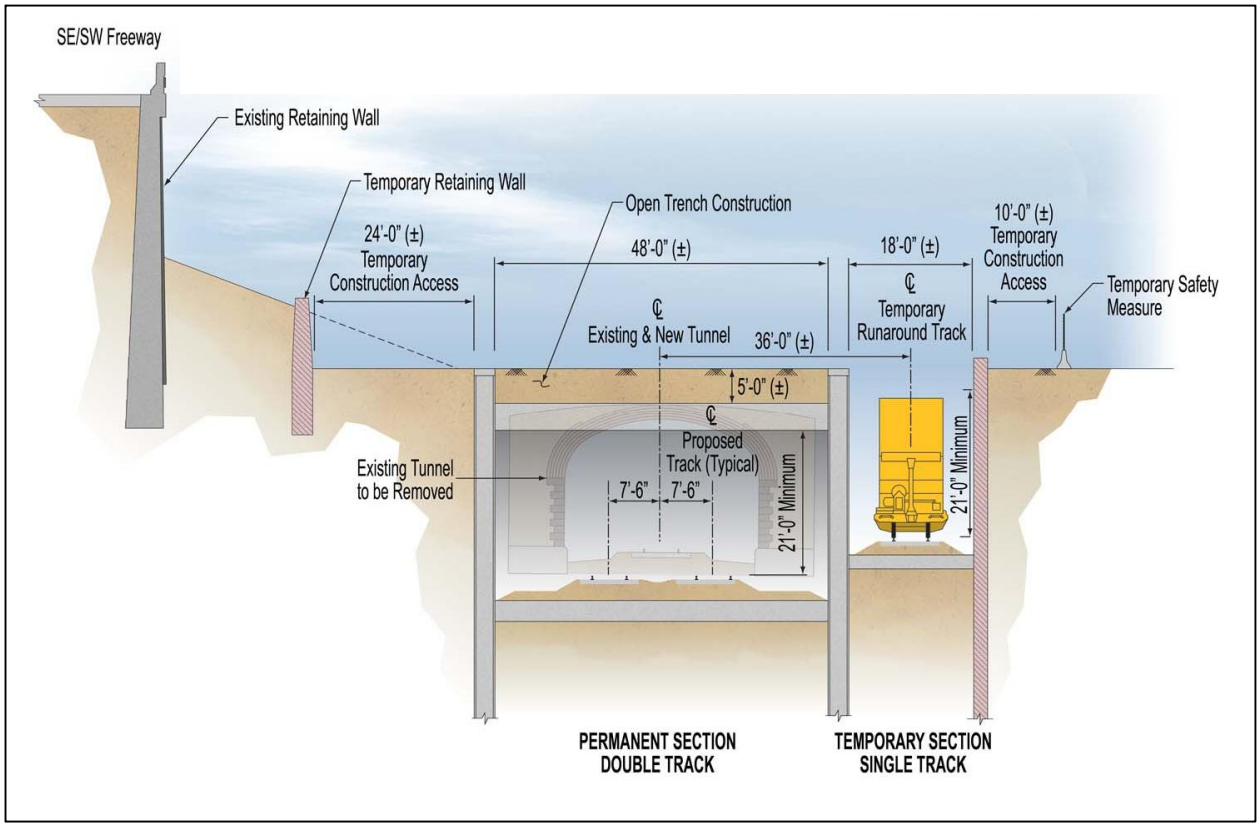
an open trench and within the Virginia Avenue SE right-of-way. Concepts 3A and 5 would not require temporary facilities to maintain freight rail operations. Concept 6 would maintain freight operations within the existing envelope of the Virginia Avenue Tunnel. Concept 7 would temporarily reroute freight trains outside the District during construction.

Following construction of any of the rebuild concepts, CSX would be able operate freight trains using double-stack intermodal container cars through the new tunnel(s) because at least 21 feet of vertical clearance would be provided. In addition, the tunnel would be double-tracked to improve the fluidity/operations of the rail line. The post-construction condition of double-track/double-stack (DT/DS) within the new Virginia Avenue Tunnel is a common characteristic among the "rebuild" concepts, with the exception of Concepts 3A and 5. Under Concepts 2, 3, 4, 6 and 7 the new Virginia Avenue Tunnel would largely be the same. Concepts 3A and 5, on the other hand, would provide two tunnels, each containing a single set of tracks, and both having the necessary vertical clearance to accommodate double-stack intermodal container freight trains. More detailed descriptions of Concepts 2 to 7 are provided below.

2.2.1 Concept 2: Rebuild, Temporary South Side Runaround

The Project under Concept 2 would reconstruct the existing single-track Virginia Avenue Tunnel into a new DT/DS tunnel within the approximate existing horizontal envelope of Virginia Avenue Tunnel, which is approximately 48 feet wide (Figure 2). To maintain freight traffic during construction of the new tunnel, Concept 2 would provide a temporary runaround track placed inside an open trench constructed immediately south of the existing tunnel alignment. The purpose of placing the temporary runaround track/trench for Concept 2 on the south side of the existing tunnel is to avoid the long-term closure during construction of the Southwest Freeway (hereinafter to referred to as I-695) off- and on-ramps located at 6th and 8th Streets SE, respectively. Intermittent short-term closures of the ramps may be required for maintenance of traffic shifts. On the west end, the temporary runaround track would connect with the existing track near the New Jersey Avenue overpass. At the east end, the temporary runaround track would connect with the existing track in the vicinity of 14th Street SE. Upon completion of the new Virginia Avenue Tunnel, the runaround track would be removed, the trench would be backfilled, and the surface of Virginia Avenue SE and other disturbed areas would be restored.

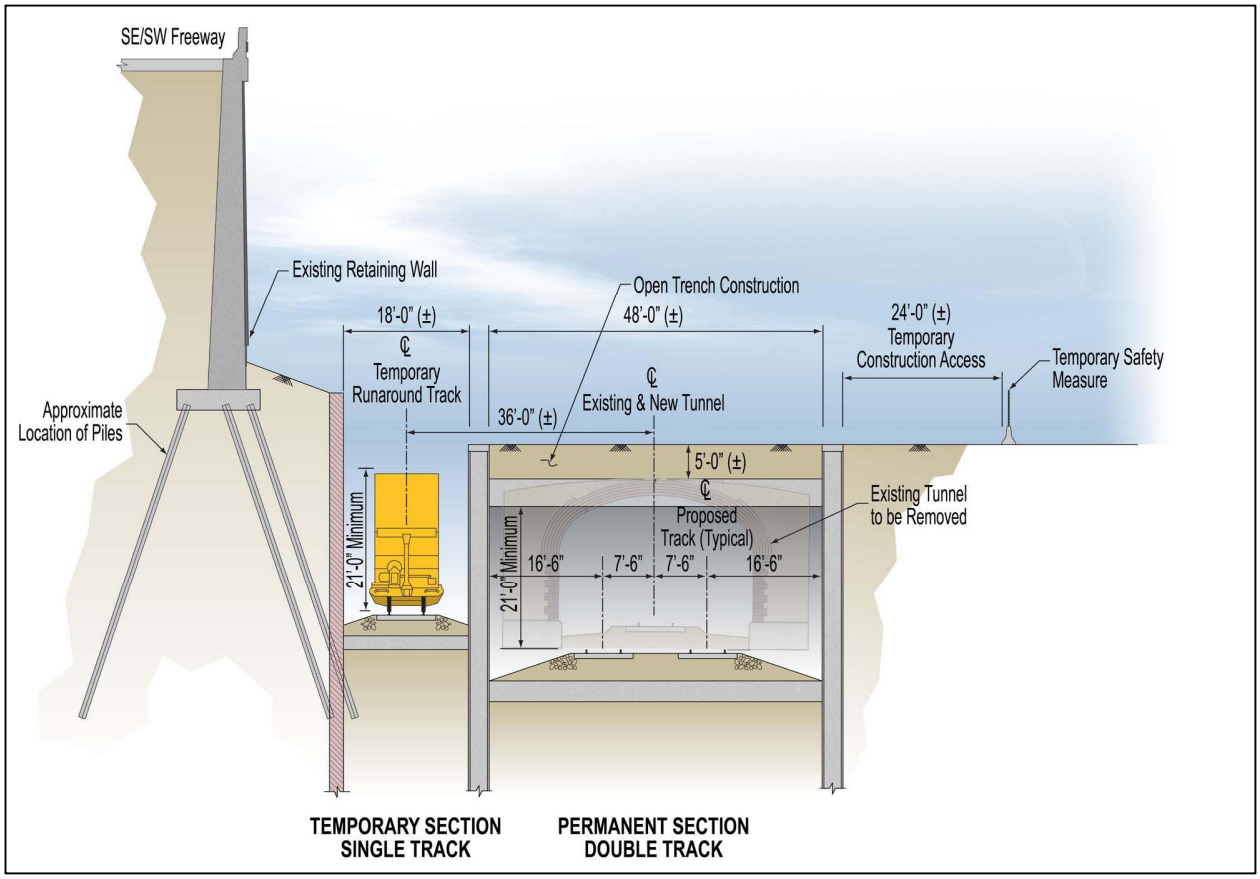
Figure 2: Concept 2: Rebuild, Temporary South Side Runaround



2.2.2 Concept 3: Rebuild, Temporary North Side Runaround

The Project under Concept 3 would be similar to Concept 2, except that instead of placing the temporary runaround track/trench on the south side of the tunnel alignment, it would be aligned immediately north of the existing tunnel alignment, or located between the existing tunnel and the I-695 viaduct (Figure 3). The purpose of placing the temporary runaround track/trench under Concept 3 on the north side of the existing tunnel is so that the temporary freight operations are located as far from existing land uses on the south side of Virginia Avenue, but still within the confines of the public right-of-way. Similar to Concept 2, the temporary runaround track would connect with existing track in the vicinity of New Jersey Avenue overpass on the west end and 14th Street SE on the east end. Due to the temporary runaround track/trench's proximity to I-695, long-term (throughout most of the construction duration) closures of the 6th Street off-ramp and 8th Street on-ramp would be required. It may be possible to stagger these closures so only one of the ramps is closed at a time, but long-term closure and disruptions would still be required. Upon completion of the new Virginia Avenue Tunnel, the runaround track would be removed, the trench would be backfilled, I-695 ramps would be reopened, and the surface of Virginia Avenue SE and other disturbed areas would be restored; the same as under Concept 2.

Figure 3: Concept 3: Rebuild, Temporary North Side Runaround

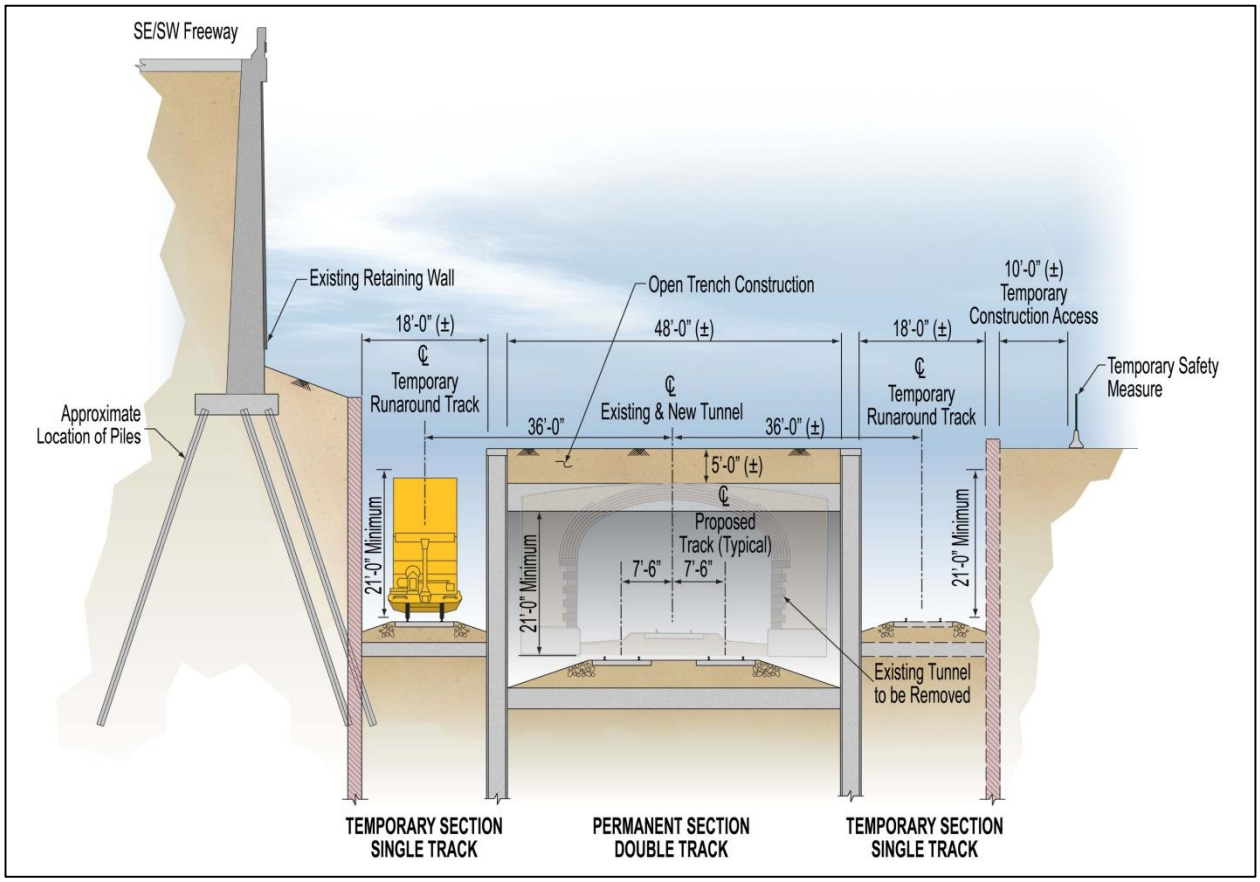


2.2.3 Concept 4: Rebuild, Temporary Combination Runaround

Concept 4 is also similar to the Concepts 2 and 3 in that the new Virginia Avenue Tunnel would be reconstructed generally within the existing horizontal envelope of the existing tunnel. Instead of placing the temporary runaround track/trench on one side or the other (north or south of the existing tunnel), it would have a serpentine alignment, crossing the existing tunnel at two locations (Figure 4). The purpose of the serpentine temporary runaround track/trench under Concept 4 is to try to minimize placing temporary freight operations near particular land uses on the south side, notably the Capitol Quarters residential community, and avoid the long-term closure of the I-695 ramps on the north side. On the west end, the detour track would veer from the existing track in the vicinity of the New Jersey Avenue overpass in the same manner as under Concept 2, and continue on the south side of the existing tunnel between 2nd and 5th Streets SE within an open trench. At 5th Street SE, the temporary runaround track/trench would transition to the north side of the existing tunnel. At 8th Street SE, the temporary runaround track/trench would transition back to the south side of the existing tunnel. The temporary runaround track would join the existing track in the vicinity of 14th Street SE. It should be noted that moving runaround alignment to the north side of the existing

tunnel between 2nd and 5th Streets SE conforms essentially to Concept 3. Upon completion of the new Virginia Avenue Tunnel, the runaround track would be removed, closure pours would be completed on the new tunnel, the trench would be backfilled, and the surface of Virginia Avenue SE and other disturbed areas would be restored, the same as under Concepts 2 and 3.

Figure 4: Concept 4: Rebuild, Temporary Combination Runaround

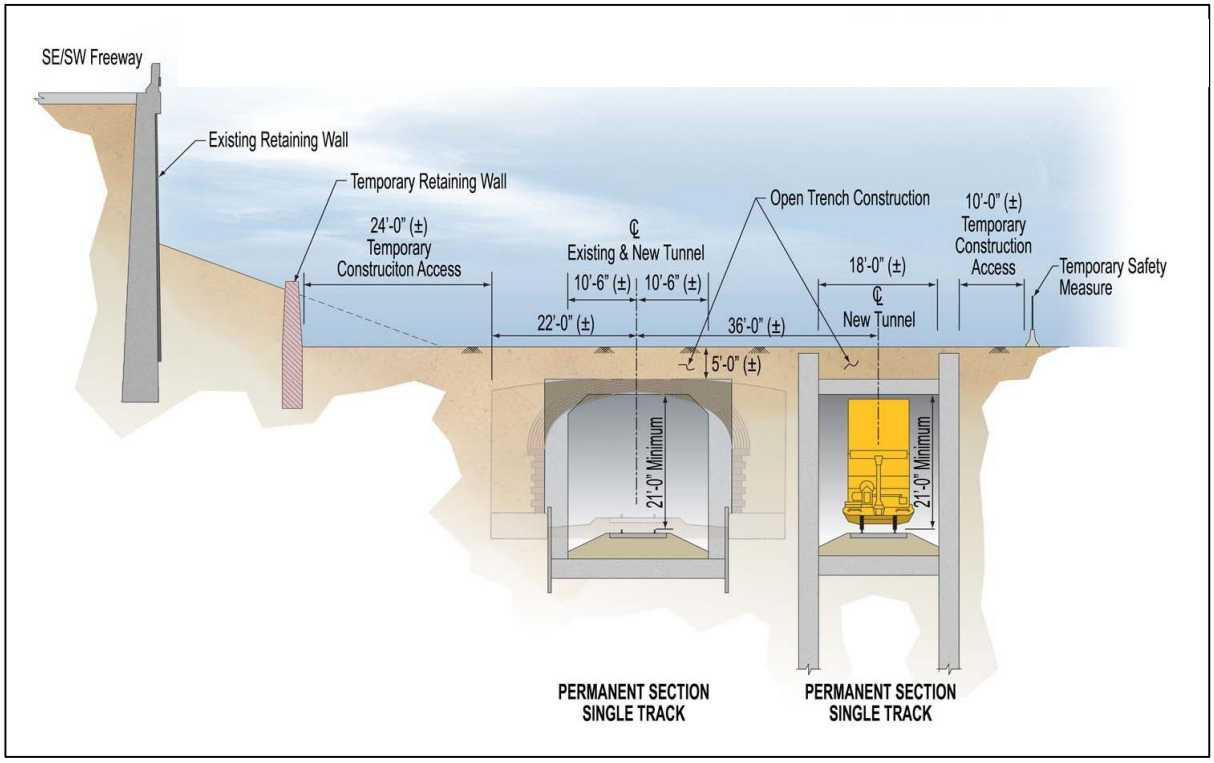


2.2.4 Concept 5: Rebuild, Permanent Twin Tunnels (New Tunnel on South Side of Existing Virginia Avenue Tunnel)

The new Virginia Avenue Tunnel under Concept 5 would be different than the new Virginia Avenue Tunnel under any of the previously described concepts. Upon completion, Concept 5 would result in the construction of two single-track/double-stack (ST/DS) tunnels (Figure 5). The purpose of Concept 5 is to avoid having to construct temporary facilities to maintain freight operations during construction. One of the ST/DS tunnels would occupy the space generally within the existing tunnel envelope. The other would have an alignment very similar to the alignment of the temporary runaround track/trench under Concept 2, or along the south side of the existing tunnel. The south side ST/DS tunnel would be constructed first. On the west end, the new permanent track would connect with the existing track near the New Jersey Avenue

overpass. At the east end, the new permanent track would connect with the existing track in the vicinity of 14th Street SE. Both new tunnels would be constructed using a cut-and-cover methodology. Once completed, the new permanent ST/DS tunnel would serve as a route for two-way train traffic while the existing tunnel is reconstructed and converted into a new ST/DS tunnel. Upon completion of the second ST/DS Virginia Avenue Tunnel, train traffic would be split with one-way traffic in each tunnel, and the surface of Virginia Avenue SE and other disturbed areas would be restored, the same as under Concepts 2, 3 and 4.

Figure 5: Concept 5: Rebuild, Permanent Twin Tunnels (New Tunnel on South Side of Existing Virginia Avenue Tunnel)



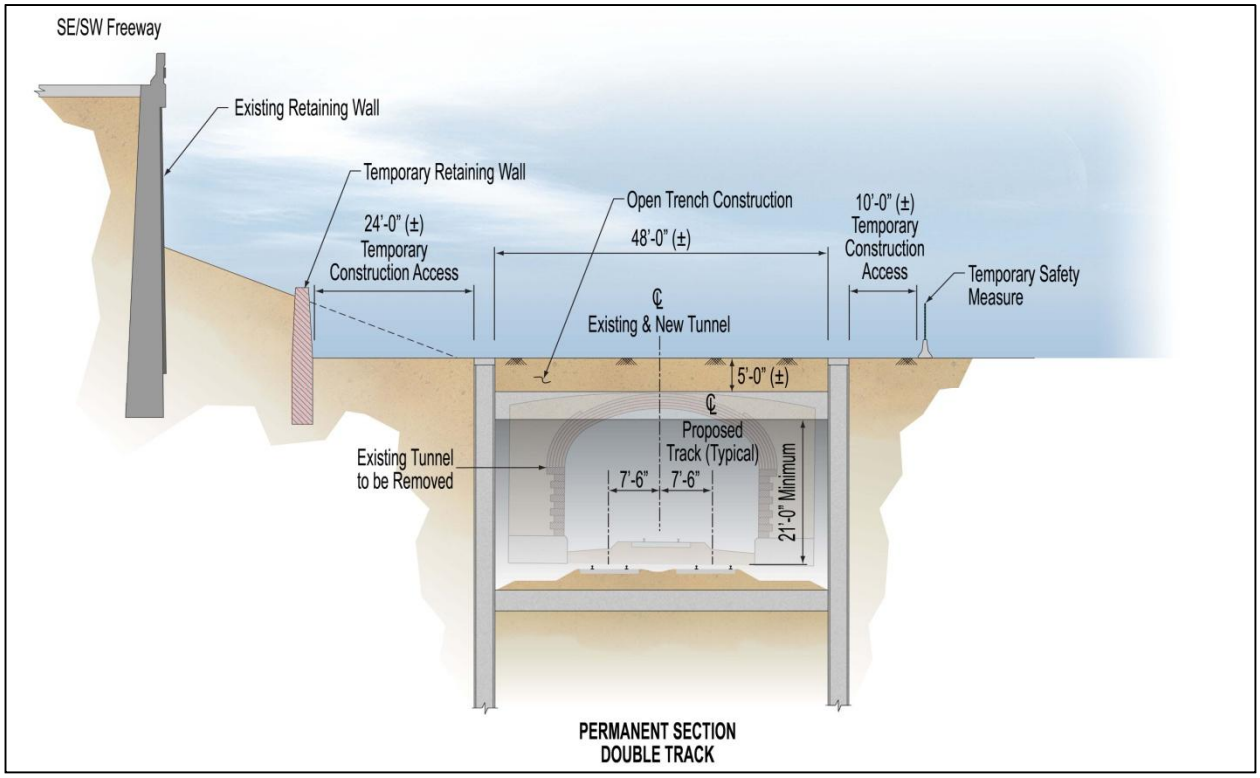
2.2.5 Concept 6: Rebuild With On-Line Construction

The Project under Concept 6 would be similar to Concepts 2 to 4 in that it would result in largely the same kind of new DT/DS tunnel within the existing 48-foot wide tunnel envelope (Figure 6). Concept 6 is different from Concepts 2 to 4 in that a runaround track/trench would not be provided to maintain freight rail traffic during construction. Instead, demolition of the old tunnel and construction of the new tunnel would occur in numerous phases with regularly shifting track alignments and all work occurring in very close proximity to live train traffic allow CSX to operate trains through the construction work area (within the 48-foot existing tunnel envelope) on a daily basis. The purpose of Concept 6 is to avoid having to construct a

temporary runaround track/trench and still maintain freight rail traffic through the Virginia Avenue SE corridor.

Concept 6 would require substantial coordination between CSX and the construction contractor to safely allow trains to pass through the construction zone on set schedules. Inevitably, this extremely complicated coordination has the potential to cause delays to both freight rail operations as well as increase the duration of construction in the Virginia Avenue SE corridor. The contractor would be under the daily obligation to ensure the rail lines through the work area are operational at all times. Therefore, this concept is a tradeoff: substantial time and effort would be allocated to activities that do not involve either demolishing the existing tunnel or rebuilding the new tunnel, and in return, a runaround track would not be used. Upon completion of the new Virginia Avenue Tunnel, the surface of Virginia Avenue SE and other disturbed areas would be restored.

Figure 6: Concept 6: Rebuild With On-Line Construction

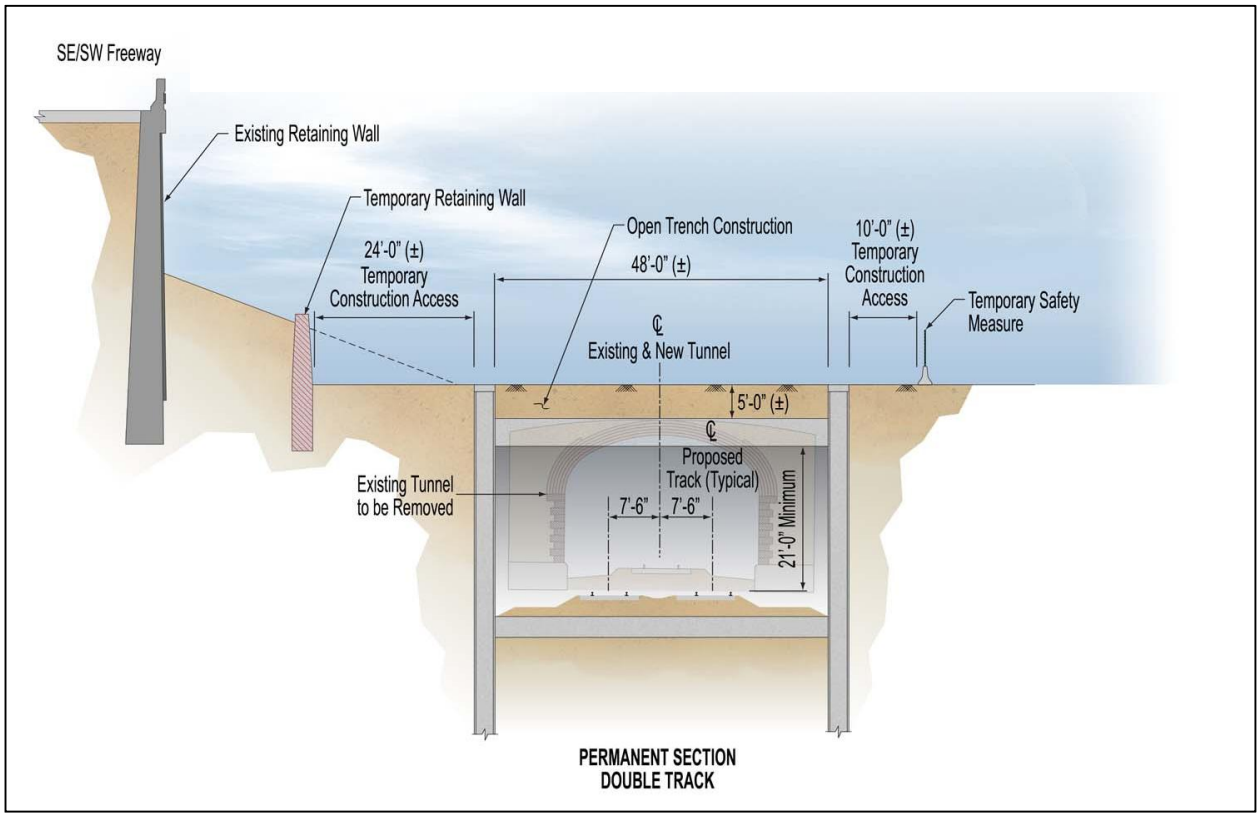


2.2.6 Concept 7: Rebuild, Temporary Reroute

Concept 7 is similar to the Concepts 2, 3, 4 and 6 in that the new Virginia Avenue Tunnel would be reconstructed generally within the existing horizontal envelope of the existing tunnel (Figure 7). Instead of accommodating the temporary train traffic within the Virginia Avenue SE corridor as would be done under Concepts 2, 3, 4 and 6, Concept 7 would temporarily detour freight

trains through Union Station and other rail routes outside the District. Figure 8 depicts the existing rail network in the immediate project area including the rail lines and users/carriers, including CSX and Amtrak. The corridor symbolized as mixed traffic can be defined as owned and operated by CSX, but also used by Amtrak and VRE. Without running through the Virginia Avenue Tunnel, the traffic must operate over other principal routes and all bypass options involve significant additional train mileage and running time. These potential bypass routes are discussed in the following paragraphs and are illustrated in Figure 9.

Figure 7: Concept 7: Rebuild, Temporary Reroute



CSX Southern Bypass Route – Northbound trains originating in Florida and destined for northeastern points would divert from the I-95 Corridor Route at Waycross, GA and be routed through Atlanta GA, Knoxville TN, Cincinnati and Cleveland OH, Buffalo NY, and into Selkirk Yard (located in the vicinity of Albany, NY). Selkirk Yard is a major classification yard where trains are separated and their cars are placed into groups bound for the critical New Jersey-New York area or for New England. For traffic destined to Baltimore and Philadelphia, the routing would be by way of Cincinnati or Columbus, OH - Pittsburgh PA - Cumberland MD, to Baltimore/Philadelphia.

Figure 8: Existing Rail Network in Vicinity of Virginia Avenue Tunnel

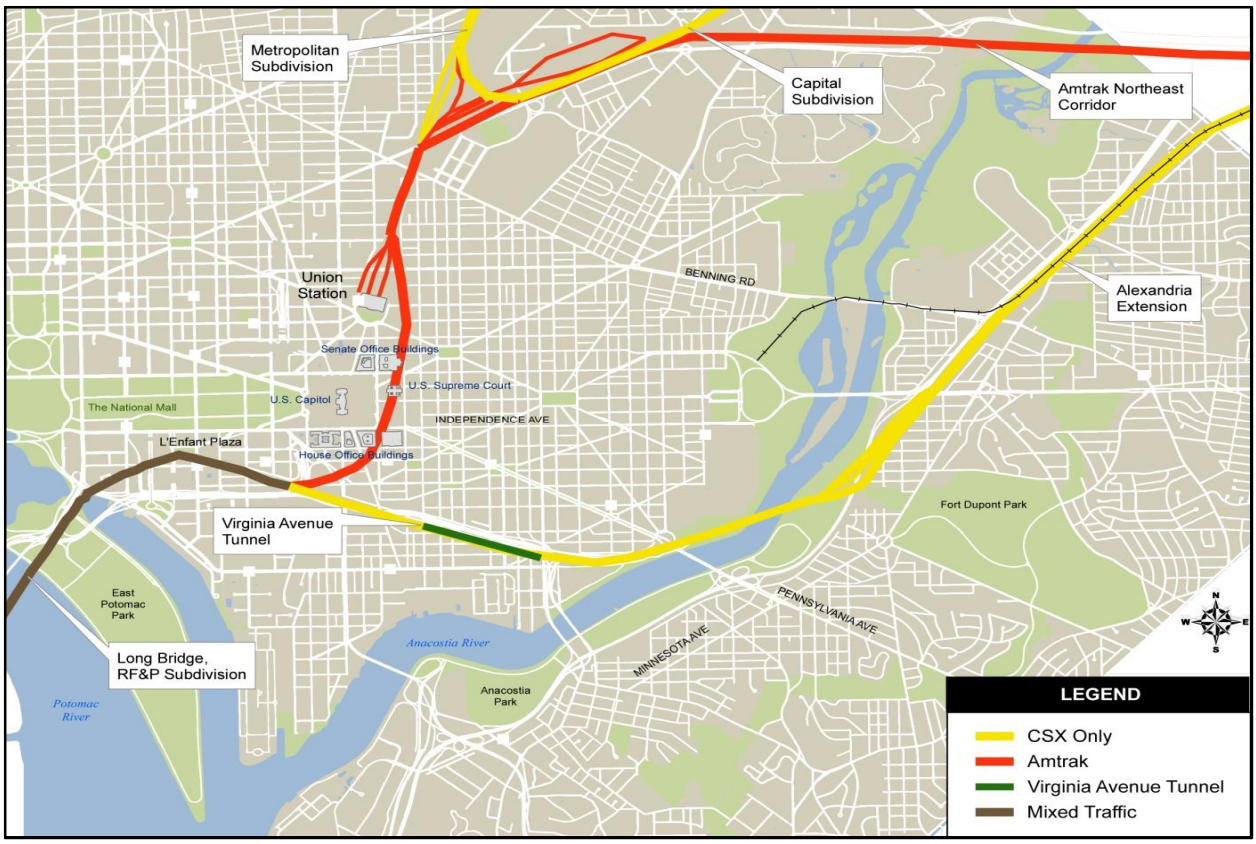
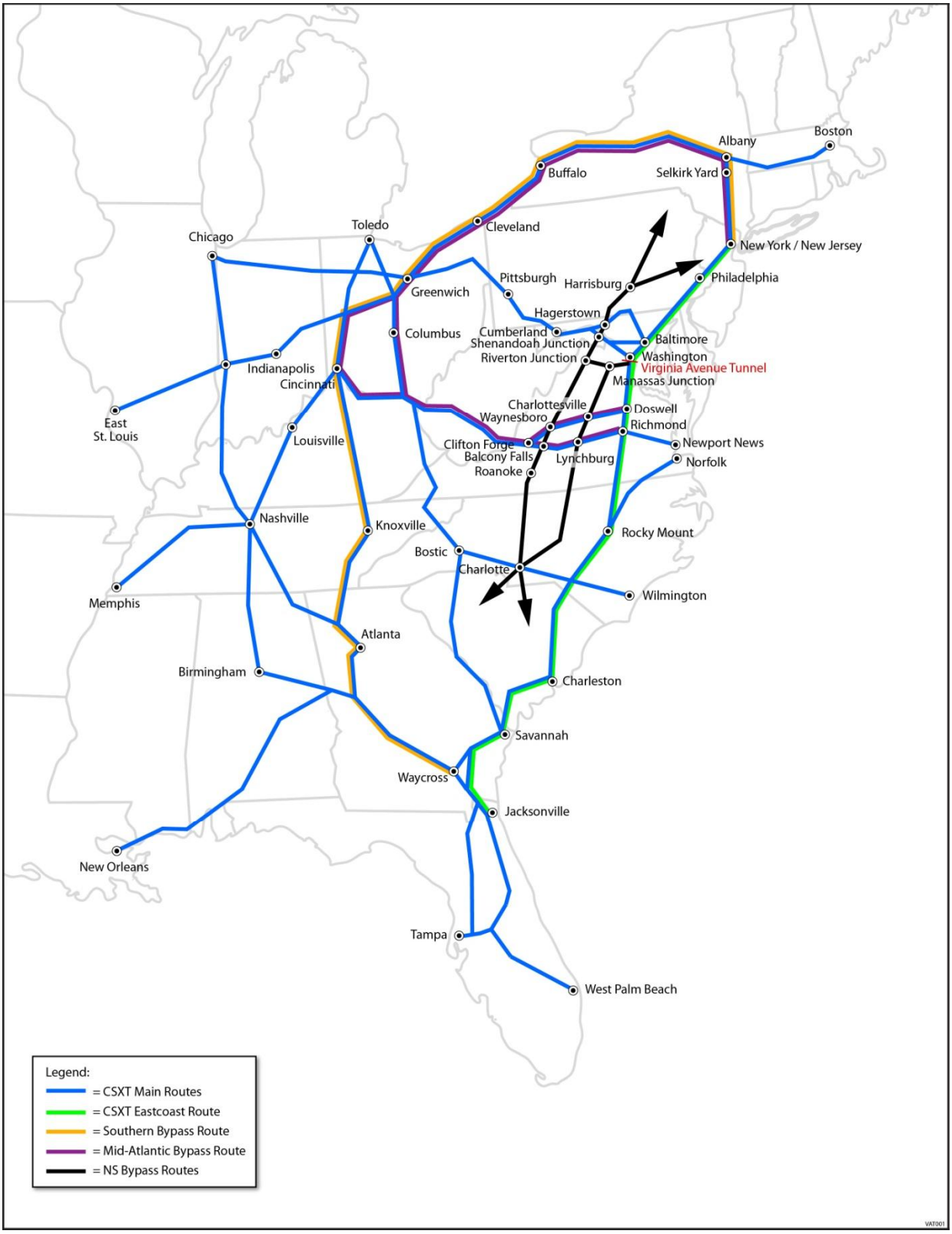


Figure 9: Concept 7: Temporary Freight Train Detour Outside the District



The segment between Waycross, GA and Cleveland (Greenwich), OH is essentially a single-track rail line with passing sidings. Much of this single-track route is already at capacity and cannot accommodate significant increases in trains per day. Also, operating characteristics limit train length.

Between Cleveland (Greenwich) OH and Selkirk Yard, a double-track mainline exists. It should be noted that New Jersey bound cars from Selkirk Yard require a south backhaul move of an additional 130 miles over a congested single-track segment between Selkirk and North New Jersey. In total, the Southern Bypass Route adds over 800 miles between Jacksonville FL and New Jersey points.

Southbound Florida trains originating at Selkirk Yard would use the reverse routing through Waycross GA.

CSXT Mid-Atlantic Bypass Route - Northbound trains originating in the Carolinas would use the I-95 Corridor Route to Richmond VA, then divert to the Mid-Atlantic Route and proceed through Lynchburg and Clifton Forge VA, Huntington WV, Columbus and Cleveland OH, and on to Selkirk Yard. As with the Southern Bypass, the Mid-Atlantic Bypass also adds over 800 miles to the overall route to New Jersey points. It should be noted that the segment between Richmond, VA and Huntington, WV is a single-track rail line for about half its length, and it is a heavily used mountainous coal route that would require helper locomotives on northbound trains.

Further, it should be noted that there is no direct connection at Richmond to operate trains from the south to the west toward Lynchburg (a southwest quadrant connection). Because only a northwest quadrant connection exists, CSX has no efficient means to direct trains coming from the south to leave the mainline track and divert toward Lynchburg. Instead, this connection only enables through movements for trains operating from the north to proceed directly toward Lynchburg. Thus, trains operating from the south would have to pull north of the existing connecting track and stop. In order to reverse direction to proceed west, the locomotives would have to uncouple and run around the train on a separate track. They would then couple on to what was originally the rear end of the train. In addition, the end-of-train safety device would also have to be relocated to the “new” end of the train. This awkward and time consuming process would involve freight trains that are usually over a mile long. Also, it requires two tracks for each operation. When multiple freight trains arrive during the extended period required by this process, significant delay can be expected as those trains wait to take their turn accomplishing this procedure. Moreover, each of these train movements requires crossing over mainline tracks that are used by 20 daily Amtrak trains. Finally, in addition to substantial delay attributable to this procedure, the run-around movement reduces train equipment utilization and adversely affects train crew on-duty time. This is not a feasible operation for multiple freight trains per day.

CSX Mid-Atlantic Bypass Route (Doswell) – The Mid-Atlantic Bypass has an alternative route between Richmond and Clifton Ford, VA. This alternative route follows the I-95 Corridor north of Richmond to Doswell VA, thence westward from there through Charlottesville and

Waynesboro, VA to rejoin the original bypass route (from Richmond VA) at Clifton Ford VA. This alternative route is about 50 miles shorter than the route from Richmond. However, the route segment between Doswell and Clifton Forge is operated by the Buckingham Branch Railroad. CSX has rights to operate over this route and uses it primary as a relief route for returning empty coal trains to West Virginia coal fields from Newport News. These coal trains are relatively light and are not on expedited schedules. The Doswell bypass route, unlike the mainline, is not feasible for increased freight use as "secondary" track traffic is restricted to 25 mph. Also, it has jointed rail, lacks the sophisticated signaling system of the mainline and siding spacing would not support high density traffic.

Norfolk Southern (NS) I-83 Hagerstown Route – Another possible bypass route involves using the NS I-83 (Inland Corridor) Route that traverses the Shenandoah Valley from Charlotte NC through Roanoke VA, Hagerstown MD (a traditional rail interchange point) and on to Harrisburg PA. Beyond Harrisburg PA, a number of NS routes are available that enable access to the Conrail service area in New Jersey. Given that this route would be a non-CSX route, train movement and track sharing would have to be negotiated before any CSX trains could use it. These agreements would have to address such items as train dispatch priorities, track usage costs, and liability. Generally, with these arrangements, the home railroad company (in this case NS) maintains absolute control of dispatching and the guest railroad trains (CSX) are run as the opportunity permits. Although rerouting is a common railroad practice under emergency conditions that are usually short in duration, negotiating a 2+-year operating agreement would be very difficult.

Beyond the agreement issues, using the NS route presents operational challenges. The preferred NS bypass route is the I-83 corridor. Northbound trains would leave Richmond, VA and use the CSX Mid-Atlantic Bypass Route through Lynchburg VA to connect with the NS at Balcony Falls. The NS I-83 Corridor Route is severely constrained in line capacity. The corridor has single-track and a limited number of rather short sidings. Much of the corridor consists of curved track and speeds are generally limited to 40-60 mph. NS has capital spending plans to increase line capacity but significant improvements remain in the future.

A second more indirect NS route exists to access the I-83 corridor. This second route extends from Lynchburg through Manassas Junction to Riverton Junction where it joins the I-83 Corridor. This latter route also has capacity constraints, particularly in the segment between Manassas Junction and Riverton. This segment has single-track, traverses a very undulating profile, has numerous back-to-back curves, and sidings are limited.

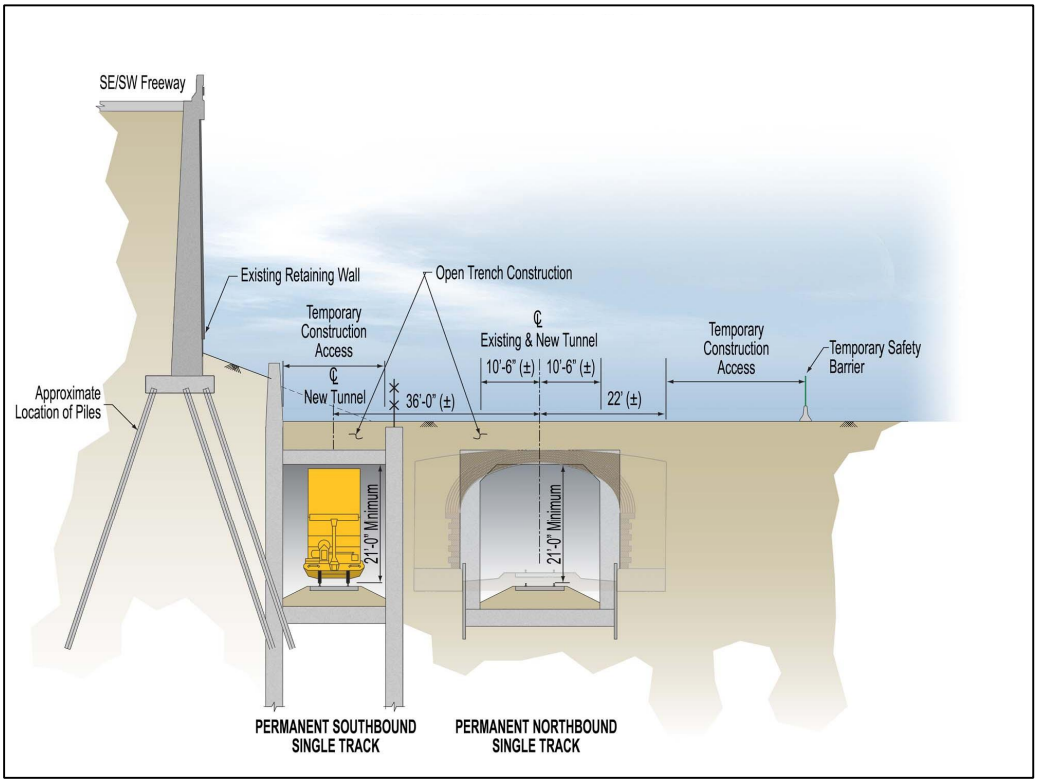
Upon completion of the new Virginia Avenue Tunnel, the surface of Virginia Avenue SE and other disturbed areas would be restored.

2.2.7 Concept 3A: Rebuild, Permanent Twin Tunnels (New Tunnel on North Side of Existing Virginia Avenue Tunnel)

Concept 3A was developed during the initial discussions involving development of the 11 original project concepts. It combines the elements of Concepts 3 and 5. Like Concept 5,

Concept 3A would result in the construction of two ST/DS tunnels (Figure 10). The second new ST/DS tunnel, the tunnel not within the existing tunnel envelope, would be set along the same alignment as the temporary northern runaround track/trench as under Concept 3. The purpose of Concept 3A is to avoid having to construct temporary facilities to maintain freight operations during construction, and to place the new tunnel as far from existing land uses on the south side of Virginia Avenue, but still within the confines of the public right-of-way. Similar to Concept 5, the north side ST/DS tunnel would be constructed first. On the west end, the new permanent track would connect with the existing track near the New Jersey Avenue overpass. At the east end, the new permanent track would connect with the existing track in the vicinity of 14th Street SE. The new tunnel would be constructed using a cut-and-cover methodology. Due to the proximity of the new tunnel to I-695, long-term (throughout most of the construction duration) closures of the 6th Street off-ramp and 8th Street on-ramp would be required. It may be possible to stagger these closures so only one of the ramps is closed at a time, but long-term closure and disruptions would still be required. Once completed, the new permanent ST/DS tunnel would serve as a route for two-way train traffic while the existing tunnel is reconstructed and converted into a new ST/DS tunnel. Upon completion of the second ST/DS Virginia Avenue Tunnel, train traffic would be split with one-way traffic in each tunnel, and the surface of Virginia Avenue SE and other disturbed areas would be restored, the same as under previous concepts described.

Figure 10: Concept 3A: Rebuild, Permanent Twin Tunnels (New Tunnel on North Side of Existing Virginia Avenue Tunnel)



2.3 Concepts 8 to 11: Reroute Concepts

Because construction of any of the "reroute" concepts (8 through 11) would not require work on Virginia Avenue SE, CSX would continue to operate freight trains through Washington, DC and the Virginia Avenue Tunnel. Upon completion of any of the reroute concepts, CSX would continue to maintain the existing railroad operations in Washington, DC and Virginia Avenue Tunnel in order to service customers in the region. Because these concepts preserve the use of the Tunnel for local rail customers and rail operations would continue through the Virginia Avenue Tunnel, these concepts may involve emergency or unplanned repairs of the tunnel at some point in the future, which may require closure of at least part of Virginia Avenue SE in order for CSX to make the repairs. In addition, the tunnel would eventually require major rehabilitation or replacement. Construction work hours would be the same for all concepts, and would allow work during weekday, daylight hours through project completion.

As previously mentioned, Concepts 9 and 10 were taken from a study conducted by the NCPC, which identified alternative routes for CSX to relocate its I-95 corridor away from the District, but still within the Washington Metropolitan Area.

2.3.1 Concept 8: Deep Bore Tunnel

Concept 8 would establish a new DT/DS tunnel approximately 80 feet below the surface of Virginia Avenue SE or approximately 45 feet below the existing tunnel (Figure 11). This depth is needed to maintain a stable foundation under the existing tunnel while the new tunnel is being excavated. The purpose of Concept 8 is to maintain the existing CSX mainline route through Washington, DC, but avoid the need for construction on Virginia Avenue SE. Rail operations would continue using the existing Virginia Avenue Tunnel for local services, including switching at Benning Yard. Constructing this tunnel would require the use of tunnel boring equipment, and would not require any major construction on Virginia Avenue SE. The diameter of the tunnel would be approximately 44 feet wide, which would be wide enough to accommodate DT/DS facilities. In order to reach a depth of 80 feet in the area of the existing tunnel while also maintaining appropriate separation from other existing features along the route (i.e., River crossings and WMATA tunneling), the portals of the new tunnel would be located no closer than near the Potomac Yard in Alexandria, VA on the west end and near the Deanwood Metrorail Station on the east end, making the minimum length of the tunnel approximately nine miles (Figure 12). For the construction of the transition area at each portal, there would be a requirement to acquire a minimum of 14-16 acres. In addition there would need to be ventilation shafts that would be located periodically along the entire tunnel length, most of which would need to be sited in urban areas.

There are several reasons for the 9-mile tunnel length. First, freight trains can only operate on tracks that have relatively gentle slopes (no greater than 1.25 percent grade). In order to reach a depth of 80 feet, the portal would have to be located at least 6,400 feet from the bottom of the slope. With a 1.25 percent grade and with the existing tunnel at approximately 3,800 feet long, a deep bore tunnel would be no shorter than approximately 16,600 feet, or a little more than three miles. Second, several natural and manmade obstructions would prevent the

minimum length of a deep bore tunnel with grades of 1.25 percent. The natural obstructions include the Anacostia and Potomac Rivers. For example, because of the relatively close proximity of the Anacostia River to the current east portal, the deep bore tunnel's rise to surface level elevation would begin on the east side of the river. The manmade obstructions include underground structures associated with freeway over- and under-passes, underground utilities including large combined sewer overflow (CSO) trunk lines, and underground transportation facilities, such as Metrorail tunnels and the 12th Street, 1st Street and I-395 tunnels. The manmade obstructions would affect the tunnel length and depth on the west side, and would force the deep bore tunnel's rise to surface level elevation to begin on the west side of the Potomac River. Finally, the length of the deep bore tunnel under Concept 8 would be affected by keeping the tunnel within the existing CSX right-of-way within the District, Maryland and Virginia.

Figure 11: Concept 8: Deep Bore Tunnel

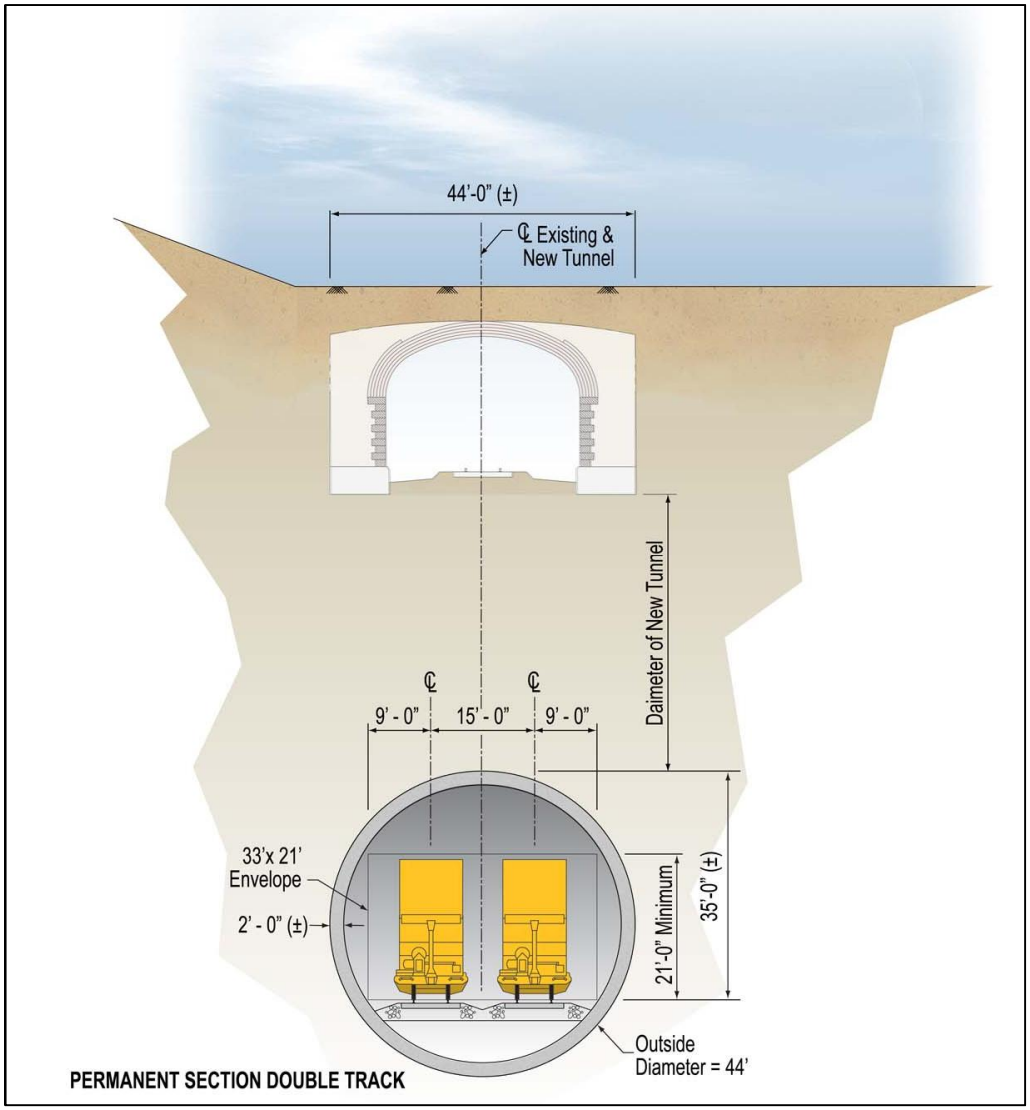
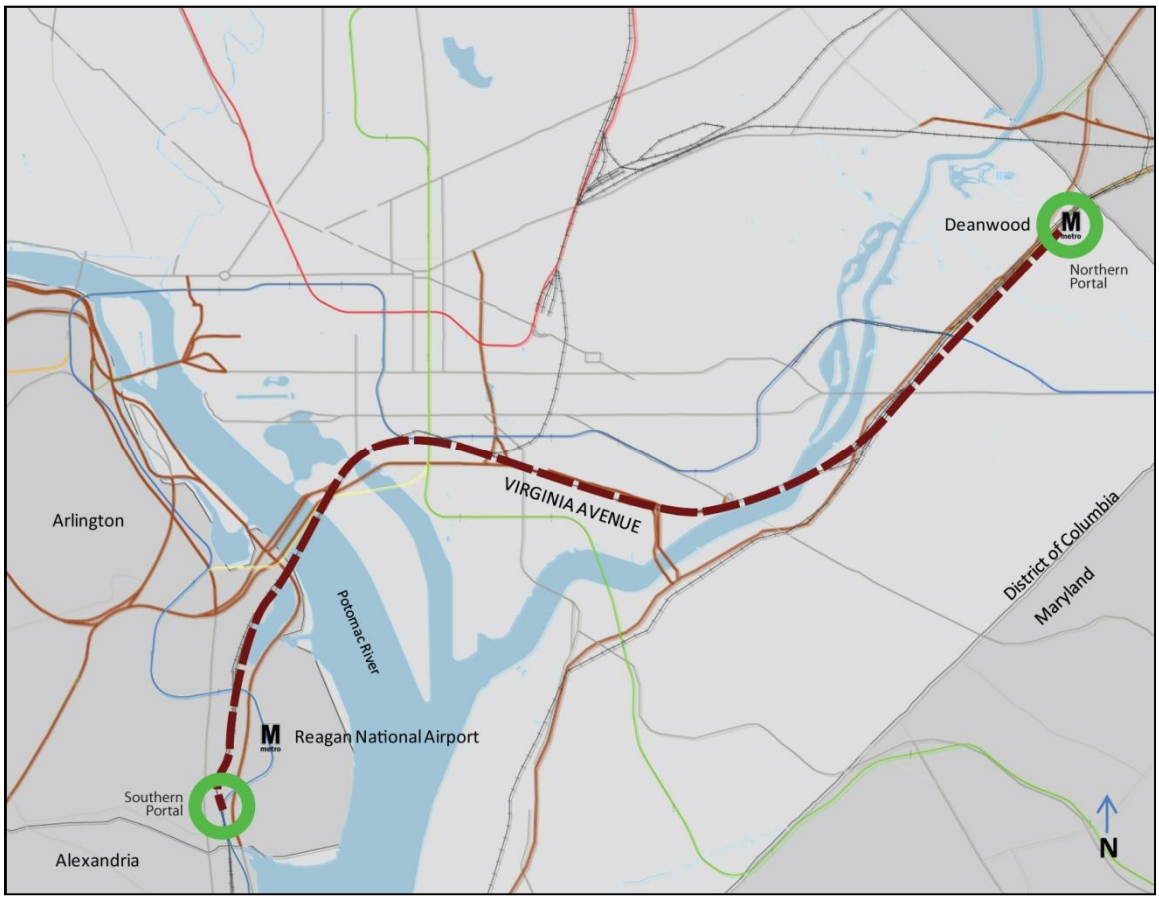


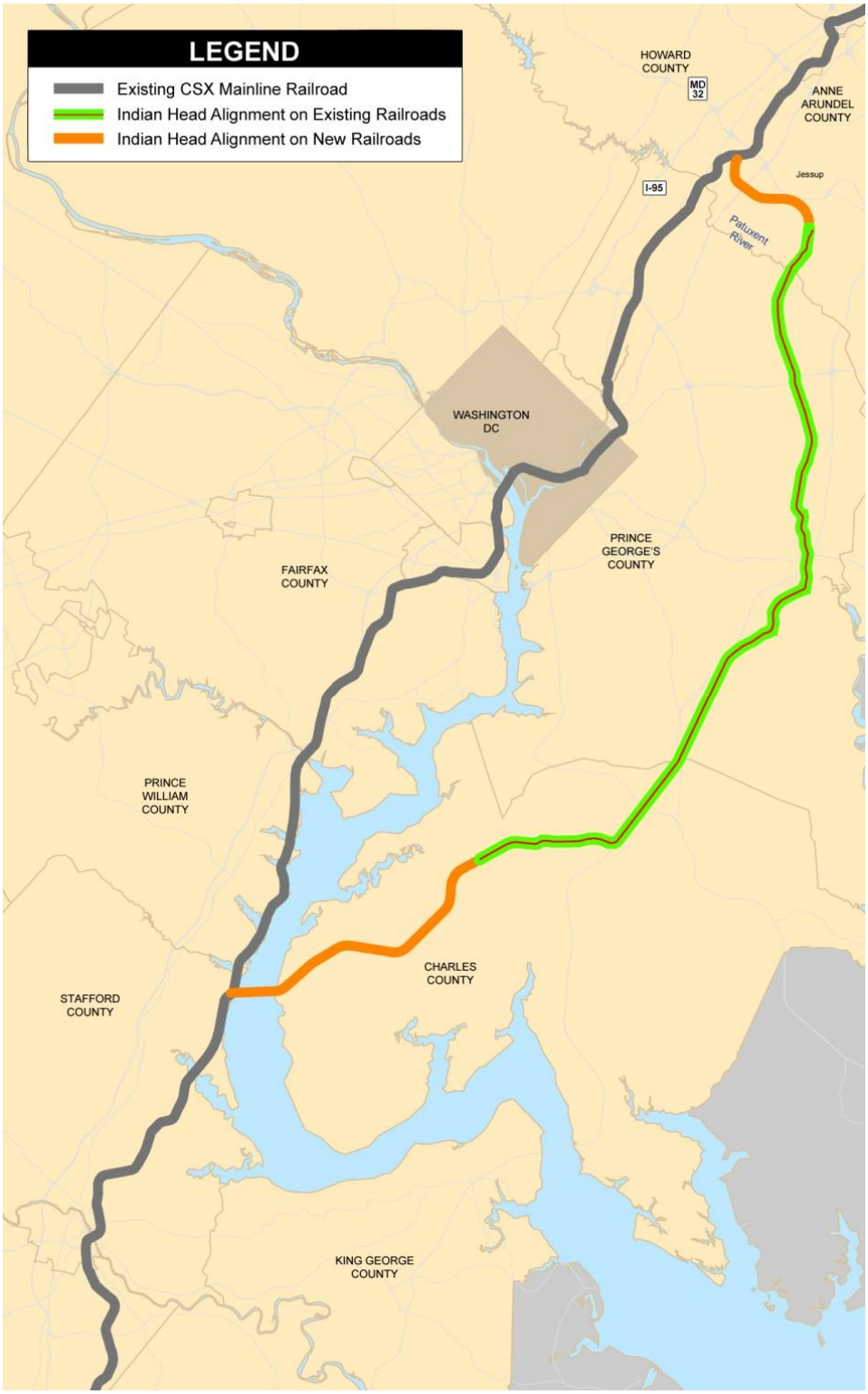
Figure 12: Concept 8 Tunnel Alignment and Portal Locations



2.3.2 Concept 9: NCPC Indian Head Alignment

Concept 9 was taken from a study conducted by the National Capital Planning Commission (NCPC) in 2007 titled, the Railroad Realignment Feasibility Study. The study identified alternative routes for CSX to relocate its I-95 corridor away from the District, but still within the Washington Metropolitan Area. The concept would use an alignment called the Indian Head Alignment, which was identified in the NPCP study (Figure 13). Under Concept 9, CSX would establish a new mainline route through the greater Washington Metropolitan Area. As noted above, the existing rail line, including Virginia Avenue Tunnel, would be maintained for local service, and would require major repair or replacement at some point in the future.

Figure 13: Concept 9: NCPC Indian Head Alignment



From Virginia, the Indian Head alignment would diverge from the existing CSX mainline in Arkendale or just south of Quantico Marine Corps Base, and cross the Potomac River via a new double-track 2.5-mile-long bridge. On the east side of the river, a new double-track rail line would be built and connect with the existing single-track Indian Head Branch, and the single-track Pope's Creek Branch. The sections of the Indian Head and Pope's Creek Branch affected by this alignment would require double-track expansion, including, where necessary, changes in grades or bridge or overpass structures to allow double-stack operations. North of Bowie, MD the alignment would run parallel to the Amtrak Northeast Corridor, and a new double-track rail line would be built between the Patuxent River and MD Route 32 to the CSX mainline traversing through Jessup, MD.

2.3.3 Concept 10: NCPC Dahlgren Alignment

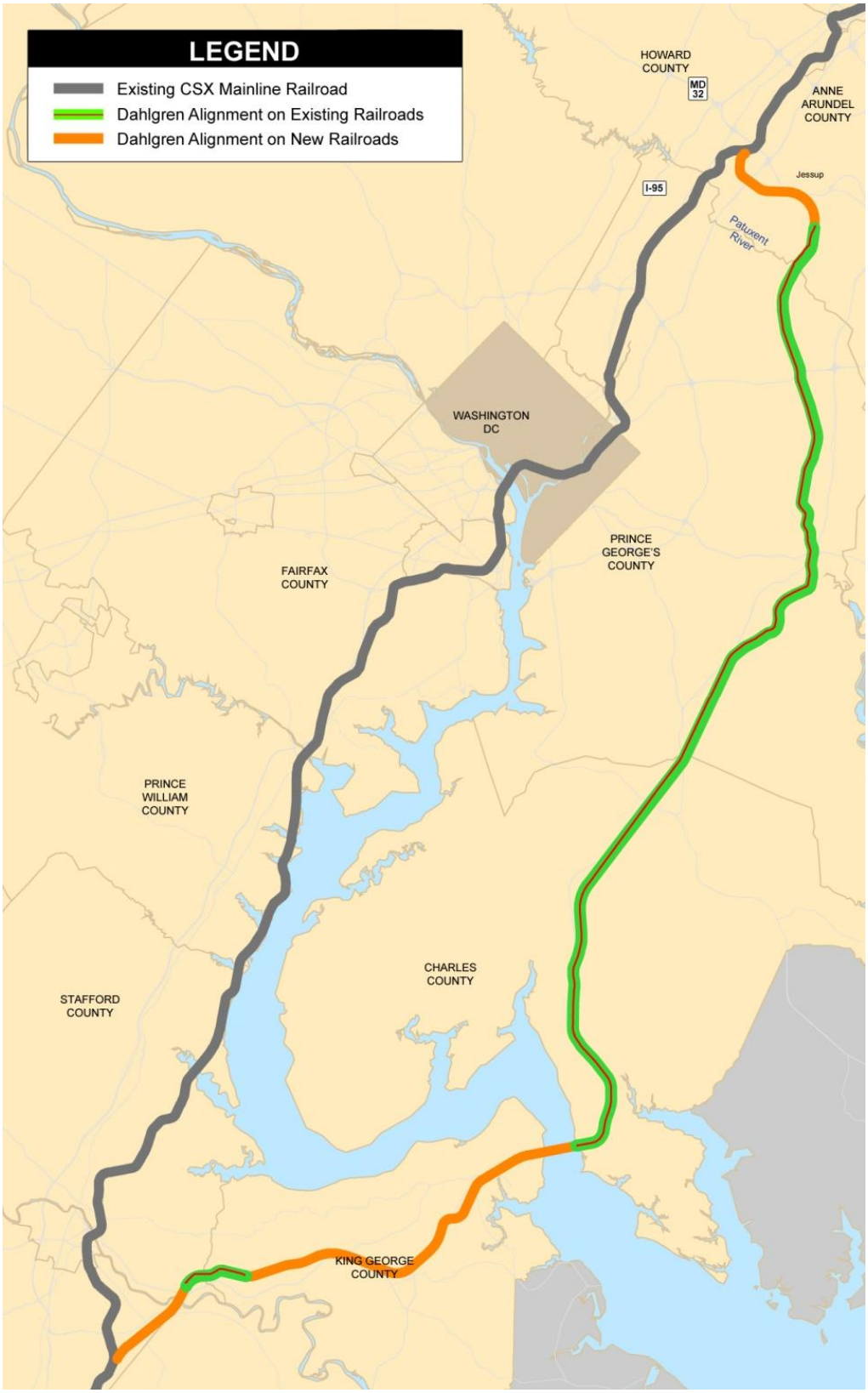
Concept 10 was also taken from the 2007 NCPC study. It would use an alignment called the Dahlgren Alignment (Figure 14). The purpose of Concept 10 is the same from Concept 9: instead of making the necessary capital improvements to maintain the existing CSX mainline route through Washington, DC, CSX would establish a new mainline route through the greater Washington Metropolitan Area. Similar to Concept 9, the existing rail line, including Virginia Avenue Tunnel, would be maintained for local service, and would require major repair or replacement at some point in the future.

From Virginia, the Dahlgren alignment would diverge from the existing CSX mainline just south of Fredericksburg where a new double-track rail line would be constructed that would traverse across King George County. Following an existing utility corridor right-of-way, the new rail line would cross the Rappahannock River and connect with the abandoned Dahlgren rail line, which would be restored to a functioning double-track railroad. The rail alignment would then parallel the recently completed Dahlgren Railroad Heritage Trail for a short distance before establishing new rail line that would partially be aligned with the U.S. Route 301 to the Potomac River. At the Potomac River, a new two-mile-long railroad drawbridge would be constructed near the existing U.S. Route 301 Bridge. The alignment would connect with the southern terminus of single-track Pope's Creek Branch, which would require double-track expansion. At and north of Waldorf, the Dahlgren alignment is the same as the Indian Head alignment.

2.3.4 Concept 11: Permanent Reroute

Concept 11 involves no proposed construction or upgrades to the existing Virginia Avenue Tunnel , and would establish new permanent routes using existing rail lines owned by CSX throughout the eastern part of the U.S. This concept would continue operations in the existing Virginia Avenue Tunnel SE while permanently routing freight trains outside the District (see Figure 9). Concept 11 would use the same routes as Concept 7; however, the reroutes would be permanent under this concept. There are no existing "beltline" rail routes around Washington DC.

Figure 14: Concept 10: NCPC Dahlgren Alignment



Because this concept preserves the use of the Tunnel all local and some regional rail operations would continue through the Tunnel, Concept 11 may also involve emergency or unplanned repairs of the tunnel at some point in the future, which may require closure of at least part of Virginia Avenue SE in order for CSX to make the repairs. In addition, the tunnel would eventually require major rehabilitation or replacement.

The differences between Concepts 7 and 11 would be the duration of rerouting (temporary versus permanent), and the impacts associated with the durations. Similar to Concept 7, the traffic must operate over other principal routes and all bypass options involve significant additional train mileage and running time. These potential bypass routes are discussed under Concept 7 and are illustrated in Figure 9.

3 Evaluation Criteria and Screening Process

3.1 Evaluation Criteria

The concepts were evaluated using the following eight criteria. Criteria 1 through 4 are based on purpose and need of the project. Criteria 5 through 8 address issues of technical and economic feasibility, such as impacts on freight traffic and cost, as well as impacts to the community, including construction duration and cost.

1. The concept, upon completion, will address the deficiencies of the Virginia Avenue Tunnel.
2. The concept, upon completion, will provide the necessary improvements for operating double-stack intermodal containers and have double-tracks for the efficient flow of commercial rail freight through the Washington Metropolitan Area.
3. The concept will avoid major impacts to the structures, traffic or access to or from I-695.
4. The concept must allow for the maintenance of traffic across Virginia Avenue and along adjacent streets throughout the duration of construction.
5. The concept will maintain interstate rail commerce without a substantial negative impact to the level of service during construction.
6. The concept will be implemented in a time frame that accommodates the near term anticipated increase in freight traffic.
7. The concept has a comparatively reasonable duration of construction in the vicinity of the existing tunnel.
8. The concept has a comparatively low cost.

A detailed description of each criterion used to evaluate the project concepts is provided below.

<u>Criterion 1: The concept, upon completion, will address the deficiencies of the Virginia Avenue Tunnel.</u>

Although the Virginia Avenue Tunnel was originally constructed to accommodate double-tracks, railroad equipment have increased in size, both length and width, since the original

construction of the tunnel. Also, the original double-trackage did not reflect modern safety clearance requirements for opposing traffic, thereby necessitating the conversion of the rails within the existing tunnel to a single-track arrangement several decades ago. This single-track within Virginia Avenue Tunnel represents the single greatest constraint on rail headway on CSX's I-95 corridor network. It is a bottleneck to the network because only a single freight train can pass through the tunnel at any one time. In essence, it is the railroad equivalent of a narrow, old-fashioned, one-lane vehicular bridge that produces serious traffic congestion because the current road has much more traffic than when the facility was first constructed.

In addition, the existing Virginia Avenue Tunnel also does not have adequate vertical clearance to allow CSX to operate freight trains that carry double-stack intermodal containers, which is increasingly becoming the industry standard practice for freight transportation in the U.S. In order to operate double-stack intermodal freight trains, a minimum vertical clearance of 21 feet above top of rail must be provided. The industry solution to meeting higher freight demands while still operating on the same rail network is to carry more freight per train. The ability to double-stack intermodal containers allows a single freight train to essentially double its capacity if needed.

In addition to addressing the capacity and height deficiencies of Virginia Avenue Tunnel, the tunnel is also nearing the end of its useful life, and showing signs of its age. While the overall structure is in relatively good shape, indicators of localized distress are evident, such as cracking in the tunnel's masonry, active water infiltration, spalling of liner brick and the deterioration of mortar in masonry joints. In addition, the tunnel's drainage system, made up of a network of ditches, wood trenches, corrugated metal and reinforced concrete pipes, and sump pits and pumps, are severely compromised by overall deterioration and fouling by sediment and debris. Similar to other transportation infrastructure, the Virginia Avenue Tunnel eventually needs to be rehabilitated or replaced at some point. If not soon, the tunnel will continue to require higher levels of investment in maintenance and repair, and increase the risk of an unplanned or emergency repair similar to what happened in the mid-1990s when an approximately 150-foot section of the tunnel roof collapsed.

In order for a concept to meet Criterion 1, CSX must be able to rebuild Virginia Avenue Tunnel to modern engineering standards, but also be able to eliminate the bottleneck within CSX's mainline I-95 corridor through the Washington Metropolitan Area. The elimination of the bottleneck does not necessarily have to be through the Virginia Avenue corridor in order to partially meet this objective.

<u>Criterion 2: The concept, upon completion, will provide the necessary improvements for operating double-stack intermodal containers and have double-tracks for the efficient flow of commercial rail freight through the Washington Metropolitan Area.</u>

According to the FHWA's Freight Analysis Framework (FAF) forecasts, overall freight tonnage will increase by 50 percent in 2040 from 2010 levels due partially to the Panama Canal expansion scheduled to be completed in 2014, as well as increasing globalization and normal population growth. Because of the environmental benefits of freight rail transportation, such

as better fuel efficiency and lower greenhouse gas (GHG) emissions as compared to long-haul trucking, and the limited amount of highway infrastructure available for trucking, it is likely that rail will be seen as the most cost- efficient and environmentally effective transportation method for capturing the predominate share of the future increase demand for freight land transportation in the U.S. In anticipation of increased freight transportation demand and its obligations as an interstate common carrier, CSX is projecting that its existing mainline rail network on the east coast, including the I-95 corridor, can accommodate anticipated demand provided that DT/DS conditions are provided throughout the network in the Washington Metropolitan Area.

Within its current I-95 rail corridor through the Washington Metropolitan Area, Virginia Avenue Tunnel is the only section where a major project is needed to upgrade the rail line to DT/DS conditions. Other sections of the rail line have at least double-track conditions, and because other structural impediments to double-stack operations are being remediated, the Tunnel project is critical to assure 21st century conditions for railroad freight operations

In order for a concept to meet Criterion 2, CSX must be able to operate at the end of construction DT/DS conditions through the Washington Metropolitan Area.

Criterion 3: The concept will avoid major impacts to the structures, traffic or access to or from I-695.

The FHWA was identified as the lead federal agency for NEPA purposes because the project has the potential to cause temporary construction-period impacts to Interstate 695 (I-295)/Southeast-Southwest Freeway. The construction of any of the rebuild concepts (Concepts 2 to 7) would affect the two I-695 off- and on-ramps to and from Virginia Avenue SE located at 6th and 8th Streets SE, respectively, and would require the temporary use of I-695 air rights. As a result, the FHWA must approve the temporary construction impacts to I-695 before the project can move forward into construction. Of course, CSX would not expect FHWA to approve a concept that would result in major traffic impacts on I-695 or risk the structural integrity of the freeway, which is an elevated section adjacent to Virginia Avenue SE.

For those concepts that involve rebuilding Virginia Avenue Tunnel at its current location (Concepts 2 to 7), only those concepts that would require a short-term temporary closure of I-695 ramps would meet Criterion 3. A rebuild concept that requires a long-term construction-period closure of a ramp or would require the re-construction of any structural element of the I-695 viaduct (e.g., columns, retaining walls, etc.) would fail to meet Criterion 3. Obviously, Concepts 8 to 11, which do not require construction along the surface of Virginia Avenue SE, would meet Criterion 3. However, it is uncertain, and beyond the point of this analysis, how the massive rail construction contemplated by any of these concepts could affect interstate highways and other major roads at other locations.

Criterion 4: The concept must allow for the maintenance of traffic across Virginia Avenue and along adjacent streets throughout the duration of construction.

Virginia Avenue SE is an important road in the Capitol Hill neighborhood. It functions as a collector road because it provides the surrounding community with access to and from I-695. Because each of the rebuild concepts is estimated to require at least a 2½-year closure of sections of Virginia Avenue SE on the south side of I-695, or along the alignment of the existing tunnel, the project must provide motorists with good options to access the freeway as well as maintaining connections between the north and south sides of I-695.

In order to meet Criterion 4, the concept must provide the opportunity for effective traffic management measures that would maintain cross-street traffic across Virginia Avenue for motorists, pedestrians and cyclists, as well as the ability for motorists to access to and from I-695.

Criterion 5: The concept will maintain interstate rail commerce without a substantial negative impact to the level of service during construction.

The ability to quickly and efficiently move goods to markets throughout the country is vital to the U.S. economy. As one of the nation's major railroad companies, CSX cannot stop freight transport on its mainline while the project is under construction. Furthermore, even if a concept has the potential to maintain current interstate rail commerce, but does so in a manner that hampers CSX from providing its customers with timely and efficient freight service during construction, it is likely that a proportion of time-sensitive freight transport would switch to or revert to trucking or other modes of transportation. Any diminution in the ability of CSX to provide reliable, consistent, timely freight rail service would make freight rail transport less competitive than truck transport. Despite the capacity deficiencies of Virginia Avenue Tunnel (single-track, does not allow double-stack intermodal container trains, and low operating speed due to the poor condition of the tunnel floor), CSX has been able to offer customers in the I-95 corridor with a consistent degree of timely and reliable service. If during construction, CSX is unable to offer the same or nearly the same level of service as today, the expected response of many freight customers to switch transport modes from rail to truck would have significant environmental and socioeconomic impacts by further adding to the already congested interstate and regional road networks, especially those along the I-95 corridor.

In order for a concept to meet Criterion 5, CSX must be able to continue to provide the same dependable level of timely freight transportation services throughout the entire duration of construction. If a concept is unable to achieve the same level of service, it would fail to meet Criterion 5.

Criterion 6: The concept will be implemented in a time frame that accommodates the near term anticipated increase in freight traffic.

In 2014, the Panama Canal is scheduled to expand capabilities to accommodate vessels carrying 12,000 intermodal containers, more than doubling the maximum freight-carrying capacity of vessels that can currently use the canal. When this occurs, freight throughput at east coast ports is expected to increase substantially because it will be less expensive to move goods from places such as Asia to east coast ports by ship than to off-load those vessels on the west coast. As a result, east coast ports are engaging in their own major infrastructure activities involving dredging, and new harbor facilities. Clearly, the major share of the freight arriving at or leaving east coast ports will use rail networks, such as the CSX network and its I-95 corridor, including through the Washington Metropolitan Area.

However, there is currently limited freight rail capacity in the I-95 rail corridor, in part due to the sharing of the corridor with passenger service and the single-tracks within the Virginia Avenue Tunnel. As a result, CSX would not be able to substantially increase the number of trains traveling through the I-95 corridor and the Washington Metropolitan Area to reflect this expected growth in commerce. In order to increase throughput, CSX needs to have the ability to operate double-stack intermodal container freight trains throughout its I-95 corridor. As noted above, the existing Virginia Avenue Tunnel does not have adequate vertical clearance for CSX to operate double-stack container freight trains.

In order for a concept to meet Criterion 6, CSX must be able to operate double-stack intermodal container trains through the Washington Metropolitan Area by 2014. A concept does not necessarily have to have construction fully completed in order to meet Criterion 6 if the concept includes a temporary measure that maintains freight operations through the Washington Metropolitan Area with the ability to operate double-stack intermodal container freight trains.

Criterion 7: The concept has a comparatively reasonable duration of construction in the vicinity of the existing tunnel.

Construction of a large infrastructure investment has the potential to cause a degree of impact to nearby neighborhoods or communities, and to also affect those who need to travel through the area under construction. There is also the potential for impacts to natural resources that may be at or near the construction site. Therefore, one objective of any such large infrastructure project is to minimize the duration of construction as much as reasonably possible, thereby limiting some of the potential for adverse impact.

All of the concepts require construction of capital improvements in some form, including Concept 1 because major repairs of the Virginia Avenue Tunnel would be required at some point in the future. If one of the rebuild concepts were selected, construction would occur within a vibrant and growing neighborhood of Washington, DC. That portion of Virginia Avenue SE within the project limits is adjacent to Capitol Quarter, a new residential community. The street is also near and serves the transportation needs of Barracks Row (8th Street SE), a

business community of restaurants and small retail shops; the Marine Corps Barracks including its recreational facility; the Navy Yard and the U.S. Department of Transportation Headquarters, two major federal employment centers; and the larger Capitol Hill community. Although some concepts involve construction outside of the District, construction durations outside of the District did not factor into the application of this Criterion.

In order to determine if a concept would meet Criterion 7, a comparison was conducted of the estimated construction durations among the project concepts. The concepts with the shorter construction durations within the Virginia Avenue SE corridor would satisfy Criterion 7.

Criterion 8: The concept has a comparatively low cost.

Under Criterion 8, a comparatively low cost essentially means a cost that is practical and feasible from an economic standpoint. In order to determine if a concept would meet Criterion 8, a cost comparison was conducted of the estimated costs of the concepts. The concepts with the lower overall costs would meet Criterion 8. Concepts with costs orders of magnitude greater than the the lower cost concepts would fail Criterion 8.

3.2 Concepts Evaluation

This section provides an evaluation of each of the project concepts against the criteria described in Section 3.1. Because Criteria 1 through 4 directly address the purpose and need for the project, a concept that is presently recognized as failing any one of these criterion is determined to be not worthy of further detailed consideration as a reasonable alternative under NEPA. When a concept appears to satisfy the first four criteria, it is appropriate to give careful analysis to whether it can meet the remaining criteria as well since Criteria 5 through 8 address other important factors in determining an alternative's "reasonableness."

3.2.1 Concept 1: No Build

Concept 1 did not undergo a concept evaluation because it will automatically be carried forward into the NEPA environmental review process as the "no build" or "no action" alternative. Under this concept, however, emergency or unplanned repairs may be required at some point in the future, and the tunnel's existing and ongoing structural limitations would eventually require major rehabilitation or replacement of the tunnel.

3.2.2 Concept 2: Rebuild Virginia Avenue Tunnel, Temporary South Side Runaround

Concept 2 meets six of the eight evaluation criteria:

- Criterion 1: Concept 2 would upgrade the Virginia Avenue Tunnel up to modern industry standards.
- Criterion 2: Concept 2's new Virginia Avenue Tunnel would provide CSX with DT/DS capabilities throughout the Washington Metropolitan Area.

- Criterion 3: Concept 2 would not require the long-term closure of either of the I-695 off- and on-ramps located at 6th and 8th Streets SE. Short-term closures would be needed to set-up temporary bridges to allow maintenance of traffic throughout the duration of construction. Concept 2 would not require re-construction of any structural elements of I-695.
- Criterion 4: Concept 2 would allow for maintenance of cross-street traffic along Virginia Avenue SE for motorists, pedestrians and cyclists, as well as the ability for motorists to access to and from I-695.
- Criterion 5: Concept 2's temporary runaround track would provide CSX with the same level of freight transportation service as today throughout the entire duration of construction.
- Criterion 8: Concept 2 has one of the lowest costs among the 11 build concepts.

Concept 2 may require additional study and evaluation because it may or may not meet the remaining two criteria. The reasons for the uncertainties in meeting the remaining criteria include:

- Criterion 6: Concept 2's temporary runaround track would be designed to accommodate double-stack intermodal container freight trains, and therefore, provide more capacity than under current conditions. Depending on how soon Concept 2's runaround track can be completed, it is uncertain if double-stack operations can be implemented in time to meet near term needs.
- Criterion 7: The need to construct a temporary runaround track before rebuilding the existing tunnel would add to the overall construction duration of Concept 2, which is estimated to be 2½ to 3½ years, or between 20 to 40% longer than the concept with the shortest construction duration within the Virginia Avenue SE corridor.

3.2.3 Concept 3: Rebuild Virginia Avenue Tunnel, Temporary North Side Runaround

Concept 3 meets four or the eight evaluation criteria:

- Criterion 1: Concept 3 would upgrade the Virginia Avenue Tunnel up to modern industry standards.
- Criterion 2: Concept 3's new Virginia Avenue Tunnel would provide CSX with DT/DS capabilities throughout the Washington Metropolitan Area.
- Criterion 4: Concept 3 would allow for maintenance of cross-street traffic along Virginia Avenue SE for motorists, pedestrians and cyclists, as well as the ability for motorists to access to and from I-695.
- Criterion 5: Concept 3's temporary runaround track would provide CSX with the same level of freight transportation service as today throughout the entire duration of construction.

Concept 3 may require additional study and evaluation because it may or may not meet the Criteria 6, 7 and 8. The reasons for the uncertainties in meeting the remaining criteria include:

- Criteria 6 and 7: Due to the complications associated with major structural modifications to I-695, Concept 3's construction duration is estimated to be 4 plus years, or at least 60% longer than the concept with the shortest construction duration within the Virginia Avenue SE corridor. In addition to requiring construction duration substantially longer than other rebuild concepts, Concepts 3's temporary runaround track may not be ready in time to meet near term freight transportation needs.
- Criterion 8: Due to its complications associated with reconstructing I-695 structural elements, Concept 3 is estimated to cost approximately 50 percent more than two of the lower cost concepts.

Concept 3 would fail to meet the Criterion 3. Concept 3 would require major structural modifications to I-695 retaining walls and the relocation of I-695 columns. In addition, because the temporary runaround track would be placed on the north side of the existing tunnel, Concept 3 would require the long-term closure of both I-695 ramps connecting with Virginia Avenue SE and possible modifications to piles.

3.2.4 Concept 4: Rebuild Virginia Avenue Tunnel, Combination Runaround

Concept 4 meets four of the eight evaluation criteria:

- Criterion 1: Concept 4 would upgrade Virginia Avenue Tunnel up to modern industry standards.
- Criterion 2: Concept 4's new Virginia Avenue Tunnel would provide CSX with DT/DS capabilities throughout the Washington Metropolitan Area.
- Criterion 4: Concept 4 would allow for maintenance of cross-street traffic along Virginia Avenue SE for motorists, pedestrians and cyclists, as well as the ability for motorists to access to and from I-695.

Concept 4 may require additional study and evaluation because it may or may not meet the remaining four criteria. The reasons for the uncertainties in meeting the remaining criteria include:

- Criterion 3: Similar to Concept 2, Concept 4 would not require the long-term closure of either of the I-695 off- and on-ramps located at 6th and 8th Streets SE. Short-term closures may be needed to set-up temporary bridges to allow maintenance of traffic throughout the duration of construction. Unlike Concept 2, Concept 4 would require structural modifications to I-695 retaining walls, although these modifications are not nearly as substantial as under Concept 3.
- Criterion 6: Concept 4's temporary runaround track would be designed to accommodate double-stack intermodal container freight trains, and therefore, provide more capacity than under current conditions. Depending on how soon Concept 4's runaround track can be completed, it is uncertain if double-stack operations can be implemented in time to meet near term needs.

- Criterion 7: The need to construct a temporary serpentine runaround track before rebuilding the existing tunnel would add to the overall construction duration of Concept 4, which is estimated to be 3½ to 4½ years, or between 40 to 80% longer than the concept with the shortest construction duration within the Virginia Avenue SE corridor.
- Criterion 8: Due to its complications associated with constructing a serpentine runaround track, Concept 4 is estimated to cost approximately 25 to 35 percent more than the lowest cost concept.

Concept 4 would fail to meet Criterion 5. Providing Concept 4's temporary serpentine runaround track would require at least two major disruptions to railroad operations, meaning the complete stoppage of freight trains movements through the District portion of the I-95 mainline rail corridor. Each stoppage would last several weeks. The first disruption would occur when constructing the two sections of the runaround track that cross through the existing tunnel alignment. This first disruption would last six weeks or longer if 24-hour / seven days per week construction were not permitted. Over 500 feet of tunnel at each crossing location would need to be demolished and portions of the new tunnel floor would need to be constructed in order to get the temporary tracks lowered to the final proposed grade at each crossing. The second disruption would occur when these crossings are reconstructed into the new tunnel configuration. This second disruption would last at least four weeks due to the need to construct and provide all elements of the rebuilt tunnel (i.e., floor, walls, and roof, tracks, utilities, etc.) at both crossing locations.

In addition to failing Criterion 5, Concept 4 would not provide any benefits to the surrounding residential community adjacent to Virginia Avenue SE in comparison to Concept 2 because the runaround track would still be located on the south side of the existing tunnel where the residences are located.

3.2.5 Concept 5: Permanent Twin Tunnels (New Tunnel on South Side of Existing Virginia Avenue Tunnel)

Concept 5 meets six of the eight evaluation criteria:

- Criterion 1: Concept 5 would upgrade Virginia Avenue Tunnel up to modern industry standards.
- Criterion 2: Concept 5's new Virginia Avenue Tunnels would provide CSX with DT/DS capabilities throughout the Washington Metropolitan Area.
- Criterion 3: Concept 5 would not require the long-term closure of either of the I-695 off- and on-ramps located at 6th and 8th Streets SE. Short-term closures may be needed to set-up temporary bridges to allow maintenance of traffic throughout the duration of construction. Concept 5 would not require re-construction of any structural elements of I-695.
- Criterion 4: Concept 5 would allow for maintenance of cross-street traffic along Virginia Avenue SE for motorists, pedestrians and cyclists, as well as the ability for motorists to access to and from I-695.

- Criterion 5: Concept 5's new second tunnel would provide CSX with the same level of freight transportation service as today throughout the entire duration of construction.
- Criterion 8: Concept 5 has one of the lowest costs among the build concepts.

Concept 5 may require additional study and evaluation because it may or may not meet the remaining two criteria. The reasons for the uncertainties in meeting the remaining criteria include:

- Criterion 6: Concept 5's new south side tunnel would be designed to accommodate double-stack intermodal container freight trains, and therefore, provide more capacity than under current conditions. Depending on how soon Concept 5's new tunnel be completed, it is uncertain if double-stack operations can be implemented in time to meet near term freight demand.
- Criterion 7: The need to construct a second permanent tunnel before rebuilding the existing tunnel would add to the overall construction duration of Concept 5, which is estimated to be 3 to 3½ years, or between 20 to 40% longer than the concept with the shortest construction duration on Virginia Avenue.

3.2.6 Concept 6: Rebuild With On-Line Construction

Concept 6 meets four of the eight evaluation criteria:

- Criterion 1: Concept 6 would upgrade Virginia Avenue Tunnel up to modern industry standards.
- Criterion 2: Concept 6's new Virginia Avenue Tunnel would provide CSX with DT/DS capabilities throughout the Washington Metropolitan Area.
- Criterion 3: Concept 6 would not require the long-term closure of either of the I-695 off- and on-ramps located at 6th and 8th Streets SE. Short-term closures maybe needed to set-up temporary bridges to allow maintenance of traffic throughout the duration of construction. Concept 6 would not require re-construction of any structural elements of I-695.
- Criterion 4: Concept 6 would allow for maintenance of cross-street traffic along Virginia Avenue SE for motorists, pedestrians and cyclists, as well as the ability for motorists to access to and from I-695.

Concept 6 may require additional study and evaluation because it may or may not meet the remaining four criteria. The reasons for the uncertainties in meeting the remaining criteria include:

- Criteria 5: Railroad operations in close proximity to construction activities could pose risks to workers' safety and could interfere with ongoing rail operations. Even with additional safety precautions, accommodating freight rail operations at the same level of service as today through the construction zone on a daily basis would be challenging for the contractor.
- Criteria 6 and 7: The need to maintain railroad operations within the same envelope as rebuilding the existing tunnel would add to the overall construction duration of Concept 6,

which is estimated to be 5 to 6 years, or at least 100 percent longer than the concept with the shortest construction duration on Virginia Avenue. It is uncertain at this time if double-stack operations can be implemented during construction in time to meet near term needs.

- Criterion 8: Due to its complications associated with maintaining railroad operations within the same envelope as rebuilding the existing tunnel, Concept 5 is estimated to cost approximately 100 percent more than two of the lowest cost concepts.

3.2.7 Concept 7: Rebuild Virginia Avenue Tunnel, Temporary Reroute

Concept 7 meets five of the eight evaluation criteria:

- Criterion 1: Concept 7 would upgrade Virginia Avenue Tunnel up to modern industry standards.
- Criterion 2: Concept 7's new Virginia Avenue Tunnel would provide CSX with DT/DS capabilities throughout the Washington Metropolitan Area.
- Criterion 3: Concept 7 would not require the long-term closure of either of the I-695 off- and on-ramps located at 6th and 8th Streets SE. Short-term closures maybe needed to set-up temporary bridges to allow maintenance of traffic throughout the duration of construction. Concept 7 would not require re-construction of any structural elements of I-695.
- Criterion 4: Concept 7 would allow for maintenance of cross-street traffic along Virginia Avenue SE for motorists, pedestrians and cyclists, as well as the ability for motorists to access to and from I-695.
- Criterion 7: Concept 7's construction duration within the Virginia Avenue SE corridor is estimated to be 2½ years, the lowest among the rebuild concepts.

Concept 6 may or may not meet the Criterion 8. The combined tunnel construction cost and additional rail equipment/personnel investment is estimated to be 50% more than two of the lowest cost concepts.

Concept 7 would fail to meet the Criteria 5 and 6. The reasons for failing to meet these criteria include:

- Criterion 5: Concept 7 fails to meet this criterion due to capacity constraints on the existing rail network which would result in a degradation of level of service to growing customer demands in the I-95 corridor. CSX's rail network does not provide an efficient bypass route from its current I-95 corridor route through Washington, DC and the Virginia Avenue Tunnel.
- Criterion 6: Although Concept 7 has the shortest construction duration among the rebuild concepts within the Virginia Avenue SE corridor, it would require procurement of additional equipment and qualified personnel to operate the longer service outside of the District which would need to be completed before construction on Virginia Avenue SE can begin, ultimately delaying commencement of tunnel reconstruction.

3.2.8 Concept 3A: Permanent Twin Tunnels (New Tunnel on North Side of Existing Virginia Avenue Tunnel)

Concept 3A meets four of the eight evaluation criteria:

- Criterion 1: Concept 3A would upgrade Virginia Avenue Tunnel up to modern industry standards.
- Criterion 2: Concept 3A's new Virginia Avenue Tunnel would provide CSX with DT/DS capabilities throughout the Washington Metropolitan Area.
- Criterion 4: Concept 3A would allow for maintenance of cross-street traffic along Virginia Avenue SE for motorists, pedestrians and cyclists, as well as the ability for motorists to access to and from I-695.
- Criterion 5: Concept 3A's new second tunnel would provide CSX with the same level of freight transportation service as today throughout the entire duration of construction.

Concept 3A may require additional study and evaluation because it may or may not meet the Criteria 6, 7 and 8. The reasons for the uncertainties in meeting the remaining criteria include:

- Criteria 6 and 7: Due to the complications associated with major structural modifications to I-695, Concept 3A's construction duration is estimated to be 4+ years, or at least 60% longer than the concept with the shortest construction duration within the Virginia Avenue SE corridor. In addition to requiring construction duration substantially longer than other rebuild concepts, Concepts 3A's new second tunnel may not be ready in time to meet near term freight transportation needs. The new second tunnel cannot be constructed as quickly as the new second tunnel under Concept 5 due to the needed major structural modifications to I-695.
- Criterion 8: Due to its complications associated with reconstructing I-695 structural elements, Concept 3A is estimated to cost approximately 60 percent more than two of the lowest cost concepts.

Concept 3A would fail to meet the Criterion 3. Concept 3A would require major structural modifications to I-695 retaining walls and the relocation of I-695 columns, and possible modifications to piles. In addition, because construction of the new tunnel would be located on the north side of the existing tunnel, Concept 3A would require the long-term closure of both I-695 ramps connecting with Virginia Avenue SE, although not as long as under Concept 3 because once the new second tunnel is completed, both freeway ramps can be opened.

3.2.9 Concept 8: Deep Bore Tunnel

Concept 8 meets four or the eight evaluation criteria:

- Criterion 2: By establishing a new mainline freight rail line, replacing the section of rail line between Alexandria, VA and DC/Maryland border, Concept 8 would provide CSX with DT/DS capabilities throughout the Washington Metropolitan Area.

- Criterion 3: Concept 8 would not require construction along the surface of the Virginia Avenue SE corridor. Therefore, it would not require the long-term closure of either of the I-695 off- and on-ramps located at 6th and 8th Streets SE, nor would it require re-construction of any structural elements of I-695.
- Criterion 4: Concept 8 would not require construction along the surface of the Virginia Avenue SE corridor. Therefore, maintenance of traffic plans for motorists, pedestrians and cyclists would not be required along the Virginia Avenue SE corridor.
- Criterion 5: Concept 8 would use the existing Virginia Avenue Tunnel to accommodate freight transportation service during construction.

Concept 8 would fail to meet the Criteria 1, 6 and 8. The reasons for failing to meet these criteria include:

- Criterion 1: Concept 8 would not address structural limitations of the existing Virginia Avenue Tunnel, which would remain in operation for local service. Similar to Concept 1, the tunnel may require emergency or unplanned repairs at some point in the future, and would eventually require rehabilitation or replacement. Concept 8 would, however, provide CSX with double-track capabilities throughout the Washington Metropolitan Area.
- Criterion 6: Construction of Concept 8 is estimated to be 5 plus years. In addition, Concept 8 would likely require years of additional planning, including extensive coordination with local communities and other agencies. Concept 8s' new deep bore tunnel would not be ready in time to meet near term freight transportation needs.
- Criterion 8: Construction of Concept 8 is estimated to be approximately $2 billion, or more than 10 times the cost of two of lower cost concepts.

Criterion 7 would not apply to Concept 8 because construction would not be required along the surface of the Virginia Avenue SE corridor.

3.2.10 Concept 9: NCPC Indian Head Alignment

Concept 9 meets four or the eight evaluation criteria:

- Criterion 2: By establishing a new mainline freight rail line, replacing the section of rail line between Arkendale, VA and Jessup, MD, Concept 9 would provide CSX with DT/DS capabilities throughout the Washington Metropolitan Area.
- Criterion 3: Concept 9 would not require construction along the surface of the Virginia Avenue SE corridor. Therefore, it would not require the long-term closure of either of the I-695 off- and on-ramps located at 6th and 8th Streets SE, nor would it require re-construction of any structural elements of I-695.
- Criterion 4: Concept 9 would not require construction along the surface of the Virginia Avenue SE corridor. Therefore, maintenance of traffic plans for motorists, pedestrians and cyclists would not be required along the Virginia Avenue SE corridor. Maintenance of traffic plans would be required along the construction areas of the new mainline rail alignment.

- Criterion 5: Concept 9 would use the existing Virginia Avenue Tunnel to accommodate freight transportation service during construction.

Concept 9 would fail to meet the Criteria 1, 6 and 8. The reasons for failing to meet these criteria include:

- Criterion 1: Concept 9 would not address structural limitations of the existing Virginia Avenue Tunnel, which would remain in operation for local service. Similar to Concept 1, the tunnel may require emergency or unplanned repairs at some point in the future, and would eventually require rehabilitation or replacement. Concept 9 would, however, provide CSX with double-track capabilities throughout the Washington Metropolitan Area.
- Criterion 6: Construction of Concept 9 is estimated to be 5+ years. But, before construction could begin Concept 9 would require several years of additional planning, including extensive coordination with local communities and other agencies. Concept 9's new mainline rail would not come close to being ready in time to meet near term freight transportation needs.
- Criterion 8: NCPC estimated that construction of Concept 9 would cost between $3.2 to 4.2 billion, or more than 16 times the cost of two of the lower cost concepts.

Criterion 7 would not apply to Concept 9 because construction would not be required along the surface of the Virginia Avenue SE corridor.

3.2.11 Concept 10: NCPC Dahlgren Alignment

Concept 10 meets four of the eight evaluation criteria:

- Criterion 2: By establishing a new mainline freight rail line, replacing the section of rail line between Fredericksburg, VA and Jessup, MD, Concept 10 would provide CSX with DT/DS capabilities throughout the Washington Metropolitan Area.
- Criterion 3: Concept 10 would not require construction along the surface of the Virginia Avenue SE corridor. Therefore, it would not require the long-term closure of either of the I-695 off- and on-ramps located at 6th and 8th Streets SE, nor would it require re-construction of any structural element of the I-695 viaduct.
- Criterion 4: Concept 10 would not require construction along the surface of the Virginia Avenue SE corridor. Therefore, maintenance of traffic plans for motorists, pedestrians and cyclists would not be required along the Virginia Avenue SE corridor. Maintenance of traffic plans would be required along the construction areas of the new mainline rail alignment.
- Criterion 5: Concept 10 would use the existing Virginia Avenue Tunnel to accommodate freight transportation service during construction.

Concept 10 would fail to meet the Criteria 1, 6 and 8. The reasons for failing to meet these criteria include:

- Criterion 1: Concept 10 would not address structural limitations of the existing Virginia Avenue Tunnel, which would remain in operation for local service. Similar to Concept 1, the

tunnel may require emergency or unplanned repairs at some point in the future, and would eventually require rehabilitation or replacement. Concept 10 would, however, provide CSX with double-track capabilities throughout the Washington Metropolitan Area.

- Criterion 6: Construction of Concept 10 is estimated to be 5+ years. In addition, Concept 10 would require several years of additional planning, including extensive coordination with local communities and other agencies. Concept 10's new mainline rail would not be ready in time to meet near-term freight transportation needs.
- Criterion 8: NCPC estimated that construction of Concept 10 would cost between $3.5 to 4.7 billion, or more than 18 times the cost of two of the lowest cost concepts.

Criterion 7 would not apply to Concept 10 because construction would not be required along the surface of the Virginia Avenue SE corridor.

3.2.12 Concept 11: Permanent Reroute

Concept 11 meets three of the eight evaluation criteria:

- Criterion 3: Concept 11 would not require construction along the surface of the Virginia Avenue SE corridor. Therefore, it would not require the long-term closure of either of the I-695 off- and on-ramps located at 6th and 8th Streets SE, nor would it require re-construction of any structural elements of I-695.
- Criterion 4: Concept 11 would not require construction along the surface of the Virginia Avenue SE corridor. Therefore, maintenance of traffic plans for motorists, pedestrians and cyclists would not be required along the Virginia Avenue SE corridor. Maintenance of traffic plans would be required along the construction areas of the new mainline rail alignment.
- Criterion 5: Concept 11 would use the existing Virginia Avenue Tunnel to accommodate freight transportation service during construction.

Concept 11 would fail to meet the Criteria 1, 2, 6 and 8. The reasons for failing to meet these criteria include:

- Criterion 1: Concept 11 would not address structural limitations of the existing Virginia Avenue Tunnel, which would remain in operation for local service. Similar to Concept 1, the tunnel may require emergency or unplanned repairs at some point in the future, and would eventually require rehabilitation or replacement. Concept 11 would also not provide CSX with double-track capabilities throughout the Washington Metropolitan Area.
- Criterion 2: Concept 11 would not provide for DT/DS capabilities throughout the Washington Metropolitan Area as needed to meet freight transport demand in the future.
- Criterion 6: Concept 11 does not make any changes to address expected near term increases in freight traffic. In order to initiate Concept 11, extensive coordination with many communities and state and local agencies would be required, which would likely take many years to complete.
- Criterion 8: Though not quantified, Concept 11 would fail to meet Criterion 8 as this concept would require substantial investment in rail capacity and equipment.

Criterion 7 would not apply to Concept 11 because construction would not be required along the surface of the Virginia Avenue SE corridor.

3.3 Summary of Concepts Evaluation

Table 1 summarizes the findings of the concepts evaluation. The table qualitatively scores each concept against the eight evaluation criteria described above. Scoring is based on ability of each concept to either meet the criteria, failure to meet the criteria, or uncertainty in meeting the criteria. It was also noted if certain criteria are not applicable to concepts.

Table 1
Concepts Evaluation Scoring

	Project Criteria	No Build	Rebuild Tunnel Concepts							Reroute Freight Traffic Concepts			
		1	2	3	3A	4	5	6	7	8	9	10	11
1	The concept, upon completion, will address the deficiencies of the Virginia Avenue Tunnel.		Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
2	The concept, upon completion, will provide the necessary improvements for operating DS intermodal containers and have DT for the efficient flow of commercial rail freight through the Washington Metropolitan Area.		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
3	The concept will avoid major impacts to the structures, traffic or access to or from I-695 (I-295).		Yes	No	No	Requires more study	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4	The concept must allow for the maintenance of traffic across Virginia Avenue and along adjacent streets throughout the duration of construction.		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5	The concept will maintain interstate rail commerce without a substantial negative impact to the level of service during construction.		Yes	Yes	Yes	No	Yes	Requires more study	No	Yes	Yes	Yes	Yes
6	The concept will be implemented in a time frame that accommodates the near term anticipated increase in freight traffic.		Requires more study	Requires more study	Requires more study	Requires more study	Requires more study	Requires more study	No	No	No	No	No
7	The concept has a comparatively reasonable duration of construction in the vicinity of the existing tunnel.		Requires more study	Requires more study	Requires more study	Requires more study	Requires more study	Requires more study	Yes	N/A	N/A	N/A	N/A
8	The concept has a comparatively low cost.		Yes	Requires more study	Requires more study	Requires more study	Yes	Requires more study	Requires more study	No	No	No	No

Legend:
- Yes
- Requires more study
- No
- N/A

4 Conclusions

Based on the evaluation described in Section 3.2, all of the reroute concepts (Concepts 8 to 11) were eliminated from further consideration, and that no further work would be conducted to develop these concepts. In summary, the major reasons for eliminating these concepts include:

- Concept 8, Deep Bore Tunnel, which failed three of the evaluation criteria, would require acquisition of 14 to 16 acres at portal locations and construction of ventilation shafts in urban areas, in addition to its extremely high cost and extensive planning effort needed to fully develop this concept.
- Concept 9, NCPC Indian Head Alignment, which failed three of the evaluation criteria, would require a new bridge over the Potomac River and 31 miles of new rail line. It would traverse through several communities and natural resources. It would have an extremely high cost and an extensive planning effort to fully develop this concept.
- Concept 10, NCPC Dahlgren Alignment, which failed three of the evaluation criteria, would require a new bridge over the Potomac River and 38 miles of new rail line. Similar to Concept 9, it would traverse through several communities and natural resources, and would have an extremely high cost and an extensive planning effort to fully develop this concept.
- Concept 11, Permanent Reroute, which failed four of the evaluation criteria, would include substantial diversion of freight traffic to trucks or other modes of transportation, with associated impacts to interstate highway congestion, higher fuel consumption, and pollution.

Among the rebuild concepts, Concepts 3, 3A, 4 and 7 were eliminated from further consideration because each would fail at least one criterion. In summary, the major reasons for eliminating these concepts include:

- Concept 3, Rebuild Virginia Avenue Tunnel, Temporary North Side Runaround, would result in major impacts to I-695 during construction.
- Concept 3A, Permanent Twin Tunnels (New Tunnel on North Side of Existing Virginia Avenue Tunnel), would also in major impacts during construction.
- Concept 4, Rebuild Virginia Avenue Tunnel with Combination Runaround, would require two major disruptions to CSX's operation, causing stoppages of freight train movements for several weeks for each disruption. In addition, Concept 5 would not provide any additional benefit to the surrounding community in comparison Concept 2 despite having the two disruptions to freight movements.
- Concept 7, Rebuild Virginia Avenue Tunnel with a Temporary Reroute, would result in a substantial degradation of freight level of service to growing customer demands in the I-95 corridor.

The remaining concepts would be retained for further evaluation, and carried forward into the EIS:

- Concept 2: Rebuild Virginia Avenue Tunnel, Temporary South Side Runaround
- Concept 5: Permanent Twin Tunnels (New Tunnel on South Side of Existing Virginia Avenue Tunnel)
- Concept 6: Rebuild Virginia Avenue Tunnel, Rebuild With On-Line Construction

The EIS will document the environmental and social impacts that could result from the concepts that are carried forward for more detailed study. Construction and long-term operational impacts will be assessed, and will describe specific measures to prevent, minimize or mitigate adverse impacts to the environment will be described. The EIS will also document compliance with other federal laws that would apply to the Project, such as Section 7 of the Endangered Species Act, Section 106 of the National Historic Preservation Act, and applicable Executive Orders.

Appendix C

Limits of Disturbance of Build Alternatives

Residential Property Mitigation Plan "Front Row" Residences

Preferred Alternative and Alternative 3

LEGEND

PROPERTY LINE / ROW	PROPOSED OUTSIDE TUNNEL ENVELOPE
PROPOSED TRACK ALIGNMENT	LAYDOWN AREA
APPROXIMATE LIMIT OF DISTURBANCE (LOD)	TEMPORARY MOT WORK ONLY
	TUNNEL EXCAVATION AREA

SCALE (FEET)

100 0 50 100

WORKING DRAFT

CSX VIRGINIA AVENUE TUNNEL
LIMIT OF DISTURBANCE - ALT. 2 & 3

OCTOBER 28, 2013

SHEET 1 OF 6

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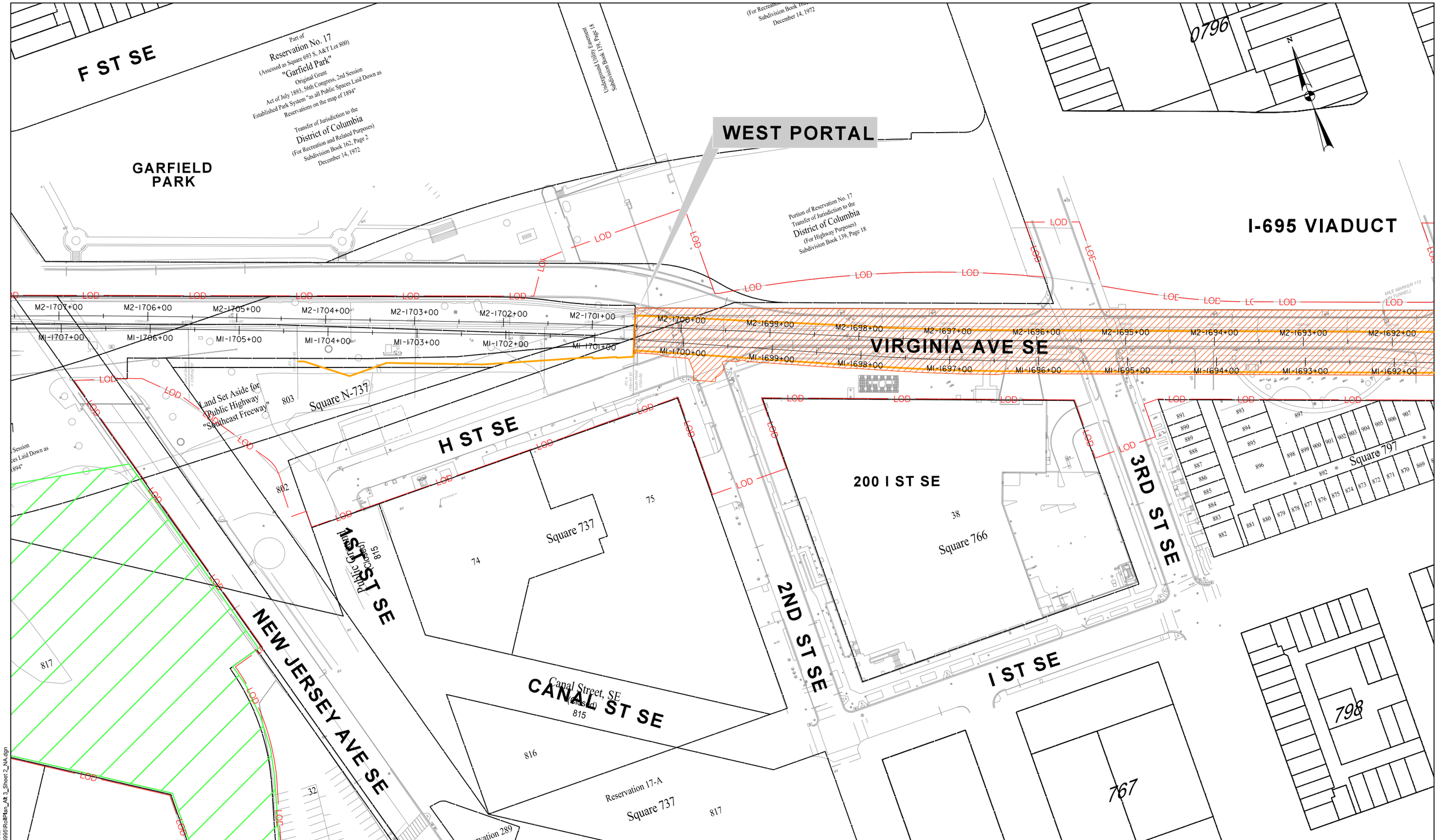

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PROPOSED TRACK ALIGNMENT	LAYDOWN AREA
APPROXIMATE LIMIT OF DISTURBANCE (LOD)	TEMPORARY MOT WORK ONLY
	TUNNEL EXCAVATION AREA

SCALE (FEET)

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LIMIT OF DISTURBANCE - ALT. 2 & 3

OCTOBER 28, 2013

SHEET 2 OF 6

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VIRGINIA AVE SE

I-695 VIADUCT

7TH ST SE

VIRGINIA AVE SE

CAPPER SENIORS

MARINE QUARTERS

ST. PAUL'S AUMP CHURCH

4TH ST SE

5TH ST SE

CAPITOL QUARTERS

K ST SE

M2-1693+00 M2-1692+00 M2-1691+00 M2-1690+00 M2-1689+00 M2-1688+00 M2-1687+00 M2-1686+00 M2-1685+00 M2-1684+00 M2-1683+00 M2-1682+00 M2-1681+00 M2-1680+00 M2-1679+00 M2-1678+00

M1-1693+00 M1-1692+00 M1-1691+00 M1-1690+00 M1-1689+00 M1-1688+00 M1-1687+00 M1-1686+00 M1-1685+00 M1-1684+00 M1-1683+00 M1-1682+00 M1-1681+00 M1-1680+00 M1-1679+00 M1-1678+00

LEGEND

PROPERTY LINE / ROW	PROPOSED OUTSIDE TUNNEL ENVELOPE
PROPOSED TRACK ALIGNMENT	LAYDOWN AREA
APPROXIMATE LIMIT OF DISTURBANCE (LOD)	TEMPORARY MOT WORK ONLY
	TUNNEL EXCAVATION AREA

SCALE (FEET)

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LIMIT OF DISTURBANCE - ALT. 2 & 3

OCTOBER 28, 2013

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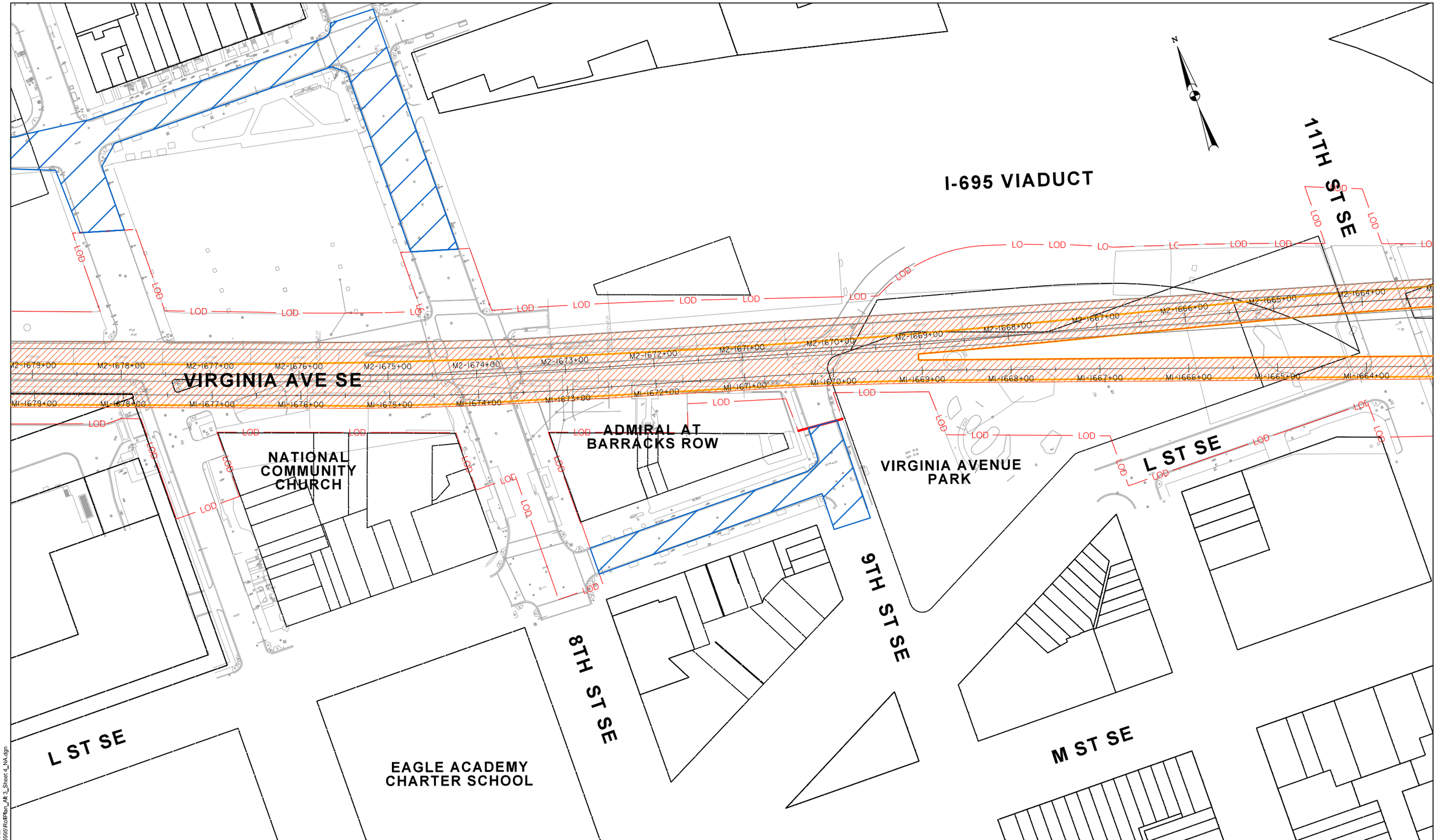

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PROPOSED TRACK ALIGNMENT	LAYDOWN AREA
APPROXIMATE LIMIT OF DISTURBANCE (LOD)	TEMPORARY MOT WORK ONLY
	TUNNEL EXCAVATION AREA

SCALE (FEET)

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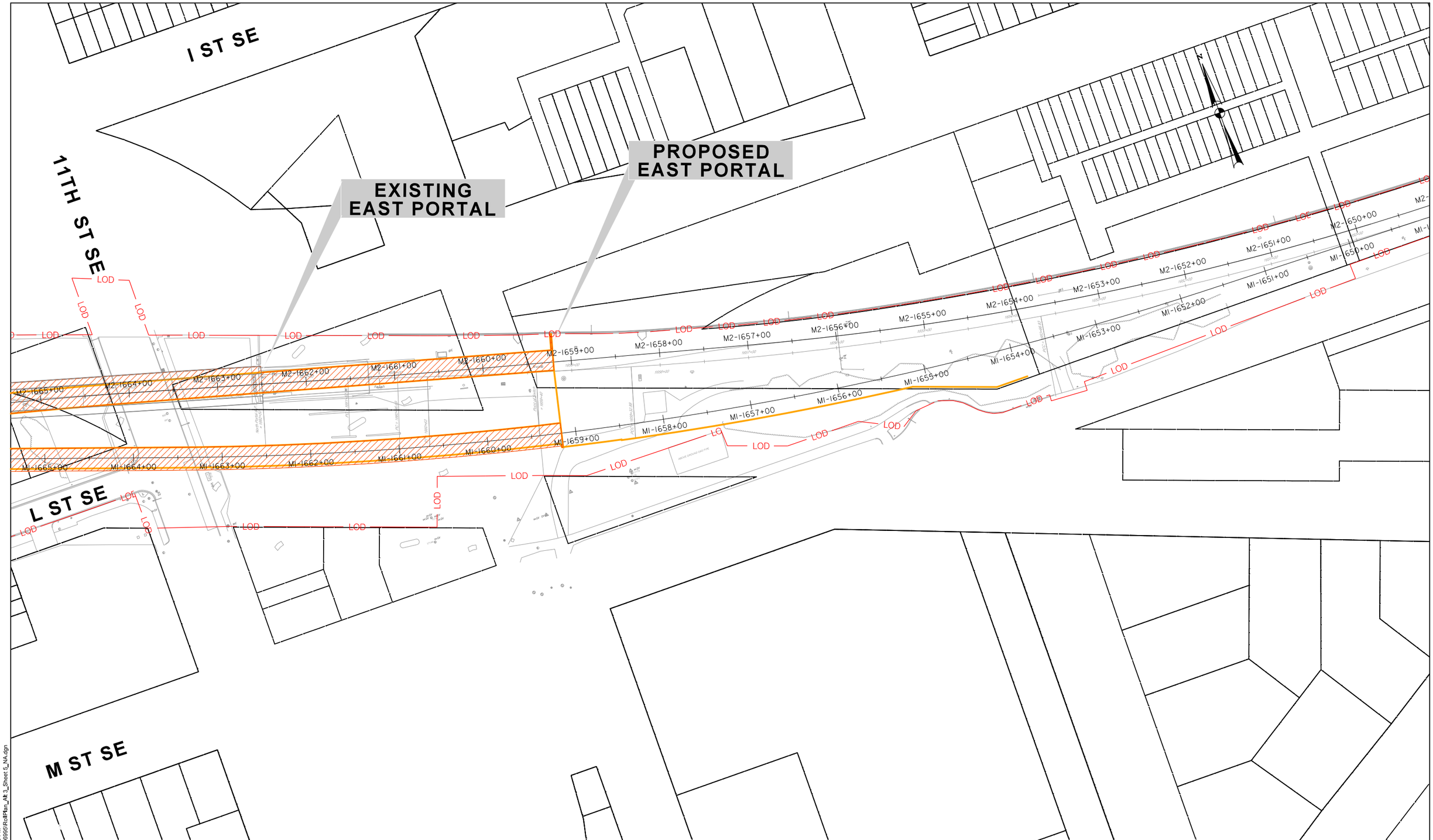

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APPROXIMATE LIMIT OF DISTURBANCE	LOD
PROPOSED OUTSIDE TUNNEL ENVELOPE	
LAYDOWN AREA	
TEMPORARY MOT WORK ONLY	
TUNNEL EXCAVATION AREA	

SCALE (FEET)

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WORKING DRAFT

CSX VIRGINIA AVENUE TUNNEL
LIMIT OF DISTURBANCE - ALT. 2 & 3

OCTOBER 28, 2013

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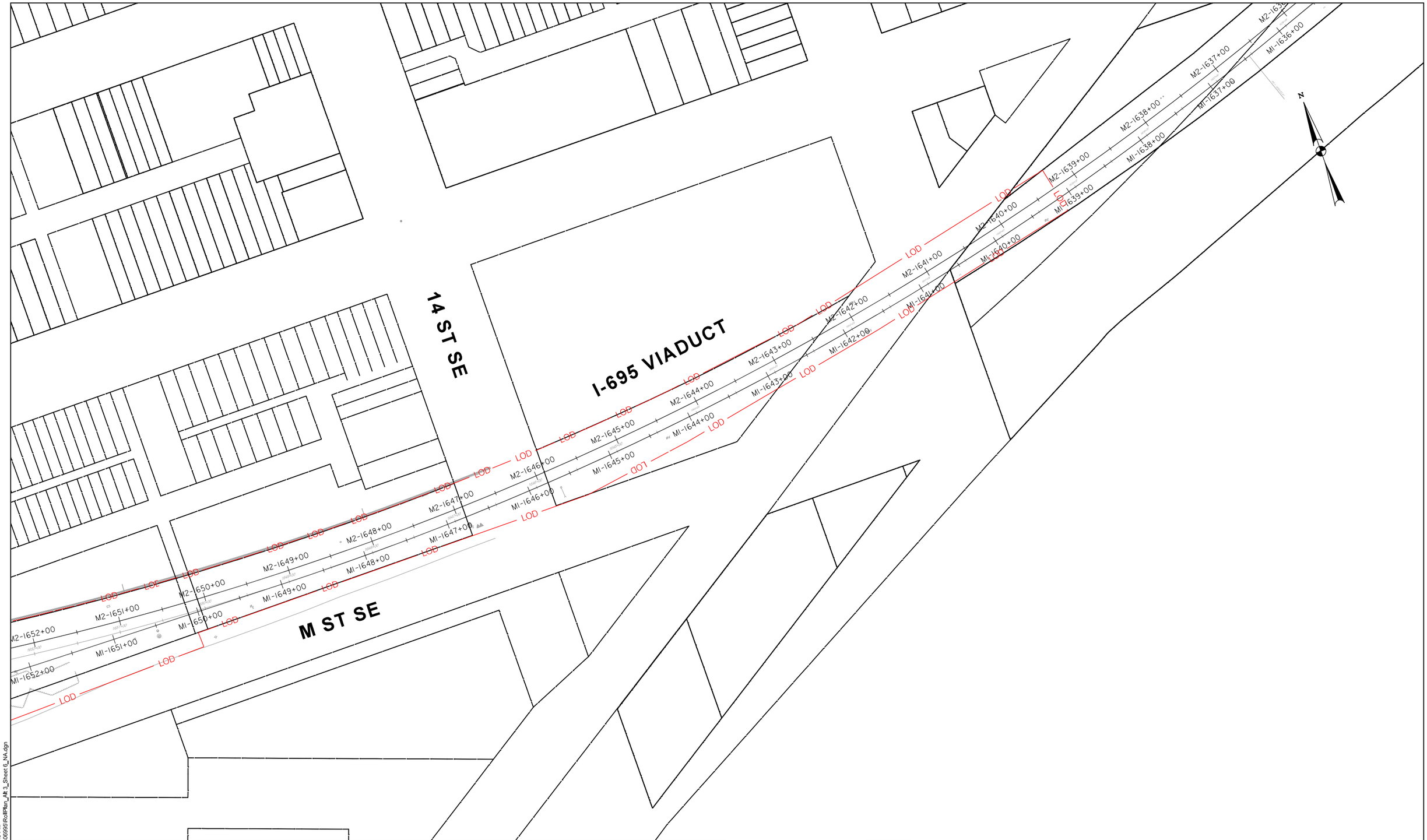

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- PROPERTY LINE / ROW
- PROPOSED TRACK ALIGNMENT
- APPROXIMATE LIMIT OF DISTURBANCE (LOD)
- PROPOSED OUTSIDE TUNNEL ENVELOPE
- LAYDOWN AREA
- TEMPORARY MOT WORK ONLY
- TUNNEL EXCAVATION AREA

SCALE (FEET)

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LIMIT OF DISTURBANCE - ALT. 2 & 3

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SHEET 6 OF 6

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Alternative 4

641

641

642

642E

N

NEW JERSEY AVE SE

GARFIELD PARK

M2-1716+00 M2-1715+00 M2-1714+00 M2-1713+00 M2-1712+00 M2-1711+00 M2-1710+00 M2-1709+00 M2-1708+00 M2-1707+00 M2-1706+00

M1-1714+00 M1-1713+00 M1-1712+00 M1-1711+00 M1-1710+00 M1-1709+00 M1-1708+00 M1-1707+00 M1-1706+00

Part of
Reservation No. 17
Original Grant
Act of July 1893, 56th Congress, 2nd Session
Established Park System "as all Public Spaces Laid Down as
Reservations on the map of 1894"

Square 695

SOUTH CAPITOL ST

31

805

808

809

810

817

818

819

I ST SE

LEGEND

PROPERTY LINE / ROW	PROPOSED OUTSIDE TUNNEL ENVELOPE
PROPOSED TRACK ALIGNMENT	LAYDOWN AREA
APPROXIMATE LIMIT OF DISTURBANCE (LOD)	TEMPORARY MOT WORK ONLY
	TUNNEL EXCAVATION AREA

SCALE (FEET)

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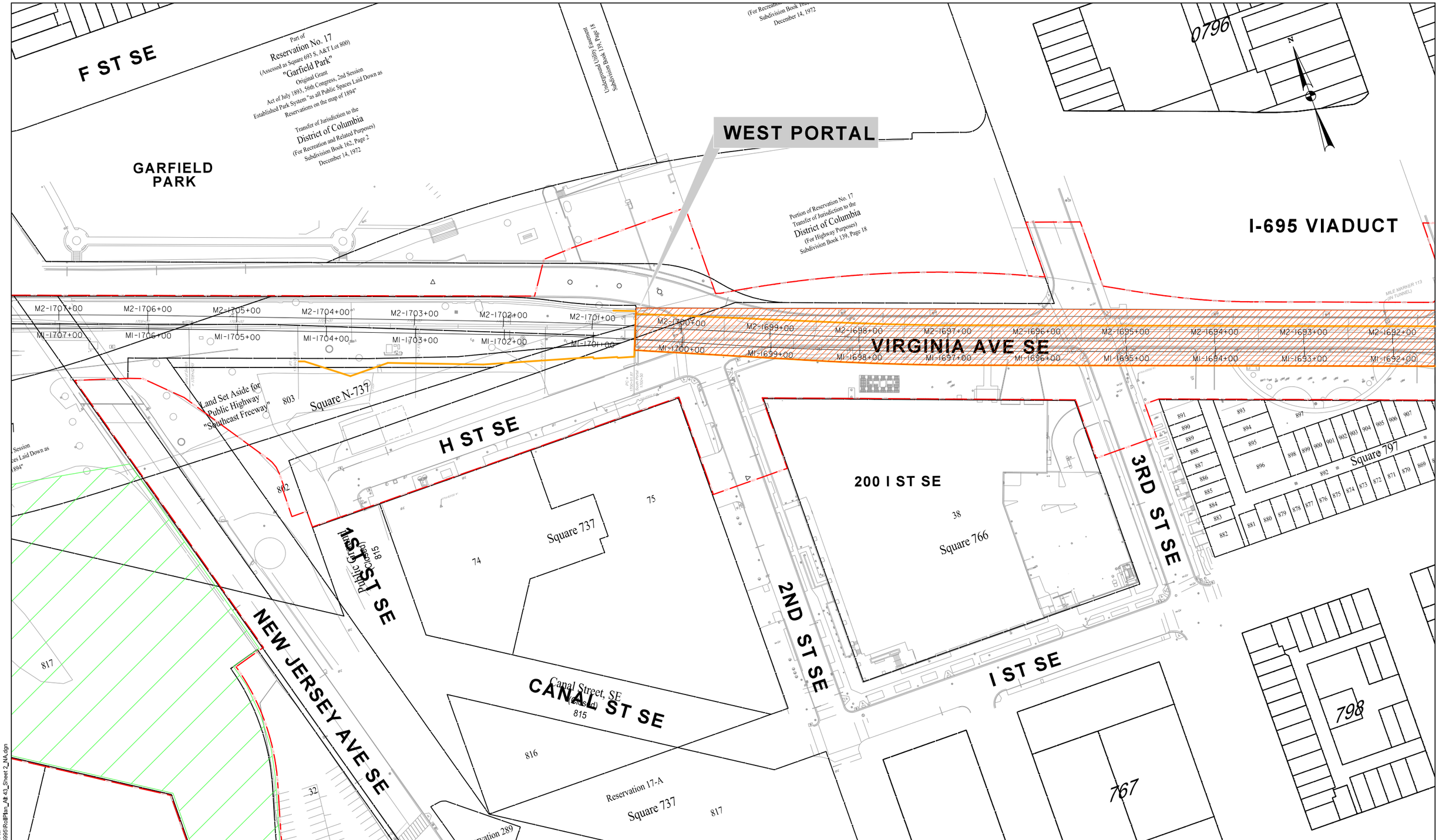

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PROPOSED TRACK ALIGNMENT	LAYDOWN AREA
APPROXIMATE LIMIT OF DISTURBANCE (LOD)	TEMPORARY MOT WORK ONLY
	TUNNEL EXCAVATION AREA

SCALE (FEET)

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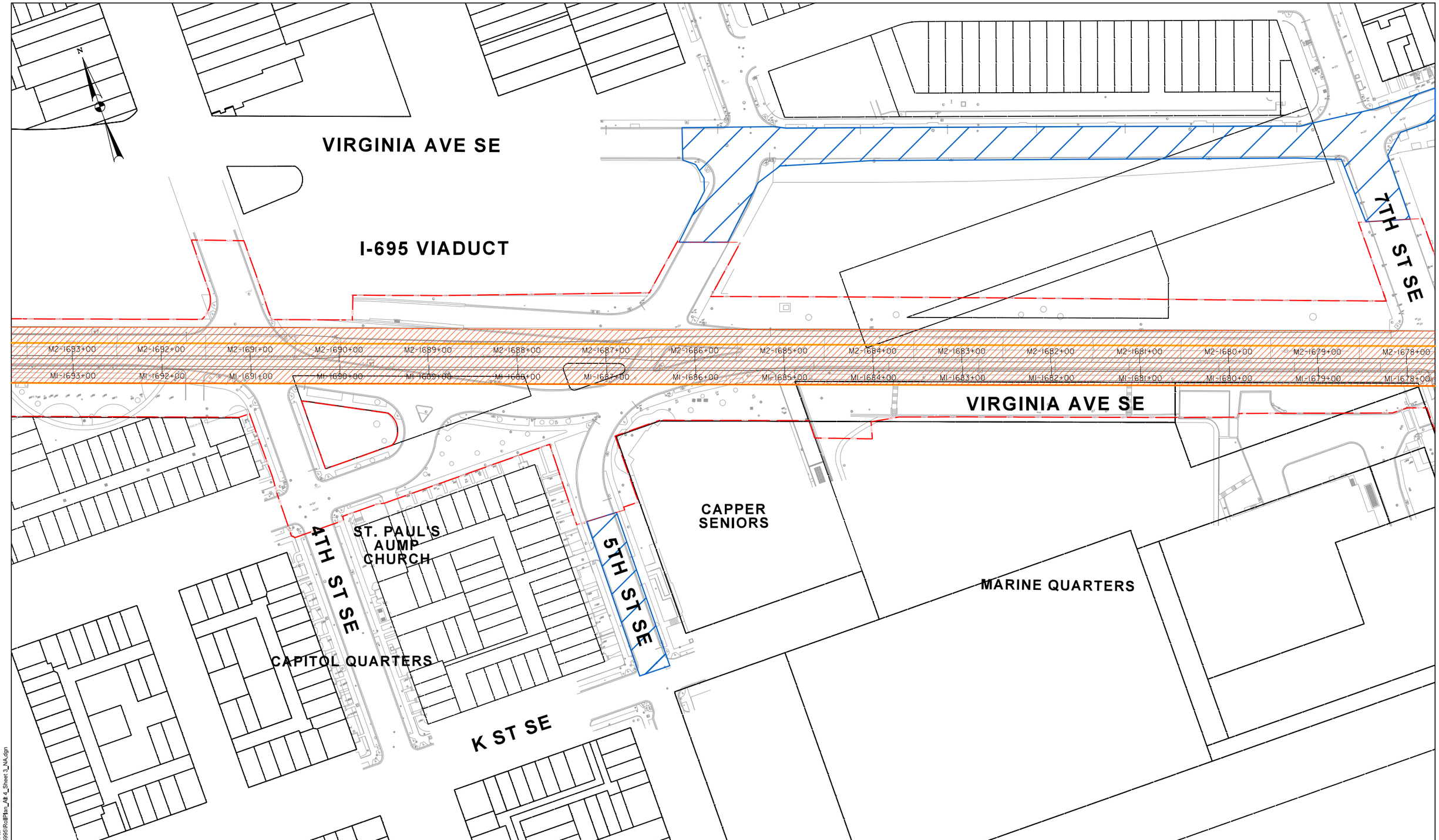

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APPROXIMATE LIMIT OF DISTURBANCE (LOD)	TEMPORARY MOT WORK ONLY
	TUNNEL EXCAVATION AREA

SCALE (FEET)

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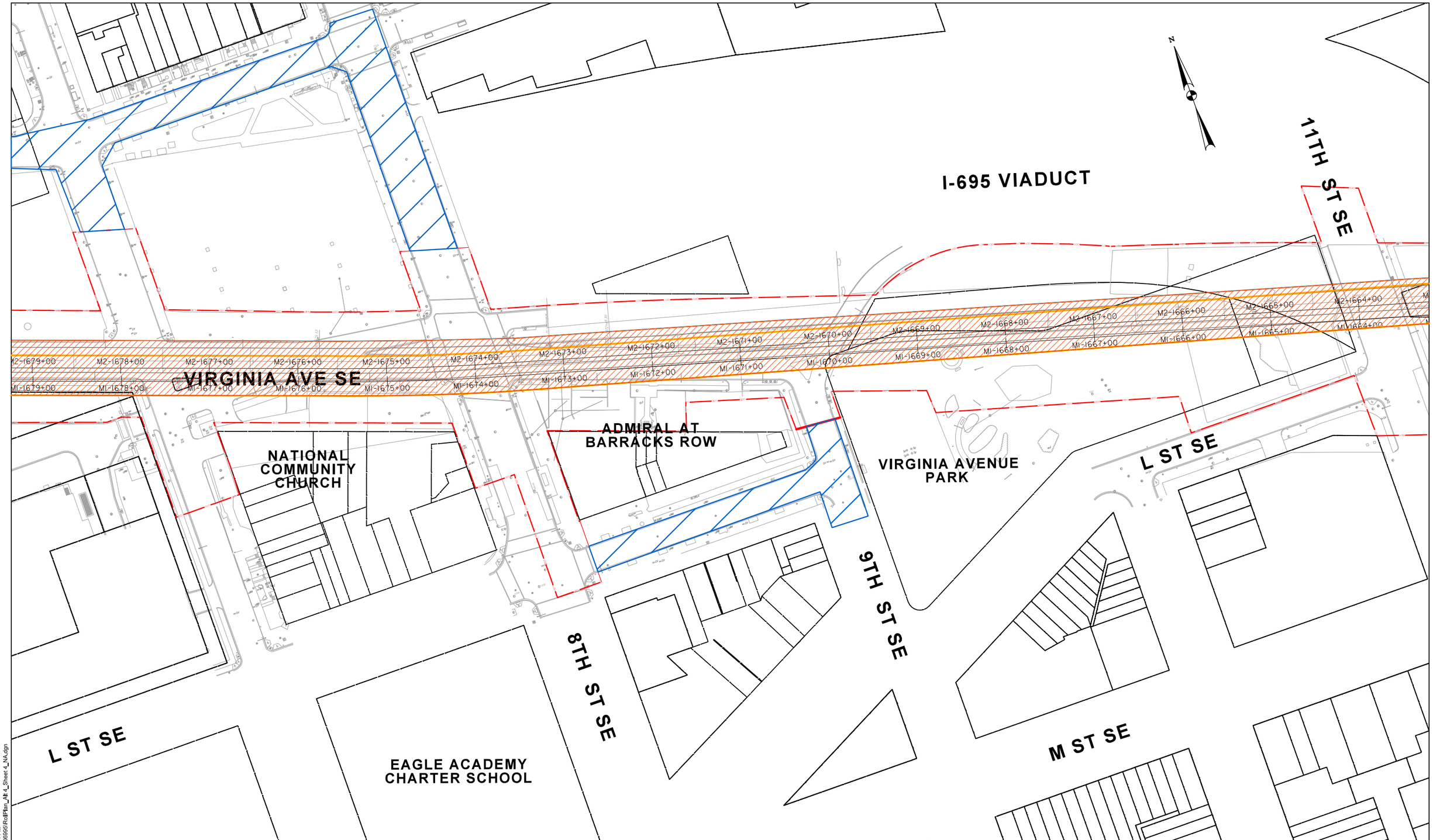

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- LAYDOWN AREA
- TEMPORARY MOT WORK ONLY
- TUNNEL EXCAVATION AREA

SCALE (FEET)

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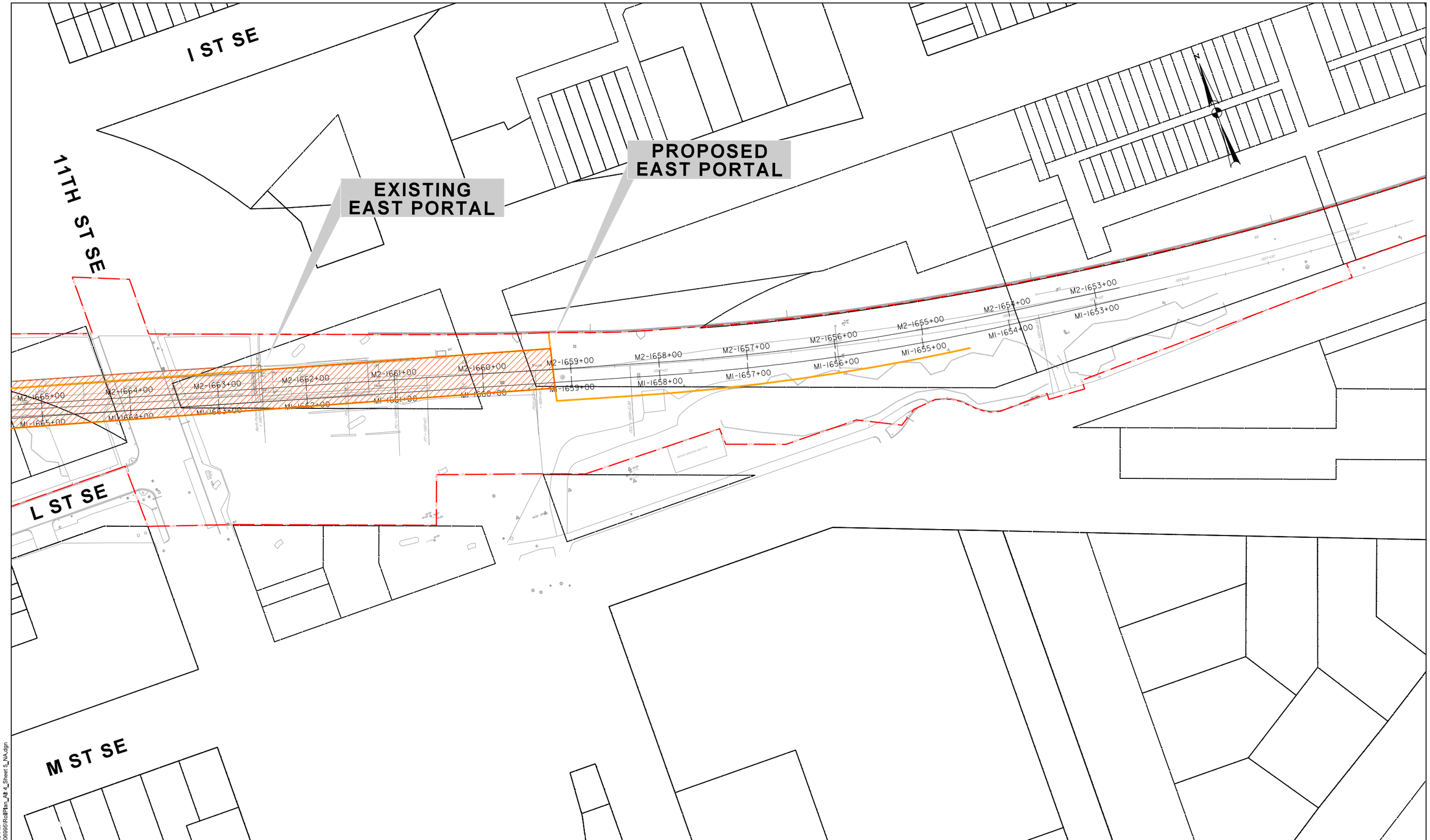

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- TEMPORARY MOT WORK ONLY
- TUNNEL EXCAVATION AREA

SCALE (FEET)

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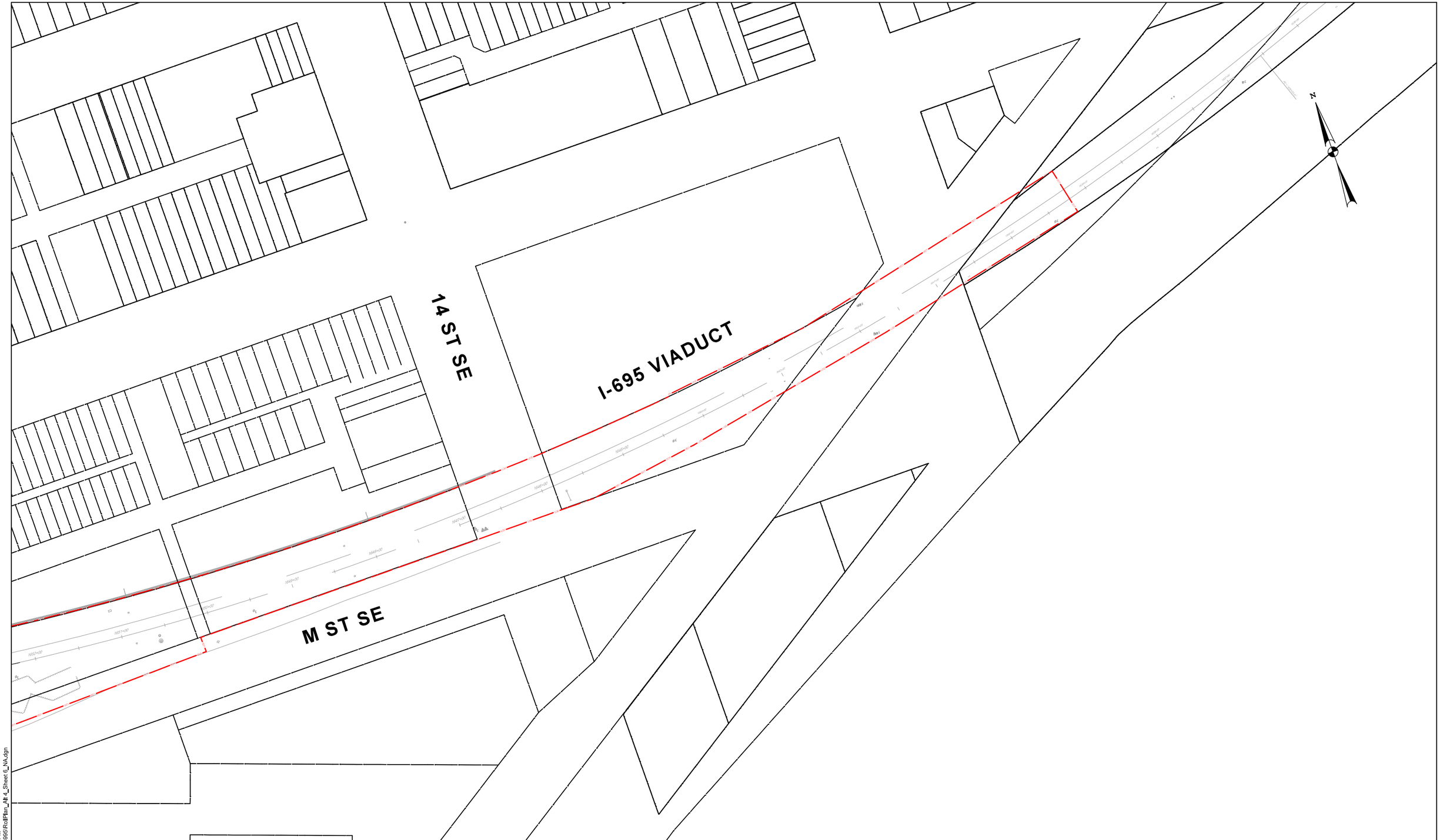

LEGEND

PROPERTY LINE / ROW	
PROPOSED TRACK ALIGNMENT	
APPROXIMATE LIMIT OF DISTURBANCE	LOD
PROPOSED OUTSIDE TUNNEL ENVELOPE	
LAYDOWN AREA	
TEMPORARY MOT WORK ONLY	
TUNNEL EXCAVATION AREA	

SCALE (FEET)

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WORKING DRAFT

CSX VIRGINIA AVENUE TUNNEL
LIMIT OF DISTURBANCE - ALT. 4

OCTOBER 2, 2013

SHEET 6 OF 6

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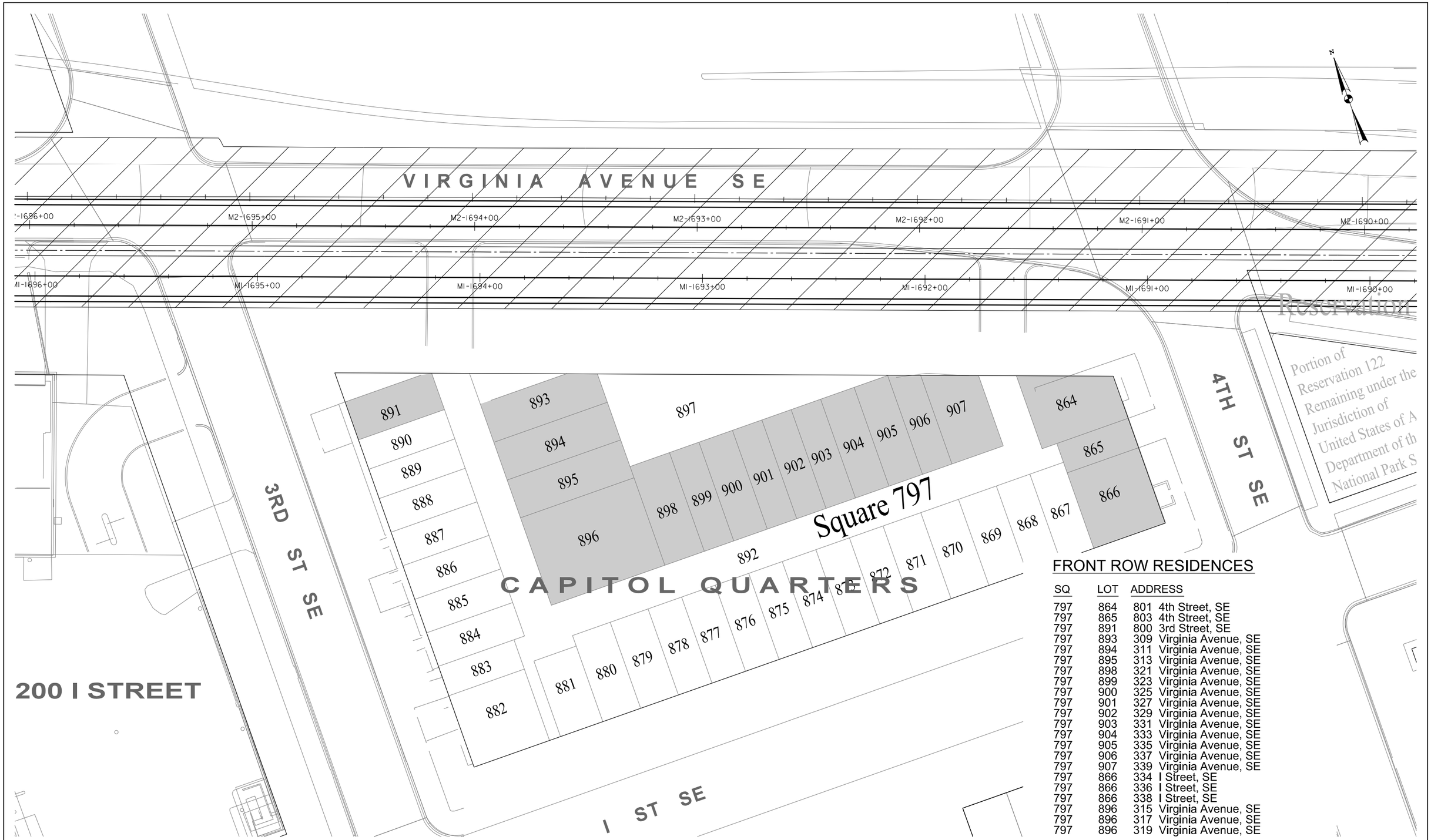
Residential Property
Mitigation Plan
“Front Row” Residences



FRONT ROW RESIDENCES

SQ	LOT	ADDRESS
797	864	801 4th Street, SE
797	865	803 4th Street, SE
797	891	800 3rd Street, SE
797	893	309 Virginia Avenue, SE
797	894	311 Virginia Avenue, SE
797	895	313 Virginia Avenue, SE
797	898	321 Virginia Avenue, SE
797	899	323 Virginia Avenue, SE
797	900	325 Virginia Avenue, SE
797	901	327 Virginia Avenue, SE
797	902	329 Virginia Avenue, SE
797	903	331 Virginia Avenue, SE
797	904	333 Virginia Avenue, SE
797	905	335 Virginia Avenue, SE
797	906	337 Virginia Avenue, SE
797	907	339 Virginia Avenue, SE
797	866	334 I Street, SE
797	866	336 I Street, SE
797	866	338 I Street, SE
797	896	315 Virginia Avenue, SE
797	896	317 Virginia Avenue, SE
797	896	319 Virginia Avenue, SE

LEGEND

- TUNNEL EXCAVATION AREA
- FRONT ROW RESIDENCES
- FRONT ROW CAPPER SENIOR CENTER RESIDENCES

VIRGINIA AVENUE TUNNEL

RESIDENTIAL PROPERTY MITIGATION PLAN

FIGURE 1

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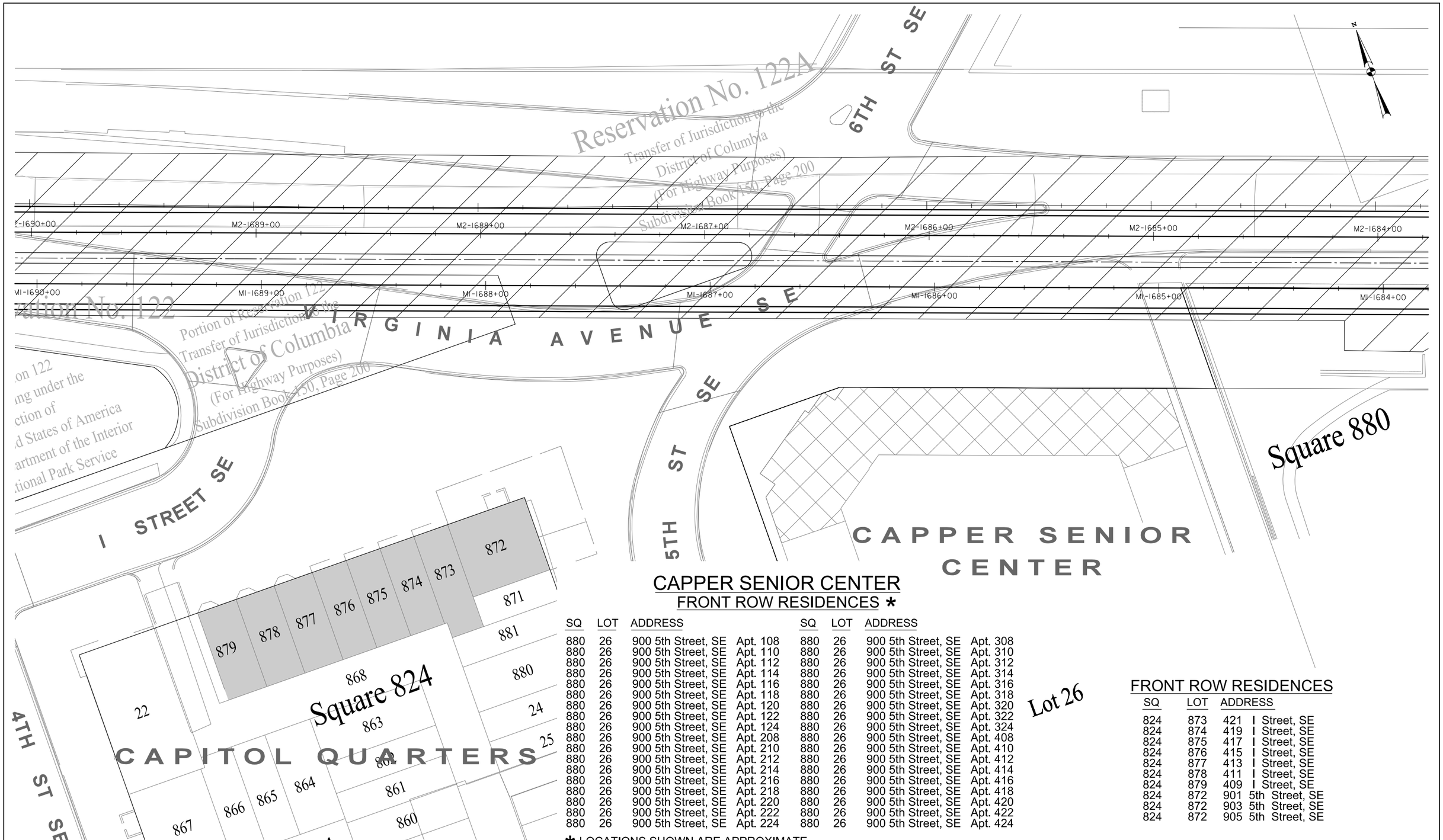

CAPPER SENIOR CENTER
FRONT ROW RESIDENCES *

SQ	LOT	ADDRESS	SQ	LOT	ADDRESS
880	26	900 5th Street, SE Apt. 108	880	26	900 5th Street, SE Apt. 308
880	26	900 5th Street, SE Apt. 110	880	26	900 5th Street, SE Apt. 310
880	26	900 5th Street, SE Apt. 112	880	26	900 5th Street, SE Apt. 312
880	26	900 5th Street, SE Apt. 114	880	26	900 5th Street, SE Apt. 314
880	26	900 5th Street, SE Apt. 116	880	26	900 5th Street, SE Apt. 316
880	26	900 5th Street, SE Apt. 118	880	26	900 5th Street, SE Apt. 318
880	26	900 5th Street, SE Apt. 120	880	26	900 5th Street, SE Apt. 320
880	26	900 5th Street, SE Apt. 122	880	26	900 5th Street, SE Apt. 322
880	26	900 5th Street, SE Apt. 124	880	26	900 5th Street, SE Apt. 324
880	26	900 5th Street, SE Apt. 208	880	26	900 5th Street, SE Apt. 408
880	26	900 5th Street, SE Apt. 210	880	26	900 5th Street, SE Apt. 410
880	26	900 5th Street, SE Apt. 212	880	26	900 5th Street, SE Apt. 412
880	26	900 5th Street, SE Apt. 214	880	26	900 5th Street, SE Apt. 414
880	26	900 5th Street, SE Apt. 216	880	26	900 5th Street, SE Apt. 416
880	26	900 5th Street, SE Apt. 218	880	26	900 5th Street, SE Apt. 418
880	26	900 5th Street, SE Apt. 220	880	26	900 5th Street, SE Apt. 420
880	26	900 5th Street, SE Apt. 222	880	26	900 5th Street, SE Apt. 422
880	26	900 5th Street, SE Apt. 224	880	26	900 5th Street, SE Apt. 424

* LOCATIONS SHOWN ARE APPROXIMATE

Lot 26

FRONT ROW RESIDENCES

SQ	LOT	ADDRESS
824	873	421 I Street, SE
824	874	419 I Street, SE
824	875	417 I Street, SE
824	876	415 I Street, SE
824	877	413 I Street, SE
824	878	411 I Street, SE
824	879	409 I Street, SE
824	872	901 5th Street, SE
824	872	903 5th Street, SE
824	872	905 5th Street, SE

LEGEND

- TUNNEL EXCAVATION AREA
- FRONT ROW RESIDENCES
- FRONT ROW CAPPER SENIOR CENTER RESIDENCES

VIRGINIA AVENUE TUNNEL

RESIDENTIAL PROPERTY MITIGATION PLAN

FIGURE 2

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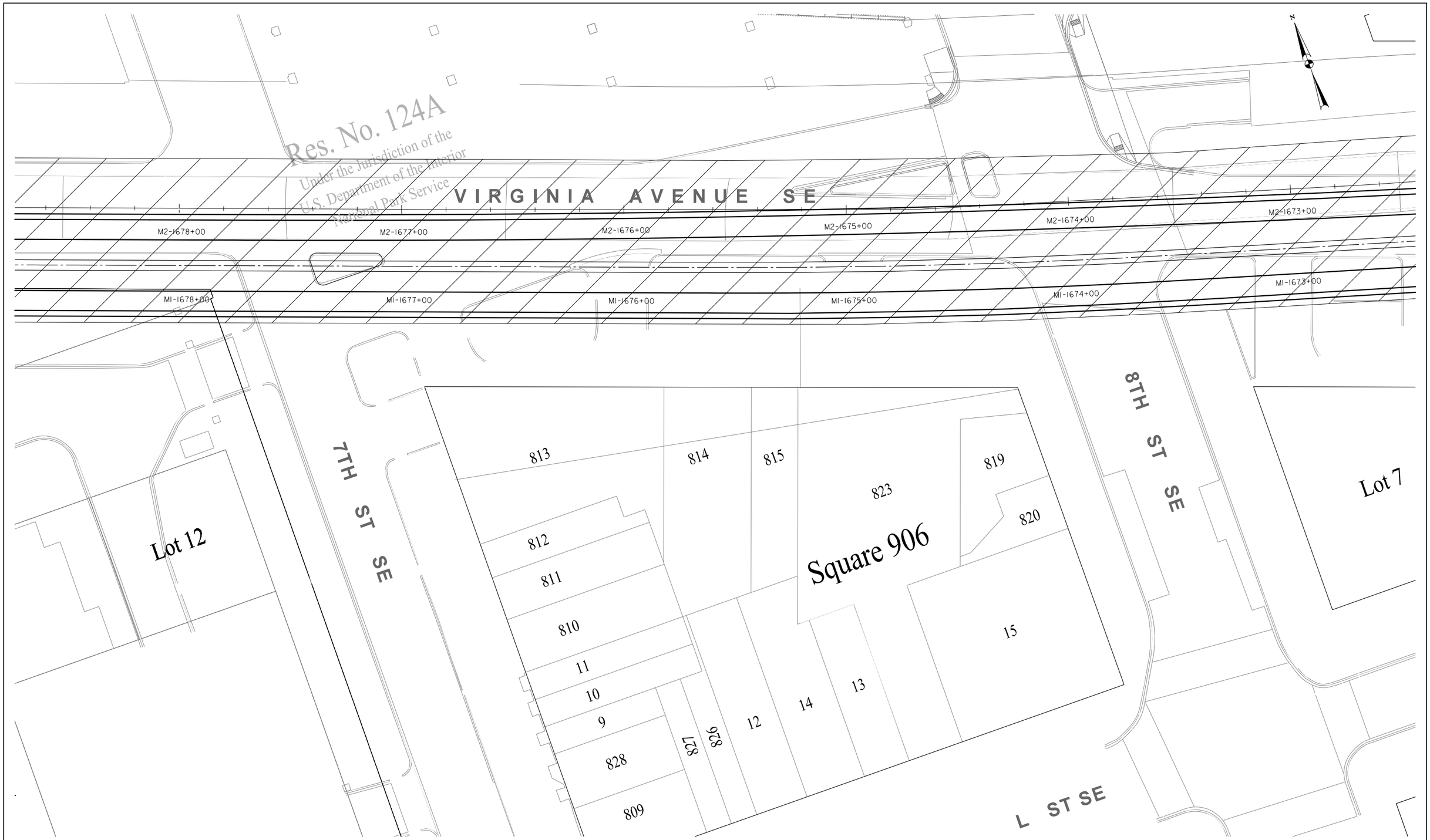

LEGEND

- TUNNEL EXCAVATION AREA
- FRONT ROW RESIDENCES
- FRONT ROW CAPPER SENIOR CENTER RESIDENCES

VIRGINIA AVENUE TUNNEL

RESIDENTIAL PROPERTY MITIGATION PLAN

FIGURE 3

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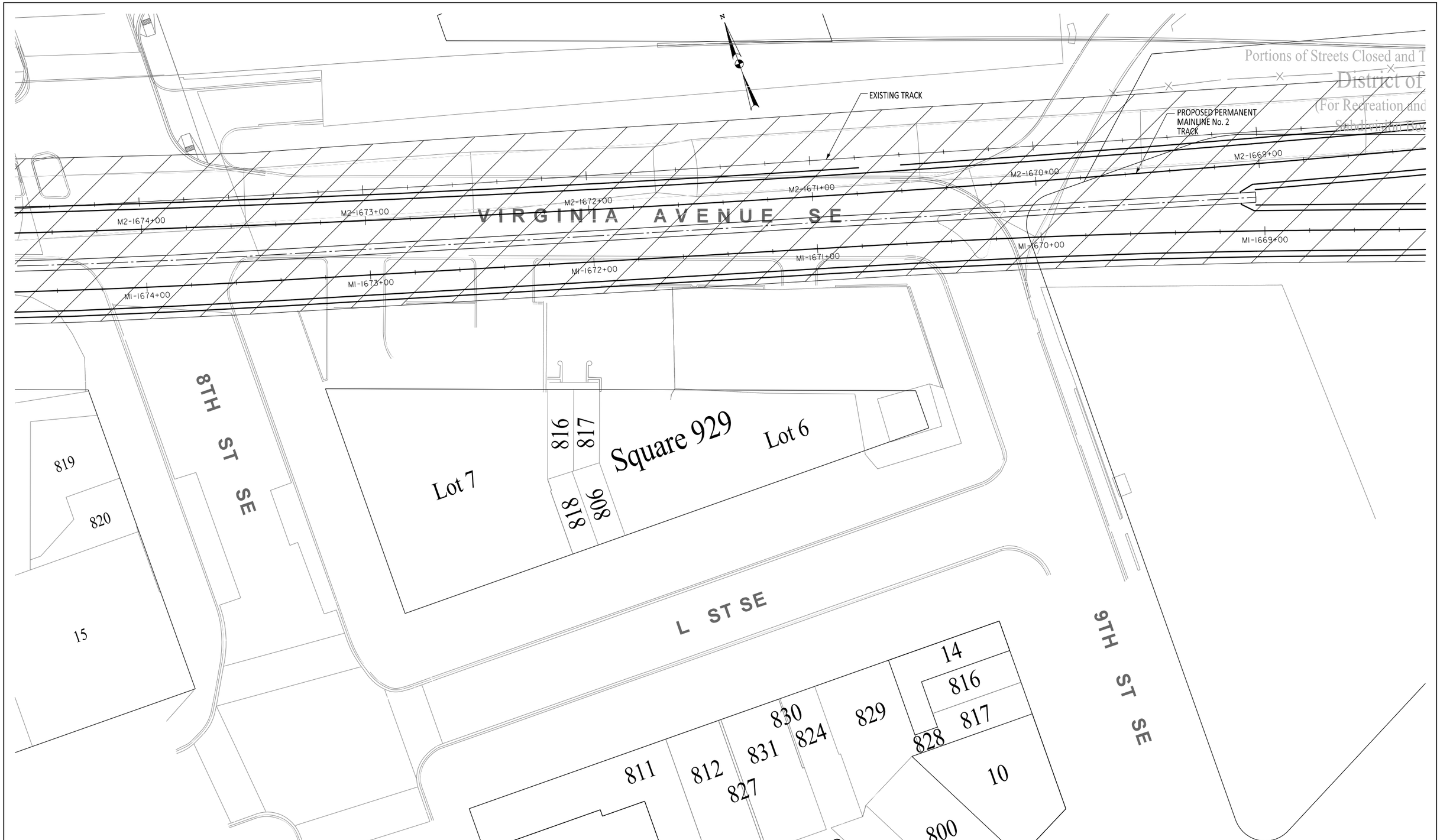

LEGEND

- TUNNEL EXCAVATION AREA
- FRONT ROW RESIDENCES
- FRONT ROW CAPPER SENIOR CENTER RESIDENCES

VIRGINIA AVENUE TUNNEL

RESIDENTIAL PROPERTY MITIGATION PLAN

FIGURE 4

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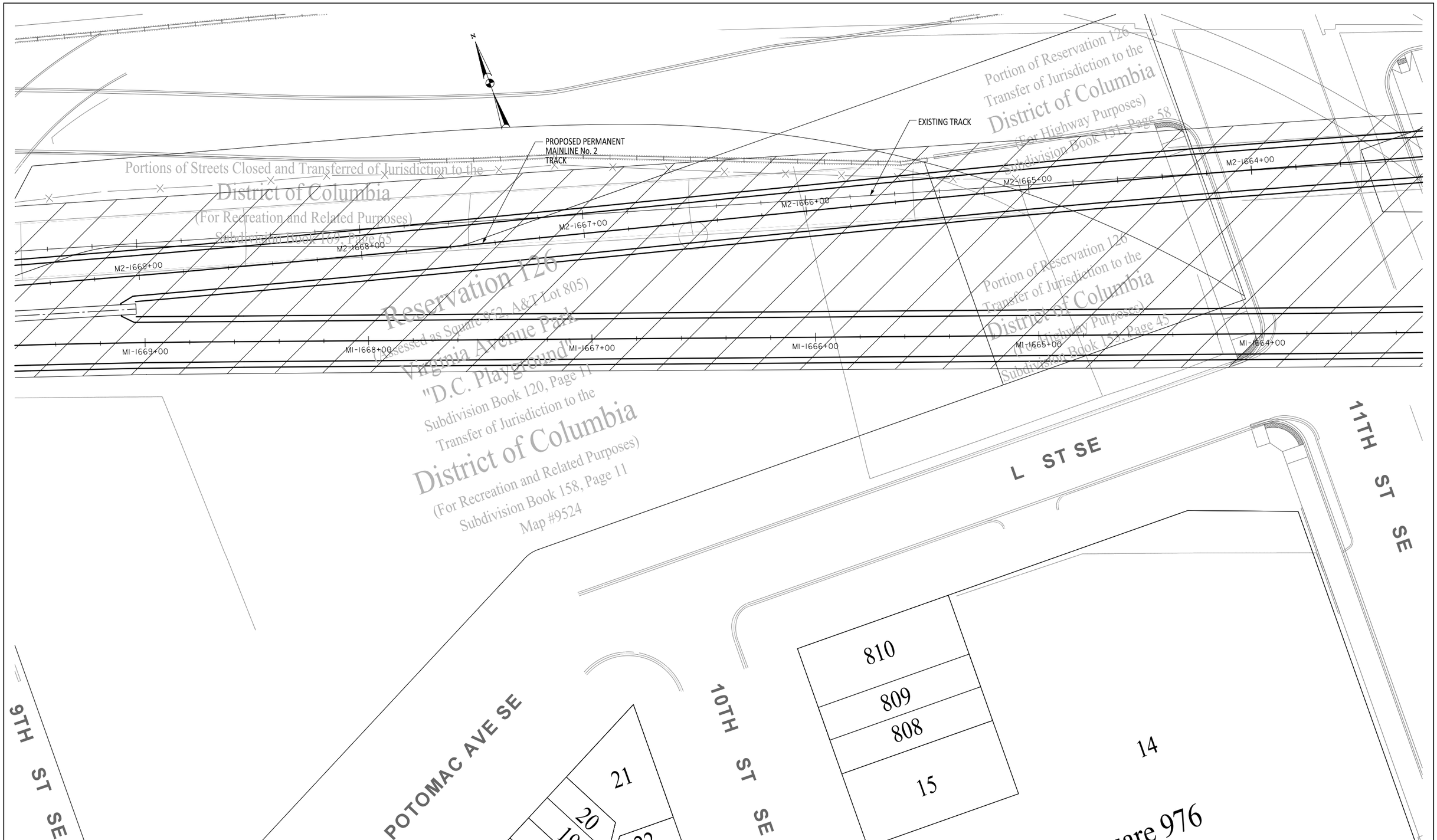

LEGEND

- TUNNEL EXCAVATION AREA
- FRONT ROW RESIDENCES
- FRONT ROW CAPPER SENIOR CENTER RESIDENCES

VIRGINIA AVENUE TUNNEL

RESIDENTIAL PROPERTY MITIGATION PLAN

FIGURE 5

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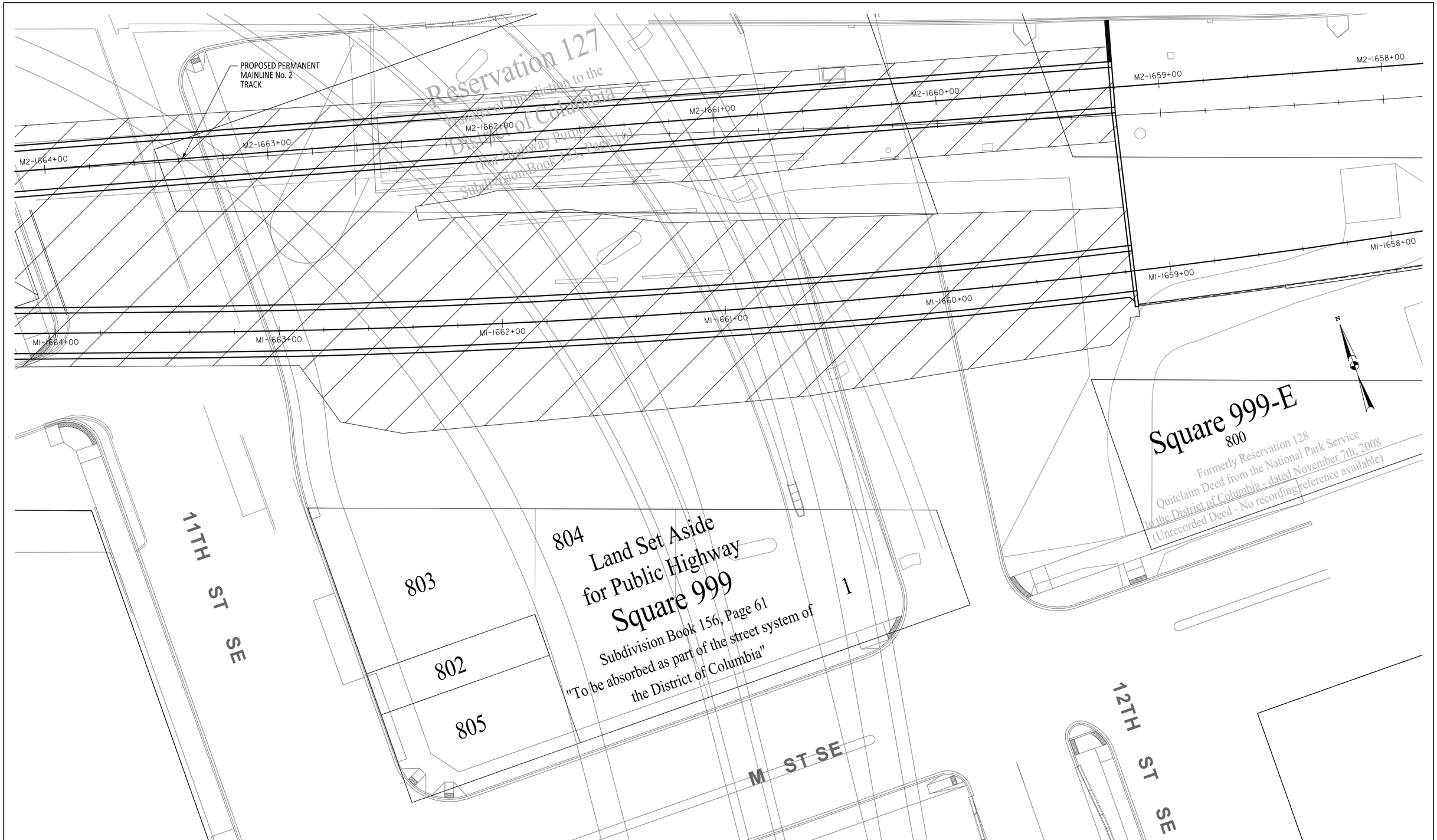

LEGEND

- TUNNEL EXCAVATION AREA
- FRONT ROW RESIDENCES
- FRONT ROW CAPPER SENIOR CENTER RESIDENCES

VIRGINIA AVENUE TUNNEL

RESIDENTIAL PROPERTY MITIGATION PLAN

FIGURE 6

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Appendix D

Air Quality Technical Report

VIRGINIA AVENUE TUNNEL RECONSTRUCTION PROJECT

Air Quality Technical Report

Prepared by:
Parsons Brinckerhoff

April 2014

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1.0 Project Description

CSX Transportation, Inc. (CSX) is proposing to reconstruct the Virginia Avenue Tunnel. The tunnel is located in the Capitol Hill neighborhood of the District of Columbia beneath eastbound Virginia Avenue SE from 2nd Street SE to 9th Street SE, Virginia Avenue Park and the 11th Street Bridge right-of-way between 9th and 11th Streets SE, and is aligned on south side of Interstate 695 (I-695) (**Figure 1**). The tunnel portals are located a short distance west of 2nd Street SE and a short distance east of 11th Street SE. CSX also owns or has easements of the rail lines immediately east and west of the tunnel. The tunnel and rail lines running through the District are part of CSX's eastern seaboard freight rail corridor, which connects Mid-Atlantic and Midwest states.

The CSX proposal includes the complete reconstruction of the tunnel, which was built over 100 years ago. In addition to its age, the tunnel is also a bottleneck to the freight rail network with its single-track configuration and with a vertical clearance that does not allow for double-stack intermodal container freight trains. The Project will transform the tunnel to a two-track configuration, matching the number of tracks immediately east and west of the tunnel, and provide the minimum 21 feet of vertical clearance to allow double-stack intermodal container freight train operations. This will allow more efficient freight movement, especially in light of expected increases in freight volume.

Reconstructing the tunnel to allow double-stack intermodal container freight trains would require lowering the grade below the rail line's New Jersey Avenue SE Overpass to provide the 21-foot minimum clearance.

The following alternatives are being considered for the Project:

Alternative 1 - No Build: The No Build alternative, which is automatically carried forward into the Draft EIS. The tunnel would not be rebuilt under this alternative. However, the railroad would continue to operate trains through the tunnel and at some point, emergency or unplanned major repairs or rehabilitation could be required to this critical, aging infrastructure that might prove equally or even more disruptive to the community than the Build Alternatives.

Alternative 2 -Rebuilt Tunnel / Temporary Runaround Track: This alternative involves rebuilding the existing Virginia Avenue Tunnel. It would be rebuilt with two tracks and enough vertical clearance to accommodate double-stack intermodal container freight trains. It would be rebuilt in generally the same location, except aligned approximately seven feet to the south of the existing tunnel center line. It would be rebuilt using protected open trench construction methods. During construction, freight trains would be temporarily routed through a protected open trench outside the existing tunnel (runaround track). The runaround track would be aligned to the south of the existing tunnel. It would be parallel to the existing tunnel and would be below street level. Due to new columns associated with the rebuilt 11th Street Bridge, the runaround track would slightly separate from the tunnel alignment on the east end starting just west of Virginia Avenue Park. Safety measures such as securing fencing would be used to prevent pedestrians and cyclists from accessing the runaround track.

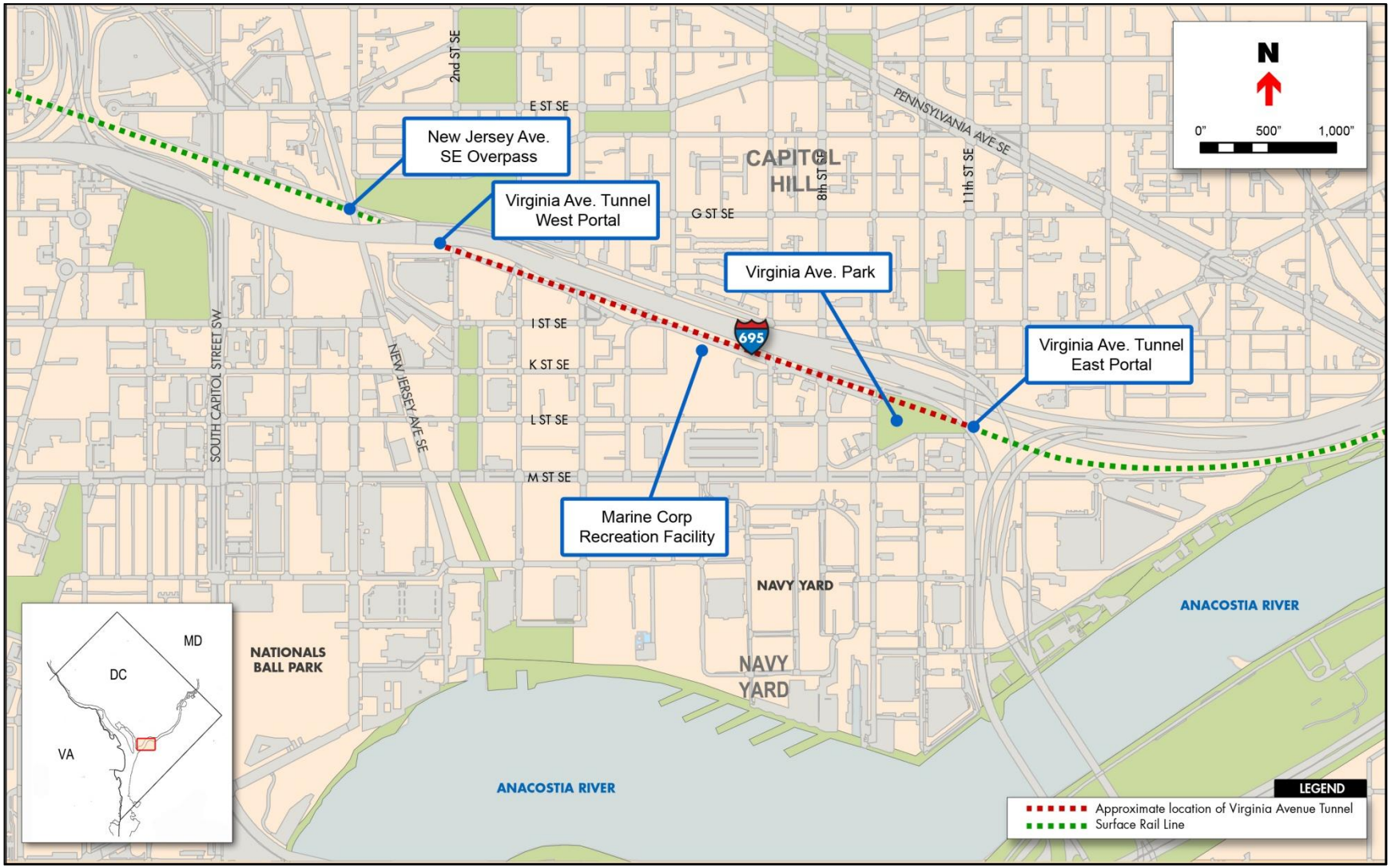
Alternative 3 - Two New Tunnels: This alternative involves replacing the existing Virginia Avenue Tunnel with two new permanent tunnels constructed sequentially. Each new tunnel would have a single track with enough vertical clearance to allow double-stack intermodal container freight trains. A new parallel south side tunnel would be built first as trains continue operating in the existing Virginia Avenue Tunnel. After the south side tunnel is completed, train

operations would switch over to the new tunnel and the existing Virginia Avenue Tunnel would be demolished and rebuilt. With the exception of operating in a protected open trench for approximately 230 feet immediately east of the 2nd Street portal (within the Virginia Avenue SE segment between 2nd and 3rd Streets SE), trains would operate in enclosed tunnels throughout construction under Alternative 3. Throughout most of the length, the two tunnels would be separated by a center wall. This center wall would be the new centerline of the two tunnels, and it would be aligned approximately 25 feet south of the existing tunnel centerline, between 2nd and 9th Streets SE. Due to new columns associated with the rebuilt 11th Street Bridge, the tunnels would be separated on the east end starting just west of Virginia Avenue Park, resulting in two separate single-track tunnels and openings at the east portal.

Alternative 4 - New Partitioned Tunnel / Online Rebuild: Alternative 4 would result in a new tunnel with a center partition wall separating two permanent single tracks. Similar to Alternative 3, the new tunnel would be partitioned and have enough vertical clearance to allow double-stack intermodal container freight trains. It would be aligned approximately 17 feet south of the existing tunnel's centerline. The new partitioned tunnel would be built using protected open trench construction methods. Safety measures such as secure fencing would be used to prevent pedestrians and bikers from accessing the protected open trench. The rebuild would occur 'online' meaning that during the period of construction, the protected open trench would accommodate both construction activities and train operations. Maintaining safe and reliable temporary train operations is a more complicated endeavor under Alternative 4 than under the other two Build Alternatives because of the online rebuild approach.

Regardless of Build Alternative, the Project would extend the east portal by approximately 330 feet to a location northeast of the 12th Street and M Street T-intersection.

FIGURE 1: PROJECT LOCATION



2.0 Environment

Air pollution is a general term that refers to one or more chemical substances that degrade the quality of the atmosphere. Individual air pollutants degrade the atmosphere by reducing visibility, damaging property, reducing the productivity or vigor of crops or natural vegetation, or reducing human or animal health causing injury to agricultural lands and livestock, and adversely affecting human health.

2.1 Applicable Regulations

The Clean Air Act (CAA), as amended by the Clean Air Act Amendments of 1990 (CAAA) and Final Conformity Rule (40 CFR Parts 51 and 93), other rules and regulations such as the Control of Hazardous Air Pollutants from Mobile Sources rule, promulgated by the US Environmental Protection Agency (EPA) implement environmental policies and regulations to promote and ensure acceptable levels of air quality. The Clean Air Act defines conformity as follows:

> "Conformity to an implementations plan's purpose of eliminating or reducing the severity and number of violations of the National Ambient Air Quality Standards (NAAQS) and achieving expeditious attainment of such standards; and that such activities will not:
>
> - *cause or contribute to any new violation of any NAAQS in any area;*
> - *increase the frequency or severity of any existing violation of any NAAQS in any area; or*
> - *delay timely attainment of any NAAQS or any required interim emission reductions or other milestones in any area."*

2.2 National and State Ambient Air Quality Standards

As required by the Clean Air Act of 1970 (CAA), NAAQS have been established for six major air pollutants. These pollutants, known as criteria pollutants, are: carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), and lead (Pb).

The federal standards are summarized in **Table 1**. The "primary" standards have been established to protect the public health. The "secondary" standards are intended to protect the nation's welfare and account for air pollutant effects on soil, water, visibility, materials, vegetation and other aspects of the general welfare.

Table 1: National Ambient Air Quality Standards

Pollutant		Standard Type	Averaging Time	Level	Form
Carbon Monoxide [76 FR 54294, Aug 31, 2011]		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead [73 FR 66964, Nov 12, 2008]		primary and secondary	Rolling 3 month average	0.15 µg/m^3 (1)	Not to be exceeded
Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]		primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		primary and secondary	Annual	53 ppb (2)	Annual mean
Ozone [73 FR 16436, Mar 27, 2008]		primary and secondary	8-hour	0.075 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution (Particulate Matter) Dec 14, 2012	$PM_{2.5}$	primary	Annual	12 µg/m^3	annual mean, averaged over 3 years
		secondary	Annual	15 µg/m^3	annual mean, averaged over 3 years
		primary and secondary	24-hour	35 µg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sept 14, 1973]		primary	1-hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

Source: USEPA Office of Air and Radiation, http://www.epa.gov/air/criteria.html (updated December 14, 2012)

(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

(2) The official level of the annual NO2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

(3) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

2.3 Criteria Pollutants and Effects

Pollutants that have established national standards are referred to as "criteria pollutants". The sources of these pollutants, their effects on human health and the nation's welfare, and their final deposition in the atmosphere vary considerably. A brief description of each pollutant is provided below.

2.3.1 *Ozone*

Ozone (O_3) is a colorless, toxic gas. As shown in **Figure 2**, O_3 is found in both the Earth's upper and lower atmospheric levels. In the upper atmosphere, O_3 is a naturally occurring gas that helps to prevent the sun's harmful ultraviolet rays from reaching the earth. In the lower layer of the atmosphere, O_3 is man-made. Although O_3 is not directly emitted, it forms in the lower atmosphere through a chemical reaction between reactive organic gases (ROG), also referred to as volatile organic compounds (VOCs), and nitrogen oxides (NOx), which are emitted from industrial sources and from automobiles. As shown in **Figure 3** and **Figure 4**, mobile sources are the primary sources of O_3 precursors (VOCs and NOx) in the Washington D.C. area.

Source: www.epa.gov/oar/oaqps/gooduphigh/good.html

Figure 2: Ozone in the Atmosphere

Substantial O_3 formations generally require a stable atmosphere with strong sunlight, thus high levels of O_3 are generally a concern in the summer. O_3 is the main ingredient of smog. O_3 enters the blood stream through the respiratory system and interferes with the transfer of oxygen, depriving sensitive tissues in the heart and brain of oxygen. O_3 also damages vegetation by inhibiting their growth.

2.3.2 *Particulate Matter*

Particulate pollution is composed of solid particles or liquid droplets that are small enough to remain suspended in the air. In general, particulate pollution can include dust, soot, and smoke; these can be irritating but usually are not poisonous.

Particulate pollution also can include bits of solid or liquid substances that can be highly toxic. Of particular concern are those particles that are smaller than, or equal to, 10 microns (PM_{10}) and 2.5 microns ($PM_{2.5}$) in size.

PM_{10} refers to particulate matter less than 10 microns in diameter, about one/seventh the thickness of a human hair (**Figure 5**). Particulate matter pollution consists of very small liquid and solid particles floating in the air, which can include smoke, soot, dust, salts, acids, and metals. Particulate matter also forms when industry and gases emitted from motor vehicles undergo chemical reactions in the atmosphere. Major sources of PM_{10} include motor vehicles; wood burning stoves and fireplaces; dust from construction, landfills, and agriculture; wildfires and brush/waste burning, industrial sources, windblown dust from open lands; and atmospheric chemical and photochemical reactions. Suspended particulates produce haze and reduce visibility.

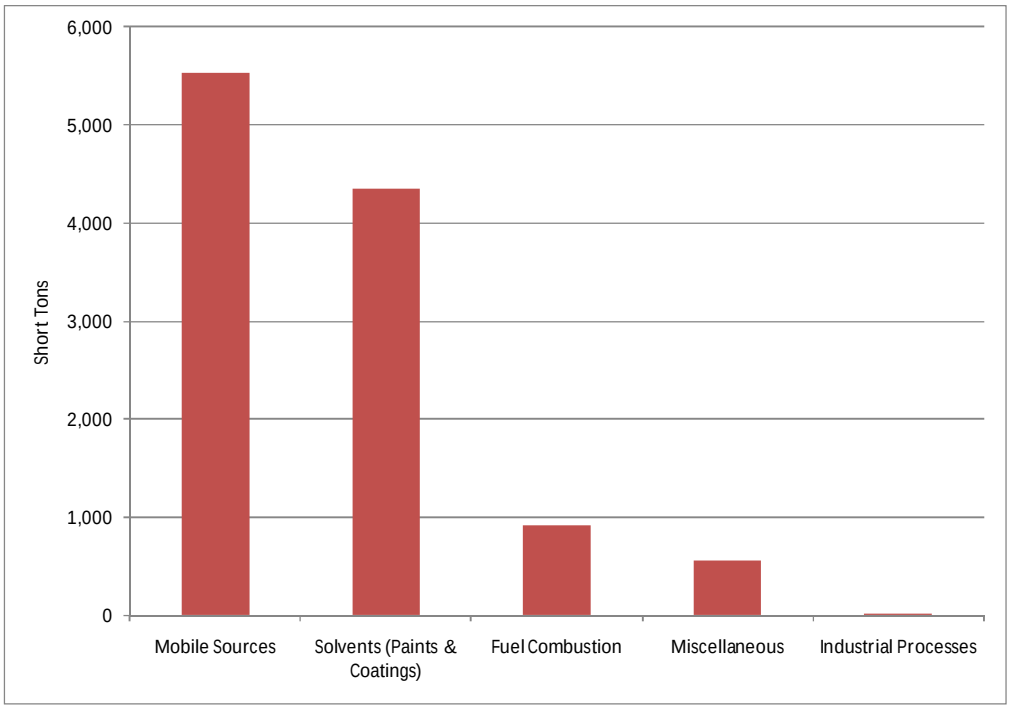


Figure 3: Sources of VOCs – District of Columbia (2008)
Source: http://www.epa.gov/air/emissions/index.htm

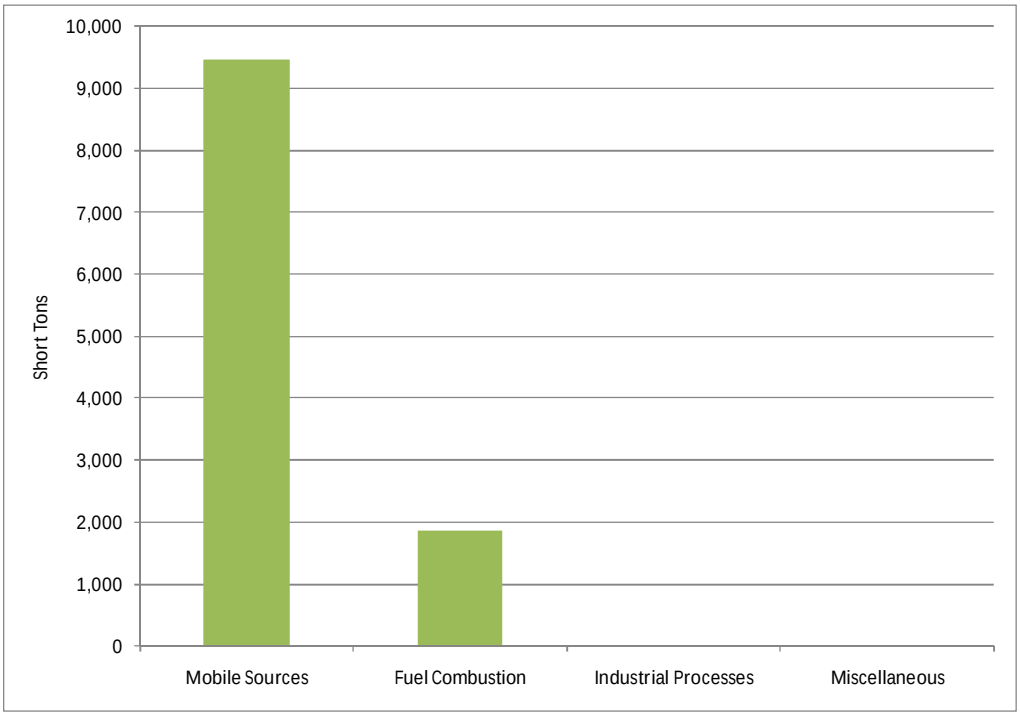
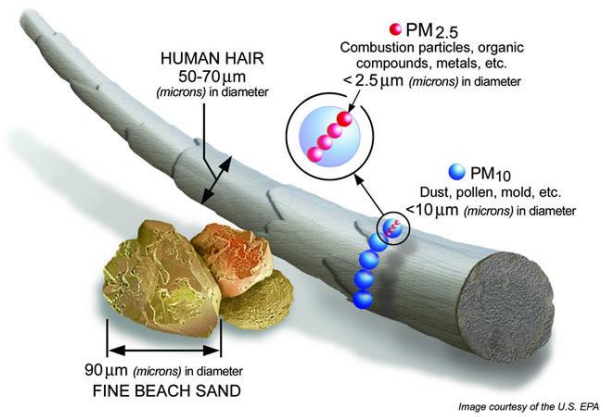


Figure 4: Sources of NOx – District of Columbia (2008)
Source: http://www.epa.gov/air/emissions/index.htm

Data collected through numerous nationwide studies indicate most PM_{10} comes from fugitive dust, wind erosion, and/or agricultural and forestry sources. A small portion of particulate matter is the product of fuel combustion processes. In the case of $PM_{2.5}$, the combustion of fossil fuels accounts for a significant portion of this pollutant. The main health effect of airborne particulate matter is on the respiratory system. $PM_{2.5}$ refers to particulates that are 2.5 microns or less in diameter, roughly 1/28th the diameter of a human hair. $PM_{2.5}$ results from fuel combustion (from motor vehicles, power generation, and industrial facilities), residential fireplaces and wood stoves. In addition, $PM_{2.5}$ can be formed in the atmosphere from gases such as sulfur dioxide, nitrogen oxides, and volatile organic compounds. Like PM_{10}, $PM_{2.5}$ can penetrate the human respiratory system's natural defenses and damage the respiratory tract when inhaled. Whereas, particles 2.5 to 10 microns in diameter tend to collect in the upper portion of the respiratory system, particles 2.5 microns or less are so tiny that they can penetrate deeper into the lungs and damage lung tissues.



Source: EPA Office of Research and Development

Figure 5: Relative Particulate Matter Size

2.3.3 *Carbon Monoxide*

Carbon Monoxide (CO), a colorless gas, interferes with the transfer of oxygen to the brain. CO is emitted almost exclusively from the incomplete combustion of fossil fuels. As shown in **Figure 6**, on-road motor vehicle exhaust is the primary source of CO in the Washington D.C. area. In cities, 85 to 95 percent of all CO emissions may come from motor vehicle exhaust. Prolonged exposure to high levels of CO can cause headaches, drowsiness, loss of equilibrium, or heart disease. CO levels are generally highest in the colder months of the year when inversion conditions (warmer air traps colder air near the ground) are more frequent. CO concentrations can vary greatly over relatively short distances. Relatively high concentrations of CO are typically found near congested intersections, along heavily used roadways carrying slow-moving traffic, and in areas where atmospheric dispersion is inhibited by urban “street canyon” conditions. Consequently, CO concentrations must be predicted on a localized, or microscale, basis.

2.3.4 *Nitrogen Dioxide*

Nitrogen Dioxide (NO_2), a brownish gas, irritates the lungs. It can cause breathing difficulties at high concentrations. Like O_3, NO_2 is not directly emitted, but is formed through a reaction between nitric oxide (NO) and atmospheric oxygen. NO and NO_2 are collectively referred to as nitrogen oxides (NOx) and are major contributors to ozone formation. NO_2 also contributes to the formation of PM_{10}, small liquid and solid particles that are less than 10 microns in diameter (see discussion of PM_{10} below). At atmospheric concentration, NO_2 is only potentially irritating. In high concentrations, the result is a brownish-red cast to the atmosphere and reduced visibility. There is some indication of a relationship between NO_2 and chronic pulmonary

fibrosis. Some increase in bronchitis in children (two and three years old) has also been observed at concentrations below 0.3 parts per million (ppm).

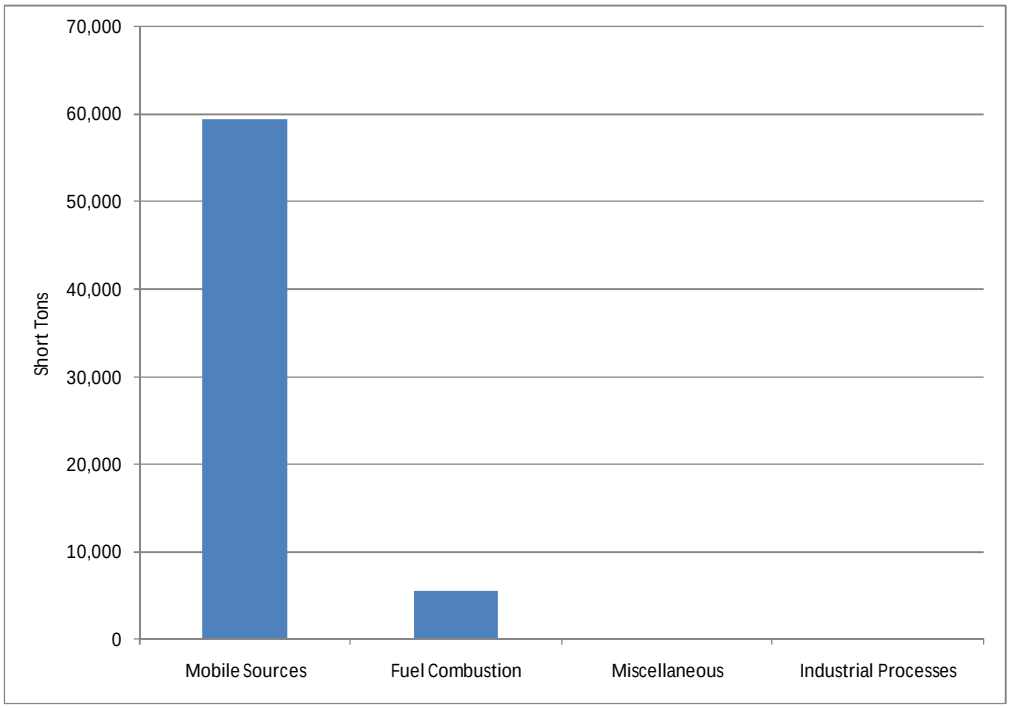


Figure 6: Sources of CO – District of Columbia (2008)
Source: http://www.epa.gov/air/emissions/index.htm

2.3.5 *Lead*

Lead (Pb) is a stable element that persists and accumulates both in the environment and in animals. Its principal effects in humans are on the blood-forming, nervous, and renal systems. Lead levels in the urban environment from mobile sources have significantly decreased due to the federally mandated switch to lead-free gasoline.

2.3.6 *Sulfur Dioxide*

Sulfur Dioxide (SO_2) is a product of high-sulfur fuel combustion. The main sources of SO_2 are coal and oil used in power stations, industry and for domestic heating. Industrial chemical manufacturing is another source of SO_2. SO_2 is an irritant gas that attacks the throat and lungs. It can cause acute respiratory symptoms and diminished ventilator function in children. SO_2 can also yellow plant leaves and erode iron and steel.

2.4 Mobile Source Air Toxics

In addition to the criteria pollutants, USEPA also regulates air toxics. Most air toxics originate from human made sources, including on-road mobile sources, non-road mobile sources (e.g., airplanes), area sources (e.g., dry cleaners), and stationary sources (e.g., factories or refineries).

Mobile Source Air Toxics (MSATs) are a subset of the 188 air toxics defined by the CAA. The MSATs are compounds emitted from highway vehicles and non-road equipment. Some toxic compounds are present in fuel and are emitted into the air when the fuel evaporates or passes through the engine unburned. Other toxics are emitted from the incomplete combustion of fuels or as secondary combustion products. Metal air toxics also result from engine wear or from impurities in oil or gasoline.

The USEPA has assessed this expansive list in their latest rule on the Control of Hazardous Air Pollutants from Mobile Sources (Federal Register, Vol. 72, No. 37, page 8430, February 26, 2007) and identified a group of 93 compounds emitted from mobile sources that are listed in their Integrated Risk Information System (IRIS) (http://www.epa.gov/ncea/iris/index.html). In addition, USEPA identified seven compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers from their 1999 National Air Toxics Assessment (NATA) (http://www.epa.gov/ttn/atw/nata1999/). These are:

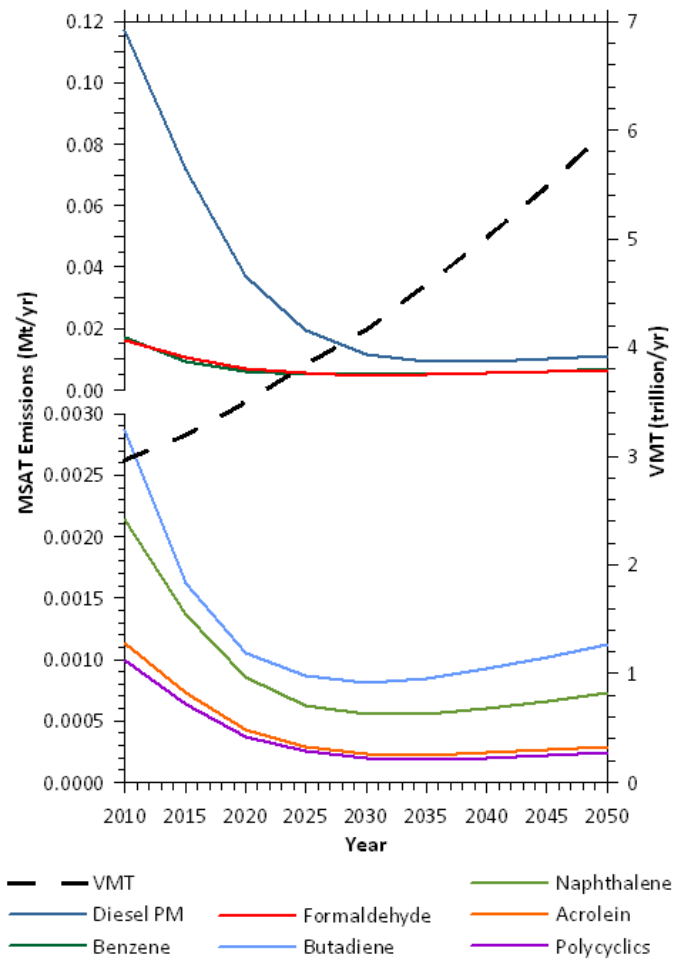
- ***Benzene –*** *characterized as a known human carcinogen.*
- ***Acrolein –*** *the potential carcinogenicity of acrolein cannot be determined because the existing data are inadequate for an assessment of human carcinogenic potential for either the oral or inhalation route of exposure.*
- ***Formaldehyde –*** *a probable human carcinogen, based on limited evidence in humans, and sufficient evidence in animals.*
- ***1,3-butadiene –*** *characterized as carcinogenic to humans by inhalation.*
- ***Diesel Exhaust*** *(DE) – likely to be carcinogenic to humans by inhalation from environmental exposures. Diesel exhaust as reviewed in this document is the combination of diesel particulate matter and diesel exhaust organic gases. Diesel exhaust also represents chronic respiratory effects, possibly the primary noncancer hazard from MSATs. Prolonged exposures may impair pulmonary function and could produce symptoms, such as cough, phlegm, and chronic bronchitis.*
- ***Naphthalene –*** *the USEPA has classified naphthalene as a possible human carcinogen. Acute exposure of humans to naphthalene by inhalation, ingestion, and dermal contact is associated with hemolytic anemia, damage to the liver, and neurological damage. Cataracts have also been reported in workers acutely exposed to naphthalene by inhalation and ingestion.*
- ***Polycyclic Organic Matter (POM) –*** *defines a broad class of compounds that includes the polycyclic aromatic hydrocarbon compounds (PAHs), of which benzo[a]pyrene is a member. Cancer is the major concern from exposure to POM. The USEPA has classified seven PAHs (benzo[a]pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene) as probable human carcinogens.*

While FHWA considers these the priority MSATs, the list is subject to change and may be adjusted in consideration of future USEPA rules.

The USEPA is the lead federal agency for administering the CAA and has certain responsibilities regarding the health effects of MSATs. The USEPA issued a Final Rule on Controlling Emissions of Hazardous Air Pollutants from Mobile Sources (66 Federal Register 17229, March 29, 2001). This rule was issued under the authority in Section 202 of the CAA. In

its rule, USEPA examined the impacts of existing and newly promulgated mobile source control programs, including its reformulated gasoline program, its national low emission vehicle standards, its Tier 2 motor vehicle emissions standards and gasoline sulfur control requirements, and its proposed heavy duty engine and vehicle standards and on-highway diesel fuel requirements. According to an FHWA analysis, future emissions likely would be lower than present levels as result of the USEPA's national control programs that are projected to reduce MSAT emission by 83 percent from 2010 to 2050, even if VMT increases by 102 percent, as shown in **Figure 7**.

Figure 7: National MSAT Emission Trends 2010 – 2050 for Vehicles Operating on Roadways Using USEPA's MOVES2010b Model



Note: Trends for specific locations may be different, depending on locally derived information representing vehicle-miles travelled, vehicle speeds, vehicle mix, fuels, emission control programs, meteorology, and other factors

Source: FHWA's *Interim Guidance Update on Air Toxic Analysis in NEPA Documents* (FHWA, 2012) - EPA MOVES2010b model runs conducted during May - June 2012 by FHWA.

On February 9, 2007 and under authority of CAA Section 202(l), USEPA signed a Final Rule, Control of Hazardous Air Pollutants from Mobile Sources, which sets standards to control MSATs from motor vehicles. Under this rule, USEPA is setting standards on fuel composition, vehicle exhaust emissions, and evaporative losses from portable containers. The new standards are estimated to reduce total emissions of MSATs by 330,000 tons in 2030, including 61,000 tons of benzene. Concurrently, total emissions of volatile organic compounds (VOCs) will be reduced by over 1 .1 million tons in 2030 as a result of adopting these standards.

2.5 Greenhouse Gases

In 2007, the Supreme Court decided in *Commonwealth of Massachusetts v. Environmental Protection Agency* that carbon dioxide is a pollutant, subject to regulation under the Clean Air Act. Since then, the federal government has taken a number of steps to regulate carbon dioxide emissions as part of an overall program addressing greenhouse gases. Thus, for example, EPA has adopted a Greenhouse Gas Monitoring, Recordkeeping and Reporting Rule requiring certain suppliers of fossil fuels or industrial greenhouse gases to report to EPA on emissions from particular facilities. That rule does not apply to the activities contemplated by the Virginia Avenue Tunnel Project.

Also, a number of federal agencies have concluded that it is not possible to link a project's emissions to particular climatic effects in a National Environmental Policy Act (NEPA) review. In particular, the 2010 Draft Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions, authored by the Council on Environmental Quality, states that "it is not currently useful for the NEPA analysis to attempt to link specific climatological changes, or the environmental impacts thereof, to the particular project or emissions, as such direct linage is difficult to isolate and to understand."

Some greenhouse gases, such as carbon dioxide, occur naturally and are emitted to the atmosphere through natural processes and human activities. Other greenhouse gases (e.g., fluorinated gases) are created and emitted solely through human activities. The principal greenhouse gases that enter the atmosphere because of human activities include:

- *Carbon Dioxide (CO_2);*
- *Methane (CH_4);*
- *Nitrous Oxide (N_2O); and*
- *Fluorinated Gases.*

For transportation projects involving fossil fuel consumption, CO_2 is the predominant GHG emitted.

2.6 Attainment Status and Conformity with Regional Air Quality Planning

Section 107 of the 1977 CAAA requires that the EPA publish a list of all geographic areas in compliance with the NAAQS, as well as those that are not in attainment of the NAAQS. The designation of an area is made on a pollutant-by-pollutant basis. The EPA's area designations are shown in **Table 2**.

Table 2: Attainment Classifications and Definitions

Classification	Definition
Attainment	Area is in compliance with the NAAQS
Unclassified	Area has insufficient data to make determination and is treated as being in attainment.
Maintenance	Area once classified as nonattainment but has since demonstrated attainment of the NAAQS.
Nonattainment	Area is not in compliance with the NAAQS

The Virginia Avenue Tunnel Reconstruction project area is classified as a maintenance area for CO, a nonattainment area for $PM_{2.5}$ (for the 1997 standard), a marginal nonattainment area for O_3, and an attainment area for all other criteria pollutants.

The CAA requires that a state implementation plan (SIP) be prepared for each nonattainment area and a maintenance plan be prepared for each former nonattainment area that subsequently demonstrated compliance with the standards. A SIP is a compilation of a state's air quality control plans and rules that are approved by EPA. Section 176(c) of the CAA provides that federal agencies cannot engage, support, or provide financial assistance for licensing, permitting, or approving any project unless the project conforms to the applicable SIP. The state and U.S. EPAs' goals are to eliminate or reduce the severity and number of violations of the NAAQS and to achieve expeditious attainment of these standards.

The District of Columbia is part of the Metropolitan Washington Council of Governments (MWCOG), a regional organization of Washington area local governments. MWCOG is composed of 20 local governments surrounding the nation's capital, plus area members of the Maryland and Virginia legislatures, the US Senate and the US House of Representatives. Among other responsibilities, the MWCOG provides daily reports and forecasts of regional air quality. Through the MWCOG, the Metropolitan Washington Air Quality Committee (MWAQC) prepares the air quality plan for the District of Columbia, Maryland and Virginia metropolitan area as regulated under Section 174 of the CAA. The Transportation Planning Board (TPB), housed within the MWCOG, is the organization that brings together key decision makers to coordinate planning and funding for the region's transportation system. TPB members include local officials, representatives of state transportation agencies, The Washington Metropolitan Area Transit Authority (WMATA), state legislators, and others. The TPB is designated as a Metropolitan Planning Organization (MPO) and is therefore responsible for meeting federal metropolitan planning requirements for transportation. The TPB is staffed by the MWCOG.

The TPB produces two basic documents. The first is the *Financially Constrained Long-Range Transportation Plan* (CLRP) which includes all major transportation projects and programs that are planned in the Washington region over the next 25 years. The second document, the *Transportation Improvement Plan* (TIP), lists projects and programs that will be funded in the next six years. The CLRP and TIP serve as the basis for the regional mobile source air quality analysis, which utilizes vehicle miles traveled (VMT) and emissions factors to determine emissions estimates for the entire transportation system. The analysis results, presented under the Transportation Conformity Rule, demonstrate that the plan and the TIP are consistent with the goals of the *State Implementation Plan* (SIP). The SIP includes a list of measures to reduce pollution in order for the area to become attainment by a designated date.

The TPB approved the 2010 CLRP on November 17, 2010 and the 2012 CLRP and FY 2013-2018 TIP on July 18, 2012. The Virginia Avenue project is listed as ID # 5959 in the 2013-2018 TIP and as #3079 in the CLRP. As part of an approved CLRP and TIP, the project is part of the region's plan to meet the required air quality goals as mandated in the Clean Air Act. The project is also part of the *National Capital Region Freight Plan 2010*, which was approved by the TPB on July 21, 2010.

2.7 Project Level Conformity

Pursuant to CAA Section 176(c) requirements, EPA promulgated Title 40 of the Code of Federal Regulations Part 51 (40 CFR 51) Subpart W and 40 CFR Part 93, Subpart B, "Determining Conformity of General Federal Actions to State or Federal Implementation Plans" (see 58 Federal Register [FR] 63214, [November 30, 1993], as amended, 75 FR 17253 [April 5, 2010]). These regulations, commonly referred to as the General Conformity (GC) Rule, apply to all federal actions except for those federal actions which are excluded from review (e.g., stationary source emissions such as from power plants) or related to transportation plans, programs, and projects under Title 23 U.S. Code or the Federal Transit Act, which are subject to Transportation Conformity. The GC Rule applies to all federal actions not addressed by the Transportation Conformity Rule, which applies primarily to transportation and transit projects.

The GC Rule is used to determine if federal actions meet the requirements of the CAA and the applicable SIP by ensuring that air emissions related to the action do not:

- *Cause or contribute to new violations of a NAAQS.*
- *Increase the frequency or severity of any existing violation of a NAAQS.*
- *Delay timely attainment of a NAAQS or interim emission reduction.*

A conformity determination under the GC Rule may be required if the federal agency determines that the action will occur in a nonattainment or maintenance area. The determination would be required if the action is not included in the federal agency's "presumed to conform" list; the emissions from the proposed action are not within the approved emissions budget for an applicable facility; and the total direct and indirect emissions of a pollutant (or its precursors) are at or above the *de minimis* levels established in the General Conformity regulations (75 FR 17255).

GC Rule criteria are listed in 40 CFR 93.158. An action will be required to conform to the applicable SIP if, for each pollutant that exceeds the *de minimis* emissions threshold provided in 40 CFR 93.153(b) or otherwise requires a conformity determination due to the total of direct and indirect emissions from the action, the action meets the requirements of 40 CFR 93.158(c). For the project area, the applicable *de minimis* emission thresholds are presented in Table 3.

The *de minimis* emission levels are applicable to both the operational and construction phases of the project. Ammonia and VOC are not included for $PM_{2.5}$ because they are not considered to be significant overall contributors to $PM_{2.5}$ overall air quality issues. SO_2 and NOx are included because they are considered to be significant overall contributors to $PM_{2.5}$ air quality issues. VOC and NO_X are included because they are ozone precursors. A 50 tons per year limit was used for VOC because the District is part of the ozone transport region, which is a multi-state region that works together to implement regional solutions to the ground-level ozone problem in theNortheast and Mid-Atlantic regions.

Table 3
General Conformity Applicability Thresholds

Pollutant	Applicability Threshold	Attainment Status
Ozone (VOCs or NOx)	50 tons per year for VOC 100 tons per year for NOx	Nonattainment (Marginal)
Particulate Matter Smaller than 2.5 Microns ($PM_{2.5}$) • Direct emissions • SO_2 • NO_x	 100 tons per year 100 tons per year 100 tons per year	Nonattainment
Carbon Monoxide (CO)	100 tons per year	Maintenance

Source: http://www.epa.gov/airquality/genconform/documents/20100324rule.pdf

http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=3604d847483102bfc4d4481d5a01eca6&ty=HTML&h=L&r=PART&n=40y21.0.1.1.7#40:21.0.1.1.7.2.1.4

2.8 Ambient Air Quality in the Project Area

2.8.1 *Local Meteorology*

The nature of the surrounding atmosphere is an important element in assessing the ambient air quality of an area. The Virginia Avenue Tunnel is located in the Capitol Hill neighborhood of the District of Columbia.

Summers in the District of Columbia area are warm and humid and winters are cold, but generally not severe. The summertime temperature is in the upper 80s and the winter is in the upper 20s. Thunderstorms can occur at any time but are most frequent during the late spring and summer. Annual precipitation has ranged from about 25 inches to more than 55 inches. Rainfalls of over 10 inches in a 24-hour period have been recorded during the passage of tropical storms. The seasonal snowfall is nearly 24 inches, but varies greatly from season to season. Snowfalls of 4 inches or more occur only twice each winter on average. Accumulations of over 20 inches from a single storm are extremely rare. Storm damage results mainly from heavy snows and freezing rains in winter and from hurricanes and severe thunderstorms during the other seasons. Precipitation helps cleanse the atmosphere of pollutants. Very small particles in the atmosphere act as condensation nuclei, triggering the formation of raindrops, while larger particles are literally washed from the air during precipitation events. Precipitation also prevents the drying of the ground, alleviating the formation of fugitive dust; however, precipitation can combine with the oxides of sulfur and nitrogen to produce another form of pollution, namely acid rain.

Prevailing winds are from the south except during the winter months when they are from the northwest. The windiest periods are late winter and early spring. Winds are generally less during the night and early morning hours and increase to a high in the afternoon. Winds may reach 50 to 60 miles per hour or even higher during severe summer thunderstorms, hurricanes, and winter storms. Wind speed direction and variability greatly influence on the dispersion of atmospheric pollutants.

2.8.2 *Monitored Air Quality*

MWCOG collects and distributes air quality data from monitors located throughout the District of Columbia. Five air quality monitors are located within the District of Columbia. The maximum pollutant concentrations collected at these locations for the years 2009-2011, and a comparison of these values with the applicable air quality standards are presented in Table 4. As shown, only exceedances of the 8-hour ozone standard were recorded; the recorded values for all of the other pollutants are less than (within) the NAAQS.

Table 4: Ambient Air Quality Monitor Data 2009-2011

Pollutant		Verizon Phone Co. 2055 L St., NW			420 34th St. NE			Takoma Sc., Piney Branch Road & Dahlia Street			2500 1st Street, N.W.			Park Services Office, 1100 Ohio Drive		
Carbon Monoxide (CO) [ppm]		**2009**	**2010**	**2011**	**2009**	**2010**	**2011**	**2009**	**2010**	**2011**	**2009**	**2010**	**2011**	**2009**	**2010**	**2011**
1-Hour	Maximum	2.5	2.8	5.0	4.2	3.7	2.7						3.1			
	2nd Maximum	2.5	2.7	4.2	4.2	3.7	2.7						3.0			
	# of Exceedences	0	0	0	0	0	0						0			
8-Hour	Maximum	2.0	2.4	2.2	4.0	3.5	2.5						2.5			
	2nd Maximum	1.9	2.0	1.9	3.8	3.1	2.3						2.4			
	# of Exceedences	0	0	0	0	0	0						0			
Particulate Matter [ug/m^3]																
PM_{10}	Maximum 24-Hour				69	91	48				60	99	45			
	# of Exceedences				0	0	0				0	0	0			
$PM_{2.5}$	98th Percentile				26.0	28.0	25.0				24.0	26.0	25.0	23.0	23.0	26.0
	Mean Annual				10.5	11.4	10.4				10.2	10.5	10.3	10.1	11.0	10.2
	# of Exceedences				0	0	0				0	0	0	0	0	0
Ozone (O_3) [ppm]																
8-Hour	Fourth Highest				0.064	0.086	0.080	0.072	0.079		0.071	0.082	0.085			
	# of Exceedences				2	15	6	1	6		2	16	11			
Nitrogen Dioxide (NO_2) [ppb]																
1-Hour	98th Percentile				63	59	55	53	55		62	57	52			
	# of Exceedences				0	0	0	0	0		0	0	0			
Sulfur Dioxide (SO_2) [ppb]																
1-Hour	99th Percentile				39	21	20						5			
	# of Exceedences				0	0	0						0			

Source: *EPA Office of Air Quality Planning and Standards (AIRSData);* http://www.epa.gov/airquality/airdata/ad_reports.html

Note: Grey shaded blocks represent areas of no measurement.

3.0 Environmental Consequences

This analysis looks at emissions from the Project both during the construction period and post-construction.

3.1 Pollutants for Analysis

Pollutants that can be traced principally to motor vehicles, construction equipment and diesel locomotives are relevant to the evaluation of the project's impacts. These pollutants include CO, HC, NO_x, O_3, SO_2, PM_{10}, $PM_{2.5}$ and MSAT. Transportation sources account for a small percentage of regional emissions of Pb; thus, a detailed analysis is not required.

HC (VOC) and NO_x emissions from transportation sources are a concern primarily because they are precursors in the formation of ozone and particulate matter. Ozone is formed through a series of reactions that occur in the atmosphere in the presence of sunlight. Since the reactions are slow and occur as the pollutants are diffusing downwind, elevated ozone levels often are found many miles from the sources of the precursor pollutants. Therefore, the effects of HC and NO_x emissions generally are examined on a regional or "mesoscale" basis.

PM_{10} and $PM_{2.5}$ impacts are both regional and local. A significant portion of particulate matter, especially PM_{10}, comes from disturbed vacant land, construction activity and paved road dust. $PM_{2.5}$ also comes from these sources. Vehicle exhaust, particularly from diesel vehicles and trains, is also a source of PM_{10} and $PM_{2.5}$. PM_{10}, and especially $PM_{2.5}$, can also be created by secondary formation from precursor elements such as sulfur dioxide (SO_2), nitrogen oxides (NO_X), volatile organic compounds (VOCs) and ammonia (NH_3). Secondary formation occurs due to chemical reaction in the atmosphere generally downwind some distance from the original emission source. Thus it is appropriate to predict concentrations of PM_{10} and $PM_{2.5}$ on both a regional and a localized basis.

CO impacts are generally localized. Even under the worst meteorological conditions and most congested traffic conditions, high concentrations are limited to a relatively short distance (300 to 600 feet) of heavily traveled roadways. Vehicle emissions are the major sources of CO. The Virginia Avenue Tunnel Reconstruction Project could change traffic patterns within the project area. Consequently, it is appropriate to predict concentrations of CO on both a regional and a localized or "microscale" basis.

MSAT impacts are both regional and local. Through the issuance of EPA's Final Rule, Control of Emissions of Hazardous Air Pollutants from Mobile Sources (66 FR 17229), it was determined that many existing and newly promulgated mobile source emission control programs would result in a reduction of MSATs. The FHWA projects that even with a 64 percent increase in VMT, the programs will reduce on-highway emissions of benzene, formaldehyde, 1,3-butadiene, and acetaldehyde by 57 percent to 65 percent, and will reduce on-highway diesel PM emissions by 87 percent. As a result, EPA has concluded that no further motor vehicle emission standards or fuel standards were necessary to further control MSATs from on-road sources

3.2 Post-Construction Phase Analysis

3.2.1 *Regional Analysis*

A regional or mesoscale analysis of a project determines a project's overall impact on regional air quality levels. This analysis uses regional Vehicle Miles Traveled (VMT) and Vehicle Hours

Traveled (VHT) within the region with and without the project to determine daily "pollutant burden" levels. In as much as the project is not expected to increase regional VMT or VHT, the project is predicted to have no negative impact on regional air quality.

Furthermore, in a larger sense, the level of emissions within the tunnel of three Project Build Alternatives is expected to be positive. Transporting freight by railroad, especially in a double-stacked intermodal container configuration, produces significantly fewer emissions than if that same quantity of freight were moved by truck, and double-stacking reduces the number of trains (and locomotives) used to transport the expecting growth in East Coast freight traffic. (source: http://www.csx.com/index.cfm/media/press-releases/csx-named-greenest-railroad-by-newsweeks-2010-green-rankings/?keywords=greenhouse gas emissions). In comparison to not rebuilding Virginia Avenue Tunnel, fewer trains may pass through the District because of the operational improvements of double-stacking intermodal containers. As such, the operational phase of the project is not predicted to exceed the GC Rule's *de minimis* emission thresholds.

3.2.2 *Greenhouse Gases*

In as much as the project is not expected to increase regional VMT or VHT, the project is predicted to have no negative impact on regional air quality or greenhouse gases. As such, the operational phase of the project is not predicted to increase greenhouse gas emissions.

Furthermore, in a larger sense, the climatological impacts of three Project Build Alternatives are expected to be positive. Transporting freight by railroad, especially in a double-stacked intermodal container configuration, produces significantly fewer emissions than if that same quantity of freight were moved by truck, and double-stacking reduces the number of trains (and locomotives) used to transport the expecting growth in East Coast freight traffic. (source: http://www.csx.com/index.cfm/media/press-releases/csx-named-greenest-railroad-by-newsweeks-2010-green-rankings/?keywords=greenhouse gas emissions)

3.2.3 *Microscale Screening Analysis*

To determine if the project has the potential to cause a localized air quality impact post-construction, a screening analysis was conducted. As detailed in the project description, the Virginia Avenue Tunnel Reconstruction Project is predicted to reduce the number of diesel locomotives needed to move freight in the future Build Alternative, as compared to the No Build Alternative, assuming current market trends. As such, the project is not expected to have any localized impact due to the operation of the trains. The project may, however, affect local street traffic due to the roadway realignment. To determine if the project had the potential to adversely affect localized or microscale air quality levels, a screening analysis was conducted on those intersections expected to be impacted by the project.

A total of 24 locations were screened based on changes in intersection volumes, delay, and levels-of-service (LOS) from the No Build to the Build Alternatives for the years 2015 (**Table 5**) and 2040 (**Table 6**). Sites fail the screening evaluation if the LOS decreases below "D" in the Build Alternative, as compared to the No Build Alternative, or if the delay and/or volume increase from the No Build to Build Alternative along with a LOS below D. As shown in Tables 5 and 6, no sites fail the screening criteria. Therefore the Project is predicted to have no measurable impacts on localized air quality levels. As such, the project is not predicted to cause or exacerbate a violation of the applicable CO NAAQS.

Table 5: 2015 Intersection Screening Analysis

Intersection No	Intersection Name	2015 No-Build Conditions						2015 Ultimate					
		AM Peak Hour			PM Peak Hour			AM Peak Hour			PM Peak Hour		
		Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS
1A	South Capitol Street and I (Eye) Street (Left)	11.6	0.67	B	15.9	0.70	B	11.6	0.67	B	15.9	0.70	B
1A	South Capitol Street and I (Eye) Street (Right)	19.3	0.73	B	19.5	0.60	B	19.3	0.73	B	19.5	0.60	B
1C	Ramps from freeway at South Capitol Street SB	101.5	1.01	F	40.8	0.68	D	101.5	1.01	F	40.8	0.68	D
2A	South Capitol Street at M Street - SB Intersection	296.7	1.55	F	35.3	0.65	D	296.7	1.55	F	35.3	0.65	D
2B	South Capitol Street at M Street - NB Intersection	38.3	0.70	D	89.6	0.72	F	38.3	0.70	D	89.6	0.72	F
3	M Street at 1st Street	23.9	0.67	C	34.9	0.76	C	23.9	0.67	C	34.9	0.76	C
4	M Street at New Jersey Avenue	15.4	0.40	B	14.3	0.56	B	15.4	0.40	B	14.3	0.56	B
5	M Street at 3rd Street	7.6	0.32	A	14.7	0.56	B	7.6	0.32	A	14.7	0.56	B
6	M Street at 4th Street	19.6	0.43	B	15.2	0.48	B	19.6	0.43	B	15.2	0.48	B
8	M Street at 8th Street	18.7	0.64	B	14.8	0.70	B	21.3	0.66	C	17.3	0.73	B
9	M Street at 9th Street	10.9	0.38	B	14.6	0.63	B	10.9	0.38	B	14.2	0.62	B
10	M Street at 11th Street	22.5	0.67	C	124.9	1.02	F	22.5	0.68	C	77.5	0.89	E
14	Virginia Avenue EB at 5th Street	35.1	0.12	D	46.6	0.36	D	N/A			N/A		
15	SE Freeway off-ramp at 6th Street/Virginia Avenue EB	17.4	0.53	B	15.4	0.43	B	15.4	0.58	B	18.5	0.49	B
16	Virginia Avenue EB at 7th Street	6.3	0.26	A	17.7	0.45	B	6.9	0.31	A	15.2	0.50	B
17A	Virginia Avenue EB at 8th Street	32.4	0.31	C	46.7	0.38	D	30.4	0.31	C	14.5	0.35	B
17B	Virginia Avenue ramp at 8th street	12.0	0.33	B	14.3	0.46	B	13.3	0.31	B	10.8	0.51	B
19	I (Eye) Street at 8th Street	19.1	0.52	B	19.9	0.52	B	19.1	0.52	B	19.9	0.52	B
20	I (Eye) Street at Virginia Avenue WB/7th Street	8.4	0.38	A	11.9	0.56	B	8.4	0.38	A	11.9	0.56	B
21	I (Eye) Street and Virginia Avenue WB at 6th Street	7.3	0.46	A	27.3	0.37	C	7.3	0.46	A	27.3	0.37	C
22	Virginia Avenue WB at 4th Street north of SE Freeway	30.3	0.47	C	28.4	0.43	C	30.3	0.47	C	28.4	0.43	C
23	Virginia Avenue WB at 3rd Street north of SE Freeway	44.8	0.84	D	122.5	1.25	F	44.8	0.84	D	122.5	1.25	F
27	G Street at 8th Street	9.0	0.31	A	11.1	0.42	B	9.0	0.31	A	11.1	0.42	B
28	M Street at Isaac Hall Avenue	4.4	0.40	A	21.2	0.64	C	4.4	0.40	A	21.2	0.64	C

Source: DEIS Traffic Analysis

Table 6: 2040 Intersection Screening Analysis

Intersection No	Intersection Name	2040 No-Build						2040 Ultimate					
		AM Peak Hour			PM Peak Hour			AM Peak Hour			PM Peak Hour		
		Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS
1A	South Capitol Street and I (Eye) Street (Left)	61.3	1.20	E	82.4	1.35	F	61.3	1.20	E	82.4	1.35	F
1A	South Capitol Street and I (Eye) Street (Right)	100.4	1.17	F	57.3	1.09	E	100.4	1.17	F	57.3	1.09	E
1C	Ramps from freeway at South Capitol Street SB	395.2	1.36	F	233.5	1.19	F	395.2	1.36	F	233.5	1.19	F
2A	South Capitol Street at M Street - SB Intersection	689.2	3.94	F	127.3	1.09	F	689.2	3.94	F	127.3	1.09	F
2B	South Capitol Street at M Street - NB Intersection	217.6	1.12	F	311.1	1.25	F	217.6	1.12	F	311.1	1.25	F
3	M Street at 1st Street	88.4	1.11	F	200.0	1.54	F	88.4	1.11	F	200.0	1.54	F
4	M Street at New Jersey Avenue	25.1	0.70	C	86.5	1.14	F	25.1	0.70	C	86.5	1.14	F
5	M Street at 3rd Street	13.5	0.56	B	93.0	1.07	F	13.5	0.56	B	93.0	1.07	F
6	M Street at 4th Street	24.2	0.76	C	28.6	0.86	C	24.2	0.76	C	28.6	0.86	C
8	M Street at 8th Street	72.1	1.03	E	97.1	1.27	F	72.1	1.03	E	97.1	1.27	F
9	M Street at 9th Street	34.2	0.75	C	95.1	1.18	F	34.2	0.75	C	95.1	1.18	F
10	M Street at 11th Street	123.8	1.14	F	532.3	2.00	F	123.8	1.14	F	532.3	2.00	F
14	Virginia Avenue EB at 5th Street	36.7	0.20	D	126.8	0.62	F	N/A			N/A		
15	SE Freeway off-ramp at 6th Street/Virginia Avenue EB	132.4	0.85	F	47.4	0.75	D	89.1	0.94	F	30.9	0.84	C
16	Virginia Avenue EB at 7th Street	6.0	0.43	A	34.3	0.78	C	7.2	0.50	A	22.0	0.86	C
17A	Virginia Avenue EB at 8th Street	23.2	0.61	C	70.7	0.80	E	15.9	0.64	B	35.6	0.70	D
17B	Virginia Avenue ramp at 8th street	12.6	0.51	B	44.8	0.89	D	13.5	0.49	B	33.6	0.87	C
19	I (Eye) Street at 8th Street	40.8	0.92	D	138.6	1.27	F	40.8	0.92	D	138.6	1.27	F
20	I (Eye) Street at Virginia Avenue WB/7th Street	11.8	0.62	B	102.5	1.03	F	11.8	0.62	B	102.5	1.03	F
21	I (Eye) Street and Virginia Avenue WB at 6th Street	12.4	0.74	B	179.4	0.62	F	12.4	0.74	B	179.4	0.62	F
22	Virginia Avenue WB at 4th Street north of SE Freeway	107.9	0.77	F	122.3	0.75	F	107.9	0.77	F	122.3	0.75	F
23	Virginia Avenue WB at 3rd Street north of SE Freeway	313.6	2.25	F	693.6	2.94	F	313.6	2.25	F	693.6	2.94	F
27	G Street at 8th Street	10.4	0.51	B	13.9	0.72	B	10.4	0.51	B	13.9	0.72	B
28	M Street at Isaac Hall Avenue	7.9	0.67	A	85.1	1.10	F	7.9	0.67	A	85.1	1.10	F

Source: DEIS Traffic Analysis

As the Virginia Avenue Reconstruction Project is not predicted to increase the number of diesel locomotives and is not expected to increase traffic at local intersections, the Project is not predicted to cause or exacerbate a violation of the applicable $PM_{2.5}$ NAAQS.

3.2.4 *MSAT Assessment*

On February 3, 2006, the FHWA released *Interim Guidance on Air Toxic Analysis in NEPA Documents.* This guidance was superseded on December 6, 2012 by FHWA's *Interim Guidance Update on Air Toxic Analysis in NEPA Documents.* The purpose of FHWA's guidance is to advise on when and how to analyze MSATs in the NEPA process for highways. This is an interim guidance because MSAT science is still evolving. As the science progresses, FHWA will update the guidance.

Technical shortcomings of emissions and dispersion models and uncertain science with respect to health effects prevent meaningful or reliable estimates of MSAT emissions and effects of this project. However, even though reliable methods do not exist to estimate accurately the health impacts of MSATs at the project level, it is possible to assess qualitatively the levels of future MSAT emissions under the project. Although a qualitative analysis cannot identify and measure health impacts from MSATs, it can give a basis for identifying and comparing the potential differences in MSAT emissions, if any, from the alternatives. The qualitative assessment presented below is derived in part from a study conducted by the FHWA titled, *A Methodology for Evaluating Mobile Source Air Toxic Emissions among Transportation Project Alternatives*, found at: www.fhwa.dot.gov/environment/airtoxic/msatcompare/msatemissions.htm.

FHWA's interim guidance groups projects into the following categories:

- *Exempt Projects and Projects with No Meaningful Potential MSAT Effects;*
- *Projects with Low Potential MSAT Effects; and,*
- *Projects with Higher Potential MSAT Effects.*

The Project Build Alternatives are not predicted to change roadway VMT as compared to the No Build scenario (see section 5.15 of the EIS). They are also not predicted to increase the number of diesel train engines. As such, based on the recommended tiering approach detailed in the FHWA methodology, the operational impacts of the project falls within the Tier 1 category as a project with no meaningful potential MSAT effects.

3.3 Construction Phase Analysis

3.3.1 *General Conformity Annual Emissions Analysis*

Under the GC Rule, construction and operational phase emissions must be compared to the *de minimis* thresholds. In as much as the project is not expected to increase regional VMT or VHT, the project is predicted to have no negative impact on regional air quality. As such, the operational phase of the project is not predicted to exceed the GC Rule's *de minimis* emission thresholds. Furthermore, in a larger sense, the level of emissions within the tunnel of three Project Build Alternatives is expected to be positive. Transporting freight by railroad, especially in a double-stacked intermodal container configuration, produces significantly fewer emissions than if that same quantity of freight were moved by truck, and double-stacking reduces the number of trains (and locomotives) used to transport the expecting growth in East Coast freight traffic. (source: http://www.csx.com/index.cfm/media/press-releases/csx-named-greenest-railroad-by-newsweeks-2010-green-rankings/?keywords=greenhouse gas emissions)

As emissions under the operational phase of the project would be less than these thresholds (i.e. regional emissions would be less with the project than under No Build conditions), the GC Rule would apply to the proposed project only if construction phase emissions would exceed the GC thresholds. As such, a quantitative analysis was conducted to estimate the amount of emissions generated by the construction of each of the proposed construction alternatives. The construction emission burdens estimated were then compared to the GC de minimis thresholds to establish if a conformity determination is required for the project.

The following activities associated with the construction of the project would generate air pollutant emissions within and near the major construction areas:

- *Excavation, demolition, grading;*
- *Handling and transport of construction material and debris;*
- *Operation of heavy-duty diesel-powered construction equipment; and*
- *Operation of heavy-duty diesel trucks for transport of construction materials within construction areas and on the area's roadways.*

These construction activities could have the potential to affect ambient air quality levels primarily within 200 to 300 feet of the activities, as pollutants tend to disperse beyond this distance. Pollutant emissions generated by construction activities and truck trips were estimated on an annual and monthly basis for the entire construction period, and potential air quality impacts were estimated during peak construction periods.

Methodology

The analysis to estimate the emission burden caused by on-site (e.g., demolition activities, construction equipment operations, and truck movements) and off-site (e.g., motor vehicle traffic effects due to truck trips and ramp closures) construction-phase activities includes the following:

- *Estimation of emissions generated by the construction activities, including fugitive dust emissions and emissions released from diesel-powered equipment and trucks based on the hours of operation of each piece of equipment;*
- *Identification of heavily traveled truck routes to estimate the cumulative effects of on-site construction activity emissions and off-site traffic emissions;*

Emission Sources: (On-Site and Off-Site)

On-site construction activities that could generate emissions include:

- *Earth moving, excavation, grading and deconstruction/demolition activities;*
- *The handling and transport of material and debris;*
- *Operations of heavy-duty diesel-powered construction equipment;*
- *Heavy-duty diesel trucks operating within construction areas, as well as traveling to the sites to deliver construction materials and from the sites transporting construction materials; and*
- *Re-entrained dust resulting from trucks and equipment traveling on paved public roads, and unpaved roads within the construction sites.*

Emission rates for these activities were estimated based on the following:

- *The number of hours per day and duration of each construction activity;*
- *The number and type of construction equipment to be used;*
- *Horsepower (HP) and utilization rates (hours per day) for each piece of equipment;*
- *The quantities of construction/demolition material produced and removed from each site; and*
- *The number of trucks trips needed to remove construction/demolition material, and to bring the supply materials to each site.*

Emissions from the off-site trucks and general traffic affected by construction truck traffic were estimated using EPA's Mobile6.2 emission factor model (*User's Guide to MOBILE 6.2, Mobile Source Emission Factor Model, Ann Arbor, Michigan,* EPA420-R-02-028*,* October 2002). MOBILE 6.2 is a mobile source emission estimate program that provides current and future estimates of emissions from highway motor vehicles. Input parameters were provided by Metropolitan Washington Council of Governments (MWCOG). Detailed information regarding the construction analysis can be found in Appendix B.

Emission Control Measures

MWCOG and DDOT guidelines will be followed during construction under any of the three Build Alternatives to minimize construction-phase emissions. In accordance with these guidelines, construction activities could be expected to include practices from the following package of measures designed to minimize air quality impacts:

- *Emission Control Measures for Diesel Equipment Exhaust*
  - Ultra-low sulfur diesel fuel for vehicles and equipment;
  - Majority of the engines for non-road construction equipment with a horsepower (HP) rating above 50 HP in compliance with EPA's Tier 2 standards;
  - Construction equipment with engines above 50 HP retrofitted with the best available control technology (BACT)
  - Limitation of extended idling of diesel-fueled vehicles; and
  - Use of electric compressors and pumps where possible, instead of diesel-powered equipment.
- *Emission Control Measures for Fugitive Dust*
  - Dust suppression with or without approved binding agents, used on-site on a routine basis that may be applied with hoses or a sprinkler system during deconstruction and material-handling activities;
  - Use of wheel-wash stations or crushed stone at construction ingress/egress areas;
  - Covering dump trucks during material transport on public roadways;
  - Limiting unnecessary idling times on diesel-powered engines; and

The control measures selected (for both diesel engines and fugitive dust) would be translated into construction specifications to ensure that the goals identified during the environmental review process are met during the construction phase.

Operating Scenarios

Emission rates of each pollutant were estimated for each type of construction activity. The construction schedules for each of the construction alternatives are presented in **Tables 6A, 6B and 6C**. These tables present the construction stages as well as the start and end dates of each stage of construction for each of the staging areas (west, middle, and east) and each of the phases (1 and 2, where applicable, as Alternative 3 only has one phase of construction). It should be noted these tables show the construction schedule at the time the general conformity de minimis analysis was completed.

Because different construction activities could range from a few months to several years in duration, separate analyses were conducted to estimate short-term (24 hours or less) and long-term (annual average) pollutant levels. Short-term emission estimates, based on peak-period activity levels at each site (defined as emissions per month), were used to compare the modeling results to short-term exposure standards (i.e., 8 hours and 24 hours). Annual average activity levels were used to compare modeling results to annual exposure standards.

Assumptions and Emission Factors

Project-specific information regarding the deployment and operation of construction equipment was applied to identify site-specific emission source parameters for use in the emission estimates and dispersion analysis. The following assumptions and emission factors were utilized:

- *Construction operations would occur 8 hours per day for 5 days per week;*
- *Estimated hourly emission rates of each pollutant from construction equipment, dust-generating activities, and project trucks operating at each construction site were summed to compute the total monthly emission rate by pollutant, reflecting the contribution of each type of emission source;*
- *Only diesel-powered construction equipment was considered in the analysis; emissions generated outside the project area to generate electricity for the electric-powered equipment were not considered;*
- *Construction-related dump trucks were considered as heavy-duty diesel vehicles with a 12 to 18 cubic-yard capacity;*
- *NO_x $PM_{2.5}$, SO_2 and CO emission factors for moving vehicles (i.e., exhaust, brakes, and tires) and queuing vehicles were estimated using the EPA MOBILE 6.2 vehicular emission factor model;*
- *Total daily on-site vehicular emission rates of NO_x $PM_{2.5}$, and SO_2 and CO were estimated by multiplying emission factors for moving vehicles (in grams per vehicle-mile) by the distance that an average vehicle would travel within the site, and by the number of on-site operating vehicles during the activity period;*
- *Re-entrained dust from the movement of trucks and vehicles within each active construction site was estimated using the current EPA equation for fugitive dust sources for $PM_{2.5}$ emissions. Because of low vehicular speeds within the active construction sites (i.e., less than 5 mph), a speed reduction factor was applied, where appropriate;*

Table 6A: Construction Schedule, Alternative 2

Construction Stage	Phase 1						Phase 2					
	West		Middle		East		West		Middle		East	
	Start Date	*End Date*	*Start Date*	*End Date*	*Start Date*	*End Date*	*Start Date*	*End Date*	*Start Date*	*End Date*	*Start Date*	*End Date*
SOE/Slurry Wall	01/01/14	02/01/14	09/01/13	01/01/14	09/01/13	11/01/13	-	-	-	-	-	-
SOE/Soldier Beam	11/01/13	03/01/14	06/15/13	11/11/13	07/12/13	12/31/13	-	-	-	-	11/01/14	12/15/14
SOE/Tieback	02/21/14	05/15/14	10/04/13	02/04/14	12/15/13	07/01/14	-	-	-	-	12/15/14	03/09/15
SOE/Lagging	02/21/14	05/15/14	10/04/13	02/04/14	12/15/13	07/01/14	-	-	-	-	12/15/14	03/09/15
SOE/Internal Bracing	02/21/14	05/15/14	10/04/13	02/04/14	12/15/13	07/01/14	-	-	-	-	12/15/14	03/09/15
Excavation	02/19/14	04/17/14	10/03/13	05/28/14	12/13/13	03/26/14	12/08/14	02/10/15	11/25/14	04/07/15	12/03/14	04/03/15
Excavation/Demolition	08/28/13	10/30/13	-	-	-	-	08/13/14	02/02/15	09/11/14	03/30/15	12/17/14	06/12/15
Structural Concrete	-	-	-	-	-	-	12/15/14	08/10/15	12/10/14	09/04/15	12/24/14	12/22/15
Site Work/Paving	-	-	-	-	-	-	06/13/16	06/24/16	06/25/16	08/04/16	08/05/16	08/19/16
Site Work/Backfill	-	-	-	-	-	-	06/29/15	09/07/15	02/04/15	10/07/15	03/18/15	01/05/16
Site Work/Subgrade/Drainage	-	-	-	-	-	-	05/16/16	07/11/16	03/25/16	07/15/16	06/23/16	08/12/16
Major Deliveries	08/04/13	02/15/14	-	-	-	-	-	-	-	-	-	-
Street Decks	11/04/13	12/13/15	07/19/13	11/04/13	07/29/13	01/06/14	07/03/14	07/22/14	02/12/14	03/15/14	08/22/14	11/19/14
Dewatering	02/19/14	12/08/14	10/03/13	11/25/14	12/13/13	12/03/14	12/08/14	09/07/15	11/25/14	10/07/15	12/03/14	01/05/16
Track Installation	05/27/14	06/13/14	06/13/14	06/27/14	06/27/14	08/06/14	08/10/15	09/22/15	09/24/15	10/27/15	01/21/16	03/21/16

Table 6B: Construction Schedule, Alternative 3

Construction Stage	Phase 1						Phase 2					
	West		Middle		East		West		Middle		East	
	Start Date	*End Date*	*Start Date*	*End Date*	*Start Date*	*End Date*	*Start Date*	*End Date*	*Start Date*	*End Date*	*Start Date*	*End Date*
SOE/Slurry Wall	06/01/13	08/11/13	08/12/13	10/22/13	10/23/13	01/01/14	-	-	-	-	-	-
SOE/Soldier Beam	06/01/13	12/20/13	10/31/13	05/21/14	09/10/13	04/01/14	-	-	-	-	-	-
SOE/Soldier Beam	04/01/15	06/21/15	05/11/15	08/01/15	05/11/15	08/01/15	-	-	-	-	-	-
SOE/Tieback	08/01/13	11/11/13	10/16/13	01/26/14	09/21/13	01/01/14	-	-	-	-	-	-
SOE/Lagging	08/01/13	12/21/13	12/22/13	05/11/14	05/12/14	10/01/14	-	-	-	-	-	-
SOE/Lagging	07/01/15	07/31/15	08/01/15	08/30/15	08/31/15	10/01/15	-	-	-	-	-	-
SOE/Internal Bracing	08/01/13	05/12/14	03/02/14	12/11/14	12/21/13	10/01/14	-	-	-	-	-	-
Excavation	09/01/13	04/01/14	09/01/13	04/01/14	09/01/13	04/01/14	-	-	-	-	-	-
Excavation/Demolition	03/01/15	02/01/16	03/01/15	02/01/16	03/01/15	02/01/16	-	-	-	-	-	-
Structural Concrete	01/01/13	05/02/15	10/01/14	01/29/17	03/02/14	07/01/16	-	-	-	-	-	-
Site Work/Paving	02/01/16	04/01/16	04/02/16	05/31/16	06/01/16	08/01/16	-	-	-	-	-	-
Site Work/Backfill/Subgrade/Drainage	02/01/14	12/02/14	12/03/14	10/01/15	10/02/15	08/01/16	-	-	-	-	-	-
Major Deliveries	06/01/13	11/01/13	-	-	-	-	-	-	-	-	-	-
Street Decks	06/01/13	10/21/13	08/11/13	01/01/14	08/11/13	01/01/14	-	-	-	-	-	-
Street Decks	03/01/15	07/31/15	08/01/15	12/30/15	12/31/15	06/01/16	-	-	-	-	-	-
Dewatering	06/01/13	08/21/17	11/20/13	02/09/17	05/11/13	08/01/16	-	-	-	-	-	-
Track Installation	11/01/13	03/23/14	03/24/14	08/11/14	08/12/14	01/01/15	-	-	-	-	-	-
Track Installation	11/01/15	01/21/16	01/22/16	04/10/16	04/11/16	07/01/16	-	-	-	-	-	-

Table 6C: Construction Schedule, Alternative 4

Construction Stage	Phase 1						Phase 2					
	West		Middle		East		West		Middle		East	
	Start Date	*End Date*	*Start Date*	*End Date*	*Start Date*	*End Date*	*Start Date*	*End Date*	*Start Date*	*End Date*	*Start Date*	*End Date*
SOE/Slurry Wall	10/09/13	12/17/13	12/17/13	04/18/14	04/18/14	08/07/14	-	-	-	-	-	-
SOE/Soldier Beam	08/01/13	08/13/13	08/13/13	10/24/13	10/24/13	02/24/14	01/31/16	03/15/16	03/15/16	06/01/16	06/01/16	09/15/16
SOE/Tieback	07/04/13	10/18/13	10/18/13	01/08/14	01/08/14	02/16/14	-	-	-	-	-	-
SOE/Lagging	-	-	-	-	-	-	02/15/16	03/30/16	03/30/16	06/16/16	06/16/16	09/30/16
SOE/Internal Bracing	-	-	-	-	-	-	02/15/16	03/30/16	03/30/16	06/16/16	06/16/16	09/30/16
Excavation	02/05/14	05/12/14	06/11/14	11/25/14	03/19/15	06/16/15	03/09/16	04/13/16	04/20/16	08/03/16	02/15/16	11/18/16
Excavation/Demolition	09/13/13	03/20/14	03/19/14	11/03/14	11/05/14	04/09/15	-	-	-	-	-	-
Structural Concrete	03/05/14	11/26/14	08/06/14	08/24/15	04/30/15	11/30/15	03/29/16	08/01/16	05/05/16	04/07/17	01/19/17	09/25/17
Site Work/Paving	-	-	-	-	-	-	09/20/16	09/26/16	07/01/17	08/08/17	12/08/17	12/15/17
Site Work/Backfill	11/11/14	12/03/14	02/11/15	08/31/15	11/30/15	01/04/16	08/08/16	09/06/16	09/06/16	04/18/17	06/20/17	10/03/17
Site Work/Subgrade/Drainage	-	-	-	-	-	-	08/31/16	10/19/16	04/01/17	06/05/17	10/19/17	12/09/17
Major Deliveries	08/04/13	06/15/14	-	-	-	-	-	-	-	-	-	-
Street Decks	08/06/13	09/10/13	09/10/13	10/23/13	05/30/14	10/30/14	08/24/16	08/31/16	09/15/16	10/25/16	09/15/17	10/19/17
Dewatering	02/05/14	02/08/16	06/11/14	02/08/16	03/19/15	02/08/16	02/09/16	09/06/16	02/09/16	04/18/17	02/09/16	10/03/17
Track Installation	10/14/15	11/11/15	11/11/15	12/02/15	12/02/15	01/01/16	08/21/17	09/18/17	09/18/17	10/09/17	10/09/17	11/08/17
SOE/Sheetpile	-	-	-	-	-	-	01/01/14	04/28/14	05/05/14	10/02/14	10/02/14	01/08/15

- *Emission rates of NO_x, $PM_{2.5}$, SO_2 VOC, and CO from diesel engines of construction equipment were estimated using the EPA NONROAD Emission Model (Report No. NR-009D, July 2010, EPA 420-R-10-018). Zero-hour emission factors were adjusted for transient operation, deterioration factors, and diesel-fuel sulfur content, following the EPA NONROAD Model guidance;*
- *As recommended in EPA's NONROAD Emission Mode, $PM_{2.5}$ emission factors for construction equipment were assumed to be 97 percent of the estimated PM_{10} emission factors for each type of equipment;*
- *Engine HP rating was provided by the project design team and utilization factors (peak usage during the working hours) for the different types of equipment were estimated based on the EPA NONROAD Model guidance. These values were used to produce an average HP usage per day; and*
- *Fugitive-dust emission factors for demolition, excavation, truck loading, and re-entrained dust were based on the equations recommended in EPA's AP-42 Report "Compilation of Air Pollutant Emission Factors," Sections 13.2.3.1/2/3 Heavy Construction Operations, 11.9.1 Uncontrolled Open Fugitive Dust Sources, and 13.2.1 Fugitive Dust from Paved Roads. The $PM_{2.5}$ to PM_{10} ratios varied depending on the type of activity performed.*

Equipment

Table 7 lists the approximate numbers and types of pieces of equipment that could be expected to operate over the project's construction period, which ranges from a little over 3 years for Alternative 2, to approximately 4½ years for Alternatives 3 and 4. This list is provided to indicate the range of types and sizes of equipment anticipated to be used. The analysis documented in this report was conducted using equipment projections specifically for the peak monthly and peak annual periods at each site.

Total Construction Emissions

Total annual estimated emissions generated during the project's construction period, are provided in **Tables 8A, 8B, and 8C.** These values are the peak on-site emissions during each analysis year plus the peak off site truck travel for each year. These values (for all three alternatives) are less than the CG *de minimis* thresholds. As such, air quality impacts are not considered to be significant and the project would not be subject to a conformity determination.

It should be noted that the results presented assumed that construction would begin in 2013. The construction start date is now estimated to be 2014 or 2015. Trends indicate that emissions will decrease in future years due to fleet turnover (newer vehicles replacing older vehicles) and regulated emission reductions. Therefore, the results presented in Tables 8A, 8B and 8C, which represent results with a construction start year of 2013, are slightly conservative as compared to an analysis that assumes a construction start year of 2014 or 2015. An update of the analysis with construction starting in 2014 is not predicted to adversely affect the results (i.e., higher predicted emission levels) as presented on Tables 8A, 8B and 8C.

3.3.2 *Localized On-Site Dispersion Modeling Analysis*

In addition to the construction emission burden analysis, a localized air quality dispersion modeling analysis was conducted to determine whether the impacts of these emissions would significantly impact nearby sensitive land uses. It should be noted that this localized dispersion

analysis was conducted to address community concerns regarding construction emissions and was not required under the GC Rule.

Table 7: Estimated Numbers of Diesel-Powered Construction Equipment Operating Over the Full Construction Period

Equipment Type	Rated Horsepower	Quantity
Air Compressor (185 CFM)	55	3
Back Hoe (Cat 325 or equivalent)	190	3
Ballast Grader	270	1
Crane (Crawler, 150 Ton)	225	2
Crane (Crawler, 200 Ton)	250	1
Crane (RT, 60 Ton)	190	2
Crane (Truck, 200 Ton)	350	1
Dewatering Pump	50	4
Dill Rig (Tieback)	225	2
Dozer (Cat D7 or equivalent)	180	1
Drill Rig (Soilmec 622)	410	1
Dump Truck	400	25
Forklift (10000 lb)	105	8
Generator (150 kWh)	200	1
Generator (350 kWh)	475	1
Grout Plant	10	2
Hoe Ram	250	4
Light Plant	55	2
Motor Grader	200	1
Paver	225	1
Pile Hammer	125	1
Roller	135	1
Slurry Plant (75 HP Pump)	75	1
Tamping Machine	130	1
Track Loader (Cat 973 or equivalent)	210	3
Tractor Trailer	350	1
Truck Mixer	350	2
Welding Machine	25	4

Table 8A: Total Annual Emissions from Construction Equipment and Activities Alternative 2

Pollutant	Emissions (Tons/Year)				General Conformity *de minimis* Thresholds
	2013	*2014*	*2015*	*2016*	
CO	2.44	4.16	5.34	0.73	100
NOx	5.26	7.95	10.76	1.68	100
SO_2 (precursor pollutant)	0.01	0.01	.02	0.00	100
$PM_{2.5}$	0.41	0.94	1.52	0.23	100
VOCs	0.36	0.61	0.80	0.13	50

Table 8B: Total Annual Emissions from Construction Equipment and Activities Alternative 3

Pollutant	Emissions (Tons/Year)				General Conformity *de minimis* Thresholds
	2013	*2014*	*2015*	*2016*	
CO	4.27	3.87	4.40	2.78	100
NOx	9.11	8.14	9.37	5.67	100
SO_2 (precursor pollutant)	0.01	0.01	.01	0.01	100
$PM_{2.5}$	0.77	0.82	1.05	0.58	100
VOCs	0.64	0.61	0.70	0.41	50

Table 8C: Total Annual Emissions from Construction Equipment and Activities Alternative 4

Pollutant	Emissions (Tons/Year)				General Conformity *de minimis* Thresholds
	2013	*2014*	*2015*	*2016*	
CO	1.28	3.83	3.14	3.63	100
NOx	2.87	7.84	5.79	7.00	100
SO_2 (precursor pollutant)	0.01	0.01	.01	0.01	100
$PM_{2.5}$	0.23	0.76	0.57	0.83	100
VOCs	0.20	0.58	0.41	0.48	50

Approach

Analyses were performed to estimate the potential air quality impacts caused by the construction of the project. These analyses estimated the effects of construction activities on the criteria pollutants associated with construction operations as well health risks associated with the emissions of toxic pollutants from the diesel equipment. All calculations of inhalation cancer risk and hazard quotients were based on EPA's *Human Health Risk Assessment Protocol* (HHRAP); inhalation unit risk factors and reference concentrations were obtained from EPA's *Integrated Risk Information System* (IRIS). Potential impacts on nearby sensitive land uses were estimated. This analysis was conducted to address community concerns regarding construction emissions and was not required under the General Conformity Rule guidelines for a project that falls below the de minimis thresholds.

Emission rates of each pollutant from the total of all emission sources that are projected to be operating at the construction site were estimated for each type of construction activity. Short-term emission estimates were based on peak period activity levels and used to estimate short-term (i.e. 1-hour, 8-hour, and 24-hour) concentrations. For comparison to 24-hour standards, it was assumed that emissions would occur every hour of the 8-hour work period, with no emissions for the rest of the day. For comparison to annual standards, emissions were estimated assuming one working 8-hour shift per day, 21.25 days per month. Three construction alternatives were evaluated: Alternative 2, 3, and 4.

Analysis

Two detailed air quality dispersion modeling analyses were conducted to estimate the potential air quality impacts of construction emissions on nearby sensitive land uses.

1. The potential impacts of criteria pollutants associated with emissions from diesel equipment and dust from vehicles traveling on paved and unpaved roads were estimated. Four criteria pollutants with averaging time periods corresponding to the NAAQS were considered -- 1-hour NO2, 8-hour CO, 24-hour PM10, and 24-hour PM2.5.
2. The potential short-term and long-term impacts of the air toxic pollutants that have the potential to be released from the diesel-fueled construction equipment were estimated. Both carcinogenic and non-carcinogenic impacts were considered. All calculations of inhalation cancer risk and hazard quotients were based on EPA's *Human Health Risk Assessment Protocol* (HHRAP); inhalation unit risk factors and reference concentrations were obtained from EPA's *Integrated Risk Information System* (IRIS). The values used for each pollutant are presented in Appendix A.

Alternatives Considered

Short-term and annual emission rates of each of the three construction alternatives (Alternative 2, 3, and 4) were estimated. Alternative 2 in 2015 was estimated to have the highest emission rates; therefore, the estimated emissions of this alternative were evaluated in the dispersion analysis. The impacts of the other alternatives would be lower than those predicted in this analysis.

Emissions

The methodology for estimating criteria pollutant emission rates are discussed in Section 2.3.1. Emission rates of the toxic air pollutants were estimated using Total Organic Compound (TOC) emission factors from EPA's *Compilation of Air Pollutant Emission Factors* (AP-42), Table 3.3-1. "Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines" (e.g., 0.35 pound/million Btu) and emission factors for each toxic compound from Table 3.3-2 "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines." Based on each

compound emission factor (in pound/million Btu) and total TOC (or VOC) emission factors, ratios of emission factors were developed and applied to the 1-hour and annual estimated concentrations. Twenty three contaminants listed in Table 3.3-2 of AP-42, as associated with internal combustion diesel engines emissions, were considered in the analysis.

Dispersion Modeling Analysis

Dispersion modeling was conducted using the latest version of the EPA AERMOD atmospheric dispersion model (version 12060) to simulate physical conditions and predict pollutant concentrations at nearby receptor locations.

AERMOD can be used to estimate impacts from simple point-source emissions (e.g., stacks) as well as emissions from volume and area sources. The model accepts actual hourly meteorological observations and directly estimates hourly and average concentrations for various time periods. Regulatory default options and the urban dispersion algorithm of the AERMOD model were used in the analysis. Five consecutive years of meteorological data (2007-2011) from Reagan National Airport, which is located approximately 3 miles from the project area, were used. AERMOD input and output files are located in Appendix C.

Emissions from the on-site construction activities were simulated as polygon area sources. The total construction site, with concurrent activities, was divided into the three polygon areas -- the East, West and Middle areas. Emissions from vehicles (including the project's haul trucks) traveling on the road adjacent to the construction site (Virginia Avenue) were also simulated as an area source. An emission release height of 12 feet was used to simulate the height of the exhaust points of the construction equipment.

Emissions from all four source groups (i.e., the three construction areas and the Virginia Avenue traffic) were modeled in one modeling run to generate the total impacts from all sources combined. Maximum impacts were the added to appropriate pollutant background concentrations, and the total estimated concentrations were compared with applicable NAAQS for criteria pollutants.

Background Values

Background values are concentrations that are added to analytically predicted project increments to estimate total pollutant concentrations (for comparison to the NAAQS). Data obtained from the air quality monitoring station located at 420 34th Street NE were considered to be representative of project area land use, and were therefore used as background values for this analysis.

NO_2 Analysis

Emissions of nitrogen oxides (NOx) from combustion in diesel-fueled engines consist predominantly (at the emission source) of nitric oxide (NO), which then converts to NO_2 in the atmosphere in the presence of ozone and sunlight. This chemical transformation usually occurs as the exhaust plume travels downwind from the source.

1-hour NOx impacts were modeled and a conversion rate of NOx/NO_2 ratio 5.9 %[1] was applied to estimate 1-hour NO_2 impacts, which were then added to the appropriate background concentration. The resulting total values were then compared to the 1-hour NO_2 standard.

[1] *Final Localized Significance Threshold Methodology*, June 2003. Revised July 2008.

Air Toxics Analysis

The procedures to estimate cancer risk and the hazard index of toxic pollutants are based on inhalation exposure concentrations outlined in EPA's Human Health Risk Assessment Protocol (HHRAP (EPA520-R-05-006)). The HHRAP is a guideline that can be used to perform health risk assessment for individual compounds with known health effects in order to determine the level of health risk posed by an increased ambient concentration of that compound at a potentially sensitive receptor. The derived health risk values from the HHRAP were used in this analysis to determine the total risk posed by the release of multiple toxic contaminants.

The air toxics emissions were considered as both carcinogens and non-carcinogens. Carcinogenic compounds were evaluated using unit risk factors (URF); non-carcinogenic compounds were evaluated using the reference concentrations for inhalation exposure (RfC) and/or acute inhalation exposure (AIEC). RfC and AIEC were used to estimate non-carcinogenic health effects of substances that are also carcinogens. A conservative cancer threshold of one in one million, as recommended by the EPA for health-risk related assessments, was used in the analysis to determine whether estimated impacts would be considered significant. All calculations of inhalation cancer risk and hazard quotients were based on EPA's *Human Health Risk Assessment Protocol* (HHRAP); inhalation unit risk factors and reference concentrations were obtained from EPA's *Integrated Risk Information System* (IRIS). The values used for each pollutant are presented in Appendix A.

Receptor Sites

Two sets of receptors (i.e., locations where pollutant concentrations were estimated) were considered. The first are ground-level receptors located on a grid network around the construction area boundary and along the travelled roadway of Virginia Avenue. The second set is comprised of actual residences (and one hotel) located in the vicinity of construction area.

Results

Total estimated concentrations of each of the criteria pollutants, which are provided in **Table 9**, are below (within) their respective NAAQS. Therefore, the impacts of criteria pollutants from on-site construction activities are not considered to be significant.

Table 9: Maximum Total Estimated Criteria Pollutant Concentrations

Pollutant	Time Period	NAAQS	Max. Estimated Impacts	Background Conc.	Max. Estimated Concentrations	Exceed NAAQS?
CO (ppm)	1-hr	35	0.6	4.2	4.8	No
CO (ppm)	8-hr	9	0.4	3.8	4.2	No
NO_2 (ug/m^3)	1-hr	188	34	119	153	No
PM_{10} (ug/m^3)	24-hr	150	58	85	143	No
$PM_{2.5}$ (ug/m^3)	24-hr	35	6	28	34	No

The result of the air toxics analysis is that the overall incremental cancer risk from all pollutants combined is below the applicable significant threshold of one in-one million (1E-06), and both the total chronic non-cancer and acute health hazard risks are less than 1. As such, the potential cancer, chronic non-cancer, and acute health risks associated with the project's construction activities are well within acceptable ranges and thus not considered to be significant. Please see Appendix A for more information.

3.3.3 *Off-Site (Mobile Source) Analysis*

Potential construction-phase air quality impacts associated with the operation of vehicles (including trucks used for the transportation of rock and debris removal, transport of construction materials and cement, and construction workers' vehicles) on the roadway network and changes in ramp configurations were estimated.

The portion of Virginia Avenue near the construction site is expected to experience the largest increase in the number of construction trucks in the study area. The impact of these vehicles was included in the on-site analysis. The combined impact of the general traffic on Virginia Avenue, the construction traffic on Virginia Avenue, and the on-site construction equipment represents the worst-case localized hot-spot impact due to the project for particulate matter. As shown in **Table 9**, NAAQS were not exceeded for any of the pollutants analyzed at this location.

To determine if the increase in vehicular traffic due to construction activities (additional trucks and detours) would result in a violation of the NAAQS for CO, a microscale analysis was conducted at a location away from the construction site. As shown in **Table 10**, an intersection screening analysis was performed based upon LOS and delay of intersections in the project area under all phases of construction (Phase 1A, Phase 1B, and Phase 2), as compared to No Build conditions.

An intersection is considered to fail the screening analysis if the project causes the intersection to decrease below LOS D, or to experience a worsening in delay with an LOS below D in both No Build and project conditions. Those intersections that failed the screening analysis were then compared to the construction haul truck routes (**Figure 8**) to find those locations that would be most exposed to the haul routes. Finally, the intersections that failed were evaluated for sensitive receptors in the vicinity.

The intersection of M Street and 8th Street was selected for a microscale analysis for the following reasons:

- The intersection worsens from AM/PM LOS of B/B in No Build to D/E under Phase 1B and Phase 2 of construction. Although the intersection could be optimized to LOS C/C under Phase 1B, it is still expected to experience a LOS of D/E under Phase 2 conditions;
- As shown in Figure 7, the intersection of M Street and 8th Street is located at the intersection of haul truck routes on both M Street and on 8th Street; and
- The Eagle Academy Public Charter School is located at the northwest corner of the intersection.

Table 10: 2015 Construction Screening Analysis

Intersection No.	Intersection Name	2015 No-Build Conditions						2015 Phase 1A					
		AM Peak Hour			PM Peak Hour			AM Peak Hour			PM Peak Hour		
		Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS
1A	South Capitol Street and I (Eye) Street (Left)	11.6	0.67	B	15.9	0.70	B	11.6	0.67	B	15.9	0.70	B
1A	South Capitol Street and I (Eye) Street (Right)	19.3	0.73	B	19.5	0.60	B	19.3	0.73	B	19.5	0.60	B
1C	Ramps from freeway at South Capitol Street SB	101.5	1.01	F	40.8	0.68	D	101.5	1.01	F	40.8	0.68	D
2A	South Capitol Street at M Street - SB Intersection	296.7	1.55	F	35.3	0.65	D	296.7	1.55	F	35.3	0.65	D
2B	South Capitol Street at M Street - NB Intersection	38.3	0.70	D	89.6	0.72	F	38.3	0.70	D	89.6	0.72	F
3	M Street at 1st Street	23.9	0.67	C	34.9	0.76	C	23.9	0.67	C	34.9	0.76	C
4	M Street at New Jersey Avenue	15.4	0.40	B	14.3	0.56	B	15.4	0.40	B	14.3	0.56	B
5	M Street at 3rd Street	7.6	0.32	A	14.7	0.56	B	7.6	0.32	A	14.7	0.56	B
6	M Street at 4th Street	19.6	0.43	B	15.2	0.48	B	19.6	0.43	B	15.2	0.48	B
8	M Street at 8th Street	18.7	0.64	B	14.8	0.70	B	18.7	0.64	B	14.8	0.70	B
9	M Street at 9th Street	10.9	0.38	B	14.6	0.63	B	10.9	0.38	B	14.6	0.63	B
10	M Street at 11th Street	22.5	0.67	C	124.9	1.02	F	22.5	0.67	C	124.9	1.02	F
14	Virginia Avenue EB at 5th Street	35.1	0.12	D	46.6	0.36	D	N/A			N/A		
15	SE Freeway off-ramp at 6th Street/Virginia Avenue EB	17.4	0.53	B	15.4	0.43	B	30.7	0.98	C	21.0	0.85	C
16	Virginia Avenue EB at 7th Street	6.3	0.26	A	17.7	0.45	B	17.6	0.79	B	47.8	0.95	D
17A	Virginia Avenue EB at 8th Street	32.4	0.31	C	46.7	0.38	D	21.0	0.55	C	46.7	0.82	D
17B	Virginia Avenue ramp at 8th street	12.0	0.33	B	14.3	0.46	B	N/A			N/A		
19	I (Eye) Street at 8th Street	19.1	0.52	B	19.9	0.52	B	19.1	0.52	B	19.9	0.52	B
20	I (Eye) Street at Virginia Avenue WB/7th Street	8.4	0.38	A	11.9	0.56	B	7.6	0.44	A	37.4	0.69	D
21	I (Eye) Street and Virginia Avenue WB at 6th Street	7.3	0.46	A	27.3	0.37	C	9.5	0.45	A	38.5	0.34	D
22	Virginia Avenue WB at 4th Street north of SE Freeway	30.3	0.47	C	28.4	0.43	C	30.3	0.47	C	28.4	0.43	C
23	Virginia Avenue WB at 3rd Street north of SE Freeway	44.8	0.84	D	122.5	1.25	F	44.8	0.84	D	122.5	1.25	F
27	G Street at 8th Street	9.0	0.31	A	11.1	0.42	B	9.0	0.31	A	11.1	0.42	B
28	M Street at Isaac Hall Avenue	4.4	0.40	A	21.2	0.64	C	4.4	0.40	A	21.2	0.64	C

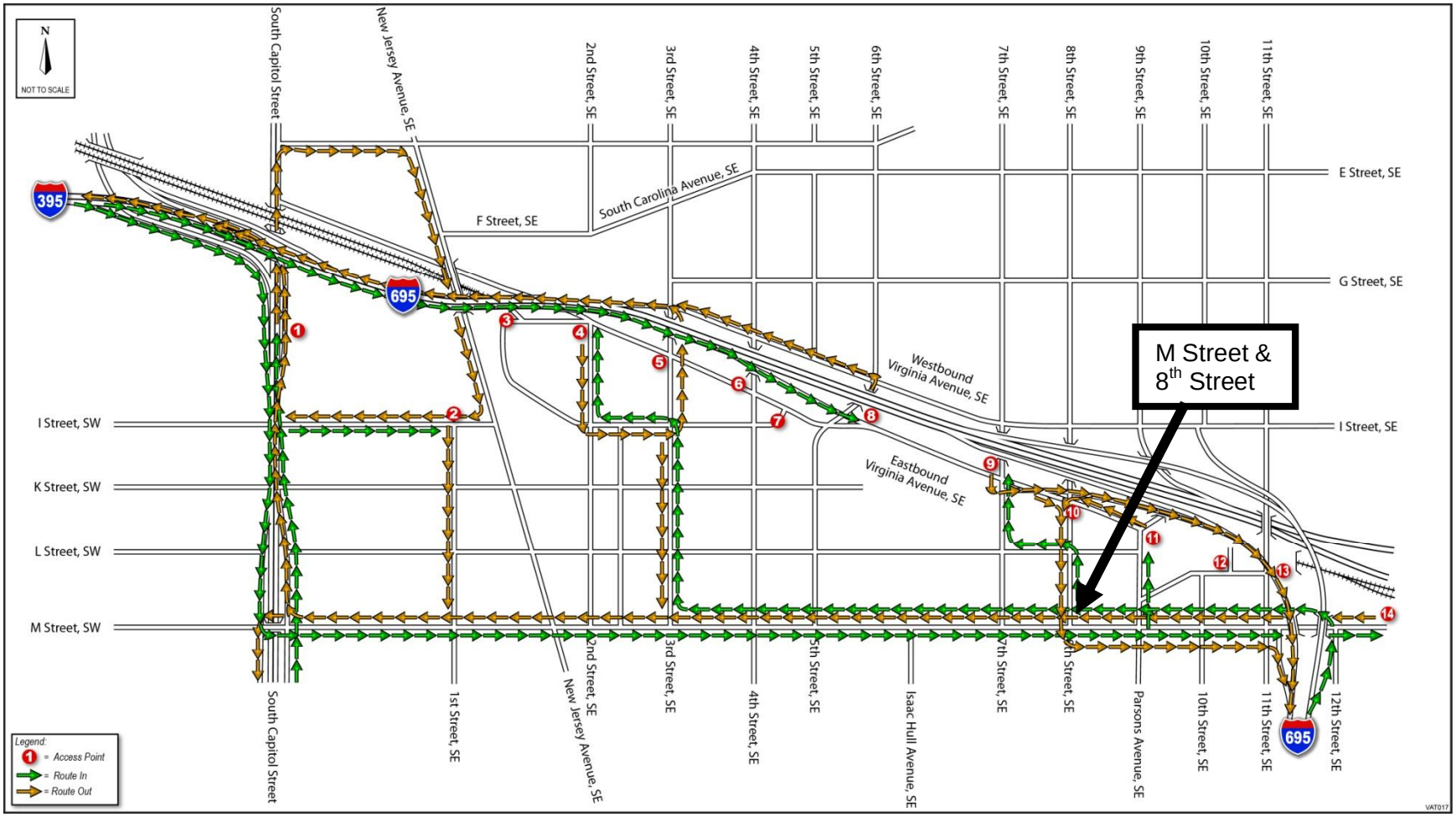
Source: DEIS Traffic Analysis

Table 10: 2015 Construction Screening Analysis (Cont'd)

Intersection No.	Intersection Name	2015 Phase 1B						2015 Phase 2					
		AM Peak Hour			PM Peak Hour			AM Peak Hour			PM Peak Hour		
		Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C	LOS
1A	South Capitol Street and I (Eye) Street (Left)	11.6	0.67	B	15.9	0.70	B	11.6	0.67	B	15.9	0.70	B
1A	South Capitol Street and I (Eye) Street (Right)	19.3	0.73	B	19.5	0.60	B	19.3	0.73	B	19.5	0.60	B
1C	Ramps from freeway at South Capitol Street SB	101.5	1.01	F	40.8	0.68	D	101.5	1.01	F	40.8	0.68	D
2A	South Capitol Street at M Street - SB Intersection	296.7	1.55	F	35.3	0.65	D	296.7	1.55	F	35.3	0.65	D
2B	South Capitol Street at M Street - NB Intersection	38.3	0.70	D	89.6	0.72	F	38.3	0.70	D	89.6	0.72	F
3	M Street at 1st Street	23.9	0.67	C	34.9	0.76	C	23.9	0.67	C	34.9	0.76	C
4	M Street at New Jersey Avenue	15.4	0.40	B	14.3	0.56	B	15.4	0.40	B	14.3	0.56	B
5	M Street at 3rd Street	7.6	0.32	A	14.7	0.56	B	7.6	0.32	A	14.7	0.56	B
6	M Street at 4th Street	19.6	0.43	B	15.2	0.48	B	19.6	0.43	B	15.2	0.48	B
8	M Street at 8th Street	51.0	0.77	D	65.9	0.88	E	51.0	0.77	D	65.9	0.88	E
9	M Street at 9th Street	12.5	0.39	B	15.6	0.69	B	12.5	0.39	B	15.6	0.69	B
10	M Street at 11th Street	22.7	0.71	C	247.0	1.21	F	22.7	0.71	C	247.0	1.21	F
14	Virginia Avenue EB at 5th Street	N/A			N/A			N/A			N/A		
15	SE Freeway off-ramp at 6th Street/Virginia Avenue EB	30.7	0.98	C	21.0	0.85	C	N/A			N/A		
16	Virginia Avenue EB at 7th Street	17.6	0.79	B	47.8	0.95	D	N/A			N/A		
17A	Virginia Avenue EB at 8th Street	16.2	0.51	B	33.9	0.68	C	N/A			N/A		
17B	Virginia Avenue ramp at 8th street	N/A			N/A			N/A			N/A		
19	I (Eye) Street at 8th Street	19.1	0.52	B	19.9	0.52	B	35.8	0.70	D	20.1	0.49	C
20	I (Eye) Street at Virginia Avenue WB/7th Street	7.6	0.44	A	37.4	0.69	D	49.1	0.70	D	30.2	0.84	C
21	I (Eye) Street and Virginia Avenue WB at 6th Street	9.5	0.45	A	38.5	0.34	D	46.5	0.94	D	179.2	0.75	F
22	Virginia Avenue WB at 4th Street north of SE Freeway	30.3	0.47	C	28.4	0.43	C	30.3	0.47	C	28.4	0.43	C
23	Virginia Avenue WB at 3rd Street north of SE Freeway	44.8	0.84	D	122.5	1.25	F	44.8	0.84	D	122.5	1.25	F
27	G Street at 8th Street	9.0	0.31	A	11.1	0.42	B	10.1	0.27	B	11.6	0.32	B
28	M Street at Isaac Hall Avenue	4.4	0.40	A	21.2	0.64	C	4.4	0.40	A	21.2	0.64	C

Source: DEIS Traffic Analysis

Figure 8: Haul Truck Routes



The microscale analysis was performed for CO using the CAL3QHC dispersion model. Emission factors were estimated using the EPA Mobile 6.2 emission algorithm. AM and PM peak traffic conditions were considered. The higher of the second maximum monitored CO levels (**Table 3**) were used for background concentrations.

The analysis was performed for future year (2015) conditions with the proposed construction scenario and future conditions without the proposed action to obtain the increment due to truck movement and the effect of lane closings in the project area. **Table 11** presents the results of the microscale analysis for No Build and Phase 2 (worst-case) construction conditions. No violations of the NAAQS are predicted.

Table 11: CO Microscale Results, M Street & 8th Street – Year 2015

Pollutant	NAAQS(ppm)	Alternative 1 (ppm)		Alternative 2 (ppm)	
		AM	*PM*	*AM*	*PM*
CO 1-Hour*	35	4.8	4.8	4.8	4.8
CO 8-Hour** (ppm)	9	4.2		4.2	

*1-Hour results include a background concentration of 4.2 ppm.
**8-Hour results include a background concentration of 3.8 ppm.
ppm = parts per million

3.4 *Summary of Results*

The following is the result of the air quality analysis:

- Operational phase emissions are not predicted to exceed the GC Rule's *de minimis* emission thresholds. As such, air quality impacts from operation of any of the Build Alternatives would not be subject to a conformity determination;
- Construction phase emissions are not predicted to exceed the GC Rule's *de minimis* emission thresholds. As such, air quality impacts from construction of any of the Build Alternatives would not be subject to a conformity determination;
- Construction phase impacts are not predicted to exceed a NAAQS at applicable sensitive land uses adjacent to the project area;
- Construction-phase of the Project has no potential for MSAT effects;
- Operational phase of the project has no potential for meaningful MSAT effects; and
- Operational phase of the project is not predicted to increase greenhouse gas emissions.

4.0 References

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Appendix A

Mobile Source Air Toxics

Inhalation Cancer Risk and Non-Cancer Hazard Index Calculations

No.	Contaminant	CAS No.	Annual Conc. (C_a)	Exposure Concentration (EC)		URF	dCR	RfC	HQ
				Carcinogen	Non-Carcinogen				
			ug/m^3	ug/m^3	ug/m^3	(ug/m3)$^{-1}$		mg/m^3	
1	Acenaphthene	83-32-9	0.000003		2.68E-06			5.0E-02	5.35E-08
2	Acenaphthylene	208-24-2	0.000010		9.53E-06			5.0E-02	1.91E-07
3	Acetaldehyde	75-07-0	0.001507	1.45E-03	1.45E-03	2.20E-06	3.18E-09	9.0E-03	1.61E-04
4	Acrolein	107-02-8	0.000182		1.74E-04			2.0E-05	8.72E-03
5	Anthracene	120-12-7	0.000004		3.52E-06			3.0E-01	1.17E-08
6	Benz[a]anthracene	56-55-3	0.000003	3.17E-06	3.17E-06	1.10E-04	3.48E-10	5.0E-02	6.33E-08
7	Benzene	71-43-2	0.001833	1.76E-03	1.76E-03	7.80E-06	1.371E-08	3.0E-02	5.86E-05
8	Benzo(a)pyrene	50-32-8	0.0000004	3.54E-07	3.54E-07	1.10E-03	3.90E-10	5.0E-02	7.09E-09
9	Benzo[k]fluoranthene	207-08-9	0.0000003	2.92E-07	2.92E-07	1.10E-04	3.21E-11	5.0E-02	5.84E-09
10	1,3-Butadiene	106-99-0	0.000036	7.68E-05	3.48E-05	3.00E-05	2.31E-09	2.0E-03	1.74E-05
11	Chrysene	218-01-9	0.0000003	6.94E-07	3.14E-07	1.10E-05	7.63E-12	5.0E-02	6.28E-09
12	Dibenzo[a,h]anthracene	53-70-3	0.000001	1.15E-06	5.19E-07	1.20E-03	1.37E-09	5.0E-02	1.04E-08
13	Formaldehyde	50-00-0	0.002319	2.22E-03	2.22E-03	1.30E-05	2.89E-08	9.8E-03	2.27E-04
14	Ideno[1,2,3-cd]pyrene	193-39-5	0.0000003	7.37E-07	3.34E-07	1.10E-04	8.11E-11	5.0E-02	6.68E-09
15	Naphthalene	91-20-3	0.000079	1.67E-04	7.55E-05	3.40E-05	5.67E-09	3.0E-03	2.52E-05
16	Toluene	108-88-3	0.000804	7.71E-04	7.71E-04			5.0E+00	1.54E-07
17	Xylenes	1330-20-7	0.000560	5.37E-04	5.37E-04			1.0E-01	5.37E-06
	Combined Cancer Risk						5.6E-08		
	Total Hazard Index								9.2E-03

Cancer Risk Calculations

All calculations of inhalation cancer risk and hazard quotients are based on the EPA's Human Health Risk Assessment Protocol (HHRAP) methodology and equations.

C_a annual concentration estimated by the AERMOD, ug/m3

EC exposure concentration, ug/m3 (HHRAP, Appendix B, Table C-2-1)

EC = C_a x EF x ED / AT x 365 days/year, where

EF exposure frequency, days/year, assumed by EPA to be equal 350 days/year

ED exposure duration, years, assumed to be 70 years

AT averaging time, years; assumed to be 70 years

dCR individual lifetime cancer risk through direct inhalation of carcinogen (unitless)

dCR = EC x URF (HHRAP, Appendix C, Table C-2-1), where

URF inhalation unit risk factor, (ug/m3)$^{-1}$. Source: EPA Integrated Risk Information System (IRIS)

Inhalation Cancer Risk and Non-Cancer Hazard Index Calculations

Non-Cancer Chronic Hazard Indexes

EC	exposure concentration, ug/m3 (the same equation for EC, as above)
RfC	reference concentration, mg/m^3. Source: EPA Integrated Risk Information System (IRIS)
HQ	hazard quotient for direct inhalation of noncarcinogen (unitless)
	HQ = EC x 0.001/RfC (HHRAP, Appendix C, Table C-2-2)
0.001	units conversion factor, mg/ug

Acute Hazard Quotient and Total Hazard Index Calculations

No.	Contaminant	CAS No.	AERMOD-Estimated 1-hour Conc. (C_{acute})	Acute Inhalation Exposure Criteria (AIEC)	Acute Hazard Quotients (AHQ)
			ug/m³	mg/m³	
1	Acenaphthene	83-32-9	4.11E-05	1.2E+00	3.4E-08
2	Acetaldehyde	75-07-0	2.22E-02	8.1E+01	2.7E-07
3	Acrolein	107-02-8	2.68E-03	1.9E-04	1.4E-02
4	Anthracene	120-12-7	5.42E-05	6.0E+00	9.0E-09
5	Benz[a]anthracene	56-55-3	4.87E-05	3.0E-01	1.6E-07
6	Benzene	71-43-2	2.70E-02	1.3E+00	2.1E-05
7	Benzo[a]pyrene	50-32-8	5.45E-06	2.3E-06	2.4E-03
8	Benzo(g,h,i) perylene	191-24-2	1.42E-05	6.0E-06	2.4E-03
9	Benzo[k]fluoranthene	207-08-9	4.49E-06	6.0E-01	7.5E-09
10	1,3-Butadiene	106-99-0	1.13E-03	1.5E+03	7.6E-10
11	Chrysene	218-01-9	1.02E-05	6.0E-01	1.7E-08
12	Dibenzo[a,h]anthracene	53-70-3	1.69E-05	3.0E+01	5.6E-10
13	Fluoranthene	206-44-0	2.20E-04	1.5E-02	1.5E-05
14	Fluorene	86-73-7	8.46E-04	2.5E+01	3.4E-08
15	Formaldehyde	50-00-0	3.42E-02	9.4E-02	3.6E-04
16	Ideno[1,2,3-cd]pyrene	193-39-5	1.09E-05	5.0E-01	2.2E-08
17	Naphthalene	91-20-3	2.46E-03	7.50E+01	3.3E-08
18	Phenanthrene	85-01-8	8.52E-04	1.00E+00	8.5E-07
19	Propylene	115-07-1	7.47E-02	3.00E+00	2.5E-05
20	Pyrene	129-00-0	1.38E-04	1.50E+01	9.2E-09
21	Toluene	108-88-3	1.18E-02	3.70E+01	3.2E-07
22	Xylenes	1330-20-7	8.26E-03	2.20E+01	3.8E-07
	Total Hazard Index				1.93E-02

Acute Hazard Index Calculations

All calculations of acute hazard indexes are based on the EPA's Human Health Risk Assessment Protocol (HHRAP) methodology and equations.

C_{acute} 1-hr concentration estimated by the AERMOD, ug/m3

C_{acute} values are based on the equation presented in HHRAP (Table B-6-1) using compound-specific emission rates

AIEC acute inhalation exposure criteria, mg/m3

AHQ acute hazard quotient, unitless

AHQ = C_{acute} x 0.001/AIEC (HHRAP, Appendix C, Table C-4-1)

0.001 units conversion factor, mg/ug

Appendix B

Construction Emissions (On-site)

(Data presented for Alternative 4)

CO Summary Table

Year	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	All Locations
2013	0.87	0.26	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.26
2014	1.29	1.62	0.40	0.18	0.22	0.09	0.00	0.00	0.00	0.00	3.79
2015	0.46	1.28	1.07	0.08	0.08	0.13	0.00	0.00	0.00	0.00	3.10
2016	0.10	0.10	0.18	0.78	1.69	0.78	0.00	0.00	0.00	0.00	3.62
2017	0.00	0.00	0.00	0.05	1.13	1.17	0.00	0.00	0.00	0.00	2.35
2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum Yearly Value (tons/year)	**1.29**	**1.62**	**1.07**	**0.78**	**1.69**	**1.17**	**0.00**	**0.00**	**0.00**	**0.00**	**3.79**
Year	**2014.00**	**2014.00**	**2015.00**	**2016.00**	**2016.00**	**2017.00**	**2013.00**	**2013.00**	**2013.00**	**2013.00**	**1.29**
Highest Monthly value from highest year - (Tons/Month)	**0.157**	**0.241**	**0.148**	**0.104**	**0.301**	**0.137**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Highest Monthly Value - from all years (Tons/Month)	**0.266**	**0.241**	**0.148**	**0.104**	**0.301**	**0.137**	**0.000**	**0.000**	**0.000**	**0.000**	**0.499**

NOx Summary Table

Year	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	All Locations
2013	1.90	0.59	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.80
2014	2.46	3.25	0.88	0.40	0.50	0.20	0.00	0.00	0.00	0.00	7.68
2015	0.62	2.34	2.01	0.20	0.20	0.30	0.00	0.00	0.00	0.00	5.67
2016	0.15	0.15	0.34	1.55	3.36	1.42	0.00	0.00	0.00	0.00	6.96
2017	0.00	0.00	0.00	0.11	2.40	2.17	0.00	0.00	0.00	0.00	4.68
2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum Yearly Value (tons/year)	**2.46**	**3.25**	**2.01**	**1.55**	**3.36**	**2.17**	**0.00**	**0.00**	**0.00**	**0.00**	**7.68**
Year	**2014.00**	**2014.00**	**2015.00**	**2016.00**	**2016.00**	**2017.00**	**2013.00**	**2013.00**	**2013.00**	**2013.00**	**2.46**
Highest Monthly value from highest year - (Tons/Month)	**0.308**	**0.498**	**0.285**	**0.204**	**0.631**	**0.260**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Highest Monthly Value - from all years (Tons/Month)	**0.563**	**0.498**	**0.309**	**0.204**	**0.631**	**0.260**	**0.000**	**0.000**	**0.000**	**0.000**	**1.018**

PM10 Summary Table

Year	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	All Locations
2013	0.27	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34
2014	0.47	0.25	0.08	0.03	0.04	0.02	0.00	0.00	0.00	0.00	0.89
2015	0.06	0.20	0.34	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.64
2016	0.01	0.01	0.04	0.38	0.48	0.50	0.00	0.00	0.00	0.00	1.43
2017	0.00	0.00	0.00	0.01	0.44	0.27	0.00	0.00	0.00	0.00	0.72
2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum Yearly Value (tons/year)	**0.47**	**0.25**	**0.34**	**0.38**	**0.48**	**0.50**	**0.00**	**0.00**	**0.00**	**0.00**	**1.43**
Year	**2014.00**	**2014.00**	**2015.00**	**2016.00**	**2016.00**	**2016.00**	**2013.00**	**2013.00**	**2013.00**	**2013.00**	**0.01**
Highest Monthly value from highest year - (Tons/Month)	**0.102**	**0.038**	**0.062**	**0.145**	**0.091**	**0.064**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Highest Monthly Value - from all years (Tons/Month)	**0.102**	**0.038**	**0.062**	**0.145**	**0.112**	**0.064**	**0.000**	**0.000**	**0.000**	**0.000**	**0.225**

PM25 Summary Table

Year	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	All Locations
2013	0.16	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22
2014	0.25	0.35	0.07	0.03	0.04	0.02	0.00	0.00	0.00	0.00	0.76
2015	0.06	0.24	0.21	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.56
2016	0.01	0.01	0.04	0.26	0.31	0.19	0.00	0.00	0.00	0.00	0.83
2017	0.00	0.00	0.00	0.01	0.26	0.23	0.00	0.00	0.00	0.00	0.51
2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum Yearly Value (tons/year)	**0.25**	**0.35**	**0.21**	**0.26**	**0.31**	**0.23**	**0.00**	**0.00**	**0.00**	**0.00**	**0.83**
Year	**2014.00**	**2014.00**	**2015.00**	**2016.00**	**2016.00**	**2017.00**	**2013.00**	**2013.00**	**2013.00**	**2013.00**	**0.01**
Highest Monthly value from highest year - (Tons/Month)	**0.033**	**0.043**	**0.026**	**0.093**	**0.054**	**0.030**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Highest Monthly Value - from all years (Tons/Month)	**0.048**	**0.043**	**0.035**	**0.093**	**0.054**	**0.030**	**0.000**	**0.000**	**0.000**	**0.000**	**0.137**

HC Summary Table

Year	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	All Locations
2013	0.13	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19
2014	0.17	0.24	0.07	0.03	0.04	0.02	0.00	0.00	0.00	0.00	0.56
2015	0.04	0.17	0.14	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.40
2016	0.01	0.01	0.02	0.12	0.22	0.10	0.00	0.00	0.00	0.00	0.48
2017	0.00	0.00	0.00	0.01	0.16	0.16	0.00	0.00	0.00	0.00	0.34
2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum Yearly Value (tons/year)	**0.17**	**0.24**	**0.14**	**0.12**	**0.22**	**0.16**	**0.00**	**0.00**	**0.00**	**0.00**	**0.56**
Year	**2014.00**	**2014.00**	**2015.00**	**2016.00**	**2016.00**	**2017.00**	**2013.00**	**2013.00**	**2013.00**	**2013.00**	**0.17**
Highest Monthly value from highest year - (Tons/Month)	**0.021**	**0.036**	**0.018**	**0.016**	**0.040**	**0.019**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Highest Monthly Value - from all years (Tons/Month)	**0.039**	**0.036**	**0.023**	**0.016**	**0.040**	**0.019**	**0.000**	**0.000**	**0.000**	**0.000**	**0.066**

SO2 Summary Table

Year	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	All Locations
2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
2015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
2017	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum Yearly Value (tons/year)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**
Year	**2014.00**	**2014.00**	**2015.00**	**2016.00**	**2016.00**	**2017.00**	**2013.00**	**2013.00**	**2013.00**	**2013.00**	**0.00**
Highest Monthly value from highest year - (Tons/Month)	**0.000**	**0.001**	**0.000**	**0.000**	**0.001**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Highest Monthly Value - from all years (Tons/Month)	**0.001**	**0.001**	**0.000**	**0.000**	**0.001**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.002**

VIRGINIA AVENUE
CSX
CONSTRUCTION EMISSIONS

Construction Equipment	Number of Units	Type of Fuel	Equipment Rated HP (2) hp/hr	Average Daily Load Factor	Average Daily Utilization Rate	Average Equipment Usage of HP (2) hrs	Total Utilized Equipment HP (all units) hp/hr	Start Date	End Date	Construction Activity Duration Months	(4) hrs/month	Estimated Pollutant Monthly Emissions CO tons	NOx tons	PM10 tons	PM2.5 tons	HC tons	CO_2 tons	SO_2 tons
A - SOE/Slurry Wall																		
Crane (Crawler, 200 Ton)	1	Diesel	250	0.60	0.80	150	150	10/9/2013	12/17/2013	3	139	0.03	0.07	0.01	0.00	0.01	12.16	0.00
Crane (RT, 60 Ton)a	1	Diesel	190	0.60	0.65	114	114	10/9/2013	12/17/2013	3	113	0.02	0.05	0.00	0.00	0.00	7.51	0.00
Air Compressor (185 CFM)	1	Diesel	55	0.60	0.85	33	33	10/9/2013	12/17/2013	3	147	0.02	0.02	0.00	0.00	0.00	3.16	0.00
Generator (150 kWh)	1	Diesel	200	0.60	0.90	120	120	10/9/2013	12/17/2013	3	156	0.03	0.07	0.00	0.00	0.01	10.94	0.00
Generator (350 kWh)	1	Diesel	475	0.60	0.90	285	285	10/9/2013	12/17/2013	3	156	0.07	0.17	0.01	0.01	0.01	26.00	0.00
Slurry Plant (75 HP Pump)	1	Diesel	75	0.60	0.90	45	45	10/9/2013	12/17/2013	3	156	0.03	0.03	0.00	0.00	0.00	4.56	0.00
Construction Equipment Total	***6***											***0.20***	***0.40***	***0.03***	***0.03***	***0.03***	***64.32***	***0.00***
B - SOE/Soldier Beam																		
Drill Rig (Soilmec 622)	1	Diesel	410	0.60	0.80	246	246	8/1/2013	8/13/2013	1	139	0.05	0.13	0.01	0.01	0.01	19.95	0.00
Forklift (10000 lb)a	1	Diesel	105	0.45	0.55	47	47	8/1/2013	8/13/2013	1	95	0.01	0.02	0.00	0.00	0.00	2.63	0.00
Welding Machine	1	Diesel	350	0.25	0.25	88	88	8/1/2013	8/13/2013	1	43	0.01	0.01	0.00	0.00	0.00	2.22	0.00
Construction Equipment Total	***3***											***0.07***	***0.16***	***0.01***	***0.01***	***0.01***	***24.80***	***0.00***
C - SOE/Tieback																		
Dill Rig (Tieback)	1	Diesel	225	0.60	0.85	135	135	7/4/2013	10/18/2013	4	147	0.03	0.07	0.00	0.00	0.01	11.62	0.00
Grout Plant	1	Diesel	10	0.60	0.85	6	6	7/4/2013	10/18/2013	4	147	0.00	0.00	0.00	0.00	0.00	0.57	0.00
Forklift (10000 lb)d	1	Diesel	105	0.50	0.65	53	53	7/4/2013	10/18/2013	4	113	0.01	0.02	0.00	0.00	0.00	3.46	0.00
Construction Equipment Total	***3***											***0.04***	***0.10***	***0.01***	***0.01***	***0.01***	***15.66***	***0.00***
D - SOE/Lagging																		
Forklift (10000 lb)c	0	Diesel	105	0.50	0.45	53	0	2/21/2014	5/15/2014	4	78	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction Equipment Total	***0***											**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
E - SOE/Internal Bracing																		
Forklift (10000 lb)d	0	Diesel	105	0.50	0.65	53	0	2/21/2014	5/15/2014	4	113	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Welding Machine b	0	Diesel	25	0.50	0.70	13	0	2/21/2014	5/15/2014	4	121	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction Equipment Total	***0***											**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
F - Excavation																		
Back Hoe (Cat 325 or equivalent)	1	Diesel	190	0.60	0.25	114	114	2/5/2014	5/12/2014	4	43	0.01	0.02	0.00	0.00	0.00	2.89	0.00
Track Loader (Cat 973 or equivalent)	1	Diesel	210	0.60	0.20	126	126	2/5/2014	5/12/2014	4	35	0.01	0.02	0.00	0.00	0.00	2.55	0.00
Dump Truck a	0	Diesel	400	0.25	0.65	100	0	2/5/2014	5/12/2014	4	113	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.01**	**0.03**	**0.00**	**0.00**	**0.00**	**5.44**	**0.00**
G - Excavation/Demolition																		
Back Hoe (Cat 325 or equivalent)	1	Diesel	190	0.60	0.25	114	114	9/13/2013	3/20/2014	7	43	0.01	0.02	0.00	0.00	0.00	2.89	0.00
Track Loader (Cat 973 or equivalent)	1	Diesel	210	0.60	0.20	126	126	9/13/2013	3/20/2014	7	35	0.01	0.02	0.00	0.00	0.00	2.55	0.00
Hoe Ram	1	Diesel	250	0.45	0.55	113	113	9/13/2013	3/20/2014	7	95	0.02	0.04	0.00	0.00	0.00	6.27	0.00
Dump Truck a	0	Diesel	400	0.25	0.65	100	0	9/13/2013	3/20/2014	7	113	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction Equipment Total	***3***											**0.03**	**0.07**	**0.00**	**0.00**	**0.01**	**11.71**	**0.00**
H - Structural Concrete																		
Truck Mixer	5	Diesel	350	0.25	0.25	88	438	3/5/2014	11/26/2014	9	43	0.03	0.07	0.00	0.00	0.00	11.09	0.00
Crane (Crawler, 150 Ton)	1	Diesel	225	0.60	0.65	135	135	3/5/2014	11/26/2014	9	113	0.02	0.05	0.00	0.00	0.00	8.89	0.00
Tractor Trailer	1	Diesel	350	0.15	0.15	53	53	3/5/2014	11/26/2014	9	26	0.00	0.01	0.00	0.00	0.00	0.80	0.00
Forklift (10000 lb)b	1	Diesel	105	0.45	0.45	47	47	3/5/2014	11/26/2014	9	78	0.01	0.01	0.00	0.00	0.00	2.15	0.00
Air Compressor	1	Diesel	55	0.60	0.70	33	33	3/5/2014	11/26/2014	9	121	0.02	0.02	0.00	0.00	0.00	2.60	0.00
Construction Equipment Total	***9***											**0.08**	**0.16**	**0.01**	**0.01**	**0.01**	**25.53**	**0.00**
J - Site Work/Backfill																		
Roller	1	Diesel	135	0.50	0.45	68	68	11/11/2014	12/3/2014	2	78	0.01	0.02	0.00	0.00	0.00	3.08	0.00

VIRGINIA AVENUE
CSX
CONSTRUCTION EMISSIONS

Construction Equipment	Number of Units	Type of Fuel	Equipment Rated HP (2) hp/hr	Average Daily Load Factor	Average Daily Utilization Rate	Average Equipment Usage of HP (2) hrs	Total Utilized Equipment HP (all units) hp/hr	Start Date	End Date	Construction Activity Duration		Estimated Pollutant Monthly Emissions						
										Months	(4) hrs/month	CO tons	NOx tons	PM10 tons	PM2.5 tons	HC tons	CO_2 tons	SO_2 tons
Light Plant	1	Diesel	55	0.25	0.10	14	14	11/11/2014	12/3/2014	2	17	0.00	0.00	0.00	0.00	0.00	0.15	0.00
Motor Grader	1	Diesel	200	0.45	0.40	90	90	11/11/2014	12/3/2014	2	69	0.01	0.02	0.00	0.00	0.00	3.65	0.00
Dozer (Cat D7 or equivalent)	2	Diesel	180	0.35	0.40	63	126	11/11/2014	12/3/2014	2	69	0.01	0.03	0.00	0.00	0.00	5.11	0.00
Construction Equipment Total	***5***											**0.03**	**0.07**	**0.01**	**0.01**	**0.01**	**11.98**	**0.00**
L - Major Deliveries																		
Crane (Truck, 200 Ton)	1	Diesel	350	0.60	0.65	210	210	8/4/2013	6/15/2014	11	113	0.04	0.09	0.01	0.01	0.00	13.83	0.00
Construction Equipment Total	***1***											**0.04**	**0.09**	**0.01**	**0.01**	**0.00**	**13.83**	**0.00**
M - Street Decks																		
Crane (RT, 60 Ton)b	1	Diesel	190	0.60	0.75	114	114	8/6/2013	9/10/2013	2	130	0.02	0.05	0.00	0.00	0.00	8.66	0.00
Forklift (10000 lb)e	1	Diesel	102	0.45	0.65	46	46	8/6/2013	9/10/2013	2	113	0.01	0.02	0.00	0.00	0.00	3.02	0.00
Welding Machine c	1	Diesel	25	0.60	0.80	15	15	8/6/2013	9/10/2013	2	139	0.01	0.01	0.00	0.00	0.00	1.35	0.00
Construction Equipment Total	***3***											**0.04**	**0.08**	**0.01**	**0.01**	**0.01**	**13.03**	**0.00**
N -Dewatering																		
Dewatering Pump	1	Diesel	50	0.75	0.95	38	38	2/5/2014	2/8/2016	25	165	0.03	0.03	0.00	0.00	0.00	4.01	0.00
Construction Equipment Total	***1***											**0.03**	**0.03**	**0.00**	**0.00**	**0.00**	**4.01**	**0.00**
O - Track Installation																		
Ballast Grader	1	Diesel	270	0.60	0.75	162	162	10/14/2015	11/11/2015	2	130	0.03	0.07	0.01	0.01	0.01	12.31	0.00
Tamping Machine	1	Diesel	130	0.60	0.75	78	78	10/14/2015	11/11/2015	2	130	0.02	0.04	0.00	0.00	0.00	5.93	0.00
Construction Equipment Total	***2***											**0.05**	**0.11**	**0.01**	**0.01**	**0.01**	**18.23**	**0.00**
Misc. Equipment																		
Other Construction Equipment	1	Diesel	450	0.45	0.40	203	203	11/1/2015	1/31/2016	3	69	0.02	0.05	0.00	0.00	0.00	8.21	0.00
Other Construction Equipment	1	Diesel	395	0.45	0.40	178	178	11/1/2015	1/31/2016	3	69	0.02	0.05	0.00	0.00	0.00	7.21	0.00
Construction Equipment Total	***2***											**0.04**	**0.10**	**0.01**	**0.01**	**0.01**	**15.42**	**0.00**

VIRGINIA AVENUE CSX
CONSTRUCTION EMISSIONS

Construction Dirt Handling, Hauling and TruckTrips	Units	Amount	Total Miles/hours per Trip	Total Number of Truck Trips Per month	Distance *Total Traveled Distance/Idle Time (all vehicles)* per Month	Start Date	End Date	Construction Activity Duration		Estimated Pollutant Monthly Emissions					
								Months	(4) hrs/month	CO tons/month	NOx tons/month	PM10 tons/month	PM2.5 tons/month	HC tons/month	SO_2 tons/month
F - Excavation															
Bulldozing	Hours of Activity per Day	2	Dirt			Feb-14	May-14	4	43			0.005	0.003		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	2	Dirt			Feb-14	May-14	4	35			0.004	0.002		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	5	1	108	54.2	Feb-14	May-14	4		0.0003	0.0004	0.0000	0.0000	0.0001	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	5	1	108	54.2	Feb-14	May-14	4				0.0346	0.0035		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	5	0.08	108	9.0	Feb-14	May-14	4		0.0001	0.0002	0.0000	0.0000	0.0000	0.0000
G - Excavation/Demolition															
Bulldozing	Hours of Activity per Day	2	Dirt			Sep-13	Mar-14	7	43			0.005	0.003		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	2	Dirt			Sep-13	Mar-14	7	35			0.004	0.002		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	5	1	108	54.2	Sep-13	Mar-14	7		0.0003	0.0004	0.0000	0.0000	0.0001	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	5	1	108	54.2	Sep-13	Mar-14	7				0.0346	0.0035		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	5	0.08	108	9.0	Sep-13	Mar-14	7		0.0001	0.0002	0.0000	0.0000	0.0000	0.0000
J - Site Work/Backfill															
Bulldozing	Hours of Activity per Day	6	Dirt			Nov-14	Dec-14	2	139			0.014	0.009		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Dirt			Nov-14	Dec-14	2	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	0	1	0	0.0	Nov-14	Dec-14	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	0	1	0	0.0	Nov-14	Dec-14	2				0.0000	0.0000		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	0	0.08	0	0.0	Nov-14	Dec-14	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
O - Track Installation															
Bulldozing	Hours of Activity per Day	6	Aggregate			Oct-15	Nov-15	2	130			0.001	0.002		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Aggregate			Oct-15	Nov-15	2	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	0	1	0	0.0	Oct-15	Nov-15	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	0	1	0	0.0	Oct-15	Nov-15	2				0.0000	0.0000		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	0	0.08	0	0.0	Oct-15	Nov-15	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

VIRGINIA AVENUE CSX
CONSTRUCTION EMISSIONS

Construction Equipment	Number of Units	Type of Fuel	Equipment Rated HP (2) hp/hr	Average Daily Load Factor	Average Daily Utilization Rate	Average Equipment Usage of HP (2) hrs	Total Utilized Equipment HP (all units) hp/hr	Start Date	End Date	Construction Activity Duration Months	(4) hrs/month	Estimated Pollutant Monthly Emissions CO tons	NOx tons	PM10 tons	PM2.5 tons	HC tons	SO_2 tons
B - SOE/Soldier Beam																	
Drill Rig (Soilmec 622)	1	Diesel	410	0.60	0.80	246	246	1/31/2016	3/15/2016	3	139	0.05	0.13	0.01	0.01	0.01	0.00
Forklift (10000 lb)a	1	Diesel	105	0.45	0.55	47	47	1/31/2016	3/15/2016	3	95	0.01	0.02	0.00	0.00	0.00	0.00
Welding Machine	1	Diesel	350	0.25	0.25	88	88	1/31/2016	3/15/2016	3	43	0.01	0.01	0.00	0.00	0.00	0.00
Construction Equipment Total	***3***											***0.07***	***0.16***	***0.01***	***0.01***	***0.01***	***0.00***
D - SOE/Lagging																	
Forklift (10000 lb)c	1	Diesel	105	0.50	0.45	53	53	2/15/2016	3/30/2016	2	78	0.01	0.01	0.00	0.00	0.00	0.00
Construction Equipment Total	***1***											**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**
E - SOE/Internal Bracing																	
Forklift (10000 lb)d	1	Diesel	105	0.50	0.65	53	53	2/15/2016	3/30/2016	2	113	0.00	0.00	0.00	0.00	0.00	0.00
Welding Machine b	1	Diesel	25	0.50	0.70	13	13	2/15/2016	3/30/2016	2	121	0.00	0.00	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
F - Excavation																	
Back Hoe (Cat 325 or equivalent)	1	Diesel	190	0.60	0.25	114	114	3/9/2016	4/13/2016	2	43	0.01	0.02	0.00	0.00	0.00	0.00
Track Loader (Cat 973 or equivalent)	1	Diesel	210	0.60	0.20	126	126	3/9/2016	4/13/2016	2	35	0.01	0.02	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.01**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**
H - Structural Concrete																	
Truck Mixer	5	Diesel	350	0.25	0.25	88	438	3/29/2016	8/1/2016	6	43	0.03	0.07	0.00	0.00	0.00	0.00
Crane (Crawler, 150 Ton)	1	Diesel	225	0.60	0.65	135	135	3/29/2016	8/1/2016	6	113	0.02	0.05	0.00	0.00	0.00	0.00
Tractor Trailer	1	Diesel	350	0.15	0.15	53	53	3/29/2016	8/1/2016	6	26	0.00	0.01	0.00	0.00	0.00	0.00
Forklift (10000 lb)b	1	Diesel	105	0.45	0.45	47	47	3/29/2016	8/1/2016	6	78	0.01	0.01	0.00	0.00	0.00	0.00
Air Compressor	1	Diesel	55	0.60	0.70	33	33	3/29/2016	8/1/2016	6	121	0.00	0.00	0.00	0.00	0.00	0.00
Construction Equipment Total	***9***											**0.06**	**0.14**	**0.01**	**0.01**	**0.01**	**0.00**
I - Site Work/Paving																	
Roller	1	Diesel	135	0.50	0.45	68	68	9/20/2016	9/26/2016	1	78	0.00	0.00	0.00	0.00	0.00	0.00
Paver	1	Diesel	225	0.55	0.45	124	124	9/20/2016	9/26/2016	1	78	0.00	0.00	0.00	0.00	0.00	0.00
Light Plant	2	Diesel	55	0.25	0.10	14	28	9/20/2016	9/26/2016	1	17	0.00	0.00	0.00	0.00	0.00	0.00
Motor Grader	1	Diesel	200	0.45	0.40	90	90	9/20/2016	9/26/2016	1	69	0.01	0.02	0.00	0.00	0.00	0.00
Dozer (Cat D7 or equivalent)	1	Diesel	180	0.35	0.40	63	63	9/20/2016	9/26/2016	1	69	0.01	0.02	0.00	0.00	0.00	0.00
Construction Equipment Total	***6***											**0.02**	**0.04**	**0.01**	**0.01**	**0.01**	**0.00**
J - Site Work/Backfill																	
Roller	1	Diesel	135	0.50	0.45	68	68	8/8/2016	9/6/2016	2	78	0.01	0.02	0.00	0.00	0.00	0.00
Light Plant	1	Diesel	55	0.25	0.10	14	14	8/8/2016	9/6/2016	2	17	0.00	0.00	0.00	0.00	0.00	0.00
Motor Grader	1	Diesel	200	0.45	0.40	90	90	8/8/2016	9/6/2016	2	69	0.01	0.02	0.00	0.00	0.00	0.00
Dozer (Cat D7 or equivalent)	2	Diesel	180	0.35	0.40	63	126	8/8/2016	9/6/2016	2	69	0.01	0.03	0.00	0.00	0.00	0.00
Construction Equipment Total	***5***											**0.03**	**0.07**	**0.01**	**0.01**	**0.01**	**0.00**
K - Subgrade/Drainage																	
Roller	1	Diesel	135	0.50	0.45	68	68	8/31/2016	10/19/2016	3	78	0.00	0.00	0.00	0.00	0.00	0.00
Light Plant	1	Diesel	55	0.25	0.10	14	14	8/31/2016	10/19/2016	3	17	0.00	0.00	0.00	0.00	0.00	0.00
Motor Grader	1	Diesel	200	0.45	0.40	90	90	8/31/2016	10/19/2016	3	69	0.01	0.02	0.00	0.00	0.00	0.00
Dozer (Cat D7 or equivalent)	2	Diesel	180	0.35	0.40	63	126	8/31/2016	10/19/2016	3	69	0.01	0.03	0.00	0.00	0.00	0.00

VIRGINIA AVENUE CSX
CONSTRUCTION EMISSIONS

Construction Equipment	Number of Units	Type of Fuel	Equipment Rated HP (2) hp/hr	Average Daily Load Factor	Average Daily Utilization Rate	Average Equipment Usage of HP (2) hrs	Total Utilized Equipment HP (all units) hp/hr	Start Date	End Date	Construction Activity Duration Months	(4) hrs/month	Estimated Pollutant Monthly Emissions CO tons	NOx tons	PM10 tons	PM2.5 tons	HC tons	SO_2 tons
Construction Equipment Total	***5***											**0.02**	**0.05**	**0.01**	**0.01**	**0.01**	**0.00**
M - Street Decks																	
Crane (RT, 60 Ton)b	1	Diesel	190	0.60	0.75	114	114	8/24/2016	8/31/2016	1	130	0.02	0.05	0.00	0.00	0.00	0.00
Forklift (10000 lb)e	1	Diesel	102	0.45	0.65	46	46	8/24/2016	8/31/2016	1	113	0.01	0.02	0.00	0.00	0.00	0.00
Welding Machine c	1	Diesel	25	0.60	0.80	15	15	8/24/2016	8/31/2016	1	139	0.01	0.01	0.00	0.00	0.00	0.00
Construction Equipment Total	***3***											**0.04**	**0.08**	**0.01**	**0.01**	**0.01**	**0.00**
N -Dewatering																	
Dewatering Pump	1	Diesel	50	0.75	0.95	38	38	2/9/2016	9/6/2016	8	165	0.03	0.03	0.00	0.00	0.00	0.00
Construction Equipment Total	***1***											**0.03**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**
O - Track Installation																	
Ballast Grader	1	Diesel	270	0.60	0.75	162	162	8/21/2017	9/18/2017	2	130	0.03	0.07	0.01	0.01	0.01	0.00
Tamping Machine	1	Diesel	130	0.60	0.75	78	78	8/21/2017	9/18/2017	2	130	0.02	0.04	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.05**	**0.11**	**0.01**	**0.01**	**0.01**	**0.00**
P - SOE/Sheetpile																	
Crane (Crawler, 150 Ton)	1	Diesel	225	0.60	0.65	135	135	1/1/2014	4/28/2014	4	113	0.02	0.05	0.00	0.00	0.00	0.00
Pile Hammer	1	Diesel	125	0.50	0.59	63	63	1/1/2014	4/28/2014	4	102	0.01	0.02	0.00	0.00	0.00	0.00
Forklift (10000 lb)e	1	Diesel	102	0.45	0.65	46	46	1/1/2014	4/28/2014	4	113	0.01	0.02	0.00	0.00	0.00	0.00
Welding Machine a	1	Diesel	25	0.40	0.45	10	10	1/1/2014	4/28/2014	4	78	0.00	0.00	0.00	0.00	0.00	0.00
Construction Equipment Total	***4***											**0.04**	**0.10**	**0.01**	**0.01**	**0.01**	**0.00**
Misc. Equipment																	
Other Construction Equipment	1	Diesel	450	0.45	0.40	203	203	11/1/2015	1/31/2016	3	69	0.02	0.05	0.00	0.00	0.00	0.00
Other Construction Equipment	1	Diesel	395	0.45	0.40	178	178	11/1/2015	1/31/2016	3	69	0.02	0.05	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.04**	**0.10**	**0.01**	**0.01**	**0.01**	**0.00**

VIRGINIA AVENUE CSX
CONSTRUCTION EMISSIONS

Construction Dirt Handling, Hauling and TruckTrips	Units	Amount	Total Miles/hours per Trip	Total Number of Truck Trips Per month	Distance *Total Traveled Distance/Idle Time (all vehicles)* per Month	Start Date	End Date	Construction Activity Duration		Estimated Pollutant Monthly Emissions					
								Months	(4) hrs/month	CO tons/month	NOx tons/month	PM10 tons/month	PM2.5 tons/month	HC tons/month	SO_2 tons/month
F - Excavation															
Bulldozing	Hours of Activity per Day	2	Dirt			Mar-16	Apr-16	2	347			0.036	0.022		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	2	Dirt			Mar-16	Apr-16	2	277			0.029	0.017		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	5	1	108	54.2	Mar-16	Apr-16	2		0.0003	0.0004	0.0000	0.0000	0.0001	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	5	1	108	54.2	Mar-16	Apr-16	2				0.0346	0.0035		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	5	0.08	108	9.0	Mar-16	Apr-16	2		0.0001	0.0002	0.0000	0.0000	0.0000	0.0000
I - Site Work/Paving															
Bulldozing	Hours of Activity per Day	3	Dirt			Sep-16	Sep-16	1	555			0.058	0.035		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Dirt			Sep-16	Sep-16	1	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	10	1	217	108.3	Sep-16	Sep-16	1		0.0006	0.0009	0.0000	0.0000	0.0001	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	10	1	217	108.3	Sep-16	Sep-16	1				0.0693	0.0069		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	10	0.08	217	18.1	Sep-16	Sep-16	1		0.0003	0.0004	0.0000	0.0000	0.0001	0.0000
J - Site Work/Backfill															
Bulldozing	Hours of Activity per Day	6	Dirt			Aug-16	Sep-16	2	1,109			0.116	0.070		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Dirt			Aug-16	Sep-16	2	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	0	1	0	0.0	Aug-16	Sep-16	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	0	1	0	0.0	Aug-16	Sep-16	2				0.0000	0.0000		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	0	0.08	0	0.0	Aug-16	Sep-16	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
K - Subgrade/Drainage															
Bulldozing	Hours of Activity per Day	6	Dirt			Aug-16	Oct-16	3	139			0.014	0.009		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Dirt			Aug-16	Oct-16	3	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	0	1	0	0.0	Aug-16	Oct-16	3		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	0	1	0	0.0	Aug-16	Oct-16	3				0.0000	0.0000		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	0	0.08	0	0.0	Aug-16	Oct-16	3		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
O - Track Installation															
Bulldozing	Hours of Activity per Day	6	Aggregate			Aug-17	Sep-17	2	130			0.001	0.002		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Aggregate			Aug-17	Sep-17	2	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	0	1	0	0.0	Aug-17	Sep-17	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	0	1	0	0.0	Aug-17	Sep-17	2				0.0000	0.0000		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	0	0.08	0	0.0	Aug-17	Sep-17	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Virginia Avenue CSX
Construction

Construction Equipment	Number of Units	Type of Fuel	Equipment Rated HP (2) hp/hr	Average Daily Load Factor	Average Daily Utilization Rate	Average Equipment Usage of HP (2) hrs	Total Utilized Equipment HP (all units) hp/hr	Start Date	End Date	Construction Activity Duration Months	(4) hrs/month	Estimated Pollutant Monthly Emissions CO tons	NOx tons	PM10 tons	PM2.5 tons	HC tons	SO_2 tons
A - SOE/Slurry Wall																	
Crane (Crawler, 200 Ton)	1	Diesel	250	0.60	0.80	150	150	12/17/2013	4/18/2014	5	139	0.03	0.07	0.01	0.00	0.01	0.00
Crane (RT, 60 Ton)a	1	Diesel	190	0.60	0.65	114	114	12/17/2013	4/18/2014	5	113	0.02	0.05	0.00	0.00	0.00	0.00
Air Compressor (185 CFM)	1	Diesel	55	0.60	0.85	33	33	12/17/2013	4/18/2014	5	147	0.02	0.02	0.00	0.00	0.00	0.00
Generator (150 kWh)	1	Diesel	200	0.60	0.90	120	120	12/17/2013	4/18/2014	5	156	0.03	0.07	0.00	0.00	0.01	0.00
Generator (350 kWh)	1	Diesel	475	0.60	0.90	285	285	12/17/2013	4/18/2014	5	156	0.07	0.17	0.01	0.01	0.01	0.00
Slurry Plant (75 HP Pump)	1	Diesel	75	0.60	0.90	45	45	12/17/2013	4/18/2014	5	156	0.03	0.03	0.00	0.00	0.00	0.00
Construction Equipment Total	***6***											***0.20***	***0.40***	***0.03***	***0.03***	***0.03***	***0.00***
B - SOE/Soldier Beam																	
Drill Rig (Soilmec 622)	1	Diesel	410	0.60	0.80	246	246	8/13/2013	10/24/2013	3	139	0.05	0.13	0.01	0.01	0.01	0.00
Forklift (10000 lb)a	1	Diesel	105	0.45	0.55	47	47	8/13/2013	10/24/2013	3	95	0.01	0.02	0.00	0.00	0.00	0.00
Welding Machine	1	Diesel	350	0.25	0.25	88	88	8/13/2013	10/24/2013	3	43	0.01	0.01	0.00	0.00	0.00	0.00
Construction Equipment Total	***3***											***0.07***	***0.16***	***0.01***	***0.01***	***0.01***	***0.00***
C - SOE/Tieback																	
Dill Rig (Tieback)	1	Diesel	225	0.60	0.85	135	135	10/18/2013	1/8/2014	4	147	0.03	0.07	0.00	0.00	0.01	0.00
Grout Plant	1	Diesel	10	0.60	0.85	6	6	10/18/2013	1/8/2014	4	147	0.00	0.00	0.00	0.00	0.00	0.00
Forklift (10000 lb)d	1	Diesel	105	0.50	0.65	53	53	10/18/2013	1/8/2014	4	113	0.01	0.02	0.00	0.00	0.00	0.00
Construction Equipment Total	***3***											***0.04***	***0.10***	***0.01***	***0.01***	***0.01***	***0.00***
D - SOE/Lagging																	
Forklift (10000 lb)c	0	Diesel	105	0.50	0.45	53	0	10/4/2013	2/4/2014	5	78	0.00	0.00	0.00	0.00	0.00	0.00
Construction Equipment Total	***0***											**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
E - SOE/Internal Bracing																	
Forklift (10000 lb)d	0	Diesel	105	0.50	0.65	53	0	10/4/2013	2/4/2014	5	113	0.00	0.00	0.00	0.00	0.00	0.00
Welding Machine b	0	Diesel	25	0.50	0.70	13	0	10/4/2013	2/4/2014	5	121	0.00	0.00	0.00	0.00	0.00	0.00
Construction Equipment Total	***0***											**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
F - Excavation																	
Back Hoe (Cat 325 or equivalent)	1	Diesel	190	0.60	0.25	114	114	6/11/2014	11/25/2014	6	43	0.01	0.02	0.00	0.00	0.00	0.00
Track Loader (Cat 973 or equivalent)	1	Diesel	210	0.60	0.20	126	126	6/11/2014	11/25/2014	6	35	0.01	0.02	0.00	0.00	0.00	0.00
Dump Truck a	0	Diesel	400	0.25	0.65	100	0	6/11/2014	11/25/2014	6	113	0.00	0.00	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.01**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**
G - Excavation/Demolition																	
Back Hoe (Cat 325 or equivalent)	1	Diesel	190	0.60	0.25	114	114	3/19/2014	11/3/2014	9	43	0.01	0.02	0.00	0.00	0.00	0.00
Track Loader (Cat 973 or equivalent)	1	Diesel	210	0.60	0.20	126	126	3/19/2014	11/3/2014	9	35	0.01	0.02	0.00	0.00	0.00	0.00
Hoe Ram	1	Diesel	250	0.45	0.55	113	113	3/19/2014	11/3/2014	9	95	0.02	0.04	0.00	0.00	0.00	0.00
Dump Truck a	0	Diesel	400	0.25	0.65	100	0	3/19/2014	11/3/2014	9	113	0.00	0.00	0.00	0.00	0.00	0.00
Construction Equipment Total	***3***											**0.03**	**0.07**	**0.00**	**0.00**	**0.01**	**0.00**
H - Structural Concrete																	
Truck Mixer	5	Diesel	350	0.25	0.25	88	438	8/6/2014	8/24/2015	13	43	0.03	0.07	0.00	0.00	0.00	0.00
Crane (Crawler, 150 Ton)	1	Diesel	225	0.60	0.65	135	135	8/6/2014	8/24/2015	13	113	0.02	0.05	0.00	0.00	0.00	0.00
Tractor Trailer	1	Diesel	350	0.15	0.15	53	53	8/6/2014	8/24/2015	13	26	0.00	0.01	0.00	0.00	0.00	0.00
Forklift (10000 lb)b	1	Diesel	105	0.45	0.45	47	47	8/6/2014	8/24/2015	13	78	0.01	0.01	0.00	0.00	0.00	0.00

Virginia Avenue CSX
Construction

Construction Equipment	Number of Units	Type of Fuel	Equipment Rated HP (2) hp/hr	Average Daily Load Factor	Average Daily Utilization Rate	Average Equipment Usage of HP (2) hrs	Total Utilized Equipment HP (all units) hp/hr	Start Date	End Date	Construction Activity Duration Months	(4) hrs/month	Estimated Pollutant Monthly Emissions CO tons	NOx tons	PM10 tons	PM2.5 tons	HC tons	SO_2 tons
Air Compressor	1	Diesel	55	0.60	0.70	33	33	8/6/2014	8/24/2015	13	121	0.02	0.02	0.00	0.00	0.00	0.00
Construction Equipment Total	***9***											**0.08**	**0.16**	**0.01**	**0.01**	**0.01**	**0.00**
J - Site Work/Backfill																	
Roller	1	Diesel	135	0.50	0.45	68	68	2/11/2015	8/31/2015	7	78	0.01	0.02	0.00	0.00	0.00	0.00
Light Plant	1	Diesel	55	0.25	0.10	14	14	2/11/2015	8/31/2015	7	17	0.00	0.00	0.00	0.00	0.00	0.00
Motor Grader	1	Diesel	200	0.45	0.40	90	90	2/11/2015	8/31/2015	7	69	0.01	0.02	0.00	0.00	0.00	0.00
Dozer (Cat D7 or equivalent)	2	Diesel	180	0.35	0.40	63	126	2/11/2015	8/31/2015	7	69	0.01	0.03	0.00	0.00	0.00	0.00
Construction Equipment Total	***5***											**0.03**	**0.07**	**0.01**	**0.01**	**0.01**	**0.00**
K - Subgrade/Drainage																	
Roller	0	Diesel	135	0.50	0.45	68	0	2/1/2016	3/31/2016	2	78	0.00	0.00	0.00	0.00	0.00	0.00
Light Plant	0	Diesel	55	0.25	0.10	14	0	2/1/2016	3/31/2016	2	17	0.00	0.00	0.00	0.00	0.00	0.00
Motor Grader	0	Diesel	200	0.45	0.40	90	0	2/1/2016	3/31/2016	2	69	0.00	0.00	0.00	0.00	0.00	0.00
Dozer (Cat D7 or equivalent)	0	Diesel	180	0.35	0.40	63	0	2/1/2016	3/31/2016	2	69	0.00	0.00	0.00	0.00	0.00	0.00
Construction Equipment Total	***0***											**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
M - Street Decks																	
Crane (RT, 60 Ton)b	1	Diesel	190	0.60	0.75	114	114	9/10/2013	10/23/2013	2	130	0.02	0.05	0.00	0.00	0.00	0.00
Forklift (10000 lb)e	1	Diesel	102	0.45	0.65	46	46	9/10/2013	10/23/2013	2	113	0.01	0.02	0.00	0.00	0.00	0.00
Welding Machine c	1	Diesel	25	0.60	0.80	15	15	9/10/2013	10/23/2013	2	139	0.01	0.01	0.00	0.00	0.00	0.00
Construction Equipment Total	***3***											**0.04**	**0.08**	**0.01**	**0.01**	**0.01**	**0.00**
N -Dewatering																	
Dewatering Pump	1	Diesel	50	0.75	0.95	38	38	6/11/2014	2/8/2016	21	165	0.03	0.03	0.00	0.00	0.00	0.00
Construction Equipment Total	***1***											**0.03**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**
O - Track Installation																	
Ballast Grader	1	Diesel	270	0.60	0.75	162	162	11/11/2015	12/2/2015	2	130	0.03	0.07	0.01	0.01	0.01	0.00
Tamping Machine	1	Diesel	130	0.60	0.75	78	78	11/11/2015	12/2/2015	2	130	0.02	0.04	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.05**	**0.11**	**0.01**	**0.01**	**0.01**	**0.00**
Misc. Equipment																	
Other Construction Equipment	1	Diesel	450	0.45	0.40	203	203	11/1/2015	1/31/2016	3	69	0.02	0.05	0.00	0.00	0.00	0.00
Other Construction Equipment	1	Diesel	395	0.45	0.40	178	178	11/1/2015	1/31/2016	3	69	0.02	0.05	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.04**	**0.10**	**0.01**	**0.01**	**0.01**	**0.00**

VIRGINIA AVENUE CSX
CONSTRUCTION EMISSIONS

Construction Dirt Handling, Hauling and TruckTrips	Units	Amount	Total Miles/hours per Trip	Total Number of Truck Trips Per month	Distance *Total Traveled Distance/Idle Time (all vehicles)* per Month	Start Date	End Date	Construction Activity Duration		Estimated Pollutant Monthly Emissions					
								Months	(4) hrs/month	CO tons/month	NOx tons/month	PM10 tons/month	PM2.5 tons/month	HC tons/month	SO_2 tons/month
F - Excavation															
Bulldozing	Hours of Activity per Day	2	Dirt			Jun-14	Nov-14	6	43			0.005	0.003		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	2	Dirt			Jun-14	Nov-14	6	35			0.004	0.002		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	5	1	108	54.2	Jun-14	Nov-14	6		0.0003	0.0004	0.0000	0.0000	0.0001	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	5	1	108	54.2	Jun-14	Nov-14	6				0.0346	0.0035		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	5	0.08	108	9.0	Jun-14	Nov-14	6		0.0001	0.0002	0.0000	0.0000	0.0000	0.0000
G - Excavation/Demolition															
Bulldozing	Hours of Activity per Day	2	Dirt			Mar-14	Nov-14	9	43			0.005	0.003		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	2	Dirt			Mar-14	Nov-14	9	35			0.004	0.002		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	5	1	108	54.2	Mar-14	Nov-14	9		0.0003	0.0004	0.0000	0.0000	0.0001	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	5	1	108	54.2	Mar-14	Nov-14	9				0.0346	0.0035		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	5	0.08	108	9.0	Mar-14	Nov-14	9		0.0001	0.0002	0.0000	0.0000	0.0000	0.0000
J - Site Work/Backfill															
Bulldozing	Hours of Activity per Day	6	Dirt			Feb-15	Aug-15	7	139			0.014	0.009		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Dirt			Feb-15	Aug-15	7	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	0	1	0	0.0	Feb-15	Aug-15	7		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	0	1	0	0.0	Feb-15	Aug-15	7				0.0000	0.0000		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	0	0.08	0	0.0	Feb-15	Aug-15	7		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
O - Track Installation															
Bulldozing	Hours of Activity per Day	6	Aggregate			11/11/2015	12/2/2015	2	130			0.001	0.002		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Aggregate			Nov-15	Dec-15	2	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	0	1	0	0.0	Nov-15	Dec-15	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	0	1	0	0.0	Nov-15	Dec-15	2				0.0000	0.0000		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	0	0.08	0	0.0	Nov-15	Dec-15	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

VIRGINIA AVENUE CSX
CONSTRUCTION EMISSIONS

Construction Equipment	Number of Units	Type of Fuel	Equipment Rated HP (2) hp/hr	Average Daily Load Factor	Average Daily Utilization Rate	Average Equipment Usage of HP (2) hrs	Total Utilized Equipment HP (all units) hp/hr	Start Date	End Date	Construction Activity Duration Months	Construction Activity Duration (4) hrs/month	Estimated Pollutant Monthly Emissions CO tons	NOx tons	PM10 tons	PM2.5 tons	HC tons	SO_2 tons
B - SOE/Soldier Beam																	
Drill Rig (Soilmec 622)	1	Diesel	410	0.60	0.80	246	246	3/15/2016	6/1/2016	4	139	0.05	0.13	0.01	0.01	0.01	0.00
Forklift (10000 lb)a	1	Diesel	105	0.45	0.55	47	47	3/15/2016	6/1/2016	4	95	0.01	0.02	0.00	0.00	0.00	0.00
Welding Machine	1	Diesel	350	0.25	0.25	88	88	3/15/2016	6/1/2016	4	43	0.01	0.01	0.00	0.00	0.00	0.00
D - SOE/Lagging																	
Forklift (10000 lb)c	1	Diesel	105	0.50	0.45	53	53	3/30/2016	6/16/2016	4	78	0.01	0.01	0.00	0.00	0.00	0.00
Construction Equipment Total	***1***											**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**
E - SOE/Internal Bracing																	
Forklift (10000 lb)d	1	Diesel	105	0.50	0.65	53	53	3/30/2016	6/16/2016	4	113	0.01	0.02	0.00	0.00	0.00	0.00
Welding Machine b	1	Diesel	25	0.50	0.70	13	13	3/30/2016	6/16/2016	4	121	0.01	0.01	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.02**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**
F - Excavation																	
Back Hoe (Cat 325 or equivalent)	1	Diesel	190	0.60	0.25	114	114	4/20/2016	8/3/2016	5	43	0.01	0.02	0.00	0.00	0.00	0.00
Track Loader (Cat 973 or equivalent)	1	Diesel	210	0.60	0.20	126	126	4/20/2016	8/3/2016	5	35	0.01	0.02	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.01**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**
H - Structural Concrete																	
Truck Mixer	5	Diesel	350	0.25	0.25	88	438	5/5/2016	4/7/2017	12	43	0.03	0.07	0.00	0.00	0.00	0.00
Crane (Crawler, 150 Ton)	1	Diesel	225	0.60	0.65	135	135	5/5/2016	4/7/2017	12	113	0.02	0.05	0.00	0.00	0.00	0.00
Tractor Trailer	1	Diesel	350	0.15	0.15	53	53	5/5/2016	4/7/2017	12	26	0.00	0.01	0.00	0.00	0.00	0.00
Forklift (10000 lb)b	1	Diesel	105	0.45	0.45	47	47	5/5/2016	4/7/2017	12	78	0.01	0.01	0.00	0.00	0.00	0.00
Air Compressor	1	Diesel	55	0.60	0.70	33	33	5/5/2016	4/7/2017	12	121	0.02	0.02	0.00	0.00	0.00	0.00
Construction Equipment Total	***9***											**0.08**	**0.16**	**0.01**	**0.01**	**0.01**	**0.00**
I - Site Work/Paving																	
Roller	1	Diesel	135	0.50	0.45	68	68	7/1/2017	8/8/2017	2	78	0.01	0.02	0.00	0.00	0.00	0.00
Paver	1	Diesel	225	0.55	0.45	124	124	7/1/2017	8/8/2017	2	78	0.01	0.03	0.00	0.00	0.00	0.00
Light Plant	2	Diesel	55	0.25	0.10	14	28	7/1/2017	8/8/2017	2	17	0.00	0.00	0.00	0.00	0.00	0.00
Motor Grader	1	Diesel	200	0.45	0.40	90	90	7/1/2017	8/8/2017	2	69	0.01	0.02	0.00	0.00	0.00	0.00
Dozer (Cat D7 or equivalent)	1	Diesel	180	0.35	0.40	63	63	7/1/2017	8/8/2017	2	69	0.01	0.02	0.00	0.00	0.00	0.00
Construction Equipment Total	***6***											**0.04**	**0.09**	**0.01**	**0.01**	**0.01**	**0.00**
J - Site Work/Backfill																	
Roller	1	Diesel	135	0.50	0.45	68	68	9/6/2016	4/18/2017	8	78	0.01	0.02	0.00	0.00	0.00	0.00
Light Plant	1	Diesel	55	0.25	0.10	14	14	9/6/2016	4/18/2017	8	17	0.00	0.00	0.00	0.00	0.00	0.00
Motor Grader	1	Diesel	200	0.45	0.40	90	90	9/6/2016	4/18/2017	8	69	0.01	0.02	0.00	0.00	0.00	0.00
Dozer (Cat D7 or equivalent)	2	Diesel	180	0.35	0.40	63	126	9/6/2016	4/18/2017	8	69	0.01	0.03	0.00	0.00	0.00	0.00
Construction Equipment Total	***5***											**0.03**	**0.07**	**0.01**	**0.01**	**0.01**	**0.00**
K - Subgrade/Drainage																	
Roller	1	Diesel	135	0.50	0.45	68	68	4/1/2017	6/5/2017	3	78	0.01	0.02	0.00	0.00	0.00	0.00
Light Plant	1	Diesel	55	0.25	0.10	14	14	4/1/2017	6/5/2017	3	17	0.00	0.00	0.00	0.00	0.00	0.00
Motor Grader	1	Diesel	200	0.45	0.40	90	90	4/1/2017	6/5/2017	3	69	0.01	0.02	0.00	0.00	0.00	0.00
Dozer (Cat D7 or equivalent)	2	Diesel	180	0.35	0.40	63	126	4/1/2017	6/5/2017	3	69	0.01	0.03	0.00	0.00	0.00	0.00
Construction Equipment Total	***5***											**0.03**	**0.07**	**0.01**	**0.01**	**0.01**	**0.00**

VIRGINIA AVENUE CSX
CONSTRUCTION EMISSIONS

Construction Equipment	Number of Units	Type of Fuel	Equipment Rated HP (2) hp/hr	Average Daily Load Factor	Average Daily Utilization Rate	Average Equipment Usage of HP (2) hrs	Total Utilized Equipment HP (all units) hp/hr	Start Date	End Date	Construction Activity Duration Months	(4) hrs/month	Estimated Pollutant Monthly Emissions CO tons	NOx tons	PM10 tons	PM2.5 tons	HC tons	SO_2 tons
M - Street Decks																	
Crane (RT, 60 Ton)b	1	Diesel	190	0.60	0.75	114	114	9/15/2016	10/25/2016	2	130	0.02	0.05	0.00	0.00	0.00	0.00
Forklift (10000 lb)e	1	Diesel	102	0.45	0.65	46	46	9/15/2016	10/25/2016	2	113	0.01	0.02	0.00	0.00	0.00	0.00
Welding Machine c	1	Diesel	25	0.60	0.80	15	15	9/15/2016	10/25/2016	2	139	0.01	0.01	0.00	0.00	0.00	0.00
Construction Equipment Total	***3***											**0.04**	**0.08**	**0.01**	**0.01**	**0.01**	**0.00**
N -Dewatering																	
Dewatering Pump	1	Diesel	50	0.75	0.95	38	38	2/9/2016	4/18/2017	15	165	0.03	0.03	0.00	0.00	0.00	0.00
Construction Equipment Total	***1***											**0.03**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**
O - Track Installation																	
Ballast Grader	1	Diesel	270	0.60	0.75	162	162	9/18/2017	10/9/2017	2	130	0.03	0.07	0.01	0.01	0.01	0.00
Tamping Machine	1	Diesel	130	0.60	0.75	78	78	9/18/2017	10/9/2017	2	130	0.02	0.04	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.05**	**0.11**	**0.01**	**0.01**	**0.01**	**0.00**
P - SOE/Sheetpile																	
Crane (Crawler, 150 Ton)	1	Diesel	225	0.60	0.65	135	135	5/5/2014	10/2/2014	6	113	0.02	0.05	0.00	0.00	0.00	0.00
Pile Hammer	1	Diesel	125	0.50	0.59	63	63	5/5/2014	10/2/2014	6	102	0.01	0.02	0.00	0.00	0.00	0.00
Forklift (10000 lb)e	1	Diesel	102	0.45	0.65	46	46	5/5/2014	10/2/2014	6	113	0.01	0.02	0.00	0.00	0.00	0.00
Welding Machine a	1	Diesel	25	0.40	0.45	10	10	5/5/2014	10/2/2014	6	78	0.00	0.00	0.00	0.00	0.00	0.00
Construction Equipment Total	***4***											**0.04**	**0.10**	**0.01**	**0.01**	**0.01**	**0.00**
Misc. Equipment																	
Other Construction Equipment	1	Diesel	450	0.45	0.40	203	203	11/1/2015	1/31/2016	3	69	0.02	0.05	0.00	0.00	0.00	0.00
Other Construction Equipment	1	Diesel	395	0.45	0.40	178	178	11/1/2015	1/31/2016	3	69	0.02	0.05	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.04**	**0.10**	**0.01**	**0.01**	**0.01**	**0.00**

VIRGINIA AVENUE CSX
CONSTRUCTION EMISSIONS

Construction Dirt Handling, Hauling and TruckTrips	Units	Amount	Total Miles/hours per Trip	Total Number of Truck Trips Per month	Distance *Total Traveled Distance/Idle Time (all vehicles)* per Month	Start Date	End Date	Construction Activity Duration		Estimated Pollutant Monthly Emissions					
								Months	(4) hrs/month	CO tons/month	NOx tons/month	PM10 tons/month	PM2.5 tons/month	HC tons/month	SO_2 tons/month
F - Excavation															
Bulldozing	Hours of Activity per Day	2	Dirt			Apr-16	Aug-16	5	43			0.005	0.003		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	2	Dirt			Apr-16	Aug-16	5	35			0.004	0.002		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	5	1	108	54.2	Apr-16	Aug-16	5		0.0003	0.0004	0.0000	0.0000	0.0001	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	5	1	108	54.2	Apr-16	Aug-16	5				0.0346	0.0035		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	5	0.08	108	9.0	Apr-16	Aug-16	5		0.0001	0.0002	0.0000	0.0000	0.0000	0.0000
I - Site Work/Paving															
Bulldozing	Hours of Activity per Day	3	Dirt			Jul-17	Aug-17	2	69			0.007	0.004		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Dirt			Jul-17	Aug-17	2	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	10	1	217	108.3	Jul-17	Aug-17	2		0.0006	0.0009	0.0000	0.0000	0.0001	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	10	1	217	108.3	Jul-17	Aug-17	2				0.0693	0.0069		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	10	0.08	217	18.1	Jul-17	Aug-17	2		0.0003	0.0004	0.0000	0.0000	0.0001	0.0000
J - Site Work/Backfill															
Bulldozing	Hours of Activity per Day	6	Dirt			Sep-16	Apr-17	8	139			0.014	0.009		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Dirt			Sep-16	Apr-17	8	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	0	1	0	0.0	Sep-16	Apr-17	8		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	0	1	0	0.0	Sep-16	Apr-17	8				0.0000	0.0000		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	0	0.08	0	0.0	Sep-16	Apr-17	8		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
K - Subgrade/Drainage															
Bulldozing	Hours of Activity per Day	6	Dirt			Apr-17	Jun-17	3	139			0.014	0.009		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Dirt			Apr-17	Jun-17	3	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	0	1	0	0.0	Apr-17	Jun-17	3		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	0	1	0	0.0	Apr-17	Jun-17	3				0.0000	0.0000		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	0	0.08	0	0.0	Apr-17	Jun-17	3		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
O - Track Installation															
Bulldozing	Hours of Activity per Day	6	Aggregate			9/18/2017	10/9/2017	2	130			0.001	0.002		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Aggregate			Sep-17	Oct-17	2	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	0	1	0	0.0	Sep-17	Oct-17	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	0	1	0	0.0	Sep-17	Oct-17	2				0.0000	0.0000		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	0	0.08	0	0.0	Sep-17	Oct-17	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

VIRGINIA AVENUE CSX
CONSTRUCTION EMISSIONS

Construction Equipment	Number of Units	Type of Fuel	Equipment Rated HP (2) hp/hr	Average Daily Load Factor	Average Daily Utilization Rate	Average Equipment Usage of HP (2) hrs	Total Utilized Equipment HP (all units) hp/hr	Start Date	End Date	Construction Activity Duration Months	Construction Activity Duration (4) hrs/month	Estimated Pollutant Monthly Emissions CO tons	NOx tons	PM10 tons	PM2.5 tons	HC tons	SO_2 tons
A - SOE/Slurry Wall																	
Crane (Crawler, 200 Ton)	1	Diesel	250	0.60	0.80	150	150	4/18/2014	8/7/2014	5	139	0.03	0.07	0.01	0.00	0.01	0.00
Crane (RT, 60 Ton)a	1	Diesel	190	0.60	0.65	114	114	4/18/2014	8/7/2014	5	113	0.02	0.05	0.00	0.00	0.00	0.00
Air Compressor (185 CFM)	1	Diesel	55	0.60	0.85	33	33	4/18/2014	8/7/2014	5	147	0.02	0.02	0.00	0.00	0.00	0.00
Generator (150 kWh)	1	Diesel	200	0.60	0.90	120	120	4/18/2014	8/7/2014	5	156	0.03	0.07	0.00	0.00	0.01	0.00
Generator (350 kWh)	1	Diesel	475	0.60	0.90	285	285	4/18/2014	8/7/2014	5	156	0.07	0.17	0.01	0.01	0.01	0.00
Slurry Plant (75 HP Pump)	1	Diesel	75	0.60	0.90	45	45	4/18/2014	8/7/2014	5	156	0.03	0.03	0.00	0.00	0.00	0.00
Construction Equipment Total	***6***											***0.20***	***0.40***	***0.03***	***0.03***	***0.03***	***0.00***
B - SOE/Soldier Beam																	
Drill Rig (Soilmec 622)	1	Diesel	410	0.60	0.80	246	246	10/24/2013	2/24/2014	5	139	0.05	0.13	0.01	0.01	0.01	0.00
Forklift (10000 lb)a	1	Diesel	105	0.45	0.55	47	47	10/24/2013	2/24/2014	5	95	0.01	0.02	0.00	0.00	0.00	0.00
Welding Machine	1	Diesel	350	0.25	0.25	88	88	10/24/2013	2/24/2014	5	43	0.01	0.01	0.00	0.00	0.00	0.00
Construction Equipment Total	***3***											***0.07***	***0.16***	***0.01***	***0.01***	***0.01***	***0.00***
C - SOE/Tieback																	
Dill Rig (Tieback)	1	Diesel	225	0.60	0.85	135	135	1/8/2014	2/16/2014	2	147	0.03	0.07	0.00	0.00	0.01	0.00
Grout Plant	1	Diesel	10	0.60	0.85	6	6	1/8/2014	2/16/2014	2	147	0.00	0.00	0.00	0.00	0.00	0.00
Forklift (10000 lb)d	1	Diesel	105	0.50	0.65	53	53	1/8/2014	2/16/2014	2	113	0.01	0.02	0.00	0.00	0.00	0.00
Construction Equipment Total	***3***											***0.04***	***0.10***	***0.01***	***0.01***	***0.01***	***0.00***
F - Excavation																	
Back Hoe (Cat 325 or equivalent)	1	Diesel	190	0.60	0.25	114	114	3/19/2015	6/16/2015	4	43	0.01	0.02	0.00	0.00	0.00	0.00
Track Loader (Cat 973 or equivalent)	1	Diesel	210	0.60	0.20	126	126	3/19/2015	6/16/2015	4	35	0.01	0.02	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.01**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**
G - Excavation/Demolition																	
Back Hoe (Cat 325 or equivalent)	1	Diesel	190	0.60	0.25	114	114	11/5/2014	4/9/2015	6	43	0.01	0.02	0.00	0.00	0.00	0.00
Track Loader (Cat 973 or equivalent)	1	Diesel	210	0.60	0.20	126	126	11/5/2014	4/9/2015	6	35	0.01	0.02	0.00	0.00	0.00	0.00
Hoe Ram	1	Diesel	250	0.45	0.55	113	113	11/5/2014	4/9/2015	6	95	0.02	0.04	0.00	0.00	0.00	0.00
Construction Equipment Total	***3***											**0.03**	**0.07**	**0.00**	**0.00**	**0.01**	**0.00**
H - Structural Concrete																	
Truck Mixer	5	Diesel	350	0.25	0.25	88	438	4/30/2015	11/30/2015	8	43	0.03	0.07	0.00	0.00	0.00	0.00
Crane (Crawler, 150 Ton)	1	Diesel	225	0.60	0.65	135	135	4/30/2015	11/30/2015	8	113	0.02	0.05	0.00	0.00	0.00	0.00
Tractor Trailer	1	Diesel	350	0.15	0.15	53	53	4/30/2015	11/30/2015	8	26	0.00	0.01	0.00	0.00	0.00	0.00
Forklift (10000 lb)b	1	Diesel	105	0.45	0.45	47	47	4/30/2015	11/30/2015	8	78	0.01	0.01	0.00	0.00	0.00	0.00
Air Compressor	1	Diesel	55	0.60	0.70	33	33	4/30/2015	11/30/2015	8	121	0.02	0.02	0.00	0.00	0.00	0.00
Construction Equipment Total	***9***											**0.08**	**0.16**	**0.01**	**0.01**	**0.01**	**0.00**

VIRGINIA AVENUE CSX
CONSTRUCTION EMISSIONS

Construction Equipment	Number of Units	Type of Fuel	Equipment Rated HP (2) hp/hr	Average Daily Load Factor	Average Daily Utilization Rate	Average Equipment Usage of HP (2) hrs	Total Utilized Equipment HP (all units) hp/hr	Start Date	End Date	Construction Activity Duration Months	(4) hrs/month	Estimated Pollutant Monthly Emissions CO tons	NOx tons	PM10 tons	PM2.5 tons	HC tons	SO_2 tons
J - Site Work/Backfill																	
Roller	1	Diesel	135	0.50	0.45	68	68	11/30/2015	1/4/2016	3	78	0.01	0.02	0.00	0.00	0.00	0.00
Light Plant	1	Diesel	55	0.25	0.10	14	14	11/30/2015	1/4/2016	3	17	0.00	0.00	0.00	0.00	0.00	0.00
Motor Grader	1	Diesel	200	0.45	0.40	90	90	11/30/2015	1/4/2016	3	69	0.01	0.02	0.00	0.00	0.00	0.00
Dozer (Cat D7 or equivalent)	2	Diesel	180	0.35	0.40	63	126	11/30/2015	1/4/2016	3	69	0.01	0.03	0.00	0.00	0.00	0.00
Construction Equipment Total	***5***											**0.03**	**0.07**	**0.01**	**0.01**	**0.01**	**0.00**
M - Street Decks																	
Crane (RT, 60 Ton)b	1	Diesel	190	0.60	0.75	114	114	5/30/2014	10/30/2014	6	130	0.02	0.05	0.00	0.00	0.00	0.00
Forklift (10000 lb)e	1	Diesel	102	0.45	0.65	46	46	5/30/2014	10/30/2014	6	113	0.01	0.02	0.00	0.00	0.00	0.00
Welding Machine c	1	Diesel	25	0.60	0.80	15	15	5/30/2014	10/30/2014	6	139	0.01	0.01	0.00	0.00	0.00	0.00
Construction Equipment Total	***3***											**0.04**	**0.08**	**0.01**	**0.01**	**0.01**	**0.00**
N -Dewatering																	
Dewatering Pump	1	Diesel	50	0.75	0.95	38	38	3/19/2015	2/8/2016	12	165	0.03	0.03	0.00	0.00	0.00	0.00
Construction Equipment Total	***1***											**0.03**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**
O - Track Installation																	
Ballast Grader	1	Diesel	270	0.60	0.75	162	162	12/2/2015	1/1/2016	2	130	0.03	0.07	0.01	0.01	0.01	0.00
Tamping Machine	1	Diesel	130	0.60	0.75	78	78	12/2/2015	1/1/2016	2	130	0.02	0.04	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.05**	**0.11**	**0.01**	**0.01**	**0.01**	**0.00**
Misc. Equipment																	
Other Construction Equipment	1	Diesel	450	0.45	0.40	203	203	11/1/2015	1/31/2016	3	69	0.02	0.05	0.00	0.00	0.00	0.00
Other Construction Equipment	1	Diesel	395	0.45	0.40	178	178	11/1/2015	1/31/2016	3	69	0.02	0.05	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.04**	**0.10**	**0.01**	**0.01**	**0.01**	**0.00**

VIRGINIA AVENUE CSX
CONSTRUCTION EMISSIONS

Construction Dirt Handling, Hauling and TruckTrips	Units	Amount	Total Miles/hours per Trip	Total Number of Truck Trips Per month	Distance *Total Traveled Distance/Idle Time (all vehicles)* per Month	Start Date	End Date	Construction Activity Duration		Estimated Pollutant Monthly Emissions					
								Months	(4) hrs/month	CO tons/month	NOx tons/month	PM10 tons/month	PM2.5 tons/month	HC tons/month	SO_2 tons/month
F - Excavation															
Bulldozing	Hours of Activity per Day	2	Dirt			Mar-15	Jun-15	4	43			0.005	0.003		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	2	Dirt			Mar-15	Jun-15	4	35			0.004	0.002		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	5	1	108	54.2	Mar-15	Jun-15	4		0.0003	0.0004	0.0000	0.0000	0.0001	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	5	1	108	54.2	Mar-15	Jun-15	4				0.0346	0.0035		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	5	0.08	108	9.0	Mar-15	Jun-15	4		0.0001	0.0002	0.0000	0.0000	0.0000	0.0000
G - Excavation/Demolition															
Bulldozing	Hours of Activity per Day	2	Dirt			Nov-14	Apr-15	6	43			0.005	0.003		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	2	Dirt			Nov-14	Apr-15	6	35			0.004	0.002		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	5	1	108	54.2	Nov-14	Apr-15	6		0.0003	0.0004	0.0000	0.0000	0.0001	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	5	1	108	54.2	Nov-14	Apr-15	6				0.0346	0.0035		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	5	0.08	108	9.0	Nov-14	Apr-15	6		0.0001	0.0002	0.0000	0.0000	0.0000	0.0000
J - Site Work/Backfill															
Bulldozing	Hours of Activity per Day	6	Dirt			Nov-15	Jan-16	3	139			0.014	0.009		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Dirt			Nov-15	Jan-16	3	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	0	1	0	0.0	Nov-15	Jan-16	3		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	0	1	0	0.0	Nov-15	Jan-16	3				0.0000	0.0000		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	0	0.08	0	0.0	Nov-15	Jan-16	3		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
O - Track Installation															
Bulldozing	Hours of Activity per Day	6	Aggregate			Dec-15	Jan-16	2	130			0.001	0.002		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Aggregate			Dec-15	Jan-16	2	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	0	1	0	0.0	Dec-15	Jan-16	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	0	1	0	0.0	Dec-15	Jan-16	2				0.0000	0.0000		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	0	0.08	0	0.0	Dec-15	Jan-16	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

VIRGINIA AVENUE CSX
CONSTRUCTION EMISSIONS

Construction Equipment	Number of Units	Type of Fuel	Equipment Rated HP (2) hp/hr	Average Daily Load Factor	Average Daily Utilization Rate	Average Equipment Usage of HP (2) hrs	Total Utilized Equipment HP (all units) hp/hr	Start Date	End Date	Construction Activity Duration Months	(4) hrs/month	Estimated Pollutant Monthly Emissions CO tons	NOx tons	PM10 tons	PM2.5 tons	HC tons	SO_2 tons
B - SOE/Soldier Beam																	
Drill Rig (Soilmec 622)	1	Diesel	410	0.60	0.80	246	246	6/1/2016	9/15/2016	4	139	0.05	0.13	0.01	0.01	0.01	0.00
Forklift (10000 lb)a	1	Diesel	105	0.45	0.55	47	47	6/1/2016	9/15/2016	4	95	0.01	0.02	0.00	0.00	0.00	0.00
Welding Machine	1	Diesel	350	0.25	0.25	88	88	6/1/2016	9/15/2016	4	43	0.01	0.01	0.00	0.00	0.00	0.00
Construction Equipment Total	***3***											***0.07***	***0.16***	***0.01***	***0.01***	***0.01***	***0.00***
D - SOE/Lagging																	
Forklift (10000 lb)c	1	Diesel	105	0.50	0.45	53	53	6/16/2016	9/30/2016	4	78	0.01	0.01	0.00	0.00	0.00	0.00
Construction Equipment Total	***1***											**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**
E - SOE/Internal Bracing																	
Forklift (10000 lb)d	1	Diesel	105	0.50	0.65	53	53	6/16/2016	9/30/2016	4	113	0.01	0.02	0.00	0.00	0.00	0.00
Welding Machine b	1	Diesel	25	0.50	0.70	13	13	6/16/2016	9/30/2016	4	121	0.01	0.01	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.02**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**
F - Excavation																	
Back Hoe (Cat 325 or equivalent)	1	Diesel	190	0.60	0.25	114	114	2/15/2016	11/18/2016	10	43	0.01	0.02	0.00	0.00	0.00	0.00
Track Loader (Cat 973 or equivalent)	1	Diesel	210	0.60	0.20	126	126	2/15/2016	11/18/2016	10	35	0.01	0.02	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.01**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**
H - Structural Concrete																	
Truck Mixer	5	Diesel	350	0.25	0.25	88	438	1/19/2017	9/25/2017	9	43	0.03	0.07	0.00	0.00	0.00	0.00
Crane (Crawler, 150 Ton)	1	Diesel	225	0.60	0.65	135	135	1/19/2017	9/25/2017	9	113	0.02	0.05	0.00	0.00	0.00	0.00
Tractor Trailer	1	Diesel	350	0.15	0.15	53	53	1/19/2017	9/25/2017	9	26	0.00	0.01	0.00	0.00	0.00	0.00
Forklift (10000 lb)b	1	Diesel	105	0.45	0.45	47	47	1/19/2017	9/25/2017	9	78	0.01	0.01	0.00	0.00	0.00	0.00
Air Compressor	1	Diesel	55	0.60	0.70	33	33	1/19/2017	9/25/2017	9	121	0.02	0.02	0.00	0.00	0.00	0.00
Construction Equipment Total	***9***											**0.08**	**0.16**	**0.01**	**0.01**	**0.01**	**0.00**
I - Site Work/Paving																	
Roller	1	Diesel	135	0.50	0.45	68	68	12/8/2017	12/15/2017	1	78	0.01	0.02	0.00	0.00	0.00	0.00
Paver	1	Diesel	225	0.55	0.45	124	124	12/8/2017	12/15/2017	1	78	0.01	0.03	0.00	0.00	0.00	0.00
Light Plant	2	Diesel	55	0.25	0.10	14	28	12/8/2017	12/15/2017	1	17	0.00	0.00	0.00	0.00	0.00	0.00
Motor Grader	1	Diesel	200	0.45	0.40	90	90	12/8/2017	12/15/2017	1	69	0.01	0.02	0.00	0.00	0.00	0.00
Dozer (Cat D7 or equivalent)	1	Diesel	180	0.35	0.40	63	63	12/8/2017	12/15/2017	1	69	0.01	0.02	0.00	0.00	0.00	0.00
Construction Equipment Total	***6***											**0.04**	**0.09**	**0.01**	**0.01**	**0.01**	**0.00**
J - Site Work/Backfill																	
Roller	1	Diesel	135	0.50	0.45	68	68	6/20/2017	10/3/2017	5	78	0.01	0.02	0.00	0.00	0.00	0.00
Light Plant	1	Diesel	55	0.25	0.10	14	14	6/20/2017	10/3/2017	5	17	0.00	0.00	0.00	0.00	0.00	0.00
Motor Grader	1	Diesel	200	0.45	0.40	90	90	6/20/2017	10/3/2017	5	69	0.01	0.02	0.00	0.00	0.00	0.00
Dozer (Cat D7 or equivalent)	2	Diesel	180	0.35	0.40	63	126	6/20/2017	10/3/2017	5	69	0.01	0.03	0.00	0.00	0.00	0.00
Construction Equipment Total	***5***											**0.03**	**0.07**	**0.01**	**0.01**	**0.01**	**0.00**
K - Subgrade/Drainage																	
Roller	1	Diesel	135	0.50	0.45	68	68	10/19/2017	12/9/2017	3	78	0.01	0.02	0.00	0.00	0.00	0.00
Light Plant	1	Diesel	55	0.25	0.10	14	14	10/19/2017	12/9/2017	3	17	0.00	0.00	0.00	0.00	0.00	0.00
Motor Grader	1	Diesel	200	0.45	0.40	90	90	10/19/2017	12/9/2017	3	69	0.01	0.02	0.00	0.00	0.00	0.00
Dozer (Cat D7 or equivalent)	2	Diesel	180	0.35	0.40	63	126	10/19/2017	12/9/2017	3	69	0.01	0.03	0.00	0.00	0.00	0.00

VIRGINIA AVENUE CSX
CONSTRUCTION EMISSIONS

Construction Equipment	Number of Units	Type of Fuel	Equipment Rated HP (2) hp/hr	Average Daily Load Factor	Average Daily Utilization Rate	Average Equipment Usage of HP (2) hrs	Total Utilized Equipment HP (all units) hp/hr	Start Date	End Date	Construction Activity Duration Months	(4) hrs/month	Estimated Pollutant Monthly Emissions CO tons	NOx tons	PM10 tons	PM2.5 tons	HC tons	SO_2 tons
Construction Equipment Total	***5***											**0.03**	**0.07**	**0.01**	**0.01**	**0.01**	**0.00**
M - Street Decks																	
Crane (RT, 60 Ton)b	1	Diesel	190	0.60	0.75	114	114	9/15/2017	10/19/2017	2	130	0.02	0.05	0.00	0.00	0.00	0.00
Forklift (10000 lb)e	1	Diesel	102	0.45	0.65	46	46	9/15/2017	10/19/2017	2	113	0.01	0.02	0.00	0.00	0.00	0.00
Welding Machine c	1	Diesel	25	0.60	0.80	15	15	9/15/2017	10/19/2017	2	139	0.01	0.01	0.00	0.00	0.00	0.00
Construction Equipment Total	***3***											**0.04**	**0.08**	**0.01**	**0.01**	**0.01**	**0.00**
N -Dewatering																	
Dewatering Pump	1	Diesel	50	0.75	0.95	38	38	2/9/2016	10/3/2017	21	165	0.03	0.03	0.00	0.00	0.00	0.00
Construction Equipment Total	***1***											**0.03**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**
O - Track Installation																	
Ballast Grader	1	Diesel	270	0.60	0.75	162	162	10/9/2017	11/8/2017	2	130	0.03	0.07	0.01	0.01	0.01	0.00
Tamping Machine	1	Diesel	130	0.60	0.75	78	78	10/9/2017	11/8/2017	2	130	0.02	0.04	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.05**	**0.11**	**0.01**	**0.01**	**0.01**	**0.00**
P - SOE/Sheetpile																	
Crane (Crawler, 150 Ton)	1	Diesel	225	0.60	0.65	135	135	10/2/2014	1/8/2015	4	113	0.02	0.05	0.00	0.00	0.00	0.00
Pile Hammer	1	Diesel	125	0.50	0.59	63	63	10/2/2014	1/8/2015	4	102	0.01	0.02	0.00	0.00	0.00	0.00
Forklift (10000 lb)e	1	Diesel	102	0.45	0.65	46	46	10/2/2014	1/8/2015	4	113	0.01	0.02	0.00	0.00	0.00	0.00
Welding Machine a	1	Diesel	25	0.40	0.45	10	10	10/2/2014	1/8/2015	4	78	0.00	0.00	0.00	0.00	0.00	0.00
Construction Equipment Total	***4***											**0.04**	**0.10**	**0.01**	**0.01**	**0.01**	**0.00**
Misc. Equipment																	
Other Construction Equipment	1	Diesel	450	0.45	0.40	203	203	11/1/2015	1/31/2016	3	69	0.02	0.05	0.00	0.00	0.00	0.00
Other Construction Equipment	1	Diesel	395	0.45	0.40	178	178	11/1/2015	1/31/2016	3	69	0.02	0.05	0.00	0.00	0.00	0.00
Construction Equipment Total	***2***											**0.04**	**0.10**	**0.01**	**0.01**	**0.01**	**0.00**

VIRGINIA AVENUE CSX
CONSTRUCTION EMISSIONS

Construction Dirt Handling, Hauling and TruckTrips	Units	Amount	Total Miles/hours per Trip	Total Number of Truck Trips Per month	Distance *Total Traveled Distance/Idle Time (all vehicles)* per Month	Start Date	End Date	Construction Activity Duration		Estimated Pollutant Monthly Emissions					
								Months	(4) hrs/month	CO tons/month	NOx tons/month	PM10 tons/month	PM2.5 tons/month	HC tons/month	SO_2 tons/month
F - Excavation															
Bulldozing	Hours of Activity per Day	2	Dirt			Feb-16	Nov-16	10	43			0.005	0.003		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	2	Dirt			Feb-16	Nov-16	10	35			0.004	0.002		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	5	1	108	54.2	Feb-16	Nov-16	10		0.0003	0.0004	0.0000	0.0000	0.0001	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	5	1	108	54.2	Feb-16	Nov-16	10				0.0346	0.0035		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	5	0.08	108	9.0	Feb-16	Nov-16	10		0.0001	0.0002	0.0000	0.0000	0.0000	0.0000
I - Site Work/Paving															
Bulldozing	Hours of Activity per Day	3	Dirt			Dec-17	Dec-17	1	69			0.007	0.004		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Dirt			Dec-17	Dec-17	1	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	10	1	217	108.3	Dec-17	Dec-17	1		0.0006	0.0009	0.0000	0.0000	0.0001	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	10	1	217	108.3	Dec-17	Dec-17	1				0.0693	0.0069		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	10	0.08	217	18.1	Dec-17	Dec-17	1		0.0003	0.0004	0.0000	0.0000	0.0001	0.0000
J - Site Work/Backfill															
Bulldozing	Hours of Activity per Day	6	Dirt			Jun-17	Oct-17	5	139			0.014	0.009		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Dirt			Jun-17	Oct-17	5	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	0	1	0	0.0	Jun-17	Oct-17	5		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	0	1	0	0.0	Jun-17	Oct-17	5				0.0000	0.0000		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	0	0.08	0	0.0	Jun-17	Oct-17	5		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
K - Subgrade/Drainage															
Bulldozing	Hours of Activity per Day	6	Dirt			Oct-17	Dec-17	3	139			0.014	0.009		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Dirt			Oct-17	Dec-17	3	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	0	1	0	0.0	Oct-17	Dec-17	3		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	0	1	0	0.0	Oct-17	Dec-17	3				0.0000	0.0000		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	0	0.08	0	0.0	Oct-17	Dec-17	3		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
O - Track Installation															
Bulldozing	Hours of Activity per Day	6	Aggregate			Oct-17	Nov-17	2	130			0.001	0.002		
Spoils / Topsoil removal (Excavation)	Hours of Activity per Day	0	Aggregate			Oct-17	Nov-17	2	0			0.000	0.000		
Truck Exhaust, (g/veh-mile) - 5 mph - on site	Number of Vehicles per Day	0	1	0	0.0	Oct-17	Nov-17	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Truck Fugitive Dust, (g/veh-mile)	Number of Vehicles per Day	0	1	0	0.0	Oct-17	Nov-17	2				0.0000	0.0000		
Truck Idling, (average per truck) (assuming 2.5 mph)	Number of Vehicles per Day	0	0.08	0	0.0	Oct-17	Nov-17	2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Appendix E

Noise Assessment Report

NOISE ASSESSMENT REPORT

Virginia Avenue Tunnel Reconstruction Project
Washington, D.C.

Prepared by:
Environmental Acoustics
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June 2013

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1. Executive Summary

A study was undertaken to assess noise impacts from the four alternatives under consideration for the Virginia Avenue Tunnel Project (the Project). The reconstruction of the Virginia Avenue Tunnel has the potential to increase noise levels at sensitive land uses near the area where construction will take place (the Project Area). The study evaluated three sources of noise for the four Project alternatives under consideration: (1) noise from train operations (2) noise from construction, and (3) noise from traffic reconfiguration. The Federal Railroad Administration (FRA) relies upon the Federal Transit Administration (FTA) noise and vibration impact assessment procedures. The methodology determined to be the most appropriate was the noise and vibration model based on the Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment manual developed for the Chicago Rail Efficiency And Transportation Efficiency (CREATE) projects. Therefore, the study utilized the methodology, procedures and guidelines outlined in the CREATE Noise and Vibration Assessment Methodology (December 2007). For noise analyses associated with traffic detours and street closures during construction, the Federal Highway Administration's Traffic Noise Model (FHWA TNM) was used. Construction noise evaluations were conducted for the major construction activities using FHWA Roadway Construction Noise Model (RCNM). Measurements were taken at a number of locations to establish existing noise levels. The neighborhood in the vicinity of the Project Area currently has high levels of noise and is classified as a "very noisy urban residential area" under the CREATE manual. Noise levels were predicted for each of the three 'build' alternatives to determine whether the Project would cause any noise impacts.

The key conclusions from the study are as follows:

- **Train Noise**. For all three 'build' alternatives, future noise from train operations was not predicted to exceed the impact criteria as outlined in the CREATE manual. Total noise levels were predicted to increase by 1-2 dB(A), levels which are below the impact threshold for increase in cumulative noise exposure. In addition, such increases are not perceived by humans. Therefore, under none of the three 'build' alternatives are future train operations expected to perceptibly or adversely increase existing noise levels.
- **Construction Noise**. For all three 'build' alternatives, the predicted sound levels will exceed the FTA construction noise criteria. Several construction noise control measures are suggested in this report. In addition, the driving of sheet piling under Alternative 4 will not be conducted until after 8:30 am and will be discontinued by 4:30 pm.
- **Traffic Noise**. Normal traffic growth can be expected to generally increase noise levels by up to 1 dB in the vicinity of the Project Area. Such an increase is not discernible to humans. Based on the analysis, none of the three 'build' alternatives for the Project are expected to perceptibly or adversely increase existing traffic noise levels.

2. Introduction and Project Description

2.1 Introduction

The purpose of this study is to assess noise impacts from the Virginia Avenue Tunnel Project. The reconstruction of the Virginia Avenue Tunnel has the potential to increase noise levels at sensitive land uses near the area where construction will take place (the Project Area). The study evaluated three sources of noise under the four alternatives under consideration: (1) noise train operations, (2) noise from construction, (3) noise from vehicle traffic reconfiguration. Whether an increase in noise generated from the construction and operation of trains is perceptible depends on the relationship between noise generated by the project relative to existing community noise levels. The following analyses describe the existing noise levels, estimate project-related levels, and then determine if the Project would cause any impacts.

The Federal Railroad Administration (FRA) relies upon the Federal Transit Administration (FTA) noise and vibration impact assessment procedures. The methodology determined to be the most appropriate was the noise and vibration model based on the Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment manual developed for the Chicago Rail Efficiency And Transportation Efficiency (CREATE) projects. Therefore, the study utilized the methodology, procedures and guidelines outlined in the CREATE Noise and Vibration Assessment Methodology (December 2007).

2.2 Project Description

CSX Transportation, Inc. (CSX) is proposing to reconstruct the Virginia Avenue Tunnel. As shown in Figure 1, the tunnel is located in the Capitol Hill neighborhood of the District of Columbia beneath eastbound Virginia Avenue SE from 2nd Street SE to 9th Street SE, Virginia Avenue Park and the 11th Street Bridge right-of-way between 9th and 11th Streets SE, and is aligned on the south side of Interstate 695 (I-695). The tunnel portals are located a short distance west of 2nd Street SE and a short distance east of 11th Street SE. CSX also owns or has easements for the rail lines immediately east and west of the tunnel. The tunnel and rail lines running through the District are part of CSX's eastern seaboard freight rail corridor, which connects Mid-Atlantic and Midwest states.

The CSX proposal includes the complete reconstruction of the tunnel, which was built over 100 years ago. In addition to its age, the tunnel is also a bottleneck to the freight rail network due to its single-track configuration and a vertical clearance that does not allow for double-stack intermodal container freight trains. The Project will transform the tunnel to a two-track configuration, matching the number of tracks immediately east and west of the tunnel, and provide the minimum 21 feet of vertical clearance to allow double-stack intermodal container freight train operations. This will allow more efficient freight movement, especially in light of expected increases in freight volume.

Reconstructing the tunnel to allow double-stack intermodal container freight trains would require lowering the grade below the rail line's New Jersey Avenue SE Overpass to provide the 21-foot minimum clearance.

The following alternatives are being considered for the Project:

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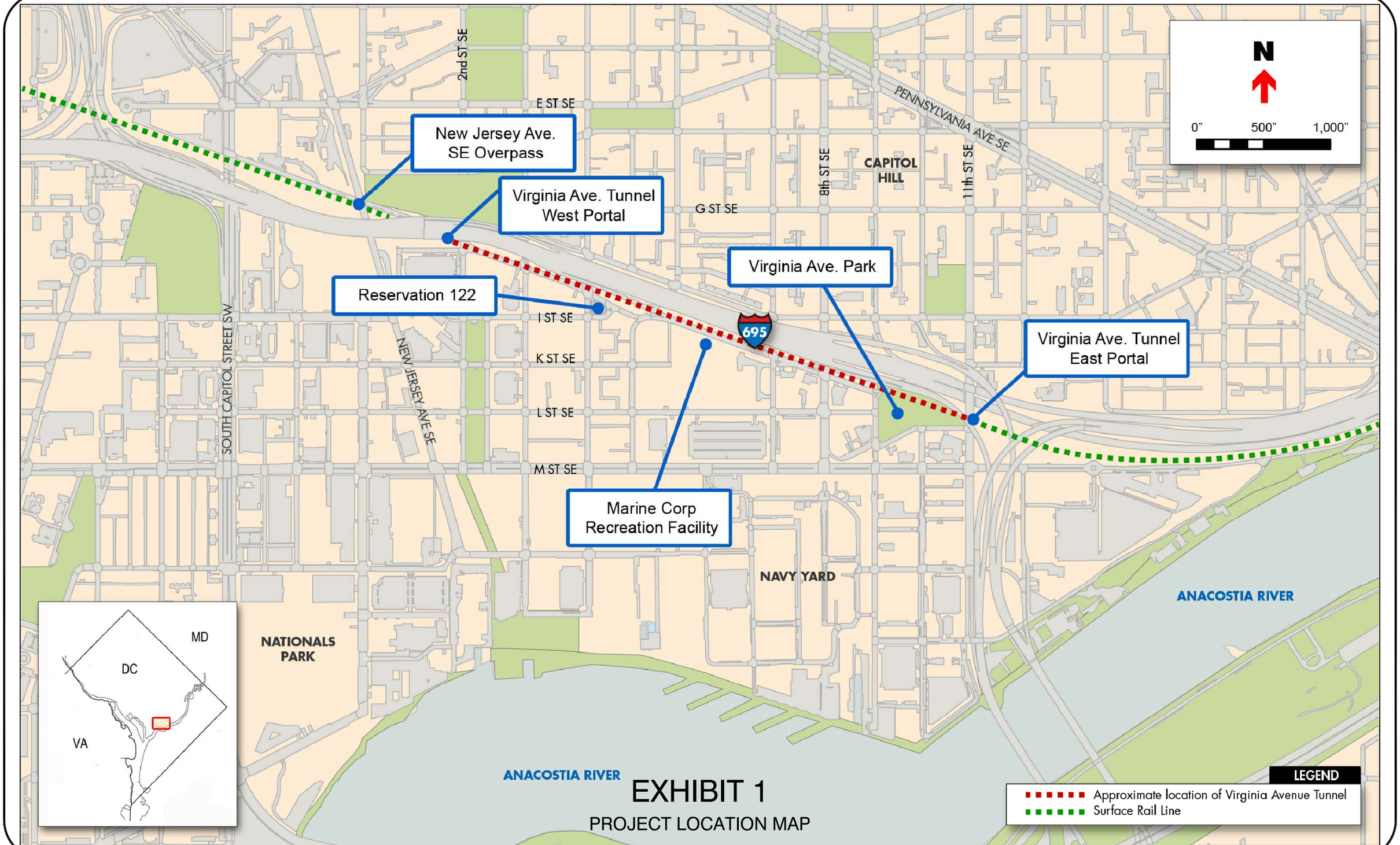


EXHIBIT 1

PROJECT LOCATION MAP

2.2.1 Alternative 1 - No Build

With the No Build alternative, the tunnel would not be rebuilt under. However, the railroad would continue to operate trains through the tunnel. At some point, emergency or unplanned major repairs or rehabilitation could be required to this critical, aging infrastructure that could prove equally or even more disruptive to the community than the Build Alternatives.

2.2.2 Alternative 2 - Rebuilt Tunnel / Temporary Runaround Track

This alternative would involve rebuilding the existing Virginia Avenue Tunnel. The tunnel would be rebuilt with two tracks and enough vertical clearance to accommodate double-stack intermodal container freight trains. It would be rebuilt in generally the same location, except aligned approximately seven feet to the south of the existing tunnel center line. It would be rebuilt using protected open trench construction methods. During construction, freight trains would be temporarily routed through a protected open trench outside of the existing tunnel (runaround track). The runaround track would be aligned to the south of the existing tunnel, would parallel the existing tunnel, and would be below street level. Due to new columns associated with the rebuilt 11th Street Bridge, the runaround track would slightly separate from the tunnel alignment on the east end starting just west of the Virginia Avenue Park. Safety measures such as secure fencing would be used to prevent pedestrians and cyclists from accessing the runaround track.

2.2.3 Alternative 3 - Two New Tunnels

This alternative would involve replacing the existing Virginia Avenue Tunnel with two new permanent tunnels constructed sequentially. Each new tunnel would have a single track with enough vertical clearance to allow double-stack intermodal container freight trains. A new parallel south side tunnel would be built first as trains continue operating in the existing Virginia Avenue Tunnel. After completion of the south side tunnel, train operations would switch over to the new tunnel and the existing Virginia Avenue Tunnel would be demolished and rebuilt. With the exception of operating in a protected open trench for approximately 230 feet immediately east of the 2nd Street portal (within the Virginia Avenue SE segment between 2nd and 3rd Streets SE), trains would operate in enclosed tunnels throughout construction of Alternative 3. Throughout most of the length, the two tunnels would be separated by a center wall, which would be the new centerline of the two tunnels, and would be aligned approximately 25 feet south of the existing tunnel centerline, between 2nd and 9th Streets SE. Due to new columns associated with the rebuilt 11th Street Bridge, the tunnels would be separated on the east end starting just west of the Virginia Avenue Park, resulting in two separate single-track tunnels with openings at the east portal.

2.2.4 Alternative 4 – New Partitioned Tunnel / Online Rebuild

Alternative 4 would result in a new tunnel with two permanent tracks. Similar to Alternative 3, the new tunnel would be partitioned and have enough vertical clearance to allow double-stack intermodal container freight trains. It would be aligned approximately 17 feet south of the existing tunnel's centerline and would be built using protected open trench construction methods. Safety measures such as secure fencing would be used to prevent pedestrians and bikers from accessing the protected open trench. The rebuild would occur 'online' meaning that during the period of construction, the protected open trench would accommodate both construction activities and train operations. Maintaining safe and reliable

temporary train operations would be a more complicated endeavor under Alternative 4 than under the other two Build Alternatives because of the online rebuild approach.

Regardless of Build Alternative, the Project would extend the east portal by approximately 330 feet to a location northeast of the 12th Street and M Street T-intersection.

3. Noise

3.1 Introduction and Methodology

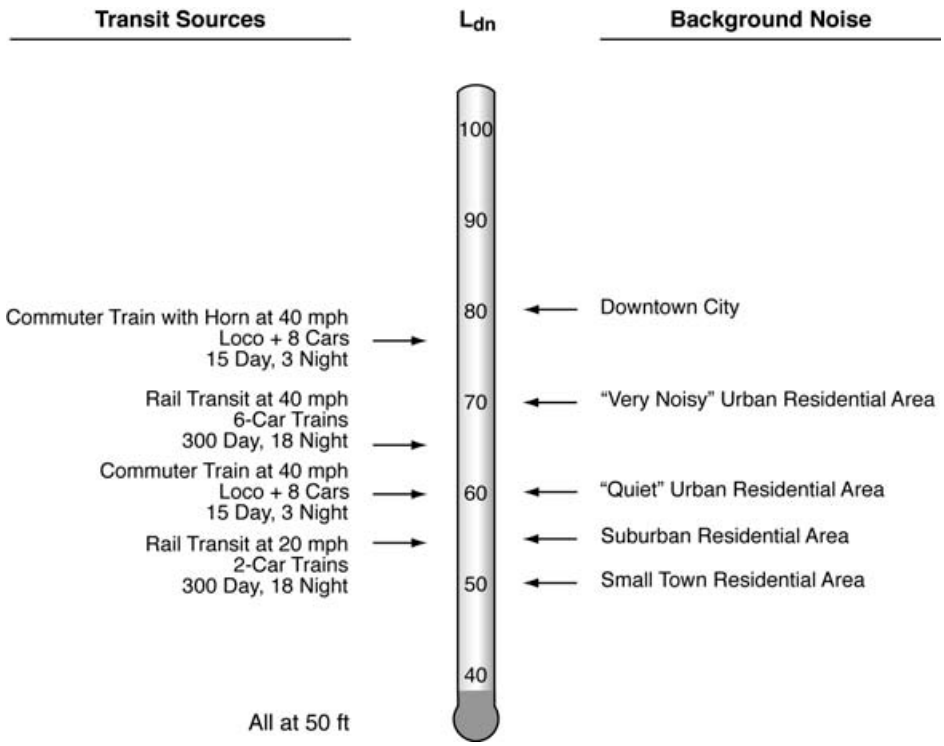
3.1.1 Overview

Noise is typically defined as unwanted or undesirable sound. Physically sound is generated by the vibration of the air molecules of an object in motion. The vibrations of the air molecules result in small fluctuations in air pressure. A sound wave is created when a series of these pressure changes move through the air. Sound waves vibrate at different rates (number of times per second) or "frequencies." The faster an object vibrates, the higher the frequency of the sound wave and the resulting sound level. The basic parameters of environmental noise that affect human subjective response are: (1) intensity or level; (2) frequency content; and (3) variation with time. Intensity or level is determined by how greatly the sound pressure fluctuates above and below the atmospheric pressure, and is expressed on a logarithmic compressed scale in units of decibels, symbolized as “dB”. By using this scale, the range of normally encountered sound can be expressed by values between 0 and 120 decibels. On a relative basis, a 3-decibel change in sound level generally represents a barely-noticeable change outside the laboratory, whereas a 10-decibel change in sound level would typically be perceived as a doubling (or halving) in the loudness of a sound.

The frequency content of noise is related to the tone or pitch of the sound, and is expressed based on the rate of the air pressure fluctuation in terms of cycles per second (called Hertz and abbreviated as Hz). The human ear can detect a wide range of frequencies from about 20 Hz to 17,000 Hz. However, because the sensitivity of human hearing varies with frequency, the A-weighting system is commonly used when measuring environmental noise to provide a single number descriptor that correlates with human subjective response. Sound levels measured using this weighting system are called “A-weighted” sound levels, and are expressed in decibel notation as “dB(A).” The A-weighted sound level is widely accepted by acousticians as a proper unit for describing environmental noise.

Because environmental noise fluctuates from moment to moment, it is common practice to condense all of this information into a single number, called the “equivalent” sound level (L_{eq}). L_{eq} can be thought of as the steady sound level that represents the same sound energy as the varying sound levels over a specified time period (typically 1-hour or 24-hour). Often the L_{eq} values over a 24-hour period are used to calculate cumulative noise exposure in terms of the Day-Night Sound Level (L_{dn}). L_{dn} is the A-weighed L_{eq} for a 24-hour period with an added 10-decibel penalty imposed on noise that occurs during the nighttime hours (between 10 PM and 7 AM), as people tend to be more sensitive to noises during these hours. Many surveys have shown that L_{dn} is well correlated with human annoyance, and therefore this descriptor is widely used to describe how humans perceive environmental noise. Exhibit 2 provides examples of typical noise environments and criteria in terms of L_{dn}. While the extremes of L_{dn} are shown to range from 50 dB(A) in a small town residential environment to 80 dB(A) in a downtown city, L_{dn} is generally found to range between 55 dB(A) and 75 dB(A) in most communities.

Exhibit 2. Typical Transit and Background Ldn Sound Levels



Source: Transit Noise and Vibration Impact Assessment, Federal Transit Administration, May 2006
N.B. 15 Day, 3 Night, is the number of train passbys during daytime and nighttime

3.1.2 FRA Noise Standards

The Federal Railroad Administration (FRA) relies upon the Federal Transit Administration (FTA) noise and vibration impact assessment procedures. The Screening and General Noise Assessment was completed in accordance with methodologies contained in the Federal Railroad Administration's (FRA) Noise and Vibration Assessment Methodology, dated December 2007). The initial review of the project aerial maps determined noise sensitive areas and/or receivers of interest were present within or adjacent to the proposed action.

3.1.2.1 FRA/FTA Noise Sensitive Land Uses and Noise Metrics

The noise criteria and descriptors used by the FRA to determine impacts depend on land use as shown in Exhibit 3. These criteria group noise sensitive land uses into the following three categories:

- Category 1: Tracks of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet as well as recording studios and concert halls. National Historic landmarks with significant outdoor usage would qualify under this category.
- Category 2: Residences and buildings where people normally sleep. This includes residences, hospitals, and hotels where nighttime sensitivity is assumed to be of utmost importance.

- Category 3: Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters and churches where it is important to avoid interference with such activities as speech, meditation and concentration on reading material. Other qualifying uses are listed in Exhibit 3.

Exhibit 3. Land Use Categories and Metrics for Transit Noise Impact Criteria

Land Use Category	Noise Metric (dB(A))	Description of Land Use Category
1	Outdoor $L_{eq}(h)$*	Tracts of land where quiet are an essential element in their intended purpose. This category includes lands set aside for serenity and quiet and such land uses as outdoor theater and concert pavilions.
2	Outdoor L_{dn}	Residences and buildings where people normally sleep. This category includes homes, hospitals and hotels where a nighttime sensitivity to noise is assumed to be of utmost importance.
3	Outdoor $L_{eq}(h)$*	Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, and churches where it is important to avoid interference with such activities as speech, meditation and concentration on reading material. Active parks. Buildings with interior spaces where quiet is important, such as medical offices and conference rooms, recording studios and concert halls, fall into this category. Places of worship, meditation or study associated with cemeteries, monuments, museums and certain historical sites are also included.

For land use Categories 1 and 3, the L_{eq} noise descriptor is used while land use Category 2 properties are assessed utilizing the L_{dn} descriptor. These criteria do not generally apply to industrial or commercial areas since such areas are generally compatible with high noise levels.

For Categories 1 and 3 land uses involving only daytime activities (e.g. churches, schools, parks), the impact is evaluated in terms of $L_{eq}(h)$, defined as the L_{eq} for the noisiest hour of transit-related activity during which human activities occur at the noise-sensitive location.

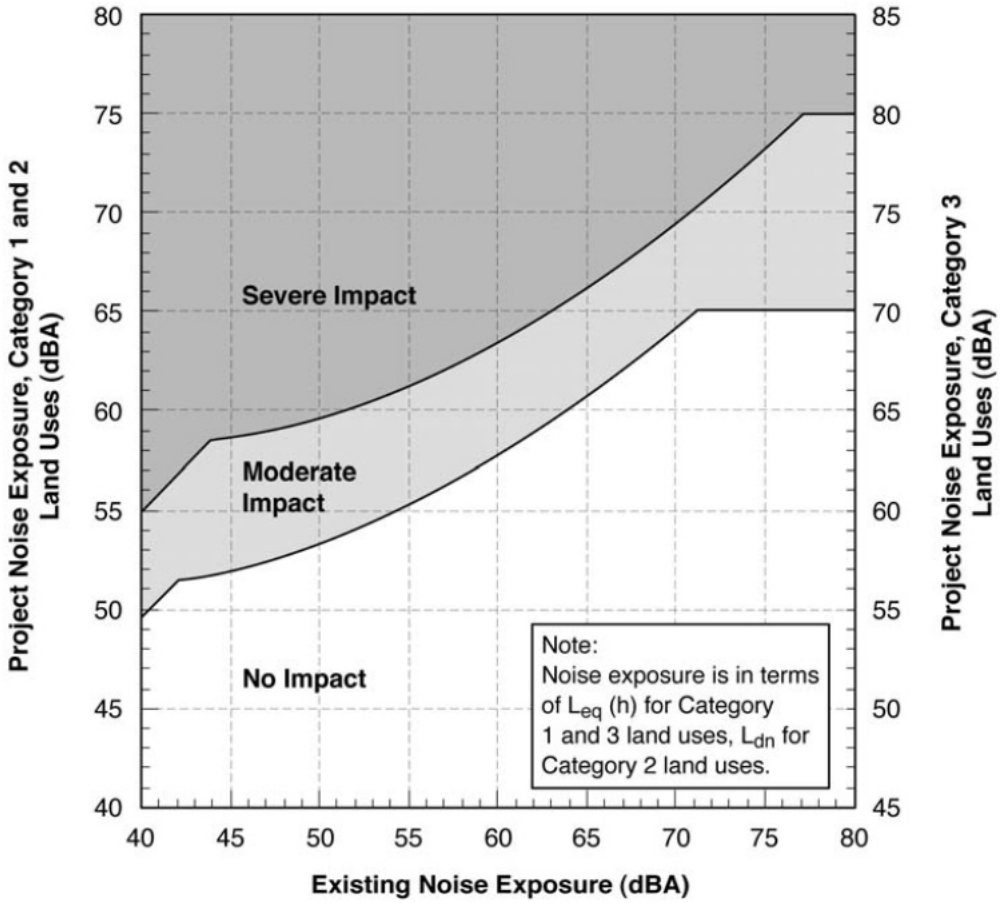
Residences near the Project Area were identified as Land Use Category 2. Since Category 2 consists of buildings where people normally sleep (e.g. residences, hospitals), nighttime sensitivity to noise is important. The noise metric used for Category 2 land uses is the previously-defined Ldn, the day-night sound level.

3.1.2.2 FRA Noise Impact Criteria

The FRA Noise Impact Criteria that define the severity of impacts for transit projects are shown in Exhibit 4 and Exhibit 5. The criteria are based on a comparison of existing and future project related outdoor noise levels, and incorporate both absolute criteria (noise from the proposed project alone), and relative criteria (annoyance as a result of project induced changes in noise levels). Impacts are assessed based on a combination of the existing ambient noise exposure and the additional noise exposure from the

project, with impacts occurring when noise levels exceed 65 dB(A) or result in an increase of 3 dB(A) above existing noise levels.

Exhibit 4. Noise Impact Criteria for Transit Projects



Source: Transit Noise and Vibration Impact Assessment, Federal Transit Administration, May 2006

Exhibit 4 shows that the noise impact criteria are defined by two curves which allow increasing project noise levels as existing noise increases up to a point, beyond which impact is determined based on project noise alone. Project noise above the upper curve is considered to cause "Severe Impact" since a significant percentage of people would be highly annoyed by the new noise. Between the two curves the proposed project is judged to have "Moderate Impact", where the change in the cumulative noise level is noticeable to most people, but may not be sufficient to cause strong, adverse reactions from the community. In this transitional area, other project-specific factors must be considered to determine the magnitude of the impact and the need for mitigation. Such considerations include the existing noise levels, the predicted increase over existing noise levels, and the types and numbers of noise-sensitive land uses affected, as described in Chapter 6 of the FTA Noise and Vibration Impact Assessment guidance manual. Exhibit 5 presents this information in a table format.

Exhibit 5. Cumulative Noise Level Increase Defining FTA Noise Impact Criteria

Existing Noise Exposure	Impact Threshold for Increase in Cumulative Noise Exposure (dBA)					
	Category 1 or 2 Sites			Category 3 Sites		
L_{eq} or L_{dn}	No Impact	Impact	Severe Impact	No Impact	Impact	Severe Impact
45	<9	9-14	>14	<13	13-19	>19
46	<8	8-13	>13	<13	13-18	>18
47	<8	8-12	>12	<12	12-17	>17
48	<7	7-12	>12	<11	11-16	>16
49	<7	7-11	>11	<11	11-16	>16
50	<6	6-10	>10	<10	10-15	>15
51	<6	6-10	>10	<9	9-14	>14
52	<5	5-9	>9	<9	9-14	>14
53	<5	5-8	>8	<8	8-13	>13
54	<4	4-8	>8	<8	8-12	>12
55	<4	4-7	>7	<7	7-12	>12
56	<4	4-7	>7	<7	7-11	>11
57	<4	4-6	>6	<7	7-10	>10
58	<3	3-6	>6	<6	6-10	>10
59	<3	3-5	>5	<6	6-9	>9
60	<3	3-5	>5	<6	6-9	>9
61	<3	3-5	>5	<5	5-9	>9
62	<3	3-4	>4	<5	5-8	>8
63	<3	3-4	>4	<5	5-8	>8
64	<3	3-4	>4	<5	5-8	>8
65	<2	2-4	>4	<4	4-7	>7
66	<2	2-4	>4	<4	4-7	>7
67	<2	2-3	>3	<4	4-7	>7
68	<2	2-3	>3	<4	4-6	>6
69	<2	2-3	>3	<4	4-6	>6
70	<2	2-3	>3	<4	4-6	>6
71	<2	2-3	>3	<4	4-6	>6
72	<2	2-3	>3	<3	3-6	>6
73	<2	2	>2	<3	3-5	>5
74	<2	2	>2	<3	3-5	>5
75	<1	1-2	>2	<2	2-5	>5

L_{dn} is used for land uses where nighttime sensitivity is a factor;
Maximum 1-hour L_{eq} is used for land use involving only daytime activities.

Source: CREATE Noise and Vibration Assessment Methodology, Federal Railroad Administration, December 2007

3.1.3 Construction Noise Standards

3.1.3.1 FTA Construction Noise Guidelines

FTA guidelines identify a set of threshold L_{eq} and L_{dn} levels for various construction activities. In urban areas with very high ambient noise levels (L_{dn} > 65 dB), L_{dn} from construction operations should not exceed existing ambient by 10 dB or more. The noise criteria and the descriptors used to evaluate construction noise are dependent on the type of land use in the vicinity of a proposed project.

Exhibit 6 shows the FTA construction noise criteria for noise assessment conducted in accordance with FTA methodologies. Using FTA guidelines, an airborne noise impact would occur if noise levels during construction exceed the FTA recommended values shown in Exhibit 6. The criteria do not differentiate between different land uses such as residences, parks, recreation areas, museums, churches, or other land uses potentially affected by the proposed action. It should be noted that the existing noise levels at sensitive receptors in the Project Area are relatively high, reflecting the urban/commercial environment.

Exhibit 6. FTA Construction Noise Criteria

Land Use	8-hour Leq (dB(A)) Day	8-hour Leq (dB(A)) Night	L_{dn} or L_{eq}(dB(A)) – 30-day Average
Residential	80	70	75 [(a)]
Commercial	85	85	80 [(b)]
Industrial	90	90	85 [(b)]

[(a)] In urban areas with very high ambient noise levels (Ldn > 65 dB), Ldn from construction operations should not exceed existing ambient + 10 dB.

[(b)] Twenty-four-hour L_{eq}, not L_{dn}.

Source: Transit Noise and Vibration Impact Assessment, Federal Transit Administration, May 2006

3.2 Affected Environment

This section describes how the FRA noise and construction noise criteria were applied to the four alternatives under consideration for the Virginia Avenue Tunnel Project. The initial task was to establish existing baseline noise conditions near the Project Area. This baseline data was used to estimate future noise impacts from the three 'build' alternatives during construction

The FRA recommends applying a screening procedure to determine if there is a likelihood of noise impact from a project, with areas defined by the screening distances sufficiently large to encompass all potentially impacted locations. For this project, screening distances were determined using relatively high-capacity scenarios for a given alternative, with a noise screening distance of 750 feet for unobstructed line of sight according to CREATE assessment guideline. The screening distances were applied from the centerline of each of three 'build' alternatives to determine the area of potential effect. Based on aerial photography and field trips to the Project Area, several residential communities were identified within 750 feet from the track centerline.

Existing noise levels were determined based on noise measurements collected at representative sites at and near the Project Area, with measurement sites selected based on an extensive review of the proposed rail alignment under each of the three 'build' alternatives. These measurements were compared to

predicted future noise levels in the study area to determine possible impacts associated with each of the three 'build' alternatives. These sites consisted mainly of residential dwellings (Category 2) and some institutional land use (Category 3), and were considered representative properties providing typical ambient noise conditions within the communities bordering the Project Area.

Physical and operational parameters that would produce the worst-case noise effect—such as train speed, frequency of operation, and distance to track—were accounted for in the determination of representative 24-hour noise measurement sites. Within a given land use category, noise measurements recorded at one site were representative of existing noise conditions at that site and provided the baseline for addressing the site's future construction noise levels. In addition, some monitoring locations were selected on the basis of site equivalence where the measurement results collected at one site were applied to multiple sites. Where such noise measurement sites were selected to be representative of a larger cluster of residential dwellings, these sites shared the following characteristics:

- Proximity to the same noise sources, such as CSX train tracks where maximum exposure to transit noise may potentially occur
- Similar type and density of housing, such as single family homes and multi-family housing in apartment complexes

All of the field measurements were collected in accordance with the procedures described in FHWA's Measurement of Highway-Related Noise (Report Number FHWA-PD-96-046,May 1996) and in FTA's *CREATE Noise and Vibration Assessment Methodology* (December 2007). A calibrated set of Rion and Larson Davis noise measuring equipment was used in the noise study, including Rion NA-28 and NA-27 and Larson Davis (LD) 706 noise meters. The Rion equipment was used for all short-term noise readings. For collecting long-term noise measurements, LD 706 noise meter instruments suitable for 24-hour noise monitoring were employed. All noise measurements were collected under acceptable weather and roadway conditions (rain free days with dry roadway pavements and wind speed less than 12 mph).

24-hour noise measurements were collected and repeated three times at 5 sites between May 22, 2012 and June 21, 2012. Exhibit 7 shows the results of the measurements conducted at these sites, with measurement locations shown in Exhibit 8.

Exhibit 7. Summary of Existing Measured Sound Levels

Site ID	Description of Measurement Location	Measurement Dates	Land Use	L_{dn} Noise Levels in dB(A)
M-1	300 Block of Virginia Ave.	5/22/12, 6/20/12, 6/21/12	Residential	70
M-2	400 Block of Virginia Ave.	6/20/12, 6/21/12	Residential	70
M-3	Capper Seniors Property	5/30/12, 6/6/12, 6/7/12	Residential	73
M-4	Fence of Marine Property	5/22/12	Residential	69
M-5	Potomac Avenue SE Property	5/30/12, 6/6/12, 6/7/12	Residential	68

As shown in Exhibit 7, day-night noise levels at measurement sites within the project study area ranged from 68 dB(A) at Receptor M-5 (residences along Potomac Avenue SE) to 73 dB(A) at Receptor M-3 (Capper Seniors multi-residential dwellings properties along Virginia Avenue). In general, the higher noise levels reflect the proximity of sensitive sites to active transportation corridors such as I-695 that carry heavy vehicular traffic. In addition, the high noise level at site M-3 is attributed to its proximity to a

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EXHIBIT 8

24 HR. NOISE MONITORING LOCATIONS

bus station as well as its proximity to the I-695 off-ramp and the intersection of Virginia Avenue and 6th Street SE. In addition, the ambient sound levels are influenced by the current freight operations in the Virginia Avenue Tunnel.

3.3 Environmental Consequences

Upon completion of the Virginia Avenue Tunnel Project, the rail line will operate within a tunnel as it passes through the study area. As such, its noise impacts to adjacent properties will be minimal, with train-related noise levels expected to be reduced as compared to existing train-related levels. The following analyses of project alternatives were performed to address predicted noise levels and potential impacts during the construction period of the ultimate tunnel when various options exist for temporarily accommodating train traffic through the project area.

3.3.1 No Build Alternative

Future noise levels under the No Build Alternative are anticipated to be similar to those under existing conditions. As shown in Exhibit 7, existing noise levels near the Project Area range from 68 to 73 dB(A). This is typical of a "very noisy' urban residential neighborhood, as shown on Exhibit 2. The neighborhood near the Project Area is characterized by urban communities that include major roadways (such as I-695). The No Build Alternative also includes consideration of the current and future CSX operations using the present Virginia Avenue Tunnel. Irrespective of other projects in the Long Range Transportation Plan, ambient noise under the No Build Alternative is anticipated to be similar as under existing conditions. For example, it takes a doubling of the traffic volumes for the noise levels to increase by 3 dB, the threshold where most listeners can detect the change. However, increases in traffic volumes are expected to result in higher congestion and lower average travel speeds, with lower associated noise levels. Therefore, no significant noise impacts were predicted with the No Build Alternative. Build Alternatives

Noise impacts were evaluated using the FRA's "CREATE Noise Assessment" guidelines in conjunction with several operating assumptions detailed below.

<u>Train Operating Assumptions</u>

The reference noise levels for each of the proposed noise sources are based on default FRA CREATE data (including train pass-bys and warning horns). Other operating characteristics are based on information included in project design criteria and are summarized below.

- Total daily operations were determined based on actual train counts between July 18 and 20, 2012. The total daily number of trains was 26 trains: 14 trains during daytime (between 7 a.m. and 10 p.m.) and 12 trains during nighttime (between 10 p.m. and 7 a.m.). These train operation assumptions represent typical daily operation regardless of any seasonal variation.
- As a conservative approach, it was assumed that the future service frequency will increase by 25% over the existing number of trains for a total 33 trains: 18 trains during daytime and 15 trains during nighttime
- It was assumed a typical freight train consisted of 3 locomotives and 120 rail cars
- Proposed train operating speeds were assumed to be a maximum speed of 25 mph in the trench

- Since Alternative 4 would be constructed using online construction and a portion of the tunnel would remain open, it was assumed as a conservative approach that the train would be operating in a trench.
- Freight trains would be operating in a trench that is 25 feet deep. Based on FRA guidelines and modeling calculations, this configuration would provide a reduction in sound levels ranging from 11 to 12 dB for Build Alternatives 2 and 4. The calculated reduction was based on guidelines presented in the FTA detailed noise analysis (Table 6-9 and Figure 6-7 in the FTA Noise and Vibration Impact Assessment guidance manual). These additional reductions were then applied to the calculated projected noise levels from ground level train operations.

Alternative 2 – Rebuilt Tunnel / Temporary Runaround Track

The predicted future noise levels from train operations associated with Alternative 2 are summarized below in Exhibit 9 and the ten receptors are shown in Exhibit 12. The existing noise levels are based on the measurements shown previously in Exhibit 7. They represent the baseline condition used in the FRA CREATE assessment methodology to assess if any noise impact will occur. Exhibit 9 shows the "Total Noise" exposure, which represents the cumulative or total future ambient noise with the Project, which is equal to the "Existing Noise" logarithmically added to the "Build Noise". The predicted noise levels reflect the conclusion of CSX mandatory practice of requiring every train to blow its horn before entering and exiting the tunnel is no longer necessary due to other safety and security measures in and around the tunnel. Therefore, the noise analyses indicate a predicted reduction in sound levels for residences closer to the East and West portals.

As summarized in Exhibit 9, the L_{dn} day-night "Total Noise" levels (train operation during construction) at residences near the Project Area under Alternative 2 are predicted to range from 69 dB(A) at Receptors R-5, R-9, and R-10 to 74 dB(A) at R-4. Exhibit 9 also indicates future total noise exposure increases over existing levels ranging from 0 to 2 dB at all analyzed receptors. Noise level increases of 1-2 dB are not typically perceived by humans. None of the studied sensitive receptors are predicted to experience project-related noise levels that would exceed the FRA increase in cumulative noise exposure impact criteria. The selected ten receptors were chosen based on their proximity to the train operations and the potential of being impacted. Since these receptors were determined not to be impacted, it is unlikely that additional receptors further away would be impacted.

Alternative 3 – Two New Tunnels

The predicted future noise levels from train operations associated with Alternative 3 are summarized in Exhibit 10 for the ten receptors shown in Exhibit 12. Future train noise levels with Alternative 3 were predicted to be similar to those under existing conditions because there will not be any trains operating in open protected trenches and there would be no potential for any noise level increase since the trains would be operating in a tunnel. None of the studied sensitive receptors were predicted to experience project-related noise levels that would exceed the FRA increase in cumulative noise exposure impact criteria and any noise increases would be primarily due to normal traffic increases from I-695 traffic, not from project train operations. The selected ten receptors were chosen based on their proximity to the train operations and the potential of being impacted. Since these receptors were determined not to be impacted, it is unlikely that additional receptors further away would be impacted. The predicted noise levels reflect the conclusion of CSX mandatory practice of requiring every train to blow its horn before entering and

EXHIBIT 12

RAIL ANALYSIS SITES

exiting the tunnel is no longer necessary due to other safety and security measures in and around the tunnel. Therefore, the noise analyses indicate a predicted reduction in sound levels for residences closer to the East and West portals.

Alternative 4 – New Partitioned Tunnel / Online Rebuild

The predicted future noise levels from train operations associated with Alternative 4 are summarized in Exhibit 11 at the ten receptors shown in Exhibit 12. Exhibit 12 shows the "Total Noise" exposure, which represents the cumulative or total future ambient noise with the Project, which is equal to the "Existing Noise" logarithmically added to the "Build Noise". The predicted noise levels reflect the conclusion of CSX mandatory practice of requiring every train to blow its horn before entering and exiting the tunnel is no longer necessary due to other safety and security measures in and around the tunnel. Therefore, the noise analyses indicate a predicted reduction in noise levels for residences closer to the East and West portals.

As summarized in Exhibit 11, the L_{dn} "Total Noise" levels associated with Alternative 2 are predicted to range from 68 dB(A) at R-9 and R-10 to 74 dB(A) at R-4. Exhibit 11 also indicates predicted future total noise exposure increases over existing levels ranging from 0 to 1 dB at all analyzed receptors. Noise level increases of 1 dB are not perceived by humans. None of the studied sensitive receptors are predicted to experience project-related noise levels that would exceed the FRA increase in cumulative noise exposure impact criteria. The selected ten receptors were chosen based on their proximity to the train operations and the potential of being impacted. Since these receptors were determined not to be impacted, it is unlikely that additional receptors further away would be impacted. Train Noise Analysis Summary

Based on the results of the Screening Analysis and the General Noise Assessment, future train-related noise levels related to all three 'build' alternatives are not predicted to exceed the FRA increase in cumulative noise exposure impact criteria. Furthermore, total noise levels are predicted to increase by an imperceptible 1-2 dB. Therefore, none of the three 'build' alternatives are expected to perceptibly or adversely increase existing noise levels.

As a result of this Project's NEPA process, CSX has concluded that its practice to require every train to blow its horn before entering and exiting the tunnel is no longer mandatory due to other safety and security measures in and around the tunnel. Like all railroad companies and consistent with federal regulations, CSX still expects its locomotive engineers to use the train horn for safety reasons both during and after construction. However, an immediate benefit of the Project's NEPA process is the elimination of the mandatory horn-blowing practice, and the resultant overall reduction of horn noise in the surrounding neighborhood.

Exhibit 9. Alternative 2 Train Future Noise Levels

Receptor		Land Use		Distance to Centerline Tracks (ft)	Warning Device	Maximum Speed (mph)	Existing Noise (dB(A))	Build Noise (dB(A))	Total Noise (dB(A))	Increase Over Existing
ID	Description	Type	FTA							
R-1	200 I street	INS	3	43	No	25	70	59	70	0
R-2	Capital Quarters (3rd/4th)	RES	2	43	No	25	70	66	72	2
R-3	Capital Quarters (4th/5th)	RES	2	95	No	25	70	61	71	1
R-4	Capper Seniors	RES	2	45	No	25	73	66	74	1
R-5	Marine Field	INS	3	45	No	25	69	58	69	0
R-6	Marine Quarters	RES	2	100	No	25	69	60	70	1
R-7	Building at 8th street	INS	3	55	No	25	69	65	71	2
R-8	Admiral at Barracks ROW	RES	2	60	No	25	69	64	70	1
R-9	Potomac Avenue SE	RES	2	120	No	25	68	59	69	1
R-10	L Street SE	RES	2	115	No	25	68	59	69	1

Land use types include single- or multi-family residences (RES), and office (INS).

Exhibit 10. Alternative 3 Train Future Noise Levels

Receptor		Land Use		Distance to Centerline Tracks (ft)	Warning Device	Maximum Speed (mph)	Existing Noise (dB(A))	Build Noise (dB(A))
ID	Description	Type	FTA					
R-1	200 I street	INS	3	43	No	25	70	Same as Existing
R-2	Capital Quarters (3rd/4th)	RES	2	43	No	25	70	
R-3	Capital Quarters (4th/5th)	RES	2	95	No	25	70	
R-4	Capper Seniors	RES	2	45	No	25	73	
R-5	Marine Field	INS	3	45	No	25	69	
R-6	Marine Quarters	RES	2	100	No	25	69	
R-7	Building at 8th street	INS	3	55	No	25	69	
R-8	Admiral at Barracks ROW	RES	2	60	No	25	69	
R-9	Potomac Avenue SE	RES	2	120	No	25	68	
R-10	L Street SE	RES	2	115	No	25	68	

Exhibit 11. Alternative 4 Train Future Noise Levels

Receptor		Land Use		Distance to Centerline Tracks (ft)	Warning Device	Maximum Speed (mph)	Existing Noise (dB(A))	Build Noise (dB(A))	Total Noise (dB(A))	Increase Over Existing
ID	Description	Type	FTA							
R-1	200 I street	INS	3	55	No	25	70	57	70	0
R-2	Capital Quarters (3rd/4th)	RES	2	55	No	25	70	65	71	1
R-3	Capital Quarters (4th/5th)	RES	2	105	No	25	70	60	70	0
R-4	Capper Seniors	RES	2	57	No	25	73	65	74	1
R-5	Marine Field	INS	3	57	No	25	69	57	69	0
R-6	Marine Quarters	RES	2	115	No	25	69	59	69	0
R-7	Building at 8th street	INS	3	70	No	25	69	63	70	1
R-8	Admiral at Barracks ROW	RES	2	80	No	25	69	62	70	1
R-9	Potomac Avenue SE	RES	2	150	No	25	68	57	68	0
R-10	L Street SE	RES	2	160	No	25	68	57	68	0

3.4 Construction Noise

3.4.1 Construction Methods

Stations, shafts, cut-and-cover tunnels and portals require very similar construction techniques. Noise from excavation associated with the cut and cover construction would include noise from construction equipment such as backhoes, bull dozers, cranes, concrete mixers, concrete delivery trucks, dump trucks, delivery trucks, front-end loaders, pile drivers and jack hammers. A general discussion of noise associated with the major construction elements for the project's new tunnels for each of the three 'build' alternatives cut and covers construction is presented below.

Airborne noise from tunneling activity, including noise from tunnel boring machines, is not anticipated to be discernible in outdoor areas adjacent to the project, as most noise would be contained underground and/or masked by existing noise levels. However, noise impacts are anticipated during hauling of excavated materials from the muck shafts and the shipping of liner segments, concrete and other materials to the shafts.

Construction noise sources are comprised of both mobile and stationary sources. Mobile equipment such as dozers, scrapers, graders, etc., may operate in a cyclic fashion in which a period of full power is followed by a period of reduced power. Mobile equipment such as trucks produce steady noise and are generally associated with supply of materials to the construction sites and disposal of waste materials from construction sites. Stationary equipment consists of equipment that generates noise from one general area and includes items such as pumps, generators, compressors, etc. These types of equipment operate at a constant noise level under normal operation and are classified as non-impact equipment. Other types of stationary equipment such as pile drivers, jackhammers, pavement breakers, blasting operations, etc., produce variable and sporadic noise levels and produce impact-type noises. Typical noise emission levels from construction equipment are included in the "FTA Transit Noise and Vibration Impact Assessment" manual, May 2006. Equipment such as compressors, although generally considered to be stationary when operating, can be readily relocated to another location for the next operation. If construction equipment is expected to be operating within 500 feet of a sensitive receptor for an extended period of time, more detailed analyses were performed.

3.4.2 Potential Impacts

Noise levels from construction activities related to the three projects 'build', although temporary, could be a nuisance for nearby sensitive receptors. Noise levels during construction are often difficult to predict and vary depending on the types of construction activity and the types of equipment used for each stage of work. Heavy machinery, a major source of noise in construction, often moves in unpredictable patterns and may not be at one location very long.

In order to gauge the level of potential noise impact from temporary construction activities, preliminary construction scenarios were developed and provided by others. In general, activities associated with construction staging and/or material lay down areas can result in adverse noise impacts if they take place in noise-sensitive areas. This analysis makes conservative assumptions regarding construction noise in order to ensure that potential maximum adverse impacts are analyzed and disclosed consistent with NEPA requirements.

The bulk of the construction under all three 'build' alternatives will occur during daylight hours when some residents are not at home, when residents who are at home are less sensitive to construction activities, and when other community noise sources contribute to higher ambient noise levels. Most construction activities are generally expected to last about 3 to 7 months at any one location, depending on the type of activity, and the overall project construction period is expected to last approximately between 36 months for Alternatives 2 and 3 and 56 months for Alternative 4.

Construction noise was evaluated for the ten receptors shown in Exhibit 12. Construction noise evaluation was conducted for the major construction activities using the FHWA Roadway Construction Noise Model (RCNM). In addition, the construction noise assessment was based on the default values that are included in the RCNM. Exhibits 13 - 15 show the predicted noise levels for the major construction activities for each of the three project 'build' alternatives.

Exhibit 13. Alternative 2 Predicted Construction Noise Levels (L_{eq}, dB(A))

Site ID	Slurry Wall	Excavation	Excavation/ Demolition	Structural Concrete	Work/Paving	Work/Backfill/ Drainage
R-1[a]	85	83	87	86	89	86
R-2[b]	85	83	87	86	89	86
R-3	78	76	80	79	82	80
R-4	85	83	86	86	88	86
R-5[a]	85	83	86	86	88	86
R-6	78	76	80	79	81	79
R-7	83	81	85	84	86	84
R-8	82	80	84	83	86	84
R-9	76	74	78	77	80	78
R-10	77	74	78	78	80	78

a: Commercial Land Use b: Residential Land Use R-2 to R-10

Exhibit 14. Alternative 3 Predicted Construction Noise Levels (L_{eq}, dB(A))

Site ID	Slurry Wall	Excavation	Excavation/ Demolition	Structural Concrete	Work/Paving	Work/Backfill/ Drainage
R-1[a]	85	83	87	86	89	86
R-2[b]	85	83	87	86	89	86
R-3	78	76	80	79	82	80
R-4	85	83	86	86	88	86
R-5[a]	85	83	86	86	88	86
R-6	78	76	80	79	81	79
R-7	83	81	85	84	86	84
R-8	82	80	84	83	86	84
R-9	76	74	78	77	80	78
R-10	77	74	78	78	80	78

a: Commercial Land Use b: Residential Land Use R-2 to R-10

Exhibit 15. Alternative 4 Predicted Construction Noise Levels (L_{eq}, dB(A))

Site ID	Slurry Wall	Excavation	Excavation/ Demolition	Structural Concrete	Work/Paving	Work/Backfill/ Drainage	Sheet pile
R-1[a]	83	81	85	84	86	84	93
R-2[b]	83	81	8185	84	86	84	93
R-3	77	75	79	78	81	79	87
R-4	83	80	84	84	86	84	93
R-5[a]	83	80	84	84	86	84	93
R-6	77	74	78	78	80	78	87
R-7	81	79	83	82	84	82	91
R-8	80	78	81	81	83	81	90
R-9	74	72	76	75	78	76	84
R-10	74	72	76	75	77	75	84

a: Commercial Land Use b: Residential Land Use R-2 to R-10

Based on the FTA criteria for detailed assessment shown in Exhibit 6 , the L_{dn} for a project located in an urban area with very high ambient noise levels (L_{dn} > 65 dB should not exceed the existing ambient noise level by more than 10dB. In addition, since all construction activity is proposed to occur during daytime hours, the L_{eq} Day criteria of 80 dB(A) will apply for residential receptors.

Exhibits 13 and 14 show that for Alternatives 2 and 3, the majority of the predicted construction noise levels exceed the FTA Construction Noise Impact Criteria shown in Exhibit 6, with the exceptions of Receptors R6 (with only one operation exceeding 80 dB(A)) and Receptors R-9 and R-10 (with no exceedences). Figure 15 shows that, for Alternative 4, the construction noise criteria are expected to be exceeded at all residential and commercial sites during at least one construction operation. It should be noted that the construction noise analyses include noise levels associated with construction vehicle traffic on all truck haul routes. In general, construction noise lasts for the duration of the construction contract and is usually limited to daylight hours when most human activity occurs. Construction activities are generally of a short duration and, depending on the nature of construction operations, could last from seconds (such as for a truck passing by) to weeks or months (such as when constructing a major bridge or retaining wall structure). Construction noise is sometimes intermittent and depends on the type of operation, location, and function of the equipment as well as the equipment usage cycle. The following section describes some noise control approaches that are recommended during construction for the proposed alternatives.

3.4.3 Noise Mitigation Measures

Although District of Columbia regulations allow construction between 7 AM to 7 PM Monday to Saturday, it is recommended that the construction contractor avoid conducting the noisiest activities near residences during the very early morning hours (e.g., 7 AM to 8 AM). If daytime Sunday or holiday work is required (e.g., erecting street crossings when traffic is lightest) and permitted by the District, the construction contractor should avoid conducting the noisiest activities near residences during the very early hours.

For each of three Build Alternatives, the majority of predicted construction noise levels associated with activities that are essential to the reconstruction of Virginia Avenue Tunnel would exceed the FTA Construction Noise Impact Criteria (see Exhibit 6). Sheet piling, which is a required activity only for Alternative 4, would not be conducted until after 8:30 AM and would be discontinued by 4:30 PM. Also, the contractor would use vibratory techniques to install the sheet piles, instead of driven techniques, if working near residences.

The following mitigation measures, which are deemed at this time to be reasonable (i.e., cost effective) and feasible (i.e., physically achievable), could reduce the amount of noise generated during construction. Additional details to these measures would be developed during final design when more information about construction is developed. These mitigation measures would be employed regardless of the Build Alternative selected.

- Adhere to DDOT construction noise specifications;
- Establish a community outreach program to notify nearby residents and businesses about upcoming high noise producing activities, such as pile installation;
- Establish procedures to address noise complaints during construction;
- Prepare a noise monitoring plan and conduct noise monitoring during construction in accordance with the plan;
- Use a type of LOD fencing (e.g., wood stockade or type of solid material) near noise sensitive receptors that could also serve as temporary noise barriers;
- Hang noise dampening blankets on the inside face of the solid fencing if the effectiveness of the noise barriers need to be improved;
- Where feasible, use drilled installation methods instead of driven methods when installing bearing and temporary support piles near residences;
- Properly maintain all motorized equipment in a state of good repair to limit wear induced noise (e.g., mufflers are in good working condition);
- Consider noise impacts in selecting construction equipment that need to run over extended periods of time, such as gen sets (whisper quiet line);
- Where feasible, use demolition equipment with crush/shear technology, instead of impact technology;
- Placing stationary noise generating equipment as far from residences as reasonably practical and feasible;
- Limit high noise generating activities to daytime and weekdays as reasonably practical and feasible; and
- Where feasible, combine operations or activities with high noise levels to occur in the same time period;
- Route heavily loaded delivery and disposal trucks away from residential streets as reasonably practical and feasible (e.g., using the west staging area and east end of the LOD where there are fewer residences).

3.5 Highway Noise

This section addresses the noise evaluation performed, for all three 'build' alternatives, to address changes in traffic volumes due to traffic detours and street closures during construction. It should be noted that the highway noise evaluation was not required according to the District Department of Transportation (DDOT) noise policy, dated January 10, 2011. The VAT project is not a "Type I" Project as defined in DDOT noise policy, hence there is no need to conduct a noise analysis. However, the study was conducted to obtain a representation of the background noise and to identify any potential noise impacts that could occur as a result of traffic diversions associated with the three 'build' alternatives.

During construction of any of the three project 'build' alternatives, street closures are expected and traffic detours will occur which will increase traffic volume on certain streets, resulting in the potential for noise impacts on adjacent residences. There are no significant differences in traffic detour routes for the three 'build' alternatives.

3.5.1 Introduction

The noise level descriptor used for this study was the hourly equivalent sound level ($L_{eq}(h)$), which is the steady state, A-weighted sound level, which contains the same amount of acoustic energy as the actual time-varying A-weighted sound level over a one-hour period. The FHWA and DDOT define noise impact based upon seven activity categories. Individual sites located within a given activity category are designated as noise sensitive receptors.

3.5.2 Noise Measurements and Model Validation

Ambient noise measurements were conducted at various locations at and near the Project Area. Short-term (20 minute duration) noise readings were taken along with concurrent traffic counts at 16 locations using ANSI Type I noise meters. It should be noted that short-term measurements were taken at various times of the day between May 22 and 30, 2012 and did not necessarily represent the noisiest condition at any particular measurement site. Measurement sites were positioned in order to enable validation of the noise prediction model and to define existing noise levels for first and second-row residences. As such, in certain locations, noise measurement sites do not exactly correspond with noise analysis sites. Measurements were used primarily for purposes of noise model validation, with year 2011 peak hour traffic volumes assumed in the prediction of worst-case existing noise levels. Measured existing L_{eq} noise levels at short-term measurement sites ranged from 61 to 71 dB(A).

Using the traffic data obtained concurrently with the short-term noise measurements, noise levels were modeled and compared to measured noise levels. Existing short-term measured noise levels and hourly traffic data based on concurrent traffic counts are summarized in Exhibit 16. Validation results shown in Exhibit 16 indicate that measured versus modeled noise levels were within the acceptable 3 dB(A) range for all sites evaluated, except for Site M-10, which was influenced by non-highway sources (children using the playground). The results of the validation process were used to "build" the FHWA Traffic Noise Model (TNM) used for purposes of modeling existing and future year highway traffic generated noise levels and determining potential future year impacts.

3.5.3 Noise Modeling

The model used to predict worst case existing and future noise levels generated by highway traffic and to evaluate noise abatement options was the FHWA TNM, Version 2.5. The FHWA TNM predicts noise levels at selected locations based on traffic data, roadway design, topographic features, and the relationship of the analysis site to nearby roadways. Traffic data, used for prediction of existing year 2011, Future No-Build 2015, and Construction Year 2015 noise levels, were obtained from a traffic point of access study prepared by Parsons (May 2012).

Exhibit 16. Model Validation

Site ID	Address	Date	Measured Noise Levels (dB(A))	Modeled Noise Levels (dB(A))	Difference
M-1	200 I Street	5.22.12	70.6	67.6	-3.0
M-2	Capital Quarters (3rd)	5.22.12	66.6	66.5	-0.1
M-3	Capital Quarters (3rd/4th)	5.22.12	65.0	66.5	1.5
M-4	Capital Quarters (4th)	5.22.12	66.3	66.1	-0.2
M-5	Capital Quarters (4th/5th)	5.22.12	65.0	65.6	0.6
M-6	Capper Seniors	5.22.12	68.3	68.9	0.6
M-7	1012 7th Street	5.22.12	61.4	64.1	2.7
M-8	Building at 8th Street	5.22.12	67.2	68.5	1.3
M-9	Virginia Avenue Park	5.22.12	60.9	60.9	0.0
M-10	Garfield Park	5.30.12	65.0	61.4	-3.6
M-11	Corner of G and 3rd Streets	5.30.12	64.4	66.2	1.8
M-12	726 4th Street	5.30.12	68.5	68.3	-0.2
M-13	Corner of 6th and I Streets	5.30.12	65.3	66.3	1.0
M-14	619-645 I street	5.30.12	66.1	67	0.9
M-15	706 I Street	5.30.12	67.3	68.8	1.5
M-16	Corner of 9th and I Streets	5.30.12	65.9	65.8	-0.1

3.5.4 Evaluation of Traffic Noise Impacts

The noise levels from the future no-build year and construction year were compared to the existing sound levels to evaluate increases over existing year noise levels due to traffic detours and to determine if there would be any noise impacts. These comparisons are summarized in Exhibit 17, using the noise analysis sites shown in Exhibit 18. The FHWA TNM was used to predict exterior noise levels for all 26 receiver sites identified as Receivers A-1 to A-26 in Figures 17 and 18. These receptors represent additional analysis locations, while sites M-1to M-16) were based on the field measurement and were used for model validation purposes only. Increase over existing (I.O.E) noise levels were generally the result of normal traffic growth predicted to occur between 2011 and 2015. These increases were in the imperceptible range of zero to one dB for all receptors, and as such were not high enough to indicate an impact. None of the studied sensitive receptors were predicted to experience noise impacts from vehicular traffic using detour routes during construction.

Exhibit 17. Existing 2011, Future No-Build 2015 and Construction Year 2015 Predicted Noise Levels

Site ID	Existing Noise Levels (dB(A))	Future No-Build (2015)		Future Construction (2015)	
		Noise Levels (dB(A))	I.O.E (dB)	Noise Levels (dB(A))	I.O.E. (dB)
A-1	71	71	0	71	0
A-2	72	72	0	72	0
A-3	71	72	1	72	1
A-4	72	72	0	72	0
A-5	70	70	0	70	0
A-6	70	71	1	70	0
A-7	71	71	0	71	0
A-8	72	72	0	71	-1
A-9	70	70	0	70	0
A-10	69	69	0	69	0
A-11	70	70	0	70	0
A-12	72	72	0	72	0
A-13	70	70	0	69	-1
A-14	68	68	0	68	0
A-15	67	67	0	67	0
A-16	68	68	0	68	0
A-17	69	69	0	69	0
A-18	71	71	0	71	0
A-19	76	77	1	76	0
A-20	74	74	0	74	0
A-21	70	70	0	70	0
A-22	71	71	0	71	0
A-23	72	72	0	72	0
A-24	71	71	0	70	-1
A-25	69	69	0	68	-1
A-26	71	71	0	71	0

N.B.: Future Construction represents the noise levels for each of the three ‘build” alternatives

3.5.5 Summary

Normal traffic growth can be expected to generally increase noise levels by up to 1 dB in the vicinity of the Project Area. Such an increase is not discernible. Based on the analysis of noise reported herein, no noise impacts exist for all 26 receivers. Therefore, none of the three project ‘build’ alternatives are expected to perceptibly or adversely impact existing traffic noise levels.

EXHIBIT 18

HIGHWAY NOISE ANALYSIS SITES

4. References

1. Federal Railroad Administration (FRA). *CREATE Noise and Vibration Assessment Methodology*. December 2007.
2. Federal Transit Administration (FTA). *Transit Noise and Vibration Impact Assessment*. U.S. Department of Transportation Report No. FTA-VA-90-1003-06, May 2006.
3. U.S. Department of Transportation, Federal Highway Administration. *FHWA Traffic Noise Model User's Guide*. FHWA-PD-96-009, January 1998
4. U.S. Department of Transportation, Federal Highway Administration. *FHWA Roadway Construction Noise Model User's Guide*. FHWA-HEP-05-054, January 2006
5. U.S. Department of Transportation, Federal Highway Administration. *FHWA Construction Noise Handbook*. FHWA-HEP-06-015, August 2006

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Appendix F

Vibration Analysis Report

VIRGINIA AVENUE TUNNEL RECONSTRUCTION PROJECT

Revised March 2014

VIBRATION ANALYSIS REPORT

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VIRGINIA AVENUE TUNNEL
RECONSTRUCTION PROJECT
WASHINGTON, DC

VIBRATION ANALYSIS REPORT

REVISED: March 2014

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ACRONYMS AND ABBREVIATIONS

AAR	Association of American Railroads
CSX	CSX Transportation, Inc.
DDOT	District of Columbia Department of Transportation
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HVAC	Heating, Ventilation, and Air Conditioning
NEPA	National Environmental Policy Act
PPV	Peak Particle Velocity
RMS	Root Means Square
USDOT	United States Department of Transportation
VAT	Virginia Avenue Tunnel
VdB	Vibration decibel

STANDARDS

The following guidelines were utilized for the vibration impact and mitigation assessment:

Federal Transit Administration, May 2006. *Transit Noise and Vibration Impact Assessment*, Technical Manual FTA-VA-90-1003-06.

ES EXECUTIVE SUMMARY

This study was conducted to assess potential vibration impacts during and after the proposed reconstruction of the Virginia Avenue Tunnel (VAT), which is located in the Capitol Hill neighborhood of the District of Columbia. Built over 100 years ago, the 3,800 foot long tunnel is located beneath eastbound Virginia Avenue SE from 2nd Street SE to 9th Street SE; beneath Virginia Avenue Park between 9th and 11th Streets SE; as well as the 11th Street Bridge right-of-way. The tunnel is also aligned along the south side of Interstate 695. The tunnel portals are located a short distance west of 2nd Street SE and a short distance east of 11th Street SE. CSX Transportation proposes to replace the existing single-track tunnel with a newly constructed two-track configuration that provides the necessary vertical clearance (minimum 21 feet) to allow for double-stack intermodal container freight train operations.

STUDY OVERVIEW AND SCOPE

This study was conducted in accordance with the procedures outlined in the Federal Transit Administration's *Transit Noise and Vibration Impact Assessment* guidelines (FTA 2006). Utilizing the FTA guidelines and applicable criteria, vibration impacts were evaluated for human annoyance, impact to special buildings, and building damage as applicable to each of the project alternatives during construction and subsequent freight operations. The Federal Railroad Administration (FRA) also uses the same guidelines for evaluating train vibration impacts. The scope of the study is summarized in **Table ES-1**.

Table ES-1. Vibration Study Scope

TOPIC EVALUATED	ALTERNATIVES			
	ALTERNATIVE 1 – EXISTING / NO BUILD	ALTERNATIVE 2 – REBUILT TUNNEL / TEMPORARY RUNAROUND TRACK	ALTERNATIVE 3 – TWO NEW TUNNELS	ALTERNATIVE 4 – NEW PARTITIONED TUNNEL / ONLINE REBUILD
Human Annoyance from Construction	Not applicable	Evaluated	Evaluated	Evaluated
Impact to Special Buildings from Construction	Not applicable	Evaluated	Evaluated	Evaluated
Building Damage from Construction	Not applicable	Evaluated	Evaluated	Evaluated
Human Annoyance from Train Operations	Evaluated	Evaluated	Evaluated	Evaluated
Impact to Special Buildings from Train Operations	Evaluated	Evaluated	Evaluated	Evaluated
Building Damage from Train Operations	Evaluated	Evaluated	Evaluated	Evaluated

"Special Buildings" is an FTA designation for buildings that can be sensitive to vibration. The band practice area at the US Marine Corps facility (Room G62 in Building 25) was evaluated using the FTA "Special Building" criteria as part of this study.

STUDY METHODOLOGY: CONSTRUCTION

Vibration during the construction of this project would result primarily from the utilization of specialty construction equipment in the performance of major construction activities such as removal of the existing surface roadway and underground tunnel elements, installation of support of excavation measures, excavation and backfill for the proposed tunnel reconstruction, as well as restoration of the Virginia Avenue roadway and streetscape. Vibration levels produced by construction equipment were obtained from the FTA *Transit Noise and Vibration Impact Assessment* (FTA 2006). Based on the typical vibration levels for the various pieces of construction equipment anticipated to be used, calculations were performed to determine the distances at which potential vibration impacts could occur during the various construction activities. Distances from the construction activity to nearby buildings were calculated based on the proposed location of each build alternative and the specific construction functions that would need to be performed for that alternative.

The results of these calculations were compared to the FTA Criteria for Human Annoyance, Special Buildings, and Building Damage. For this study a conservative approach was utilized by applying the FTA limit specified for "fragile buildings" to all buildings, regardless of the type and age.

STUDY METHODOLOGY: TRAIN OPERATIONS

Existing background and train pass-by vibration levels were measured at 12 sites along the Virginia Avenue Tunnel. Results of these vibration measurements provided data that were used to:

- Determine vibration levels generated by train pass-bys. The highest recorded train vibration level was used as the train vibration source in calculating the impact distances in order to avoid understating future vibration levels.
- Calculate the degree to which the existing tunnel structure reduces vibrations from train pass-bys.
- Calculate the vibration transferability characteristics of the soil.

The measured data was used to depict vibration levels from current train operations at nearby buildings under Alternative 1 (Existing /No Build). Furthermore, this data then served as the basis to predict the potential impacts from train operations for Build Alternatives 2, 3, and 4. The following issues were addressed in this process:

- The centerline of the southernmost track in the proposed tunnel locations for each of the three candidate build alternatives was utilized to determine the distance between the vibration sensitive receptors (buildings and people) and the vibration sources (construction and train operations).

- The shallowest tunnel depth adjacent to the sensitive receptors was used for calculating the highest possible vibration levels which would be produced from train operations.
- The proposed maximum operating train speed for the new tunnels of 40 mph was used. This is the most conservative approach which would predict higher vibration levels.
- The proposed track configuration for each of the build alternatives was used, including the elimination of the existing "turnout", (a transfer point between two tracks) near the east tunnel portal where the single track in the tunnel transitions to a two track configuration.
- Vibration impact predictions assumed two trains were traveling in the tunnel simultaneously.
- Train weight was evaluated and was not modified for assessing vibration impacts during future operations. Locomotives are the heaviest component of a freight train. Changes in locomotive weight or the number of locomotives utilized per train are not anticipated. Replacing the tunnel will introduce double-stacked intermodal container operations to this segment of the rail network. However, historical data for the rail industry clearly indicates that intermodal containers are one of the lightest classes of freight shipped by rail. Trains that are primarily or entirely comprised of double-stacked intermodal containers weigh less than many current trains currently utilizing the Virginia Avenue Tunnel (see Chapter 2 for additional information).
- Reconstruction of the tunnel under any of the candidate build alternatives would include replacing the existing dirt track bed with a 3-foot thick concrete slab. A large mass such as a 3-foot thick reinforced concrete slab will reduce the vibration energy generated by train operations. **However, this potential reduction in vibration provided by the reinforced concrete floor was <u>not</u> considered** when modeling future vibration levels from train operations under any of the build alternatives. This is a very conservative approach and would predict higher vibration levels than are anticipated with the modern track bed that will be used.

STUDY FINDINGS: GENERAL

- The soil vibration transferability characteristics along the entire length of the tunnel are consistent and predictable at varying distances from the tunnel. This, in combination with the observed geologic features of the area, supports the finding that the calculated vibration transferability characteristics of the soils at the specific data collection sites are applicable along the entire length of the tunnel.
- The degree to which the existing tunnel structure reduces vibration transmission into the surrounding soils from train operations is consistent and likewise predictable along the entire length of the tunnel. This supports the finding that the calculated vibration reductions from the proposed tunnel structure for each build alternative are applicable along the entire length of the tunnel.
- Vibration measurements conducted in May 2012 and December 2013 did not reveal any major differences between tunnel reduction effect and soil transferability characteristics.

- Numerous vibration events were recorded when there were no train operations in the tunnel. Many of these events produced vibration levels that were of equal or greater magnitude than vibration levels generated from train operations. It was beyond the scope of this study to determine the specific nature of the events causing these vibrations. However, neither the frequency nor the magnitudes of these "non-train" vibrations are unusual in an urban environment.
- There was one observed instance in the December 2013 data where a high vibration incident unrelated to train operations occurred during a train passage. This was determined to be a concurrent event by analyzing the vibrations from that same train at other locations along the tunnel. In addition there were numerous additional vibration events not related to train passage that were recorded that were equal or greater than those recorded during train passage.

Specific impacts of the vibration study are summarized in **Table ES-2** and are discussed in further detail in the following sections.

Table ES-2. Vibration Study Results

TOPIC EVALUATED	ALTERNATIVES			
	ALTERNATIVE 1 – EXISTING/ NO BUILD	ALTERNATIVE 2 – REBUILT TUNNEL / TEMPORARY RUNAROUND TRACK	ALTERNATIVE 3 – TWO NEW TUNNELS	ALTERNATIVE 4 – NEW PARTITIONED TUNNEL / ONLINE REBUILD
Human Annoyance from Construction	Not applicable	Potential Impact - Mitigation Required	Potential Impact - Mitigation Required	Potential Impact - Mitigation Required
Impact to Special Buildings from Construction	Not applicable	None Predicted	None Predicted	None Predicted
Building Damage from Construction	Not applicable	None Predicted	None Predicted	None Predicted
Human Annoyance from Train Operations	None Detected	None Predicted	None Predicted	None Predicted
Impact to Special Buildings from Train Operations	None Detected	None Predicted	None Predicted	None Predicted
Building Damage from Train Operations	None Detected	None Predicted	None Predicted	None Predicted

STUDY FINDINGS: CONSTRUCTION

- **Human Annoyance:** There will be the potential for human annoyance impacts during certain construction operations for each of the build alternatives. Mitigation measures would be considered if construction activities or equipment were to operate close to residential or institutional buildings and potentially cause human annoyance. In addition, contractors may need to use different types of equipment for each activity versus those used for predicting vibration in this study; therefore, a plan will be put in place where vibration levels will be monitored during construction. If measurement results show that vibration levels exceed impact thresholds, construction methods will be reevaluated to bring vibrations back under the thresholds where possible or mitigations will be implemented. (Further information on potential vibration mitigations can be found in Chapter 6 of this report.)

- **Special Buildings:** The Marine Band Practice Hall is considered as an auditorium under the special building category of FTA guidelines. Results of the existing vibration measurements indicated that some of the building internal sources, such as HVAC system are a prevalent source of vibration. Construction or operation vibration impacts are not predicted in the Practice Hall.
- **Building Damage:** There would be no vibration related building damages due to construction operations under any of the build alternatives.

STUDY FINDINGS: TRAIN OPERATIONS

- **Human Annoyance**: Results of vibration measurements and modeling indicate that there is "No Impact" to human annoyance per FTA guidelines from train operations under any of the Build Alternative tunnel configurations. Measurements and modeling show that train operation vibrations would cause human annoyance at distances ranging from 12 to 30 feet from the center of the track depending on the alternative. See **Table ES-3** for additional details.

Table ES-3. Vibration Impact Distances from Train Operations (Centerline of Tracks) in the Tunnel

ALTERNATIVES	DISTANCE TO POTENTIAL VIBRATION HUMAN ANNOYANCE (FEET)
Existing/No Build	12
Alternative 2 (open trench during construction)	12
Alternative 2	30
Alternative 3	30
Alternative 4	30

While Alternatives 2, 3, and 4 have equal vibration impact distances the proposed tunnel alignments vary by alternative. Between 2nd and 9th Streets Alternative 3 would be aligned closest to the sensitive receptors and the centerline of the southernmost track would be approximately 15 feet south of the exterior face of the existing tunnel's south wall. However, even in this area, the nearest buildings are at least 12 feet further away from the outside limit for human annoyance (i.e., 42 feet from the proposed track centerline). Therefore, the conclusion of "None Predicted" is an appropriate finding for the potential of future train operations to exceed the human annoyance threshold for any of the candidate build alternatives in accordance with FTA guidelines. As indicated in Table ES-3, human annoyance impacts would not occur at distances greater than 30 feet away from the track centerline even if there were two trains traveling through the tunnel or tunnels at the same time. Accordingly, vibration impacts are not anticipated to result from future, post-construction train operations because the nearest residential building to any of the candidate build alternative alignments is located at least 42 feet from the southernmost proposed track centerline.

- **Impact to Special Buildings**: Results of the analysis indicates that there would be no impacts at the Marine Band Practice Hall (Room G62 in Building 25) per the FTA guidelines for an auditorium.
- **Building Damage**: The analysis indicates that under all of the candidate build alternatives, nearby building structures are not expected to be impacted**.** The calculated

impact distance (27 feet from track centerline) for potential building damage vibration is less than the minimum depth from the ground surface to the bottom of the tunnel of 34 feet. Furthermore, the shortest possible path between the vibration source (track center line) and a building structure is 52 feet. Therefore, any building at ground level, even a hypothetical structure located directly above the tunnel, would not be damaged by train operations. (See Figure 5-1 and Table 5-6 in Chapter 5 of this report for further details).

1 INTRODUCTION

1.1 PURPOSE OF VIBRATION STUDY

The purpose of this study is to evaluate existing and assess future vibration levels at sensitive locations along the Virginia Avenue Tunnel (VAT) Reconstruction Project. This report was updated in order to reflect comments and input received from the Federal Highway Administration (FHWA), District Department of Transportation (DDOT), other governmental agencies and the public. Additional vibration tests were conducted in December 2013 to characterize the existing vibration levels at several of the buildings closest to the proposed project during a typical 24 hour period and results were used to further refine the predicted vibration affects from the proposed project.

The study results are described in six sections. Chapter 1 presents the Virginia Avenue Tunnel project description. Chapter 2 explains general vibration terminology. Chapter 3 presents the guidelines and criteria used to assess the potential vibration impacts. Chapter 4 presents the results of baseline vibration measurements. Chapter 5 analyzes the potential impacts of construction and future train operations through the tunnel. Chapter 6 discusses possible mitigation measures that could be implemented to reduce potential vibration impacts of the proposed project.

1.2 PROJECT DESCRIPTION

CSX Transportation, Inc. (CSX) is proposing to reconstruct the Virginia Avenue Tunnel. The tunnel is located in the Capitol Hill neighborhood of the District of Columbia, as shown in **Figure 1-1**. The existing tunnel is 3,800 feet in length and aligned along the south side of Interstate 695 (I-695), located beneath eastbound Virginia Avenue SE from 2nd Street SE to 9th Street SE; Virginia Avenue Park between 9th and 11th Streets SE; and the 11th Street Bridge right-of-way. The tunnel portals are located a short distance west of 2nd Street SE and a short distance east of 11th Street SE. The tunnel is an integral part of CSX's freight rail network that encompasses approximately 21,000 miles of railroad track in the District, 23 states, and the Canadian provinces of Ontario and Quebec. Specifically, the tunnel is located along CSX's eastern seaboard freight rail corridor, which stretches from the southeast through the Mid-Atlantic and connecting to the Midwest, thereby making it a key link in the nation's network of major freight rail lines.

If the Virginia Avenue Tunnel were not replaced or reconstructed, it will continue to require increasingly higher levels of investment for maintenance and repair, resulting in more frequent service interruptions and higher risks for localized disturbances. In addition, the tunnel has notable operational deficiencies. Specifically, the tunnel has just a single railroad track, which limits the flow of freight train traffic. Virginia Avenue Tunnel was identified as a bottleneck on the east coast (District of Columbia Freight Forum, Volume 1, Issue 1 [January 2012]). Furthermore, the tunnel does not have sufficient vertical clearance to accommodate rail cars that are loaded with two intermodal containers set one on top of the other, which is called

"double-stacking". The VAT Reconstruction Project will transform the tunnel to a two-track configuration and provide the necessary vertical clearance to allow double-stack intermodal container freight train operations. Reconstruction of the tunnel will allow more efficient freight movement (Freight Forum, January 2012). In order to accommodate double-stack intermodal container freight trains, track lowering will be required at the New Jersey Avenue SE Overpass to provide the 21-foot minimum clearance as well as in the reconstructed tunnel.

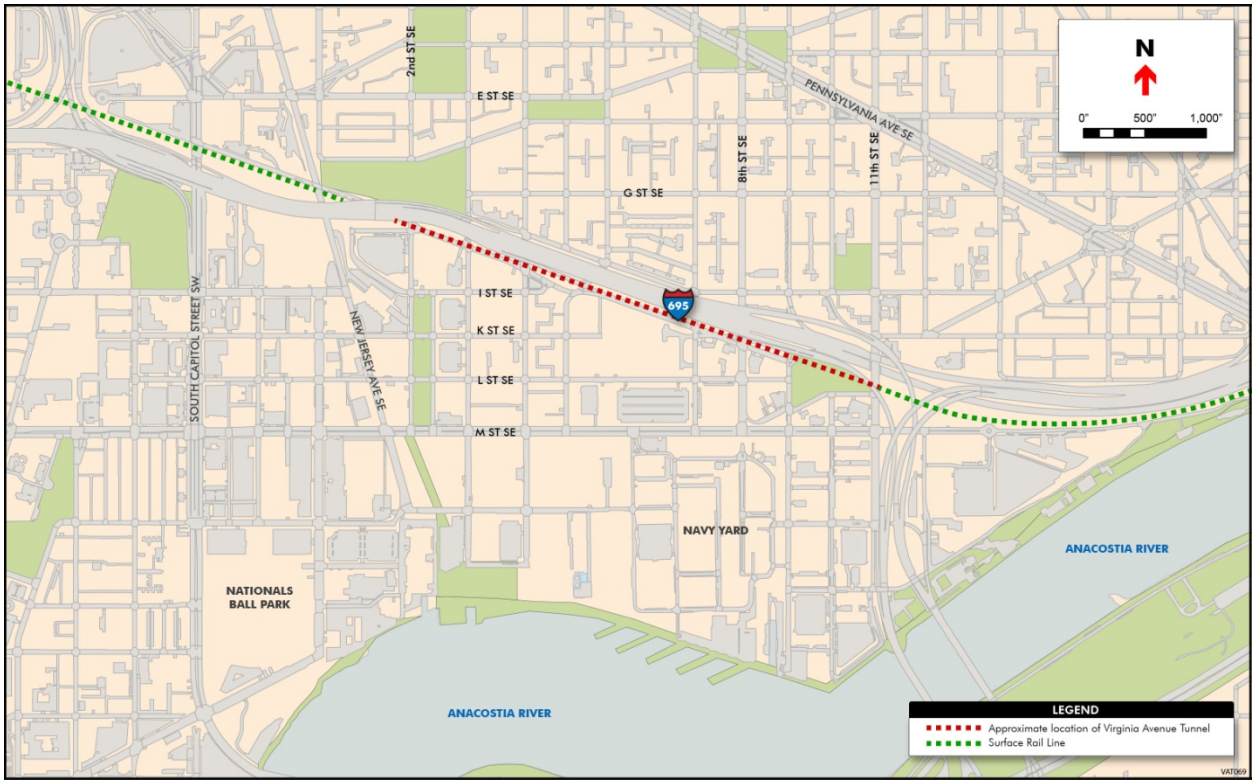

Figure 1-1. Project Location Map

The following alternatives are being considered for the project:

Alternative 1 – No Build: The tunnel would not be rebuilt under this alternative. However, the railroad would continue to operate trains through the tunnel and at some point, emergency or unplanned major repairs or rehabilitation could be required to this critical, aging infrastructure that might prove disruptive to the community. See **Figure 1-2** at the end of this chapter.

Alternative 2 – Rebuilt Tunnel / Temporary Runaround Track: This alternative involves rebuilding the existing Virginia Avenue Tunnel. It would be rebuilt with two railroad tracks and adequate vertical clearance to accommodate double-stack intermodal container freight trains. It would be rebuilt in generally the same location, except the centerline of the rebuilt two-track tunnel would be aligned approximately seven feet to the south of the existing tunnel center line. It would be rebuilt using protected open trench construction methods. During construction, freight trains would be temporarily routed through a protected open trench outside the existing tunnel (runaround track). The runaround track would be aligned to the south and generally parallel to the existing tunnel, and would be located below street level. Due to new columns associated with the rebuilt 11th Street Bridge, the runaround track would

slightly separate from the tunnel alignment on the east end starting just west of Virginia Avenue Park. Safety measures such as securing fencing would be used to prevent pedestrians and cyclists from accessing the runaround track. See **Figure 1-3** at the end of this chapter.

Alternative 3 – Two New Tunnels: This alternative involves replacing the existing Virginia Avenue Tunnel with two new permanent tunnels constructed sequentially. Each new tunnel would have a single railroad track with enough vertical clearance to allow double-stack intermodal container freight trains. A new parallel south side tunnel would be built first as trains continue operating in the existing Virginia Avenue Tunnel. This tunnel would be built using protected open trench construction methods. After the south side tunnel is completed, train operations would switch over to the new tunnel and the existing Virginia Avenue Tunnel would be demolished and rebuilt. With the exception of operating in a protected open trench for approximately 230 feet immediately east of the 2nd Street SE portal (within the Virginia Avenue SE segment between 2nd and 3rd Streets SE), trains would operate in enclosed tunnels throughout construction under Alternative 3. Throughout most of the length of the rebuilt tunnel, the two tunnels would be separated by a center wall. This center wall would be the new centerline of the two tunnels, and it would be aligned approximately 25 feet south of the existing tunnel centerline, between 2nd and 9th Streets SE. Due to new columns associated with the rebuilt 11th Street Bridge, the tunnels would be separated on the east end starting just west of Virginia Avenue Park, resulting in two separate single-track tunnels and openings at the east portal. See **Figure 1-4** at the end of this chapter.

Alternative 4 – New Partitioned Tunnel / Online Rebuild: Alternative 4 would result in a new tunnel with two permanent tracks. Similar to Alternative 3, the new tunnel would be partitioned and have enough vertical clearance to allow double-stack intermodal container freight trains. It would be aligned approximately 17 feet south of the existing tunnel's centerline. The new tunnel would be built using protected open trench construction methods. The rebuild would occur 'online', meaning that during the period of construction, the protected open trench would accommodate both construction activities and train operations. Maintaining safe and reliable temporary train operations is a more complicated endeavor under Alternative 4 than under the other two Build Alternatives because of the online rebuild approach. See **Figure 1-5** at the end of this chapter.

Under all candidate build alternatives, the total length of the rebuilt Virginia Avenue Tunnel will be extended by approximately 330 feet on the east end. The new east tunnel portal will be located northeast of the existing M Street SE / 12th Street SE T-intersection.

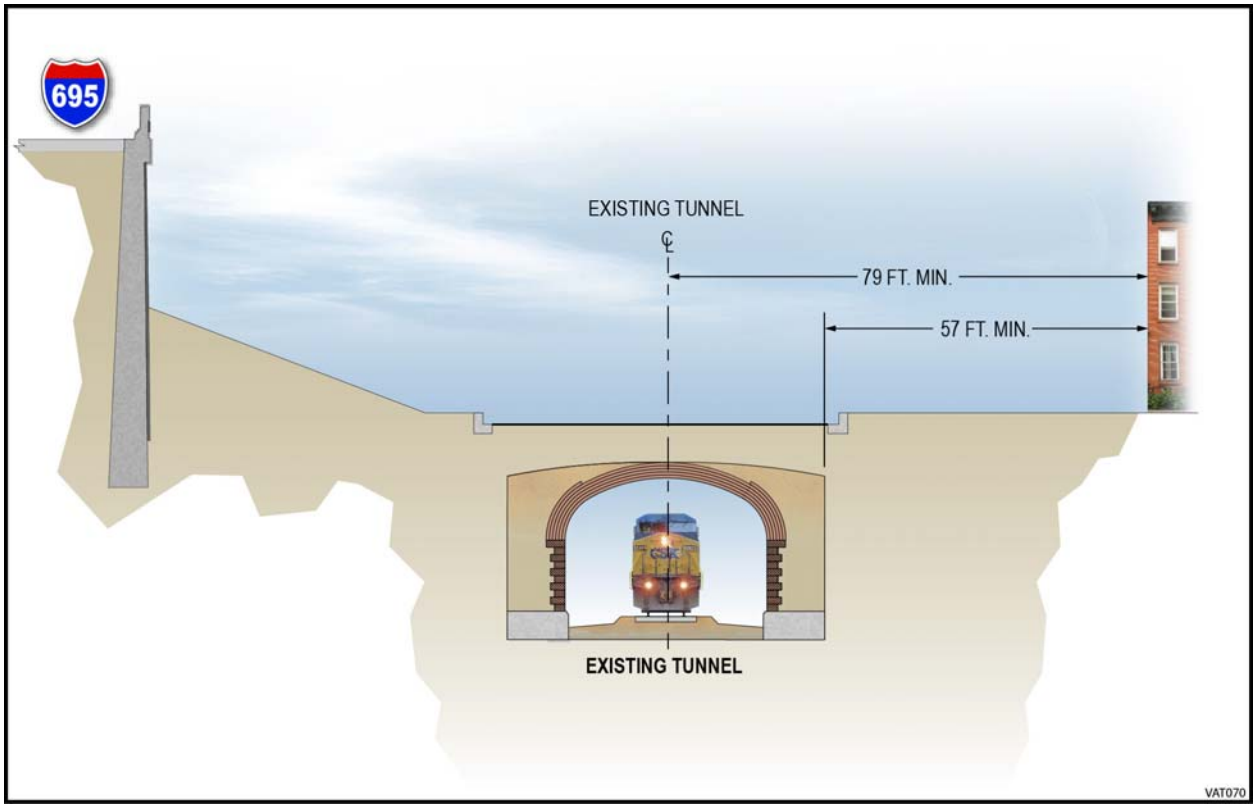

Figure 1-2. Alternative 1 – No-Build

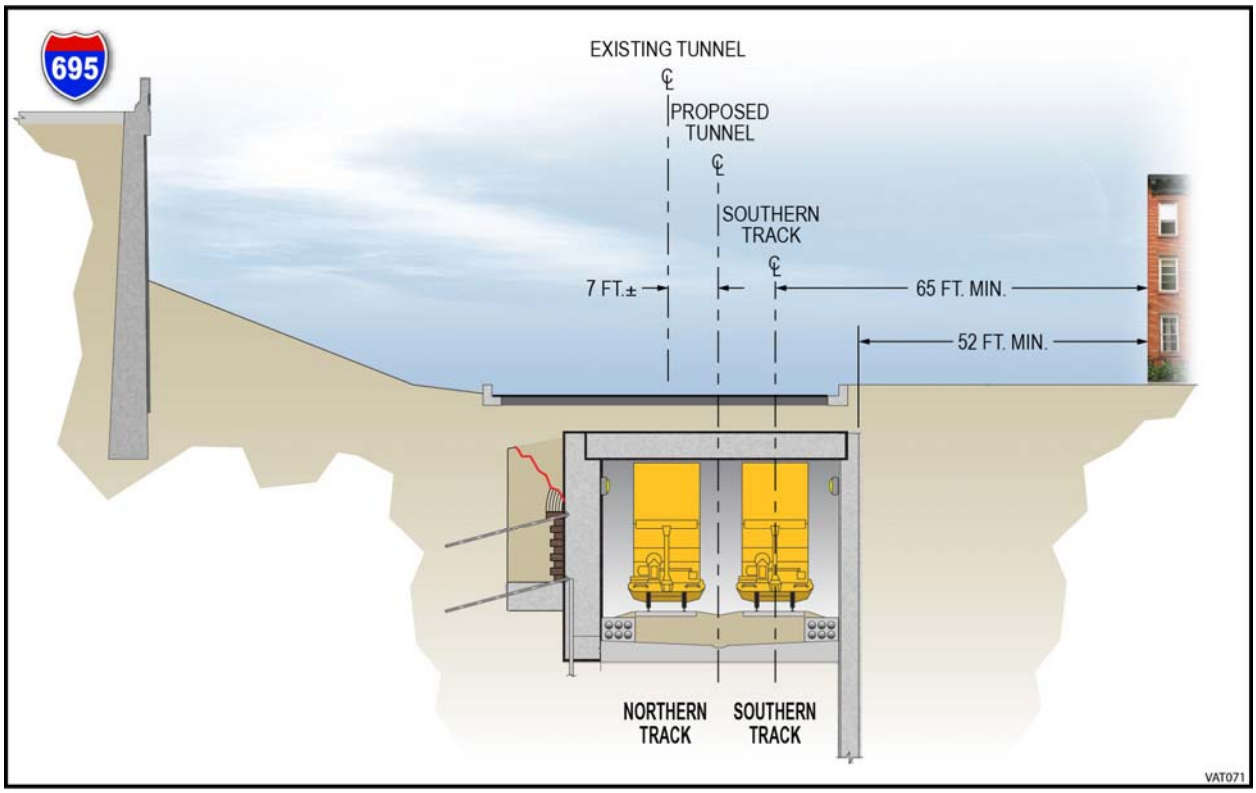

Figure 1-3. Alternative 2 – Rebuilt Tunnel / Temporary Runaround Track

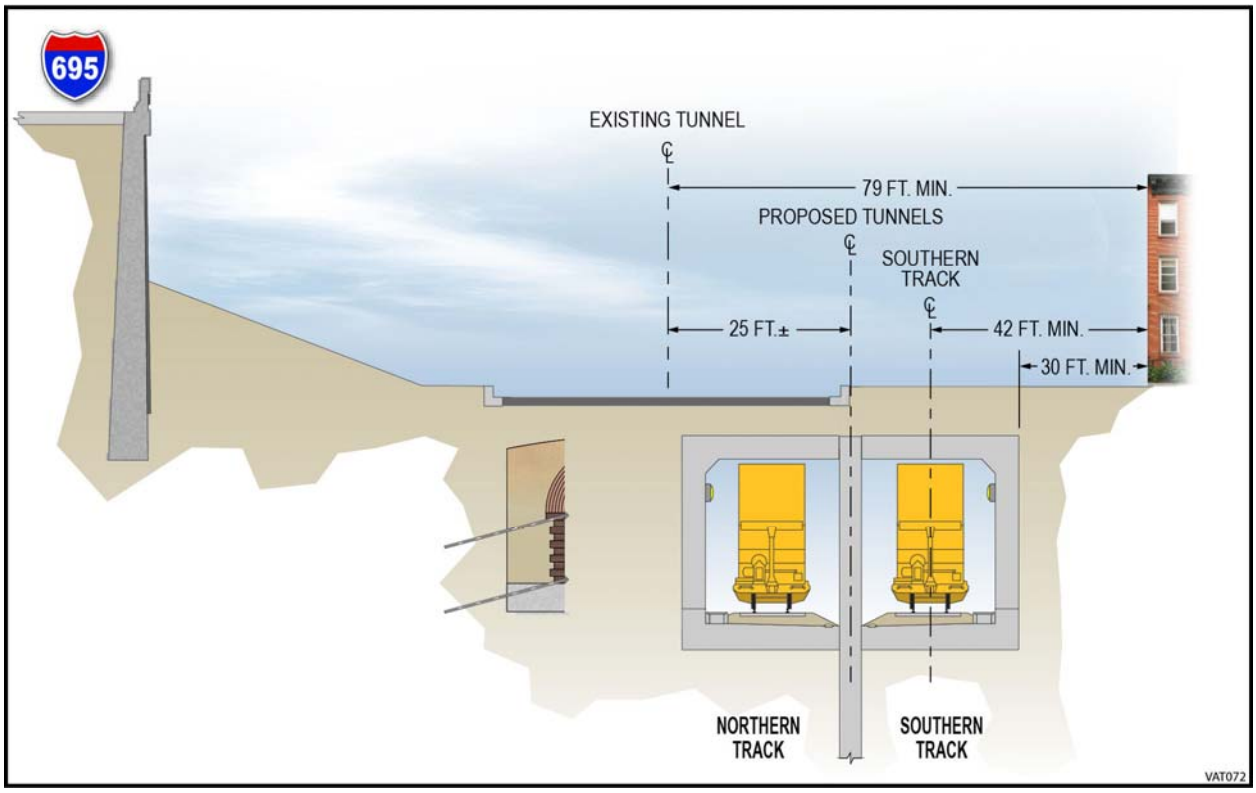

Figure 1-4. Alternative 3 – Two New Tunnels

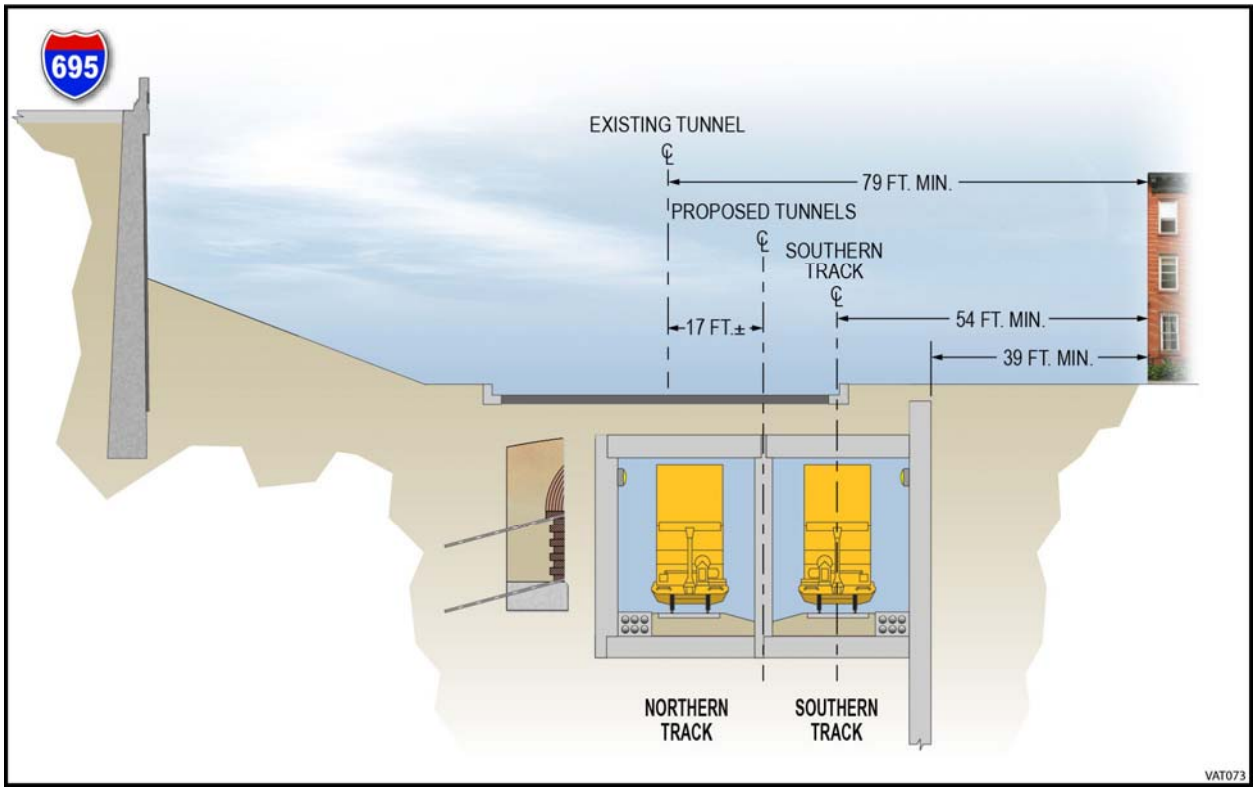

Figure 1-5. Alternative 4 – New Partitioned Tunnel / Online Rebuild

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2 VIBRATION BACKGROUND

This section describes the basic concepts and general terminology of vibration and provides background for the assessment procedures described in the later sections.

Vibration is an oscillatory motion that can be described in terms of displacement, velocity, or acceleration. Displacement, in the case of a vibrating floor, is simply the distance that a point on the floor moves away from its static position. The velocity represents the instantaneous speed of the floor movement, and acceleration is the rate of change of the speed. The response of humans, buildings, and equipment to vibration is normally described using velocity or acceleration. In this report, velocity will be used to describe ground-borne vibration.

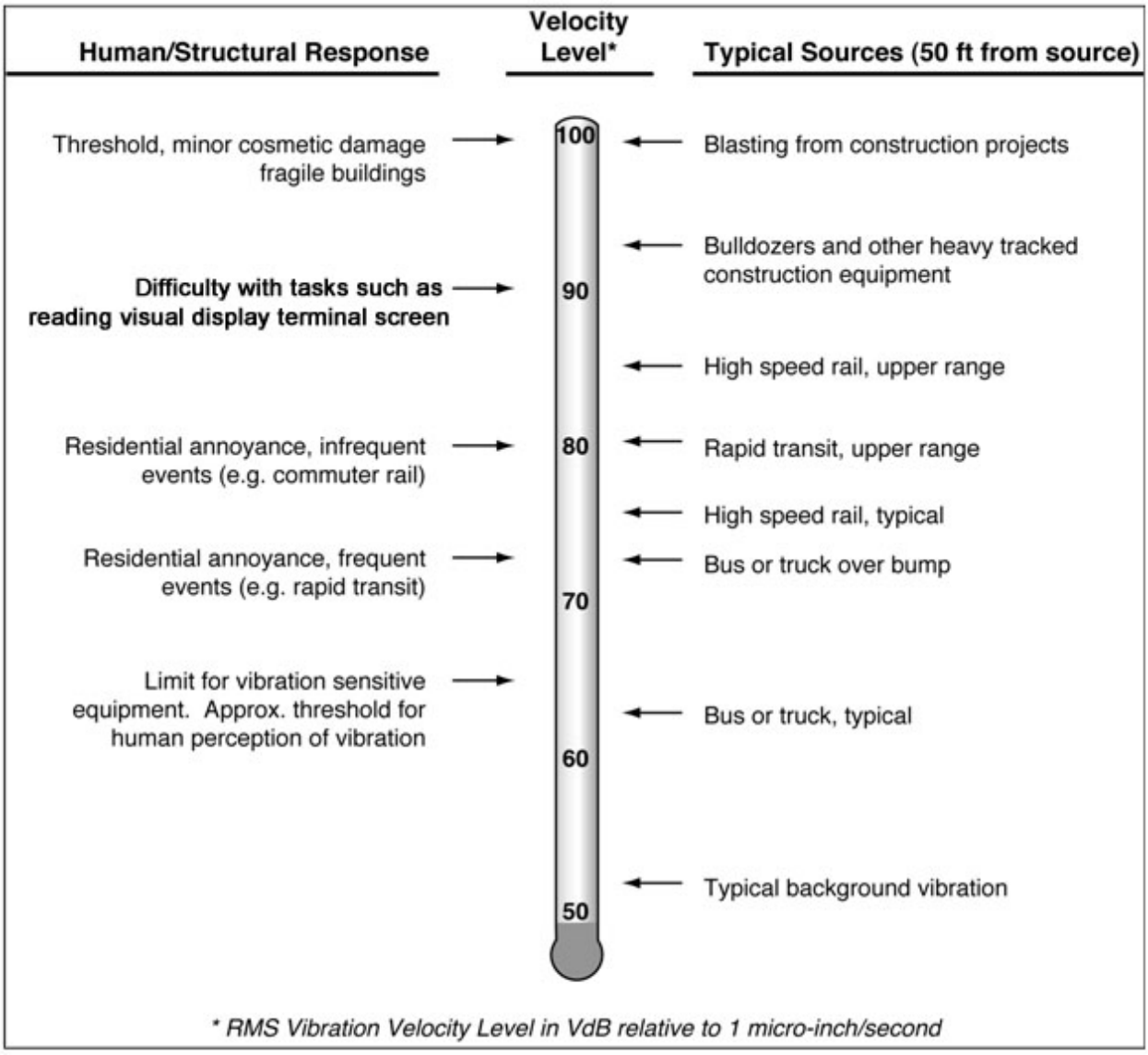
Vibration amplitudes are usually expressed as either peak particle velocity (PPV) or the root mean square (RMS) velocity. The PPV is defined as the maximum instantaneous peak of the vibration signal in inches per second. The RMS of a signal is the average of the squared amplitude of the signal in inches per second. Although PPV is appropriate for evaluating the potential of building damage, it is not suitable for evaluating human response. Since it takes some time for the human body to respond to vibration signals, RMS amplitude is more appropriate to evaluate human response to vibration than PPV.

The Federal Transit Administration (FTA), a division of the U.S. Department of Transportation (USDOT), uses the abbreviation "VdB" for vibration decibels (FTA, 2006) to reduce the potential for confusion with sound decibel. When determining the VdB level for vibration sources such as trains, first a conversion factor of 4 is applied to the measured PPV value to obtain the RMS value. This conversion number is known as the crest factor and is the ratio between the PPV amplitude and the RMS amplitude. Next, the RMS vibration value is logarithmically adjusted against the reference value of 1 micro-inch per second and multiplied by 20 to be expressed in VdB values used throughout this report and shown as the following equation:

$$VdB = 20\, x\, Log10(\frac{v}{vref})$$

Where: v = PPV/4 and $vref$ = 1× 10-6 in/sec

Figure 2-1 illustrates common vibration sources and the corresponding human and structural response to the associated ground-borne vibration. As shown in the figure, the threshold of perception for human response is approximately 65 VdB; however, human response to vibration is not usually significant unless the vibration exceeds 70 VdB.



Source: FTA, 2006

Figure 2-1. Typical Levels of Ground-Borne Vibration

VIBRATION FROM TRAINS

Vibration from trains is caused by interaction of the wheels rolling on the tracks when moving. The force caused by this interaction depends on train speed, the smoothness of the rails and wheels, and the resonance frequencies of the vehicle suspension and track support systems. When vibration does occur, it is then radiated into the surrounding ground. The extent to which the vibration waves propagate away from the track depends upon factors such as the strength of the original wave, the depth to bedrock, and the soil type. However, the amplitude of the wave is typically diminished with distance. This diminishment of energy results from both the material dampening of the wave created by the medium and the expansion of the wave front. If the vibration reaches building foundation, it can cause floor, walls, and ceiling in living spaces to vibrate.

VIBRATION FROM CONSTRUCTION

An additional source of vibration would be related to the construction of the proposed Virginia Avenue Tunnel. The operation of construction equipment causes ground vibrations that spread through the surrounding ground. While these vibrations tend to diminish over distance, depending upon the type of construction equipment and duration of the activity, nearby sensitive receptors could be affected. Human annoyance from construction is typically dependent upon the extent, distance, and duration of the vibration generating activities. As with vibration created from train operations, construction-related vibration rarely causes structural damage to normal building structures. However, some building damage can occur when construction-related activities are near older, more fragile buildings. As a result, construction-related vibration impact criteria give special consideration to these more fragile buildings.

VIBRATION SOURCE

The highest vibration levels typically generated by a freight train pass-by are from the locomotive itself. In general, train pass-by vibration levels are directly related to the weight of both the locomotive and the freight cars; heavier trains traveling at the same speed and on the same tracks will produce higher vibration levels. Note that factors such as speed, stiff primary suspension on the vehicle, and flat or worn wheels will increase the potential for ground-borne vibration.

Train weight was evaluated and was not modified for assessing vibration impacts during future operations. Locomotives are the heaviest component of a freight train. Modern 6-axle freight locomotives generally weigh 210 to 216 tons. Changes in locomotive weight or the number of locomotives utilized per train are not anticipated.

Replacing the tunnel will introduce double stacked intermodal container operations to this segment of the rail network. However, industry data for the rail industry indicates that intermodal containers are one of the lightest classes of freight shipped by rail. Most sizes or types of intermodal containers have a maximum allowable weight of 19 to 22 tons. Data from the Association of American Railroads (AAR) shows that freight railcars transporting intermodal containers have an average weight of 15 tons. By comparison numerous other commodities shipped by rail are heavier according to AAR data. This includes:

- Food and Food Products 65 tons per freight car
- Lumber & Wood Products 78 tons per freight car
- Grain 95 tons per freight car
- Sand and Gravel 101 tons per freight car
- Coal 116 tons per freight car

Freight trains comprised of double-stacked intermodal containers will weigh less than many of the current trains currently utilizing the Virginia Avenue Tunnel.

The length of the train is not a major factor when evaluating possible building damage. However, while peak vibration intensity is typically not higher for longer trains, they can cause greater annoyance due to the duration of the event.

Finally, the height of the freight car also does not directly influence the vibration intensity; double-stack freight cars do not produce higher vibrations just because they are carrying two containers.

3 IMPACT CRITERIA

This section presents the guidelines, criteria, and regulations that were used to assess vibration impacts associated with the proposed project. The District of Columbia Department of Transportation (DDOT) environmental regulations do not address potential vibration impacts; therefore, the criteria in the FTA *Transit Noise and Vibration Impact Assessment* (FTA 2006) were used to evaluate vibration impacts from tunnel construction and train operations. The evaluation of vibration impacts can be divided into two categories: (1) human annoyance and (2) building damage.

3.1 OPERATION VIBRATION IMPACT CRITERIA

HUMAN ANNOYANCE CRITERIA

Table 3-1 presents the human annoyance criteria for various land use categories by frequency of events. The criteria establish the limits beyond which ground-borne vibration would cause human annoyance or interfere with the use of vibration sensitive equipment. The criteria are expressed in terms of RMS velocity levels. PPV has been added to this table to allow for an easier comparison with the measured data for this project (which is described further in Chapter 4).

Table 3-1. Land Use Categories and Metrics for Rail Vibration Impact Criteria

LAND USE CATEGORY	GROUND-BORNE VIBRATION IMPACT LEVELS PPV AND VdB [5]					
	FREQUENT EVENTS[1]		OCCASIONAL EVENTS[2]		INFREQUENT EVENTS[3]	
Category 1: Buildings where vibration would interfere with interior operations.	0.007 in/sec	65 VdB[4]	0.007 in/sec	65 VdB[4]	0.007 in/sec	65 VdB[4]
Category 2: Residences and buildings where people normally sleep.	0.016 in/sec	72 VdB	0.023 in/sec	75 VdB	0.040 in/sec	80 VdB
Category 3: Institutional land uses with primarily daytime use.	0.023 in/sec	75 VdB	0.032 in/sec	78 VdB	0.056 in/sec	83 VdB

Source: FTA, 2006.

Notes:

1. "Frequent Events" is defined as more than 70 vibration events per day.
2. "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day.
3. "Infrequent Events" is defined as fewer than 30 vibration events per day.
4. This criterion limit is based on levels that are acceptable for most moderately sensitive equipment, such as optical microscopes. Vibration-sensitive manufacturing or research, such as MRI or electron microscopes, would require detailed evaluation to define acceptable vibration levels.
5. The vibration reference level used to calculate VdB is 1 micro-inch per second.

There are some buildings that can be sensitive to vibration and noise, but do not fit into any of the three categories listed in Table 3-1. Because of the sensitivity of these buildings, they usually warrant special attention. **Table 3-2** provides criteria for acceptable levels of ground-borne vibration for various types of special buildings.

Table 3-2. Ground-Borne Vibration Criteria for Special Buildings

TYPE OF BUILDING OR ROOM	GROUND-BORNE VIBRATION IMPACT LEVELS PPV AND VdB [3]			
	FREQUENT[1] EVENTS		OCCASIONAL OR INFREQUENT EVENTS[2]	
Concert or Band Halls, TV Studios, Recording Studios	0.007 in/sec	65 VdB	0.007 in/sec	65 VdB
Auditoriums, Theaters	0.016 in/sec	72 VdB	0.040 in/sec	80 VdB

Source: FTA, 2006.

Notes:

1. "Frequent Events" is defined as more than 70 vibration events per day.
2. "Occasional or Infrequent Events" is defined as fewer than 70 vibration events per day.
3. The vibration reference level used to calculate VdB is 1 micro-inch per second.

BUILDING DAMAGE CRITERIA

The effects of ground-borne vibration include detectable movement of building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. It is extremely rare for vibration from train operations to cause any sort of building damage, even minor cosmetic damage (FTA 2006). However, there is sometimes concern about damage to fragile buildings located near the right-of-way. Accordingly, for the evaluation of vibration impacts, the FTA provides for typical train operations a vibration damage threshold criterion of 0.50 in/sec PPV for typical buildings and 0.12 in/sec PPV for fragile buildings (FTA 2006).

3.2 CONSTRUCTION IMPACT CRITERIA

Construction activities can result in varying degrees of ground vibration, depending on the equipment and methods employed. The vibration associated with this construction project will result from the following activities: demolition, excavation, and shoring of a tunnel. The construction vibration is generally assessed in terms of PPV. **Table 3-3** summarizes the construction vibration limits shown in FTA guidelines (FTA 2006).

Table 3-3. Construction Vibration Building Damage Criteria

BUILDING CATEGORY	PPV (IN/SEC)	VdB
I. Reinforced-concrete, steel, or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

Source: FTA, 2006.

4 EXISTING SETTING AND MEASUREMENT METHODOLOGY

4.1 EXISTING LAND USE

All of the candidate build alternatives would replace the existing 3,800-foot tunnel underneath Virginia Avenue SE, and include an additional 330-foot extension for the proposed location of the new east portal providing further protection to vibration sensitive land use areas and buildings currently located to the west of the existing portal location. For the purpose of this study, vibration sensitive receptors were selected based on their proximity to the three candidate build alternative alignments and based on existing land use, as described in the following paragraphs.

The Southeast/Southwest Freeway (I-695), located on the north side of the VAT, serves as a "barrier" that creates a discontinuity in vibration path from the proposed project to any sensitive receptors located to the north of the freeway. As a result there will be no vibration impacts from the construction or the trains operations of the proposed project at any of the buildings located north of I-695.

The following is a list of potentially vibration sensitive buildings from east to west that are located south of the proposed project and could be affected by the construction and/or by train operation vibrations:

- 809 Virginia Avenue - office building
- Marine Barracks, which includes the Enlisted Men's Quarters and the Marine Band Practice Hall - residential/special building (auditorium)
- Capper Senior Apartments – residential
- St. Paul African Union Methodist Protestant Church - institutional
- Capitol Quarter Townhomes – residential
- 200 I Street - institutional

There are other residential buildings as well as schools, hospitals, religious organizations, and similar institutions in the project vicinity but they are further away from the proposed project limits than the facilities noted above. **Figures 2** through **4 in Appendix A** show the location of the proposed Alternative 3 tunnel and the nearby buildings; these represent the condition with the closest track alignment adjacent to the sensitive receptors.

4.2 VIBRATION MEASUREMENT METHODOLOGY

Vibration measurements were conducted to determine baseline vibration levels from existing train pass-bys and to calculate vibration transferability characteristics of the soil for the purpose

of projecting expected vibration levels during construction and from train operations. Vibration propagation is highly dependent on the soil, discontinuities in the path by which vibration travels, and the type of building foundation. Measuring the vibration levels from trains passing through the existing tunnel provides the most definitive information on how vibration is propagated in the surrounding area of the project.

The purpose of the measurements was to determine the force generated by train pass-bys, calculate soil vibration transferability characteristics, and predict tunnel vibration reduction effects. Measurements conducted near the east portal were the closest locations to the tracks where the strongest vibration signal could be measured without interference from the tunnel or other obstructions. Results of these measurements were suitable for calculating the soil vibration transferability characteristics and determining the highest train pass-by vibration level. Using the soil factor and train generated vibration levels, vibration effects could be calculated at various measurement sites near the tunnel. Therefore, differences between the measured and calculated vibration levels at a given site will provide the amount of the vibration reduction provided by the tunnel at that location. Knowing the vibration created by a train pass-by, soil factor, and tunnel vibration reduction amount, vibration levels can be predicted from the future tunnel at different locations.

Measurements were conducted near the tunnel on two separate occasions: between May 22 and 23, 2012 and between December 19 and 20, 2013. The vibration measurements were conducted using GeoSonic 3000EZ Plus and 3000LC portable seismographs. Vibration levels were measured on the vertical, transverse, and longitudinal axes and recorded as PPV vibrations (in inches per second). The seismograph includes an internal calibration sequence and was operated according to the manufacturer's specifications. Vibration measurements were conducted by Parsons staff.

Table 4-1 presents the list of measurement sites and **Figure 1** in **Appendix A** shows the general location of the sites. **Figures 2** through **4** in Appendix A show the measurement sites overlaid on an aerial background with the Alternative 3 track alignments and the nearby buildings. Note that Alternative 3 represents the condition with the closest track alignment to adjacent sensitive receptors.

Vibration levels at each location were measured for at least five train pass-bys. During each measurement, the speed of the train was recorded near the east portal using a radar gun and the number of locomotives as well as number of cars was recorded for each train. Baseline vibration levels collected just before and after each train pass-by during the day at each site were also recorded at each measurement site.

Three measurement probes were left overnight at the Marine Building 25 and Band Practice Hall (Room G62 in Building 25) locations because it was not feasible to gain access to them during the afternoon. Additional train pass-bys were recorded by the two probes outside of Marine Building 25 and the one probe near the Practice Hall before they were picked up on the morning of May 23, 2012.

Table 4-1. Vibration Measurement Sites

SITE NO	DATE	MONITORING LOCATION DESCRIPTION	DISTANCE TO THE EXISTING TRACK CENTER LINE (FEET)	PROPERTY USE
1	May 2012	Approximately 375 feet east of the east portal	19	Right-of-Way
2	May 2012	Approximately 375 feet east of the east portal	74	Right-of-Way
3	Dec 2013	Approximately 250 feet east of the east portal	28	Right-of-Way
4	Dec 2013	Approximately 250 feet east of the east portal	60	Right-of-Way
5	May 2012	Marine Building 25 [2]	61	Residential
6	May 2012	Marine Building 25 [3]	127	Residential
7	May 2012	Marine Building 25 - inside a closet across the hallway from the Practice Hall (Room G62)[1]	150 (approximate)	Band Practice Hall (auditorium)
8	Dec 2013	Capper Senior Apartments [2]	25	Residential
9	Dec 2013	Capper Senior Apartments [2]	68	Residential
10	Dec 2013	St. Paul African Union Methodist Protestant Church [2]	179	Church
11	May 2012	Capitol Quarter Townhomes [2]	40	Residential
12	May 2012	Capitol Quarter Townhomes [2]	73	Residential

Notes:

1. This location was chosen instead of a location inside the Practice Hall to avoid interference from the vibration levels created by the activities within the Practice Hall itself.
2. Grassy area between Virginia Avenue SE and the building
3. Grassy area adjacent to Marine Building 25

The four measurement probes at the Capper Senior Apartments and near the east portal were left overnight. Additional train pass-bys were recorded by these probes before they were picked up on the morning of December 20, 2013.

Table 4-2 shows a summary of the measurement results for the train pass-bys recorded on May 22, 2012 and December 19, 2013. Vibration Summary

Measurement results show that even though train vibration levels could be as high as 0.063 in/sec close to the tracks near the east portal, these levels drop almost by half at the closest buildings to the tracks. The majority of the measured train pass-by vibration levels were less than 0.020 in/sec at the closest buildings. The recorded reductions in vibration are due to the distance the building is located from the tunnel and the reduction provided by the existing tunnel structure.

Figure 4-1 shows results of the vibration measurements near Marine Building 25 (Site 6). The highest train pass-by vibration levels at this measurement site are approximately 0.010 in/sec which are several orders of magnitude below the FTA human annoyance impact limit of 0.040 in/sec. Measurement results indicate some non-train events are higher than the highest train pass-by vibration levels.

Figure 4-2 shows the measured interior data near the Marine Band Practice Hall, Room G62 in Building 25 (Site 7). The data revealed that the building's internal sources, such as the HVAC system, are a prevalent source of vibration. As shown in Figure 4-4, between 21:45 and 04:30, baseline measurements at Site 7 are much lower than baseline measurements outside this time range when the HVAC system was apparently on a lower setting. Some of the measured train vibration levels are higher than HVAC and other non-train generated vibration levels. At each

train pass-by the measured cumulative vibration levels in the Practice Hall remained well below the FTA threshold of 0.040 in/sec for auditoriums in the special building category.

Table 4-2. Highest Train Pass-By and Non-Train Event Vibration Measurements

SITE NO	DATE	MONITORING LOCATION DESCRIPTION	DISTANCE TO EXISTING TRACK CENTER LINE (FEET)	PROPERTY USE	HIGHEST MEASURED TRAIN PASS-BY		HIGHEST MEASURED NON-TRAIN EVENT	
					PPV (IN/SEC)	VdB	PPV (IN/SEC)	VdB
1	May 2012	Approximately 375 feet east of the east portal	19	Right-of-Way	0.088	87	0.015	71
2	May 2012	Approximately 375 feet east of the east portal	74	Right-of-Way	0.050	82	0.008	66
3	Dec 2013	Approximately 250 feet east of the east portal	28	Right-of-Way	0.075	85	0.008	66
4	Dec 2013	Approximately 250 feet east of the east portal	60	Right-of-Way	0.038	80	0.008	66
5	May 2012	Marine Building 25 [2]	61	Residential	0.015	71	0.010	68
6	May 2012	Marine Building 25 [3]	127	Residential	0.010	68	0.013	70
7	May 2012	Marine Building 25 - inside a closet across the hallway from the Practice Hall (Room G62)[1]	150 (approximate)	Band Practice Hall (auditorium)	0.023 [4]	75 [4]	0.068 [4]	85 [4]
8	Dec 2013	Capper Senior Apartments [2]	25	Residential	0.045	81	0.028	77
9	Dec 2013	Capper Senior Apartments [2]	68	Residential	0.010	68	0.018	73
10	Dec 2013	St. Paul African Union Methodist Protestant Church [2]	179	Church	0.015	70	0.008	66
11	May 2012	Capitol Quarter Townhomes [2]	40	Residential	0.015	71	0.008	66
12	May 2012	Capitol Quarter Townhomes [2]	73	Residential	0.013	70	0.010	68

Notes:

1. This location was chosen instead of a location inside the Practice Hall to avoid interference from the vibration levels created by the activities within the Practice Hall itself.
2. Grassy area between Virginia Avenue SE and the building.
3. Grassy area adjacent to Marine Building 25.
4. Unknown activities occurred throughout the day in the Practice Hall in the vicinity of the closet containing the seismograph that combines with the measured vibrations of the trains.

Figure 4-3 shows the measured vibration levels near Capper Senior Apartments (Site 9) in December 2013. Spikes in the vibration levels indicate train pass-bys or other events. Non train pass-by measured events were identified to have occurred at the Capper Senior Apartments by comparing the actual logged train schedule and the recorded time of vibration spikes.

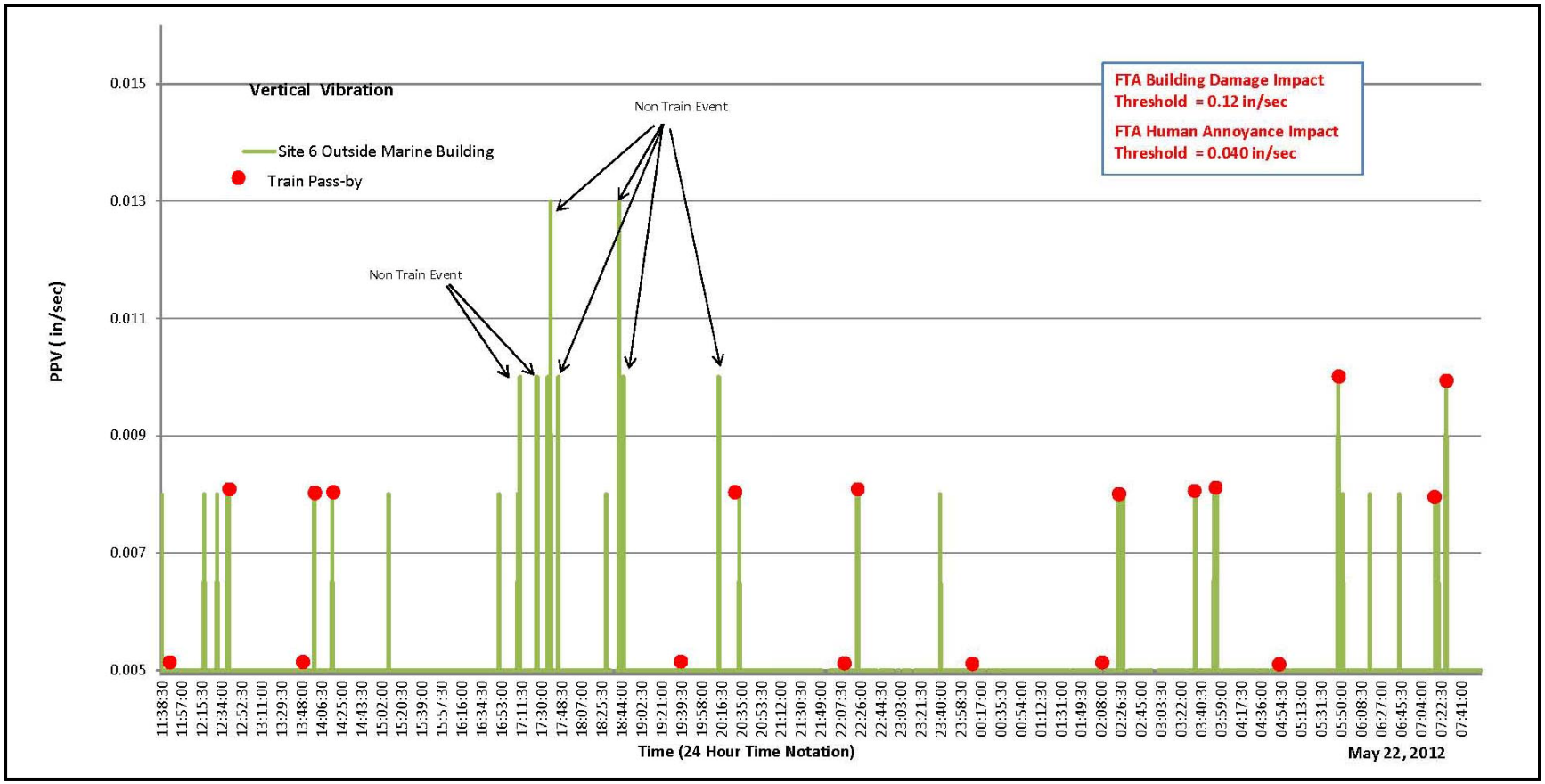


Figure 4-1. Existing Vertical Vibration Measurement near the Marine Building (Room G62 in Building 25)

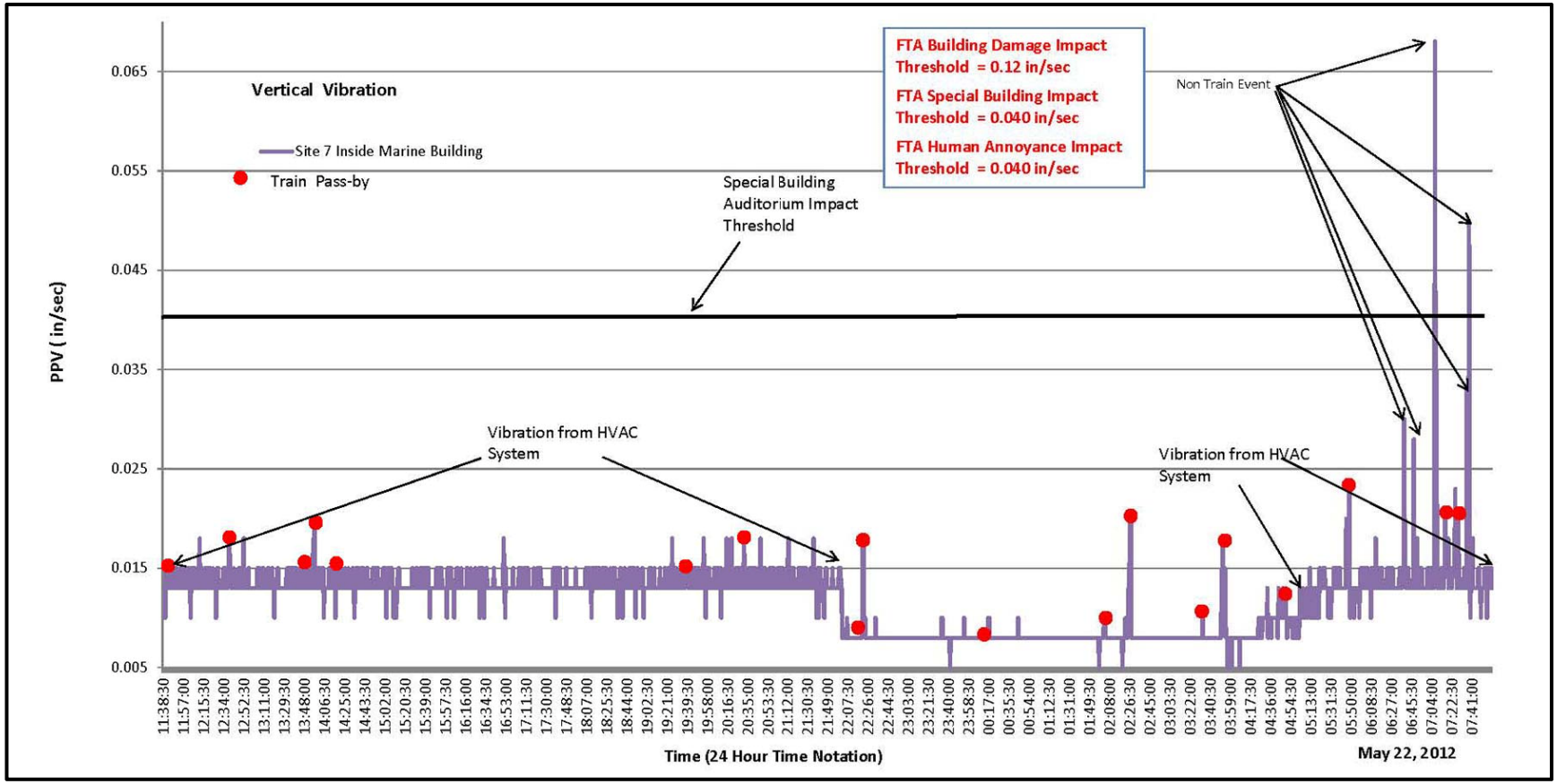


Figure 4-2. Existing Vertical Vibration Measurements at the Marine Band Practice Hall (Room G62 in Building 25)

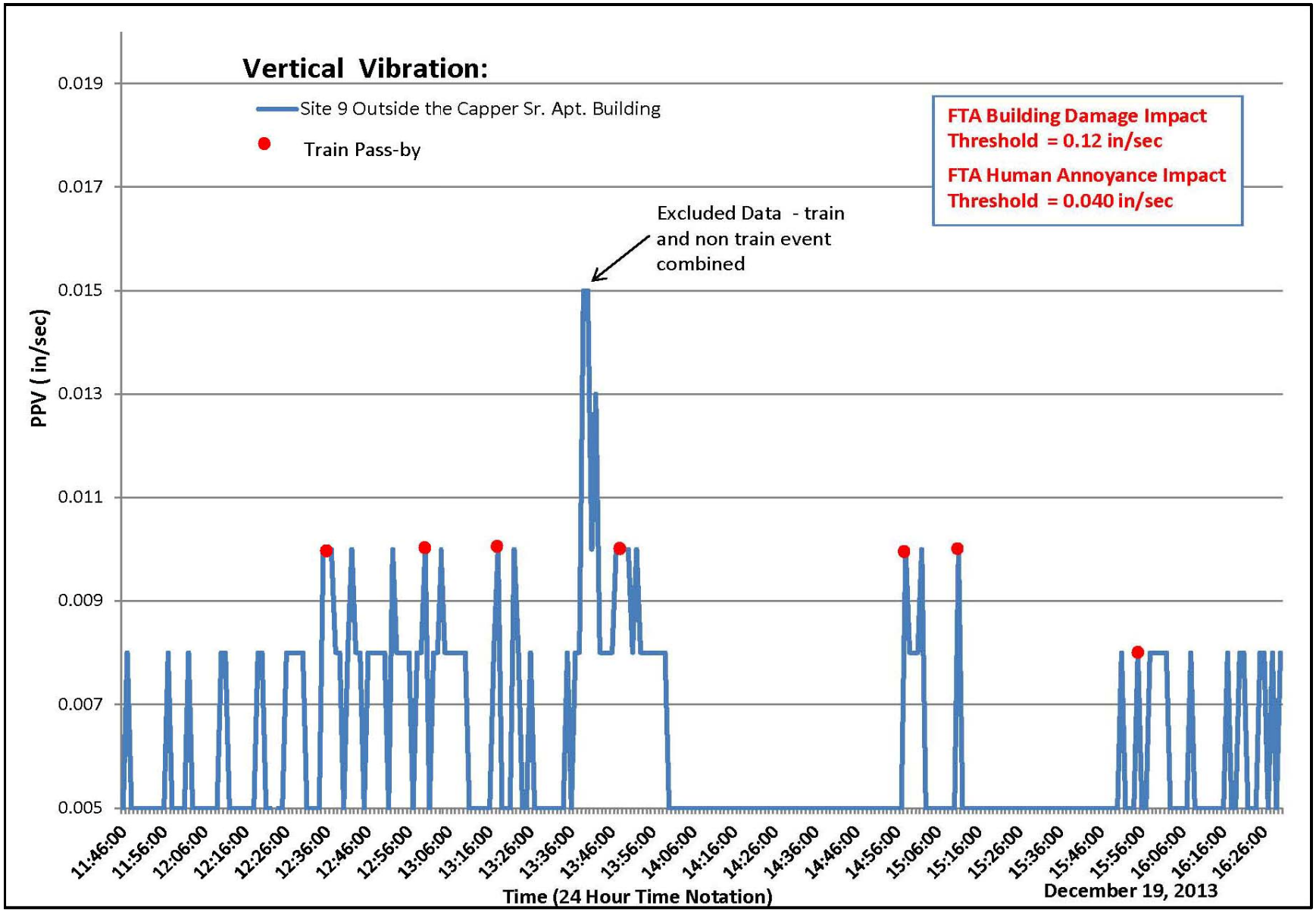


Figure 4-3. Existing Vertical Vibration Measurements near Capper Senior Apartments

Results indicate that the train pass-by is not the highest vibration source near the Capper Senior Apartments. As indicated in the graph in Figure 4-3, there were numerous non-train events that resulted in vibration levels as high as those recorded for train events. The highest train generated vibration levels were about 0.010 in/sec which are several orders of magnitude below the FTA human annoyance impact limit of 0.040 in/sec. Furthermore, these vibration levels would not be capable of causing cosmetic building damage or rattling windows at the Capper Senior Apartments.

Notably, a vibration level of 0.015 in/sec was recorded near the Capper Senior Apartments at 13:39 as a train was passing by. This vibration level is almost twice as high as other train pass-by measurements at that location. However, vibration measurements taken for the same train at the east portal of the existing tunnel showed vibration levels consistent with the recorded levels of other trains. As a result, it was determined that this single incident of high vibration at the Senior Apartments was an anomaly, produced by combination of the train pass-by and by another vibration-producing event in the neighborhood that caused this single aberrant recording. Accordingly, this one measurement was disregarded and not considered in the remainder of this analysis.

Figure 4-4 shows a typical single train pass-by, with measurements both at the portal and next to the Capper Senior Apartments (Site 9), along with two non-train vibration events recorded at the Senior Apartments. Typically each train pass-by produces several spikes depending on the train length. This set of data confirms that most of the vibration levels generated by trains passing by are about the same as vibration levels generated by other events near that building.

Figure 4-5 shows the train pass-by and baseline measurements at St. Paul African Union Methodist Protestant Church (Site 10). Measurements were between 0.005 and 0.015 in/sec (66 to 70 VdB), which is substantially less than the FTA threshold of 0.040 in/sec.

Figure 4-6 shows the measured existing vibration levels near the Capitol Quarter Townhomes (Site 12) indicating that the existing train pass-by vibration levels are nominally greater than the baseline levels. Yet all these levels are substantially below FTA limits for the human annoyance impact.

Recorded vibration levels do not demonstrate that vibrations from the existing train pass-bys are capable of causing structural or cosmetic damage at the nearby buildings. Measured vibration levels were well below the vibration damage threshold criterion of 0.50 in/sec for typical buildings and 0.12 in/sec for extremely fragile buildings.

In summary, the measured train pass-by vibration levels at the church, institutional and residential buildings closest to the tracks are barely perceivable; therefore, these levels are not capable of rattling windows, moving furniture, or causing building damages.

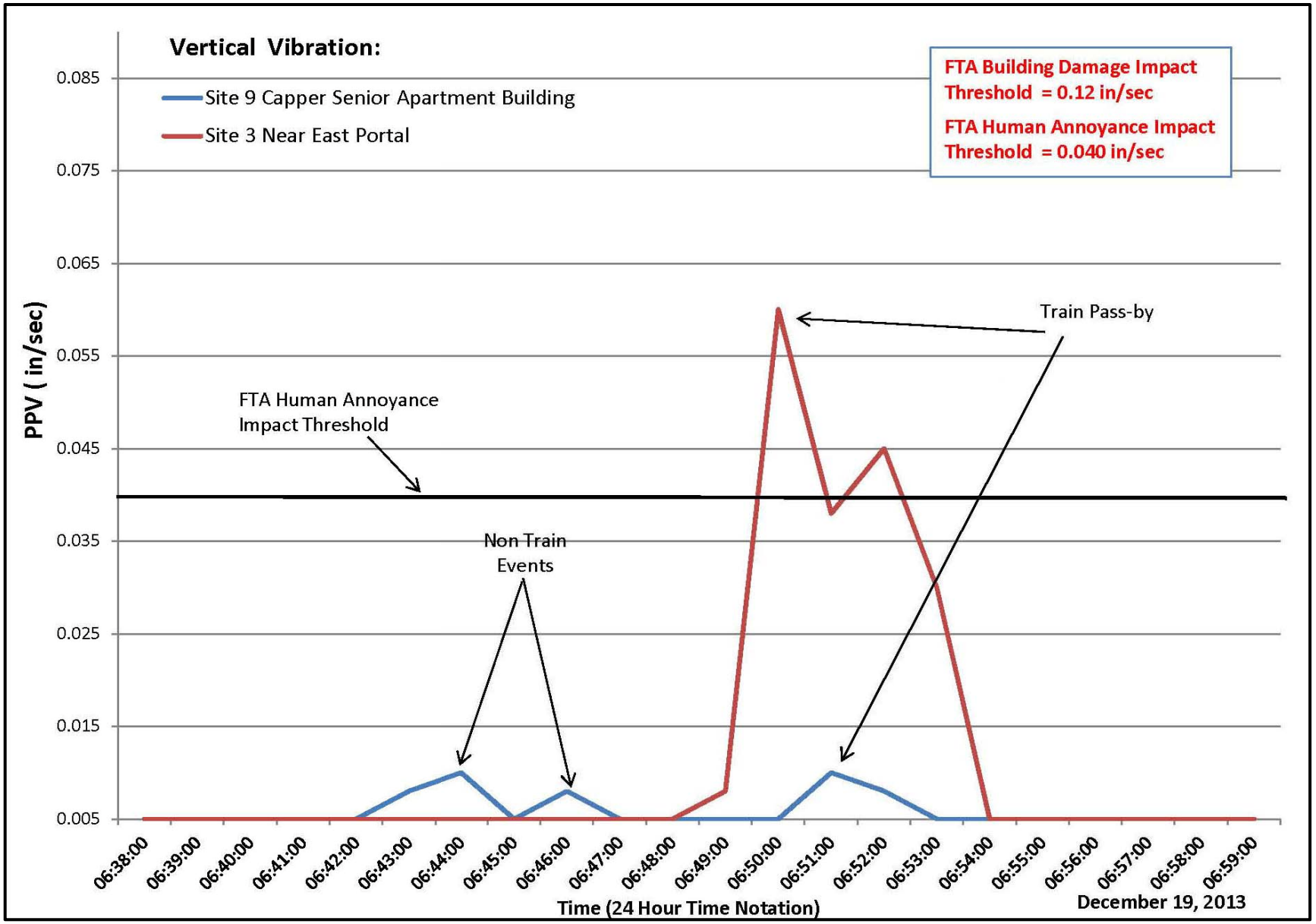


Figure 4-4. Single Train Pass-By Vertical Vibration Movement

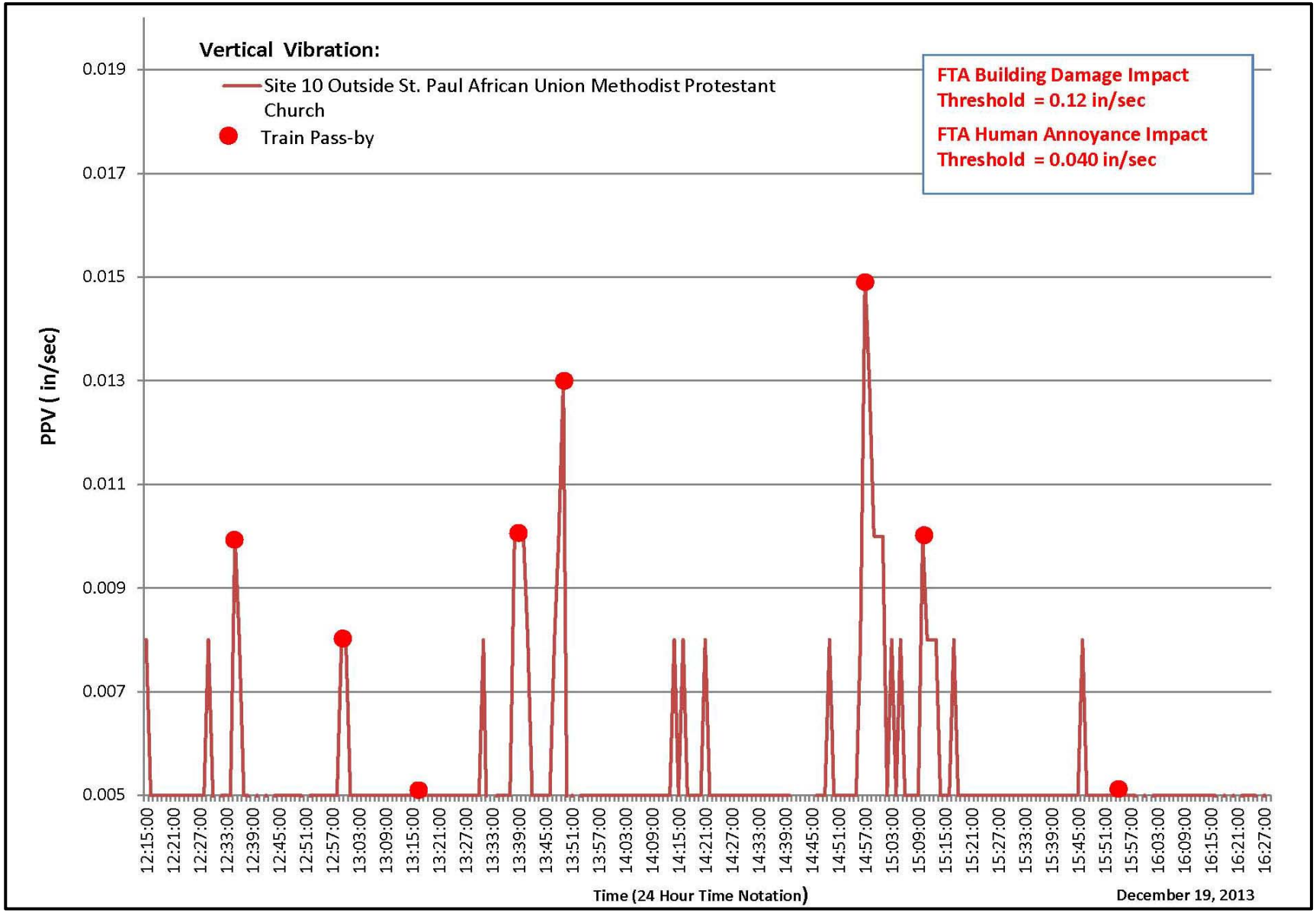


Figure 4-5. Train Pass-by and Baseline Measurements at St. Paul African Union Methodist Protestant Church

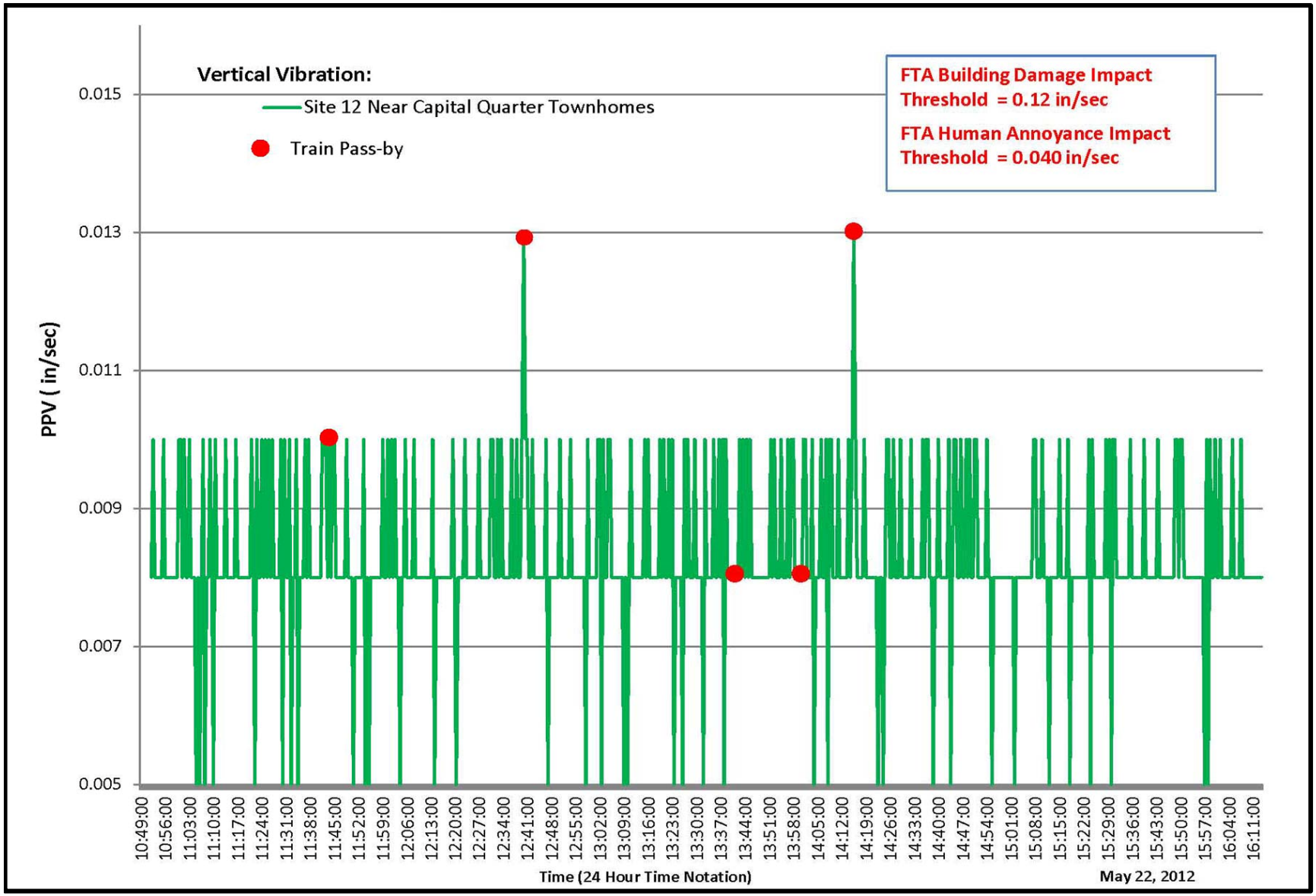


Figure 4-6. Existing Train Pass-By Vertical Vibration Measurements at the Capital Quarter Townhomes

4.3 SOIL PROPAGATION CHARACTERISTICS

The soil vibration propagation characteristic was calculated by comparing the PPV at different distances from the track. The east portal site was the most suitable location within the project area to measure the train tunnel pass-bys closest to the track; the data at this location is crucial in order to calculate the soil propagation characteristic. Results of measurements conducted in both May 2012 and December 2013 were used for calculating the soil vibration transferability characteristics.

It was determined from geotechnical field investigations conducted in support of the NEPA document by others (Mueser Rutledge Consulting Engineers) that the geology surrounding the proposed project area is similar and that the proposed tunnel base along the alignment would be founded on the same stratum of soils. Therefore, the calculated average soil factor from the measurements conducted near the east portal where they were unaffected by any tunnel structure reducing effects was used for the entire project area.

The vibration wave from the train pass-by dissipates as the wave transfers through the soil between two discrete points. This dissipation rate is dependent on the local soil composition and is called the soil factor in this report. The soil factors at the east portal vibration measurement site were calculated using recorded vibration levels at 30 second intervals for each train pass-by event. These values were then averaged to calculate the soil factor for the surrounding area of the project. **Table B-1** in **Appendix B** contains the data sets that were used to calculate the soil factor.

The vertical-axis results were used for this analysis, as recommended in the FTA manual (FTA 2006), because the vertical vibration is usually transmitted more efficiently into building foundations than transverse or longitudinal vibration.

5 IMPACT ASSESSMENT

Reconstruction of the Virginia Avenue Tunnel was evaluated to determine potential vibration impacts during the reconstruction project and from train operations. The impact assessment presented in this section was conducted in accordance with procedures outlined in FTA's *Transit Noise and Vibration Impact Assessment* manual (FTA 2006).

5.1 CONSTRUCTION VIBRATION

Two types of potential construction vibration impacts were analyzed: (1) human annoyance and (2) building damage. The potential for human annoyance occurs when construction vibration rises significantly above the threshold of human perception for extended periods of time. Building damage can be cosmetic or structural. As a general matter, fragile buildings such as older masonry structures have a greater potential to be susceptible to damage from ground vibration than buildings that are not particularly fragile (see Table 3-3 in Chapter 3).

Vibration levels produced by construction equipment were obtained from the FTA *Transit Noise and Vibration Impact Assessment* (FTA 2006). Based on the typical vibration levels for the various types of construction equipment expected to be used and as listed in **Table 5-1**, calculations were performed to determine the distances at which vibration impacts could occur during different activities and stages of the construction operations according to the FTA criteria discussed in Section 3.2.

Table 5-1. Ground-Borne Vibration Source Levels for Construction Equipment

EQUIPMENT	PPV AT 25 FEET (IN/SEC)	VdB AT 25 FEET
Large Bulldozer	0.089	87
Loaded Trucks	0.076	86
Hoe Ram	0.089	87
Caisson Drill	0.089	87
Sheet Driver (Sonic)	0.170	93
Jackhammer	0.035	79

Source: FTA, 2006

Vibration levels for the different construction activities were predicted using the best information available at the time the study was prepared. **Appendix C** contains a list of the equipment that most likely would be used during the different construction activities and their respective distances to each of the nearby buildings. **Table 5-2** shows in detail predicted vibration levels at nearby sensitive receivers from various construction activities that could create high vibration levels. There would be no structural vibration impacts due to construction operations under any of the candidate build alternatives. However, results in Table 5-2 indicate that there would be the potential for human annoyance impacts due to construction operations

in accordance to the thresholds established in the FTA guidelines. It is anticipated that certain vibration producing construction activities would cause annoyance to the closest units of Capitol Quarter Townhomes and the Capper Senior Apartments. Vibration from certain construction activities may also exceed the FTA guidelines in the offices closest to the construction on the north side of the 200 I Street building. However no impacts are predicted for other more distant structures.

Vibration levels of 80 VdB (0.040 in/sec) and above have a potential to cause human annoyance in residential receptors according to FTA guidelines. Mitigation measures would need to be considered, if construction activities or equipment operating close to residential or institutional buildings are causing human annoyance. It is possible contractors may need to use different types of equipment for each activity instead of those used for predicting vibration in this study; therefore, vibration levels will be monitored during construction. If measurement results conducted during construction show that vibration levels exceed impact thresholds, construction methods will be reevaluated to reduce vibrations levels to below these thresholds.

Additional vibration from the train pass-bys in the open trench during the construction period for Alternative 2 was also considered and the assessment is presented in the following section as one of the project alternatives (see Table 5-3).

Table 5-2. Highest Construction Activity Vibration Levels

CONSTRUCTION ACTIVITY	809 VIRGINIA AVENUE		MARINE BUILDING		CAPPER SENIOR APARTMENTS		ST. PAUL AFRICAN UNION METHODIST PROTESTANT CHURCH		CAPITOL QUARTER TOWNHOUSES		200 I STREET	
	PPV (IN/SEC)	VdB	PPV (IN/SEC)	VdB	PPV (IN/SEC)	VdB	PPV (IN/SEC)	VdB	PPV (IN/SEC)	VdB	PPV (IN/SEC)	VdB
Utility Relocation	0.009	67	0.002	52	0.021	74	0.001	45	0.025	76	0.025	76
Surface Demolition	0.008	66	0.002	54	0.069	85	0.017	73	0.035	79	0.015	71
Existing Tunnel Demolition	0.010	68	0.003	59	0.014	71	0.002	53	0.017	72	0.017	73
Support of Excavation	0.029	77	0.006	63	0.061	84	0.003	57	0.070	85	0.070	85
Excavation	0.027	77	0.006	63	0.057	83	0.003	57	0.065	84	0.065	84
Tunnel Structure Construction	0.026	76	0.006	63	0.053	82	0.003	56	0.061	84	0.061	84
Backfill	0.027	77	0.006	63	0.057	83	0.003	57	0.065	84	0.065	84
Roadway Construction	0.017	73	0.004	60	0.061	84	0.003	56	0.021	74	0.033	78
Sheet Pile (Alt 4 Only)	0.021	74	0.007	64	0.029	77	0.004	59	0.034	79	0.036	79

Note: Because of the sensitivity of numbers, actual calculated/measured PPV values were used up to five decimals to convert from PPV to VdB. While PPV numbers shown in the table are rounded to 3 decimals and VdB to nearest full number.

5.2 TRAIN OPERATION VIBRATION

Train operational vibration assessment was conducted using FTA procedures and impact criteria along with the measured data collected close to the tracks (source) and at nearby vibration sensitive sites (receivers) within the project area. As described in Section 1.2, the three build alternatives include one tunnel with two tracks, two tunnels with one track in each tunnel, and a partitioned tunnel with two single tracks.

Measured vibration levels from the existing train pass-bys at different locations were used to calculate soil vibration transferability characteristics, the highest vibration levels generated by the train, and tunnel structure vibration reduction effects. These values were then used to predict the future train pass-by vibrations impacts at various nearby sensitive locations.

Descriptions of the source of vibration from a freight train, the potential effects of the new tunnel on reducing vibration, and a summary of the parameters that were utilized to predict vibration levels associated with train pass-bys are presented in this section. Finally, the results of the impact assessment are provided, including the impact distances for existing and future ground-borne vibration from train pass-bys.

EFFECTS OF THE NEW TUNNEL

The majority of track structure within the existing tunnel is sitting on dirt, while the proposed track structure within the new tunnel will be supported by a 3-foot thick reinforced concrete floor. A large mass such as the 3-foot thick concrete slab would reduce the vibrational energy generated by train pass-bys. Vibration levels at sensitive receptors would therefore be less from the new tunnel with its integral reinforced concrete floor in comparison to the existing tunnel with a natural earth floor. In addition the proposed use of a ballasted track section on top of the floor instead of directly attaching the tracks to the concrete floor slab, known as "direct fixation" has conservatively not been considered as well. The presence of ballast would serve to further reduce the vibrations reaching the soils below the floor slab. An exact vibration reduction effect for the proposed tunnel features cannot be determined from standard vibration modeling or from a review of published research data.

Despite the use of these techniques, future train vibration levels were predicted assuming a natural dirt floor that transmits more vibration energy into the surrounding soil in order to predict worst-case vibration levels. Vibration reduction effects of the new concrete walls were also not considered in the calculation; therefore, it can be expected that actual vibration levels would be substantially less than those estimated herein at receiver locations.

Is summary, as the tunnel adjustment factors (described further below) were determined from the measurements collected as part of this study, they would be lower than what is expected from measurements associated with the new tunnel.

ASSUMPTIONS AND ADJUSTMENTS TO VIBRATION PARAMETERS

The following are list of assumptions that were made in order to calculate vibration levels from the Virginia Avenue Tunnel:

- Train Speed: Train operation vibration is typically higher when trains are traveling at higher speeds. The strength of ground-borne vibration reduces or increases approximately as much as 20 times the logarithm of the speed ratio of existing speed and proposed speed. This means that doubling the train speed will increase vibration levels approximately 6 VdB. Existing measured peak vibration levels were for a train travelling at an average speed of 20 mph; however, trains in the proposed tunnel would be traveling at a maximum speed of 40 mph. Therefore, a **speed adjustment factor of an additional 6 VdB was applied to predict the future train pass-by vibration levels**.

- Building Category: In determining the potential vibration impact distance, the **lower limit of 0.012 in/sec specified by FTA for fragile buildings was utilized** regardless of the type and age of the building (see Table 3-3). This is a conservative approach and has a safety factor built in.
- Train Vibration Source: The measured vibration levels at the east portal (Sites 1, 2, 3, and 4), which are the closest sites to the tracks without a tunnel structure or other interferences were used as the train source for calculating impact distances for the existing/no build alternative, temporary trench route for Alternative 2, and the three candidate build alternatives.
- Highest Vibration Levels: **The highest recorded vibration level was used as the train vibration source** in calculating the temporary trench alternative and the three candidate build concepts to ensure that future impact distances were not under predicted. One high train pass-by measured vibration was eliminated because it was determined that some unknown non-train vibration source occurred concurrently with the train generated vibration.
- Soil Disturbance: Soil to the south of the existing tunnel will be disturbed (excavated and replaced) up to the shoring line adjacent to the new south wall of the proposed tunnel. The remaining soils south of the shoring line will remain undisturbed. Along much of the alignment the area that will be disturbed is small in comparison to the amount of soil between the source (track) and the receivers (buildings). Therefore, the soil vibration transferability characteristics are predicted to be the same as they would be under existing conditions.
- Number of Trains: Vibration **impact predictions were prepared assuming two trains were traveling in the tunnel simultaneously**. This approach yielded the highest possible vibration impact resulting from train operations.
- Vibration Propagation: When a train is moving through a tunnel the vibration waves propagate less effectively from the tunnel floor to the ground surface than vibration waves generated by a train operating at grade (where vibration waves travel more effectively along the ground surface).

The following are list of assumptions that were made in order to calculate vibration levels from the proposed build alternatives for the reconstructed Virginia Avenue Tunnel:

- Proposed Track Alignment: An adjustment was applied to the measured vibration levels to account for a turnout near the east tunnel portal. This turnout will be eliminated once the new tunnel is constructed. Therefore, as per FTA guidelines, measured existing **vibration levels that are used for calculating future vibration levels were reduced by 5 VdB with the removal of the discontinuity in the track** represented by the turnout. This adjustment is needed to determine the vibration force generated by train pass-bys without the discontinuity which is then utilized for calculating the vibration effects from the trains in the new tunnel.
- Soil Factor: The **calculated soil factor** (see Section 4.2) was used as a parameter to adjust the rate that the vibration wave would decline in strength as it propagates away from the train.

- Tunnel Adjustment Factor: Using the train force strength measured near the tracks at Sites 1, 2, 3, and 4 and the calculated soil factor, vibration levels were calculated at the other measurement locations. All of the calculated levels were higher than the measured level. The differences between the calculated and measured levels can be attributed to the tunnel's vibration reduction characteristic. **Tables B-2** and **B-3** in **Appendix B** summarize the measured (with tunnel) and calculated (without tunnel) vibration levels for ten of the train pass-bys that were recorded in May 2012 and December 2013. Measurements from ten train pass-bys are sufficient for calculating a reliable tunnel adjustment factor. An averaged tunnel adjustment factor of 0.021 in/sec was derived from an analysis of both sets of data. This adjustment is for the existing tunnel and will be higher for the future tunnel due to the proposed integral reinforced concrete foundation which would provide a higher vibration reduction effect.

VIBRATION IMPACT DISTANCES

The outer calculated limit of vibration impact, when measured from the source of the vibration, is known as the impact distance. These vibration impact distances were calculated using the parameters and adjustments described in the preceding section. The impact distances for human annoyance for existing conditions and for each of the candidate build alternatives are shown in **Table 5-3**.

Table 5-3. Human Annoyance Impact Distances for Existing and Predicted Train Pass-Bys

ALTERNATIVES	DISTANCE TO POTENTIAL VIBRATION HUMAN ANNOYANCE (FEET)
Existing/ No Build	12
Alternative 2 (during construction when there is a Temporary Trench Route)	12
Alternative 2	30
Alternative 3	30
Alternative 4	30

Note: The vibration reduction effects of the ballasted track bed on an integral reinforced concrete floor slab were not considered in predicting the future vibration levels.

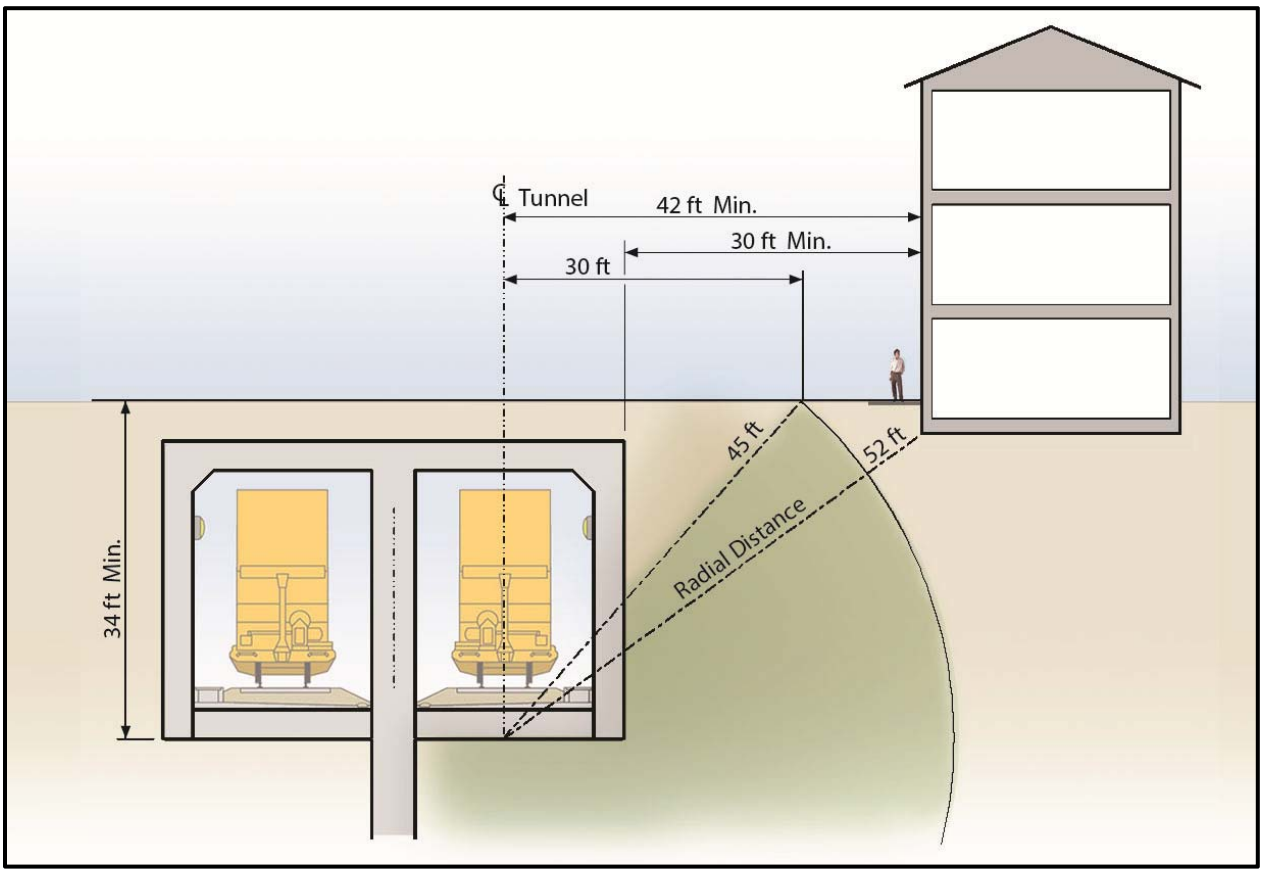
Table 5-4 shows that human annoyance impacts (as defined by FTA) from train pass-bys would not be experienced more than 45 feet away from the track under any of the candidate build alternatives, i.e., two trains using one tunnel with two tracks or using two tunnels with one track in each. The calculated annoyance distance of 45 feet from the track centerline is only true if the tracks were located at grade. However, because trains will be traveling in the tunnel, the 45 feet distance is a radial distance at which the vibration waves generated by a train will reach the ground surface. Therefore the human annoyance distance at the ground surface from the track centerline would be 30 feet. **Figure 5-1** shows this concept graphically.

Table 5-4. Impact Distances from Train Pass-Bys

LOCATION	MINIMUM HORIZONTAL DISTANCE TO SOUTHERNMOST TRACK (feet)[1]	RADIAL DISTANCE TO THE NEAREST TRACK (feet)[1]	ESTIMATED RADIAL DISTANCE TO VIBRATION POTENTIAL HUMAN ANNOYANCE (feet)[1]	HUMAN ANNOYANCE EXPECTED?	ESTIMATED RADIAL DISTANCE TO VIBRATION POTENTIAL BUILDING DAMAGE (feet)[1]	BUILDING DAMAGE EXPECTED?
809 Virginia Avenue	57	66	45	No	27	No
Marine Band Practice Hall	107	113	45	No	27	No
Capper Senior Apartments	44	52	45	No	27	No
St. Paul African Union Methodist Protestant Church	147	150	45	No	27	No
Capital Quarter Townhomes	42	52	45	No	27	No
200 I Street	42	50	45	No	27	No

Note:

1. Dimension from bottom of tunnel floor to grade at the face of adjacent building.
2. Predictions based on Alternative 3 which is the closest potential track to sensitive receptors



Note: While the primary vibration source will propagate from the base of the tunnel as the freight trains run along the tracks, secondary vibrations will radiate from the tunnel walls. The graphic depicts Alternative 3 which is the condition with the closest track alignment to the adjacent sensitive receptors.

Figure 5-1. Train Pass-By Vibration Levels

Figures 2 through **4** in **Appendix A** show the 30-foot human annoyance impact line from two trains operating in the tunnel at the same time. As there are no residential buildings located between the impact line and the southern track of Alternative 3 (the closest potential track to sensitive receptors), there would be no predicted vibration impact from future train operations.

Table 5-5 and **Table 5-6** provide a summary of the predicted level of ground borne vibration from construction and train operations, respectively, at each of the of the identified sensitive receptors along the tunnel alignment. The locations of all monitoring and prediction sites are shown in Appendix A – Figure 1. Note that some monitoring sites were selected to determine soil transferability characteristics and were not used for prediction sites (due to absence of receptors). For prediction purposes the offset distance, calculated PPV and VdB at the receptors and the controlling construction activity for Alternative 3 alignment was used as this represents the condition with the closest track alignment to the sensitive receptors. Further it should be noted that the estimated vibration levels shown on the tables do not consider the vibration reduction effect of the integral reinforced concrete floor, which would reduce the reported values for the peak estimated vibration levels shown in the tables.

Table 5-4 also shows that any building located 27 feet or more from the track centerline would not experience significant operational vibration impacts. As the tracks will be located a minimum of 34 feet underground with propagation paths (radial distances) of 52 to 150 feet for the receptor facilities along the corridor, no building damage is anticipated.

Table 5-5. Predicted Level of Ground Borne Vibration – Construction

MONITORING SITE NO	PROPERTY USE	LOCATION	FTA LAND USE CATEGORY	CONTROLLING CONSTRUCTION ACTIVITY [5]	DISTANCE (FEET) [5]	FTA LIMITS FOR HUMAN ANNOYANCE		FTA LIMITS FOR BUILDING DAMAGE		PEAK ESTIMATED VIBRATION LEVELS [5]		HUMAN ANNOYANCE IMPACT	BUILDING DAMAGE IMPACT
						PPV, IN/SEC	VdB[6]	PPV, IN/SEC	VdB[6]	PPV, IN/SEC	VdB[6]		
--	Institutional	809 Virginia Ave	3	Support of Excavation, Excavation, Backfill	43	0.056	83	0.120	90	0.029	77	No	No
6	Residential	Marine Building 25 [3]	2	Support of Excavation, Excavation, Tunnel Structure Construction, Backfill	93	0.040	80	0.120	90	0.006	63	No	No
7	Band Practice Hall (auditorium)	Marine Building 25 - inside a closet across the hallway from the Practice Hall (Room G62) [1]	N/A[1,4]	Support of Excavation, Excavation, Tunnel Structure Construction, Backfill	113	0.040	80	0.120	90	0.006	63	No	No
9	Residential	Capper Senior Apartments [2]	2	Surface Demolition	18	0.040	80	0.120	90	0.069	85	Yes	No
10	Church	St. Paul African Union Methodist Protestant Church [2]	3	Surface Demolition	35	0.040	80	0.120	90	0.017	73	No	No
12	Residential	Capitol Quarter Townhomes [2]	2	Support of Excavation	28	0.040	80	0.120	90	0.070	85	Yes	No
--	Institutional	200 I Street	3	Support of Excavation	28	0.056	83	0.120	90	0.070	85	Yes	No

Notes:

1. This location was chosen instead of a location inside the Practice Hall to avoid interference from the vibration levels created by the activities within the Practice Hall itself.
2. Grassy area between Virginia Avenue SE and the building.
3. Grassy area adjacent to Marine Building.
4. Categorized as a special building usage in Table 8-2 of "Transit Noise and Vibration Assessment," FTA, 2006.
5. Alternative 3 has been used as it represents the condition with the closest track alignment adjacent to the sensitive receptors.
6. Because of the sensitivity of numbers, actual calculated/measured PPV values were used up to five decimals to convert from PPV to VdB. While PPV numbers shown in the table are rounded to 3 decimals and VdB to nearest full number.

Table 5-6. Predicted Level of Ground Borne Vibration – Future Train Operations

SITE NO	PROPERTY USE	LOCATION	FTA LAND USE CATEGORY	TRAIN SPEED (MPH)	RADIAL DISTANCE (FEET) [5]	FTA LIMITS FOR HUMAN ANNOYANCE		FTA LIMITS FOR BUILDING DAMAGE		PEAK ESTIMATED VIBRATION LEVELS [5]		HUMAN ANNOYANCE IMPACT	BUILDING DAMAGE IMPACT
						PPV, IN/SEC	VdB [6]	PPV, IN/SEC	VdB [6]	PPV, IN/SEC	VdB [6]		
--	Institutional	809 Virginia Ave	3	40	66	0.056	83	0.120	90	0.018	73	No	No
6	Residential	Marine Building 25 [3]	2	40	113	0.040	80	0.120	90	0.006	63	No	No
7	Band Practice Hall (auditorium)	Marine Building 25 - inside a closet across the hallway from the Practice Hall (Room G62) [1]	N/A [4]	40	150	0.040	80	0.120	90	0.003	58	No	No
9	Residential	Capper Senior Apartments [2]	2	40	52	0.040	80	0.120	90	0.030	78	No	No
10	Church	St. Paul African Union Methodist Protestant Church[2]	3	40	150	0.040	80	0.120	90	0.003	58	No	No
12	Residential	Capitol Quarter Townhomes [2]	2	40	52	0.040	80	0.120	90	0.030	78	No	No
--	Institutional	200 I Street	3	40	50	0.056	83	0.120	90	0.033	78	No	No

Notes:

1. This location was chosen instead of a location inside the Practice Hall to avoid interference from the vibration levels created by the activities within the Practice Hall itself.
2. Grassy area between Virginia Avenue SE and the building.
3. Grassy area adjacent to Marine Building.
4. Categorized as a special building usage in Table 8-2 of "Transit Noise and Vibration Assessment," FTA, 2006.
5. Alternative 3 has been used as it represents the condition with the closest track alignment adjacent to the sensitive receptors.
6. Because of the sensitivity of numbers, actual calculated/measured PPV values were used up to five decimals to convert from PPV to VdB. While PPV numbers shown in the table are rounded to 3 decimals and VdB to nearest full number.

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6 MITIGATION

This section discusses potential mitigation measures that can be implemented to reduce or mitigate vibration impacts resulting from reconstruction of the Virginia Avenue Tunnel and future train operations.

6.1 CONSTRUCTION VIBRATION MITIGATION

It is possible that certain construction activities could cause intermittent localized concern from vibrations in the project area. Processes such as earth moving with bulldozers, the use of vibratory compaction rollers, and demolition could cause some human annoyance impacts. There are cases where it may be necessary to use this type of equipment in close proximity to residential buildings.

A vibration monitoring and mitigation plan will be prepared by a qualified vibration engineer prior to the start of construction. The plan would include vibration monitoring procedures at predetermined vibration sensitive sites, updated calculations of predicted vibration levels at the receptors based on measurements at the source of the actual construction activities, and recommendations for mitigation measures if they are needed based on the calculations. The plan will be a living document throughout construction and will be updated and submitted to DDOT should there be any major changes in findings, proposed mitigations or to the planned construction activities.

The plan would identify buildings that are candidates for pre- and post-construction surveys if they are close enough to a construction vibration source that may cause vibration impacts. The surveys would document the pre-construction condition of the structures in detail and final condition post construction. Findings if any, of damage as documented by the surveys would be addressed via the claims process which is described in the Environmental Impact Statement. Surveys would be conducted only with the permission of the owners of buildings.

The vibration monitoring and mitigation plan would also include, but not be limited to, the following items:

- The name and qualifications of the vibration specialist(s), who must have a Bachelor of Science or higher degree from a qualified program in engineering or physics offered by an accredited university or college, and at least 10 years of experience in vibration control engineering and vibration analysis. In addition to the basic requirements, vibration specialist must demonstrate substantial and responsible experience in conducting vibration measurements, calculating vibration propagation, as well as designing and overseeing the implementation of vibration abatement measures.

- The location of seismograph(s) placements on the existing and temporary tunnel, as well as nearby buildings, as directed by the vibration monitoring specialist.
- The scheduled start dates and length of construction operations that require vibration monitoring. There would be separate time intervals for each construction operation.
- The location of any sewer or water line in proximity to construction operations.
- Specifications of the seismograph including: the manufacturer's name, model number, and documentation of factory calibration performed within the preceding 12 months. The seismograph will be capable of measuring peak particle velocity (PPV) data in three mutually perpendicular directions.
- Appropriate detailed procedures for placing and operating the seismograph.
- The procedure for tracking PPV throughout construction operations (e.g., sonic piling and drilling operations).
- A record of the time of day when each monitored construction activity took place.

The following are procedures that can be used to minimize the potential for human annoyance from construction vibration:

- Conduct vibration monitoring during vibration-intensive activities.
- Properly maintain all motorized equipment in a state of good repair to limit wear-induced vibration.
- Where feasible, avoid the use of impact type pile driving near residences; instead use drilled piles or the use of a sonic or vibratory pile driver, which cause lower vibration levels (where the geological conditions permit their use).
- When there is a possibility of human annoyance from construction activities, such as the operation of vibratory rollers, absent urgent and unexpected circumstances, conduct such activity only during weekday daytime hours when the ambient background noise and vibration is higher and many residents are away from their homes at work.
- Develop a phasing plan so that high vibration generating activities do not occur within the same time period is close proximity to each other, to the maximum extent practicable.
- Avoid routing heavily-loaded trucks through densely concentrated residential areas, when ever reasonably possible within the approved maintenance of traffic plans.
- Where feasible, use demolition methods that do not involve use of high impact tooling such as hoe rams and use crushing style attachments instead.
- Avoid the use of large vibratory rollers and packers near sensitive areas, when possible and use smaller equipment with smaller lifts.

A combination of the noted mitigation techniques for equipment vibration control as well as administrative measures, when properly implemented, can be selected to achieve the most effective means to minimize the effects of construction activities. Application of the noted

mitigation measures will reduce the construction impacts; however, temporary increases in vibration would likely occur at some locations during some construction activities. The extent of potential impacts cannot be determined until detailed construction work plans for each phase of the construction operations have been developed. Once known the vibration monitoring plan described above will be the principle tool for determining which measures will be most effective for each of the construction activities.

6.2 TRAIN OPERATION VIBRATION MITIGATION

As described in the results of the vibration impact analysis in Chapter 5, ground-borne vibrations are not predicted to exceed the FTA criteria for train operations under any of the candidate build alternatives; therefore, vibration mitigation would not be necessary.

Even though there would be no vibration impacts associated with the train operations, some design features have conservatively not been considered in the reports calculations and analysis that would in fact serve to further reduce the calculated train pass-by vibration levels if used. These features are:

- The presence of a proposed 3-foot thick reinforced concrete floor foundation for the tunnel.
- The use of a ballasted track section on top of the floor instead of directly attaching the tracks to the concrete floor slab. This will further reduce the vibrations reaching the soils below the floor slab.

For areas where the estimated peak vibration levels for future train operations are close to the FTA limits (the 300 block and 500 block of Virginia Avenue) for human annoyance the introduction of a ballast mat in the southernmost tunnel on top of the concrete floor foundation prior to construction of the track bed would serve to further reduce the potential ground borne vibrations at the adjacent receptors.

Table 6-1 provides a summary of potential impacts and actions to potentially avoid or minimize them.

Table 6-1. Summary of Impact and Mitigation Measures

MITIGATION OF VIBRATION IMPACTS	CONSTRUCTION IMPACTS		TRAIN OPERATION IMPACTS	
	POTENTIAL BUILDING DAMAGE	POTENTIAL HUMAN ANNOYANCE	POTENTIAL BUILDING DAMAGE	POTENTIAL HUMAN ANNOYANCE
Avoidance	Yes	To the extent practical	Yes	Yes
Minimization	Not required since impacts are avoided	Yes	Not required since impacts are avoided	Not required since impacts are avoided
Repair or Restore	Not required since impacts are avoided	Not required since impacts are avoided	Not required since impacts are avoided	Not required since impacts are avoided
Reduce over Time	Not required since impacts are avoided	Not required since impacts are avoided	Not required since impacts are avoided	Not required since impacts are avoided
Compensate	Not required since impacts are avoided	Not required since impacts are avoided	Not required since impacts are avoided	Not required since impacts are avoided

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A VIBRATION MEASUREMENT SITES

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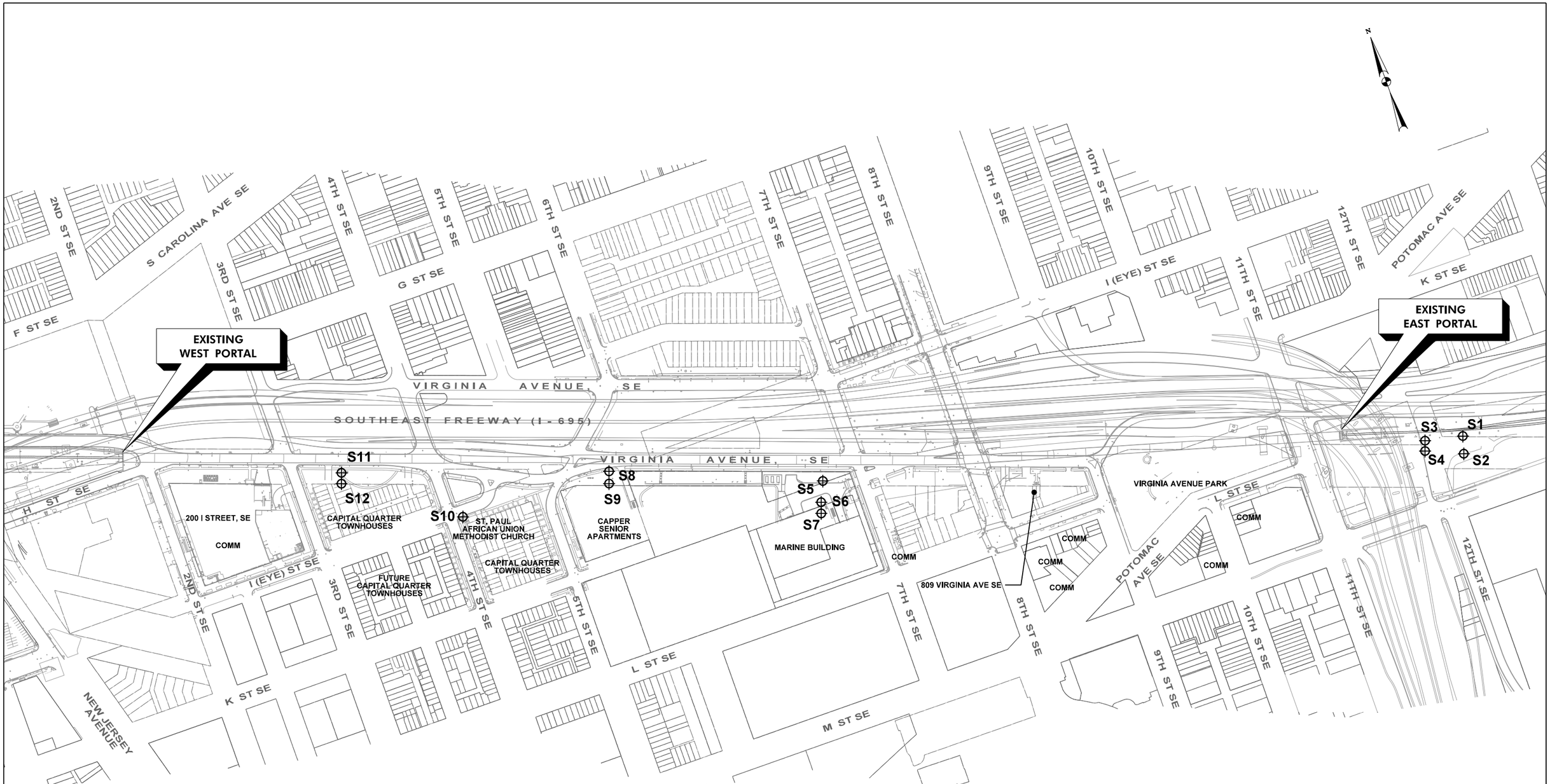

LEGEND

⊕ VIBRATION MEASUREMENT SITE

S12 VIBRATION MEASUREMENT SITE NUMBER

COMM COMMERCIAL

CLARK CONSTRUCTION
PARSONS
100 M Street SE, Washington, DC 20003

VIRGINIA AVENUE TUNNEL

VIBRATION MEASUREMENT SITES

FIGURE 1

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34972
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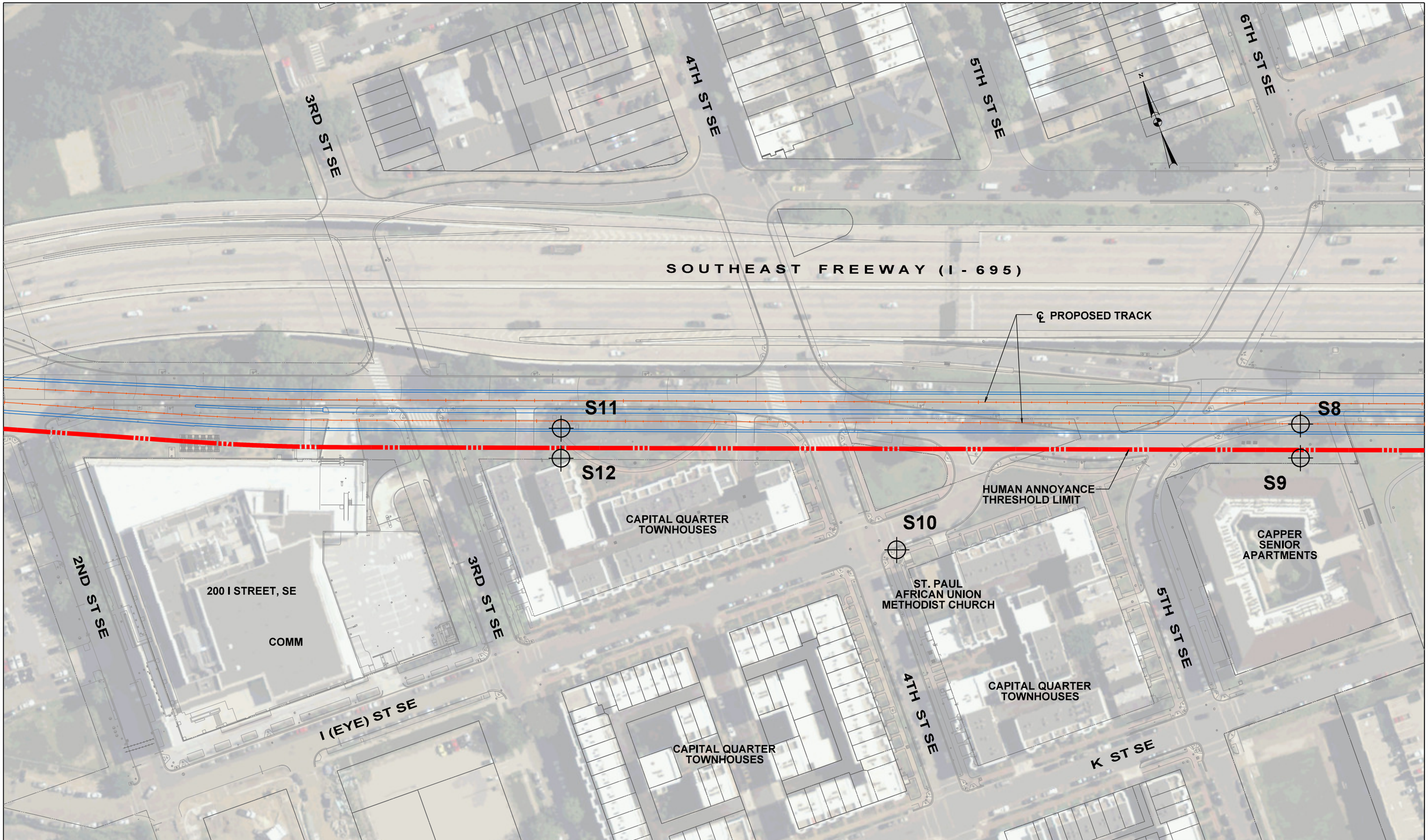

LEGEND

⊕	VIBRATION MEASUREMENT SITE	COMM	COMMERCIAL
S12	VIBRATION MEASUREMENT SITE NUMBER		℄ PROPOSED TRACK
	HUMAN ANNOYANCE IMPACT LINE		PROPOSED TUNNEL WALL

CLARK CONSTRUCTION
PARSONS
100 M Street SE, Washington, DC 20003

VIRGINIA AVENUE TUNNEL

VIBRATION MEASUREMENT SITES - ALTERNATIVE 3

FIGURE 2

c:\pw_working\dci\34972\dms15190\pVMI-P002_CSXVAT_VIBRATION_FIGURE-2.dgn
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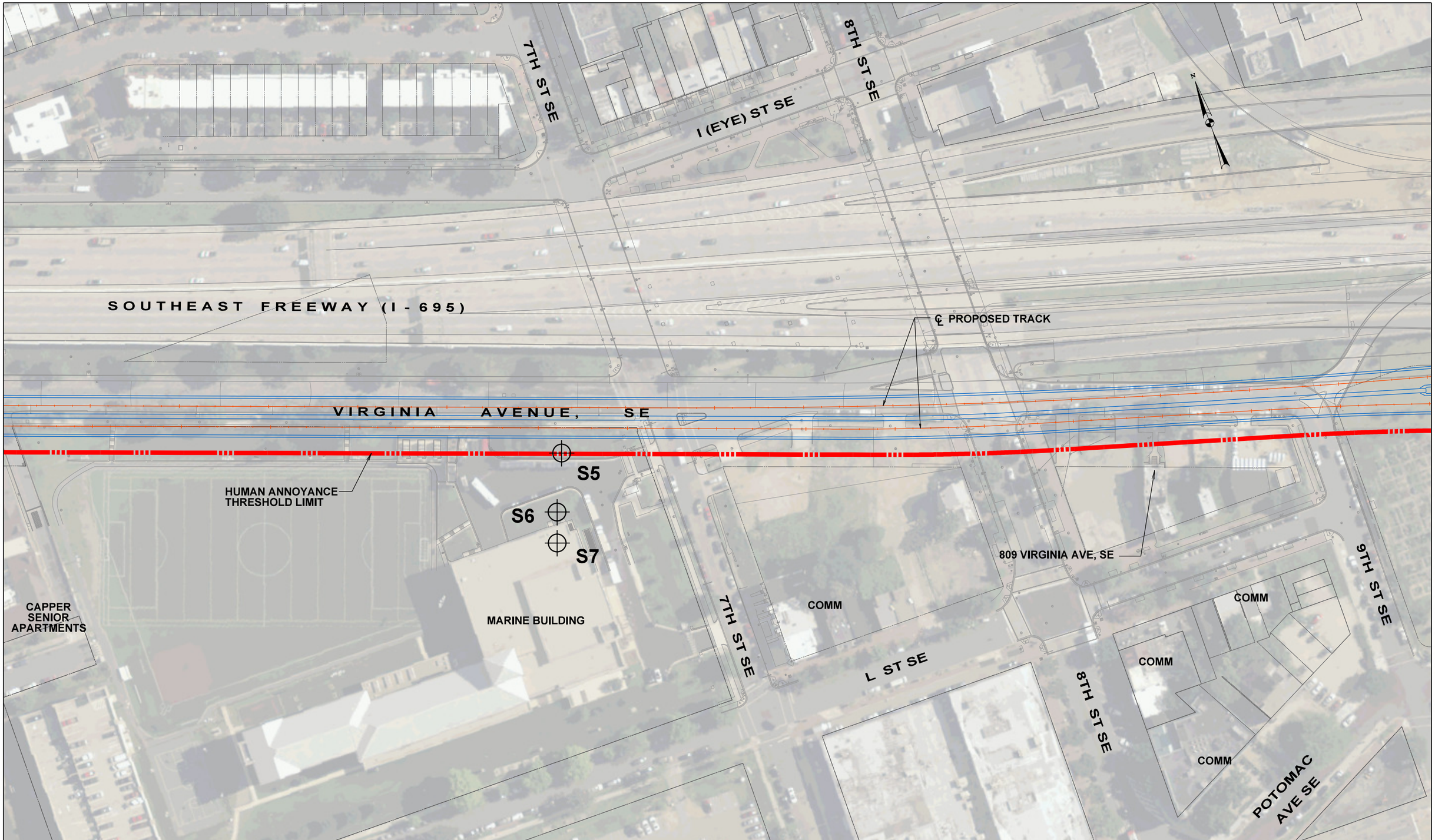

LEGEND

⊕	VIBRATION MEASUREMENT SITE	COMM	COMMERCIAL
S12	VIBRATION MEASUREMENT SITE NUMBER	℄	PROPOSED TRACK
▬	HUMAN ANNOYANCE IMPACT LINE	═	PROPOSED TUNNEL WALL

CLARK CONSTRUCTION
PARSONS
100 M Street SE, Washington, DC 20003

VIRGINIA AVENUE TUNNEL

VIBRATION MEASUREMENT SITES - ALTERNATIVE 3

FIGURE 3

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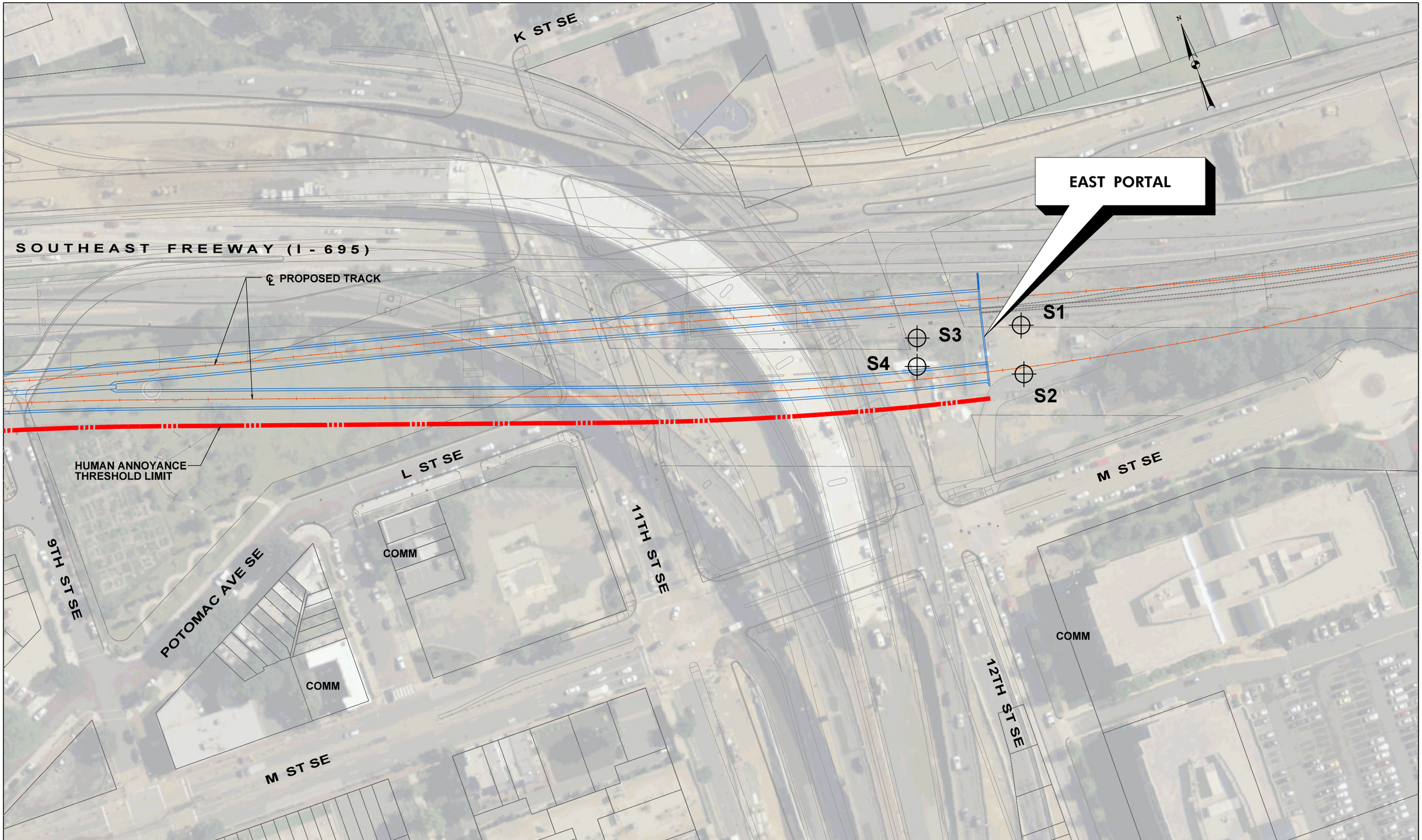

LEGEND

⊕	VIBRATION MEASUREMENT SITE	COMM	COMMERCIAL
S12	VIBRATION MEASUREMENT SITE NUMBER	℄	℄ PROPOSED TRACK
▬	HUMAN ANNOYANCE IMPACT LINE	═	PROPOSED TUNNEL WALL

CLARK CONSTRUCTION
PARSONS
100 M Street SE, Washington, DC 20003

VIRGINIA AVENUE TUNNEL

VIBRATION MEASUREMENT SITES - ALTERNATIVE 3

FIGURE 4

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B SOIL VIBRATION TRANSFERABILITY AND REDUCTION DATA

Table B-1. Soil Vibration Transferability Characteristic Calculations

Measurement Date	Peak Measurements				Soil Factor
	Sites 1 and 3 (Near)		Sites 2 and 4 (Far)		
	Vert		Vert.		
	RMS VdB[1]	PPV (in/sec)	RMS VdB[1]	PPV (in/sec)	
5/23/2012	85	0.070	82	0.048	**0.28**
5/23/2012	86	0.083	82	0.050	**0.37**
5/23/2012	82	0.050	78	0.030	**0.38**
5/23/2012	87	0.088	82	0.050	**0.42**
5/23/2012	82	0.053	78	0.030	**0.42**
5/23/2012	82	0.050	77	0.028	**0.43**
5/23/2012	82	0.050	77	0.028	**0.43**
5/23/2012	83	0.055	78	0.030	**0.45**
5/23/2012	86	0.080	81	0.043	**0.46**
5/23/2012	81	0.043	75	0.023	**0.46**
5/23/2012	82	0.048	76	0.025	**0.48**
5/23/2012	84	0.060	78	0.030	**0.51**
5/23/2012	85	0.070	79	0.035	**0.51**
5/23/2012	82	0.048	75	0.023	**0.54**
5/23/2012	84	0.063	78	0.030	**0.55**
5/23/2012	84	0.065	78	0.030	**0.57**
5/23/2012	84	0.065	78	0.030	**0.57**
5/23/2012	82	0.050	75	0.023	**0.57**
5/23/2012	83	0.055	76	0.025	**0.58**
5/23/2012	84	0.063	77	0.028	**0.60**
5/23/2012	84	0.065	77	0.028	**0.62**
5/23/2012	79	0.035	71	0.015	**0.62**
5/23/2012	85	0.068	77	0.028	**0.65**
5/23/2012	83	0.058	75	0.023	**0.68**
5/23/2012	83	0.058	75	0.023	**0.68**
12/19/2013	80	0.040	78	0.033	**0.25**
12/19/2013	80	0.040	78	0.033	**0.25**
12/19/2013	77	0.028	75	0.023	**0.26**
12/19/2013	77	0.028	75	0.023	**0.26**
12/19/2013	81	0.043	79	0.035	**0.27**
12/19/2013	76	0.025	74	0.020	**0.29**
12/19/2013	79	0.035	77	0.028	**0.29**
12/19/2013	79	0.035	77	0.028	**0.29**
12/19/2013	76	0.025	74	0.020	**0.29**
12/19/2013	79	0.035	77	0.028	**0.29**
12/19/2013	81	0.045	79	0.035	**0.33**
12/19/2013	81	0.045	79	0.035	**0.33**
12/19/2013	78	0.030	75	0.023	**0.35**
12/19/2013	78	0.030	75	0.023	**0.35**
12/19/2013	78	0.030	75	0.023	**0.35**
12/19/2013	78	0.030	75	0.023	**0.35**
12/19/2013	78	0.033	76	0.025	**0.36**
12/19/2013	78	0.033	76	0.025	**0.36**
12/19/2013	74	0.020	71	0.015	**0.38**
12/19/2013	80	0.040	78	0.030	**0.38**
12/19/2013	80	0.040	78	0.030	**0.38**
12/19/2013	80	0.040	78	0.030	**0.38**
12/19/2013	80	0.040	78	0.030	**0.38**
12/19/2013	80	0.040	78	0.030	**0.38**
12/19/2013	80	0.038	77	0.028	**0.40**
12/19/2013	73	0.018	70	0.013	**0.43**
12/19/2013	76	0.025	73	0.018	**0.43**
12/19/2013	76	0.025	73	0.018	**0.43**
12/19/2013	79	0.035	76	0.025	**0.44**
12/19/2013	77	0.028	74	0.020	**0.44**

Measurement Date	Peak Measurements				Soil Factor
	Sites 3 (Near)		Sites 4 (Far)		
	Vert		Vert.		
	RMS VdB[1]	PPV (in/sec)	RMS VdB[1]	PPV (in/sec)	
12/19/2013	77	0.028	74	0.020	**0.44**
12/19/2013	77	0.028	74	0.020	**0.44**
12/19/2013	79	0.035	76	0.025	**0.44**
12/19/2013	80	0.040	77	0.028	**0.47**
12/19/2013	80	0.040	77	0.028	**0.47**
12/19/2013	80	0.040	77	0.028	**0.47**
12/19/2013	80	0.040	77	0.028	**0.47**
12/19/2013	80	0.040	77	0.028	**0.47**
12/19/2013	81	0.043	78	0.030	**0.47**
12/19/2013	81	0.043	78	0.030	**0.47**
12/19/2013	81	0.043	78	0.030	**0.47**
12/19/2013	81	0.043	78	0.030	**0.47**
12/19/2013	81	0.043	78	0.030	**0.47**
12/19/2013	78	0.033	75	0.023	**0.47**
12/19/2013	78	0.033	75	0.023	**0.47**
12/19/2013	78	0.033	75	0.023	**0.47**
12/19/2013	78	0.033	75	0.023	**0.47**
12/19/2013	78	0.033	75	0.023	**0.47**
12/19/2013	71	0.015	68	0.010	**0.53**
12/19/2013	78	0.030	74	0.020	**0.53**
12/19/2013	81	0.045	78	0.030	**0.53**
12/19/2013	81	0.045	78	0.030	**0.53**
12/19/2013	81	0.045	78	0.030	**0.53**
12/19/2013	82	0.053	79	0.035	**0.54**
12/19/2013	82	0.050	78	0.033	**0.55**
12/19/2013	80	0.038	76	0.025	**0.55**
12/19/2013	80	0.038	76	0.025	**0.55**
12/19/2013	80	0.038	76	0.025	**0.55**
12/19/2013	80	0.038	76	0.025	**0.55**
12/19/2013	75	0.023	71	0.015	**0.56**
12/19/2013	75	0.023	71	0.015	**0.56**
12/19/2013	75	0.023	71	0.015	**0.56**
12/19/2013	81	0.043	77	0.028	**0.56**
12/19/2013	77	0.028	73	0.018	**0.58**
12/19/2013	77	0.028	73	0.018	**0.58**
12/19/2013	83	0.055	79	0.035	**0.59**
12/19/2013	84	0.063	80	0.040	**0.60**
12/19/2013	82	0.048	78	0.030	**0.62**
12/19/2013	66	0.008	62	0.005	**0.62**
12/19/2013	82	0.048	78	0.030	**0.62**
12/19/2013	82	0.053	78	0.033	**0.62**
12/19/2013	81	0.045	77	0.028	**0.62**
12/19/2013	81	0.045	77	0.028	**0.62**
12/19/2013	81	0.045	77	0.028	**0.62**
12/19/2013	70	0.013	66	0.008	**0.64**
12/19/2013	80	0.038	75	0.023	**0.66**
12/19/2013	80	0.038	75	0.023	**0.66**
12/19/2013	84	0.063	80	0.038	**0.66**
12/19/2013	76	0.025	71	0.015	**0.67**
12/19/2013	78	0.030	73	0.018	**0.67**
12/19/2013	78	0.030	73	0.018	**0.67**
12/19/2013	82	0.050	78	0.030	**0.67**
				Average	**0.48**

Note:

1 - Levels in VdB (re: 10-6 in/sec.)

Soil Factor Calculations

$PPV_2 = PPV_1 \times (D1/D2)^a$

Where: PPV_1 = Vibration at point 1, in/sec

PPV_2 = Vibration at point 2, in/sec

D1 = Distance from source to point 1, ft

D2 = Distance from source to point 2, ft

a = Soil transfer factor

Table B-2. Vibration Reduction Adjustment Factor due to the Existing Tunnel May 2012

Vibration Source	Time	Marine Band Practice Hall						Capitol Quarter Townhomes					
		Site 5 61 ft from center of track			Site 6 127 ft from center of track			Site 11 40 ft from center of track			Site 12 73 ft from center of track		
		PPV, (in/sec)			PPV, (in/sec)			PPV, (in/sec)			PPV, (in/sec)		
		With Tunnel	Without Tunnel	Reduction due to Tunnel	With Tunnel	Without Tunnel	Reduction due to Tunnel	With Tunnel	Without Tunnel	Reduction due to Tunnel	With Tunnel	Without Tunnel	Reduction due to Tunnel
Train with 120 Cars traveling at 19 mph	11:45:00	0.013	0.054	**0.041**	0.005	0.041	**0.036**	0.013	0.063	**0.050**	0.01	0.050	**0.040**
	11:45:30	0.005	0.027	**0.022**	0.005	0.019	**0.014**	0.005	0.034	**0.029**	0.01	0.025	**0.015**
	11:46:00	0.005	0.025	**0.020**	0.005	0.018	**0.013**	0.008	0.031	**0.023**	0.008	0.023	**0.015**
	11:46:30	0.008	0.026	**0.018**	0.005	0.017	**0.012**	0.008	0.032	**0.024**	0.008	0.023	**0.015**
	11:47:00	0.005	0.033	**0.028**	0.005	0.022	**0.017**	0.008	0.043	**0.035**	0.008	0.030	**0.022**
	11:47:30	0.005	0.026	**0.021**	0.005	0.017	**0.012**	0.005	0.033	**0.028**	0.008	0.023	**0.015**
	11:48:00	0.008	0.032	**0.024**	0.005	0.020	**0.015**	0.008	0.042	**0.034**	0.008	0.028	**0.020**
	11:48:30	0.005	0.033	**0.028**	0.005	0.024	**0.019**	0.008	0.039	**0.031**	0.008	0.030	**0.022**
Train with 70 Cars traveling at 12 mph	12:40:00	0.005	0.033	**0.028**	0.005	0.022	**0.017**	0.013	0.043	**0.030**	0.01	0.030	**0.020**
	12:40:30	0.01	0.030	**0.020**	0.005	0.022	**0.017**	0.015	0.036	**0.021**	0.013	0.028	**0.015**
	12:41:00	0.01	0.026	**0.016**	0.008	0.016	**0.008**	0.013	0.035	**0.022**	0.01	0.023	**0.013**
	12:41:30	0.008	0.032	**0.024**	0.005	0.019	**0.014**	0.013	0.044	**0.031**	0.01	0.028	**0.018**
	12:42:00	0.01	0.026	**0.016**	0.005	0.016	**0.011**	0.005	0.035	**0.030**	0.008	0.023	**0.015**
Train with 143 Cars traveling at 14 mph	13:47:30	0.008	0.051	**0.043**	0.005	0.041	**0.036**	0.005	0.057	**0.052**	0.008	0.048	**0.040**
	13:48:00	0.01	0.033	**0.023**	0.005	0.022	**0.017**	0.005	0.042	**0.037**	0.008	0.030	**0.022**
	13:48:30	0.005	0.032	**0.027**	0.005	0.020	**0.015**	0.005	0.041	**0.036**	0.008	0.028	**0.020**
	13:49:00	0.005	0.031	**0.026**	0.005	0.020	**0.015**	0.005	0.040	**0.035**	0.008	0.028	**0.020**
	13:50:00	0.008	0.029	**0.021**	0.005	0.017	**0.012**	0.005	0.039	**0.034**	0.008	0.025	**0.017**
	13:50:30	0.008	0.030	**0.022**	0.005	0.022	**0.017**	0.005	0.036	**0.031**	0.008	0.028	**0.020**
	13:51:00	0.005	0.033	**0.028**	0.005	0.023	**0.018**	0.005	0.041	**0.036**	0.008	0.030	**0.022**
	13:51:30	0.008	0.033	**0.025**	0.005	0.024	**0.019**	0.01	0.039	**0.029**	0.008	0.030	**0.022**
	13:52:00	0.01	0.028	**0.018**	0.005	0.018	**0.013**	0.005	0.036	**0.031**	0.01	0.025	**0.015**
Train with 47 Cars traveling at 20 mph	14:00:30	0.013	0.054	**0.041**	0.008	0.040	**0.032**	0.01	0.065	**0.055**	0.01	0.050	**0.040**
	14:01:30	0.008	0.032	**0.024**	0.005	0.024	**0.019**	0.005	0.038	**0.033**	0.008	0.030	**0.022**
	14:02:00	0.01	0.039	**0.029**	0.005	0.027	**0.022**	0.005	0.048	**0.043**	0.008	0.035	**0.027**
	14:02:30	0.008	0.017	**0.009**	0.005	0.011	**0.006**	0.005	0.022	**0.017**	0.008	0.015	**0.007**
Train with 28 Cars traveling at 20 mph	14:16:00	0.015	0.047	**0.032**	0.005	0.034	**0.029**	0.013	0.057	**0.044**	0.013	0.043	**0.030**
Average		0.008	0.033	**0.025**	0.005	0.023	**0.018**	0.008	0.041	**0.033**	0.009	0.030	**0.021**

Table B-3. Vibration Reduction Adjustment Factor due to the Existing Tunnel December 2013

Vibration Source	Time	Capper Senior Apartments						St. Paul African Union Methodist Protestant Church		
		Site 8 25 ft from center of track			Site 9 68 ft from center of track			Site 10 179 ft from center of track		
		PPV, (in/sec)			PPV, (in/sec)			PPV, (in/sec)		
		With Tunnel	Without Tunnel	Reduction due to Tunnel	With Tunnel	Without Tunnel	Reduction due to Tunnel	With Tunnel	Without Tunnel	Reduction due to Tunnel
12:35 Train with 69 Cars traveling at 19 mph	12:35:00	0.035	0.068	**0.033**	0.013	0.033	**0.020**	0.008	0.016	**0.008**
12:58 Train with 42 Cars traveling at 14 mph	12:58:00	0.018	0.049	**0.031**	0.008	0.025	**0.017**	0.008	0.015	**0.007**
	12:59:00	0.028	0.041	**0.013**	0.01	0.020	**0.010**	0.008	0.010	**0.002**
13:14 Train with 66 Cars traveling at 12 mph	13:14:00	0.015	0.042	**0.027**	0.008	0.025	**0.017**	0.005	0.015	**0.010**
13:40 Train with 86 Cars traveling at 19 mph	13:42:00	0.013	0.052	**0.039**	0.008	0.026	**0.018**	0.005	0.014	**0.009**
	13:43:00	0.013	0.047	**0.034**	0.008	0.033	**0.025**	0.005	0.023	**0.018**
13:46 Train with 64 Cars traveling at 18 mph	13:46:00	0.018	0.042	**0.024**	0.010	0.025	**0.015**	0.010	0.015	**0.005**
	13:47:00	0.025	0.042	**0.017**	0.010	0.028	**0.018**	0.013	0.019	**0.006**
	13:48:00	0.023	0.041	**0.018**	0.010	0.022	**0.012**	0.003	0.012	**0.009**
Average		0.021	0.047	**0.026**	0.009	0.027	**0.017**	0.007	0.015	**0.008**

Average tunnel reduction calculated using May 2012 and Dec 2013 data 0.021 in/sec

C CONSTRUCTION ACTIVITIY

Table C-1. Construction Activities Assumptions for Vibration Estimates

CONSTRUCTION ACTIVITY [1]	ANTICIPATED EQUIPMENT	MINIMUM DISTANCE TO CONSTRUCTION ACTIVITY (FT)					
		809 VIRGINIA AVENUE	MARINE BAND PRACTICE HALL	CAPPER SENIOR APARTMENTS	ST. PAUL AFRICAN UNION METHODIST PROTESTANT CHURCH	CAPITAL QUARTER TOWNHOUSES	200 I STREET
Utility Relocation	• Small Back Hoe [2] • Utility Truck	38	88	25	128	23	23
Surface Demolition	• Jack Hammer [2] • Front End Loader • Dump Truck	50	100	18	18	25	38
Existing Tunnel Demolition	• Back Hoe (Cat 325 or equivalent) • Track Loader (Cat 973 or equivalent) • Hoe Ram [2] • Dump Truck	70	120	60	160	56	55
Support of Excavation	• Drill Rig (Soilmec 622) [2] • Forklift (10000 lb) • Welding Machine	43	93	30	133	28	28
Excavation	• Back Hoe (Cat 325 or equivalent) • Track Loader (Cat 973 or equivalent) [2] • Dump Truck	44	94	31	134	29	29
Tunnel Structure Construction	• Truck Mixer • Crane (60 Ton Rubber Tire) [2] • Tractor Trailer • Forklift (10000 lb) • Air Compressor	45	95	32	135	30	30
Backfill	• Roller/Compactor • Light Plant • Motor Grader • Dozer (Cat D7 or equivalent) [2]	44	94	31	134	29	29
Roadway Construction	• Non-vibratory Roller • Paver • Dump Truck • Light Plant • Motor Grader • Dozer (Cat D7 or equivalent) [2]	55	110	30	135	50	40
Sheet Pile (Alt 4 Only) [3]	• Vibratory Pile Driver [2] • 100 Ton Crawler Crane • Crane (60 Ton Rubber Tire) • Welding Machine	68	118	58	158	54	53

Notes:

[1] Construction activities were predicted using the best information available at the time the study was prepared.

[2] Indicates the highest vibration producing construction equipment that was used to predict vibration levels for the construction activity.

[3] Indicates that the construction activity will only take place for Alternative 4.

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Appendix G

Modified Phase I Environmental Site Assessment

Modified Phase I Environmental Site Assessment

Virginia Avenue Tunnel Reconstruction Project

Virginia Avenue SE
Washington, DC 20003

May 2013

Project # 173712E

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1.0 EXECUTIVE SUMMARY

Parsons Brinckerhoff, Inc. (PB) has performed a modified Phase I environmental site assessment (ESA) of the Virginia Avenue Tunnel corridor (the Site[1]) along Virginia Avenue SE in Washington, DC for CSX Transportation, Inc. No party other than those listed in Section 2.7 may rely upon any information or opinion contained in this report.

This ESA was performed in partial conformance with the scope and limitations of 40 CFR Part 312 (Standards and Practices for All Appropriate Inquiries) and ASTM Method E 1527-05 (Standard Practice for Environmental Site Assessments). Any exceptions to, or deletions from this practice are described in Section 12.0 of this report.

This executive summary briefly discusses the conclusions of this assessment. Reading it should not be considered a substitute for reading the entire report. Only the report in its entirety should be relied upon to provide complete information regarding PB's observations when reviewing the environmental conditions for this Site.

The ESA included a site walkover, review of government records, assembly and review of data from area maps and directories, and assessment of aerial photographs and Sanborn maps. This assessment has revealed no evidence of recognized environmental conditions in connection with the property except for the following:

1) The 1998 materials investigation report for the Virginia Avenue Tunnel identified TPH-DRO in six of 10 soil samples collected from within the tunnel at concentrations exceeding residential cleanup criteria. The 2012 testing conducted along the tunnel corridor identified at least one SVOC present in soil samples from the zero to 15 foot interval in seven borings at concentrations exceeding the residential cleanup criteria. Hexavalent chromium (Cr^{6+}) was present in samples from the deeper depth intervals in five soil borings at concentrations exceeding the residential cleanup criteria. None of the contaminants are present at concentrations exceeding the industrial cleanup criteria. The borings from which all of these samples were collected were widely spaced, indicating that the contamination is pervasive. PB believes that the presence of contaminants in the soil at concentrations exceeding residential cleanup criteria is a REC.

2) The 1998 materials investigation report for the Virginia Avenue Tunnel identified TPH-GRO, TPH–ERO, and oil and grease in three of the groundwater seep

[1] Please refer to Section 3.1 for a description of the Site, and how it differs from the Project Area.

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samples in the tunnel at concentrations "requiring proper management." The 2012 testing conducted along the tunnel corridor identified naphthalene in the M-8 boring at concentrations exceeding the Tier I residential groundwater standard for domestic use. The contaminants in the groundwater seeps in the tunnel may be the result of contaminants leaching from the fill material surrounding the tunnel, while the contaminants in the M-8 boring are likely the result of contamination originating from a nearby facility of concern. PB believes that the presence of contaminated groundwater along the tunnel at concentrations exceeding residential cleanup criteria is a REC.

3) The asbestos survey conducted on the Virginia Avenue Tunnel in 2012 showed that approximately 8,000 square feet of black felt paper located inside the concrete vaults enclosing the electrical conduit contained asbestos. The report did not indicate whether the material was friable or likely to become friable; however, it did state that the material should not be disturbed or handled by CSX personnel. The report further stated that if tunnel expansion activities would disturb this material, it must be removed and properly disposed by a licensed asbestos abatement contractor. PB believes that the presence of the asbestos containing material in the tunnel is a REC.

4) PB's research revealed the presence of 63 nearby facilities of concern in the vicinity of the Site. Some of these facilities were identified through multiple sources; others were identified from a single source. These facilities include former gasoline stations, vehicle repair facilities, dry cleaners, properties with underground storage tanks, a manufactured gas plant, and an NPL facility. Each of these properties are either known to be contaminated, or were likely to have used, stored, or handled hazardous substances or petroleum products as part of their operations. Based on their distance from the Site, the known or probable contaminants used, and the lithology of the area, PB believes that contamination emanating from these properties could impact the soil and/or groundwater surrounding the tunnel. These facilities are therefore considered to be RECs.

Based on the information gathered as part of this Modified Phase I ESA, review of the relevant data, and understanding of the planned Site uses, PB recommends the following activities be completed:

1) Although soil contamination has been identified at concentrations exceeding residential cleanup criteria, it does not exceed the industrial cleanup criteria or construction worker protection cleanup criteria. Because the borings from which the samples were collected were widely spaced, localized pockets of more highly

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contaminated soil could be encountered during construction activities. Construction workers should be informed of the possible presence of contaminated soil surrounding the tunnel, so precautions can be taken to protect the workers. Suspected contaminated soil should be stockpiled and sampled for characterization. Contaminated soil should be handled and managed in accordance with appropriate local, district, and/or federal rules and regulations.

2) Although contaminated groundwater has been identified at concentrations exceeding the Tier I criteria for domestic water use, it does not exceed any of the Tier I standards for incidental dermal contact. Because the borings from which the samples were collected were widely spaced, localized pockets of more highly contaminated groundwater could be encountered during construction activities. Construction workers should be informed of the possible presence of contaminated groundwater, so precautions can be taken to protect the workers. Groundwater that is generated through dewatering activities during construction should be handled, managed, and discharged in accordance with appropriate local, district, and/or federal rules and regulations. This may include temporary storage in a tank, characterization for the possible presence of contaminants, filtering through granular activated carbon, and/or discharge permitting.

3) The black felt material in the utility chase within the Virginia Avenue Tunnel should be properly removed and disposed by a licensed asbestos abatement contractor if these areas are planned for any disturbance (renovation, demolition, replacement, etc.).

4) Because of the presence of the nearby facilities of concern, construction activities should include provisions for evaluating the soil and groundwater for potential contaminants (as discussed in #1 and #2, above). Contaminated soil and groundwater should be handled and/or disposed in accordance with appropriate regulations.

5) Although a CERCLA liability defense is not being sought, CSX Transportation, Inc should review the User's Ongoing Responsibilities (included in Section 11.0 of this report), and comply with the provisions therein.

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2.0 INTRODUCTION

2.1 Purpose of ESA

This modified Phase I ESA report was intended to provide an initial step toward evaluating the Site for potential environmental concerns. Because of client-imposed restrictions, several of the normal Phase I ESA activities were not completed (which are discussed in Section(s) 2.2 and 12.0)This modified Phase I ESA is therefore not intended to satisfy all appropriate inquiries (AAI) or be in full compliance with ASTM Method E1527-05.

An "all appropriate inquiries" (AAI) assessment is a necessary component for persons seeking to establish either CERCLA's innocent landowner defense in 42 U.S.C. §9607(b)(3), the bona fide prospective purchaser defense in 42 U.S.C. §9607(r), or the contiguous property owner defense in 42 U.S.C. §9607(q). The User's additional on-going responsibilities, also necessary to establish the above defenses, are summarized in Section 11.0.

According to the rules promulgated by the U.S. EPA pursuant to CERCLA (at 40 CFR Part 312), the primary objectives of an ESA are to identify the following types of information about the Site prior to acquiring the property: (1) current and past property uses and occupancies, (2) current and past uses of hazardous substances, (3) waste management and disposal activities that could have caused releases or threatened releases of hazardous substances, (4) current and past corrective actions and response activities undertaken to address past and on-going releases of hazardous substances, (5) engineering controls, (6) institutional controls, and (7) properties adjoining or located near the Site that have environmental conditions indicative of releases or threatened releases of hazardous substances on, at, in, or to the Site. This information was gathered to evaluate the Site for evidence of conditions indicative of a release.

The ASTM standards were written to not only satisfy the U.S. EPA's requirements for an AAI environmental site assessment, but also to evaluate "business environmental risk" associated with a parcel of commercial real estate. Accordingly, for this ESA, PB evaluated the Site for evidence of hazardous substance disposal or releases from or onto the Site, environmental threats from adjacent properties, and current recognized environmental conditions (RECs[2]) and historic recognized environmental conditions (HRECs[3]). This evaluation involved only a review

[2] According to ASTM, a REC (pronounced "wreck") is "the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, groundwater or surface water of the property. The term includes hazardous substances or petroleum products even under conditions in compliance with laws. The term is not intended to include *de minimis* conditions that generally do not present a material risk of harm to public health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies."

[3] According to ASTM, an HREC (pronounced "H-wreck") is a "condition which in the past would have been considered a recognized environmental condition, but which may or may not be considered a recognized environmental condition currently. The final decision rests with the environmental professional and will be influenced by the impact of the historic recognized environmental condition on the property currently."

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of historical information and publicly-available government agency records. PB used this information to decide whether further environmental testing of the Site is warranted.

In the U.S. EPA's "Standards and Practices for All Appropriate Inquires," the phrase "conditions indicative of releases or threatened releases of hazardous substances on, at, in or to the property" was used. PB considers a REC to be synonymous with this phrase. PB elected to use the terms REC and HREC in this report. Commonly used acronyms are defined in Section 14.0.

The work for this modified ESA was completed by Adam W. Heft and reviewed by David R. VanGoethem. All activities were completed by an Environmental Professional, with the exception of the Site walkover. The qualifications of each individual involved in preparing this report are included in Appendix J.

2.2 Detailed Scope-of-Work

2.2.1 Items Included in Scope of Work

PB completed the following tasks during this ESA.

Site Visit

PB personnel conducted a partial, non-comprehensive site visit to observe current conditions and look for obvious characteristics that suggested contamination may be present. Adjacent properties were also viewed from public rights-of-way.

Aerial Photographs

PB reviewed aerial photographs that were available from public sources to identify whether these photographs contained evidence of potential contaminant sources.

Public Records Evaluation

PB subcontracted with Environmental Data Resources (EDR) of Milford, Connecticut to compile information about facilities that use, or store chemicals, or that have suspected or known contamination from governmental databases. Using the information provided by this report, PB evaluated the potential impact that identified facilities might have on the Site.

Fire Insurance Map Review

PB obtained available historic fire insurance maps from EDR that show the past uses of the Site, and identify features such as the former existence of underground and aboveground storage tanks, which now are considered RECs.

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City Directory Research and Review

PB subcontracted EDR to provide city directory information. PB reviewed the city directories to help identify former uses of the Site and surrounding areas that indicate the existence of potentially-contaminating businesses. PB personnel also reviewed supplemental city directory information at a local library.

Specialized or Actual Knowledge

The PB personnel conducting this ESA have included any specialized or actual knowledge they have regarding the Site or nearby properties believed likely to have impacted the Site.

2.2.2 User Provided Information

The User of this ESA did not provide PB with all the required information as discussed in Section 4.0 as of the time of this draft.

2.2.3 Items Not Included in Scope of Work

The above services focused on identifying possible soil and/or groundwater contamination on the Site. The proposed scope of work did not, however, include the collection or testing of soil, groundwater, surface water or building materials. Examples of other activities not included in the Phase I ESA are:

- Interviews - PB did not interview the property owners or others familiar with the Site as part of this ESA because of client-imposed restrictions.
- Agency Regulatory Records – Also due to client-imposed restrictions, PB did not review agency files and/or consult with local health department, fire department, building department, and local or state governmental offices to help clarify information provided by the EDR report.
- Environmental Lien Search – PB did not conduct a lien search of the corridor property or review title records.
- Asbestos Inspection – PB did not conduct an asbestos survey of the tunnel; however an asbestos survey was conducted by others. The results of the asbestos survey are discussed in this report.
- Lead Paint Assessment
- Radon and Other Indoor Air Quality Evaluation (vapor intrusion assessment). An assessment of potential contaminant vapor intrusion into the tunnel was not conducted.

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- PCB Evaluation – PB did not conduct a PCB survey of the tunnel; however a PCB survey was conducted by others. The results of the PCB survey are discussed in this report.
- Mold Survey
- Review or Analysis for Permit, Regulation, or Statute Violations
- Review of Zoning Restrictions
- Special Flood Hazard Area Determinations
- Cultural and Historic Resource Survey
- Industrial Hygiene Assessment
- Health and Safety Review
- Wetlands, Ecological Resources and Endangered Species Surveys
- High Voltage Power Lines Identification

2.3 PB's Specialized or Actual Knowledge

The PB personnel involved in conducting this ESA have no specialized or actual knowledge regarding the Site.

2.4 Significant Assumptions

Certain information contained in this report was obtained from agencies or from the client. In preparing this report, PB relied on the information provided by these sources unless PB had actual knowledge the information was incorrect, or believed that certain information was incorrect based on other information obtained while performing the ESA. Except as discussed in the report, PB did not verify the accuracy of the information provided to it.

2.5 Objectives of ESA

For this ESA, PB consulted historical sources to learn about the Site's former owners and occupants, developed a history of the previous uses of the property and surrounding area, and used this information to identify the likelihood that either on- or off-site past property uses might have created RECs in connection with the Site. The historic information and uses of the Site and surrounding area are summarized in Section 5.5 and 5.6.

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PB attempted to identify obvious property uses from the present back to either the Site's first developed use (including agricultural uses and placement of fill dirt) or to at least 1940, whichever was earliest. Any data gaps or failures have been identified in Section 12.0.

2.6 Special Terms and Conditions

In the professional judgment of PB, the scope of this investigation was sufficient to determine whether further investigation is needed, given the nature and specific circumstances of the Site. PB performed this ESA in conformance with the care and skill currently exercised by reputable environmental consulting firms practicing under similar conditions. No other warranty or representation of any kind, expressed or implied, at common law or created by statute, is extended, made or intended by PB's rendering of consulting services or furnishing oral and/or written reports of its findings.

Contaminants may be hidden in subsurface materials, having been intentionally covered, or because they were covered by foliage, water, snow, concrete, asphalt, or other materials. This contamination may not be present in predictable locations. The most that PB could do is formulate a logical assessment program with reasonable time and cost limits to reduce, but not eliminate, the client's risk of later discovering previously unknown contamination. More extensive exploration could reduce the probability of finding contamination, if present; however, even after extensive exploration, PB would be unable to say with total certainty that no RECs are present on this Site.

PB conducted what it believes was an appropriate inquiry into possible conditions indicative of a release on the Site given the client-imposed restrictions. This inquiry was not an exhaustive assessment. A point exists at which the cost of the information obtained or the time required to gather it outweighs the usefulness of the information and, in fact may be a material detriment to the orderly completion of the transaction. PB attempted to balance the cost and time to perform this ESA with the need to reduce uncertainty about unknown conditions by obtaining additional information.

No warranty can be made that conditions observed were representative of areas not observed. Tests or data collected for this report were obtained only for the purposes stated in this report, and should not be used for reasons other than those intended.

This report does not constitute legal advice, nor does PB purport to give legal advice. Environmental conditions and regulations are subject to constant change and reinterpretation.

It should not be assumed that current conditions and/or regulatory positions will remain constant. Furthermore, because the facts stated in this report are subject to professional interpretation, differing conclusions could be reached by other Environmental Professionals.

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Since CSX Transportation, Inc. already occupies the Site, it likely could not qualify for a defense from CERCLA liability; however, CSX Transportation, Inc. should still comply with all ongoing responsibilities identified in Section 11.0 of this report.

2.7 Reliance

PB has no obligation to any third party who intends to or will rely on this report and specifically disclaims such responsibility. PB assumes no obligation for reporting any facts revealed by the ESA or contained in the report to any entity other than CSX Transportation, Inc, the District Department of Transportation (DDOT) and the Federal Highway Administration (FHWA). CSX Transportation, Inc., DDOT and FHWA may rely on the conclusions in this report.

3.0 SITE DESCRIPTION

3.1 Location and Legal Description

The approximately 3,800 feet long Virginia Avenue Tunnel is located in the Capitol Hill neighborhood of the District of Columbia beneath eastbound Virginia Avenue SE from 2nd Street SE to 9th Street SE, Virginia Avenue Park and the 11th Street Bridge right-of-way between 9th and 11th Streets SE, and is aligned on south side of Interstate 695 (I-695). The tunnel portals are located about 100 feet west of 2nd Street SE and about 100 feet east of 11th Street SE (Figure 1 and Figure 2 in 0). PB used an address of 700 Virginia Avenue for purposes of locating the tunnel corridor when ordering research data from EDR; however, the corridor extends to the east and west of this address.

This Modified Phase I ESA focused on evaluating potential RECs that could impact the Virginia Avenue Tunnel as described above. For purposes of this report, the term “Site” will refer to the actual Virginia Avenue Tunnel and surface area overlying the tunnel. The term “Project Area” will refer to the tunnel plus a larger area along the railroad to the east and west, areas of nearby surface streets, and rights-of-way that will be affected by construction activities as described in Section 4.4. Those portions of the Project Area, other than the actual tunnel, were not fully evaluated for the possible presence of RECs.

The extent of the Site is illustrated by the blue line as shown on Figures 3A-C in 0, while the Project Area is outlined in pink in Figure 3 and on Figures 3A-C.

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3.2 Photographs of Site and Possible RECs

While performing its reconnaissance of the Site, PB photographed the characteristics of the Site and surrounding properties, and RECs that could be seen. A copy of selected photographs showing conditions on the Site is included in Appendix B.

3.3 Description of Structures and Other Features on the Site

The Site contains a railroad tunnel with a single track; Virginia Avenue SE is on the ground surface above the tunnel. The Project Area extends east and west of the tunnel. No other structures exist within the Site.

3.4 Current Uses of the Site

The Site is used for vehicular traffic on the ground surface along Virginia Avenue SE, while railroad traffic passes through the tunnel below. Both the street and the railroad line are currently in use.

3.5 Current Uses of Adjoining and Nearby Properties

The site investigation included a review of the conditions and uses of nearby and adjoining properties to identify potential environmental problems that might adversely impact the Site. PB viewed these properties from either the Site boundary or readily accessible public rights-of-way. During its reconnaissance, PB attempted to identify the current and historic activities on nearby and adjoining properties, and whether potentially contaminating substances were used as part of these activities. The following list includes properties immediately adjacent to the Site; along with nearby properties PB believes could have stored or used potentially contaminating materials.

Adjacent and Nearby to the North:

- Green space area (landscaped grass with trees and bushes)
- The 695 expressway and ramps
- Garfield Park
- Westbound Virginia Avenue SE
- Streets: 2nd Street through 11th Street
- Residential areas

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Adjacent and Nearby to the East:

- Railroad line

Adjacent and Nearby to the South:

- Commercial buildings
- Residential housing
- A church
- Capital Motor Works (closed and fenced)
- DogMa (pet boarding and grooming)
- Community garden
- Streets: 2nd Street through 11th Street
- US Navy Yard complex

Adjacent and Nearby to the West:

- Railroad line

During its reconnaissance of nearby and adjacent properties, and through its other research, PB attempted to identify the current and historic activities on adjoining properties, and whether potentially contaminating substances were used as part of these activities. PB believes that potentially contaminating substances have been used at the former Capital Motor Works facility and within the US Navy Yard complex. The potential impact of the contaminants at these facilities is discussed in Section 8.0 of this report.

4.0 USER-PROVIDED INFORMATION

4.1 Knowledge of the Site

PB requested CSX Transportation to provide any common, actual, or specialized knowledge it has that could help identify RECs on the Site. The information requested by PB included the client's knowledge of the historic uses of the Site, the use or disposal of potential contaminants on the Site, the existence of environmental liens within the title records, or the possible presence of contamination on adjacent or nearby properties. PB was provided with copies of environmental documentation regarding current and prior testing of the tunnel area; these reports are discussed below in Section 4.5.

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4.2 Valuation Reduction for Environmental Issues

PB was informed that no transaction is occurring as part of this project, and that a valuation reduction evaluation of a purchase price is inapplicable for this ESA.

4.3 Owner, Site Manager and Occupant Information

The owner of the Site is CSX Transportation, Inc. The Site is not continuously occupied, but is traversed by railroad vehicles. The ground surface is occupied by Virginia Avenue SE and is a public thoroughfare.

4.4 Reason for Performing the Phase I ESA

CSX Transportation, Inc. (CSX) is proposing to reconstruct the Virginia Avenue Tunnel. The tunnel is located in the Capitol Hill neighborhood of the District of Columbia beneath eastbound Virginia Avenue SE from 2nd Street SE to 9th Street SE, Virginia Avenue Park and the 11th Street Bridge right-of-way between 9th and 11th Streets SE, and is aligned on south side of Interstate 695 (I-695). The tunnel portals are located a short distance west of 2nd Street SE and a short distance east of 11th Street SE. CSX also owns or has easements of the rail lines immediately east and west of the tunnel. The tunnel and rail lines running through the District are part of CSX's eastern seaboard freight rail corridor, which connects Mid-Atlantic and Midwest states.

The CSX proposal includes the complete reconstruction of the tunnel, which was built over 100 years ago. In addition to its age, the tunnel is also a bottleneck to the freight rail network with its single-track configuration and with a vertical clearance that does not allow for double-stack intermodal container freight trains. The Project will transform the tunnel to a two-track configuration, matching the number of tracks immediately east and west of the tunnel, and provide the minimum 21 feet of vertical clearance to allow double-stack intermodal container freight train operations. This will allow more efficient freight movement, especially in light of expected increases in freight volume. Reconstructing the tunnel to allow double-stack intermodal container freight trains would require lowering the grade below the rail line's New Jersey Avenue SE Overpass to provide the 21-foot minimum clearance.

The following alternatives are being considered for the Project:

<u>Alternative 1 - No Build:</u> The No Build alternative, which is automatically carried forward into the Draft EIS. The tunnel would not be rebuilt under this alternative. However, the railroad would continue to operate trains through the tunnel and at some point, emergency or unplanned major repairs or rehabilitation could be required to this critical, aging infrastructure that might prove equally disruptive to the community than the Build Alternatives.

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Alternative 2 -Rebuilt Tunnel / Temporary Runaround Track: This alternative involves rebuilding the existing Virginia Avenue Tunnel. It would be rebuilt with two tracks and enough vertical clearance to accommodate double-stack intermodal container freight trains. It would be rebuilt in generally the same location, except aligned approximately seven feet to the south of the existing tunnel center line. It would be rebuilt using protected open trench construction methods. During construction, freight trains would be temporarily routed through a protected open trench outside the existing tunnel (runaround track). The runaround track would be aligned to the south and generally parallel to the existing tunnel, and would be located below street level. Due to new columns associated with the rebuilt 11th Street Bridge, the runaround track would slightly separate from the tunnel alignment on the east end starting just west of Virginia Avenue Park. Safety measures such as securing fencing would be used to prevent pedestrians and cyclists from accessing the runaround track.

Alternative 3 - Two New Tunnels: This alternative involves replacing the existing Virginia Avenue Tunnel with two new permanent tunnels constructed sequentially. Each new tunnel would have a single track with enough vertical clearance to allow double-stack intermodal container freight trains. A new parallel south side tunnel would be built first as trains continue operating in the existing Virginia Avenue Tunnel. After the south side tunnel is completed, train operations would switch over to the new tunnel and the existing Virginia Avenue Tunnel would be demolished and rebuilt. With the exception of operating in a protected open trench for approximately 230 feet immediately east of the 2nd Street portal (within the Virginia Avenue SE segment between 2nd and 3rd Streets SE), trains would operate in enclosed tunnels throughout construction under Alternative 3. Throughout most of the length, the two tunnels would be separated by a center wall. This center wall would be the new centerline of the two tunnels, and it would be aligned approximately 25 feet south of the existing tunnel centerline, between 2nd and 9th Streets SE. Due to new columns associated with the rebuilt 11th Street Bridge, the tunnels would be separated on the east end starting just west of Virginia Avenue Park, resulting in two separate single-track tunnels and openings at the east portal.

Alternative 4 - New Partitioned Tunnel / Online Rebuild: Alternative 4 would result in a new tunnel with two permanent tracks. Similar to Alternative 3, the new tunnel would be partitioned and have enough vertical clearance to allow double-stack intermodal container freight trains. It would be aligned approximately 17 feet south of the existing tunnel's centerline. The new partitioned tunnel would be built using protected open trench construction methods. Safety measures such as secure fencing would be used to prevent pedestrians and bikers from accessing the protected open trench. The rebuild would occur 'online' meaning that during the period of construction, the protected open trench would accommodate both construction activities and train operations. Maintaining safe and reliable temporary train operations is a more complicated endeavor under Alternative 4 than under the other two Build Alternatives because of the online rebuild approach.

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Regardless of Build Alternative, the Project would extend the east portal by approximately 330 feet to a location northeast of the 12th Street and M Street T-intersection.

CSX intends to use this ESA to help check for RECs prior to commencing project activities, and as part of the documentation required for the project.

4.5 Prior Environmental Reports

PB was provided with environmental reports relevant to the Virginia Avenue Tunnel prepared by others for CSX Transportation. PB reviewed these reports to gather information regarding the conditions on the Site. A copy of relevant portions of the reports is included in Appendix C.

4.5.1 11th Street Bridges FEIS

A final environmental impact statement (FEIS) report for the nearby 11th Street Bridges project contained some background information relevant to this investigation. The FEIS included agency record information for two nearby facilities of concern, including the Washington Navy Yard and the Washington Gas Plant. The documentation included some historical information on the facilities, including operations involving contaminants, a summary of the area known to be contaminated, and remediation activities. Facility specific information is included in Section 8.4.

4.5.2 1998 Material Evaluation Report

A material evaluation report for the Virginia Avenue Tunnel was prepared by Ogden Environmental and Energy Services, Inc. (Ogden) for CSX Transportation, Inc. in 1998. The report documented a sampling program from within and immediately adjacent to the tunnel, and included collecting samples from 10 soil borings drilled above and adjacent to the tunnel, 10 soil samples collected from the sub grade inside the tunnel, seven water samples from inside the tunnel, five electrical duct liquid/sediment samples inside the tunnel, five electrical duct seal samples from inside the tunnel, and one soot sample collected inside the tunnel.

The 10 soil borings drilled adjacent to the tunnel were drilled using hollow stem augers and split-spoons advanced every five feet (providing intermittent lithologic information). The boring logs show that fill soil was present in most of the borings at varying thicknesses up to about 26 feet. The fill appeared to consist of a sandy silty clay mixture with rocks and cobbles. Generally, red and gray clay or silty clay layers were below the fill material to the maximum depth of the borings (35 or 40 feet below the ground surface). Groundwater was not encountered in any of the borings; however, the soil in boring B-7 was very moist.

Samples were analyzed for polychlorinated biphenyls (PCBs), total petroleum hydrocarbons in the gasoline and diesel range organics (TPH-GRO and TPH-ERO), benzene, toluene, ethylbenzene, and xylenes (collectively BTEX compounds), toxicity characteristic leaching

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procedure (TCLP) for volatile and semivolatile organic compounds (VOCs and SVOCs), "RCRA 8" metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver), asbestos, and oil and grease.

Laboratory analytical results showed that TPH-DRO was present in seven of the 10 soil samples collected within the tunnel, and the concentration of six of the seven samples exceeded the soil action limits established by the DC Municipal Regulations.

Barium was detected in three of the 10 soil samples collected from the borings drilled outside the tunnel; however, the concentration in these samples did not exceed action limits.

Three of the water samples collected from inside the tunnel from seeps contained TPH-GRO, TPH-ERO and oil and grease at concentrations requiring proper management. Other surface water samples contained analyzed parameters at concentrations exceeding method detection limits, but below action levels. The report concluded that soils outside the tunnel at the seep locations may contain the same constituents detected in the seep samples.

The samples collected from the electrical duct did not contain PCBs or asbestos; however, the report concluded that the duct and conduit materials should be properly disposed, and any oil be properly managed as used oil. The tunnel soot sample did not contain TCLP VOCs, SVOCs, or metals.

4.5.3 2012 Shaw Environmental PCB and Asbestos Investigations

In July 2012, Shaw Environmental & Infrastructure, Inc. (Shaw) completed investigations of the Virginia Avenue Tunnel for the possible presence of PCBs and asbestos containing materials.

Shaw collected 15 wipe samples from surfaces surrounding the electrical conduits and three additional samples of sediment and soot underlying the electrical conduits located within the concrete vaults. Each of these samples was submitted to a laboratory for analysis of PCBs. Laboratory analytical results showed that none of the samples contained PCBs at concentrations exceeding the laboratory reporting limits. The report recommended, however, that if the conduits were found to contain oil, that the liquid be placed in drums and sampled to evaluate whether it contains PCBs prior to disposal.

Shaw also evaluated various materials found within the tunnel for the possible presence of asbestos. Suspect materials were sampled and submitted to a laboratory for polarized light microscopy analysis. Laboratory analytical results showed that approximately 8,000 square feet of black felt paper located inside the concrete vaults enclosing the electrical conduit contained asbestos.

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4.5.4 2012 Clark-Parsons Investigation

Clark-Parsons subcontracted Mueser Rutledge Consulting Engineers (Mueser) to complete a geotechnical investigation of the project area. Mueser completed the investigation in two phases between March and July 2012.

The first phase consisted of drilling 12 geotechnical soil borings outside the tunnel at depths up to 150 feet below the ground surface. Eight standpipe piezometers were installed south of the tunnel, and four inclinometers were installed north of the tunnel. The location of each of the borings is depicted on Figures 3A-3C in 0.

The soil borings were drilled using mud rotary drilling techniques. A 24-inch long, two-inch diameter split-spoon was advanced every five feet ahead of the mud rotary drill bit to obtain undisturbed soil samples. These soil samples were used to identify the lithology of the tunnel corridor, establish geotechnical properties of the soils, and to also evaluate whether the soil was contaminated.

Each of the soil borings was divided into three 15-foot deep intervals (zero to 15 feet, 15 to 30 feet, and 30 to 45 feet, respectively). The three split-spoon samples obtained from these intervals were screened using a photoionization detector (PID meter); the sample with the highest reading was selected for laboratory analysis of VOCs. After the sample for VOC analysis was collected, the remaining soil from the three split-spoons within the interval was composited, and a sample obtained for laboratory analysis of SVOCs, heavy metals on the "RCRA 8" list, PCBs, TPH-GRO, and TPH-DRO. Three soil samples were therefore collected from each geotechnical boring.

After the borings were drilled to the maximum depth, the lower portion of the borings were abandoned, and 4¼-inch diameter hollow stem augers were used to ream out the borehole, and a two-inch diameter piezometer was installed. Piezometers were installed in 16 of the borings; however, only five of the piezometers contained groundwater. Groundwater samples were obtained from those piezometers, and the samples were submitted to a laboratory for analysis of VOCs, SVOCs, RCRA 8 metals, PCBs, TPH-GRO, and TPH-DRO.

The second phase consisted of drilling five geotechnical soil borings in the track bed of the tunnel, several liner probes into the wall of the tunnel, tunnel invert slab probes, and five geotechnical soil borings drilled at track level outside the tunnel portals. The geotechnical borings drilled in the tunnel were advanced to a depth of 20 feet, while the borings drilled outside the tunnel were drilled to depths between 15 and 25 feet. Split-spoon samples were obtained at approximately four-foot intervals within these borings.

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The geotechnical borings provided lithologic information for the vicinity of the tunnel corridor. Fill soil and natural terrace deposits were present in all of the borings along the tunnel corridor, and generally range in thickness from about 10 to 45 feet. These soils consist of clayey or silty sands. Below the fill and terrace deposits is an upper clay horizon. This unit consists of stiff to hard mottled gray, brown, and red silts and clays. The clays have occasional fissures and slickenside features, indicating some deformation has occurred. A compact gray and brown, fine to medium grained sand is present below the upper clay. The sand includes some silt, trace silty clay, or clayey sand layers. A lower clay horizon was encountered below the sand in the two deep borings; the lower clay is a hard mottled gray, brown or red color.

Groundwater was generally found to be present within the upper clay at depths between 30 and 45 feet below the ground surface. A perched water table was also found within the fill materials. This perched groundwater table is generally present below about 20 feet, with a locally higher elevation of around 18 feet below the ground surface near 7th Street SE.

Laboratory analytical results of the soil samples collected as part of the geotechnical investigation showed that the soil in the shallow interval (zero to 15 feet) in several borings (M-2, M-5, M-13, I-1, I-4, I-5, and I-6) and the soil in the 15 to 30 foot interval in the I-5 boring contained at least one SVOC at concentrations exceeding the DDOE Tier I residential standards or the EPA residential standards. Hexavalent chromium was present in soil from either the 15 to 30 foot interval or the 30 to 45 foot interval in borings M-1, M-2, M-5, M-8, and M-13 at concentrations exceeding the EPA residential standards. Arsenic was present in almost all of the samples collected in all of the borings at concentrations exceeding the EPA residential standards. No other analyzed parameters were present in the soil samples at concentrations exceeding the method detection limits. The SVOCs, hexavalent chromium, and arsenic that were present at concentrations exceeding the residential standards do not exceed the industrial standards. The arsenic concentrations were also believed to be within acceptable regional background concentrations.

Laboratory analytical results of the groundwater samples collected from the piezometers installed as part of this investigation showed that groundwater in borings M-4, M-8, M-10, and WB-1 contained VOCs, SVOCs, and heavy metals at concentrations exceeding method detection limits. Only naphthalene in boring M-8 was present at a concentration exceeding the DDOE Tier I groundwater standard for domestic water use; no other standards were exceeded in any of the water samples.

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5.0 RECORDS REVIEW

PB searched for reasonably ascertainable documents and photographs to assist in compiling information about the historic use of the Site. These reasonably ascertainable items included aerial photographs, street directory listings, fire insurance maps, and other historical records. PB also obtained an EDR report that identified facilities included in governmental databases that are known to be contaminated or that use contaminating substances.

5.1 Environmental Record Sources

5.1.1 Street Directories

PB reviewed city directory information compiled by EDR. City directory information was provided for a portion of the area around the Site. Coverage for this area was included in Haines Company, The Chesapeake and Potomac Telephone Company of Virginia, C&P Telephone, and Polk's Directories for the surrounding area, including parts of Virginia Avenue SE, 7th Street SE, I Street SE, and K Street SE from 1922 to 2006. No coverage for the area was available by address listing prior to 1922. Specifically, information was obtained from the 1922, 1926, 1931, 1936, 1940, 1943, 1948, 1954, 1960, 1964, 1969, 1973, 1978, 1983, 1993, 2000, and 2006 directories. A copy of the city directory information obtained from EDR is included in Appendix D.

PB personnel also reviewed city directory information at the Martin Luther King Jr. Memorial Library in Washington DC to supplement the information provided by EDR. Coverage for the area around the Site was included in the Haines Criss-Cross Directory, Polk's Washington City Directory, and Boyd's District of Columbia Directory from 1918 through 2011. No coverage for the area was available by address listing prior to 1918. Specifically, information was obtained from the 1918, 1923, 1928, 1933, 1938, 1943, 1948, 1954, 1960, 1965, 1970, 1975, 1981, 1986, 1991, 1996, 2001, 2006, and 2011 directories. A summary table of information obtained from the directories is included in Appendix D.

Most of the listings identified in the directories were for residential occupants for the entire period of coverage. Several commercial listings were also included, and of those, some have the potential to have used or stored hazardous substances or petroleum products. These include the following listings:

- Evening Star News at 225 Virginia Avenue SE in the 1960s and 1970s
- Eareckson Carpet Cleaner at 502 Virginia Avenue SE from 1918 until 1948
- Tower Cleaners & Launderers at 636 Virginia Avenue SE in 1960

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- Phillips Clothing Cleaner at 700 Virginia Avenue SE in the 1940s and 1950s
- Hill Auto Repair (most recently) at 701 Virginia Avenue SE. This property was a gas station from the early 1930s until the late 1970s.
- Tune-up Kit (most recently) at 801 Virginia Avenue SE. This property was a gas station from the early 1930s until the early 1970s.
- A laundry at the southwest corner of Virginia Avenue SE and 8th Street SE in the 1920s and early 1930s.
- Mathiason Metal Works at 821 Virginia Avenue SE in the late 1920s and 1930s.
- Anacastia Auto Body (auto repairs) at 1113 Virginia Avenue SE in the 1960s.
- The Evening Star Garage at 841 2nd Street from the early 1930s to the early 1970s
- Speed Queen Laundry at 809 3rd Street during the 1960s and early 1970s
- AM Forest Pond Printing Department at 811 3rd Street in 1970
- Thompson Cleaners at 700 4th Street in the 1950s, followed by Lillian's Beauty Salon in the early 1960s
- A laundry with different names at 801 4th Street from 1918 until the mid 1920s
- Townsend Beauty Shop at 1132 5th Street in the late 1940s
- Cleaners & Dyers with multiple names at 732 6th Street from the mid 1920s until the mid 1940s
- An auto repair with multiple names at 728 7th Street from the mid 1920s until the late 1970s
- An auto repair at 730 7th Street in the mid 1970s
- Torchinsky Cleaners at 900 8th Street in the 1930s
- Clothing cleaner/tailor with multiple names at 904 8th Street during the 1930s and 1940s
- Wash it Yourself Laundry at 908 8th Street in 1960
- A laundry at 911 8th Street in the late 1940s

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- Zimmerman Cleaner at 912 8th Street in 1918
- Lee Jas Laundry at 922 8th Street from the mid 1930s to the mid 1940s
- Cleaners with multiple names at 924 8th Street from the mid 1930s to the late 1960s
- Chin Laundry at 1001 8th Street from the mid 1930s to the early 1960s
- Sing Lee Laundry at 1013 8th Street from 1918 until the mid 1920s
- An auto repair at 1015 8th Street from 1918 until the mid 1920s
- Greers Cleaners at 1110 8th Street in 1970
- Eddies Dry Cleaners at 1112 8th Street from the mid 1940s (possibly earlier) through the late 1950s
- The Navy Yard Garage at 1102 9th Street in 1928
- Burrows Motor Sales at the southwest corner of 9th and Potomac Avenue SE from the mid 1940s through the late 1950s
- An Exxon gas station at 900 11th Street from the early 1970s through the early 1980s; Martins Automotive in the late 1980s, and Auto Wash Club from the early 1990s until the late 2000s
- Capitol Lithographers at 914 11th Street in 1960
- Hooe Coal, Chesapeake Motor Auto Repairs, Prices Service Station at 1100 11th Street from 1918 through the late 1920s, the mid 1940s, and the late 1940s through the late 1950s, respectively
- An auto supply/repair facility with multiple names at 1101 11th Street from the mid 1930s until the early 1970s
- An auto wrecker with multiple names at 1102 11th Street from the mid 1920s to the late 1930s
- A gas station with multiple names at 1110 to 1112 11th Street from the early 1930s to the late 1960s
- Miller gas station at 1260 11th Street in the early 1940s

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- Brown Trucking at 600 I Street SE in the 1960s
- Terdrlinsky Dyer at 717 I Street in 1918
- Superior Cleaners at 641 K Street SE in the late 1940s
- BHB Printers at 718 L Street in the mid 1980s
- Warner Coal at 1009 L Street in the early 1930s
- A gas station with multiple names at 1101 Potomac Avenue SE from the early 1930s until the late 2000s

5.1.2 Aerial Photographs

Digital aerial photographs for the years 1949, 1957, 1960, 1971, 1977, 1980, 1988, 1994, 1988, 2005, and 2007 were obtained from EDR. A 2010 satellite aerial photograph was obtained from the Google Earth Pro website. No aerial photographs were available from before 1949. The aerial photographs are included in Appendix E.

1949 Aerial Photograph

The clarity of the photograph was fair. The east and west ends of the railroad tunnel were visible east of 11th Street and west of 2nd Street, respectively. Virginia Avenue SE was present between 2nd Street and 9th Street; an extension of the road connected to 11th Street and Potomac Avenue SE near the east end of the corridor. Virginia Avenue SE was fronted by buildings on both the north and south sides, although the buildings were set back almost the width of the road from the edge of the Street. There were no buildings along Virginia Avenue SE between 4th and 5th Streets on the south side, on part of the south side between 6th and 7th Streets, and on the south side between 9th and 11th Streets. Garfield Park was on the north side of Virginia Avenue SE between 2nd and 3rd Streets.

1957 Aerial Photograph

The clarity of the photograph was excellent. The conditions on the Site and in the surrounding area were similar to those in the 1949 photograph; however, numerous trees lined both sides of Virginia Avenue SE. A new large commercial building was immediately south of Virginia Avenue SE and east of 2nd Street, replacing the smaller structures that had been previously present.

1960 Aerial Photograph

The clarity of the photograph was poor and had a larger scale. The conditions on the Site and in the surrounding area were similar to those in the 1957 photograph; however, the commercial building immediately south of Virginia Avenue SE and east of 2nd Street was larger than was

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shown in 1957. The area east of the Site was visible in this photograph, and a bulk petroleum storage facility was present, with several large cylindrical ASTs visible north and south of the railroad tracks.

1971 Aerial Photograph

The clarity of the photograph was fair. The conditions on the Site and in the surrounding area were similar to those in the 1960 photograph; however, the 695 expressway was present immediately north of Virginia Avenue SE. Several buildings formerly occupying this area were no longer present, and some north-south cross streets no longer crossed Virginia Avenue SE. The AST on the north side of the railroad tracks and slightly east of the east portal was no longer visible, although the ASTs south of the railroad tracks were still present.

1977 Aerial Photograph

The clarity of the photograph was poor. The conditions on the Site and in the surrounding area could not be discerned beyond a few general features.

1980 Aerial Photograph

The clarity of the photograph was fair. The conditions on the Site and in the surrounding area were similar to those in the 1977 photograph.

1988 Aerial Photograph

The clarity of the photograph was poor. The conditions on the Site and in the surrounding area were similar to those in the 1980 photograph; however, the large petroleum ASTs east of the corridor were no longer present. Five smaller ASTs were still visible.

1994 Aerial Photograph

The clarity of the photograph was poor. The conditions on the Site and in the surrounding area could not be discerned beyond a few general features.

1998 Aerial Photograph

The clarity of the photograph was good. The conditions on the Site and in the surrounding area were similar to those in the 1994 photograph; however, the south half of the block immediately north of the expressway between 6th and 7th Streets was bare soil, indicating the structures previously present had been demolished. All of the petroleum ASTs east of the Site had been removed and were no longer present.

2005 Aerial Photograph

The clarity of the photograph was fair. The conditions on the Site and in the surrounding area were similar to those in the 1998 photograph; however, the area south of the Site between 5th

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and 7th Streets had been redeveloped. The structures formerly present had been removed, and the area was either bare soil or occupied by new structures and green space. New buildings were present north of the expressway between 6th and 7th Streets. The commercial buildings that were present south of the west portal on the west side of 2nd Street had been demolished, and a parking lot was present.

2007 Aerial Photograph

The clarity of the photograph was good. The conditions on the Site and in the surrounding area were similar to those in the 2005 photograph; however, most of the buildings between 3rd and 6th streets north of M Street and south of the Site had been demolished.

2010 Aerial Photograph

The clarity of the photograph was excellent. The conditions on the Site and in the surrounding area were similar to those in the 2007 photograph; however, several of the properties where buildings had previously been demolished south of the Site had been redeveloped. The property southeast of the east portal had also been redeveloped.

5.1.3 Sanborn Maps

During the late 1800's and throughout much of the 1900's, the Sanborn Map Company periodically prepared detailed maps showing the locations and types of buildings, and uses of properties in areas of many towns and cities throughout the United States. Included on these maps are the locations of aboveground and underground storage tanks, and other features now recognized as RECs. Environmental Data Resources, Inc. (EDR) of Milford, Connecticut now possesses the most complete archive of these maps.

PB requested EDR to search for fire insurance maps for the Site. EDR identified and provided PB with Sanborn maps for the years 1888, 1904, 1928, 1959, 1977, 1984, 1988, 1990, 1991, 1992, 1994, and 1998. A copy of the portion of the maps which includes the Site is included in Appendix F. Details of the tunnel and businesses that potentially used, stored, or handled hazardous substances or petroleum products shown on the maps are discussed below:

- The 1904 maps showed the route of the Virginia Avenue Tunnel. The tunnel was depicted as beginning just east of 11th Street and south of L Street, and running beneath Virginia Avenue SE to a point between 7th Street and 6½ Street. Two railroad lines exited the tunnel and continued west along K Street. Subsequent maps showed only the portal locations (the east portal east of 11th Street, and the west portal west of 2nd Street).

- The block bounded by Virginia Avenue, K Street, 9th Street and 10th Street was a coal yard in 1904.

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- A business near the southwest corner of Virginia Avenue and 4th Street was depicted as a Chinese Laundry in 1904.
- A tin shop was depicted at the southeast corner of Virginia Avenue and 9th Street in 1928.
- Two gas stations were at the southeast corner of Virginia Avenue and 8th Street in 1928. Only one of these gas stations was present in 1959.
- A UST was in the southwest part of the block bounded by 6½ and 7th Streets and K and L Streets in 1928.
- A business depicted as a dyer & cleaner (possibly a dry cleaner) was on the east side of 6th Street north of the alley north of I Street in 1928 and 1959.
- A gas station was at 701 Virginia Avenue at the southeast corner of Virginia Avenue and 7th Street in 1928 and 1959.
- A carpet cleaner and machine shop were at the northeast corner of Virginia Avenue and 5th Street in 1928.
- A UST was in the center of the block south of Virginia Avenue and west of 2nd Street in the Evening Star warehouse building in 1928.
- Three USTs were depicted in the block west of 2nd Avenue and south of the west portal in the 1959 through 1998 maps. Two of the USTs were north of the Evening Star garage in the southeast part of the block, and the third was in the alley in the southwest part of the block.
- Three USTs were located in the block bounded by 2nd Street, 3rd Street, I Street, and Virginia Avenue in 1959 and 1977. One of the tanks had a capacity of 10,000 gallons, and the other two had a capacity of 20,000 gallons; all three tanks contained fuel oil used by the Evening Star Newspaper Company.
- A gas station was at the southeast corner of the intersection of 11th and I Streets in 1977 and 1984.
- A UST was associated with a police station in the small block bounded by Virginia Avenue, 9th Street, and K Street in 1959.
- A gas station with five USTs was about 50 feet north of the east portal on the north side of L Street, the east side of 11th Street, and the south side of Potomac Avenue in 1959.

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- The block between 12th and 13th Streets south of L Street and north of the railroad tracks was occupied by a 1,000,000-gallon gasoline UST, a fueling shed, and a large fuel oil AST in 1959.

5.1.4 Historic Topographic Maps

PB obtained a copy of historic topographic maps for the years 1885, 1894, 1906, 1943, 1950, 1951, 1956, 1965, 1971 (photorevised from 1965), 1979 (photorevised from 1965) 1980 (photorevised from 1965) 1983 (photorevised from 1965) and 1994 (photorevised from 1965), from EDR. Not all of the maps include full coverage of the Site. A copy of these historic topographic maps is included in Appendix G.

1885 Historic Topographic Map

The 1885 Historic Topographic map (15-minute map series) showed only the western portion of the Site, which was within the District of Columbia urban area. Virginia Avenue was present. A railroad line was depicted on K Street south of Virginia Avenue. This line probably connected to Virginia Avenue on the eastern part (not shown) of the Site.

1894 Historic Topographic Map

The 1894 Historic Topographic map (30 minute series) showed similar conditions and coverage area as the 1885 map, but fewer details could be discerned due to the scale of the map.

1906 Historic Topographic Map

The 1906 Historic Topographic map (30 minute series) showed similar conditions as the 1894 map; however, the map showed the entire Site. Potomac Avenue extended through Virginia Avenue.

1943 Historic Topographic Map

The 1943 Historic Topographic map (7.5 minute series) showed the entire Site. The railroad line along Virginia Avenue was depicted as dashed (indicating it was subsurface) from west of 2nd Street to east of 11th Street. Buildings were depicted between 4th and 5th Streets north and south of Virginia Avenue. Potomac Avenue was not present between 10th and 12th Streets.

1950 Historic Topographic Map

The 1950 Historic Topographic map (7.5 minute series) showed conditions on the Site to be similar to those depicted on the 1943 map.

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1951 Historic Topographic Map

The 1951 Historic Topographic map (7.5 minute series) showed conditions on the Site to be similar to those depicted on the 1950 map; however, buildings were now shown between 3rd and 5th Streets north of the Site.

1956 Historic Topographic Map

The 1956 Historic Topographic map (7.5 minute series) showed conditions on the Site to be similar to those depicted on the 1951 map.

1965 Historic Topographic Map

The 1965 Historic Topographic map (7.5 minute series) showed conditions on the Site to be similar to those depicted on the 1956 map; however, an expressway was on the north side of Virginia Avenue to the west of 6th Street.

1971 Historic Topographic Map

The 1971 Historic Topographic map (7.5 minute series) showed conditions on the Site to be similar to those depicted on the 1965 map; however, the expressway was present along Virginia Avenue and the Site from west of 2nd Street to 11th Street, where it turned south.

1979 Historic Topographic Map

The 1979 Historic Topographic map (7.5 minute series) showed conditions on the Site to be similar to those depicted on the 1971 map; however the map only showed the corridor east of 5th Street.

1980 Historic Topographic Map

The 1980 Historic Topographic map (7.5 minute series) showed conditions on the Site to be similar to those depicted on the 1971 map; however, the map only showed the corridor west of 5th Street.

1983 Historic Topographic Map

The 1983 Historic Topographic map (7.5 minute series) showed conditions and coverage area on the Site to be similar to those depicted on the 1980 map.

1994 Historic Topographic Map

The 1994 Historic Topographic map (15 minute series) showed conditions and coverage area on the Site to be similar to those depicted on the 1983 map.

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5.1.5 Historic Plat Maps

PB did not search for historic plat maps as part of this ESA, because it believed that this information would not provide significant information.

5.1.6 Other Historic Maps

The information provided in the Clark-Parsons Geotechnical Data Report (discussed in Section 4.5.4) included portions of three historic maps of Washington DC. A copy of these maps is included with the text of the geotechnical report in Appendix C.

1870 Plan of the City of Washington DC

The 1870 map shows that Virginia Avenue SE and the cross streets as currently configured were present through the Project Area. Potomac Avenue SE was named Georgia Avenue. The railroad was not present in the Project Area. The US Navy Yard was present to the south, but only occupied the area south of M Street between about where 6th Street would extend to and 9th Street. A cove was immediately west of the Navy Yard. The US Marine barracks was north of I Street between 8th and 9th Streets. A canal extended north from the Anacostia River along the 2nd Street alignment as far north as I Street, and then to the northwest where it crossed Virginia Avenue at South Capitol Street.

1879 Plan of the City of Washington DC

The 1879 map shows that the B&P Railroad was present in the area. It extended along Virginia Avenue SE from the southeast end at the Anacostia River to just west of 6th Street. From there, the railroad ran west along I Street to west of 2nd Street, and then followed the former path of the canal (now filled north of I Street) back to Virginia Avenue and then northwest. The entire length of the railroad appeared to be on the surface; the Virginia Avenue Tunnel was not present.

1902 Business Atlas Map of Washington DC

The 1902 map shows that the railroad had been reconfigured. Rather than following Virginia Avenue SE from the river, it followed the current path to the portal of the Virginia Avenue Tunnel just east of 11th Street. The tunnel extended under Virginia Avenue as far as 7th Street, where it ended. From there, the railroad ran west along K Street to a point just west of 2nd Street, and then northwest back to Virginia Avenue. Virginia Avenue SE was not present between 3rd Street and South Capitol Street, since this area was occupied by Garfield Park. The canal that formerly extended along the position of 2nd Street only extended as far north as N Street.

5.1.7 Review of State and Federal Databases

Databases maintained by various state and federal agencies were reviewed for information regarding the Site and nearby properties. The compilation of data was performed by EDR in

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February 2012. EDR uses computers to search governmental agency databases for information about contaminated properties and potentially contaminated properties within search ranges (specified in 40 CFR §312.26) around the Site. The search distances range from the Site boundary to one mile from the Site depending on the database. Information regarding the listed facilities is included in the EDR report in Appendix H.

PB reviewed the information about the facilities in the databases to ascertain the potential impact of these facilities on the Site. While doing this review, PB considered (a) the likely contaminating substances that were or could have been released, (b) the pathways these contaminants would likely follow to reach surface water or underlying groundwater, (c) the potential that groundwater or surface water would migrate from these facilities onto or beneath the Site, and (d) the potential that pumping from water wells on the Site or in the area might influence the movement of groundwater and contaminants.

When facilities were identified as being within the ASTM search distance, they were included and mapped in the EDR report. Several facilities in the EDR report are unmapped (referred to as "orphan" sites) due to an incomplete address, an inaccurate address, or a street address that could not be accurately identified. Where possible, PB ascertained the locations of the unmapped sites, and evaluated the potential impact of these sites for this assessment. A brief summary of each database that contained facility listings within the specified search range is presented below.

NPL: National Priorities List

The National Priorities List (NPL) identifies the most serious hazardous waste sites regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Sites on the NPL have been targeted by the U.S. EPA for priority cleanup. This database was last updated in June 2011.

> The Washington Navy Yard facility identified in the search is not the Site; however, it is approximately 375 feet south of the Site. Its potential impact to the Site is discussed in Section 8.0. Further information regarding this facility is also in the EDR report in Appendix H.

CERCLIS: Comprehensive Environmental Response, Compensation and Liability Act Information System

The Comprehensive Environmental Response, Compensation and Liability Act Information System (CERCLIS) assists U.S. EPA headquarters and regional offices in managing and overseeing the Superfund program. It has two purposes: to maintain an automated inventory of abandoned, inactive, or uncontrolled hazardous waste sites, and to allow EPA regional offices to track the status of site clean-ups and report this information to EPA headquarters. This database was last updated in February 2011.

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The facilities identified in the search did not include the Site; however, the listed Washington Navy Yard and Washington Gas – East Station facilities are approximately 375 feet south and 500 feet southeast of the Site, respectively. The potential impact of each facility to the Site is discussed in Section 8.0. PB identified the locations of the other listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding all listed facilities is in the EDR report in Appendix H.

CERC–NFRAP: CERCLIS—No Further Remedial Action Planned

The No Further Remedial Action Planned (NFRAP) data is a collection of sites removed from the U.S. EPA's CERCLIS list where no contamination was found following an initial investigation, contamination was removed quickly without the need for the Site to be placed on the NPL, or the contamination was not serious enough to require Federal Superfund action or NPL consideration. This database was last updated in February 2011.

The facilities identified in the search did not include the Site or the immediately adjacent or nearby properties listed in Section 3.5 of this report. PB identified the locations of listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding these facilities is in the EDR report in Appendix H.

CORRACTS: Corrective Action Report

The CORRACTS database includes facilities that handle hazardous wastes and at which RCRA corrective action has occurred. This database is maintained by the U.S. EPA and was last updated by EDR in August 2011.

The facilities identified in the search did not include the Site; however, the listed Washington Navy Yard facility is approximately 375 feet south of the Site. Its potential impact to the Site is discussed in Section 8.0. PB identified the locations of the other listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding all listed facilities is in the EDR report in Appendix H.

RCRA Generators:

The Resource Conservation and Recovery Act – Generators Database contains data compiled in accordance with the 1984 Hazardous and Solid Waste Amendments (HSWA) to RCRA. RCRA Generator Facilities are divided into three categories: Fully Regulated Generators (FRGs) producing more than 1,000 kilograms of hazardous and/or one kilogram of acutely hazardous waste per month, Small Quantity Generators (SQGs) producing between 100 and 1,000 kilograms of hazardous and/or less than one kilogram of acutely hazardous waste per month, and Conditionally Exempt SQGs (CESQGs) producing less than 100 kilograms of hazardous waste and less than one kilogram of acutely hazardous waste. This database was last updated in June 2011.

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The facilities identified in the search did not include the Site; however, the listed Washington Navy Yard, Washington Gas – East Station, Alpha Auto Service, Tune Up Kit of Capitol Hill, and Washington Post Newspaper South facilities are approximately 375 feet south, 500 feet southeast, 100 feet north, 120 feet south, and 100 feet south of the Site, respectively. The potential impact of each facility to the Site is discussed in Section 8.0. PB identified the locations of the other listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding all listed facilities is in the EDR report in Appendix H.

ERNS Spills: Emergency Response Notification System

The Emergency Response Notification System (ERNS) is a national database with information regarding releases of oil and hazardous substances. This database was last updated in October 2011.

The facilities identified in the search did not include the Site; however, the listed Virginia Avenue Rail Tunnel incident is approximately 475 feet east of the east portal of the tunnel. Its potential impact to the Site is discussed in Section 8.0. PB identified the locations of the other listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding all listed facilities is in the EDR report in Appendix H.

US ENG CONTROLS: Engineering Controls Sites List

The USEPA created this database, which lists facilities with engineering controls in place. Engineering controls include various forms of caps, building foundations, liners, and treatment methods to create pathway elimination for regulated substances to enter environmental media or affect human health. This database was last updated in December 2011.

The facilities identified in the search did not include the Site; however, the listed Washington Navy Yard and Washington Gas – East Station facilities are approximately 375 feet south and 500 feet southeast of the Site, respectively. The potential impact of each facility to the Site is discussed in Section 8.0. PB identified the locations of the other listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding all listed facilities is in the EDR report in Appendix H.

US INST CONTROL: Sites with Institutional Controls

The U.S. EPA developed a listing of properties with institutional controls in place. The institutional controls include administrative measures, such as groundwater use restrictions, construction restrictions, property use restrictions, and post remediation care requirements intended to prevent exposure to contaminants remaining on the property. Deed restrictions are generally required as part of the institutional controls. This database was last updated in December 2011.

The Washington Gas – East Station facility identified in the search is not the Site; however, it is approximately 500 feet southeast of the Site. Its potential impact to the

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Site is discussed in Section 8.0. Further information regarding this facility is also in the EDR report in Appendix H.

DOD: Department of Defense Sites

The DOD database consists of federally owned or administered lands that are administered by the Department of Defense, and are greater than 640 acres in size. These properties are located in the United States, Puerto Rico, and the U.S. Virgin Islands. This database was last updated in July 2011.

The facility identified in the search was neither the Site nor an immediately adjacent or nearby property listed in Section 3.5 of this report. PB identified the location of the listed facility and believes it is at a distance that does not pose a risk of environmental contamination to the Site. Further information regarding this facility is in the EDR report in Appendix H.

FUDS: Formerly Used Defense Sites

The US Army Corps of Engineers created this database, which includes the locations of formerly used defense site properties where the US Army Corps of Engineers is actively working or will take necessary cleanup actions. This database was last updated in December 2009.

The facilities identified in the search did not include the Site; however, the listed Washington Navy Yard facility is approximately 375 feet south of the Site. Its potential impact to the Site is discussed in Section 8.0. PB identified the locations of the other listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding all listed facilities is in the EDR report in Appendix H.

ROD: Records of Decision System

The Records of Decision System (RODS) data are obtained from the U.S. EPA Office of Emergency and Remedial Response and contains the text of signed Superfund Records of Decision. RODS serves as an information base so that sites with similar environmental characteristics are treated consistently by the U.S. EPA. The RODS data provide additional information regarding Superfund sites also listed in either the CERCLIS or NPL databases. EDR does not identify RODS sites separately on the maps included in its reports. This database was last updated in September 2011.

The facilities identified in the search did not include the Site; however, the listed Washington Navy Yard and Washington Gas – East Station facilities are approximately 375 feet south and 500 feet southeast of the Site, respectively. The potential impact of each facility to the Site is discussed in Section 8.0. PB identified the locations of the other listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding all listed facilities is in the EDR report in Appendix H.

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FINDS: Facility Index System

The Facility Index System (FINDS) contains a computerized inventory of over 600,000 facilities regulated by the U.S. EPA. FINDS is used as a cross-check for sites identified though other sources. EDR has on-line access to the FINDS system. This database was last updated in August 2011.

The facilities identified in the search did not include the Site or the immediately adjacent or nearby properties listed in Section 3.5 of this report. PB identified the locations of listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding these facilities is in the EDR report in Appendix H.

Leaking USTs: Leaking Underground Storage Tanks

LUST records contain an inventory of reported leaking underground storage tank incidents. Not all states maintain these records, and the information stored varies by state. This database was last updated in October 2011.

The facilities identified in the search did not include the Site; however, the listed Sound Car Auto Repair, Washington Post Newspaper – South, 636 I Street, Greenwood Warehouse, 1022 M Street, 841 2nd Street, 912 4th Street, 901 M Street, and 1016 4th Street facilities are approximately 120 feet south, 100 feet south,350 feet north, 425 feet north, 150 feet south, 80 feet south, 225 feet south, 520 feet south, and 525 feet south of the Site, respectively. The potential impact of each facility to the Site is discussed in Section 8.0. PB identified the locations of the other listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding all listed facilities is in the EDR report in Appendix H.

UST: Underground Storage Tanks

UST's are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA) and must be registered with the state department responsible for administering the UST program. Available information varies by state program. This database was last updated in October 2011.

The facilities identified in the search did not include the Site; however, the listed Capital Motor Works, Washington Post Newspaper Company, Lenox, Arthur Capper Apartment buildings, National Medical Care, and 1003 4th Street facilities are approximately 100 feet south, 100 feet south, 360 feet north, 150 to 530 feet south, 400 feet south, and 500 feet south of the Site, respectively. The potential impact of each facility to the Site is discussed in Section 8.0. PB identified the locations of the other listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding all listed facilities is in the EDR report in Appendix H.

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VCP: Voluntary Cleanup Program

The Voluntary Cleanup Program oversees owner or developer initiated voluntary remediation of contaminated lands and buildings that return actual or potentially contaminated properties to productive uses. This database was last updated in July 2011.

The facilities identified in the search did not include the Site or the immediately adjacent or nearby properties listed in Section 3.5 of this report. PB identified the locations of listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding these facilities is in the EDR report in Appendix H.

HIST UST: Historical UST Listing

During the process of the database upgrade, all facilities that the UST Program was unable to confirm their existence were removed from the working revelation UST Database before the conversion and put into an excel spreadsheet. These facilities became known as "Project Unknown." This listing is not current and has been not updated.

The facilities identified in the search did not include the Site; however, the listed 1102 to 1112 11th Street, 1102 9th Street, 502-04 Virginia Avenue, 704 I Street, 1100 M Street, Arthur Capper Community Center, and Calomiris GP facilities are immediately adjacent, approximately 350 feet south, 50 feet south, 300 feet north, 300 feet south, 150 to 530 feet south, and 350 feet south of the Site, respectively. The potential impact of each facility to the Site is discussed in Section 8.0. PB identified the locations of the other listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding all listed facilities is in the EDR report in Appendix H.

Brownfields

The Brownfield database contains a listing of potential Brownfields site locations. This is not a complete listing of all potential Brownfield properties. This database was last updated in August 2011.

The facilities identified in the search did not include the Site; however, the listed Washington Gas – East Station and 225 Virginia Avenue facilities are approximately 500 feet southeast and 100 feet south of the Site, respectively. The potential impact of each facility to the Site is discussed in Section 8.0. PB identified the locations of the other listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding all listed facilities is in the EDR report in Appendix H.

Coal Gas

Coal Gas was manufactured at numerous facilities throughout the United States in the late 1800's and early 1900's. Wastes generated at these facilities often were poorly handled, and many of these former plant sites contain impacted soil and groundwater. The locations of many

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of these facilities were researched by Real Property Scan, Inc., and are included in the EDR database.

The facilities identified in the search did not include the Site; however, the listed Washington Gas Light Co. at 1240 12th Street SE is approximately 500 feet southeast of the Site. The potential impact of this facility to the Site is discussed in Section 8.0. PB identified the location of the other listed facility and believes it is at a distance that does not pose a risk of environmental contamination to the Site. Further information regarding all listed facilities is in the EDR report in Appendix H.

EDR Historical Auto Stations

A proprietary database compiled by EDR researchers reviewing collections of business directories. This database includes categories of sources including gas, gas station, gasoline station, filling station, auto, automobile repair, auto service station, etc.

The facilities identified in the search did not include the Site; however, the listed Price Service Station, Chesapeake Motor Co., and Sanford Amoco Service Station (these three collectively at 1100 to 1110 11 Street), and the Fenwick Service station and Rundlett Rim & Wheel (these two at the northwest corner of 11th Street and M Street) facilities are immediately adjacent and approximately 150 feet south of the Site, respectively. The potential impact of each facility to the Site is discussed in Section 8.0. PB identified the locations of the other listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding all listed facilities is in the EDR report in Appendix H.

EDR Historical Cleaners

A proprietary database compiled by EDR researchers reviewing collections of business directories. This database includes categories of sources including dry cleaners, cleaners, laundry, Laundromat, cleaning/laundry, wash & dry, etc.

The facilities identified in the search did not include the Site; however, the listed Anna Rice/Lee Chong, Sam Moy/Thos Sweeney, Mon Der/B&B Cleaners, and Unity Cleaners facilities are approximately 420 feet north, 560 feet north, 780 feet north, and 560 feet north of the Site, respectively. The potential impact of each facility to the Site is discussed in Section 8.0. PB identified the locations of the other listed facilities and believes they are at distances that do not pose a risk of environmental contamination to the Site. Further information regarding all listed facilities is in the EDR report in Appendix H.

5.2 Title Records

PB was not provided with title records by the client, and did not independently obtain them. PB believes, however, that other information obtained by PB was sufficient to identify the historical uses of the Site.

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5.3 Activity and Use Limitations and Environmental Liens

PB was not provided with information regarding potential environmental liens or activity and use limitations, and did not independently request them as part of this ESA.

5.4 Geologic Setting

5.4.1 Surficial Soils

PB reviewed the soil survey maps prepared by the U.S. Department of Agriculture, Natural Resources Conservation Services (formerly the Soil Conservation Service) for the District of Columbia to obtain general information about the surficial soils along the Site.

The soil conservation maps show that soils along the Site fall within the Urban Land classification and the Udorthents, clayey, smoothed, classification. The soils in these classifications are generally well drained, and are moderately permeable.

5.4.2 Soils Overlying the Bedrock Formation

The map, "Geological Map of Washington DC and Vicinity" (Johnson, 1958), shows that the surficial soil along the Site is part of the Pleistocene Age Wicomico Formation. This formation consists of gravel, sand, and silt, and has local basal deposits of carbonaceous clay containing tree stumps and other woody debris.

The more recent Geologic Map of Maryland (Conkwright, 1968) shows that the surficial soil along the Site is Lowland Deposits of Pleistocene Age, and consists of gravel, sand, silt, and clay. Medium to coarse grained sand and gravel with cobbles and boulders near the base commonly contain reworked Eocene glauconite. Varicolored silts and clays and brown to dark gray lignitic clay contain estuarine to marine fauna in some areas. The thickness of the deposits ranges from zero to 150 feet.

PB obtained information about the geology of the surrounding area while reviewing soil boring logs for soil borings drilled by others along the Site. Fill soil and natural terrace deposits were present in all of the geotechnical borings drilled along the tunnel, and generally range in thickness from about 10 to 45 feet. These soils consist of clayey or silty sands. Below the fill and terrace deposits is an upper clay horizon. This unit consists of stiff to hard mottled gray, brown, and red silts and clays. The clays have occasional fissures and slickenside features, indicating some deformation has occurred. A compact gray and brown, fine to medium grained sand is present below the upper clay. The sand includes some silt, trace silty clay, or clayey sand layers. A lower clay horizon was encountered below the sand in the two deep borings; the lower clay is a hard mottled gray, brown or red color.

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5.4.3 Site Hydrology and Hydrogeology

The surface topography of the Site and the surrounding area is generally flat to gently sloped. According to the USGS 7½-minute topographic map of the Washington East and Washington West Quadrangles, the Site is approximately 40 to 50 feet above mean sea level (Figure 2 in 0).

Surface water on the Site drains into storm sewers along Virginia Avenue, or into collection sumps within the tunnel. During the 2012 geotechnical investigation completed by Clark-Parsons, groundwater was generally found to be present within the upper clay at depths between 30 and 45 feet below the ground surface. A perched water table was also found within the fill materials. This perched groundwater table is generally present below about 20 feet, with a locally higher elevation of around 18 feet below the ground surface near 7th Street SE. The direction of groundwater flow in the unconsolidated glacial materials above the bedrock is unknown, but is believed to be to the south-southeast.

5.4.4 Anticipated Susceptibility of Groundwater to Contamination

Based on the geology of the Site and the general area, PB believes that contaminants leaked or spilled on the Site would have a moderate potential to migrate vertically to underlying water-bearing zones. Information obtained by PB suggests that the uppermost water-bearing zone is moderately permeable, thus lateral groundwater movement and contaminant migration from potentially impacted areas are expected to be moderately slow.

5.5 Historic Use Information Regarding the Site

Based upon the foregoing historical information, it appears as though the Site was originally developed as Virginia Avenue SE for use as a public thoroughfare. A railroad was constructed along the surface of Virginia Avenue SE from the Anacostia River past 11th Street to about 6th Street where it curved onto I Street as far west as 2nd Street, and then northwest back to Virginia Avenue SE at South Capitol Street in the 1870s, possibly in 1872. The eastern part of the Virginia Avenue tunnel (from the existing east end to a point between 7th and 8th Streets was constructed between 1879 and 1902. In 1904, the remainder of the tunnel was constructed. Virginia Avenue SE has been present over the tunnel since that time, and was disrupted during construction of the tunnel.

5.6 Historic Use Information Regarding the Nearby and Adjoining Properties

Based upon the foregoing historical information, it appears as though the surrounding properties have been used for a wide variety of purposes. Some properties have been occupied by dwellings and residential units, while others were used for commercial purposes, including gas stations, motor vehicle repair facilities, dry cleaners, beauty shops, restaurants, tailors, and

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laundries. The property at the southeast corner of M Street and 12th Street was part of the Washington Gas Plant, and the area south of M Street and west of 11th Street was part of the Washington Navy Yard.

6.0 SITE RECONNAISSANCE

6.1 Methodology and Limiting Conditions

Only a partial, non-comprehensive site walkover was conducted as part of this ESA. Mike Folli and Mark Cheskey, the PB staff members who performed the site walkover, are not Environmental professionals as defined in 40 CFR §312.10(b)(1). The purpose of the site walkover was to observe current conditions and look for obvious characteristics that suggest contamination may be present. They performed the site walkover on June 18 and 19, 2012.

6.2 General Site Observations

The Project Area consists of the railroad line from South Capitol Street to about 15th Street; the area between 2nd Street and 11th Street is within the Virginia Avenue Tunnel (the Site) with Virginia Avenue SE (eastbound) located above the tunnel.

PB did not observe any hazardous substances or petroleum products, storage tanks, odors, drums or containers (in connection with an identified use, unidentified use, or unidentified substances), or possible PCB-containing equipment within the project area during its walkover. Two 500-gallon ASTs were within a construction area beneath the elevated expressway east of 11th Street and south of the railroad line.

6.3 Exterior Areas

The area overlying the tunnel was mostly occupied by eastbound Virginia Avenue SE. The area overlying the eastern part of the tunnel was occupied by a park and community garden. The area along the south side of Virginia Avenue SE was occupied by sidewalks and landscaped grassy areas with trees. The north side of Virginia Avenue SE was maintained grass bordering the I-695 expressway and expressway ramps.

The eastern and western parts of the Project Area were occupied by the railroad line and its associated right-of-way. The western end of the project area was part of a railroad yard. The area south of the main railroad line was used as a storage and staging area. Numerous 55-gallon drums of soil cuttings from the environmental and geotechnical soil borings were stockpiled in this area while awaiting characterization and disposal. A decontamination area was located near the drums.

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PB did not observe any pits, ponds, or lagoons, stained soil or pavement, or stressed vegetation during its walkover.

6.3.1 Solid Waste

The area immediately surrounding the tunnel was fill soil that was placed after construction of the tunnel. This soil consisted of a mixture of clay, silt, and sand.

The area beneath the expressway in close proximity to the west end of the tunnel contained a significant amount of household items and trash. No hazardous materials were noted in this area, and none of the items appeared likely to potentially contaminate the underlying soil.

6.4 Interior Areas

PB personnel viewed the interior of the tunnel to identify the uses of the Site, and whether potentially contaminating activities have taken place on the Site.

The interior of the tunnel was generally dirty, with soot coating parts of the walls and ceiling. The tunnel walls were constructed of stone blocks in the lower part, and bricks and concrete in the upper part. A concrete utility chase was along the base of the wall of the tunnel. The chase contained pipes and electrical lines.

The floor of the tunnel was generally covered with stone ballast for the railroad tracks; however, soil was present within, and sometimes covering the stone. In places, “mud volcanoes” were present between the rail lines. These features were caused by the vibration of trains passing, and causing some of the underlying soil to liquefy and migrate upward through the stone ballast onto the surface, where the soil was deposited.

PB personnel noted that a partially open sanitary sewer was present in one section of the tunnel. The top of the sewer was covered by steel plates beneath the railroad ties and rails. It was unclear what condition the sewer was in, only that the sewer crossed the tunnel.

6.4.1 Pools of Liquids

Standing water was noted within the tunnel between the walls and the rails. Some of the pools of water were murky and rust-colored. The standing water was probably the result of groundwater infiltrating into the tunnel.

6.4.2 Stains or Evidence of Corrosion

PB observed soot and similar staining on the walls and ceiling of the tunnel. The soot was likely the result of exhaust from trains (particularly early, coal-fired engines) and maintenance equipment.

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6.4.3 Floor Drains or Sumps

Several sump pits were present within the tunnel. Groundwater (probably perched within the fill material surrounding the tunnel) accumulated in the pits where sump pumps would pump the water into pipes located within the utility chase along the edge of the tunnel. The water in the sumps was generally murky and sometimes iron stained.

7.0 FINDINGS

Through the activities described above, PB identified the following potential RECs, HRECs, and *de minimis* environmental conditions on the Site or in the surrounding area. PB's opinion as to the potential impact of these issues on the Site is discussed in Section 8.0.

7.1 Contaminated Soil

The 1998 materials investigation report for the Virginia Avenue Tunnel identified TPH-DRO in six of 10 soil samples collected from within the tunnel at concentrations exceeding residential cleanup criteria. The 2012 testing conducted along the tunnel corridor identified at least one SVOC present in soil samples from the zero to 15 foot interval in seven borings at concentrations exceeding the residential cleanup criteria. Hexavalent chromium (Cr^{6+}) was present in samples from the deeper depth intervals in five soil borings at concentrations exceeding the residential cleanup criteria.

7.2 Contaminated Groundwater

The 1998 materials investigation report for the Virginia Avenue Tunnel identified TPH-GRO, TPH-ERO, and oil and grease in three of the groundwater seep samples in the tunnel at concentrations "requiring proper management." The 2012 testing conducted along the tunnel corridor identified naphthalene in the M-8 boring at concentrations exceeding the Tier I residential groundwater standard for domestic use.

7.3 Asbestos Containing Materials

The asbestos survey conducted on the Virginia Avenue Tunnel in 2012 showed that approximately 8,000 square feet of black felt paper located inside the concrete vaults enclosing the electrical conduit contained asbestos.

7.4 Nearby and Adjacent Properties of Concern

PB's research revealed the presence of 63 nearby facilities of concern in the vicinity of the Site. Some of these facilities were identified through multiple sources; others were identified from a

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single source. These facilities include former gasoline stations, vehicle repair facilities, dry cleaners, properties with underground storage tanks, a manufactured gas plant, and an NPL facility. The complete listing of these facilities is presented below and is summarized in Table 1 included in Appendix A:

1. Virginia Ave Rail Tunnel, Mile Post 113.7 (Capitol Subdivision), chemical spill
2. Washington Navy Yard, 1013 O Street SE, NPL facility
3. Price Service Station/Chesapeake Motor Co./Sanford Amoco Service Station/Hooe Coal, 1100 to 1112 11th Street SE, former gas station
4. 502-04 Virginia Avenue SE facility, Carpet Cleaning and machine shop, USTs
5. 841 2nd Street SE facility/Evening Star Garage, 841 2nd Street SE, LUST facility
6. Washington Post Newspaper, 225 Virginia Avenue SE/804 2nd Street, USTs
7. Alpha Auto Service/Capitol Motor Works/Hill Auto Repair, 701 Virginia Avenue SE, USTs/former gas station
8. Sound Car Audio Repair/Tune Up Kit of Capitol Hill, 801 Virginia Avenue SE, LUST facility
9. Arthur Capper Properties, 501 Virginia Avenue SE/601 L Street SE/1000 5th Street SE, USTs
10. Rundlett Rim & Wheel Co/Warner Coal, 1014 M Street SE/1022 M Street SE/1009 L Street SE, former gas station
11. DC Housing, 912 4th Street SE, LUST facility
12. 704 I Street SE facility, 704 I Street SE, USTs
13. 1100 M Street SE facility, USTs
14. Boiler Plant Building, 636 I Street SE, LUST facility
15. Navy Yard Garage, 1102 9th Street SE, USTs
16. Calomiris GP, 816 Potomac Avenue SE, USTs
17. Lenox, 725 5th Street SE, USTs
18. National Medical Care, 900 M Street SE, USTs
19. Anna Rice/Lee Chong property/Capitol Lithographers, 916/914 11th PL SE, former cleaners/printer
20. Greenwood Warehouse/former Rainbow Dyeing & Cleaning/former Atlantic Cleaners & Dyers, 732 6th Street SE, LUST facility/former dry cleaner
21. Washington Gas, M St SE / 12th St SE intersection, contaminated property
22. Fenwick Service Station, 1024 Potomac Avenue SE, former gas station
23. 1003 4th Street SE facility, USTs
24. part of Washington Navy Yard, 901 M Street SE, LUST facility
25. 1016 4th Street SE facility, LUST facility
26. Sam Moy / Thos Sweeny property, 1200/1202 Potomac Avenue SE, former cleaners
27. Unity Cleaners, 1224 Potomac Avenue SE, former cleaners
28. Mon Der / B&B Cleaners, 1215/1217 Potomac Avenue SE, former cleaners
29. Evening Star/Reis paper Co./US Dept of Labor, 811/831 2nd Street SE, USTs
30. former Chinese laundry, 801 4th Street SE, former cleaners
31. former storage facility, 626 L Street SE, USTs

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32. former Metropolitan Police Boys Club, SEC of K St SE and 9th Avenue SE (under highway), USTs
33. Mathiason Metal Works, 821 Virginia Avenue SE, former tin shop
34. former HC Emrich Coal, block bounded by Virginia Avenue, 9th, 10th, K Street SE, coal yard
35. Exxon Station; Martins Automotive; Auto Wash Club, 900 11th Street SE, former gas station
36. former gasoline filling station, 1101 Potomac Avenue SE, former gas station
37. former petroleum UST, SEC of 12th Street and L Street, east of portal, USTs
38. Tower Cleaners and Launderers, 636 Virginia Avenue SE, former cleaners
39. Phillips Clothing Cleaner , 700 Virginia Avenue SE, former cleaners
40. Laundry, SWC of Virginia Avenue SE & 8th St SE, former cleaners
41. Anacastia Auto Body, 1113 Virginia Avenue SE, former auto repair
42. Speed Queen Laundry, 809 3rd Street SE, former cleaners
43. Thompson Cleaners/Lillian's Beauty Shop, 700 4th Street SE, former cleaners & beauty shop
44. auto repair with several names, 728 / 730 7th Street SE, former auto repair facility
45. Torchinsky Cleaners, 900 8th Street SE, former dry cleaners
46. Berlinsky Cleaners, 904 8th Street SE, former cleaners
47. Wash it Yourself, 908 8th Street SE, former cleaners
48. Gong Laundry, 911 8th Street SE, former cleaners
49. Zimmerman Laundry, 912 8th Street SE, former cleaners
50. Lee Jas Laundry, 922 8th Street SE, former cleaners
51. Smiths Cleaners, 924 8th Street SE, former cleaners
52. Gong Laundry, 1001 8th Street SE, former cleaners
53. Sing Lee Laundry, 1013 8th Street SE, former cleaners
54. auto repair, 1015 8th Street SE, former auto repair
55. Greers Cleaners, 1110 8th Street SE, former cleaners
56. DeMarco Cleaners, 1112 8th Street SE, former cleaners
57. Auto repair with multiple names, 1101 11th Street SE, former auto repair
58. Auto wrecker with multiple names, 1102 11th Street SE, former auto repair
59. Miller gas station, 1260 11th Street SE, former gas station
60. Brown Trucking, 600 I Street SE, former auto maintenance
61. Terdrlinsky Dyer, 717 I Street SE, former cleaners
62. Superior Cleaners, 641 K Street SE, former cleaners
63. BHB Printers, 718 L Street SE, former printers

8.0 OPINION

Using information gathered as part of this ESA, PB evaluated the potential RECs, HRECs, and *de minimis* environmental conditions identified in Section 7.0 on both the Site and at nearby facilities as to their possible impact to the Site. To assess these issues, PB used its best professional efforts to evaluate the possible contaminants that could be present, the toxicity and

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mobility of these contaminants, and geological factors that could influence the migration of possible contaminants.

8.1 Contaminated Soil

The 1998 materials investigation report for the Virginia Avenue Tunnel identified TPH-DRO in six of 10 soil samples collected from within the tunnel at concentrations exceeding residential cleanup criteria. The 2012 testing conducted along the tunnel corridor identified at least one SVOC present in soil samples from the zero to 15 foot interval in seven borings at concentrations exceeding the residential cleanup criteria. Cr^{6+} was present in samples from the deeper depth intervals in five soil borings at concentrations exceeding the residential cleanup criteria. None of the contaminants are present at concentrations exceeding the industrial cleanup criteria. The borings from which all of these samples were collected were widely spaced, indicating that the contamination is pervasive. PB believes that the presence of contaminants in the soil at concentrations exceeding residential cleanup criteria is a REC.

8.2 Contaminated Groundwater

The 1998 materials investigation report for the Virginia Avenue Tunnel identified TPH-GRO, TPH–ERO, and oil and grease in three of the groundwater seep samples in the tunnel at concentrations "requiring proper management." The 2012 testing conducted along the tunnel corridor identified naphthalene in the M-8 boring at concentrations exceeding the Tier I residential groundwater standard for domestic use. The contaminants in the groundwater seeps in the tunnel may be the result of contaminants leaching from the fill material surrounding the tunnel, while the contaminants in the M-8 boring are likely the result of contamination originating from a nearby facility of concern. PB believes that the presence of contaminated groundwater along the tunnel at concentrations exceeding residential cleanup criteria is a REC.

8.3 Asbestos Containing Materials

The asbestos survey conducted on the Virginia Avenue Tunnel in 2012 showed that approximately 8,000 square feet of black felt paper located inside the concrete vaults enclosing the electrical conduit contained asbestos. The report did not indicate whether the material was friable or likely to become friable; however, it did state that the material should not be disturbed or handled by CSX personnel. The report further stated that if tunnel expansion activities would disturb this material, it must be removed and properly disposed by a licensed asbestos abatement contractor. PB believes that the presence of the asbestos containing material in the tunnel is a REC.

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8.4 Nearby and Adjacent Properties of Concern

PB's research revealed the presence of 63 nearby facilities of concern in the vicinity of the Site. Some of these facilities were identified through multiple sources; others were identified from a single source. These facilities include former gasoline stations, vehicle repair facilities, dry cleaners, properties with underground storage tanks, a manufactured gas plant, and an NPL facility. Each of these properties are either known to be contaminated, or were likely to have used, stored, or handled hazardous substances or petroleum products as part of their operations. Based on their distance from the Site, the known or probable contaminants used, and the lithology of the area, PB believes that contamination emanating from these properties could impact the soil and/or groundwater surrounding the tunnel. These facilities are therefore considered to be RECs. The complete listing of these facilities is presented below:

8.4.1 Virginia Ave Rail Tunnel, Mile Post 113.7

This facility was listed in the ERNS database in the "Unmapped" summary of the Executive Summary. The EDR Site Report for this incident was obtained; however, it does not provide specific information regarding the spill incident or whether contamination exists at the spill location. PB was able to determine that the spill incident occurred approximately 475 feet east of the north portal on the railroad tracks. PB believes this spill incident should be classified as a high risk due to its close proximity to the tunnel and the unknown extent of contamination resulting from the spill.

8.4.2 Washington Navy Yard

This facility is listed in the NPL, CERCLIS, CORRACTS, RCRA-LQG, US Engineering Controls, ROD, and Manifest databases. The Washington Navy Yard is the oldest continuously operating Navy facility in the United States, having operated since the 1800s. Industrial operations ceased in the 1960s; however, many former shops and storage buildings were converted into offices. This is an approximately 70-acre property (the area is enclosed by M Street SE on the north, 11th Street SE on the east, 4th Street SE on the west, and the Anacostia River on the south) which is known to be contaminated with a wide variety of substances, including volatile organic compounds (VOCs), PCBs, and heavy metals. At its closest point, it is approximately 375 feet from the tunnel. Some remediation activities have occurred; however, contamination remains on the property. Although contamination is present on the Yard property, there is no indication that widespread contamination has migrated north of M Street. Since NPL/CERCLIS sites; however, are considered among the most contaminated facilities, PB believes that this facility should be considered a high risk to potentially impact the area near the tunnel.

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8.4.3 Price Service Station/Chesapeake Motor Co./Sanford Amoco Service Station/Hooe Coal

This property is immediately adjacent to the tunnel (approximately 50 feet), and is listed in the HIST UST and Historic Auto Stations databases. No information is available to indicate whether this property is contaminated, but the former presence of an operating gasoline service station makes it likely that contamination exists. It is also possible that underground storage tanks could remain on the property. Due to its close proximity to the tunnel and the nature of potential petroleum contamination, PB believes this facility should be classified as a high risk.

8.4.4 502-04 Virginia Avenue SE

This property is listed in the HIST UST database, and was once likely situated approximately 50 feet north of the tunnel. No information is available regarding the size and contents of the former UST or whether this property is contaminated. Due to its close proximity to the project area and the uncertainty regarding the use of the former UST, this facility is classified by PB as a high risk.

8.4.5 841 2nd Street SE facility/Evening Star Garage

This facility is listed in the LUST database. A release of gasoline occurred from this property, and although the release incident is listed as "Closed," it is unclear whether residual contamination remains and the property is still contaminated. The facility was situated about 80 feet south of the tunnel area. Due to its close proximity, PB believes this facility should be classified as a medium risk.

8.4.6 Washington Post Newspaper

This facility is listed in the UST, RCRA-NonGen, FINDS, LUST, and Brownfields databases and is about 100 feet south of the tunnel. The facility formerly had nine USTs that ranged in size from 1,000 to 20,000 gallon capacity, and contained gasoline, diesel fuel, heating oil, "hazardous substance" (unspecified), and "other." The facility has had two separate release incidents, both involving gasoline; one in 1990, and one in 2002. Both release incidents are listed as "Closed," however, PB believes residual contamination may remain. Due to its close proximity, PB believes this facility should be classified as a medium risk.

8.4.7 Alpha Auto Service/Capitol Motor Works/Hill Auto Repair

This facility is listed in the UST, RCRA-CESQG, FINDS, and Manifest databases and was formerly situated approximately 80 feet from the tunnel. Four 1,000-gallon gasoline underground storage tanks have been removed from the property. No information was available regarding whether the property is contaminated. Due to its close proximity and unknown nature, PB believes this facility should be classified as a high risk.

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8.4.8 Sound Car Audio Repair/Tune Up Kit of Capitol Hill

This facility was situated about 60 feet from the tunnel area and was listed in the RCRA-NonGen, FINDS, and LUST databases. The LUST investigation is listed as "Open" and the products released from underground storage tanks include heating oil and diesel fuel. The facility also formerly generated small quantities of waste, including benzene and tetrachloroethylene. Some contamination exists on the property; however, the extent of the contamination was not included in the EDR report. Due to its close proximity and unknown nature, PB believes this facility should be classified as a high risk.

8.4.9 Arthur Capper Properties

The "Arthur Capper" properties are listed at 501 Virginia Avenue SE, 601 L Street SE, and 1000 5th Street SE, and range from about 150 feet to 530 feet from the tunnel. These listings are all in the UST databases; one is also in the HIST UST database. The properties contained either heating oil USTs or a small diesel UST. No information is available to indicate whether the properties are contaminated, and PB believes the facility poses a low risk.

8.4.10 Rundlett Rim & Wheel Co / Warner Coal / Historic Gasoline Station

These facilities are listed in the EDR Historic Auto Stations, HIST UST, and LUST databases and are situated approximately 175 feet from the tunnel. The property has had two releases of gasoline; and both releases are listed as "Closed." PB believes that residual contamination associated with this facility is likely and that it should be classified as high risk.

8.4.11 DC Housing

This facility is listed in the UST and LUST databases. A release of heating oil from a former 3,000-gallon UST was reported; the release is listed as "Closed." Residual contamination may remain; however due to its distance to the tunnel (225 feet), PB believes the facility poses a low risk.

8.4.12 704 I Street SE

This property is listed in the HIST UST database and is situated about 300 feet from the tunnel. No information is available regarding the size and contents of the former UST or whether this property is contaminated. Due to its distance to the tunnel, PB believes the facility poses a low risk.

8.4.13 1100 M Street SE

This property is listed in the HIST UST database and was likely near the historic gasoline station at the northwest corner of M Street SE and 11th Street SE (see #10 above). No information is

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available regarding the size and contents of the former UST or whether this property is contaminated. PB believes this facility is a low risk.

8.4.14 Boiler Plant Building

This facility is listed in the UST and LUST databases and is about 350 feet from the tunnel. Two 10,000 gallon heating oil USTs were formerly present on the property, and a release of gasoline and heating oil was reported. The release incident is listed as "Closed," and it is unclear whether the property is still contaminated. Due to its distance to the tunnel, PB believes this facility poses a low risk.

8.4.15 Navy Yard Garage

This 1102 9th Street SE facility is listed in the HIST UST database and is approximately 350 feet from the tunnel. No information is available regarding the size and contents of the former UST or whether this property is contaminated. Due to its distance to the tunnel, PB believes this facility poses a low risk.

8.4.16 Calomiris GP

This property is listed in the HIST UST database and is about 350 feet from the tunnel. No information is available regarding the size and contents of the former UST or whether this property is contaminated. Due to its distance to the tunnel, PB believes this facility poses a low risk.

8.4.17 Lenox

This facility is listed in the UST database and is about 360 feet from the tunnel. A 5,000-gallon heating oil UST is currently in use on the property. No information is available to indicate whether this property is contaminated; however, based on its distance to the tunnel, PB believes this facility should be classified as a low risk.

8.4.18 National Medical Care

This facility is listed in the UST database and is approximately 400 feet from the tunnel. The property formerly contained a 2,000-gallon heating oil UST and a 550-gallon diesel UST. No information is available to indicate whether this property is contaminated; however, based on its distance to the tunnel, PB believes this facility should be classified as a low risk.

8.4.19 Anna Rice/Lee Chong property/Capitol Lithographers

The facility listings are in the EDR proprietary Historical Cleaners database, and were cleaners & dyers and a Chinese Laundry about 420 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with

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dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.20 Greenwood Warehouse/former Rainbow Dyeing & Cleaning/former Atlantic Cleaners & Dyers

The facility formerly had six USTs that ranged in size from 1,000 to 4,350 gallon capacity and contained either gasoline or heating oil. The release incident is listed as "Closed," however residual contamination may remain. The Sanborn maps identify this facility as a large cleaning company, and street directories list multiple cleaner/dyer businesses from 1920 until the 1940s. Although the facility is approximately 425 feet from the tunnel, solvent contamination associated with these types of facilities can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.21 Washington Gas

This facility listing was situated southeast of the intersection of M Street SE and 12th Street SE, and was a former coal gasification plant. Based on historical aerial photographs, this facility probably occupied the entire piece of property southeast of this intersection, and as such, is about 450 feet from the tunnel at its closest point. The aerial photographs also show multiple large aboveground storage tanks on the property. The EDR Site Report for this facility was obtained; however, it does not provide specific information regarding the contamination on the property. Since the property is listed in the US Brownfield database, the property is contaminated.

Information regarding the nature of the contamination associated with this facility was obtained from the 11th Street Bridges FEIS report. This facility produced manufactured gas from the 1880s until 1948. Generation of the gas was from coal and oil; byproducts included tar, oil, coke, and lampblack. Woodchips were used to absorb some of the tar, and were placed on the property as fill material. Beginning in 1976, investigations and corrective actions were undertaken at the facility. Contaminants of concern included VOCs, SVOCs, PAHs, metals, and cyanide. In addition, a coal tar based dense nonaqueous phase liquid (DNAPL) was identified at three locations on the property near and south of Water Street. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.22 Fenwick Service Station

This property is listed in the Historical Auto Stations database, and was a gas station that operated under various names in the 1940s and 1950s. This former facility may have been situated beneath the highway near the Potomac Avenue and 11th Street intersection, approximately 100 feet from the tunnel. No information is available to indicate whether this

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property is contaminated; however, based on its close proximity to the tunnel, PB believes this facility should be classified as a high risk.

8.4.23 1003 4th Street SE

The property formerly contained a 3,000-gallon heating oil UST about 500 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, based on its distance to the tunnel, PB believes this facility should be classified as a low risk.

8.4.24 Part of Washington Navy Yard

This facility is listed in the LUST database and is associated with the Washington Navy Yard discussed in Section 8.4.2 above. Multiple releases have been reported from this facility, which includes different buildings within the Navy Yard complex. Some releases are listed as "Closed," and others are listed as "Open." PB believes these LUST releases should be classified as a medium risk to the tunnel.

8.4.25 1016 4th Street SE

This facility is listed in the LUST database and is approximately 525 feet from the tunnel. A release of heating oil occurred from this property, and the release is listed as "Closed." Residual contamination may remain; however due to its distance to the tunnel, PB believes the facility poses a low risk.

8.4.26 Sam Moy / Thos Sweeny property

The facility is listed in the Historical Cleaners database, and was formerly a Chinese Laundry and a clothes presser & cleaner about 560 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.27 Unity Cleaners

The facility listing is in the Historical Cleaners database, and was a cleaner & dyer in the 1950s about 560 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.28 Mon Der / B&B Cleaners

The facility is listed in the Historical Cleaners database, and was a laundry and a cleaner & dyer about 780 feet to the tunnel. No information is available to indicate whether this property is

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contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a low risk.

8.4.29 Evening Star/Reis paper Co./US Dept of Labor

This facility is approximately 250 feet from the tunnel and was identified on the Sanborn maps as having USTs on the property. Two USTs were on the north side of the Evening Star garage from about 1959 until 1998, one UST was in the alley in the southwest part of the block from 1959 until 1998, and one UST was in the center of the block in 1928. No information is available to indicate whether this property is contaminated; however, the sources show that these USTs were in place for about 40 years. Based on its distance to the tunnel and the age of the USTs, PB believes this property should be classified as a medium risk.

8.4.30 801 4th Street SE

The 801 4th Street property was formerly situated approximately 50 feet from the tunnel. Sanborn maps and city directory listings identified this property as a Chinese laundry and cleaners from the early 1900s to the mid-1920s. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its close proximity to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.31 626 L Street SE

The property is a former storage facility about 325 feet from the tunnel. A UST was identified in the 1928 Sanborn map. No information is available to indicate whether this property is contaminated; however, based on its distance to the tunnel, PB believes this facility should be classified as a low risk.

8.4.32 Former Metropolitan Police Boys Club

The facility was situated near the southeast corner of K Street SE and 9th Avenue SE, under the current highway and about 50feet from the tunnel. A UST was identified in the 1959 Sanborn map. No information is available to indicate whether this property is contaminated; however, based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.33 Mathiason Metal Works

Based on Sanborn maps and city directory research, this facility was a former tin shop and metal working facility present in the 1920s and 1930s, and was situated approximately 50 feet from the

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tunnel. The types of contaminants (heavy metals) associated with this land use are typically immobile, therefore, PB believes this facility should be classified as a low risk.

8.4.34 Former HC Emrich Coal

Based on Sanborn maps, this facility was a coal storage facility, formerly situated under the current highway, approximately 50 feet from the tunnel. The types of contaminants (heavy metals, acid drainage, etc.) associated with this land use are typically immobile, therefore, PB believes this facility should be classified as a low risk.

8.4.35 Exxon Station/Martins Automotive/Auto Wash Club

The facility is a gasoline service station approximately 440 feet from the tunnel that likely operated in the 1970s and 1980s. It is currently closed and now operates as a car wash. No information is available to indicate whether this property is contaminated; however, based on its distance to the tunnel, PB believes this facility should be classified as a low risk.

8.4.36 1101 Potomac Avenue SE – Former Gasoline Station

Sanborn maps and city directory research showed that five USTs were associated with this former gasoline service station. This property is approximately 100 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, based on its distance to the tunnel, PB believes this facility should be classified as a high risk.

8.4.37 Southeast Corner of 12th Street and L Street

The 1959 Sanborn map identified a 1,000,000-gallon, five compartment UST containing petroleum and a large AST containing fuel oil. PB did not obtain any information indicating whether this property is contaminated. Although the tank location is about 330 feet from the tunnel, PB believes this property should be classified as a high risk based on the large volume of petroleum storage and potential for significant contamination.

8.4.38 Tower Cleaners and Launderers

The Tower Cleaners and Launderers facility was identified in the 1960 street directory and was formerly situated approximately 50 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a high risk.

8.4.39 Phillips Clothing Cleaners

Based on city directory information, the Phillips Clothing Cleaners facility operated in the 1940s and 1950s, and was formerly situated approximately 50 feet from the tunnel. No information is

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available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a high risk.

8.4.40 Former Laundry at the Southeast Corner of Virginia Avenue & 8th Street

Based on city directory information, the former laundry facility and possible dry cleaner operated in the 1940s and 1950s, and was situated approximately 100 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.41 Anacastia Auto Body

Based on city directory information, this facility was an automotive repair facility in the 1960s, and was formerly situated approximately 100 feet from the tunnel. Automotive repair facilities use a variety of petroleum and solvent based contaminants as part of its operations; however, no information is available to indicate whether this property is contaminated. Based on its distance to the tunnel, PB believes this facility should be classified as a low risk.

8.4.42 Speed Queen Laundry

Based on city directory information, the Speed Queen Laundry facility and possible dry cleaner operated in the 1960s and 1970s, and was formerly situated approximately 50 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.43 Thompson Cleaners/Lillian's Beauty Shop

According to city directory information, this facility was a dry cleaner in the 1950s and a beauty salon in the 1960s. The facility was situated about 450 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.44 728/730 7th Street Auto Repair Facilities

Based on city directory information, this facility was an automotive repair facility from the 1920s until the 1970s. It was situated approximately 670 feet from the tunnel. Automotive repair facilities use a variety of petroleum and solvent based contaminants as part of its operations;

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however, no information is available to indicate whether this property is contaminated. Based on its distance to the tunnel, PB believes this facility should be classified as a low risk.

8.4.45 Torchinsky Cleaners

Based on city directory information, the Torchinsky Cleaners facility operated in the 1930s, and was formerly situated approximately 150 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a high risk.

8.4.46 Berlinsky Cleaners

Based on city directory information, the Berlinsky Cleaners facility operated in the 1930s and 1940s, and was formerly situated approximately 130 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a high risk.

8.4.47 Wash it Yourself

Based on city directory information, the Wash it Yourself laundry facility and possible dry cleaner operated in the 1960s, and was formerly situated approximately 110 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.48 Gong Laundry (911 8th Street)

Based on city directory information, the Gong Laundry facility and possible dry cleaner at 911 8th Street operated in the 1960s, and was formerly situated approximately 100 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.49 Zimmerman Laundry

Based on city directory information, the Zimmerman Laundry facility and possible dry cleaner operated in the 1910s, and was formerly situated approximately 90 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface.

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Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.50 Les Jas Laundry

Based on city directory information, the Les Jas Laundry facility and possible dry cleaner operated in the 1930s and 1940s, and was formerly situated approximately 70 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.51 Smiths Cleaners

Based on city directory information, the Smiths Cleaners facility operated from the 1930s to the 1960s, and was formerly situated approximately 50 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a high risk.

8.4.52 Gong Laundry (1001 8th Street)

Based on city directory information, the Gong Laundry facility and possible dry cleaner at 1001 8th Street operated from the 1910s to the 1960s, and was formerly situated approximately 50 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.53 Sing Lee Laundry

Based on city directory information, the Sing Lee Laundry facility and possible dry cleaner operated in the 1910s and 1920s, and was formerly situated approximately 150 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.54 1015 8th Street Auto Repair

Based on city directory information, this facility was an automotive repair facility in the 1920s and was situated approximately 170 feet from the tunnel. Automotive repair facilities use a variety of petroleum and solvent based contaminants as part of its operations; however, no information is

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available to indicate whether this property is contaminated. Based on its distance to the tunnel, PB believes this facility should be classified as a low risk.

8.4.55 Greers Cleaners

Based on city directory information, the Greers Cleaners facility operated in the 1970s and was formerly situated approximately 360 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.56 DeMarco Cleaners

Based on city directory information, the DeMarco Cleaners facility operated in the 1940s and 1950s, and was formerly situated approximately 380 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.57 1101 11th Street Auto Repair

Based on city directory information, this facility was an automotive repair facility from the 1930s until the 1970s and was situated approximately 120 feet from the tunnel near the southwest corner of the 11th Street and L Street intersection. PB believes that this facility is associated with the former gasoline station discussed in Section 8.4.10 above. Based on its distance to the tunnel and its likely affiliation with the former gasoline service station, PB believes this facility should be classified as a high risk.

8.4.58 1102 11th Street Auto Wrecker

Based on city directory information, this facility was an automotive wrecker (towing) in the 1920s and 1930s, and was situated approximately 60 feet from the tunnel. It is unknown whether any automotive repair activities occurred at the property and no information is available to indicate whether this property is contaminated. PB believes this facility should be classified as a low risk.

8.4.59 Miller Gas Station

The Miller Gas Station facility was identified in the 1940s city directories and was approximately 875 feet from the tunnel. No information was available regarding the USTs or whether contamination exists on the property. Based on its distance to the tunnel, PB believes this facility should be classified as a low risk.

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8.4.60 Brown Trucking

The Brown Trucking facility was identified in the 1960s city directories and was likely formerly situated under the current highway location, approximately 120 feet from the tunnel. No information was available to indicate whether USTs were present on the property or if contamination exists on the property. Based on its distance to the tunnel, PB believes this facility should be classified as a low risk.

8.4.61 Terdrlinsky Dyer

Based on city directory information, the Terdrlinsky Dyer facility operated in the 1910s, and was formerly situated approximately 250 feet from the tunnel. No information is available to indicate whether this property is contaminated. Based on its distance to the tunnel, PB believes this facility should be classified as a low risk.

8.4.62 Superior Cleaners

Based on city directory information, the Superior Cleaners facility operated in the 1940s, and was formerly situated approximately 300 feet from the tunnel. No information is available to indicate whether this property is contaminated; however, solvent contamination associated with dry cleaners can travel significant distances in the subsurface. Based on its distance to the tunnel, PB believes this facility should be classified as a medium risk.

8.4.63 BHB Printers

The BHB Printers facility was identified in the 1980s city directories, approximately 200 feet from the tunnel. No information was available to indicate whether contamination exists on the property. Based on its distance to the tunnel, PB believes this facility should be classified as a low risk.

9.0 CONCLUSIONS

Parsons Brinckerhoff, Inc. (PB) has performed a modified Phase I environmental site assessment (ESA) of the Virginia Avenue Tunnel corridor (the Site) along Virginia Avenue SE in Washington, DC for CSX Transportation, Inc. No party other than those listed in Section 2.7 may rely upon any information or opinion contained in this report.

This ESA was performed in partial conformance with the scope and limitations of 40 CFR Part 312 (Standards and Practices for All Appropriate Inquiries) and ASTM Method E 1527-05 (Standard Practice for Environmental Site Assessments). Any exceptions to, or deletions from this practice are described in Section 12.0 of this report.

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The ESA included a site walkover, review of government records, assembly and review of data from area maps and directories, and assessment of aerial photographs and Sanborn maps. This assessment has revealed no evidence of recognized environmental conditions in connection with the property except for the following:

1) The 1998 materials investigation report for the Virginia Avenue Tunnel identified TPH-DRO in six of 10 soil samples collected from within the tunnel at concentrations exceeding residential cleanup criteria. The 2012 testing conducted along the tunnel corridor identified at least one SVOC present in soil samples from the zero to 15 foot interval in seven borings at concentrations exceeding the residential cleanup criteria. Hexavalent chromium (Cr^{6+}) was present in samples from the deeper depth intervals in five soil borings at concentrations exceeding the residential cleanup criteria. None of the contaminants are present at concentrations exceeding the industrial cleanup criteria. The borings from which all of these samples were collected were widely spaced, indicating that the contamination is pervasive. PB believes that the presence of contaminants in the soil at concentrations exceeding residential cleanup criteria is a REC.

2) The 1998 materials investigation report for the Virginia Avenue Tunnel identified TPH-GRO, TPH-ERO, and oil and grease were present in three of the groundwater seep samples in the tunnel at concentrations "requiring proper management." The 2012 testing conducted along the tunnel corridor identified naphthalene in the M-8 boring at concentrations exceeding the Tier I residential groundwater standard for domestic use. The contaminants in the groundwater seeps in the tunnel may be the result of contaminants leaching from the fill material surrounding the tunnel, while the contaminants in the M-8 boring are likely the result of contamination originating from a nearby facility of concern. PB believes that the presence of contaminated groundwater along the tunnel at concentrations exceeding residential cleanup criteria is a REC.

3) The asbestos survey conducted on the Virginia Avenue Tunnel in 2012 showed that approximately 8,000 square feet of black felt paper located inside the concrete vaults enclosing the electrical conduit contained asbestos. The report did not indicate whether the material was friable or likely to become friable; however, it did state that the material should not be disturbed or handled by CSX personnel. The report further stated that if tunnel expansion activities would disturb this material, it must be removed and properly disposed by a licensed asbestos abatement contractor. PB believes that the presence of the asbestos containing material in the tunnel is a REC.

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4) PB's research revealed the presence of 63 nearby facilities of concern in the vicinity of the Site. Some of these facilities were identified through multiple sources; others were identified from a single source. These facilities include former gasoline stations, vehicle repair facilities, dry cleaners, properties with underground storage tanks, a manufactured gas plant, and an NPL facility. Each of these properties are either known to be contaminated, or were likely to have used, stored, or handled hazardous substances or petroleum products as part of their operations. Based on their distance from the Site, the known or probable contaminants used, and the lithology of the area, PB believes that contamination emanating from these properties could impact the soil and/or groundwater surrounding the tunnel. These facilities are therefore considered to be RECs.

10.0 RECOMMENDATIONS

Based on the information gathered as part of this Modified Phase I ESA, review of the relevant data, and understanding of the planned Site uses, PB recommends the following activities be completed:

1) Although soil contamination has been identified at concentrations exceeding residential cleanup criteria, it does not exceed the industrial cleanup criteria or construction worker protection cleanup criteria. Because the borings from which the samples were collected were widely spaced, localized pockets of more highly contaminated soil could be encountered during construction activities. Construction workers should be informed of the possible presence of contaminated soil surrounding the tunnel, so precautions can be taken to protect the workers. Suspected contaminated soil should be stockpiled and sampled for characterization. Contaminated soil should be handled and managed in accordance with appropriate local, state, and/or federal rules and regulations..

2) Although contaminated groundwater has been identified at concentrations exceeding the Tier I criteria for domestic water use, it does not exceed any of the Tier I standards for incidental dermal contact. Because the borings from which the samples were collected were widely spaced, localized pockets of more highly contaminated groundwater could be encountered during construction activities. Construction workers should be informed of the possible presence of contaminated groundwater, so precautions can be taken to protect the workers. Groundwater that is generated through dewatering activities during construction should be handled, managed, and discharged in accordance with appropriate local, district, and/or federal rules and regulations. This may include temporary

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storage in a tank, characterization for the possible presence of contaminants, filtering through granular activated carbon, and/or discharge permitting. .

3) The black felt material in the utility chase within the Virginia Avenue Tunnel should be properly removed and disposed by a licensed asbestos abatement contractor if these areas are planned for any disturbance (renovation, demolition, replacement, etc.)Because of the presence of the nearby facilities of concern, construction activities should include provisions for checking the soil and groundwater for potential contaminants (as discussed in #1 and #2, above). Contaminated soil and groundwater should be handled and/or disposed in accordance with appropriate regulations.

4) Although a CERCLA liability defense is not being sought, CSX Transportation, Inc should review the User's Ongoing Responsibilities (included in Section 11.0 of this report), and comply with the provisions therein.

11.0 USER'S CONTINUING OBLIGATIONS UNDER CERCLA

Conducting this ESA does not alone provide a landowner with protection against CERCLA liability. Landowners who want to maintain a Bona Fide Prospective Purchaser, an Innocent Landowner, or a Contiguous Property Owner Defense must also comply with other pre- and post-acquisition requirements in the CERCLA regulations and AAI standards.

Since the User already occupies the Site, it likely could not qualify for a defense from CERCLA liability; however, the User of this report should still comply with all ongoing responsibilities summarized below.

11.1 Bona Fide Prospective Purchaser Responsibilities

The Bona Fide Prospective Purchaser defense is intended for individuals or entities purchasing a property known to be contaminated. To obtain and maintain the defense, the individual or entity seeking the defense must also satisfy the following requirements (AAI, Section II D. 1.):

- Have acquired a property after all disposal activities involving hazardous substances ceased at the property;
- Provide all legally required notices with respect to the discovery or release of any hazardous substances at the property;

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- Exercise appropriate care by taking reasonable steps to stop continuing releases, prevent any threatened future releases, and prevent or limit human, environmental, or natural resources exposure to any previously released hazardous substance;
- Provide full cooperation, assistance, and access to persons authorized to conduct response actions or natural resource restorations;
- Comply with land use restrictions established or relied on in connection with a response action;
- Not impede the effectiveness or integrity of any institutional controls;
- Comply with any CERCLA request for information or administrative subpoena; and
- Not be potentially liable, or affiliated with any other person who is potentially liable for response costs for addressing releases at the property.

11.2 Innocent Landowner Responsibilities

The Innocent Landowner Defense protects individuals or entities (ultimately the "property owner") purchasing a property that is not known to be contaminated. The property owner must also satisfy the following requirements to obtain and maintain the defense (AAI, Section II D. 3 and CERCLA Section 107(b)(3)):

- Have no reason to know that any hazardous substance which is the subject of a release or threatened release was disposed of on, in, or at the facility;
- Provide full cooperation, assistance and access to persons authorized to conduct response actions at the property;
- Comply with any land use restrictions and not impeding the effectiveness or integrity of any institutional controls;
- Take reasonable steps to stop continuing releases, prevent any threatened release, and prevent or limit human, environmental, or natural resource exposure to any hazardous substances released on or from the landowner's property;
- Demonstrate that the act or omission that caused the release or threat of release of hazardous substances and the resulting damages were caused by a third party with whom the person does not have employment, agency, or a contractual relationship;

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- Exercise due care with respect to the hazardous substance concerned, taking into consideration the characteristics of such hazardous substance, in light of all relevant facts and circumstances;
- Take precautions against foreseeable acts or omissions of a third party and the consequences that could result from such acts or omissions.

11.3 Contiguous Property Owner Defenses

The Contiguous Property Owner Defense protects individuals or entities purchasing a property that is not known to be contaminated, but could be contaminated by migration from a contiguous property owned by someone else. To qualify as a contiguous property owner, a landowner must have no knowledge of contamination prior to acquisition and meet all of the criteria set forth in AAI Section II. D. 2. and CERCLA Section 107(q)(1)(A):

- Not cause, contribute, or consent to the release or threatened release;
- Not be potentially liable nor affiliated with any other person potentially liable for response costs at the property;
- Take reasonable steps to stop continuing releases, prevent any threatened release, and prevent or limit human, environmental, or natural resource exposure to any hazardous substances released on or from the landowner's property;
- Provide full cooperation, assistance, and access to persons authorized to conduct response actions or natural resource restorations;
- Comply with land use restrictions established or relied on in connection with a response action;
- Not impede the effectiveness or integrity of any institutional controls;
- Comply with any CERCLA request for information or administrative subpoena;
- Provide all legally required notices with respect to discovery or release of any hazardous substances at the property.

12.0 DEVIATIONS

PB deviated from the procedures in ASTM Standard E 1527-05 and 40 CFR Part 312 in the following ways:

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PB did not conduct interviews with CSX (the tunnel owner) since CSX provided general information regarding the tunnel. No interviews were conducted with governmental agencies that would have ownership of Virginia Avenue at the request of CSX. PB did not conduct an agency records review of any of the nearby facilities of concern at the request of CSX and due to the voluminous number of facilities and amount of file information. PB also did not request a lien search of the tunnel corridor since no defined parcel exists.

13.0 DATA GAPS AND DATA FAILURES

Data failure occurs when all of the standard historical sources that are reasonably ascertainable and likely to be useful have been reviewed and yet the historical research objectives have not been met. A data gap is a lack or inability to obtain information required by the ASTM and AAI standards, in spite of PB's "good faith efforts[4]" to obtain the information.

PB does not believe that any data failures or data gaps exist for this report since it completed each of the tasks identified in Section 2.2.1 and has achieved the historical research objectives.

14.0 GLOSSARY

This section of the report provides definitions of acronyms and special terms used in the report. It is not all inclusive.

AAI: All Appropriate Inquiry. An investigation into the historical use and possible presence of contamination on a property that is a necessary component for persons seeking to establish one of the three CERCLA defenses as part of conducting due diligence.

ACM: Asbestos Containing Material. This is a material that contains more than one percent of an asbestos mineral. These materials are only identified in PB's reports if an asbestos survey was performed prior to, or in conjunction with, PB's environmental assessment.

AST: Aboveground Storage Tank. Any aboveground storage container larger than a 55-gallon drum, either empty or full.

ASTM: American Society of Testing Materials. This is the organization that creates standards for materials and testing; in this case, the standard for environmental site assessments, which is also based on the U.S. EPA standards for all appropriate inquiry.

[4] According to AAI, good faith effort is defined as "…the absence of any intention to seek an unfair advantage or to defraud another party; an honest and sincere intention to fulfill one's obligations in the conduct or transaction concerned."

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AUL: Activity and Use Limitation. A legal mechanism that imposes land use controls (such as an ordinance barring the installation of water wells in a municipal area) or engineering controls (such as a deed restriction limiting a property's use to commercial zoning).

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act. Facilities regulated by this act are listed in the CERCLIS database.

CERCLIS: Comprehensive Environmental Response, Compensation, and Liability Information System. The CERCLIS database lists properties that are on or are proposed to be on the National Priorities List.

CFR: Code of Federal Regulations. The regulatory code developed by federal agencies pursuant to acts passed by the US Congress.

Data Failure: Data failure occurs when all of the standard historical sources that are reasonably ascertainable and likely to be useful have been reviewed and yet the historical research objectives have not been met.

Data Gap: A data gap is a lack or inability to obtain information required by the ASTM and AAI standards, in spite of good faith efforts to obtain the information.

DDOE: District Department of the Environment.

***de minimis*:** Conditions that generally do not present a material risk of harm to public health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies.

Due Diligence: The care a reasonable person should take before entering into a transaction with another party.

EDR: Environmental Data Resources. This company owns the Sanborn Fire Insurance Map Company holdings, and provides the governmental records search used in PB's reports.

Environmental Professional: An individual who, as defined in the standards for all appropriate inquiry, possess the education and experience requirements to conduct and/or oversee certain aspects of environmental site assessments.

EPA: The U.S. Environmental Protection Agency.

ESA: Environmental Site Assessment.

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Good Faith Effort: According to the AAI standards, good faith effort is "the absence of any intention to seek an unfair advantage or to defraud another party; an honest and sincere intention to fulfill one's obligations in the conduct or transaction concerned."

HREC: Historic Recognized Environmental Condition. A condition which in the past would have been considered a recognized environmental condition, but which may or may not be considered a recognized environmental condition currently.

LUST: Leaking Underground Storage Tank.

NPL: National Priorities List. A list of contaminated properties whose cleanup is being overseen by the U.S. EPA.

PCBs: Polychlorinated Biphenyls. A contaminant commonly found in old hydraulic equipment or electrical transformers.

RCRA: Resource Conservation and Recovery Act. The RCRA database includes selective information on facilities that generate, transport, store, treat and/or dispose of hazardous wastes.

RCRA 8 Metals: The list of heavy metals includes arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

REC: Recognized Environmental Condition. The presence or likely presence of any hazardous substance or petroleum products on a property that indicates an existing release, past release, or material threat of a release at the property. In PB's ESA reports, all issues identified as a recognized environmental condition are listed in the executive summary and conclusion. These are issues that warrant additional investigation and/or testing.

SHWS: State Hazardous Waste Sites. Properties included in the SHWS database have been identified by the State environmental regulatory agency as having been contaminated with hazardous wastes.

SVOCs: Semivolatile organic compounds.

TPH-DRO: Total petroleum hydrocarbons – diesel range organics.

TPH-GRO: Total petroleum hydrocarbons – gasoline range organics.

USC: U.S. Code. The full set of Laws passed by the U.S. Congress.

User: The individual or entity for which the Phase I environmental assessment has been prepared.

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UST: Underground Storage Tank. Any buried storage container larger than a 55-gallon drum, either empty or full. Underground storage tanks do not include septic tanks.

VOCs: Volatile organic compounds.

15.0 REFERENCES

Professional Standards

40 CFR Part 312, Standards and Practices for All Appropriate Inquiries, 69 Fed. Reg. 52541, November 1, 2005.

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Ogden Environmental and Energy Services Co., Inc., *Material Evaluation Report of the Virginia Avenue Tunnel, Washington DC*, performed for CSX Transportation, Inc., November 5, 1998.

Shaw Environmental & Infrastructure, Inc., *Polychlorinated Biphenyl Sampling Report, for the Virginia Avenue Tunnel, Virginia Avenue SE, Washington DC*, performed for CSX Transportation, Inc., July 23, 2012.

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16.0 SIGNATURES OF ENVIRONMENTAL PROFESSIONALS

We declare that, to the best of our knowledge and belief, we meet the definition of Environmental Professional as defined in §312.10 of 40 CFR Part 312. We have the specific qualifications based on education, training, and experience to assess a property of the nature, history, and setting of the subject property. We have developed and performed the all appropriate inquiries in partial conformance with the standards and practices set forth in 40 CFR Part 312. All work done by other individuals who might not meet the definition of an Environmental Professional was done under our supervision.

Adam W. Heft, CPG
Senior Supervising Geologist

David R. VanGoethem, P.E.
Senior Supervising Engineer

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APPENDICES NOT INCLUDED

Appendix H

Tree Inventory Composite Species List

03.09.12, 6.19.12, 8.21.12
Virginia Avenue Tunnel
Tree Survey

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
1	Black Locust	*Robinia pseudoacacia*	6”	14’-0”	Fair
2	Tree of Heaven	*Ailanthus altissima*	6”	18’-0”	Fair
3	Tree of Heaven	*Ailanthus altissima*	6”	18’-0”	Fair
4	Tree of Heaven	*Ailanthus altissima*	5”	16’-0”	Fair
5	Sugar Maple	*Acer saccharum*	14”	40’-0’	Poor; trunk damage
5A	Scarlet Oak	*Quercus coccinea*	20.2”	32’-0”	Fair
6	Oak	*Quercus sp.*	19.9”	32’-0”	Dead
7	Scarlet Oak	*Quercus coccinea*	18.7”	34’-0”	Poor; trunk damage
8	Hackberry	*Celtis occidentalis*	7.6”	18’-0”	Poor; leaning trunk
9	Northern Red Oak	*Quercus rubra*	22.5”	40’-0”	Fair; die-back in crown
10	Northern Red Oak	*Quercus rubra*	20.6	34’-0”	Fair; some dead branches
11	Northern Red Oak	*Quercus rubra*	21.4”	40’-0”	Fair; some dead branches
12	Willow Oak	*Quercus phellos*	28.3”	50’-0”	Fair
13	Scarlet Oak	*Quercus coccinea*	16.4”	32’-0”	Fair
14	Northern Red Oak	*Quercus rubra*	26”	44’-0”	Fair; dead branches
15	Black Pine	*Pinus nigra*	8.8”	12’-0”	Poor; broken branches and leaning
16	Northern Red Oak	*Quercus rubra*	27.9”	44’-0”	Fair; girdling roots

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
17	Northern Red Oak	*Quercus rubra*	21.8”	44’-0”	Fair
18	Northern Red Oak	*Quercus rubra*	28.6”	44’-0”	Fair
19	Northern Red Oak	*Quercus rubra*	25.6”	32’-0”	Fair
20	Tulip Poplar	*Liriodendron tulipifera*	22.2”	34’-0”	Fair
21	Pin Oak	*Quercus palustris*	25.6”	44’-0”	Good
22	Scarlet Oak	*Quercus coccinea*	26”	54’-0”	Fair; girdling root
23	Willow Oak	*Quercus phellos*	26”	54’-0”	Good
24	Scarlet Oak	*Quercus coccinea*	14.9”	28’-0”	Poor
25	Tree removed	*Tree removed*	N/A	N/A	Removed
25A	Northern Red Oak	*Quercus rubra*	1”	N/A	New
25B	Northern Red Oak	*Quercus rubra*	1”	N/A	New
26	Northern Red Oak	*Quercus rubra*	14.9”	28’-0”	Poor; die-back in crown
26A	Northern Red Oak	*Quercus rubra*	1”	N/A	New
26B	Northern Red Oak	*Quercus rubra*	1”	N/A	New
27	Eastern White Pine	*Pinus strobus*	10.3”	24’-0”	Poor; trunk damage
27A	Dogwood	*Cornus sp.*	1.5”	4’-0”	Good
28	Thornless Honey Locust	*Gleditsia tricanthos inermis*	3.1”	12’-0”	New
29	Thornless Honey Locust	*Gleditsia tricanthos inermis*	3.4”	8’-0”	New

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
30	Thornless Honey Locust	*Gleditsia tricanthos inermis*	3.1”	12’-0”	New
31	American Sycamore	*Platanus occidentalis*	3.1”	12’-0”	New
32	Northern Red Oak	*Quercus rubra*	2.7”	6’-0”	New
33	Northern Red Oak	*Quercus rubra*	22.9”	40’-0”	Good
34	Northern Red Oak	*Quercus rubra*	1.9”	6’-0”	New
35	Northern Red Oak	*Quercus rubra*	2.3”	8’-0”	New
36	Northern Red Oak	*Quercus rubra*	2.3”	8’-0”	New
37	Northern Red Oak	*Quercus rubra*	2.7”	8’-0”	New
38	Northern Red Oak	*Quercus rubra*	1.9”	6’-0”	New
39	Northern Red Oak	*Quercus rubra*	18.3”	30’-0”	Good
40	Northern Red Oak	*Quercus rubra*	18.7”	30’-0”	Fair
41	Northern Red Oak	*Quercus rubra*	3.1”	12’-0”	New
42	Northern Red Oak	*Quercus rubra*	20.6”	48’-0”	Excellent
43	Northern Red Oak	*Quercus rubra*	3.1”	12’-0”	New
44	Tree removed	Tree removed	N/A	N/A	Removed
45	American Sycamore	*Platanus occidentalis*	3.1”	12’-0”	New
46	American Sycamore	*Platanus occidentalis*	3.1”	12’-0”	New
47	Northern Red Oak	*Quercus rubra*	2.3”	12’-0”	New

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
48	Pin Oak	*Quercus palustris*	8”	30’-0”	Good
49	American Sycamore	*Platanus occidentalis*	3.1”	12’-0”	New
50	Pin Oak	*Quercus palustris*	15.3”	40’-0”	Good
51	Red Maple	*Acer rubrum*	1.9”	10’-0”	New
52	Scarlet Oak	*Quercus coccinea*	19.5”	60’-0”	Good
53	Northern Red Oak	*Quercus rubra*	1.9”	10’-0”	New
54	Pine	*Pinus sp.*	9.2”	20’-0”	Dead
55	Northern Red Oak	*Quercus rubra*	12.6”	36’-0”	Good; 4 trunks
56	Norway Maple	*Acer platanoides*	6.5”	14’-0”	Poor; die-back in crown
57	Pin Oak	*Quercus palustris*	1.9”	6’-0”	New
57A	Pin Oak	*Quercus palustris*	N/A	N/A	New
58	Pin Oak	*Quercus palustris*	17.6”	30’-0”	Good
59	Pin Oak	*Quercus palustris*	18.3”	30’-0”	Good
59A	Pin Oak	*Quercus palustris*	N/A	N/A	New
59B	Pin Oak	*Quercus palustris*	N/A	N/A	New
59C	Pin Oak	*Quercus palustris*	N/A	N/A	New
60	Sugar Maple	*Acer saccharum*	5.8”	12’-0”	Dying
61	Sugar Maple	*Acer saccharum*	10.0”	24’-0”	Dying

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
62	Sugar Maple	*Acer saccharum*	7.2”	14’-0”	Dead
63	Tulip Poplar	*Liriodendron tulipifera*	2.0”	4’-0”	New
64	Linden	*Tilia sp.*	1.9”	6’-0”	New
65	Linden	*Tilia sp.*	2.3”	4’-0”	New
66	Crape Myrtle	*Lagerstroemia indica*	1.1”	8’-0”	Good
67	Linden	*Tilia sp.*	3.4”	8’-0”	New
68	Linden	*Tilia sp.*	3.4”	8’-0”	New
69	Linden	*Tilia sp.*	3.4”	8’-0”	New
70	Crape Myrtle	*Lagerstroemia indica*	2.3”	8’-0”	New; good
71	Dogwood	*Cornus sp.*	1.1”	4’-0”	Good
72	Dogwood	*Cornus sp.*	2.3”	6’-0”	Good; triple stem
73	Dogwood	*Cornus sp.*	2.7”	4’-0”	Good
74	Sweetbay Magnolia	*Magnolia virginiana*	1.1”	4’-0”	Good
75	American Sycamore	*Platanus occidentalis*	3.4”	12’-0”	New
76	American Sycamore	*Platanus occidentalis*	3.4”	12’-0”	New
77	American Sycamore	*Platanus occidentalis*	3.4”	12’-0”	New
78	American Sycamore	*Platanus occidentalis*	3.4”	12’-0”	New
79	American Sycamore	*Platanus occidentalis*	3.4”	12’-0”	New

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
80	Eastern Redbud	*Cercis canadensis*	1.1”	4’-0”	New
81	Eastern White Pine	*Pinus strobus*	2.3”	8’-0”	New
82	Scholar Tree	*Sophora japonica*	2.3”	8’-0”	New
83	Red Maple	*Acer rubrum*	3.4”	8’-0”	Dying
84	Eastern Redbud	*Cercis canadensis*	1.5”	4’-0”	New
85	Scholar Tree	*Sophora japonica*	2.3”	8’-0”	New
86	Eastern Redbud	*Cercis canadensis*	1.1”	4’-0”	New
87	Scholar Tree	*Sophora japonica*	1.5”	4’-0”	New
88	Northern Red Oak	*Quercus rubra*	16.8”	32’-0”	Fair
89	Scholar Tree	*Sophora japonica*	1.1”	4’-0”	New
90	Eastern White Pine	*Pinus strobus*	1.5”	4’-0”	New
91	Eastern Redbud	*Cercis canadensis*	1.1”	4’-0”	New
92	Scholar Tree	*Sophora japonica*	1.5”	4’-0”	New
93	Eastern Redbud	*Cercis canadensis*	1.5”	4’-0”	New
94	Eastern Redbud	*Cercis canadensis*	1.1”	4’-0”	New
95	Scholar Tree	*Sophora japonica*	1.9”	6’-0”	New
96	Scholar Tree	*Sophora japonica*	2.3”	8’-0”	New
97	Eastern Redbud	*Cercis canadensis*	1.1”	4’-0”	New

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
98	Thornless Honey Locust	*Gleditsia tricanthos inermis*	16.4”	30’-0”	Good
98A	Crape Myrtle	*Lagerstroemia indica*	N/A	N/A	Good
99	Thornless Honey Locust	*Gleditsia tricanthos inermis*	18.0”	30’-0”	Good
99A	Crape Myrtle	*Lagerstroemia indica*	N/A	N/A	Good
100	Thornless Honey Locust	*Gleditsia tricanthos inermis*	18.3”	34’-0”	Good
101	Thornless Honey Locust	*Gleditsia tricanthos inermis*	14.1”	30’-0”	Good
102	Willow Oak	*Quercus phellos*	16.0”	24’-0”	Good
102A	Crape Myrtle	*Lagerstroemia indica*	N/A	N/A	Good
102B	Crape Myrtle	*Lagerstroemia indica*	N/A	N/A	Good
102C	Crape Myrtle	*Lagerstroemia indica*	N/A	N/A	Good
103	Thornless Honey Locust	*Gleditsia tricanthos inermis*	17.2”	32’-0”	Good
104	Crape Myrtle	*Lagerstroemia indica*	8.8”	24’-0”	Good
105	Mulberry	*Morus sp.*	4.6”	24’-0”	Fair
106	Thornless Honey Locust	*Gleditsia tricanthos inermis*	12.2”	36’-0”	Good
107	Thornless Honey Locust	*Gleditsia tricanthos inermis*	18.3”	40’-0”	Good
107A	Crape Myrtle	*Lagerstroemia indica*	N/A	N/A	Good
108	Thornless Honey Locust	*Gleditsia tricanthos inermis*	14.9”	24’-0”	Good
109	Willow Oak	*Quercus phellos*	5.4”	12’-0”	Good

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
110	Red Maple	*Quercus rubra*	4.6”	8’-0”	Good
111	Willow Oak	*Quercus phellos*	5.4”	12’-0”	Good
111A	Northern Red Oak	*Quercus rubra*	22.2”	40’-0”	Good
112	Leyland Cypress	*Cupressocyparis leylandii*	7.6”	12’-0”	Good
113	Leyland Cypress	*Cupressocyparis leylandii*	8.8”	12’-0”	Good
114	Leyland Cypress	*Cupressocyparis leylandii*	7.6”	14’-0”	Good
115	Leyland Cypress	*Cupressocyparis leylandii*	6.9”	14’-0”	Good
116	Leyland Cypress	*Cupressocyparis leylandii*	7.6”	14’-0”	Fair
117	Leyland Cypress	*Cupressocyparis leylandii*	7.6”	12’-0”	Good
118	Leyland Cypress	*Cupressocyparis leylandii*	7.6”	12’-0”	Good
119	Northern Red Oak	*Quercus rubra*	14.5”	30’-0”	Dead
120	Scarlet Oak	*Quercus coccinea*	40.1”	70’-0”	Fair; dead branches
121	Scarlet Oak	*Quercus coccinea*	21.8”	36’-0”	Good
122	Norway Maple	*Acer platanoides*	8.8”	16’-0”	Good
123	American Sycamore	*Platanus occidentalis*	29.8”	50’-0”	Poor; die-back in crown
124	Northern Red Oak	*Quercus rubra*	17.6”	34’-0”	Fair; die-back in crown
125	Northern Red Oak	*Quercus rubra*	21.4”	30’-0”	Fair; die-back in crown
126	Northern Red Oak	*Quercus rubra*	21.8”	30’-0”	Poor

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
127	Scarlet Oak	*Quercus coccinea*	11.5”	24’-0”	Poor
128	Northern Red Oak	*Quercus rubra*	22.1”	46’-0”	Fair
129	Scarlet Oak	*Quercus coccinea*	3.9”	12’-0”	New
130	Scarlet Oak	*Quercus coccinea*	3.4”	10’-0”	New
131	Scarlet Oak	*Quercus coccinea*	3.9”	10’-0”	New
132	Scarlet Oak	*Quercus coccinea*	3.4”	10’-0”	New
133	Scarlet Oak	*Quercus coccinea*	5.3”	10’-0”	Good
134	Eastern Redbud	*Cercis canadensis*	3.4”	8’-0”	Good
135	Scarlet Oak	*Quercus coccinea*	3.9”	10’-0”	Poor
136	Northern Red Oak	*Quercus rubra*	15.8”	28’-0”	Fair
137	Red Maple	*Acer rubrum*	4.5”	14’-0”	Good
138	Silver Linden	*Tilia tomentosa*	2.4”	4’-0”	Good
139	Red Maple	*Acer rubrum*	5.0”	14’-0”	Poor
140	Red Maple	*Acer rubrum*	5.2”	16’-0”	Good
141	Red Maple	*Acer rubrum*	5.8”	14’-0”	Fair
142	Silver Linden	*Tilia tomentosa*	2.4”	4’-0”	Good
143	Not used	Not used	N/A	N/A	Not used
144	Red Maple	*Acer rubrum*	13.0”	20’-0”	Poor

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
145	Southern Magnolia	*Magnolia grandiflora*	13.0”	16’-0”	Fair
146	Mulberry	*Morus sp.*	3.8”	14’-0”	Fair
147	Black Pine	*Pinus nigra*	7.6”	14’-0”	Poor
148	Black Pine	*Pinus nigra*	9.9”	12’-0”	Poor; trunk damage
149	Southern Magnolia	*Magnolia grandiflora*	12.6”	20’-0”	Fair
150	Black Pine	*Pinus nigra*	9.5”	20’-0”	Fair
151	Southern Magnolia	*Magnolia grandiflora*	9.9”	24’-0”	Fair
152	Mulberry	*Morus sp.*	4.6”	14’-0”	Fair; triple stem
153	Black Pine	*Pinus nigra*	18.3”	28’-0”	Fair
154	Mulberry	*Morus sp.*	5.7”	24’-0”	Poor
155	Unknown Tree	Unknown Tree	6.9”	22’-0”	Poor
156	Oak	*Quercus sp.*	2.3”	4’-0”	Dead
157	Scarlet Oak	*Quercus coccinea*	2.3”	6’-0”	New
158	Northern Red Oak	*Quercus rubra*	24.8”	44’-0”	Fair; die-back in crown
159	Northern Red Oak	*Quercus rubra*	21.4”	30’-0”	Good
160	Chinese Elm	*Ulmus parvifolia*	7.6”	20’-0”	Good
161	Chinese Elm	*Ulmus parvifolia*	8.8”	26’-0”	Good
162	Chinese Elm	*Ulmus parvifolia*	8.8”	26’-0”	Good

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
163	Chinese Elm	*Ulmus parvifolia*	9.6”	24’-0”	Good
164	Chinese Elm	*Ulmus parvifolia*	13.0”	32’-0”	Good
165	Chinese Elm	*Ulmus parvifolia*	9.5”	24’-0”	Good
166	Northern Red Oak	*Quercus rubra*	21.8”	40’-0”	Good
167	Siberian Elm	*Ulmus pumila*	2.3”	10’-0”	Poor
168	Siberian Elm	*Ulmus pumila*	2.3”	10’-0”	Fair
169	Siberian Elm	*Ulmus pumila*	2.3”	10’-0”	Poor
170	Siberian Elm	*Ulmus pumila*	2.7”	6’-0”	Fair
171	Eastern Redcedar	*Juniperus virginiana*	5.3”	8’-0”	Fair
172	Eastern Redcedar	*Juniperus virginiana*	4.6”	6’-0”	Fair
173	Eastern Redcedar	*Juniperus virginiana*	4.6”	6’-0”	Fair
174	Red Maple	*Acer rubrum*	2.7”	4’-0”	Dead
175	American Holly	*Ilex opaca*	2.3”	2’-0”	Fair
176	Southern Magnolia	*Magnolia grandiflora*	2.7”	8’-0”	Good
177	Siberian Elm	*Ulmus pumila*	22.9”	50’-0”	Poor
178	River Birch	*Betula nigra*	3.1”	14’-0”	Fair; 4 stems
179	Mulberry	*Morus sp.*	3.4”	14’-0”	Fair; 5 stems
180	River Birch	*Betula nigra*	1.1”	4’-0”	Poor

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
181	Mulberry	*Morus sp.*	1.1”	4’-0”	Fair
182	River Birch	*Betula nigra*	2.3”	8’-0”	Poor
183	River Birch	*Betula nigra*	1.1”	4’-0”	Poor
184	Mulberry	*Morus sp.*	1.9”	4’-0”	Fair
185	Red Maple	*Acer rubrum*	3.1”	6’-0”	Good
186	Chinese Elm	*Ulmus parvifolia*	5.7”	12’-0”	Fair
187	Chinese Elm	*Ulmus parvifolia*	6”	10’-0”	Good
188	Chinese Elm	*Ulmus parvifolia*	7.3”	12’-0”	Good
189	Chinese Elm	*Ulmus parvifolia*	8.4”	20’-0”	Good
190	Chinese Elm	*Ulmus parvifolia*	6.9”	12’-0”	Good
191	Kwanzan Cherry	*Prunus serrulata“Kwanzan”*	1.9”	4’-0”	Dead
192	Kwanzan Cherry	*Prunus serrulata “Kwanzan”*	1.9”	10’-0”	Good
193	Kwanzan Cherry	*Prunus serrulata “Kwanzan”*	1.9”	4’-0”	Good
194	Kwanzan Cherry	*Prunus serrulata “Kwanzan”*	2.7”	8’-0”	Good
195	Kwanzan Cherry	*Prunus serrulata “Kwanzan”*	1.9”	6’-0”	Good
196	Kwanzan Cherry	*Prunus serrulata “Kwanzan”*	1.9”	6’-0”	Good
197	Cherry	*Prunus sp.*	5.3”	16’-0”	Poor
198	Cherry	*Prunus sp.*	3.8”	8’-0”	Poor

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
199	Cherry	*Prunus sp.*	3.8”	10’-0”	Fair
200	Cherry	*Prunus sp.*	3.8”	10’-0”	Fair
201	Cherry	*Prunus sp.*	3.8”	12’-0”	Poor
202	Dead Tree	Dead Tree	2.7”	4’-0”	Dead
203	Elm	*Ulmus sp.*	22.9”	40’-0”	Poor
204	Eastern White Pine	*Pinus strobus*	2.7”	6’-0”	Poor; 2 stems
205	Unknown shrub	Unknown shrub	1.5”	4’-0”	Poor; multi-stem
206	Unknown shrub	Unknown shrub	1.5”	4’-0”	Poor; multi-stem
207	Crabapple	*Malus sp.*	2.7”	6’-0”	Poor
208	Crape Myrtle	*Lagerstroemia indica*	1.9”	6’-0”	Poor; multi-stem
209	Crabapple	*Malus sp.*	2.7”	4’-0”	Poor
210	Unknown Tree	Unknown Tree	2.7”	4’-0”	Poor
211	Eastern White Pine	*Pinus strobus*	2.7”	4’-0”	Poor
212	Tree of Heaven	*Ailanthus altissima*	14”	26’-0”	Fair
213	Slippery Elm	*Ulmus rubra*	12”	30’-0”	Fair
214	Unknown Tree	N/A	12”	28’-0”	Fair
215	Slippery Elm	*Ulmus rubra*	7”	24’-0”	Fair
216	Cottonwood	*Populus deltoides*	14”	30’-0”	Good

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
217	Cottonwood	*Populus deltoides*	13”	30’-0”	Good
218	Siberian Elm	*Ulmus pumila*	18”	38’-0”	Good
219	Siberian Elm	*Ulmus pumila*	5”	16’-0”	Good
220	Black locust	*Robinia pseudoacacia*	6”	18’-0”	Good
221	Siberian Elm	*Ulmus pumila*	6”	18’-0”	Good
222	Catalpa	*Catalpa speciosa*	6”	13’-0”	Good
223	Slippery Elm	*Ulmus rubra*	9”	24’-0”	Good
224	Mulberry	*Morus sp.*	5”	14’-0”	Good
225	Catalpa	*Catalpa speciosa*	14”	30’-0”	Good
226	Slippery Elm	*Ulmus rubra*	9”	20’-0”	Good
227	Slippery Elm	*Ulmus rubra*	8”	17’-0”	Good
228	Slippery Elm	*Ulmus rubra*	11”	28’-0”	Good
229	Slippery Elm	*Ulmus rubra*	3”	16’-0”	Good
230	Cottonwood	*Populus deltoides*	8”	19’-0”	Good
231	Mulberry	*Morus sp.*	5”	15’-0”	Good
232	Catalpa	*Catalpa speciosa*	9”	19’-0”	Good
233	Mulberry	*Morus sp.*	16”	31’-0”	Good
234	Mulberry	*Morus sp.*	10”	30’-0”	Good

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
235	Mulberry	*Morus sp.*	9”	26’-0”	Good
236	Cottonwood	*Populus deltoides*	18”	36’-0”	Good
237	Cottonwood	*Populus deltoides*	24”	37’-0”	Good
238	Cottonwood	*Populus deltoides*	19”	32’-0”	Good
239	Cottonwood	*Populus deltoides*	7”	20’-0”	Good
240	Slippery Elm	*Ulmus rubra*	4”	12’-0”	Good
241	Slippery Elm	*Ulmus rubra*	2.5”	8’-0”	Good
242	Slippery Elm	*Ulmus rubra*	3”	9’-0”	Good
243	Slippery Elm	*Ulmus rubra*	3”	10’-0”	Good
244	Slippery Elm	*Ulmus rubra*	5”	16’-0”	Good
245	Slippery Elm	*Ulmus rubra*	5”	14’-0”	Good
246	Slippery Elm	*Ulmus rubra*	5”	14’-0”	Good
247	Slippery Elm	*Ulmus rubra*	5”	13’-0”	Good
248	Slippery Elm	*Ulmus rubra*	5”	12’-0”	Good
249	Slippery Elm	*Ulmus rubra*	4”	15’-0”	Good
250	American hackberry	*Celtis occidentalis*	16”	29’-0”	Good
251	Catalpa	*Catalpa speciosa*	6”	18’-0”	Good
252	American hackberry	*Celtis occidentalis*	4”	12’-0”	Good

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
253	Mulberry	*Morus sp.*	12”	30’-0”	Good
254	Catalpa	*Catalpa speciosa*	14”	30’-0”	Good
255	Catalpa	*Catalpa speciosa*	14”	30’-0”	Good
256	Tree of Heaven	*Ailanthus altissima*	5”	16’-0”	Fair
257	Slippery Elm	*Ulmus rubra*	4.5”	16’-0”	Fair
258	Catalpa	*Catalpa speciosa*	12”	25’-0”	Fair
259	Slippery Elm	*Ulmus rubra*	2”	7’-0”	Fair
260	Slippery Elm	*Ulmus rubra*	6.5”	18’-0”	Fair
261	Slippery Elm	*Ulmus rubra*	8”	22’-0”	Fair
262	Slippery Elm	*Ulmus rubra*	7”	19’-0”	Fair
263	Slippery Elm	*Ulmus rubra*	6”	17’-0”	Fair
264	Slippery Elm	*Ulmus rubra*	8”	22’-0”	Fair
265	Slippery Elm	*Ulmus rubra*	7”	20’-0”	Fair
266	Slippery Elm	*Ulmus rubra*	1.5”	5’-0”	Fair
267	Slippery Elm	*Ulmus rubra*	4”	19’-0”	Fair
268	Slippery Elm	*Ulmus rubra*	7”	24’-0”	Fair
269	Slippery Elm	*Ulmus rubra*	7”	23’-0”	Fair
270	Slippery Elm	*Ulmus rubra*	9”	28’-0”	Fair

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
271	Slippery Elm	*Ulmus rubra*	7.5”	30’-0”	Fair
272	Slippery Elm	*Ulmus rubra*	4.5”	17’-0”	Fair
273	Slippery Elm	*Ulmus rubra*	12”	30’-0”	Fair
274	Slippery Elm	*Ulmus rubra*	4.5”	14’-0”	Fair
275	Slippery Elm	*Ulmus rubra*	5”	18’-0”	Fair
276	Slippery Elm	*Ulmus rubra*	5”	18’-0”	Fair
277	Eastern Redbud	*Cercis canadensis*	1.5”	4’-0”	Fair
278	Tree Removed	N/A	N/A	N/A	Removed
279	Eastern Redbud	*Cercis canadensis*	1.5”	4’-0”	Fair
280	Thornless Honey Locust	*Gleditsia tricanthos inermis*	1”	4’-0”	Fair
281	Black Locust	*Robinia pseudoacacia*	3”	6’-0”	Fair
282	Mulberry	*Morus sp.*	6”	15’-0”	Fair
283	Tree of Heaven	*Ailanthus altissima*	4”	9’-0”	Fair
284	Mulberry	*Morus sp.*	4”	14’-0”	Fair
285	Tree of Heaven	*Ailanthus altissima*	5”	10’-0”	Fair
286	Mulberry	*Morus sp.*	4”	14’-0”	Fair
287	Tree of Heaven	*Ailanthus altissima*	5”	9’-0”	Fair
288	Tree of Heaven	*Ailanthus altissima*	5”	13’-0”	Fair

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
289	Slippery Elm	*Ulmus rubra*	9”	28’-0”	Fair
290	Tree of Heaven	*Ailanthus altissima*	3”	7’-0”	Fair
291	Slippery Elm	*Ulmus rubra*	12”	30’-0”	Fair
292	Unknown Tree	N/A	N/A	N/A	Dead
293	Tree of Heaven	*Ailanthus altissima*	3”	8’-0”	Fair
294	Tree of Heaven	*Ailanthus altissima*	2”	7’-0”	Fair
295	Willow Oak	*Quercus phellos*	36”	49’-0”	Good
296	Willow Oak	*Quercus phellos*	36”	50’-0”	Good
297	Willow Oak	*Quercus phellos*	48”	61’-0”	Good
298	Willow Oak	*Quercus phellos*	36”	50’-0”	Good
299	Sugar Maple	*Acer saccharum*	15”	30’-0”	Good
300	Sugar Maple	*Acer saccharum*	19”	32’-0”	Good
301	Tree Removed	N/A	N/A	N/A	Removed
302	Silver Linden	*Tilia tormentosa*	2”	5’-0”	New
303	Chinese Elm	*Ulmus parvifolia*	6.5”	23’-0”	Good
304	Black Oak	*Quercus velutina*	26”	42’-0”	Good
305	Black Oak	*Quercus velutina*	15”	30’-0”	Good
306	Red Oak	*Quercus rubra*	10”	12’-0”	Fair

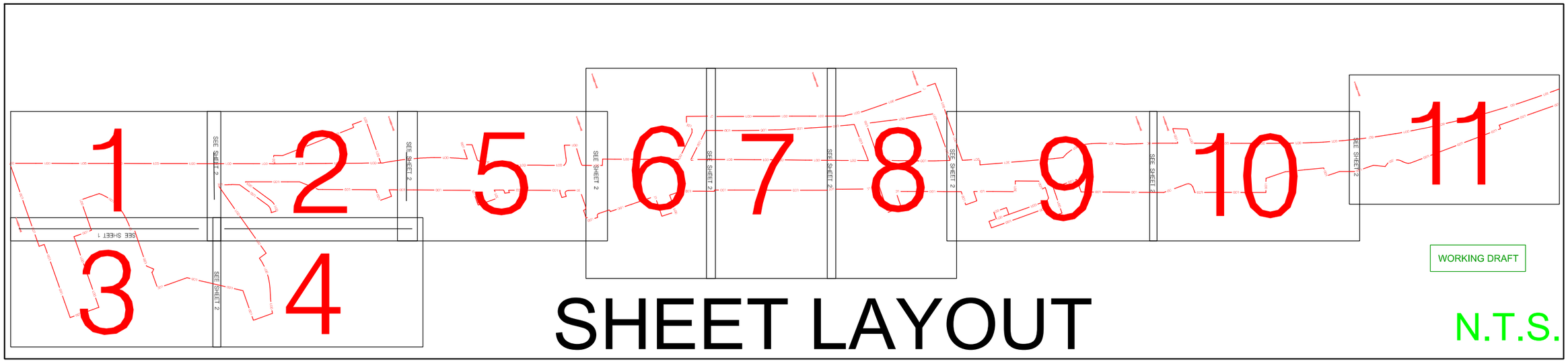
No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
307	Black Oak	*Quercus velutina*	18”	30’-0”	Poor; many dead branches
308	Black Oak	*Quercus velutina*	15”	36’-0”	Good
309	Black Oak	*Quercus velutina*	24”	30’-0”	Good
310	White Oak	*Quercus alba*	8.5”	18’-0”	Good
311	Black Oak	*Quercus velutina*	24”	36’-0”	Good
312	Red Maple	*Acer rubrum*	5.5”	12’-0”	Good
313	Red Maple	*Acer rubrum*	12”	24’-0”	Fair
314	Red Maple	*Acer rubrum*	14”	30’-0”	Good
315	Red Maple	*Acer rubrum*	14”	22’-0”	Fair
316	Norway Maple	*Acer platanoides*	7”	12’-0”	Poor
317	Sweet Gum	*Liquidambar styraciflua*	5.5”	12’-0”	Good
318	Red Maple	*Acer rubrum*	17”	42’-0”	Good
319	Norway Maple	*Acer platanoides*	8”	30’-0”	Good
320	American Elm	*Ulmus americana*	5.5”	24’-0”	Fair
321	American Elm	*Ulmus americana*	8”	18’-0”	Good
322	Red Maple	*Acer rubrum*	4”	9’-0”	Fair
323	Red Maple	*Acer rubrum*	3”	9’-0”	Poor
324	Red Maple	*Acer rubrum*	3”	12’-0”	Good

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
325	Red Maple	*Acer rubrum*	4”	15’-0”	Good
326	Red Maple	*Acer rubrum*	4”	12’-0”	Good
327	Red Maple	*Acer rubrum*	3.5”	15’-0”	Good
328	Red Maple	*Acer rubrum*	3.5”	12’-0”	good
329	Red Maple	*Acer rubrum*	4.5”	12’-0”	Good
330	Red Maple	*Acer rubrum*	5”	24’-0”	Good
331	Red Maple	*Acer rubrum*	4”	18’-0”	Good
332	Red Maple	*Acer rubrum*	4”	18’-0”	Good
333	Sweetbay Magnolia	*Magnolia virginiana*	7.5”	18’-0”	Good
334	Unknown Tree	N/A	4.5”	15’-0”	Fair
335	Austrian Pine	*Pinus nigra*	8.5”	14’-0”	Good
336	Dogwood	*Cornus sp.*	6”	36’-0”	Dead
337	Washington Hawthorn	*Crataegus phaenopyrum*	5”	12’-0”	Fair
338	Willow Oak	*Quercus phellos*	27”	42’-0”	Good; against abutment wall
339	Washington Hawthorn	*Crataegus phaenopyrum*	6”	12’-0”	Poor; half dead canopy
340	American Hackberry	*Celtis occidentalis*	12”	24’-0”	Poor
341	American Elm	*Ulmus americana*	12”	30’-0”	Poor; against abutment wall; fungus
342	American Elm	*Ulmus americana*	10”	30’-0”	Poor; against abutment wall; fungus

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
343	Red Maple	*Acer rubrum*	14”	48’-0”	Good
344	Red Maple	*Acer rubrum*	1.5”	4’-0”	Newly planted
345	Red Maple	*Acer rubrum*	1”	3’-0”	Newly planted
346	Red Maple	*Acer rubrum*	14”	30’-0”	Fair
347	Smooth sumac	*Rhus glabra*	1.5”	6’-0”	Withered
348	Smooth sumac	*Rhus glabra*	1.5”	6’-0”	Withered
349	Red Maple	*Acer rubrum*	7”	12’-0”	Good
350	Kwanzan Cherry	*Prunus serrulata “Kwanzan”*	1.5”	3’-0”	New
351	Kwanzan Cherry	*Prunus serrulata “Kwanzan”*	1.5”	3’-0”	New
352	Kwanzan Cherry	*Prunus serrulata “Kwanzan”*	3”	8’-0”	Good
353	Red Maple	*Acer rubrum*	18”	27’-0”	Good
354	Red Maple	*Acer rubrum*	14”	40’-0”	Good
355	Red Maple	*Acer rubrum*	15”	48’-0”	Poor
356	Chinese Elm	*Ulmus parvifolia*	14”	36’-0”	Poor; on top of 10’ incline
357	Red Maple	*Acer rubrum*	3”	9’-0”	Fair
358	Red Maple	*Acer rubrum*	3.5”	9’-0”	Poor
359	Slippery Elm	*Ulmus rubra*	20”	42’-0”	Poor
360	Ash	*Fraxinus sp.*	22”	35’-0”	Good; some dead branches

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
361	Slippery Elm	*Ulmus rubra*	19”	22’-0”	Good
362	Slippery Elm	*Ulmus rubra*	10” , 19”	18’-0”	Poor; dead central leader
363	Slippery Elm	*Ulmus rubra*	17.5”	18’-0”	Poor
364	Mulberry	*Morus sp.*	10” , 13”	25’-0”	Fair; multi stem
365	Red Maple	*Acer rubrum*	18.5”	28’-0”	Fair; vines
366	Ash	*Fraxinus sp.*	11” ,17.5”	36’-0”	Fair; vines
367	Slippery Elm	*Ulmus rubra*	12” , 17”	33’-0”	Fair; vines
368	Hickory	*Carya sp.*	20”	5’-0”	Dead
369	Black Locust	*Robinia pseudoacacia*	15” , 12”	18’-0”	Poor; multi-stem
370	Sycamore	*Platanus occidentalis*	18”	20’-0”	Dying; central leader broken off
371	Ash	*Fraxinus sp.*	13” , 12”	32’-0”	Good; multi-stem
372	Slippery Elm	*Ulmus rubra*	19”	30’-0”	Fair
373	Hackberry	*Celtis sp.*	11”	18’-0”	Fair
374	Slippery Elm	*Ulmus rubra*	4”	10’-0”	Fair
375	Princess Tree	*Paulownia tomentosa*	9”	25’-0”	Fair
376	Slippery Elm	*Ulmus rubra*	13”	35’-0”	Fair
377	Tree of Heaven	*Ailanthus altissima*	2.5”	12’-0”	Fair; vines
378	Pin Oak	*Quercus palustris*	1”	6’-0”	Poor; vines

No.	Common Name	Botanical Name	Diameter at Breast Height (DBH)	Canopy Spread (Diameter)	Condition/Remarks
379	Slippery Elm	*Ulmus rubra*	12” , 11”	25’-0”	Fair, multi-stem
380	Mulberry	*Morus sp.*	15” , 23”	36’-0”	Fair
381	Black Locust	*Robinia pseudoacacia*	19”	30’-0”	Fair; on slope
382	Catalpa	*Catalpa sp.*	21”	25’-0”	Fair; vines
383	Slippery Elm	*Ulmus rubra*	18” , 19”	35’-0”	Fair; multi-stem
384	Mulberry	*Morus sp.*	17.5”	30’-0”	Fai; vines
385	Mulberry	*Morus sp.*	21”	30’-0”	Fair; multi-stem
386	Slippery Elm	*Ulmus rubra*	8.5” , 9”	23’-0”	Fair; multi-stem; vines
387	Tree unknown	N/A	13”	25’-0”	Fair; vines
388	Slippery Elm	*Ulmus rubra*	17.5”	22’-0”	Fair
389	Black Willow	*Salix nigra*	5”, 6”, 6.5”	31’-0”	Fair; multi-stem
390	Chinese Elm	*Ulmus parvifolia*	17.5”	31’-0”	Fair



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CSX TRANSPORTATION

VIRGINIA AVENUE TUNNEL
RECONSTRUCTION PROJECT

GENERAL PLAN

SCALE 1" = 60' DATE OCTOBER 2013 CONTRACT NO. _____

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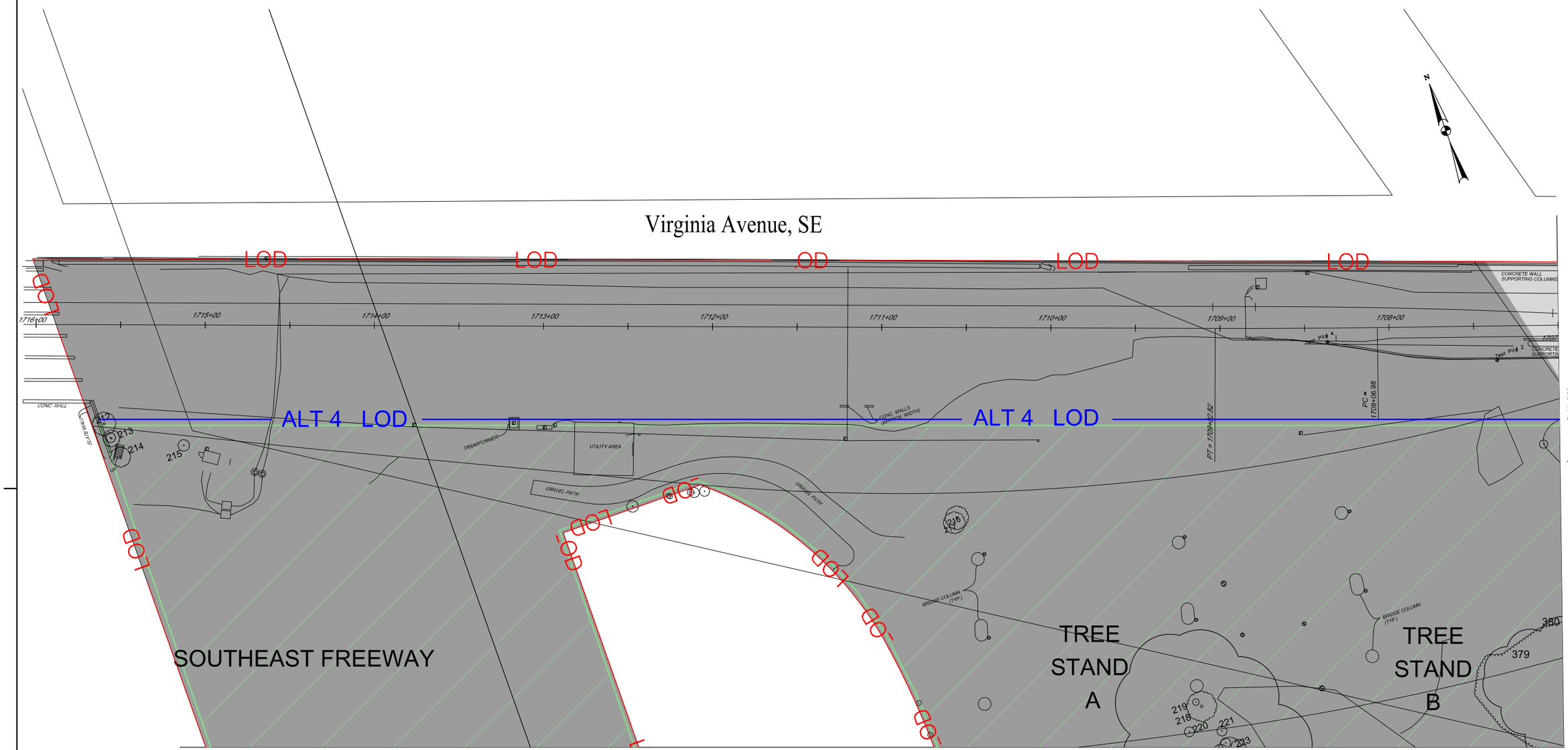

LEGEND

LIMIT OF DISTURBANCE (ALTERNATIVE 2 & 3)	LOD
LIMIT OF DISTURBANCE (ALTERNATIVE 4)	ALT 4 LOD
PROPOSED LAYDOWN AREA	
TRAFFIC AREA	
EXISTING RIGHT OF WAY	
PRIVATE PROPERTY	
TREE STAND	
TREE IDENTIFICATION	000

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MATCHLINE, SEE SHEET 01

MATCHLINE, SEE SHEET 05

MATCHLINE, SEE SHEET 04

VIRGINIA AVENUE, SE
(100' RECORD WIDTH)

NEW JERSEY AVENUE, SE
(80' RECORD WIDTH)

H STREET, SE
(80' ROW)

2ND STREET, SE
(100' ROW)

TREE STAND C

TREE STAND B

LOD

ALT 4 LOD

Test Pit # 1

Test Pit # 3B

Test Pit # 3A

INTERIOR LIMITS OF UNDERGROUND TUNNEL

LEGEND

LIMIT OF DISTURBANCE (ALTERNATIVE 2 & 3)	LOD
LIMIT OF DISTURBANCE (ALTERNATIVE 4)	ALT 4 LOD
PROPOSED LAYDOWN AREA	
TRAFFIC AREA	
EXISTING RIGHT OF WAY	
PRIVATE PROPERTY	
TREE STAND	
TREE IDENTIFICATION	000

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SHEET NO. 02 OF 11

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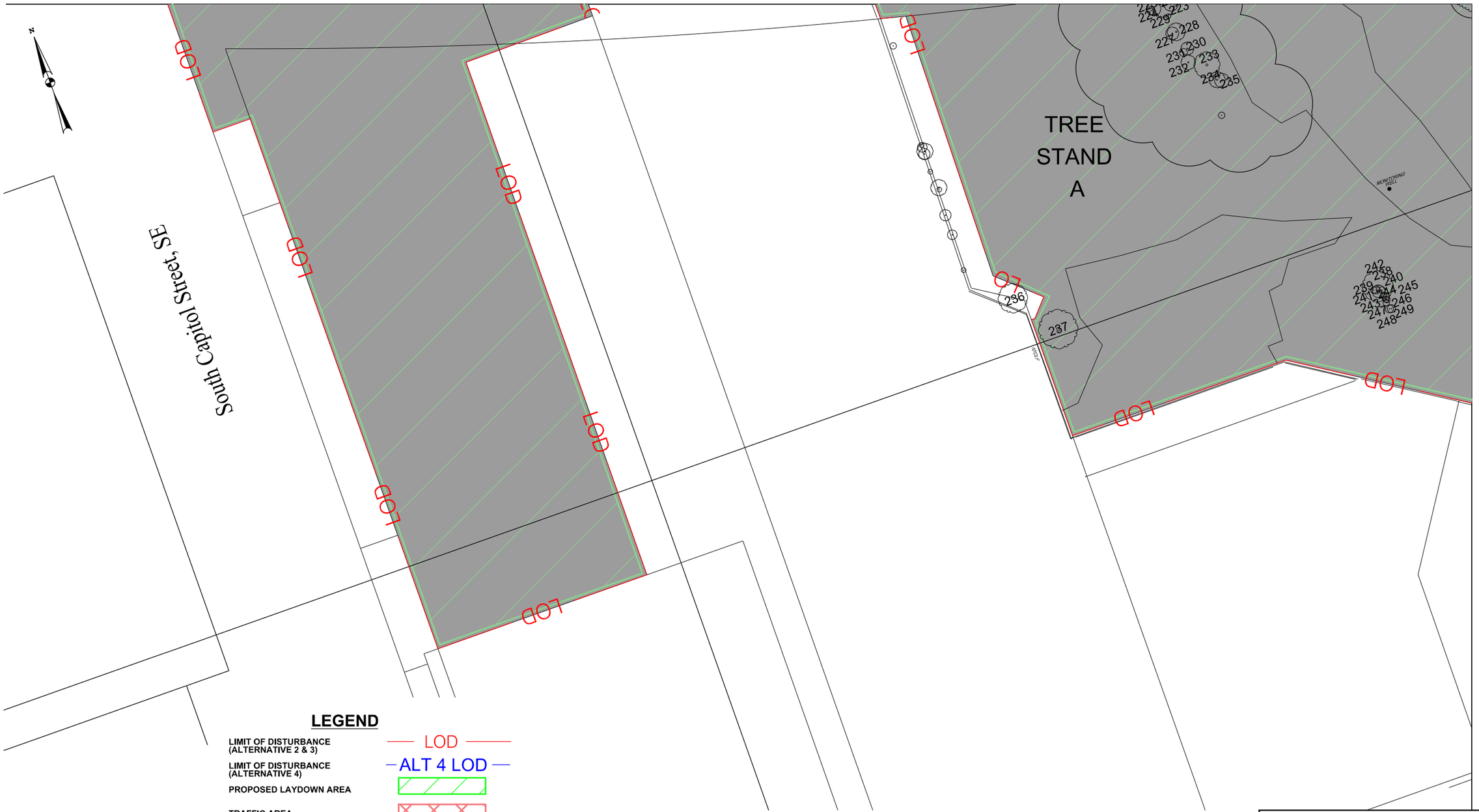
MATCHLINE, SEE SHEET 01



MATCHLINE, SEE SHEET 04

LEGEND

LIMIT OF DISTURBANCE (ALTERNATIVE 2 & 3)	LOD
LIMIT OF DISTURBANCE (ALTERNATIVE 4)	ALT 4 LOD
PROPOSED LAYDOWN AREA	
TRAFFIC AREA	
EXISTING RIGHT OF WAY	
PRIVATE PROPERTY	
TREE STAND	
TREE IDENTIFICATION	000

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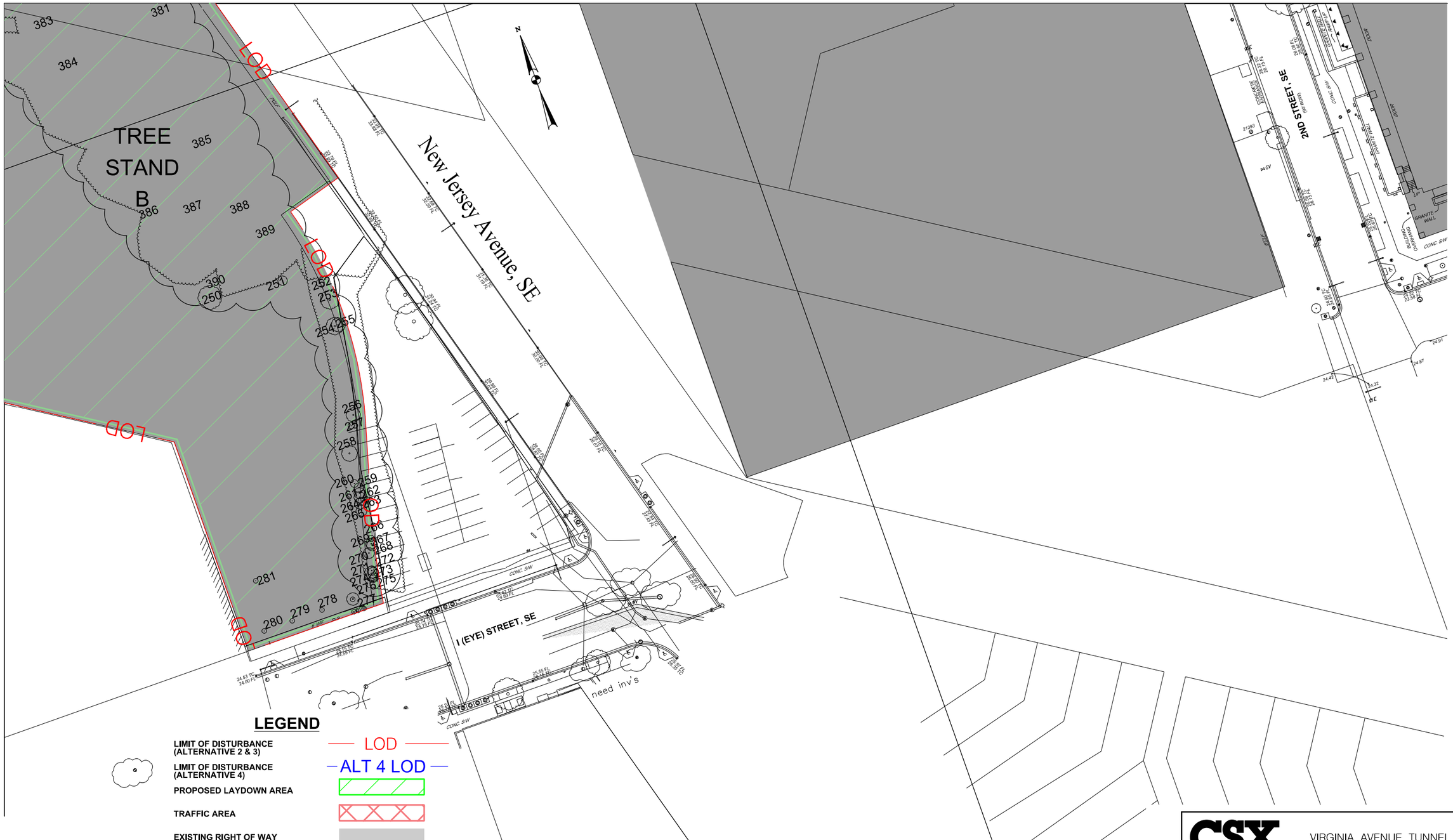
MATCHLINE, SEE SHEET 02



MATCHLINE, SEE SHEET 03

LEGEND

LIMIT OF DISTURBANCE (ALTERNATIVE 2 & 3)	LOD
LIMIT OF DISTURBANCE (ALTERNATIVE 4)	ALT 4 LOD
PROPOSED LAYDOWN AREA	
TRAFFIC AREA	
EXISTING RIGHT OF WAY	
PRIVATE PROPERTY	
TREE STAND	
TREE IDENTIFICATION	000

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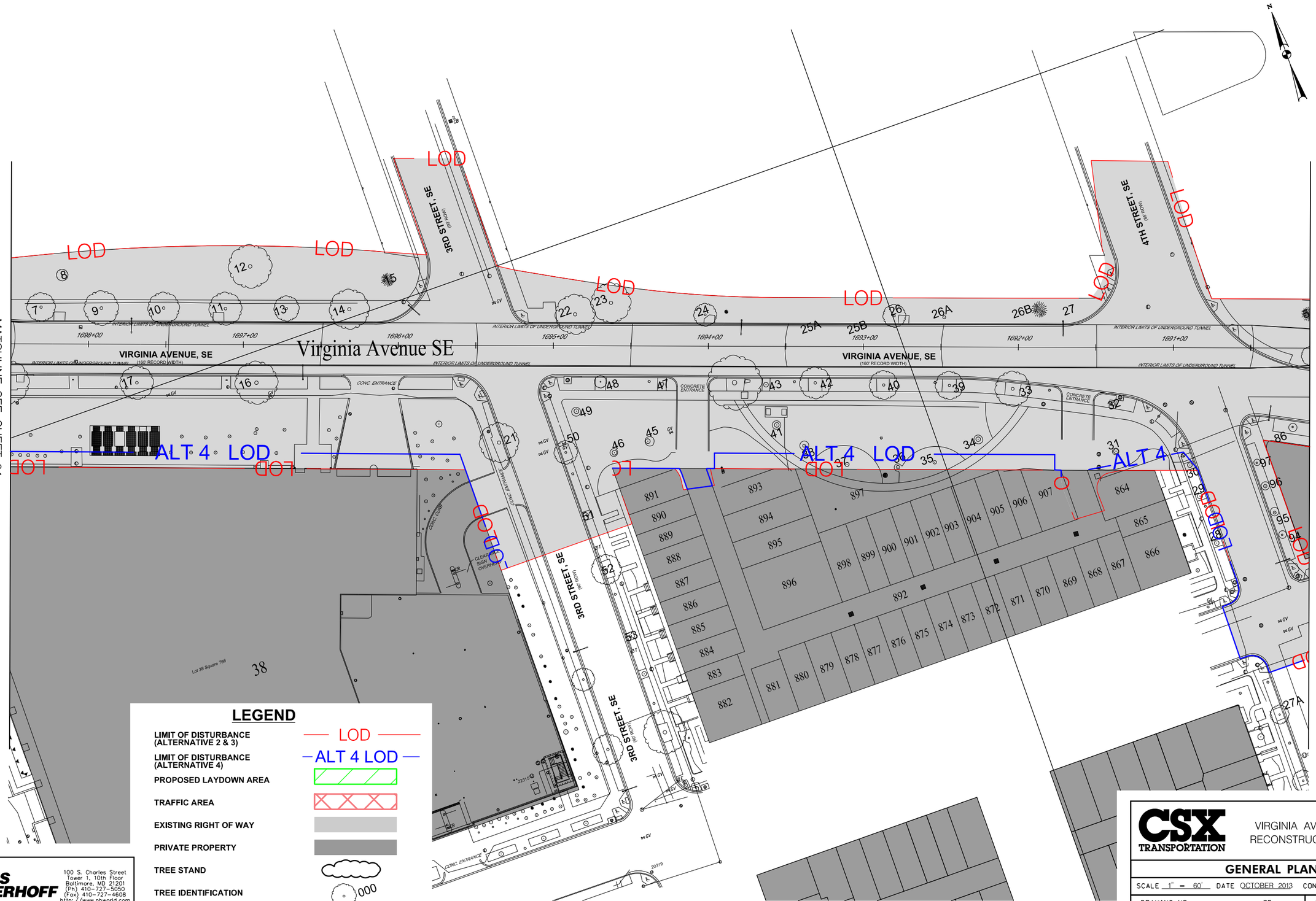

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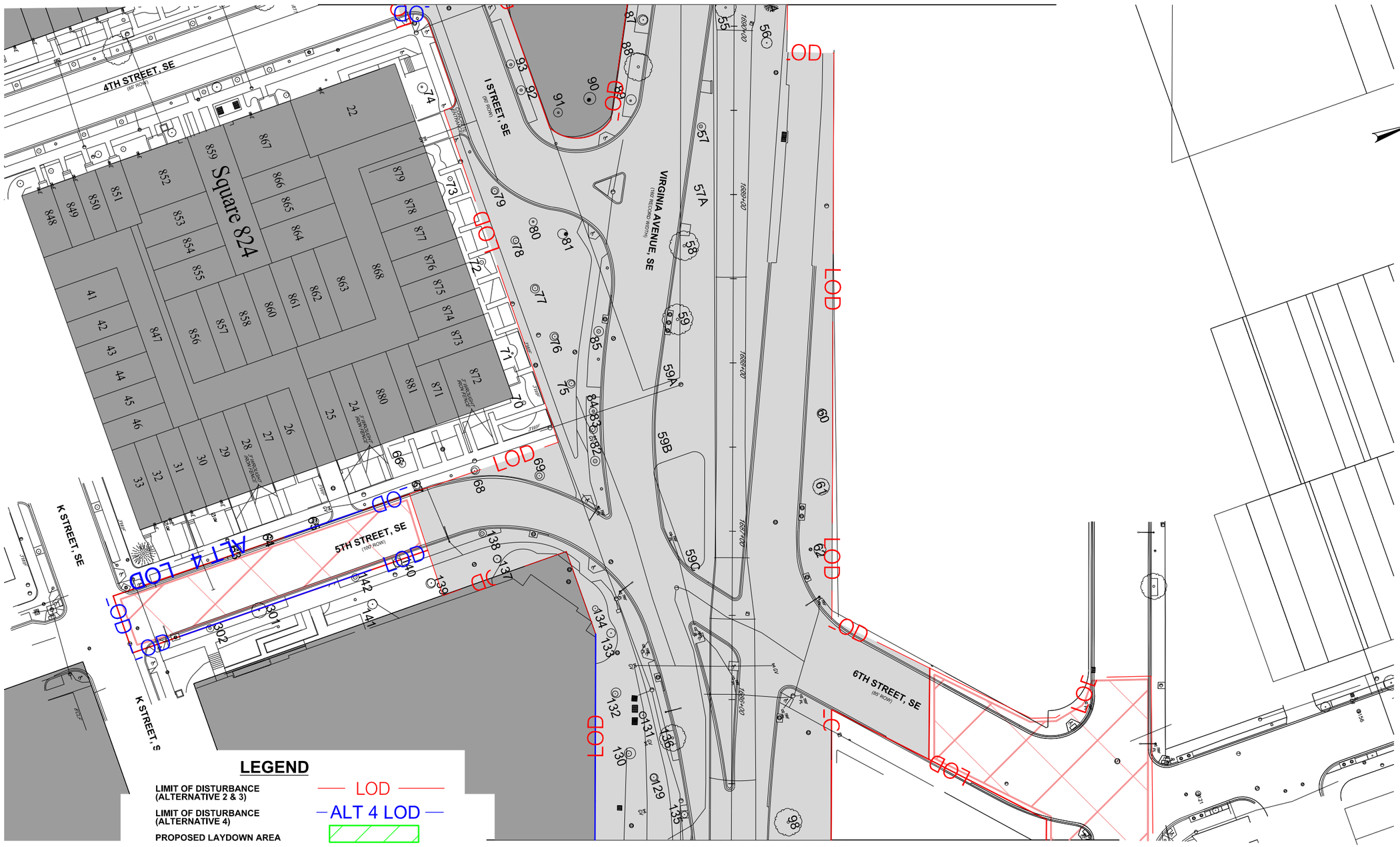
MATCHLINE, SEE SHEET 05



MATCHLINE, SEE SHEET 07

LEGEND

LIMIT OF DISTURBANCE (ALTERNATIVE 2 & 3)	LOD
LIMIT OF DISTURBANCE (ALTERNATIVE 4)	ALT 4 LOD
PROPOSED LAYDOWN AREA	
TRAFFIC AREA	
EXISTING RIGHT OF WAY	
PRIVATE PROPERTY	
TREE STAND	
TREE IDENTIFICATION	000

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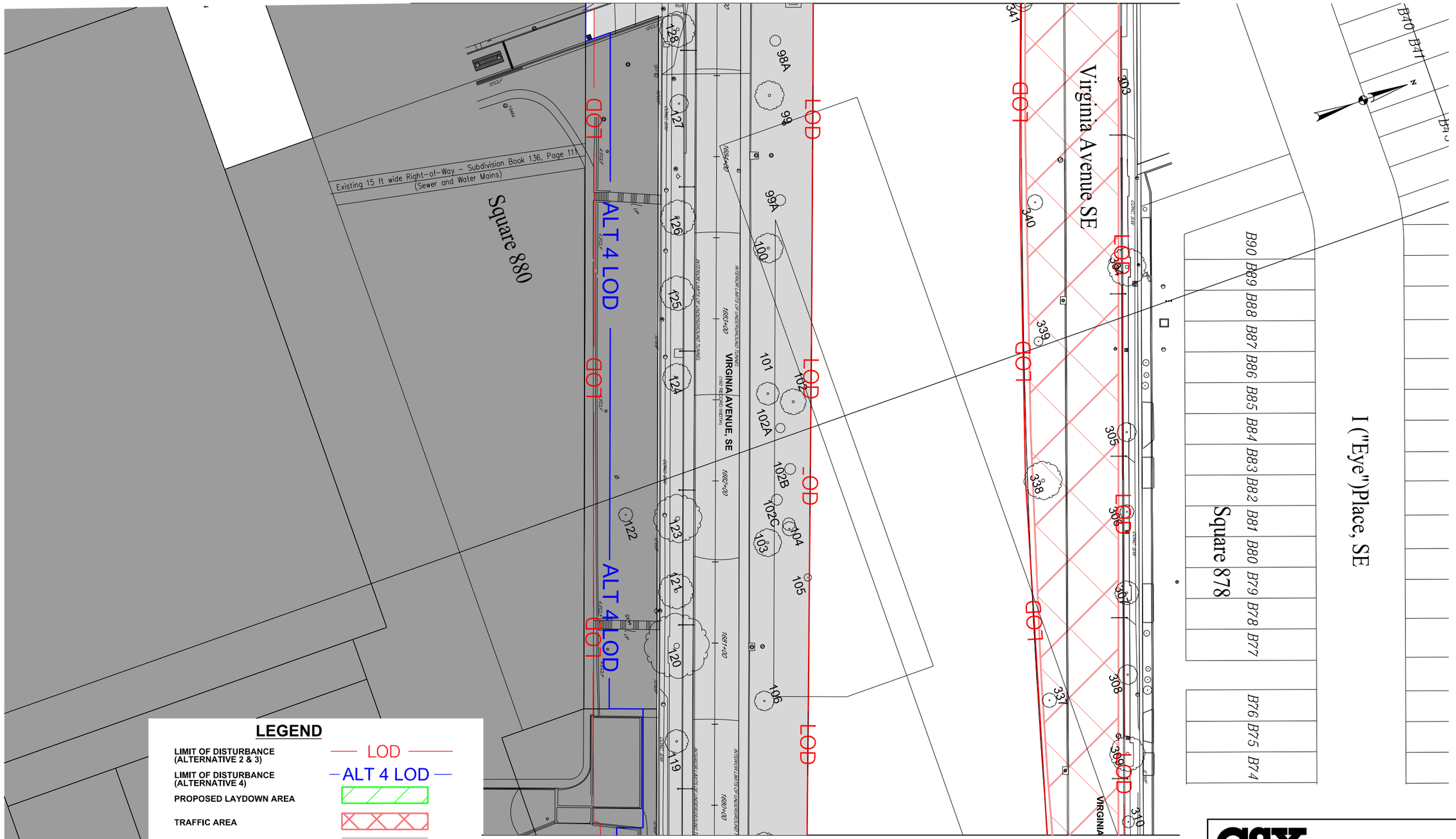
MATCHLINE, SEE SHEET 06



MATCHLINE, SEE SHEET 08

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RECONSTRUCTION PROJECT

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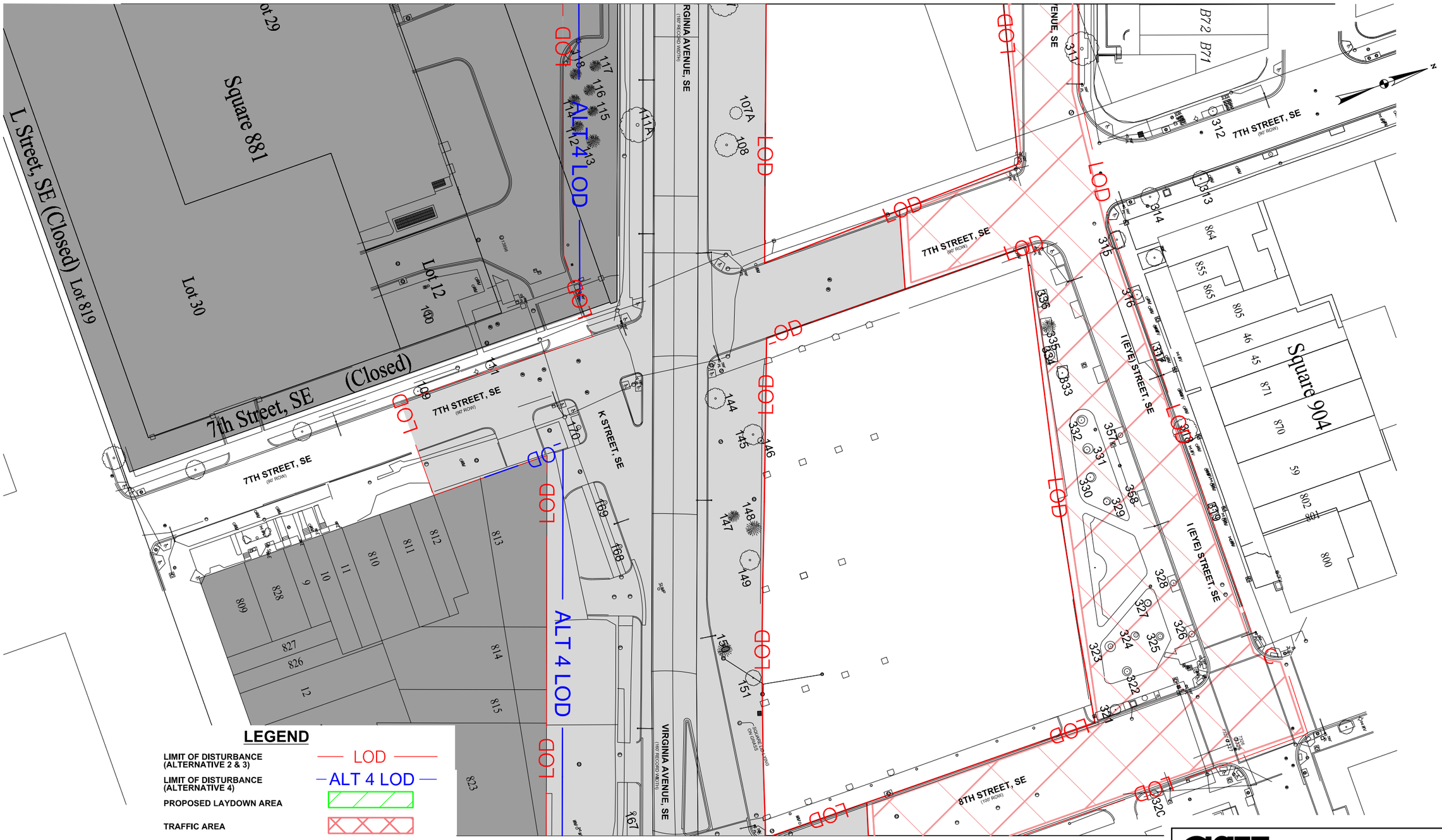
MATCHLINE, SEE SHEET 07



MATCHLINE, SEE SHEET 09

LEGEND

LIMIT OF DISTURBANCE (ALTERNATIVE 2 & 3)	LOD
LIMIT OF DISTURBANCE (ALTERNATIVE 4)	ALT 4 LOD
PROPOSED LAYDOWN AREA	
TRAFFIC AREA	
EXISTING RIGHT OF WAY	
PRIVATE PROPERTY	
TREE STAND	
TREE IDENTIFICATION	000

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MATCHLINE, SEE SHEET 08

MATCHLINE, SEE SHEET 10

Supporting Wall For Bridge

Virginia Avenue, SE

L Street, SE

VIRGINIA AVENUE, SE
(160' RECORD WIDTH)

8TH STREET, SE
(HOW 80')

9TH STREET, SE
(HOW 80')

10TH STREET, SE
(HOW 80')

POTOMAC AVE, SE
(160' ROW)

L STREET, NE

Square 929

Lot 6

Lot 7

Potomac Avenue SE

9th Street SE

L Street, SE

ALT 4 LOD

LOD

LEGEND

LIMIT OF DISTURBANCE (ALTERNATIVE 2 & 3)	LOD
LIMIT OF DISTURBANCE (ALTERNATIVE 4)	ALT 4 LOD
PROPOSED LAYDOWN AREA	
TRAFFIC AREA	
EXISTING RIGHT OF WAY	
PRIVATE PROPERTY	
TREE STAND	
TREE IDENTIFICATION	000

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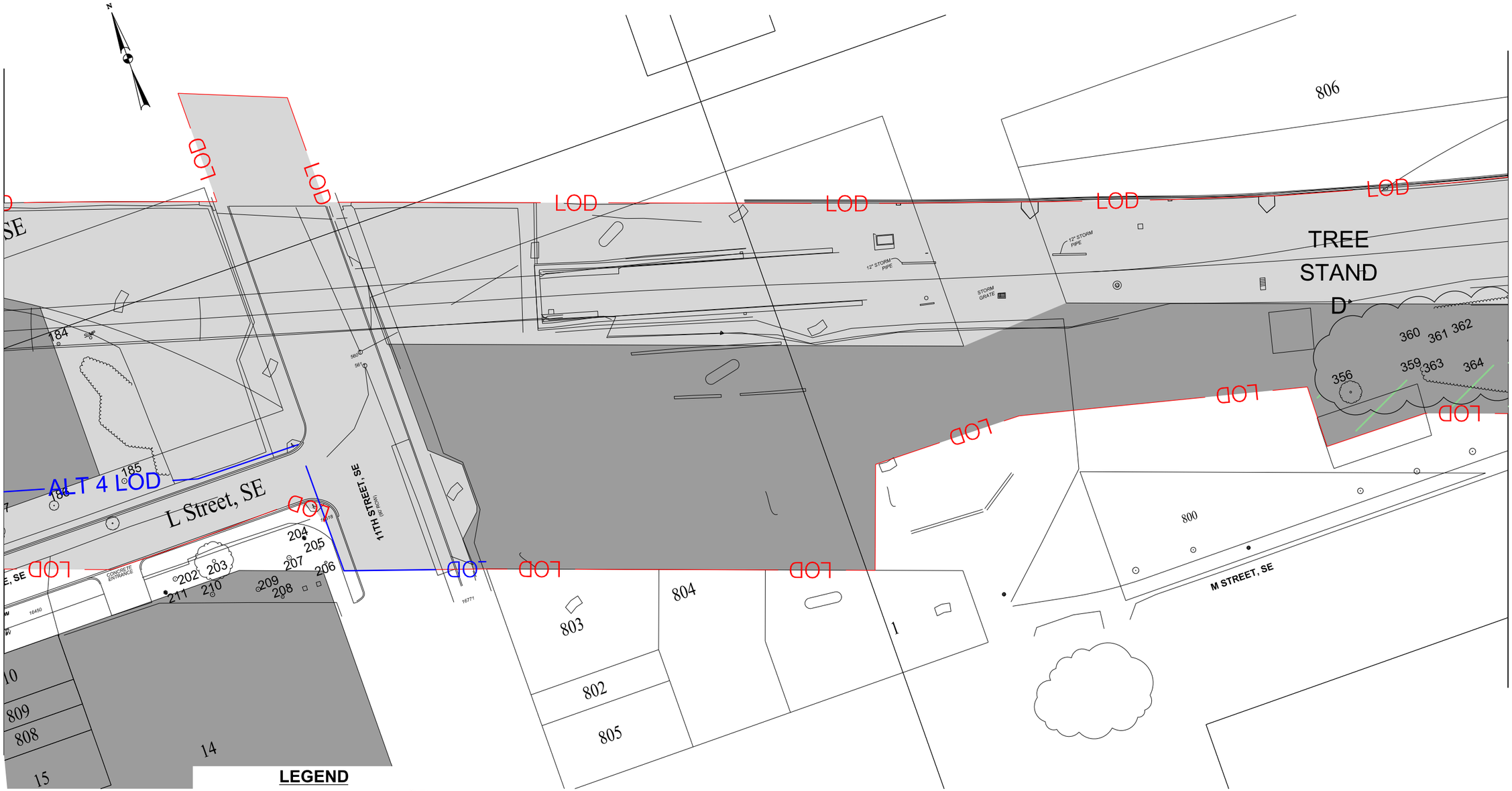

MATCHLINE, SEE SHEET 09

MATCHLINE, SEE SHEET 11

LEGEND

LIMIT OF DISTURBANCE (ALTERNATIVE 2 & 3)	LOD
LIMIT OF DISTURBANCE (ALTERNATIVE 4)	ALT 4 LOD
PROPOSED LAYDOWN AREA	
TRAFFIC AREA	
EXISTING RIGHT OF WAY	
PRIVATE PROPERTY	
TREE STAND	
TREE IDENTIFICATION	000

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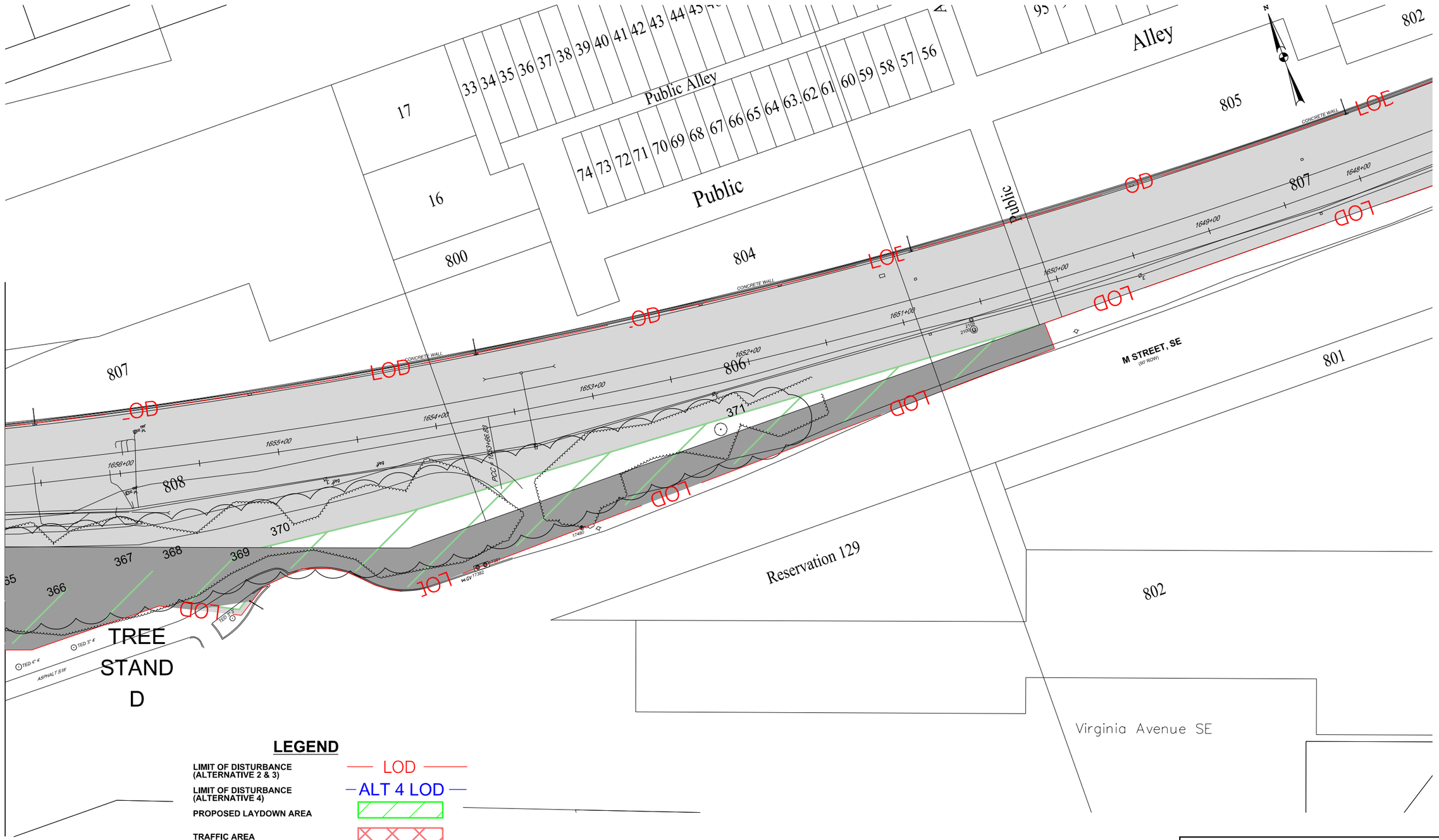

LEGEND

LIMIT OF DISTURBANCE (ALTERNATIVE 2 & 3)	LOD
LIMIT OF DISTURBANCE (ALTERNATIVE 4)	ALT 4 LOD
PROPOSED LAYDOWN AREA	
TRAFFIC AREA	
EXISTING RIGHT OF WAY	
PRIVATE PROPERTY	
TREE STAND	
TREE IDENTIFICATION	000

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SCALE 1" = 60' DATE OCTOBER 2013 CONTRACT NO.

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BY: $USERNAME$

PLOTTED: $DATETIME$
FILE: $FILE$

VIRGINIA AVENUE TUNNEL
COMPOSITE WILDLIFE SPECIES LIST

Mammals		**Field Observed**
Opossum	*Didelphis marsupialis*	
Norway rat	*Rattus norvegicus*	
Striped skunk	*Mephitis mephitis*	
Northern Raccoon	*Procyon lotor*	
Eastern gray squirrel	*Sciurus carolinensis*	**X**
Groundhog	*Marmota monax*	
Eastern mole	*Scalopus aquaticus*	
House mouse	*Mus musculus*	
Eastern cottontail	*Sylvilagus floridanus*	
Eastern chipmunk	*Tamias striatus*	
Meadow vole	*Microtus pennsylvanicus*	
Woodland vole	*Microtus pinetorum*	
Muskrat	*Ondatra zibethica*	
White-footed mouse	*Peromyscus leucopus*	
Virginia opossum	*Didelphis virginiana*	

Birds		
Red-winged blackbird	*Agelaius phoeniceus*	
Mallard	*Anas platyrhynchos*	
Canada goose	*Branta canadensis*	
Northern cardinal	*Cardinalis cardinalis*	**X**
American crow	*Corvus brachyrhynchos*	**X**
Blue jay	*Cyanocitta cristata*	
Gray catbird	*Dumetella carolinensis*	
Northern mockingbird	*Mimus polyglottos*	
American robin	*Turdus migratorius*	
Mourning dove	*Zenaida macroura*	
European starling	*Sturnus vulgaris*	
Song sparrow	*Melospiza melodia*	
House sparrow	*Passer domesticus*	

Reptiles	
Marbled salamander	*Ambystoma opacum*
American toad	*Anaxyrus americanus*
Spotted turtle	*Clemmys guttata*
Northern black racer	*Coluber constrictor constrictor*
Eastern hognose snake	*Heterodon platyrhinos*
Northern fence lizard	*Sceloporus undulates hyacinthinus*
Eastern kingsnake	*Lampropeltis getula getula*
Southern leopard frog	*Rana sphenocephala*
Eastern box turtle	*Terrapene carolina*
Common garter snake	*Thamnophis sirtalis*
Spotted salamander	*Ambystoma maculatum*
Northern Brown Snake	*Storeria dekayi*

Ring-necked snake	*Diadophis punctatus*
Black Ratsnake	*Elaphe obsoleta*
Wormsnake	*Carphophis amoneus*
Bullfrog	*Rana catesbeiana*
Eastern Red-backed Salamander	*Plethodon cinereus*
Eastern Snapping Turtle	*Chelydra s. serpentine*
Broad-headed Skink	*Plestiodon laticeps*
Common Five-lined Skink	*Plestiodon fasciatus*

Insects

Tree hole mosquito	*Aedes triseriatus*
Honey bee	*Apis mellifera*
Precious underwing	*Catocala p. pretiosa*
Deer fly	*Chrysops spp.*
Eastern wood tick	*Dermacentor spp.*
Deer tick	*Ixodes dammini*
Black widow spider	*Latrodectus mactans*
Eastern daddy long legs	*Leiobunum spp.*
Lemmer's noctuid moth	*Lithophane lemmeri*
Gypsy moth	*Lymantria dispar*
American tent caterpillar	*Malacosoma americanum*
Jumping spider	*Metaphidippus spp.*
Slug moth	*Monoleuca semifascia*
Fungus gnat	*Mycetophila spp.*
Mason bee	*Osmia spp.*
Black fly	*Simulium spp.*
Cicada killer	*Sphecius speciosus*
Yellow jacket	*Vespula spp.*
Camel cricket	*Ceuthophilus maculates*
Boxelder bug	*Boisea trivittata*
Carpenter bee	*Xylocopa spp.*
Bumble bee	*Bombus spp.*
Brown recluse spider	*Loxosceles recluse*
American cockroach	*Periplaneta americana*

Appendix I

Section 106 Assessment of Effects for Historic Properties

VIRGINIA AVENUE TUNNEL RECONSTRUCTION PROJECT

Section 106 Assessment of Effects for Historic Properties

Submitted by:
Parsons Brinckerhoff

August 2013

Abstract

The Virginia Avenue Tunnel Reconstruction Project is a proposed rebuild of the existing Virginia Avenue Tunnel. The tunnel, which is approximately 3,800 feet long, is located beneath eastbound Virginia Avenue SE from just west of 2nd Street SE to 9th Street SE, Virginia Avenue Park, and the 11th Street Bridge right-of-way between 9th and just east of 11th Streets SE in the Capitol Hill neighborhood of the District of Columbia. The tunnel was built in two phases between 1872 and 1904. At this time, four project alternatives are under consideration: a no-build alternative and three build alternatives.

Section 106 of the National Historic Preservation Act of 1966 (as amended) requires that the Federal Highway Administration (FHWA) identify historic properties within the project's Area of Potential Effects (APE); assess effects to historic properties; avoid, minimize, and/or mitigate any adverse effects; and consult with the District of Columbia State Historic Preservation Officer and other consulting parties throughout the Section 106 process, as appropriate.

Eighteen historic properties listed in or determined eligible for the National Register of Historic Places have been identified within the Project's APE. These include seventeen built historic properties and one archeological property. Potential project effects to all historic properties were assessed and are documented in this report.

As a result of the effects assessments documented in this report, the Virginia Avenue Tunnel Reconstruction project will have adverse effect on five historic properties and no effect on thirteen properties. Once an official adverse effects determination is made by FHWA, a Memorandum of Agreement (MOA) to resolve these adverse effects will be developed pursuant to the requirements of the Section 106.

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Introduction

CSX Transportation, Inc. (CSX) proposes to remove and reconstruct the existing Virginia Avenue Tunnel, which is located in the Capitol Hill neighborhood of the District of Columbia (District). Built more than one hundred years ago, the tunnel is located beneath eastbound Virginia Avenue SE from just west of 2nd Street SE (west portal) to 9th Street SE, Virginia Avenue Park, and the 11th Street Bridge right-of-way between 9th and just east of 11th Streets SE (east portal).

The tunnel is approximately 3,800 feet long and is an integral part of CSX's regional freight rail network that encompasses approximately 21,000 route miles of track in the District, 23 states and the Canadian provinces of Ontario and Quebec. Specifically, the tunnel is located along CSX's eastern seaboard freight rail corridor, which stretches from the southeast through the Mid-Atlantic and connecting to the Midwest, thereby making it a key link in the nation's network of major freight rail lines.

If the Virginia Avenue Tunnel were not replaced or reconstructed, it would continue to require increasingly higher levels of investment for maintenance and repair, resulting in more frequent service interruptions and higher risks for localized disturbances. In addition, the tunnel has notable operational deficiencies. Specifically, the tunnel has just a single track, which limits the flow of freight train traffic. Additionally, the tunnel does not have sufficient vertical clearance to accommodate rail cars that are loaded with two intermodal containers set one on top of the other, which is called "double-stacking".

The Virginia Avenue Tunnel Reconstruction Project (the Project) will transform the tunnel to a two-track configuration and provide the necessary vertical clearance to allow double-stack intermodal container freight train operations. Reconstruction of the tunnel will allow more efficient freight movement and reduce truck traffic. Reconstructing the tunnel to allow double-stacking would also involve lowering the grade below the rail line's New Jersey Avenue SE Overpass.

Upon completion of the Project, freight rail transportation through the District will improve substantially, meeting not only the commerce needs of the Washington Metropolitan Area, but also regional and national needs for efficient freight conveyance throughout the Eastern portion of the nation.

Despite no expected long-term impacts to the project-adjacent I-695, the Project requires Federal Highway Administration (FHWA) approval to allow CSX to conduct construction that would temporarily affect I-695 ramps. This FHWA approval is subject to compliance with the National Historic Preservation Act of 1966 (as amended). FHWA will serve as the lead federal agency for this undertaking.

In addition to the FHWA approval, the Project will require approvals from the National Park Service (NPS) and the U.S. Marine Corps to allow construction on their properties. The NPS

affected property is Virginia Avenue Park located at the east end of Virginia Avenue SE between 9th and 11th Streets SE. NPS owns other properties along Virginia Avenue SE, but they are under the jurisdiction of the District Department of Transportation (DDOT) and used for transportation purposes. The U.S. Marine Corps affected property is a recreational facility located along Virginia Avenue SE between 6th and 7th Streets SE.

Due to the required closure of Virginia Avenue SE for construction of the Project and the need for an occupancy permit for the new tunnel, DDOT, the owner of this and other streets within the project area, must also provide approval. DDOT assumed the role as the lead local agency for NHPA compliance.

Project Area History and Description

Virginia Avenue Tunnel was originally constructed in two phases between 1872 and 1904. During both phases, "cut-and-cover" construction was used to build the tunnel, which involved digging down to a depth of about 30 feet. The first phase consisted of the portion of the tunnel from 11th Street SE to a location between 7th and 8th Streets SE. The second phase of construction extended the location of the tunnel's west portal by an additional half-mile to 2nd Street SE. In 1901 as part of an effort to eliminate certain at-grade rail crossings, and relocate certain rail lines, terminals and rail yards (including removing tracks from the National Mall and Pennsylvania Avenue, NW), Congress authorized and directed CSX (at the time, the Baltimore and Potomac Railroad Company) to move its tracks located on streets to the south of Virginia Avenue SE into a tunnel to be located generally under Virginia Avenue SE.

Today Virginia Avenue Tunnel lies generally beneath eastbound Virginia Avenue SE (except where it is under Virginia Avenue Park, 11th Street SE and the 11th Street Bridges right-of-way), extending from just west of 2nd Street SE (west portal) and just east of 11th Street SE (east portal). The approximately 3,800-foot long tunnel, as well as other CSX rail lines within the District, Virginia and Maryland, is part of CSX's primary mainline freight rail route for freight traffic along the eastern seaboard and Midwest. When completed in 1904, the tunnel contained two sets of tracks. However, due to modernization of train equipment throughout the twentieth century, the approximately 28 feet of interior horizontal clearance within the tunnel forced the conversion to a single track. The rail lines immediately on the east and west ends of the tunnel still contain two tracks.

The current CSX rail network through the District was established at the time of the McMillan Plan. From the southwest, the CSX freight rail line enters the District via the Long Bridge, which connects Arlington, Virginia, and southwest DC in the vicinity of the Tidal Basin of the National Mall. Grade-separated from city streets, the rail line is aligned along Maryland Avenue SW, transitioning to Virginia Avenue SW between 9th and 7th Street SW. Between 2nd and 11th Streets SE, the rail line is within the Virginia Avenue Tunnel. Continuing eastward, the rail line is aligned near the Anacostia River, crossing the river via a bridge in the vicinity of the Congressional Cemetery. On the east side of the Anacostia River, the rail line is generally oriented in a southwest-northeast alignment, still grade-separated from city streets, and

crossing into Prince George's County, Maryland, at Eastern Avenue NE. CSX also owns rail lines in Northeast and Northwest DC.

CSX shares some of its rail lines with passenger rail service operated by AMTRAK, Virginia Railway Express (VRE) and Maryland Area Regional Commuter (MARC). AMTRAK provides regional or intra-state service throughout the east coast and the rest of the U.S. VRE and MARC provide commuter train service serving Virginia, Maryland and West Virginia. Sharing rail lines with other users limits the number of trains that can use the track at a given time, slowing train speeds and limiting the freight carrying capacity of the affected rail lines.

Project Purpose and Need

The proposed action is to rebuild the existing Virginia Avenue Tunnel and its single-track configuration with a new two-track, double-stack tunnel. Two-track means that there will be two separate tracks in the tunnel. Double-stack means that trains operating within the tunnel would be able to pull rail cars carrying two vertically stacked intermodal freight containers. This will allow double-stack intermodal container freight trains to move in both directions, simultaneously, if necessary, and enabling more efficient freight movement.

The purpose of the proposed action is to preserve, over the long-term, the continued ability to provide efficient freight transportation services in the District of Columbia, the Washington Metropolitan Area and the eastern seaboard. These services would continue if the following needs are met:

1. Address the structural and operational deficiencies of the century-old Virginia Avenue Tunnel;
2. Accommodate expected increases in freight transportation that, in part, would stem from the Panama Canal expansion scheduled for 2015; and
3. Ensure that during construction freight transportation services remain uninterrupted while the functions of the tunnel are being replaced with a new facility.

Virginia Avenue Tunnel's horizontal clearance only allows a single railroad track within the tunnel, which causes a bottleneck in the rail network due to the existence of two railroad tracks on both sides of the tunnel. In addition, the tunnel's vertical clearance does not allow the operation of double-stack intermodal container freight trains, a type of operation that CSX and other major railroad companies have adopted as the norm in the freight rail transportation industry where the rail network allows it. Finally, as an aging piece of infrastructure nearing the end of its useful life, the tunnel is increasingly subject to inspection and preventative maintenance for safe rail operations. These frequent inspections and preventive maintenance activities are difficult to conduct without compromising normal rail operations.

Virginia Avenue Tunnel and the eastern seaboard freight rail corridor need to accommodate expected increases in freight transportation demand over the next few years, in part due to the Panama Canal expansion scheduled to occur in 2015. The projected increased demand for freight transportation requires taking steps now to modernize the freight rail network, including replacing the tunnel with a more modern facility. By accommodating double-stacked

intermodal containers, CSX would be able to transport the expected increase in freight in fewer trains than would otherwise be possible.

Reconstructing an existing and vital piece of transportation infrastructure presents challenges in terms of how to maintain freight operations during the construction of the replacement tunnel. The ability to quickly and efficiently move goods to markets throughout the country is vital to the U.S. economy. As one of the nation's major freight railroad companies, CSX provides a valuable service by facilitating the shipment of goods and services to the general public.

In carrying out the Project, good construction practices will be utilized that are intended to:

- Minimize construction impacts to the adjacent communities, including traffic impacts to I-695 and the surrounding street grid, by establishing appropriate maintenance of traffic plans and other mitigation measures as deemed necessary;
- Ensure that the construction area and temporary railroad operations are protected from any unauthorized access and members of the community are kept safe;
- Continue to interact with and involve consulting parties throughout the NHPA Section 106 process, including monitoring the implementation of mitigation measures; and
- Maintain the appropriate level of freight transport services through the District during the period of construction that would be consistent with CSX's commitment that any interim measure would maintain commerce through the District within the local area in which the Virginia Avenue Tunnel exists.
- Conduct construction in a manner that will:
    - Occur in as timely a manner as possible to minimize any adverse effects to the local community,
    - Include appropriate mitigation for any adverse effects to the community identified in the NHPA Section 106 process and agreed to by the appropriate parties, and
    - Be coordinated and communicated with the public in advance of planned work.

Finally, CSX has committed to provide community benefits as part of the Project. At the end of construction, Virginia Avenue SE between 2nd and 9th Streets, and affected areas of Virginia Avenue Park and the Marine Corps Recreation Facility would be restored. CSX is committed to not only restoring these resources, but also working with the community to solicit input on restoration opportunities and other potential mitigation elements that could enhance the community. CSX will continue to work with the DDOT, other District agencies, the NPS, the Marine Corps, and the community on how best to incorporate community enhancements while meeting the needs of the District, the community and stakeholders.

Description of Project Alternatives

This section describes reasonable alternatives for the Project, including the 'no action' alternative, as required by NEPA, and three 'build' alternatives that involve the reconstruction of Virginia Avenue Tunnel at its current location. These four candidate alternatives were

selected through a rigorous evaluation following a detailed screening process that identified and evaluated twelve different concepts for the Project. Only the four alternatives that are now under consideration are described in this report.

In the initial phases of project development, twelve concepts were developed and analyzed to determine whether they met the Project's Purpose and Need. The four alternatives retained for detailed analysis are as follows:

- Alternative 1 - No Build: The No Build alternative is automatically carried forward into the Draft EIS. The tunnel would not be rebuilt under this alternative. However, the railroad would continue to operate trains through the tunnel and at some point, emergency or unplanned major repairs or rehabilitation could be required to this critical, aging infrastructure that might prove equally disruptive to the community than the Build Alternatives.

- Alternative 2 -Rebuilt Tunnel / Temporary Runaround Track: This alternative involves rebuilding the existing Virginia Avenue Tunnel. It would be rebuilt with two railroad tracks and enough vertical clearance to accommodate double-stack intermodal container freight trains. It would be rebuilt in generally the same location, except aligned approximately seven feet to the south of the existing tunnel center line. It would be rebuilt using protected open trench construction methods. During construction, freight trains would be temporarily routed through a protected open trench outside the existing tunnel (runaround track). The runaround track would be aligned to the south and generally parallel to the existing tunnel, and would be located below street level. Due to new columns associated with the rebuilt 11th Street Bridge, the runaround track would slightly separate from the tunnel alignment on the east end starting just west of Virginia Avenue Park. Safety measures such as securing fencing would be used to prevent pedestrians and cyclists from accessing the runaround track.

- Alternative 3 - Two New Tunnels: This alternative involves replacing the existing Virginia Avenue Tunnel with two new permanent tunnels constructed sequentially. Each new tunnel would have a single railroad track with enough vertical clearance to allow double-stack intermodal container freight trains. A new parallel, south side tunnel would be built first as trains continue operating in the existing Virginia Avenue Tunnel. After the south side tunnel is completed, train operations would switch over to the new tunnel and the existing Virginia Avenue Tunnel would be demolished and rebuilt. With the exception of operating in a protected open trench for approximately 230 feet immediately east of the 2nd Street portal (within the Virginia Avenue SE segment between 2nd and 3rd Streets SE), trains would operate in enclosed tunnels throughout construction under Alternative 3. Throughout most of the length of the rebuilt tunnel, the two tunnels would be separated by a center wall. This center wall would be the new centerline of the two tunnels, and it would be aligned approximately 25 feet south of the existing tunnel centerline, between 2nd and 9th Streets SE. Due to new columns associated with the rebuilt 11th Street Bridge, the tunnels would be separated on the

east end starting just west of Virginia Avenue Park, resulting in two separate single-track tunnels and openings at the east portal.

- Alternative 4 - New Partitioned Tunnel / Online Rebuild: Alternative 4 would result in a new tunnel with two permanent tracks. Similar to Alternative 3, the new tunnel would be partitioned and have enough vertical clearance to allow double-stack intermodal container freight trains. It would be aligned approximately 17 feet south of the existing tunnel's centerline. The new tunnel would be built using protected open trench construction methods. The rebuild would occur 'online' meaning that during the period of construction, the protected open trench would accommodate both construction activities and train operations. Maintaining safe and reliable temporary train operations is a more complicated endeavor under Alternative 4 than under the other two Build Alternatives due to the online rebuild approach.

To meet the Project's Purpose and Need, each of the candidate Build Alternatives would result in two tracks that can accommodate double-stack intermodal container freight trains. Under each of the Build Alternatives, the railroad bed crossing underneath New Jersey Avenue SE would be lowered to accommodate double-stack intermodal container freight trains.

Regardless of Build Alternative, the total length of the rebuilt Virginia Avenue Tunnel would be extended by approximately 330 feet on the east end. The new east tunnel portal would be located northeast of the existing M Street SE / 12th Street SE T-intersection. Extending the tunnel east by approximately 330 feet and completion of a DDOT planned project to convert the Southeast Freeway to an urban boulevard between 11th Street SE and Barney Circle would allow DDOT to connect 12th Street SE between K and M Streets SE. This would support Anacostia Waterfront Initiatives to better connect the waterfront with the larger Capitol Hill neighborhood.

Construction of the Project will be complex. The Project will be accomplished in segments, with some activities been potentially more noticeable than others. Although construction will proceed in phases or segments, the Project Area would remain secured throughout most of construction.

Section 106 Legal and Regulatory Context

The Project is subject to compliance with the National Historic Preservation Act (NHPA) of 1966, as amended (16 USC 470 et seq.) and its implementing regulations (36 CFR 800). Specifically, Section 106 of the NHPA requires that the responsible Federal agency consider the effects of its actions on historic properties, which are properties listed in or determined eligible for listing in the National Register of Historic Places (NRHP), and provide the Federal Advisory Council on Historic Preservation (ACHP) an opportunity to comment on the undertaking.

Per Section 106 requirements, the lead Federal agency, in consultation with the State Historic Preservation Officer (SHPO), develops the APE, identifies historic properties (i.e., NRHP-listed and NRHP-eligible) in the APE, and makes determinations of the proposed project's effect on

historic properties in the APE. Section 106 regulations require that the lead Federal agency consult with the SHPO and identified parties with an interest in historic resources during planning and development of the proposed project. The ACHP may participate in the consultation or may leave such involvement to the SHPO and other consulting parties. ACHP, if participating, and SHPO are provided an opportunity to comment on the proposed project and its effects on historic properties. They participate in development of a Memorandum of Agreement (MOA) or Programmatic Agreement (PA) to avoid, minimize, or mitigate adverse effects, as applicable. Stipulations in a MOA or a PA must be implemented. If a National Historic Landmark (NHL) is located within the APE and would be adversely affected by the project, the Federal agency must also comply with Section 110(f) of the NHPA. Section 110(f) requires that the agency undertake, to the maximum extent possible, planning and actions to minimize harm to any adversely affected NHL and afford the ACHP an opportunity to comment. Per 36 CFR 800.10(c), the agency must notify the Secretary of the Interior of any consultation regarding an NHL and invite the Secretary and the ACHP to participate in consultation where an adverse effect to an NHL may occur. Section 106 work on the Virginia Avenue Tunnel Reconstruction Project was executed by staff that meets the Secretary of the Interior's Professional Qualification Standards in history and architectural history.

Area of Potential Effects

The Area of Potential Effects (APE) is defined in Section 106 of the NHPA as "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties if any such properties exist. The APE is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking."

At project initiation, CSX consulted with the District of Columbia State Historic Preservation Office (DC SHPO) to establish the project's Area of Potential Effects (APE). An initial APE was established for initial Section 106 investigations. However, as the project plans evolved, the APE was amended and enlarged to accommodate larger project limits of disturbance (LOD). The APE was also amended to include all areas where construction will take place, including areas needed for staging, materials stockpiling, and temporary freight train operations. In this project, Alternatives 2 and 3 would have identical LOD, but the LOD for Alternative 4 would have a slightly smaller LOD. To accommodate these differences and accurately establish an APE, the LODs for all alternatives were included within the APE, and additional areas were incorporated to consider indirect effects such as maintenance of traffic (MOT), noise, vibration, and visual effects, in addition to direct effects. The LOD and MOT areas are depicted on the mapping in this report, as are historic property boundaries.

Additionally, although CSX, FHWA, and the DC SHPO concurred on the revised APE, select consulting parties requested that the APE be enlarged to include a portion of the Washington Navy Yard and additional areas of the Capitol Hill Historic District. CSX, FHWA, and the DC SHPO agreed to accommodate these requests and the APE was revised to incorporate these areas. The APE is shown in Figure 1

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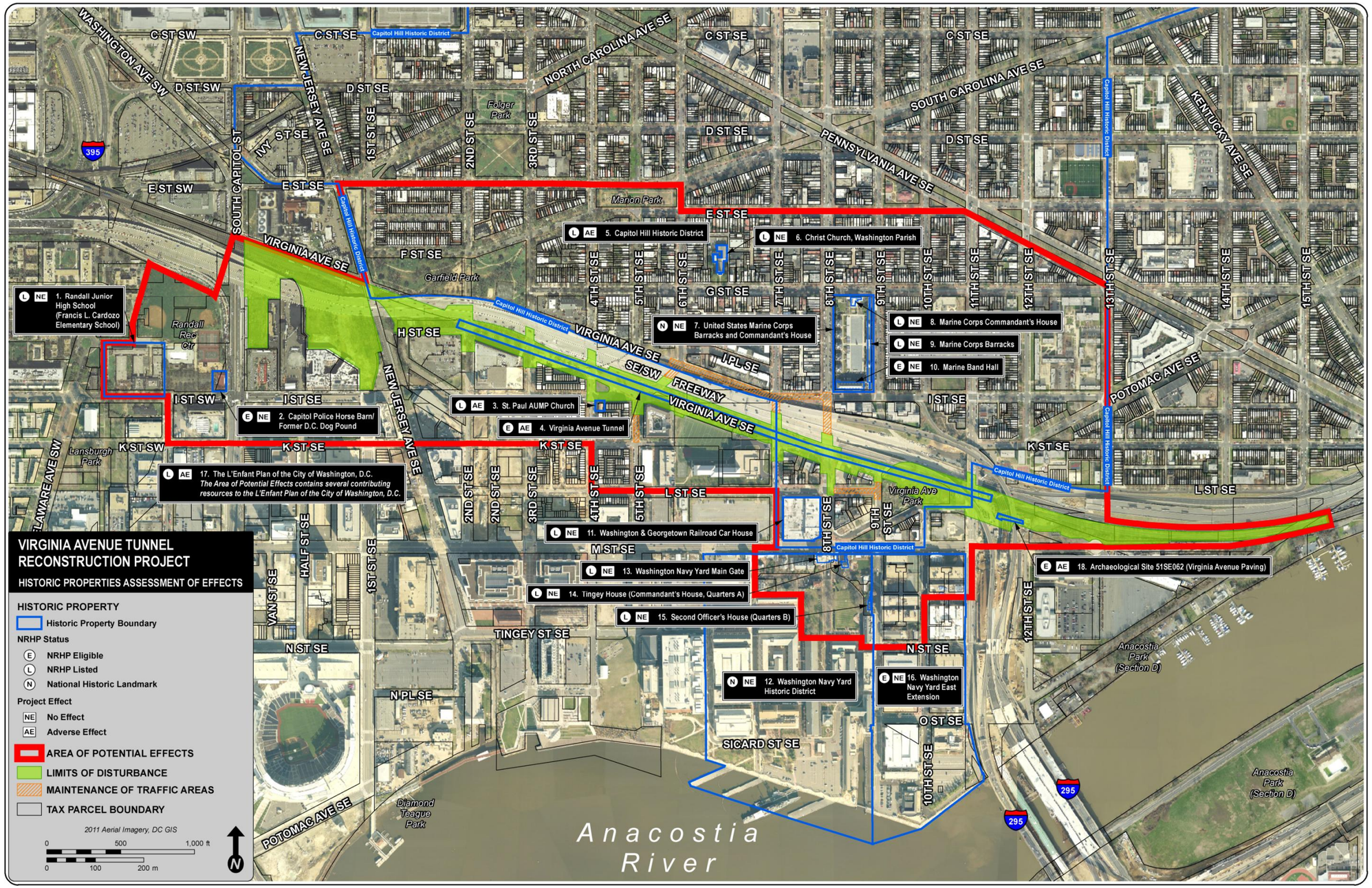


Figure 1. Virginia Avenue Tunnel Reconstruction Project: Area of Potential Effects and Assessment of Effects

Identification of Historic Properties

Historic properties are listed in or determined eligible for listing in the NRHP by applying the NRHP Criteria for Evaluation to evaluate a property's historic significance. The Criteria state that the quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and that:

- Are associated with events that have made a significant contribution to the broad patterns of our history; or
- Are associated with the lives of persons significant in our past; or
- Embody the distinctive characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction; or
- Have yielded, or may be likely to yield, information important in prehistory or history.

Built resources are typically evaluated under Criteria A, B, and C; Criterion D applies primarily to archeological resources.

If a property is determined to possess historic significance, its integrity is evaluated using the following seven Aspects of Integrity to determine if it conveys historic significance: location; design; setting; materials; workmanship; feeling; and association. If a property is determined to possess historic significance under one or more Criteria and retains integrity to convey its significance, the property is deemed eligible for the NRHP during Section 106 review.

Within the Virginia Avenue Tunnel Reconstruction Project's APE, there are eighteen historic properties: seventeen built properties and one archeological property. Generally, the area is well-surveyed and documented. These properties were identified by reviewing files at the National Register of Historic Places and DC SHPO office, as well as reports completed for other prior projects executed within the APE. These historic properties are identified in the summary matrix at the end of this document and are also included on the APE map, Figure 1.

Determination of Effect

Effects assessments are based on the criteria of adverse effect as defined in 36 CFR 800.5 "Assessment of adverse effects." According to this portion of the regulations, the criteria of adverse effect are defined as follows:

An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Consideration shall be given to all qualifying characteristics of a historic property, including those that may have been identified subsequent to the original evaluation of the property's eligibility for the National Register. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative.

Examples of adverse effects are identified in 36 CFR 800.5 and include, but are not limited to, the following:

- Physical destruction of or damage to all or part of the property;
- Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation, and provision of handicapped access, that is not consistent with the Secretary's Standards for the Treatment of Historic Properties (36 CFR 68) and applicable guidelines;
- Removal of the property from its historic location;
- Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance;
- Introduction of visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features;
- Neglect of a property that causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian tribe or Native Hawaiian organization; and
- Transfer, lease, or sale of property out of federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

NRHP bulletins do not address assessments of effects, as effects evaluations are related to the Section 106 process and not the Section 110 process in which the National Register guidance is more commonly used. However, crucial information on integrity assessments (used for eligibility determinations) provides information regarding what each aspect of integrity entails and how each aspect relates to the select National Register criteria for eligibility. As described above, retention of relevant aspects of integrity is critical to a property's significance under the NRHP Criteria for Evaluation. The National Register Bulletin *How to Apply the National Register Criteria for Evaluation* (NPS 1997) identifies the aspects of integrity and describes their relevance to the NRHP Criteria for Evaluation. The seven aspects of integrity are described in the bulletin as follows:

> Location is the place where the historic property was constructed or the place where the historic event occurred. The relationship between the property and its location is often important to understanding why the property was created or why something happened. The actual location of a historic property, complemented by its setting, is particularly important in recapturing the sense of historic events and persons.
>
> **Design is the combination of elements that create the form, plan, space, structure, and style of a property.** It results from conscious decisions made during the original conception and planning of a property (or its significant alteration) and applies to activities as diverse as community planning, engineering, architecture, and landscape architecture. Design includes such elements as organization of space, proportion, scale, technology, ornamentation, and materials. A property's design reflects historic functions and technologies as well as aesthetics. It includes such considerations as the structural system; massing; arrangement of spaces; pattern of fenestration; textures

and colors of surface materials; type, amount, and style of ornamental detailing; and arrangement and type of plantings in a designed landscape.

Design can also apply to districts, whether they are important primarily for historic association, architectural value, information potential, or a combination thereof. For districts significant primarily for historic association or architectural value, design concerns more than just the individual buildings or structures located within the boundaries. It also applies to the way in which buildings, sites, or structures are related.

Setting is the physical environment of a historic property. Whereas location refers to the specific place where a property was built or an event occurred, setting refers to the *character* of the place in which the property played its historical role. It involves *how*, not just where, the property is situated and its relationship to surrounding features and open space. Setting often reflects the basic physical conditions under which a property was built and the functions it was intended to serve. In addition, the way in which a property is positioned in its environment can reflect the designer's concept of nature and aesthetic preferences.

The physical features that constitute the setting of a historic property can be either natural or manmade, including such elements as: topographic features (a gorge or the crest of a hill); vegetation; simple manmade features (paths or fences); and relationships between buildings and other features or open space. These features and their relationships should be examined not only within the exact boundaries of the property, but also between the property and its *surroundings*. This is particularly important for districts.

Materials are the physical elements that were combined or deposited during a particular period of time and in a particular pattern or configuration to form a historic property. The choice and combination of materials reveal the preferences of those who created the property and indicate the availability of particular types of materials and technologies. Indigenous materials are often the focus of regional building traditions and thereby help define an area's sense of time and place. A property must retain the key exterior materials dating from the period of its historic significance. If the property has been rehabilitated, the historic materials and significant features must have been preserved.

Workmanship is the physical evidence of the crafts of a particular culture or people during any given period in history or prehistory. It is the evidence of artisans' labor and skill in constructing or altering a building, structure, object, or site. Workmanship can apply to the property as a whole or to its individual components. It can be expressed in vernacular methods of construction and plain finishes or in highly sophisticated configurations and ornamental detailing. It can be based on common traditions or innovative period techniques. Workmanship is important because it can furnish evidence of the technology of a craft, illustrate the aesthetic principles of a

historic or prehistoric period, and reveal individual, local, regional, or national applications of both technological practices and aesthetic principles.

Feeling is a property's expression of the aesthetic or historic sense of a particular period of time. It results from the presence of physical features that, taken together, convey the property's historic character.

Association is the direct link between an important historic event or person and a historic property. A property retains association if it is the place where the event or activity occurred and is intact to convey that relationship to an observer. Like feeling, association requires the presence of physical features that convey a property's historic character.

According to guidance found in *How to Apply the National Register Criteria for Evaluation*, different aspects of integrity may be more or less relevant dependent on why a specific historic property was listed in or determined eligible for listing in the NRHP. For example, a property that is significant for its historic association (Criteria A or B) is eligible if it retains the essential physical features that made up its character or appearance during the period of its association with the important event, historical pattern, or person(s). A property determined eligible under Criteria A or B ideally might retain some features of all aspects of integrity, although aspects such as design and workmanship might not be as important.

A property important for illustrating a particular architectural style or construction technique (Criterion C) must retain most of the physical features that constitute that style or technique. A property that has lost some historic materials or details can be eligible if it retains the majority of features that illustrate its type and/or style in terms of the massing, spatial relationships, proportion, pattern of windows and doors, texture of materials, and ornamentation. The property is not eligible, however, if it retains some basic features conveying massing but has lost the majority of the features that once characterized its type or style. A property significant under Criterion C must retain those physical features that characterize the type, period, or method of construction that the property represents. Retention of design, workmanship, and materials will usually be more important than location, setting, feeling, and association. Location and setting will be important for those properties whose design is a reflection of their immediate environment (such as designed landscapes).

For a historic district to retain integrity, the majority of the components that make up the district's historic character must possess integrity even if they are individually undistinguished. In addition, the relationships among the district's components must be substantially unchanged since the period of significance.

In some cases, select aspects of integrity are currently and substantially compromised by prior undertakings not related to the current project. These changes may have been made prior to determinations of eligibility or since these determinations were made.

Prior documentation for historic properties was reviewed to determine under which Criteria for Evaluation a property was deemed eligible for the NRHP, which historic characteristics and features of a property qualified it for eligibility, and which areas of integrity were most relevant to the eligibility determination and to what degree the property retains them. This information provides useful insight when applying the criteria for adverse effects and making accurate effects determinations.

Because of common misunderstandings regarding the application of the criteria of adverse effects to historic properties, it is necessary to clearly state that just because project components may be visible from a historic property, this does not necessarily constitute an adverse effect. Factors considered include proximity of project components, the significance of viewsheds as indicated in prior documentation (including earlier documentation and more recent updates), and the overall importance of integrity of setting to the historic property's determination of eligibility. Direct impacts to historic properties were predisposed to result in adverse effect determinations. Other causes of adverse effects primarily included cumulative effects where project-related construction would be located proximate to historic properties or within historic districts where integrity of setting remained intact. Cumulative adverse effects can result from changes that occurred prior to the current undertaking with project-related changes contributing to an adverse effect. Cumulative adverse effects can also result from distinct impacts, such as noise, vibration, and visual effects, resulting from the project that individually may not constitute adverse effects but collectively and cumulatively diminish character-defining features and/or aspects of integrity.

During the current assessment of effects, information available for each historic property was reviewed to determine if the setting within and/or outside of the historic boundary, as well as viewsheds to and from each property, was historically significant and contributed to the property's eligibility. Using the same information, a determination was made regarding which aspects of integrity were most critical to a historic property's NRHP eligibility.

Section 106 does not stipulate specific noise or vibration thresholds that would constitute adverse effects. Preliminary noise and vibration monitoring and data analyses were conducted within the project area; potential impacts historic properties exist and are being scrutinized as part of these studies. These analyses will consider both construction-related (including tunneling) and operational noise or vibration effects to historic properties. The results of these noise and vibration analyses were reviewed to determine the potential for effects to historic properties. At this time, CSX and DDOT are committing to mitigating any potential noise and vibration impacts indicated by the studies. CSX will require all contractors to implement measures and best professional practices to avoid impacts, and if necessary will include design refinements or other measures to avoid impacts. Therefore, it is currently anticipated that the Virginia Avenue Tunnel Reconstruction Project will have no actual noise or vibration impacts that would result in adverse effects. The project's Programmatic Agreement may include measures to confirm this. In addition to the pre-construction testing, construction monitoring will be conducted, if appropriate. This would potentially include measures to monitor noise, vibration, and settling of historic buildings. Monitoring will be important, particularly in the

areas adjacent to vibration-inducing equipment and activities, to ensure that no adverse vibration impacts or settling would adversely affect historic buildings during construction.

To determine project effects, architectural historians conducted site visits to each historic property in the APE and reviewed project plans and additional documentation. Following guidelines set forth in 36 CFR 800 and supported by information on integrity set forth in the National Register Bulletin *How to Apply the National Register Criteria for Evaluation*, the following findings were used to assess project effects to historic properties:

- *No Effect:* Per 36 CFR 800.4(d)(1), an undertaking may have no effect to historic properties present in the APE, and a finding of "No Effect" may be determined for an undertaking. This finding indicates that an undertaking would not alter any aspects of integrity for any historic properties. This rationale has been used to assess effects to historic properties within the APE for the Virginia Avenue Tunnel Project.
- *No Adverse Effect:* Per 36 CFR 800.5(b), an undertaking may be determined to have "No Adverse Effect" to historic properties if the undertaking's effects do not meet the criteria of adverse effect as described above. If project implementation would alter a specific aspect of integrity for a historic property but the effect would not alter a characteristic that qualifies that resource for inclusion in the NRHP in a manner that diminishes the significant aspect of integrity, then the finding for that aspect of integrity is "No Adverse Effect."
- *Adverse Effect:* An adverse effect is determined if the undertaking would alter a characteristic that qualifies that contributing resource for inclusion in the NRHP in a manner that diminishes the significant aspect(s) of integrity.

Avoidance Alternatives, Planning To Minimize Effects, and Mitigation

Per 36 CFR 800.6, a finding of adverse effect to historic properties requires that efforts to resolve such effects by developing and evaluating alternatives or modifications to the undertaking that could avoid, minimize, or mitigate adverse effects must be undertaken.

To determine if any historic properties within the project's APE would be affected by the Virginia Avenue Tunnel Reconstruction Project, documentation was reviewed for all NRHP-listed and eligible properties within this portion of the APE, project plans were reviewed, and additional field visits were conducted to each historic property. Using the criteria of adverse effect established in 36 CFR 800.5(a)(1) and guidance found in *How to Apply the National Register Criteria for Evaluation*, each historic property was evaluated to determine if implementation of the Virginia Avenue Tunnel Reconstruction Project would alter any historically significant characteristics or features of each historic property by diminishing relevant aspects of that property's historic integrity. Indirect and cumulative effects to historic properties have also been considered; such effects may include reasonably foreseeable land use changes. Throughout the course of project planning, significant efforts have been made to avoid and/or minimize adverse effects to historic properties. These efforts have resulted in fewer adverse effect determinations.

Assessment of Effects

Consideration was given to each of the four proposed project alternatives as effects were assessed. In all cases, Alternative 1, the No Build Alternative, would result in no effect to each of the eighteen historic properties within the APE. Although Alternatives 2, 3, and 4 are distinct in terms of project approaches, their impacts to historic properties are not differentiated. The assessment of effects is consistent for each historic property, regardless of Build Alternative. Although Section 106 regulations indicate that an overall finding of effect is determined for the entire project, each historic property must be assessed individually to reach the project finding and also to inform assessments that may require completion to fulfill Section 4(f) of the U.S. Department of Transportation Act of 1966. Although Section 4(f) is a separate regulation, Section 106 assessments of effect inform compliance with Section 4(f).

Eighteen historic properties listed in or determined eligible for the National Register of Historic Places have been identified within the Project's APE. These include seventeen built historic properties and one archeological property. Potential project effects to all historic properties were assessed and are documented in this report.

As a result of the effects assessments documented in this report, the Virginia Avenue Tunnel Reconstruction Project will have an adverse effect to five historic properties: St. Paul AUMP Church; Virginia Avenue Tunnel; Capitol Hill Historic District; L'Enfant Plan of the City of Washington, DC; and Virginia Avenue Paving. The project was determined to have no effect to thirteen properties. No properties received a determination of no adverse effect. Therefore, an official overall finding of adverse effect by the FHWA is anticipated for the Virginia Avenue Tunnel Reconstruction Project in accordance with Section 106.

1. Randall Junior High School (Francis L. Cardozo Elementary School)

61 I Street SW

The two-story main block of the Randall Junior High School, constructed in 1906, originally served the African American community in southwest Washington, DC, as the Francis L. Cardozo Elementary School. The prominent architectural firm Marsh & Peter designed the seven-bay-wide Georgian Revival-style school, accessed by a Colonial Revival-style entrance. This main block building, which presently serves as the central portion of the school complex, has received several additions since 1906. The NRHP boundary of this property includes the 1906 main block building and all subsequent additions, and is bounded by H Street SW to the north, 1st Street SW to the east, I Street SW to the south, and Half Street SW to the west. In 1912, Marsh & Peter constructed a free-standing building in a similar style west of main building on the site. In 1924, the newly established Randall Junior High School student body switched locations with the Francis L. Cardozo elementary school to accommodate a growing student population. When the school continued to experience growth, Municipal Architect Albert L. Harris designed two Colonial Revival-style wings to be attached to the main building. Constructed in 1927, the east wing houses the school's auditorium and the west wing abuts the freestanding building to the main building. Between 1932 and 1973, subsequent additions were carried out, but they do not contribute to the historical or architectural significance of the property. The school survived Washington, DC's urban renewal program efforts, carried out in the 1950s, and continued to serve as a defining and dominant force in the community. The Randall Junior High School is listed in the NRHP under Criterion A for its connection to the educational history of the African American community in southwest Washington, DC, and as one of the few pre-urban renewal structures in the community. The school is also listed under Criterion C as a Georgian Revival-style school building with Colonial Revival-style additions and as an excellent example of the school building style adopted by Washington, DC.

Near the Randall Junior High School, Virginia Avenue Tunnel Project components would primarily occur between New Jersey Avenue SE and 2nd Street SE. This activity would include lowering approximately 500 feet of track—between Virginia Avenue SE and the south portal of the tunnel at 2nd Street SE—to meet existing track grade. Beyond the tunnel's south portal, project activity would primarily occur along Virginia Avenue SE. Approximately 565 feet spans between the project's limits of disturbance at Capitol Street SE and the property's northeast NRHP boundary. No potential noise or vibration impacts to the property have been identified during project studies.

No physical impacts to the Randall Junior High School would occur as a result of Virginia Avenue Tunnel project activity. No project components would occur within the property's NRHP boundary. Therefore, no effects to the property's integrity of location, design, materials, and workmanship would occur.

The Randall Junior High School no longer retains integrity of setting. Urban renewal efforts in the 1950s and the construction of the Southeast-Southwest Freeway in the 1960s significantly altered the property's historic setting. Additionally, the property is oriented south toward I

Street SE and project activity would occur north of the property. While proposed project activity would be minimally visible from the property's north elevation, any project activity would be considerably screened from view by the presence of the Southeast-Southwest Freeway. Therefore, project activity would have no effect to the Randall Junior High School's already compromised setting. No character-defining features of the property's setting would be affected and no historically significant views to or from the property would be obscured. Because no historically significant views would be obscured, no visual effects to the property were identified. Therefore, project implementation would have no effect to the integrity of the Randall Junior High School's setting.

Proposed project activity would have no effect to the property's feeling as an early twentieth century Georgian Revival-style school building with Colonial-Revival additions, or association with the those styles or as a public school that served the African American community in southwest Washington, DC.

Based on this evaluation, the Virginia Avenue Tunnel Project will have no effect to the Randall Junior High School.

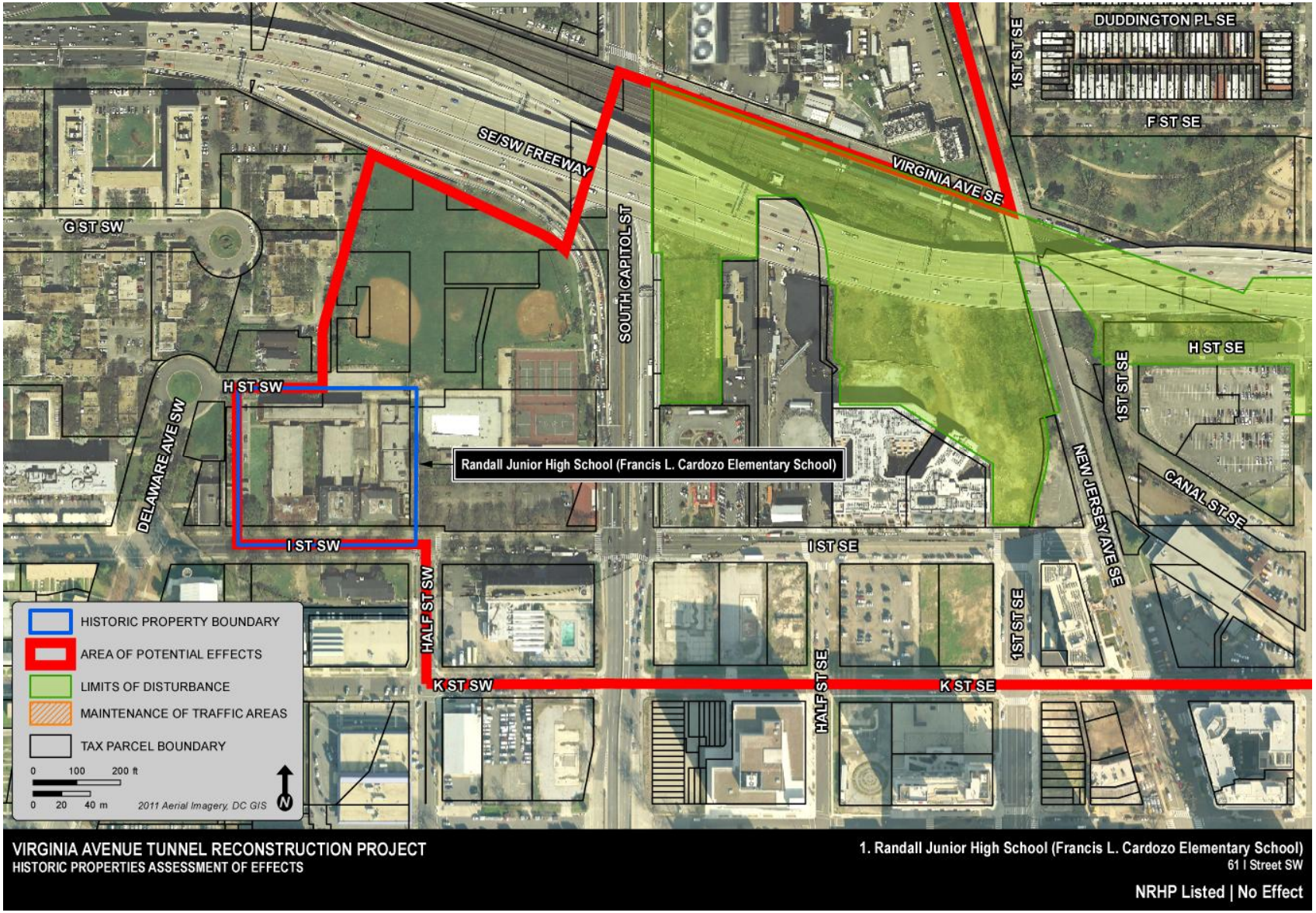


Figure 2. Proposed project activity in the vicinity of the Randall Junior High School (Francis L. Cardozo Elementary School)

Figure 3. View north toward the vicinity of Virginia Avenue SE from the Randall Junior High School, at I Street SW and Half Street SW

Figure 4. View northeast toward the vicinity of Virginia Avenue SE from the rear of the Randall Junior High School, at H Street SW

2. *Capitol Police Horse Barn/Former DC Dog Pound*

Intersection of I Street SW and South Capitol Street

The Capitol Police Horse Barn/Former DC Dog Pound is a one-story brick building, built circa 1920. The property originally operated as a horse barn for the Capitol Police and later, according to a 1943 map, operated as the DC Dog Pound. The building's floor plan is I-shaped and it features very little ornamentation. A wide entry, now filled, and five stall openings located along the building's west elevation are indicators of the horse barn's utilitarian use. The property survived 1950's urban renewal program efforts that dramatically changed the appearance of Southwest Washington, DC, because of the demolition of historic buildings. The property is eligible for listing in the NRHP under Criterion A for its connection to pre-urban renewal southwest Washington, DC, and the Capitol Police and also under Criterion C as a brick building whose function dictated its design.

Virginia Avenue Tunnel Project activity near the Capitol Police Horse Barn/Former DC Dog Pound would primarily occur between New Jersey Avenue SE and 2nd Street SE. Project implementation would include lowering approximately 500 feet of track—between New Jersey Avenue SE and the south portal of the tunnel at 2nd Street SE—to meet existing grade. Beyond the tunnel's south portal, project activity would primarily occur along Virginia Avenue SE. Approximately 215 feet spans between the property's boundary and the project's limits of disturbance. No potential noise or vibration impacts to this property have been identified during project studies; if appropriate, monitoring of the property would occur during project activity to confirm these findings.

No physical impacts to the Capitol Police Horse Barn/Former DC Dog Pound would occur as a result of project implementation. No project activity would occur in the property's historic boundary. Therefore, no effects to the property's integrity of location, design, materials, and workmanship would occur.

The Capitol Police Horse Barn/Former DC Dog Pound does not retain integrity of setting. The building survived urban renewal efforts that were carried out in southwest Washington, DC, during the 1950s; however, surrounding buildings are all more recently constructed than the horse barn/dog pound. The construction of the Southeast-Southwest Freeway in the 1960s also dramatically altered the property's historic setting. Though the building's north and east elevations are oriented toward project activity, the elevated freeway, mature trees and vegetation, and buildings considerably screen proposed project activity from view; additionally, no historic views or vistas remain because of changes to the setting. Therefore, project activity would have no effect to the property's integrity of setting would occur.

Virginia Avenue Tunnel Project activity would have no effect to the property's feeling as an early-twentieth century purpose-built building, or its association with the Capitol Police and district government in southwest Washington, DC.

Based on this evaluation the Virginia Avenue Tunnel Project would have no effect to the Capitol Police Horse Barn/Former DC Dog Pound.

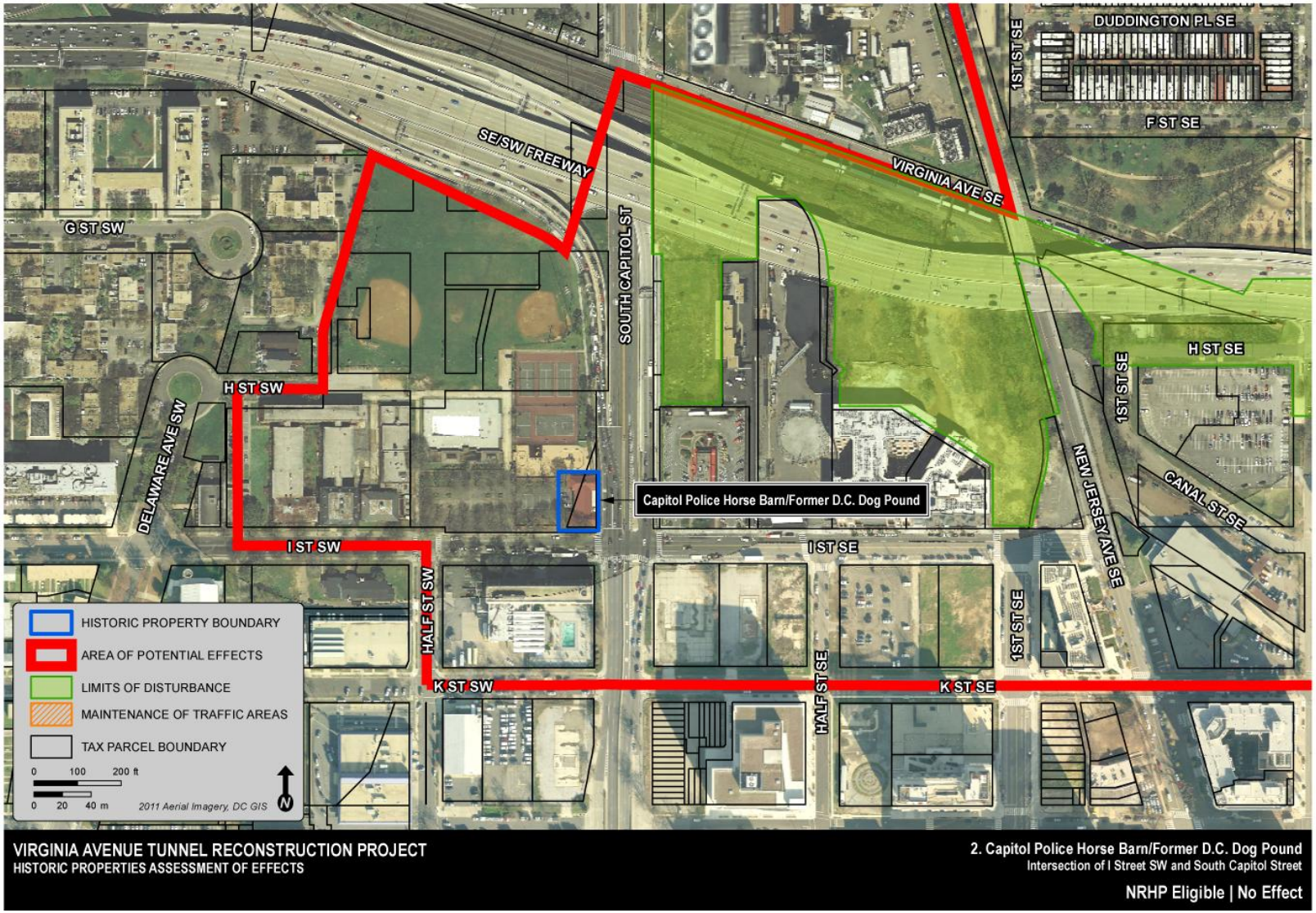


Figure 5. Proposed project activity in the vicinity of the Capitol Police Horse Barn/Former DC Dog Pound

Figure 6. View north toward the vicinity of Virginia Avenue SE from within the complex of the Capitol Police Horse Barn/Former D.C. Dog Pound.

Figure 7. View toward the vicinity of Virginia Avenue SE, north of the Capitol Police Horse Barn/Former D.C. Dog Pound.

Figure 8. View northeast toward the vicinity of Virginia Avenue SE from the Capitol Police Horse Barn/Former D.C. Dog Pound

3. St. Paul AUMP Church

The St. Paul AUMP Church is a historically and architecturally significant sacred building. The church, built in 1924, is an excellent example of a vernacular Gothic Revival religious building. It features a gabled roof, arched windows, crenellated battlements, and a tower. The congregation is the only church in Washington that evolved from the oldest incorporated, independent African denomination in the United States. The architect of the church was R.C. Archer, Jr., who was the second licensed African American architect in Washington, DC. The St. Paul AUMP Church, which was listed in the NRHP under Criterion A for its connection to the oldest incorporated, independent African American denomination in the United States, and under Criterion C as an example of a vernacular Gothic Revival religious building designed by an African American architect. The church was also listed under Criterion Consideration A, which allows religious buildings to be listed for architectural and historic significance.

Virginia Avenue Tunnel Project components would occur directly adjacent to St. Paul AUMP Church, primarily along Virginia Avenue SE. Project studies indicate that no noise or vibration impacts would adversely affect the structural integrity of the building; however, the project team has agreed to monitor the church because of the age of the building and the proximity of the work. A site visit by project team members, including structural engineers and cultural resources professionals, to gather information on existing conditions occurred in April 2013.

All project-related work will occur outside of the St. Paul AUMP Church's NRHP boundary, although the LOD boundary is concurrent with the historic boundary limit. Therefore, no effects to the St. Paul AUMP Church's integrity of location, design, materials, and workmanship would occur.

The Virginia Avenue Tunnel Project activity would have an adverse effect to the St. Paul AUMP Church's integrity of setting. Although the elevated freeway and new construction surround the church, Section 106 guidelines stipulate that adverse effects can be cumulative and temporary. Project-related construction will represent a disruption that is adjacent to the historic church, and while none of these construction components, such as noise or vibration or visual effects, individually may cause an adverse effect according to project studies and implementation of best construction practices, collectively they will change the setting of the historic church. While these effects are related to construction, and not long-term or permanent project impacts, the temporary construction impacts will constitute an adverse effect to the St. Paul AUMP Church's integrity of setting.

Project activity would not alter the church's feeling as a significant early twentieth century sacred building or its association with early African American religious establishment or vernacular Gothic Revival architecture; the church will continue to convey both its historic and architectural significance. Therefore, no effect to the church's integrity of feeling or association would occur.

Based on this evaluation Virginia Avenue Tunnel Project activity would have an adverse effect to the St. Paul AUMP Church.

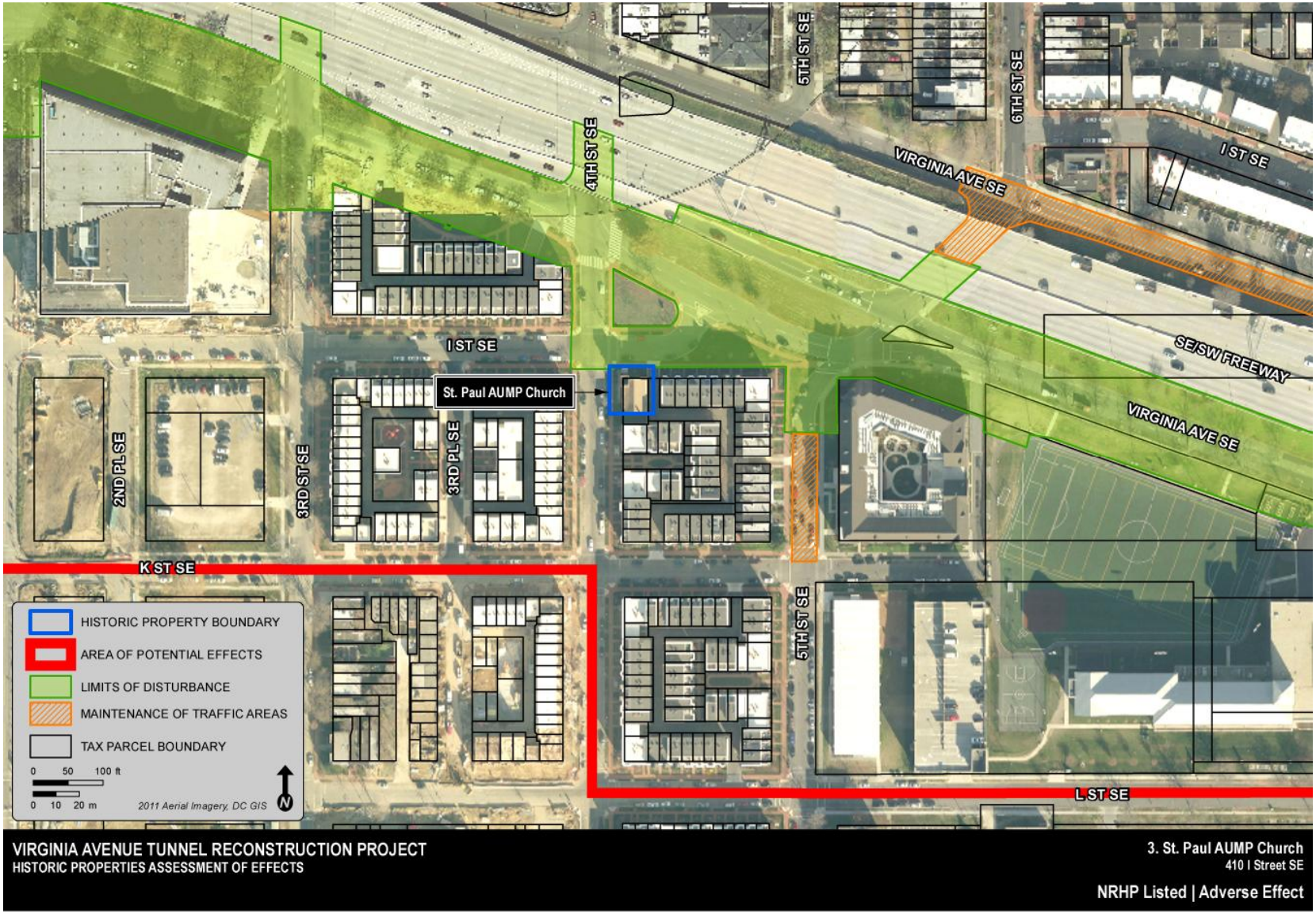


Figure 9. Proposed project activity in the vicinity of St. Paul AUMP Church

Figure 10. View north toward Virginia Avenue SE from the St. Paul AUMP Church, at the intersection of I Street SE and 4th Street SE

Figure 11. View northeast toward Virginia Avenue SE from the St. Paul AUMP Church, at I Street SE

4. Virginia Avenue Tunnel

Located beneath Virginia Avenue and bounded by 11th Street SE near the south portal and 2nd Street SE near the north portal

The Virginia Avenue Tunnel is a historically and architecturally significant railroad property that was constructed by the Baltimore & Potomac Railroad with a cut-and-cover method in 1872. The tunnel was later in extended in 1904. The tunnel is approximately 4,000 feet in length and includes stone portals and retaining walls as well as the tunnel itself. The Virginia Avenue Tunnel is eligible for listing in the NRHP under Criterion A for providing important railroad access to Washington, DC, and also under Criterion C for its demonstrated engineering prowess.

The Virginia Avenue Tunnel Project would require that the tunnel be removed and rebuilt using new materials due to deterioration. Therefore, the proposed project would have an adverse effect to the integrity of location, design, setting, materials, workmanship, feeling, and association of the Virginia Avenue Tunnel.

Based on this evaluation Virginia Avenue Tunnel Project activity would have an adverse effect to the Virginia Avenue Tunnel.

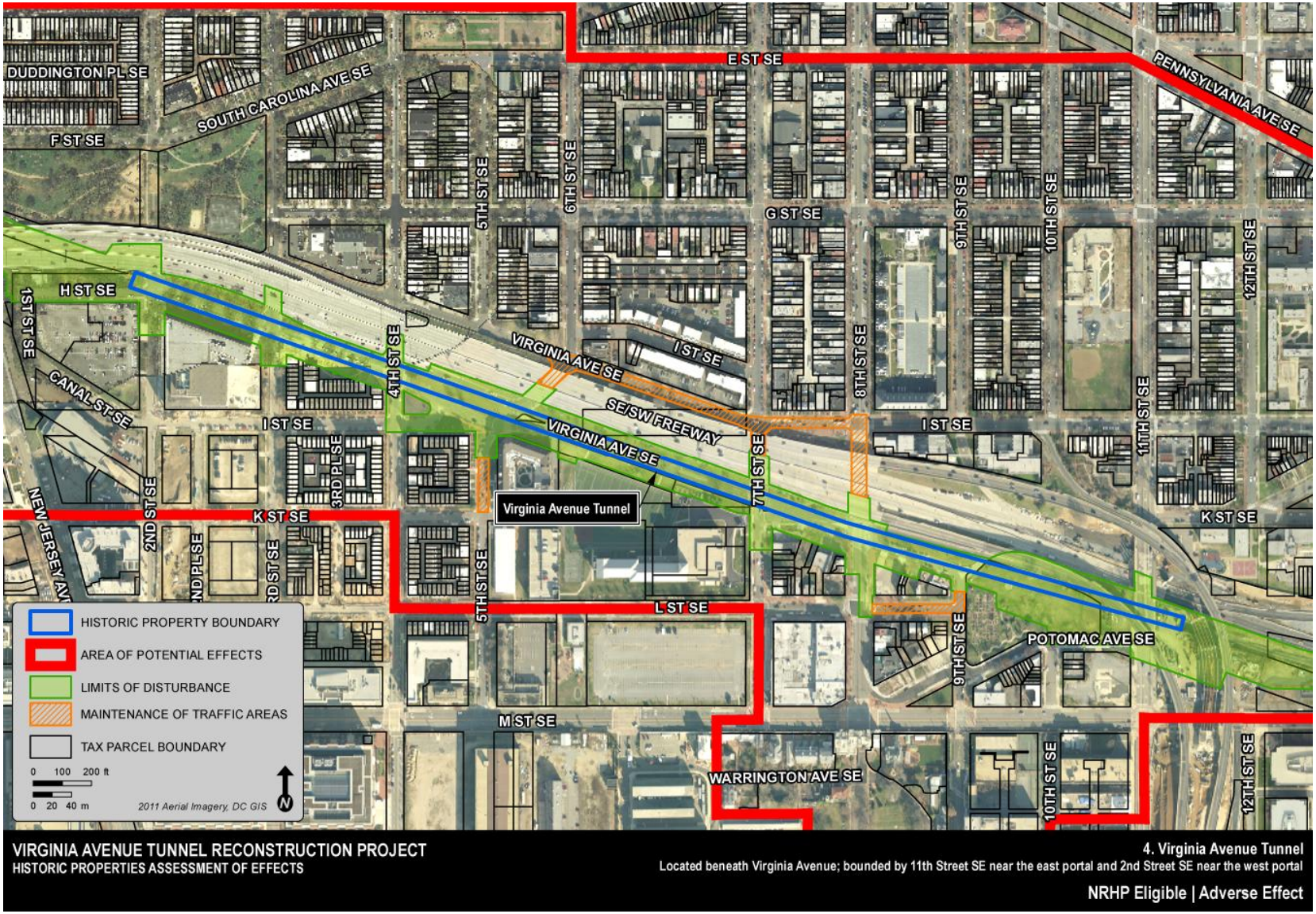


Figure 12. Proposed project activity in the vicinity of the Virginia Avenue Tunnel

Figure 13. Virginia Avenue Tunnel, East Portal

5. Capitol Hill Historic District

See map for the portion of the historic district that is within the project's APE.

The Capitol Hill Historic District is a historically and architecturally significant residential and commercial historic district that also contains public, religious, and military buildings as well as parks. The district, the oldest and largest residential community within Washington, DC, contains two- and three-story rowhouses that display a variety of architectural styles, including Federal, Greek Revival, Italianate, Queen Anne, Romanesque Revival, and vernacular interpretations and blends of these styles. The Capitol Hill Historic District, which was listed in the NRHP in 1976 with a boundary increase approved in 2003, is listed in the under Criterion A for its connection to the early history of the city and under Criterion C for the district's well-preserved collection of architecture.

Virginia Avenue Tunnel Project components would occur within the Capitol Hill Historic District, primarily along Virginia Avenue SE. Project studies indicate that no noise or vibration impacts would adversely affect the structural integrity of historic buildings.

There are no permanent impacts to contributing resources within the Capitol Hill Historic District and no adverse effects to the district's integrity of location, design, materials, and workmanship would occur. The Virginia Avenue Tunnel Project activity would have an adverse effect to the historic district's integrity of setting. Section 106 guidelines stipulate that adverse effects can be cumulative and temporary. According to the Project designers, construction staging will not be conducted within Virginia Avenue Park (Reservation 126). Construction staging, which includes materials stockpiling needed throughout the entire construction area and field offices, will be contained within CSX properties, in particular CSX's New Jersey Yard property. However, equipment, vehicles and materials needed to support construction activities specifically within Virginia Avenue Park between 9th and 11th streets would be stored within the project LOD within portions of the park between 30-54 months depending on the Build Alternative selected. Project plans include restoration and historically appropriate enhancements to the park, so there will be no permanent effects to the park. Project-related construction will represent a disruption within the district, and while none of these construction components, such as noise, vibration, or visual effects, individually may cause an adverse effect, collectively they will change the setting of the district during construction. While these are not permanent impacts, the temporary construction impacts will constitute an adverse effect to the historic district's integrity of setting.

Project activity would not alter the historic district's feeling as an eighteenth and nineteenth century residential and commercial area or its association with the early development of the city; the district will continue to convey both its historic and architectural significance. The district is large, and work will only occur in a comparatively small area, with much of the district unaffected by proposed project work. Therefore, no adverse effect to the district's integrity of feeling or association would occur.

Based on this evaluation Virginia Avenue Tunnel Project activity would have an adverse effect to the Capitol Hill Historic District.

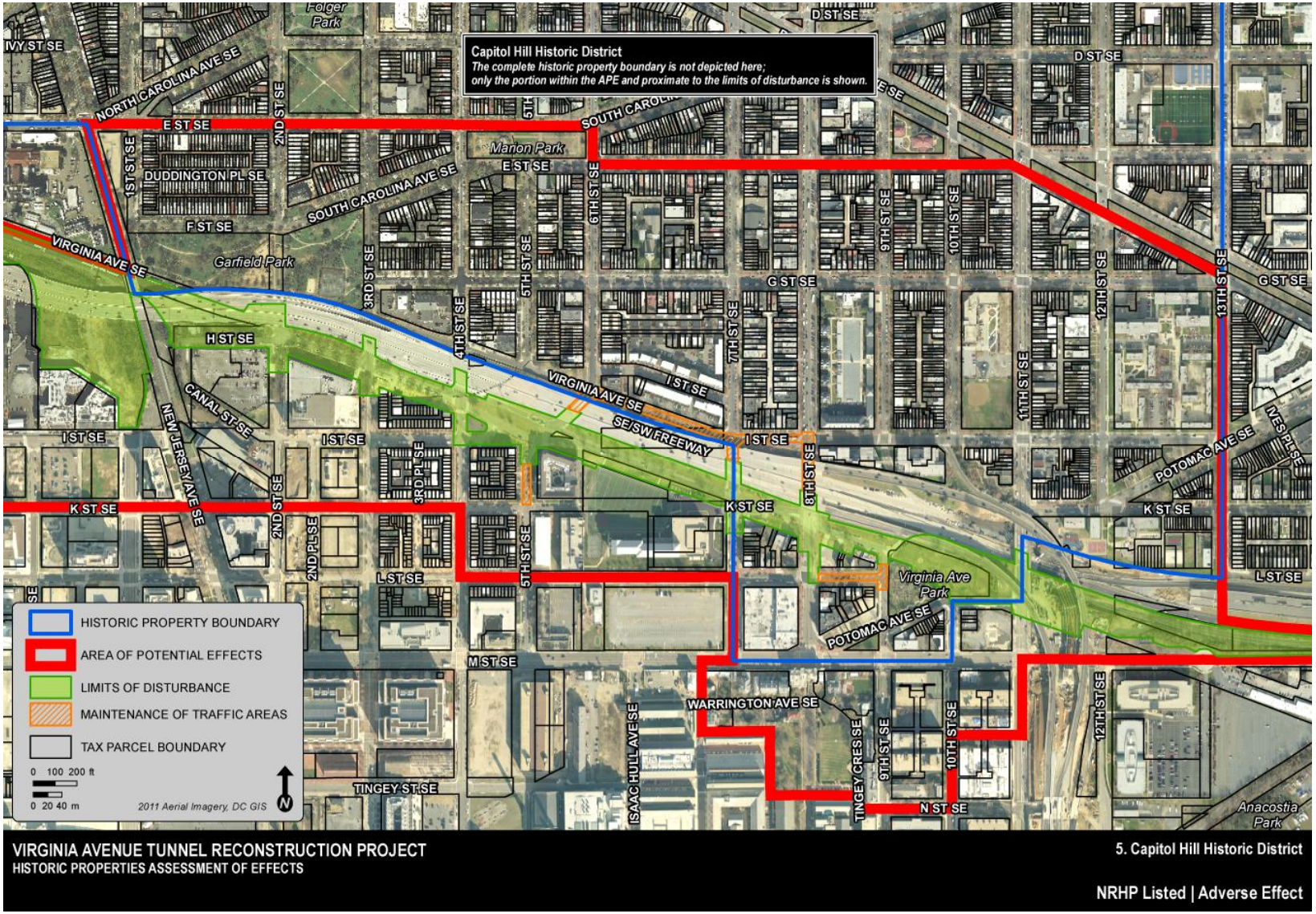


Figure 14. Proposed project activity in the vicinity of the Capitol Hill Historic District

Figure 15. View north toward Virginia Avenue SE from 8th Street SE, between L Street SE and M Street SE, within the Capitol Hill Historic District

Figure 16. View north from the Virginia Avenue Park, within the Capitol Hill Historic District

Figure 17. View northwest toward Virginia Avenue SE from the Virginia Avenue Park, within the Capitol Hill Historic District

Figure 18. View northeast from the Virginia Avenue Park, within the Capitol Hill Historic District (Virginia Avenue Tunnel directly underground)

Figure 19. View south toward Virginia Avenue SE (beyond viaduct) from Garfield Park, within the Capitol Hill Historic District

Figure 20. View south toward Virginia Avenue SE from Garfield Park, at 3rd Street SE, within the Capitol Hill Historic District

Figure 21. View south toward Virginia Avenue SE (beyond viaduct) from 4th Street SE, within the Capitol Hill Historic District

Figure 22. View south toward Virginia Avenue SE (beyond interstate highway) at 5Th Street SE and Virginia Avenue SE, within the Capitol Hill Historic District

Figure 23. View southeast toward Virginia Avenue SE (beyond interstate highway) at 5th Street SE and Virginia Avenue SE, within the Capitol Hill Historic District

Figure 24. View southwest toward Virginia Avenue SE (beyond interstate highway) at 5th Street SE and Virginia Avenue SE, within the Capitol Hill Historic District

Figure 25. View south toward the vicinity of Virginia Avenue SE from 6th Street SE, within the Capitol Hill Historic District

Figure 26. View south toward Virginia Avenue SE (beyond viaduct) from the intersection of 6th Street SE and Virginia Avenue SE, within the Capitol Hill Historic District

Figure 27. View southeast toward Virginia Avenue SE (beyond viaduct) from the intersection of 7th Street SE and I Street SE, within the Capitol Hill Historic District

Figure 28. View south toward the vicinity of Virginia Avenue SE at 10th Street SE and I Street SE, within the Capitol Hill Historic District

Figure 29. View south toward the vicinity of Virginia Avenue SE from the intersection of 11TH Street SE and I Street SE, within the Capitol Hill Historic District

Figure 30. View south toward the CSX railroad on the east end of Virginia Avenue Tunnel from 13th Street SE, the eastern boundary of the Capitol Hill Historic District

Figure 31. View southeast along L Street SE toward the CSX railroad on the east end of Virginia Avenue Tunnel from the 13th Street SE, the eastern boundary of the Capitol Hill Historic District

6. Christ Church, Washington Parish

620 G Street SE

Christ Church, Washington Parish is a two-and-a-half story rectangular Gothic Revival-style structure with a stuccoed exterior and a high square bell tower located over the narthex. Robert Alexander designed the church in 1806, though the design is often attributed to Benjamin Henry Latrobe, which was constructed in 1807. Today the church is located within the Capitol Hill Historic District. The building's design has been altered and enlarged since 1806—the first major addition was executed in 1824—but the church does retain several of its original design elements. Christ Church, Washington Parish is listed in the NRHP under Criterion A for its connection to significant events in this history of Washington, D.C.; under Criterion C as an example of a Gothic Revival-style church. The church was also listed under Criterion Consideration A, which allows religious buildings to be listed for architectural and historic significance.

In the vicinity of Christ Church, Washington Parish, Virginia Avenue Tunnel Reconstruction Project activity would primarily occur along Virginia Avenue SE. The church's NRHP boundary is approximately 780 feet from the project's limits of disturbance at Virginia Avenue SE. No potential noise or vibration impacts to the property have been identified during project studies.

No physical impacts to Christ Church, Washington Parish would occur as a result of the rehabilitation and replacement of the Virginia Avenue Tunnel. No project activity would occur within the property's NRHP boundary. Therefore no effects to the property's location, design, materials, and workmanship would occur.

The Virginia Avenue Tunnel Reconstruction Project components would have no effect to Christ Church, Washington Parish's setting. The church is located within the primarily residential Capitol Hill Historic District, which retains much of its nineteenth and early twentieth century character. The church retains its original historic setting, set back from the street behind an iron fence. Project activity would not be visible from the property due to distance and the density of surrounding buildings and vegetation. Thus, project implementation would have no effect to historically significant views to or from the property. Because no effects to the character-defining features of the property's setting have been identified, project activity would have no effect to the property's integrity of setting.

Project activity would not alter Christ Church, Washington Parish's feeling as a Gothic Revival-style church or its association with the style or a place of worship serving the Capitol Hill neighborhood. Therefore, the project would have no effect to Christ Church, Washington Parish's integrity of feeling or association.

Based on this evaluation, the Virginia Avenue Tunnel Project would have no effect to Christ Church, Washington Parish.

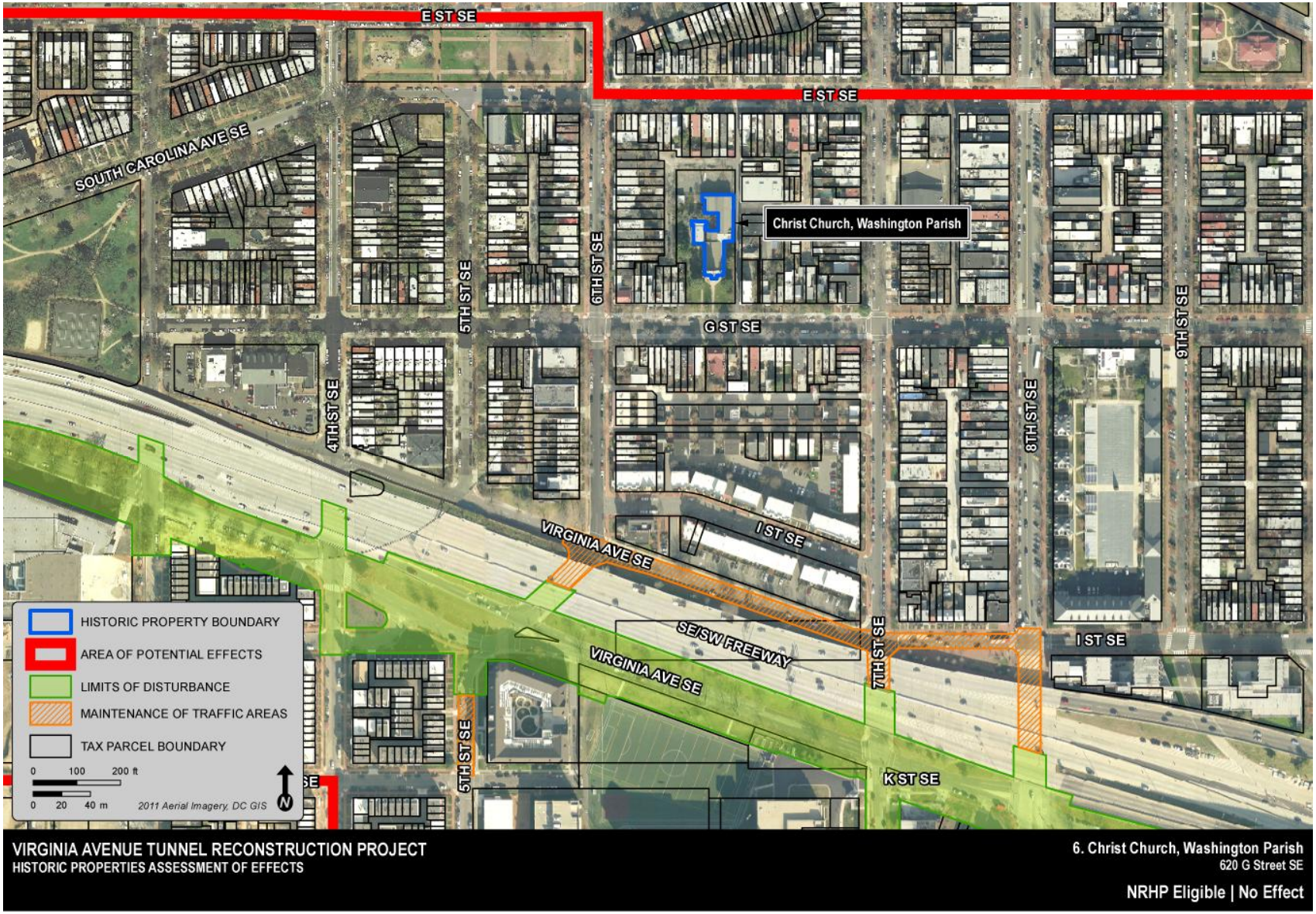


Figure 32. Proposed project activity in the vicinity of the Christ Church, Washington Parish

Figure 33. View south toward the vicinity of Virginia Avenue SE from Christ Church, Washington Parish within the Capitol Hill Historic District

7. United States Marine Corps Barrack and Commandant's House

(Note that all Marine Barracks buildings are assessed for effects as they are designated; some designations are redundant and therefore, the effects assessments are similar.)

Bounded by I Street SE to the north, 8th Street SE to the east, G Street SE to the south, and 9th Street SE to the west

The United States Marine Corps Barracks and Commandant's House is a National Historic Landmark and the oldest continually active Marine Corps instillation in the United States. The post is a rectangular enclosed site with a central parade ground. The site was selected by William Ward Burrows I, Second Command of the Marine Corps, and Thomas Jefferson. The contributing buildings within the building are the barracks, band hall, row of five officers' houses, and the Commandant's House. The two-and-one-half story Federal style Commandant's House is the only original building on the post. The United States Marine Corps Barracks and Commandant's House is listed in the NRHP and has also been designated as a National Historic Landmark (NHL). The property is significant for its connection to the history of the United States Marine Corps; for associations with numerous historical and military; and as a rare example of unified design, rarely found in military instillations. The Marine Corps Commandant's House and the Marine Corps Barracks are both individually listed in the NRHP, and the band hall is individually eligible for listing in the NRHP. Each historic property is assessed collectively and individually as appropriate according to these designations.

Virginia Avenue Tunnel project activity in the vicinity of the United States Marine Corps Barracks and Commandant's House would primarily occur along Virginia Ave SE. Approximately 300 feet span between the barracks south NRHP and NHL boundary and the project's limits of disturbance. No potential noise or vibration impacts have been identified.

No physical impacts to the United States Marine Corps Barracks and Commandant's House would occur as a result of project implementation. No project activity is proposed to occur within the property's NRHP and NHL boundary. Therefore, no effects to the United States Marine Corps Barracks building's integrity of design, location, materials, and workmanship would occur.

Virginia Avenue Tunnel project implementation would have no effect to the United States Marine Corps Barracks and Commandant's House's integrity of setting. Project activity within the vicinity of the property would primarily occur along Virginia Avenue SE. The United States Marine Corps Barracks is oriented to the interior of the post behind the installation's walls and the Commandant's House is oriented to the north; the urban setting outside of the walls and near the project area retains little integrity of setting primarily due to the elevated freeway. Brick walls, a gate, and mature trees, the project area is not visible from the barracks. Project implementation would have no effect to the property's visual setting or the character-defining features of its setting. Because no historically significant views would be obscured, no visual effects have been identified. Therefore, project activity would have no effect to the integrity of the setting of the United States Marine Corps Barracks and Commandant's House.

Furthermore, no project activity would alter the property's feeling as a historic military installation, or its association as a residence for members of the United States Marine Corps. Therefore, project activity would have no effect to the property's integrity of feeling or association.

Based on this evaluation, the Virginia Avenue Tunnel Project would have no effect to the United States Marine Corps Barracks and Commandant's House.

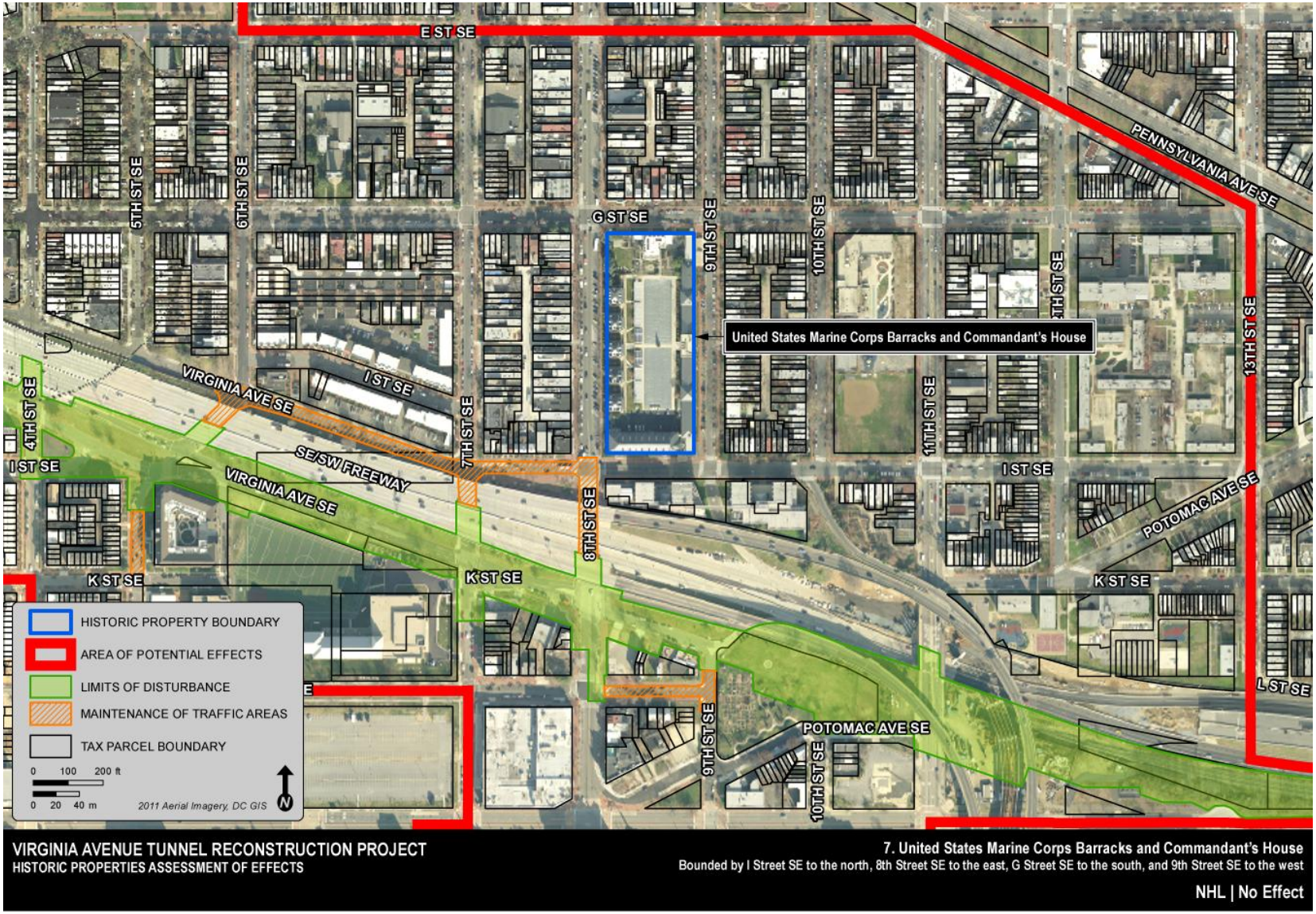


Figure 34. Project activity in the vicinity of the United States Marine Corps Barracks and Commandant's House

Figure 35. View to the southwest toward Virginia Avenue SE (beyond viaduct) from the United States Marine Corps Barracks and Commandant's House.

8. Marine Corps Commandant's House

(Note that all Marine Barracks buildings are assessed for effects as they are designated; some designations are redundant and therefore, the effects assessments are similar.)
801 G Street SE

The Marine Corps Commandants House, part of the Marine Barracks Post, at 801 G Street SE has undergone several alterations since its original 1801 construction. The Federal style house is located on the north end of the post, which is also bounded by 9th Street SE to the east, I Street SE to the south, and 8th Street SE to the west. Architect George Hadfield designed the Commandant's House and it is believed that Benjamin Latrobe closely supervised the project. Because the original barracks were replaced in 1902, the Commandant's House is the only original building on the site and its history is closely linked to the founding of Washington, D.C. and the United States Marine Corps. Originally, the two-and-one-half story, Federal style house clad in Flemish bond brick comprised a three-bay-wide, north-facing facade with a central, round-arch entrance. Completed in 1840, a two-story addition to the east elevation of the house lengthened the north-facing facade, with an additional bay located in its first and upper stories. A three-bay-wide, one-story addition to the west elevation and a one-story, enclosed porch addition to the south elevation were completed the same year. In 1891, the original roof was removed and the mansard roof with dormers was added. A one-story addition to the east elevation housing a kitchen and pantry were added in 1934. The Marine Corps Commandant's House is listed in the NRHP under Criterion A for its association with the founding of Washington DC and the United States Marine Corps, as this is the oldest Marine Corps instillation in the United States; it is also listed under Criterion C for its use of the character-defining elements on the Federal style.

Virginia Avenue Tunnel project activity in the vicinity of the Marine Corps Commandant's House would primarily occur along Virginia Avenue SE. The project's limits of disturbance extend eastward along Virginia Avenue SE, approximately 855 feet from the house's southern NRHP boundary. No potential noise or vibration impacts to the property have been identified during project studies.

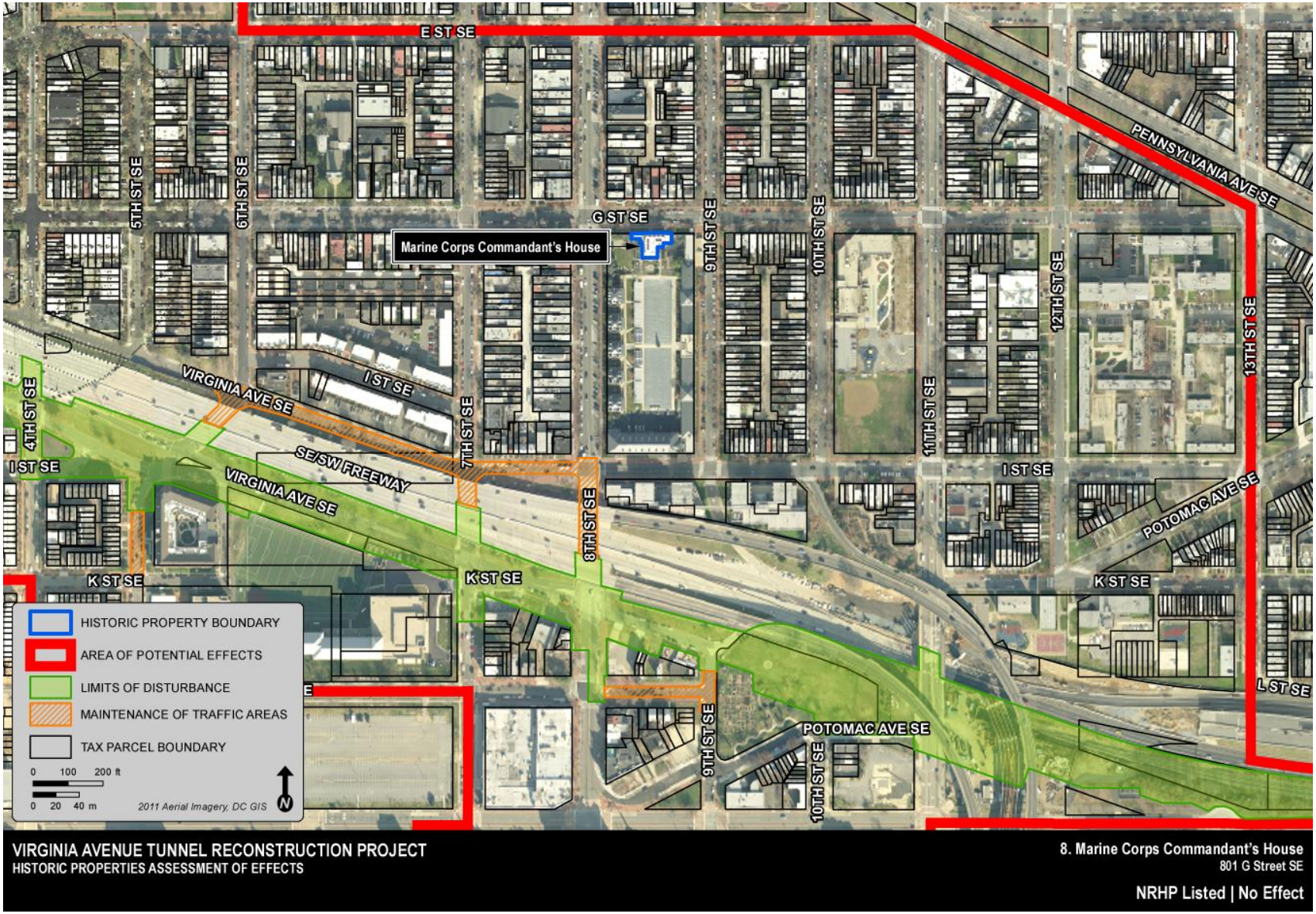
No physical impacts to the Marine Corps Commandant's House would occur as a result of project implementation. No project activity would occur within the property's NRHP boundary. Therefore, no effects to the property's integrity of location, design, materials, and workmanship would occur.

Project implementation would have no effect to the visual setting of the Commandant's House. The Marine Barracks Post occupies a rectangular site bounded by 9th Street SE to the east, I Street SE to the south, 8th Street SE to the west, and G Street SE to the north. In addition to the Commandant's House on G Street SE, the other buildings on the post—a range of barracks, the Band Hall, and officer's quarter's—enclose the rectangular post and parade grounds. The Commandant's House is the only building on the post that does not face in toward the parade grounds; the house is oriented to the north away from project activity. The other buildings on the post, along with mature trees located within and outside the post, provide a visual and

physical buffer between the Commandant's House and proposed project activity; project activity would not be visible from the property. Project implementation would have no effect to the property's visual setting or the character-defining features of its setting. Because no historically significant views would be obscured, no visual effects to the property have been identified. Therefore, project activity would have no effect to the integrity of the setting of the Commandant's House.

Furthermore, no project activity would alter the property's feeling as a Federal style residence. Additionally, project activity would have no effect to the property's association with the Federal style, the residence of the Commandant, or the founding of the Nation's Capital and the United States Marine Corps. Therefore, project activity would have no effect to the property's integrity of feeling or association.

Based on this evaluation, the Virginia Avenue Tunnel Project would have no effect to the Marine Corps Commandant's House.



VIRGINIA AVENUE TUNNEL RECONSTRUCTION PROJECT
HISTORIC PROPERTIES ASSESSMENT OF EFFECTS

8. Marine Corps Commandant's House
801 G Street SE
NRHP Listed | No Effect

Figure 36. Proposed project activity in vicinity of the Marine Corps Commandant's House

Figure 37. View south along 8th Street SE toward the vicinity of Virginia Avenue SE from outside the post, west of the Marine Corp's Commandant's House east elevation.

9. Marine Corps Barracks

(Note that all Marine Barracks buildings are assessed for effects as they are designated; some designations are redundant and therefore, the effects assessments are similar.)
Intersection of I Street SE and 8th Street SE

Architects Hornblower and Marshall designed the Marine Corps Barracks, which was constructed between 1902 and 1906. The building replaced the original barracks on post, designed by George Hadfield and constructed in 1802, when they fell into disrepair. The building borders 9th Street SE, extending between I and G streets SE, and is oriented to the west. The barracks open onto the parade grounds, located in the interior of the post. The two-and-a-half story building features three pavilions that are slightly higher than the rest of the building. The building's ground story contains an arcaded loggia and the exterior is clad in brick. The style of the barracks is eclectic and represents the strength and the solidity of the military. The United States Marine Corps Barracks is listed in the NRHP under Criterion A for its continuous association with this history of the United States Marine Corps; it is also listed under Criterion C for its eclectic design, which represents the strength of the United States Marine Corps.

Virginia Avenue Tunnel project activity in the vicinity of the United States Marine Corps Barracks building would primarily occur along Virginia Ave SE. Approximately 390 feet span between the barracks south NRHP boundary and the project's limits of disturbance. No potential noise or vibration impacts have been identified.

No physical impacts to the United States Marine Corps Barracks building would occur as a result of project implementation. No project activity is proposed to occur within the property's NRHP boundary. Therefore, no effects to the United States Marine Corps Barracks building's integrity of design, location, materials, and workmanship would occur.

Virginia Avenue Tunnel project implementation would have no effect to the United States Marine Corps Barracks building's integrity of setting. The building is not oriented toward the project area. Project activity within the vicinity of the barracks would primarily occur along Virginia Avenue SE. The United States Marine Corps Barracks building is oriented to the interior of the post behind the installation's walls; the urban setting outside of the walls and near the project area retains little integrity of setting primarily due to the elevated I-695 expressway. Due to other buildings located on the Marine Corps post that enclose the site, along with brick walls, a gate, and mature trees, the project area is not visible from the barracks. Project implementation would have no effect to the building's visual setting or the character-defining features of its setting. Because no historically significant views would be obscured, no visual effects to the building have been identified. Therefore, project activity would have no effect to the integrity of the setting of the United States Marine Corps Barracks building.

Furthermore, no project activity would alter the property's feeling as an eclectic early-nineteenth century military instillation, or its association with the style or as a residence for

members of the United States Marine Corps. Therefore, project activity would have no effect to the property's integrity of feeling or association.

Based on this evaluation, the Virginia Avenue Tunnel Project would have no effect to the Marine Corps Barracks.

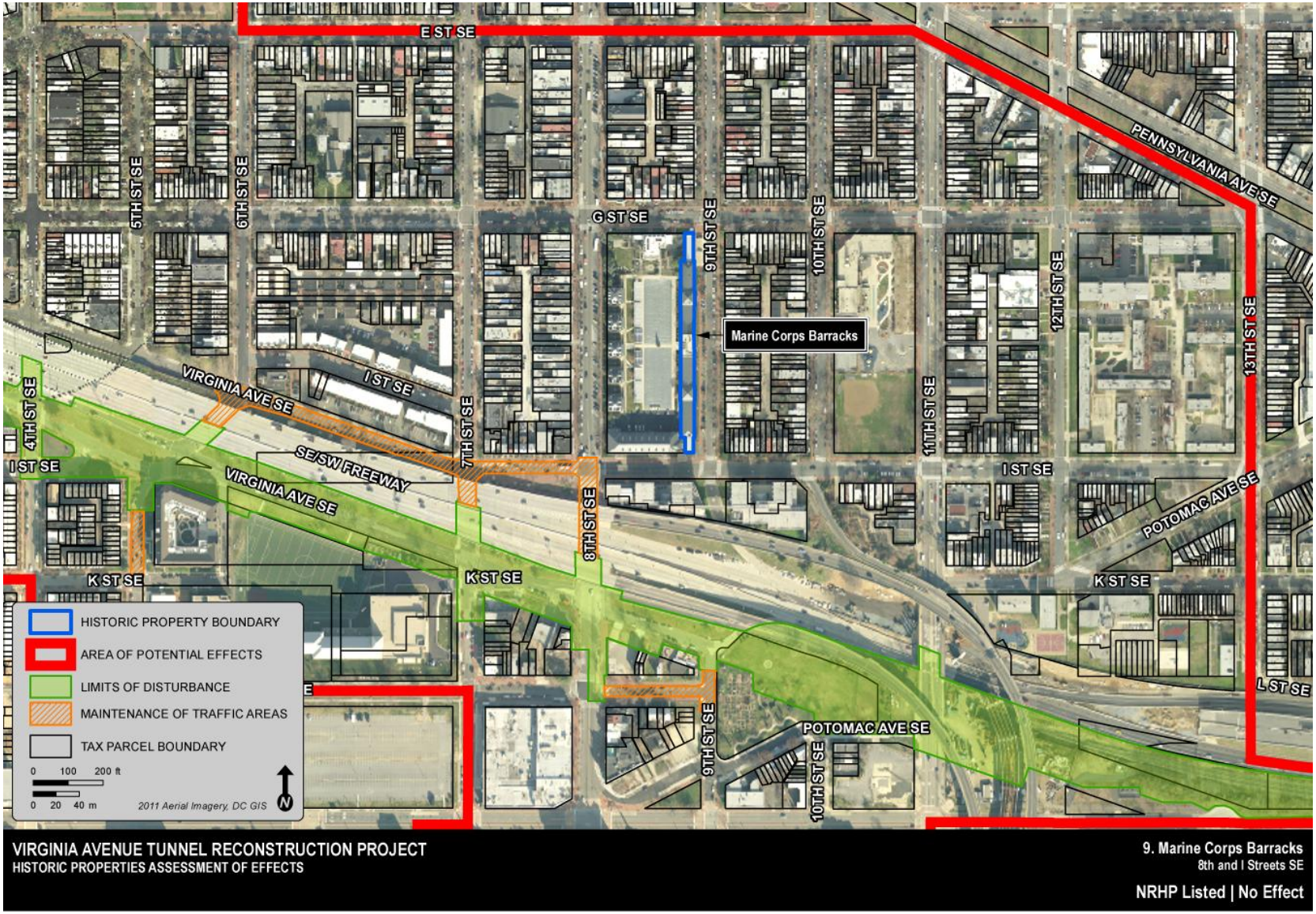


Figure 38. Proposed project in the vicinity of the United States Marine Corps Barracks building

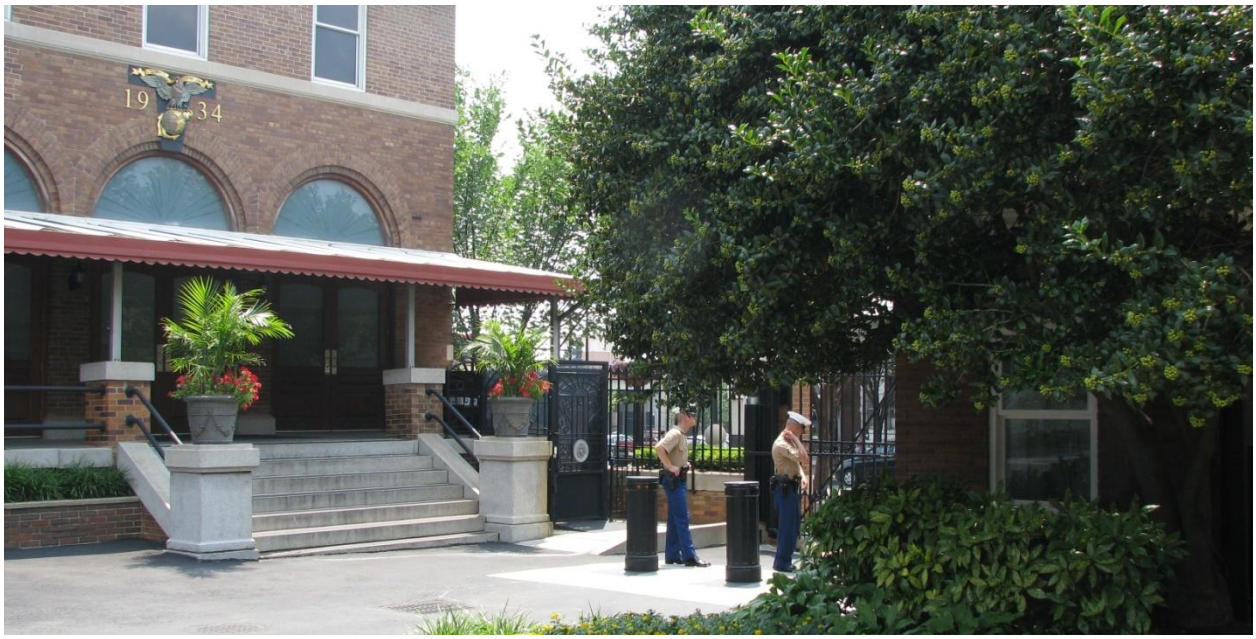


Figure 39. View southwest toward the vicinity of Virginia Avenue SE from within the United States Marine Corps Post

10. Marine Band Hall

(Note that all Marine Barracks buildings are assessed for effects as they are designated; some designations are redundant and therefore, the effects assessments are similar.)
I Street SE

The Marine Band Hall is one of several buildings comprising the rectangular Marine Corps Barracks post, bounded by G Street SE to the north, 8th Street SE to the east, I Street SE to the south, and 9th Street SE to the west. The Marine Band Hall extends along I Street SE, between 8th and 9th streets SE, and faces south onto the southern end of the parade grounds within the post. As the oldest Marine Corps post in the nation, the site has been the home of the Marine Band since 1801, although the original building is no longer extant. The current band hall is associated with John Phillip Sousa, who composed "Semper Fidelis" during his time as conductor of the Marine Band. Both the band hall and the east range of barracks were constructed between 1902 and 1906, replacing the 1801 buildings on the post. Designed by architects Hornblower and Marshall, the two buildings feature different detailing, but share some common design elements and materials. The band hall, along with the east range of barracks, is a noteworthy example of military architecture. The simple two-and-one-half story, rectangular plan building is clad in brick. The ground-level, north facade contains an arcaded loggia that continues along the west facade of the east range of barracks. The second-story contains twenty-two double-hung windows and the band hall terminates in a hipped roof pierced by eight dormers. The Marine Band Hall is eligible for listing in the NRHP under Criterion A for its association with the founding and history of the United States Marine Corps and the Marine Band; under Criterion B for its association with its association with John Phillips Sousa; and under Criterion C as a noteworthy example of military architecture.

Virginia Avenue Tunnel project activity in the vicinity of the Marine Band Hall would primarily occur along Virginia Avenue SE. The project's limits of disturbance extend eastward along Virginia Avenue SE, approximately 295 feet from the closest point of the historic property's NRHP boundary. No potential noise or vibration impacts to the property have been identified as a result of project studies.

No physical impacts to the Marine Band Hall would occur as a result of project implementation. No project activity would occur within the property's NRHP boundary. Therefore no effects to the property's integrity of location, design, materials, and workmanship would occur.

Virginia Avenue Tunnel Project components would have no effect to the property's integrity of setting and project implementation would primarily occur along Virginia Avenue SE. The Band Hall is oriented to the north, away from project activity, and faces in toward the Marine Barrack's enclosed parade grounds. All proposed project activity would occur south of the property and development along the south side of I Street SE provides a physical and visual buffer between the south facade of the barracks and project activity. Most notably, in this area, the I-695 expressway is a looming presence that diminishes the integrity of setting of the Marine Band Hall. Project implementation would have no effect to historically significant views to and from the property, the property's visual setting, or the character-defining features of its

setting. Because no historically significant views would be obscured, no visual effects to the property have been identified. Therefore, Virginia Avenue Tunnel project activity would have no effect on the integrity of the setting of the Marine Band Hall.

Furthermore, Virginia Avenue Tunnel project activity would have no effect to the property's feeling as a military band hall on the Marine Barracks Post or as an example of early-twentieth-century military architecture. The project also will not diminish its association with the history of the Marine Corps and the Marine Band, or John Phillips Sousa. Therefore, project activity would have no effect on the property's integrity of feeling or association.

Based on this evaluation Virginia Avenue Tunnel Project activity would have no effect on the Marine Band Hall.

Figure 40. Project activity in the vicinity of the Marine Band Hall

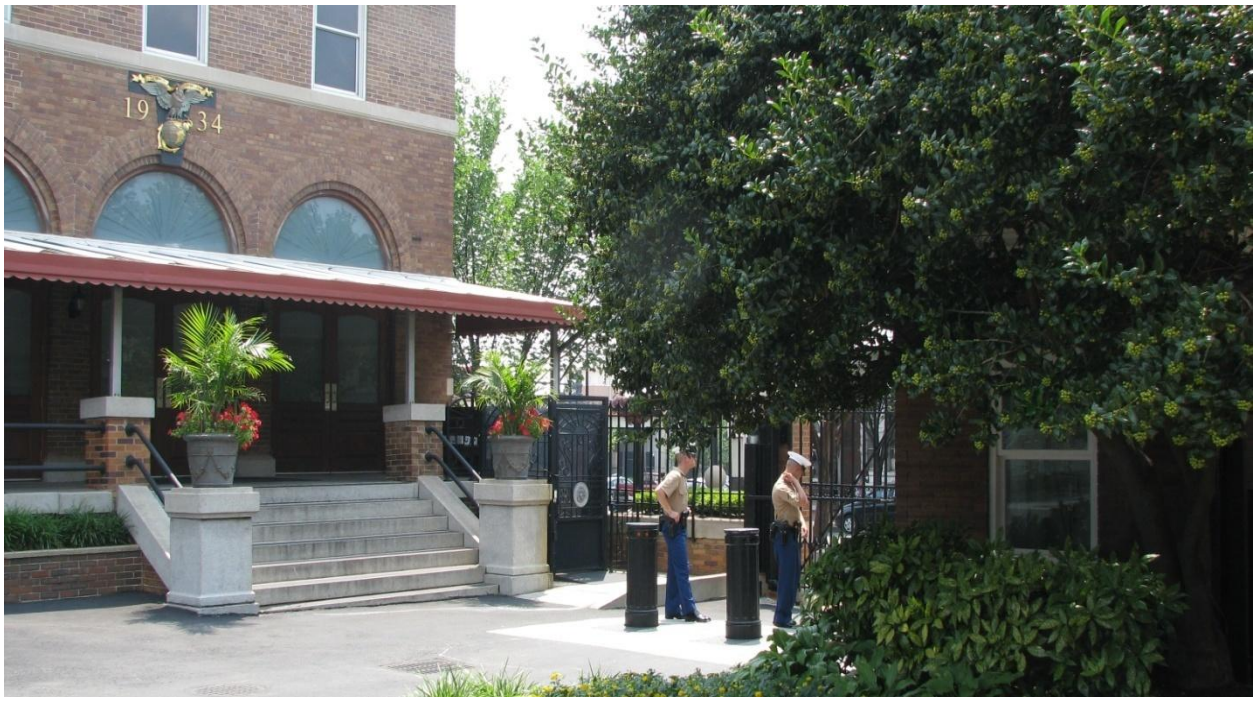


Figure 41. View southwest toward the vicinity of Virginia Avenue SE from within the Marine Barracks Post, north of the north facade of the Band Hall

Figure 42. View south toward the vicinity of Virginia Avenue SE from the south elevation of the Band Hall, at I Street SE

Figure 43. View southwest toward Virginia Avenue SE (beyond viaduct) from the south elevation of the United States Marines Corps Band Hall, at the intersection of 8th Street SE and I Street SE

11. Washington & Georgetown Railroad Car House

770 M Street SE

Kansas City-based architect Walter C. Root designed the two-story Romanesque Revival-style Washington & Georgetown Railroad Car House for the Washington & Georgetown Railroad Company. Construction company S .H. and D. F. Adams built the cable car barn in 1891. The façade features angled towers, watch towers, blind arrow slits, conical roofs, and corbelled parapets. The rectangular building occupied the eastern half of the square between M and L streets SE and is the only extant purpose-built cable car building in Washington, DC. In 1909 a one-story addition, carried out by the Capital Traction Company, expanded the building to occupy the entire square. Cable was a short lived venture; between 1890 and 1899 only two District companies utilized cable as a substitute for horse drawn traction. After this experimental phase, the building was modernized to provide electric traction, operating as such until 1962. The Washington & Georgetown Railroad Car House is listed in the NRHP under Criterion A as one of the four streetcar-related buildings by Root and the only extant purpose-built cable car building from its period. It is also listed under Criterion C as an industrial building that employs the character-defining features of the Romanesque Revival-style.

Virginia Avenue Tunnel Project components would primarily occur along Virginia Avenue SE near the Washington & Georgetown Railroad Car House. The project's limits of disturbance, which extend south from Virginia Avenue, SE on 8th Street, SE, are approximately 50 feet from the car house's northern NRHP boundary; the work in this most proximate area consists of basic roadway improvements. The majority of project work in this area will occur on Virginia Avenue, SE, which is separated at various longer distances from the historic property boundary by buildings and urban development. At the closest point, the tunnel work will be approximately 220 feet from the car house. No potential noise or vibration impacts to the property have been identified during project studies.

No physical impacts to the Washington & Georgetown Railroad Car House would occur as a result of project activity. No project activity would occur within the property's NRHP boundary. Therefore, no effects to the property's location, design, materials, or workmanship would occur.

Virginia Avenue Tunnel Project components would have no effect to the property's integrity of setting. Project activity would be minimally visible from property's east and a portion of its north elevation. Buildings, mature trees, and vegetation considerably screen any proposed project activity from view. Project activity would have no effect to historically significant views to or from the property. Additionally, project activity would have no effect to character-defining features of the property's setting. Because project activity would have no effect to property's visual character, no effects have been identified. Therefore, Virginia Avenue Tunnel Project components would have no effect to the Washington & Georgetown Railroad Car House's integrity of setting.

Project implementation would have no effect to the property's feeling as Romanesque Revival style or its association with the style or as a cable car storage barn for the Washington &

Georgetown Railroad company. Therefore, project activity would have no effect to the property's integrity of feeling or association.

Based on this evaluation, the Virginia Avenue Tunnel Project components would have no effect to the Washington & Georgetown Railroad Car House.

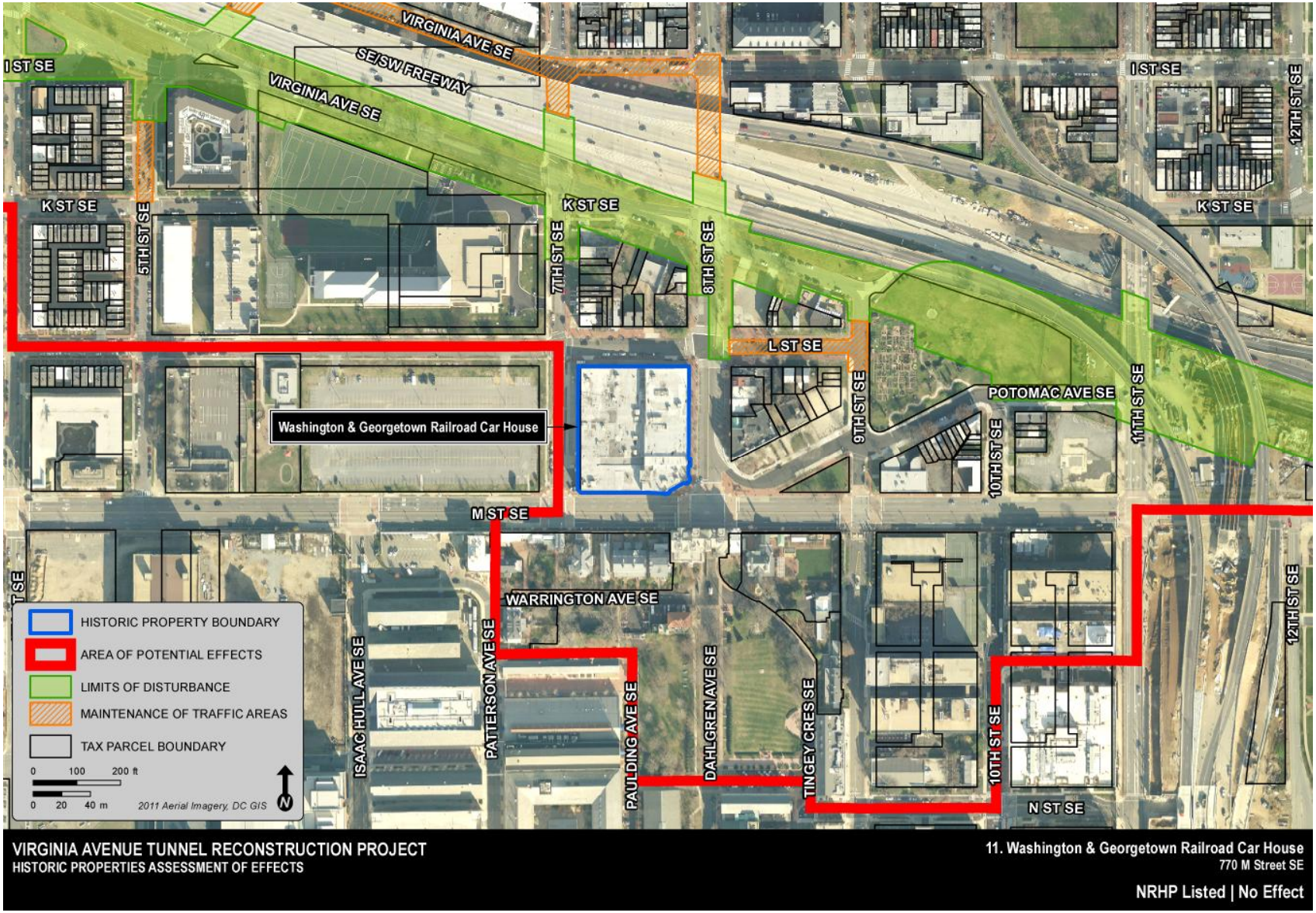


Figure 44. Proposed project activity in the vicinity of the Washington & Georgetown Railroad Car House

Figure 45. View north toward Virginia Avenue SE from the Washington & Georgetown Railroad Car House, at 8th and M streets SE

12. Washington Navy Yard Historic District

8th and M streets SE (Main Entrance), bounded by the Anacostia River to the south

As the United States Navy's first home port, the Washington Navy Yard Historic District served as the Navy's center for early operations. The Navy made significant developments in weaponry and defense at the yard during the early nineteenth century, elevating the young United States to a world superpower in a relatively short amount of time. Early permanent development at the yard includes extant residences for officers—the Second Officer's House (1801) and the Tingey House (1804)—and the yard's Main Gate (1806). Following the War of 1812, the Washington Navy Yard began to take on an increasingly industrial character. The Navy manufactured ship equipment, conducted research, repaired battle damaged ships, and corrected manufacturing deficiencies at the yard until 1945. Following World War II, the Washington Navy Yard became the "United States Naval Gun Factory." The gun factory closed in 1962 and the yard's industrial buildings were converted into office spaces for naval administrative needs in 1964. While the interior of these industrial buildings have been altered, the exterior historical appearance of the yard remains intact. The Washington Navy Yard Historic District is listed in the NRHP under Criterion A for its connection to the early history of the United States and development of the United States Navy; under Criterion B for the important innovations developed by significant individuals at the yard; and under Criterion C for the yard's well-preserved nineteenth and early-twentieth century industrial architectural appearance.

In the vicinity of the Washington Navy Yard Historic District, Virginia Avenue Tunnel Project components would primarily occur along Virginia Avenue SE. The distance between the project's limits of disturbance and select points within the district can substantially vary because of the size of the historic district. At the closest point, approximately 400 feet separates the district and the project's limits of disturbance. No potential noise or vibration impacts have been identified during project studies.

No physical impacts to the Washington Navy Yard Historic District would occur as a result of project implementation. No project components would occur within the district's NRHP boundary. Therefore, no effects to the Washington Navy Yard Historic District's integrity of location, design, materials, and workmanship would occur.

The Virginia Avenue Tunnel Project activity would have no effect to the district's integrity of setting. Project components would primarily occur along Virginia Avenue SE, well outside of the wall that surrounds the Washington Navy Yard. From within the Washington Navy Yard Historic District, project activity would not be visible due to the topography of the land and the wall. At the closest point, approximately 400 feet spans between the Washington Navy Yard Historic District's north NRHP boundary and the project's limits of disturbance. Project activity would have no effect to historically significant views to or from the district or the character-defining features of the district's setting. Because no historically significant views would be obscured, no visual effects to the property have been identified. Therefore, project implementation would have no effect to the district's integrity of setting.

Furthermore, no project activity would alter the district's feeling as a nineteenth and early-twentieth century industrial naval yard or its association with the development of the United States Navy. Therefore, no impact the district's integrity of feeling or association would occur.

Based on this evaluation Virginia Avenue Tunnel Project activity would have no effect to the Washington Navy Yard Historic District.

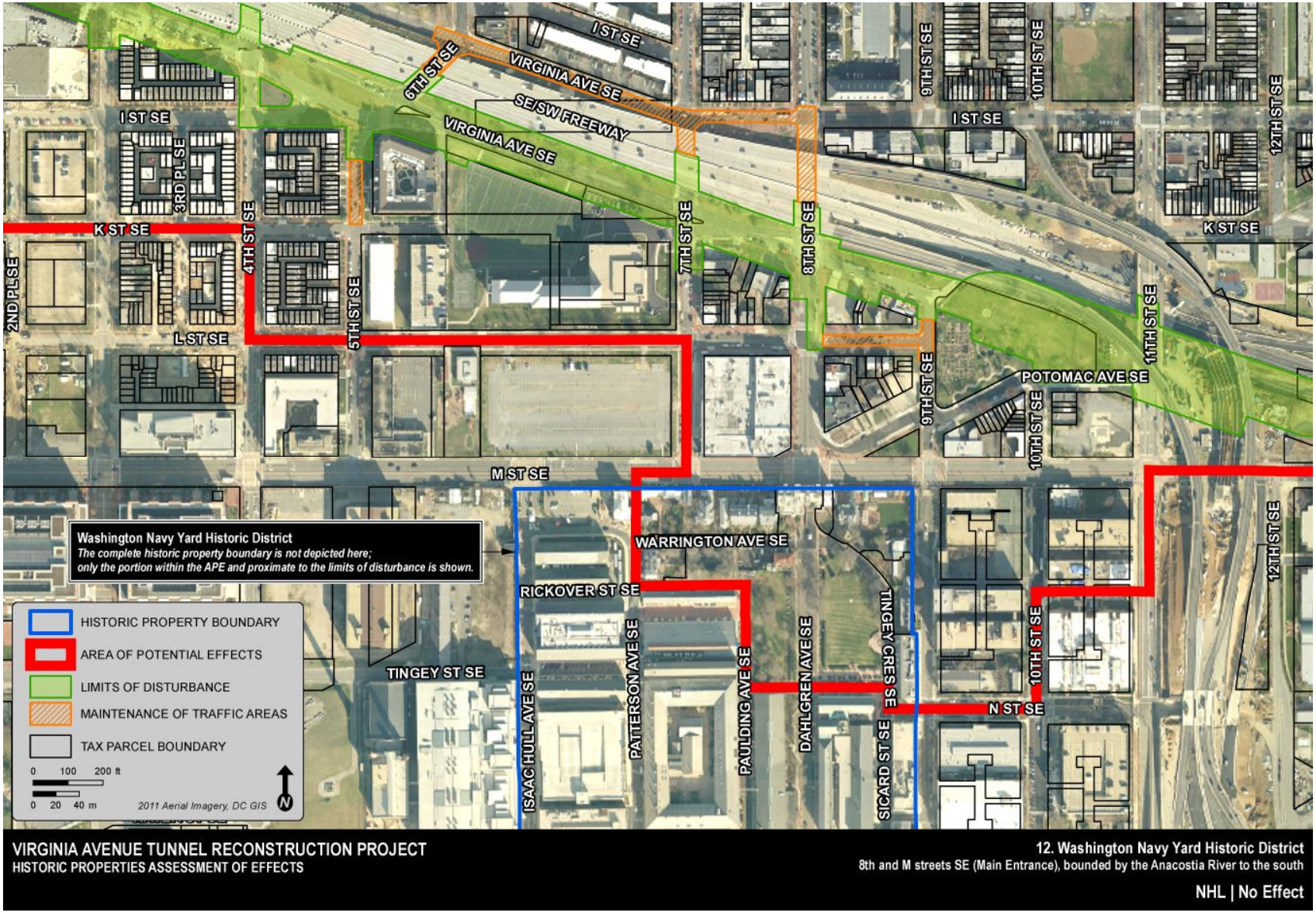


Figure 46. Project activity in the vicinity of the Washington Navy Yard Historic District.

Figure 47. View north toward the vicinity of Virginia Avenue SE from Dahlgren Avenue SE, within the Washington Navy Yard East Extension

Figure 48. View north toward Virginia Avenue SE from the Main Gate Entrance of the Washington Navy Yard, at 8th and M streets SE

13. Main Gate, Washington Navy Yard

8th and I streets SE

Renowned architect Benjamin Henry Latrobe designed the Main Gate of the Washington Navy Yard in 1804. Completed in 1806, the gate is an imposing Greek Revival-style structure with north and south facades, connected by a colonnade, and covered by a hipped roof. The gate is one of the Navy Yard's earliest structures and one of the earliest of Latrobe's designs completed at the Navy Yard. Today, the Main Gate is the only extant Navy Yard structure attributed to Latrobe. The Main Gate survived the British invasion of Washington, DC, and the burning of the Washington Navy Yard in 1814. Between 1880 and 1881, the Main Gate was incorporated into the façade of a three-story late Victorian-era building. However, Latrobe's structure retains much of its original Greek Revival character. The Main Gate of the Washington Navy Yard is listed in the NRHP under Criterion A for its connection to the history of the Washington Navy Yard and the early United States Navy and also under Criterion C for its Greek Revival character, which influenced an entire movement of architectural design in the United States.

Virginia Avenue Tunnel Project components would primarily occur along Virginia Avenue SE in the vicinity of the Main Gate. Approximately 390 feet span between the project's limits of disturbance on 8th Street SE and the Main Gate's north NRHP boundary at 8th Street SE. No potential noise or vibration impacts to this structure have been identified as a result of project studies.

No physical impacts would occur to the Main Gate as a result of the Virginia Avenue Tunnel Project. No project activity would occur within the structure's NRHP boundary. Therefore, no effects to the structure's integrity of location, design, materials, and workmanship would occur.

Virginia Avenue Tunnel Project activity would have no effect to the Main Gate's integrity of setting. Project activity near the Main Gate would primarily occur along Virginia Avenue SE. Project activity that would not occur along Virginia Avenue SE would only be minimally visible from the structure's north façade. Approximately 390 feet span between the project's limits of disturbance and the north elevation of the Main Gate. Buildings and trees that line 8th Street SE substantially shield historically significant views to and from the structure, which is in an altered urban environment. Because no visual effects to the structure have been identified, project activity would have no effect to the character-defining features of the Main Gate's setting. Therefore, project activity would have no effect to the integrity of the Main Gate's setting.

Project implementation would not alter the structure's feeling as a nineteenth century Greek Revival-style gate, or its association with the style or as a grand entranceway into the Washington Navy Yard. Therefore, project implementation would have no effect to the Main Gate's integrity of feeling or association.

Based on this evaluation, the Virginia Avenue Tunnel Project would have no effect to the Main Gate of the Washington Navy Yard.

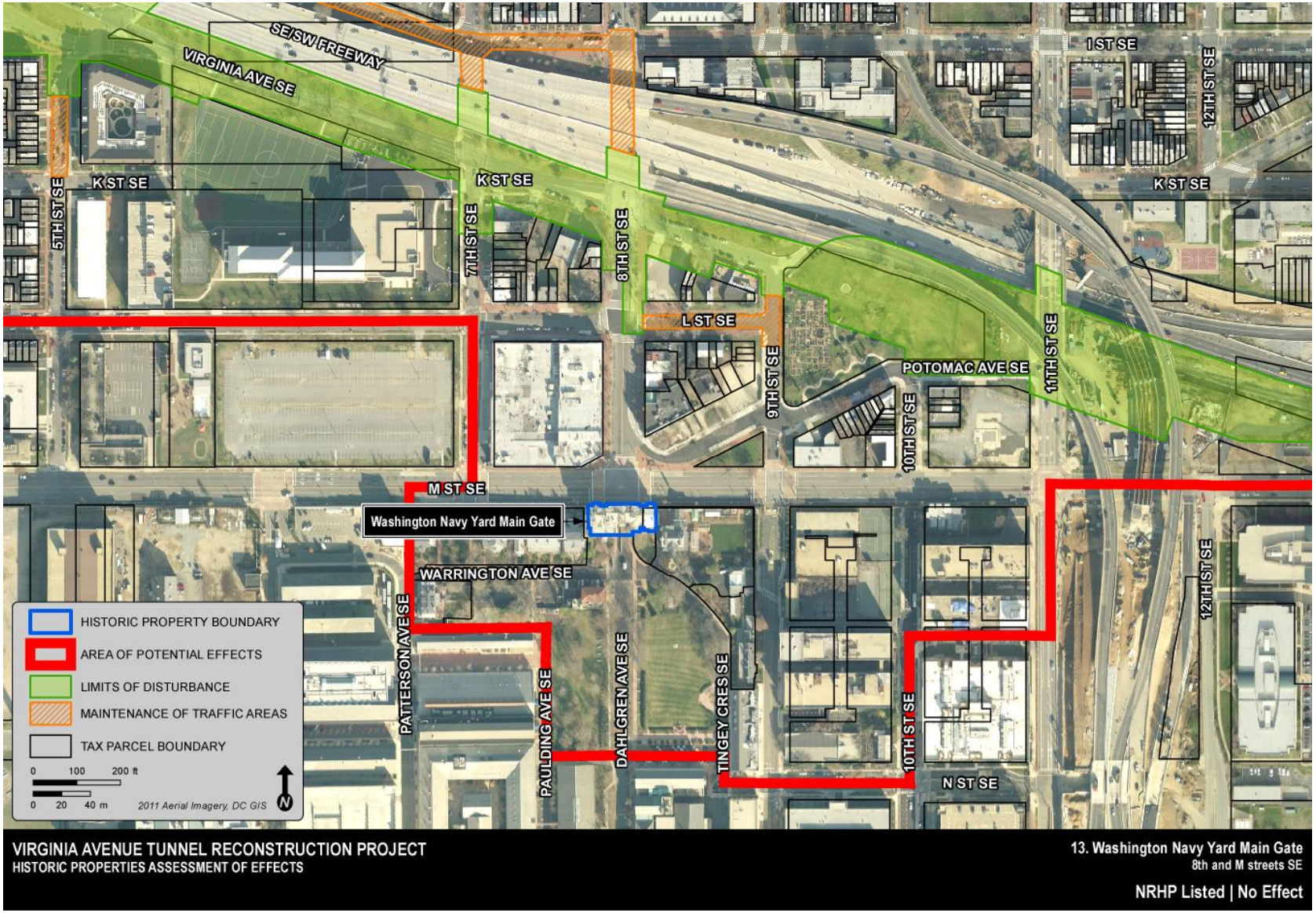


Figure 49. Proposed project in the vicinity of the Main Gate of the Washington Navy Yard.

Figure 50. View north toward Virginia Avenue SE from the Main Gate of the Washington Navy Yard, at 8th Street SE and M Street SE.

14. Tingey House (Commandant's House, Quarter's A)

East of the Main Gate and south of M Street SE within the Washington Navy Yard

Built by an unknown architect in 1804, the Tingey House is a two-and-a-half-story Georgian Revival-style house. Although alterations have occurred, most notably changes to windows, the building remains a good example of the style. The house is clad in Flemish bond brick, painted white. While the architect is unknown, the home is cited in Benjamin Latrobe's 1804 plan of the Washington Navy Yard. As one of the yard's earliest permanently built structures, the Tingey House survived the 1814 invasion of Washington, DC, and burning of the Washington Navy Yard. Formally known as the Commandant's House or Quarters A, the home received its popular name from the first Commandant of the Navy Yard, Captain Thomas Tingey, who occupied the residence from 1812 to 1829. Since that time, the home has served as the residence for all Washington Navy Yard Commandants. As an important figure in Washington, DC, Tingey played an active role in the development of the young city. The Tingey House is listed in the NRHP under Criterion A for its association with the development of the Washington Navy Yard and history of the United States Navy; under Criterion B for its association with Thomas Tingey and all subsequent Commandants of the Washington Navy Yard; and under Criterion C as an example of Georgian Revival-style architecture.

Near the Tingey House, Virginia Avenue Tunnel Project components would primarily occur along Virginia Avenue SE. Approximately 400 feet span between the project's limits of disturbance at L Street SE and the property's north NRHP boundary. No potential noise or vibration impacts have been identified.

No physical impacts to the Tingey House would occur as a result of the Virginia Avenue Tunnel Project components. No project activity is proposed within the property's NRHP boundary. Therefore, no effects to the property's integrity of location, design, materials, and workmanship would occur.

Project implementation would have no effect to the Tingey House's setting. The Tingey House is located within the Washington Navy Yard Historic District; the property is oriented to the south, facing into the Navy Yard. Buildings, mature trees, and the wall that encloses the Washington Navy Yard screen historically significant views to and from the property. All project activity would occur north of the Tingey House, approximately 400 feet from the property's north NRHP boundary. Therefore, project implementation would have no effect to the character-defining features of the property's setting. Thus, Virginia Avenue Tunnel Project activity would have no effect to the integrity of the Tingey House's setting.

Furthermore, no project activity would alter the property's feeling as a Georgian Revival-style home or its association with this style or as the residence of the Commandant of the Navy Yard. Therefore, project activity would have no effect to the Tingey House's integrity of feeling or association.

Based on this evaluation, the Virginia Avenue Tunnel Project would have no effect to the Tingey House.

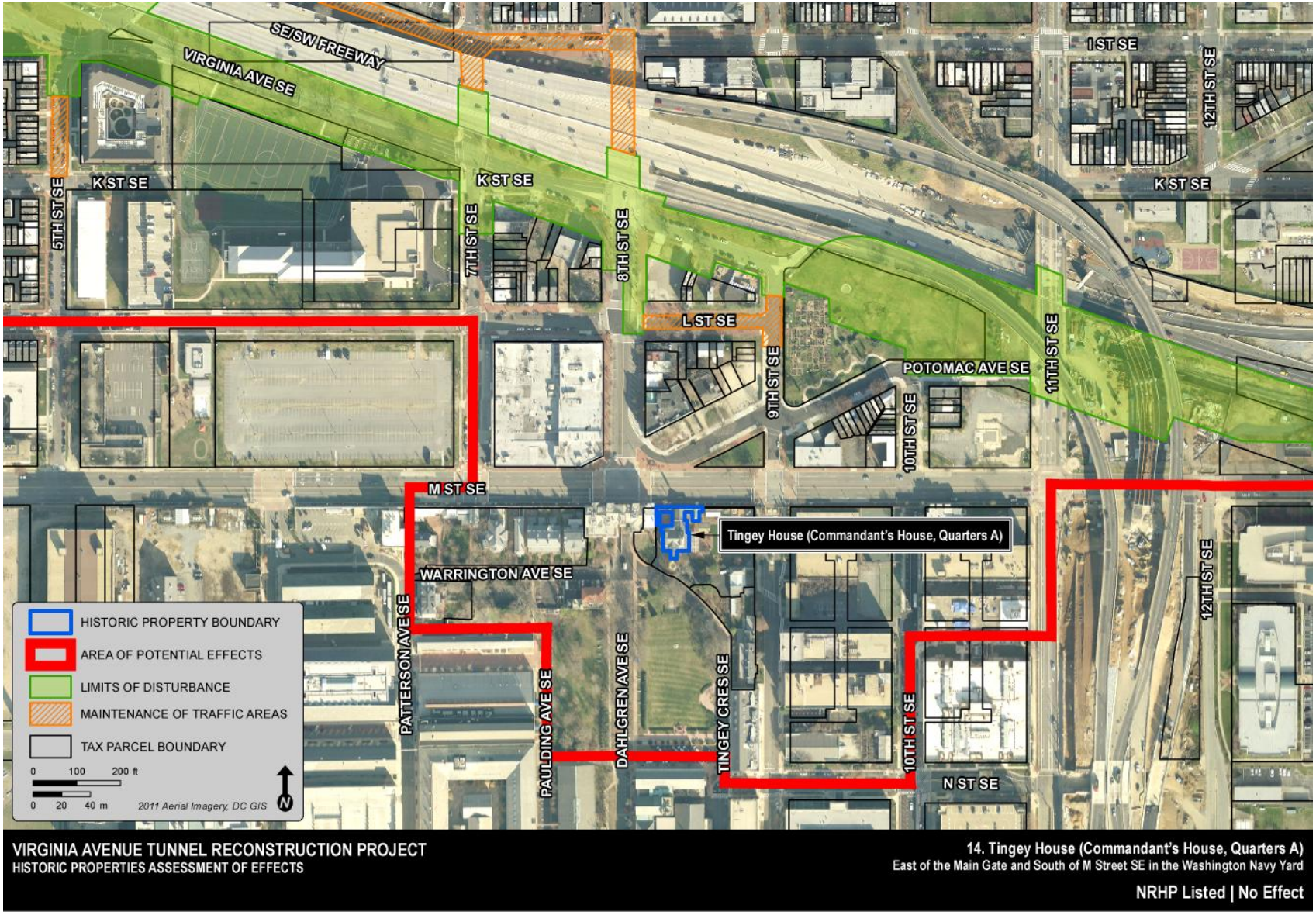


Figure 51. Proposed project in the vicinity of the Tingey House

Figure 52. View north toward Virginia Avenue SE on 8th Street SE, from outside the Washington Navy Yard Historic District and outside of the wall, facing away from the rear elevation of the Tingey House.

15. Second Officer's House (Quarters B)

Charles Morris Avenue in the Washington Navy Yard

The Second Officer's House, also known as Quarters B, has been substantially enlarged twice since its original construction in 1801. Presently, the Second Officer's House is a two-and-a-half-story Federal style brick house with a gable roof pierced by three dormers. A two-story flat-roof veranda projects outward from the main façade. The home is located in the northern portion of the Washington Navy Yard and has served as the home of the second officer of the yard during the majority of its existence. Originally, the superintendent of the Navy Yard and the officer of the Marines responsible for guarding the yard occupied the residence. It is believed that the home was divided into two quarters at this time; however, there is little evidence of the home's original floor plan. The Second Officer's House is listed in the NRHP under Criterion A for its association with the development of the Washington Navy Yard and the United States Navy and also under Criterion C for its use of character-defining elements of the Federal style.

Virginia Avenue Tunnel Project components would occur primarily along Virginia Avenue SE in the vicinity of the Second Officer's House. The project's limits of disturbance extend westward along L Street SE, approximately 650 feet from the property's north NRHP boundary. No noise or vibration impacts have been identified during project studies.

No physical effects to the Second Officer's House would occur as a result of the Virginia Avenue Tunnel rehabilitation and replacement. No project activity would occur within the property's NRHP boundary. Therefore, no effects to the property's integrity of location, design, materials, and workmanship would occur.

Project implementation would have no effect to the visual setting of the Second Officer's House. Located within the walls of the Washington Navy Yard, the property is oriented west and retains its historical setting. The wall that encloses the yard, mature trees and vegetation, and buildings within the district screen historically significant views to and from the property. All proposed project activity would occur north of the Second Officer's House—approximately 650 feet from the property's north NRHP boundary—and would not be visible from the property. The project would have no effect to the integrity of setting.

Furthermore, no project activity would alter the property's feeling as a Federal-style residence, or its association with the style or as the residence of the second officer of the yard. Therefore, project activity would have no effect to the property's integrity of feeling or association.

Based on this evaluation, the Virginia Avenue Tunnel Project would have no effect to the Second Officer's House.

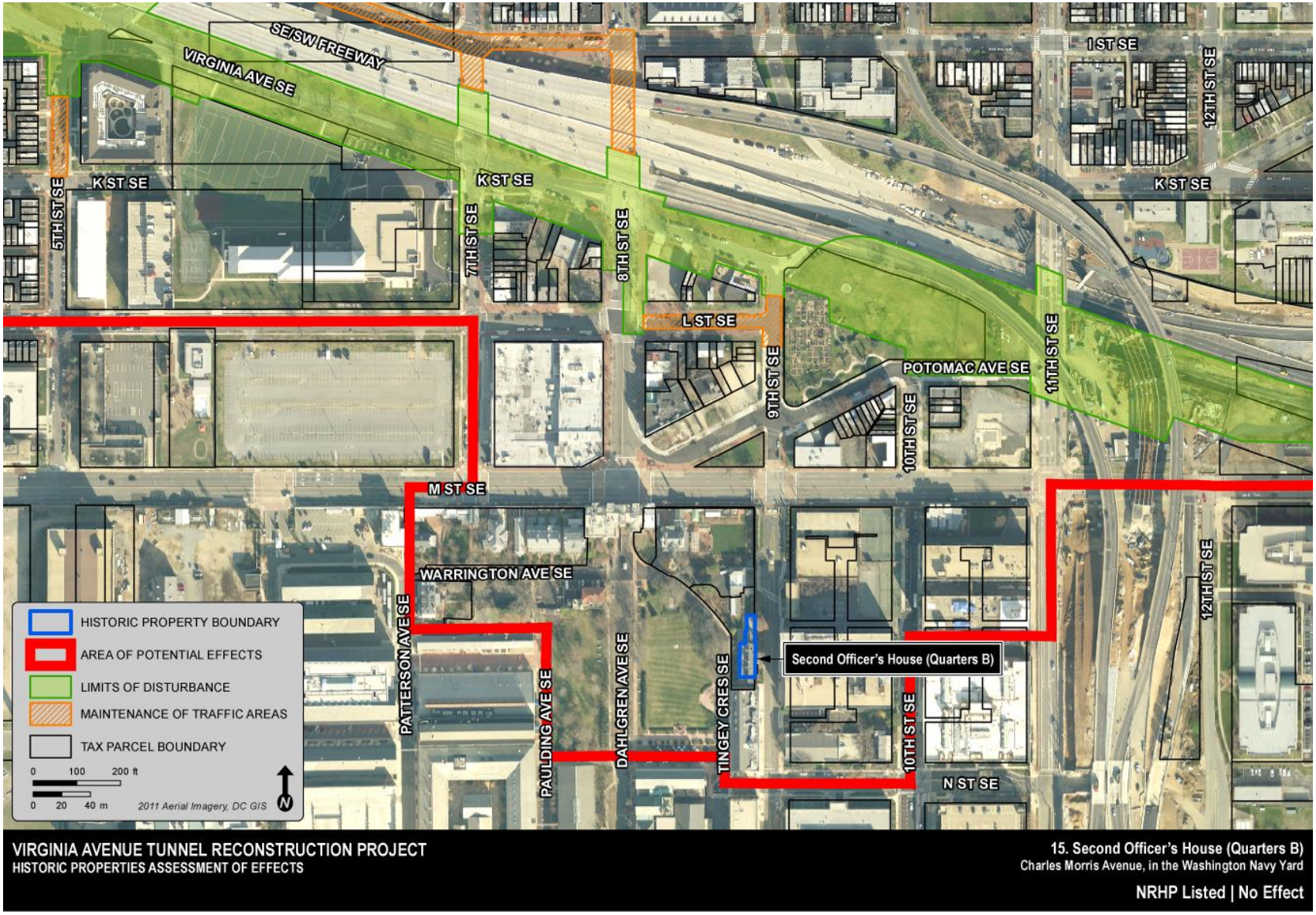


Figure 53. Project activity in the vicinity of the Second Officer's House

Figure 54. View north toward the vicinity of Virginia Avenue SE from 10th St SE, within the Washington Navy Yard East Extension, just east of the Second Officer's House. (Note that due to security limitations, photos from the Second Officer's House were not permitted.)

16. Washington Navy Yard East Extension

Bounded by M Street SE to the north, the Anacostia River to the south, and 2nd Street SE to the west

The Washington Navy Yard East Extension comprises the eastward development of the Washington Navy Yard that accommodated a greater complex of industrial buildings devoted to naval weapons development and testing. Carried out between 1902 and 1945, the most comprehensive building campaign occurred from circa 1918 to 1944, after the navy acquired a large portion of land in 1917. With World War I approaching, the Navy recognized the need for expansion; these buildings were crucial to the development of ordinance technology and naval weapons testing during World Wars I and II. The Washington Navy Yard East Extension is eligible for listing in the NRHP under Criterion A for its association with the development of ordinance technology and naval weapons testing crucial to the United States' twentieth-century wartime strength and the nation's role during World Wars I and II; it is also eligible under Criterion C for its extant collection of well-preserved industrial buildings associated with the yard's development of ordinance technology and testing of naval weapons during the first half of the twentieth century.

In the vicinity of the Washington Navy Yard East Extension, Virginia Avenue Tunnel Project activity would primarily occur along Virginia Avenue SE. Within the project's area of potential effects, the distance between the historic district boundary and the limits of disturbance is approximately 245 feet at their closest points. No potential noise or vibration impacts to the East Extension have been identified during project studies.

No physical impacts to the Washington Navy Yard East Extension would occur as a result of Virginia Avenue Tunnel Project implementation. No project components would occur with the East Extension's NRHP boundary. Therefore, no effects to the Washington Navy Yard East Extension's integrity of location, design, materials and workmanship would occur.

Virginia Avenue Tunnel project activity would have no effect to the Washington Navy Yard East Extension's integrity of setting. Project implementation would primarily occur along Virginia Avenue SE. From within the Washington Navy Yard East Extension project activity would not be visible due to the topography of the land, the wall that encloses the Washington Navy Yard, and the substantial commercial development separating the Washington Navy Yard East Extension from the project's limits of disturbance. Due to the enclosed nature of the Washington Navy Yard East Extension and the distance spanning between the projects north NRHP boundary and the project's limits of disturbance, project implementation would have no effect to historically significant views to or from the East Extension or the character-defining features of the extension's setting. Because no historically significant views would be obscured, no visual effects to the East Extension have been identified. Therefore, Virginia Avenue Tunnel Project activity would have no effect to the Washington Navy Yard East Extension's integrity of setting. Furthermore, project implementation would not alter the Washington Navy Yard East Extension's feeling as an early to mid-twentieth century industrial complex or its association with the development of ordnance technology or weapons testing carried out by the United

States Navy. Therefore, no impact to the Washington Navy Yard East Extension's integrity of feeling or association would occur.

Based on this evaluation, Virginia Avenue Tunnel project activity would have no effect to the Washington Navy Yard East Extension.

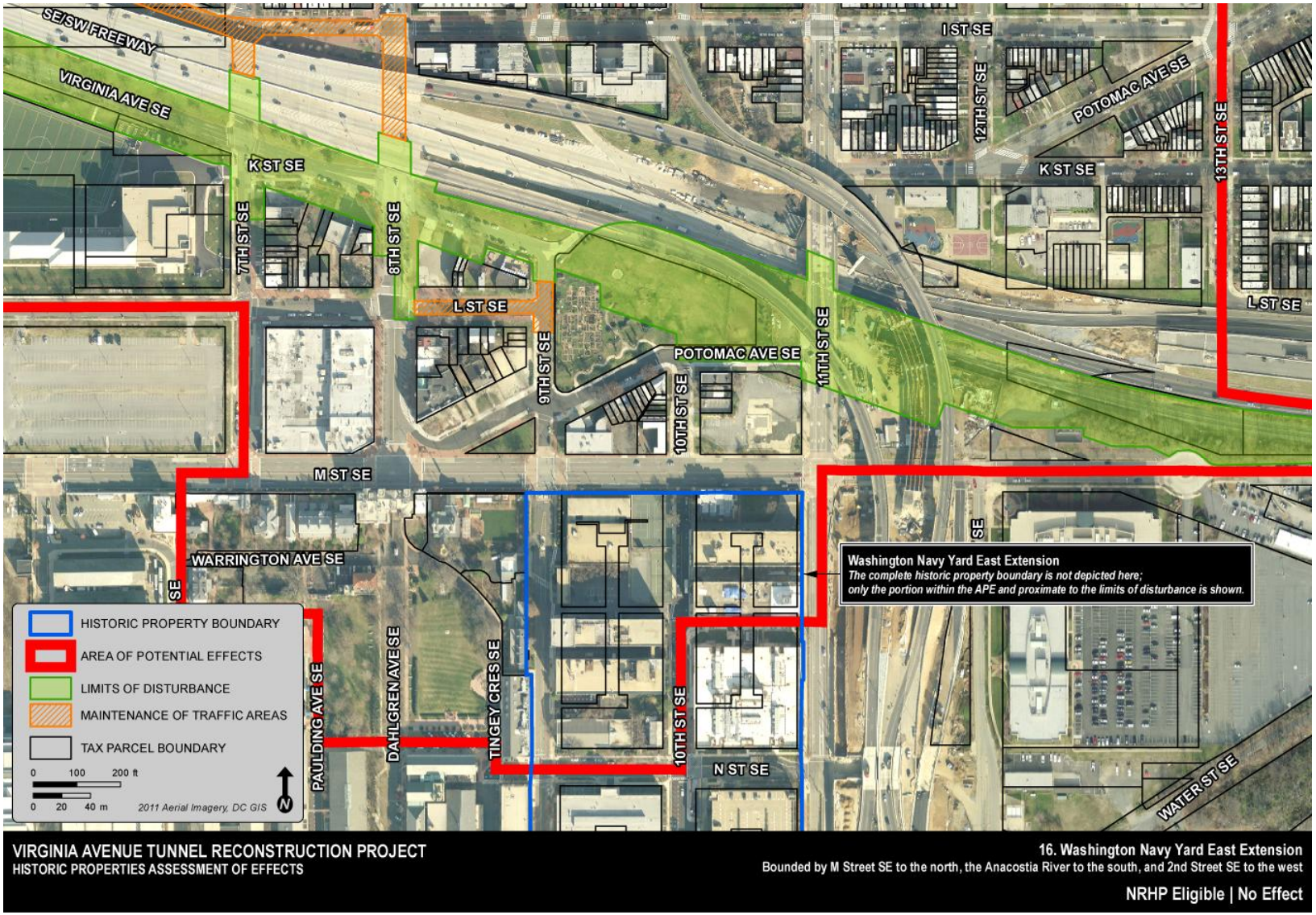


Figure 55. Project activity in the vicinity of the Washington Navy Yard East Extension

Figure 56. View north toward the vicinity of Virginia Avenue SE from within the Washington Navy Yard East Extension, at 10th Street SE

17. L'Enfant Plan of the City of Washington, DC

See map for the portion of the L'Enfant Plan that is within the project's APE.

The L'Enfant Plan of the City of Washington, DC, is a Baroque city plan with Beaux Arts components. Designed for the City of Washington by Pierre L'Enfant, the plan employs a regular orthogonal grid (which are the lettered and numbered streets in the district) that is intersected by diagonal, radiating avenues. Important contributing components of the L'Enfant Plan include parks, medians, avenues, and reservations. The L'Enfant Plan of the City of Washington, DC, is listed in the NRHP under Criterion A for its influence on city planning efforts nationwide; under Criterion B for its association with Pierre L'Enfant and other important organizations and designers; and under Criterion C as a well-preserved Baroque city plan with Beaux Arts modifications.

Project work will occur within the designated historic property boundary of the L'Enfant Plan. Project-related work would occur within the Virginia Avenue Park (Reservation 126), which is a contributing resource. According to the Project designers, construction staging will not be conducted within Virginia Avenue Park (Reservation 126). Construction staging, which includes materials stockpiling needed throughout the entire construction area and field offices, will be contained within CSX properties, in particular CSX's New Jersey Yard property. However, equipment, vehicles and materials needed to support construction activities specifically within Virginia Avenue Park between 9th and 11th streets will be stored within the project LOD within portions of the park for approximately two years. Project plans include restoration and historically appropriate enhancements to the park. Similarly, there will be construction-related impacts to Virginia Avenue SE; these direct impacts will not be permanent and the road will be restored to align with the L'Enfant Plan's intent after construction is complete. Therefore, there are no permanent impacts to the park and no adverse effects to the L'Enfant Plan's integrity of location, design, materials, and workmanship would occur.

The Virginia Avenue Tunnel Project activity would have an adverse effect to the L'Enfant Plan's integrity of setting. Section 106 guidelines stipulate that adverse effects can be cumulative and temporary. Project-related construction will represent a disruption within the historic boundary, and while none of these construction components, such as noise or vibration or visual effects, individually may cause an adverse effect, collectively they will change the setting of the historic district. While these effects are related to construction, and not long-term or permanent project impacts, the temporary construction impacts will constitute an adverse effect to the Virginia Avenue Park, a contributing resource to the L'Enfant Plan, and this will diminish the integrity of setting.

Project activity would not alter the plan's feeling as a significant city plan or its association with the early development of Washington, DC; the L'Enfant Plan, which extends well outside of the project's APE, will continue to convey significance. Therefore, no adverse effect to the L'Enfant Plan's integrity of feeling or association would occur.

Based on this evaluation Virginia Avenue Tunnel Project activity would have an adverse effect to the L'Enfant Plan of the City of Washington, DC.

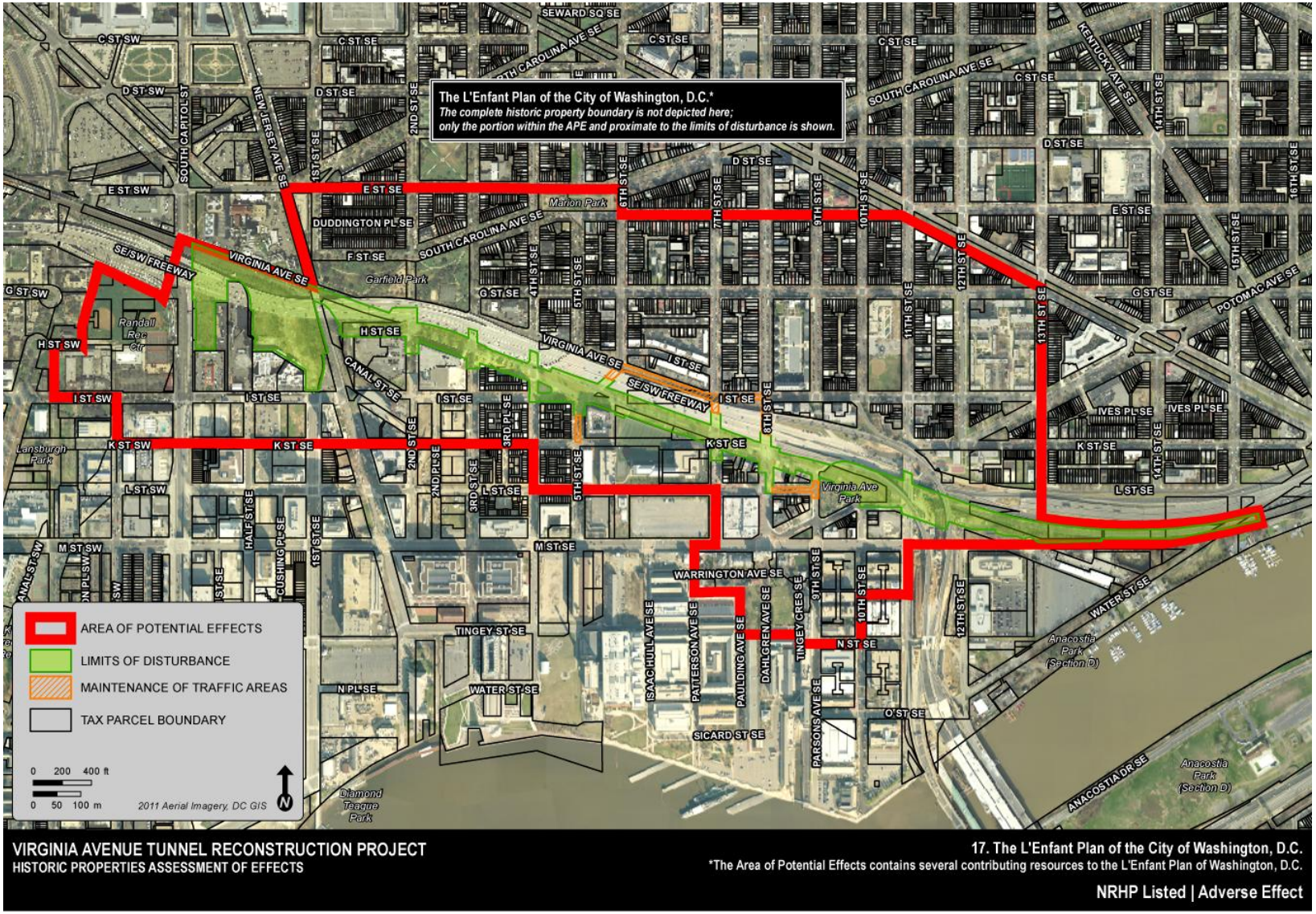


Figure 57. Project activity in the vicinity of the L'Enfant Plan of the City of Washington, DC

Figure 58. Virginia Avenue Park, Reservation 126, in the project vicinity

18. Virginia Avenue Paving

Block 999: Virginia Avenue (N), M Street (S), 11th Street (W) and 12th Streets (E)
DC HPO Site Number: 51SE062

Virginia Avenue Paving represents a subsurface archeological resource uncovered during Phase II archeological testing associated with the 11th Street Bridges project. The archeological feature represents three areas of intact cut granite block paving, located along the original alignment of Virginia Avenue. The archeological features are located on Block 999, between 11th and 12th Streets SE, bound to the north by Virginia Avenue SE and to south by M Street SE.

The paving is formed by quarried and cut granite blocks, measuring approximately 4 by 10 inches, and are dry laid directly into soil with no evident bedding or fill material. The blocks are laid in staggered rows, with the long dimension of the blocks parallel to the direction of vehicular traffic. Archival research suggests that these features are surviving remnants of the cut granite block paving along Virginia Avenue. They would appear to date to Mayor Sheppard's post-Civil War roadway improvements for the city and would have been laid by the 1880s. Although the majority of block paving would have been disturbed by subsequent roadway construction, these limited areas of intact paving survived and were eventually buried under fill soils. Given the existence of these areas of intact paving, it is anticipated that additional areas of buried block paving may still exist in the area, particularly along roadway margins and cross streets along Virginia Avenue.

Virginia Avenue Paving represents a significant part of the city's roadway network and is listed on the National Register of Historic Places as part of the L'Enfant Plan for the City Of Washington, DC. The staff of the DC SHPO has determined these archeological features to be contributing elements to the L'Enfant Plan, and therefore are considered to be an eligible historic archeological property. The paving is being assessed separately from the L'Enfant Plan because of the nature of the resource and the project impacts. Continuing consultation with the DC SHPO and other consulting parties will determine the appropriate treatment for any paving materials that may be discovered during the Virginia Avenue Tunnel project.

The Virginia Avenue Paving features are located in close proximity to the east portal of the Virginia Avenue Tunnel, and within the LOD. Given its location within the LOD, it has been determined that these features cannot be avoided during construction, and that their physical disturbance would constitute an adverse effect.

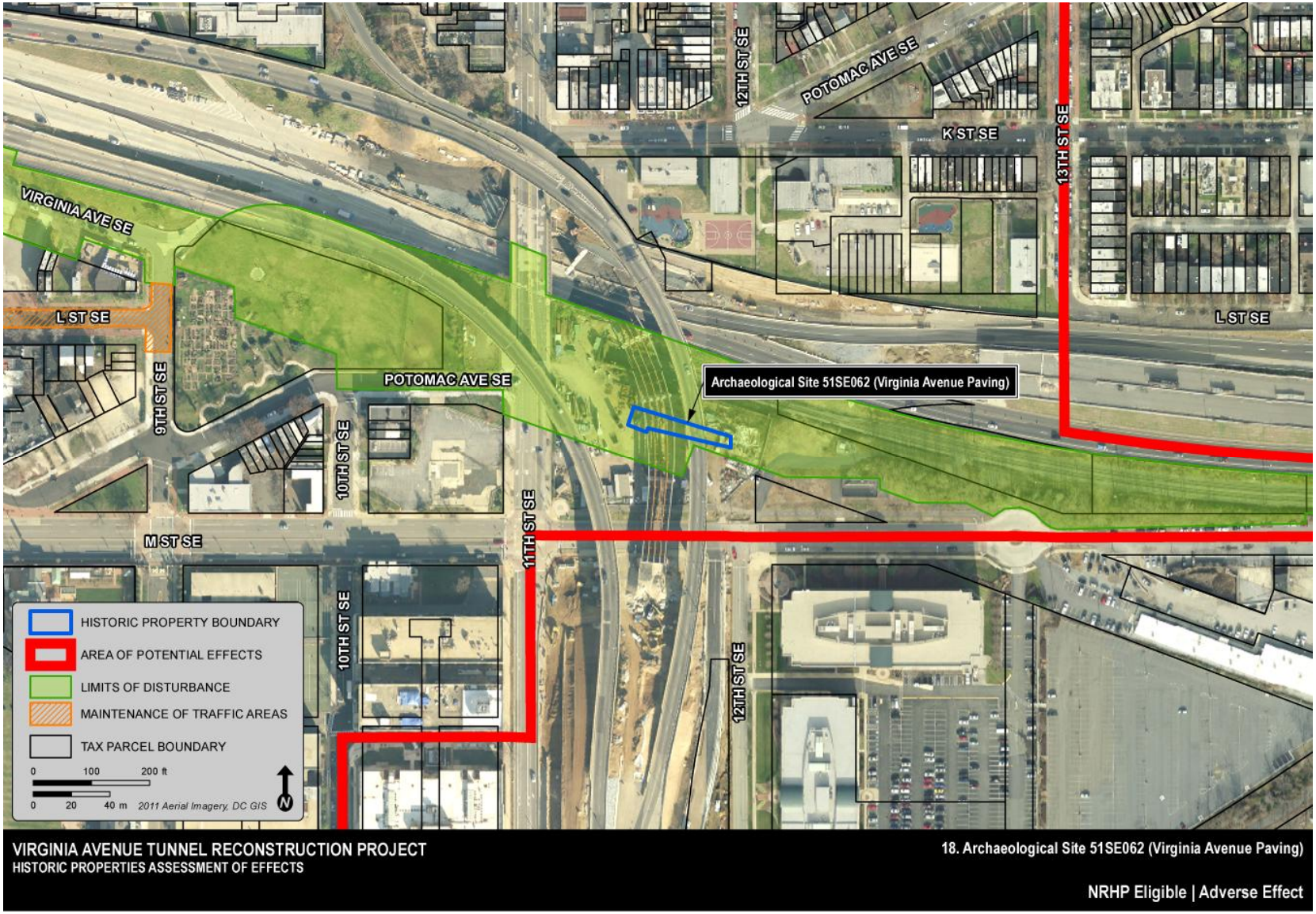


Figure 59. Project activity in the vicinity of Archeological Site 51SE062

Figure 60. Historic granite paving within the project vicinity

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Summary Matrix

The following matrix summarizes information regarding the historic properties within the Virginia Avenue Tunnel Reconstruction Project's APE, as well as the effects assessment for each property.

Effects Assessments for Historic Properties Located Within the Virginia Avenue Tunnel Reconstruction Project's Area of Potential Effects

HISTORIC PROPERTY IDEN-TIFIER	PHOTOGRAPH	NAME/LOCATION (Washington, D.C.)	DESCRIPTION	BUILD DATE	NRHP STATUS	NRHP CRITERIA	EFFECT ASSESS-MENT
1		Randall Junior High School (Francis L. Cardozo Elementary School) 61 I Street SW	1906 main block building is a 2-story 7-bay-wide structure clad in brick laid in Flemish bond with limestone trim and detailing accessed by a Colonial Revival entrance; a similar style freestanding building (1912) in brick was later attached to the main building via the west wing (1927); 1-story brick east wing (1927) houses the auditorium; later additions do not contribute to the property's significance.	1906, 1912, 1927; later alterations date from 1932-1973	Listed	A, C	No Effect
2		Capitol Police Horse Barn/Former DC Dog Pound Intersection of I Street SW and South Capitol Street	1-story I-plan utilitarian building clad in brick with a wide entry (infilled) and five stall openings along the west elevation; 1943 map labels building as "DC Pound," but originally built as Capitol Police Horse Barn.	Ca. 1915-1925	Eligible	A, C	No Effect

HISTORIC PROPERTY IDEN-TIFIER	PHOTOGRAPH	NAME/LOCATION (Washington, D.C.)	DESCRIPTION	BUILD DATE	NRHP STATUS	NRHP CRITERIA	EFFECT ASSESS-MENT
3		St. Paul AUMP Church 410 I Street SE	1.5-story Gothic Revival style rectangular church, with gabled asphalt roof; features arched windows, crenellated battlements, and a tower; Washington's second licensed African American architect, R.C. Archer Jr., designed the church; the only church in Washington that evolved from the oldest incorporated, independent African American denomination in the United States.	1924	Listed	A, C; Criteria Consider-ation A	Adverse Effect

HISTORIC PROPERTY IDEN-TIFIER	PHOTOGRAPH	NAME/LOCATION (Washington, D.C.)	DESCRIPTION	BUILD DATE	NRHP STATUS	NRHP CRITERIA	EFFECT ASSESS-MENT
4		Virginia Avenue Tunnel Located beneath Virginia Avenue; bounded by 11th Street SE near the south portal and 2nd Street SE near the north portal	Constructed by the Baltimore & Potomac Railroad with a cut and cover method in 1872; later extended in 1904; approximately 4,000 feet in length; provides railroad access to the district terminating at a depot near the present day National Gallery of Art .	1872, 1904	Eligible	A, C	Adverse Effect

HISTORIC PROPERTY IDEN-TIFIER	PHOTOGRAPH	NAME/LOCATION (Washington, D.C.)	DESCRIPTION	BUILD DATE	NRHP STATUS	NRHP CRITERIA	EFFECT ASSESS-MENT
5		Capitol Hill Historic District Roughly bounded by the United States Capitol and related buildings to west, F Street NE and Constitutional Avenue to the north, 14TH, 13th, and 11th streets SW to the east, and the Washington Navy Yard and Southeast-Southwest Freeway to the south	Primarily a residential area with 2 to 3-story row houses and small frame houses in a variety of architectural styles including Federal, Italianate, Greek Revival, Queen Anne, Romanesque Revival, and vernacular interpretations; began as boarding house community for members of Congress; one of the city's oldest and its largest residential community; includes contributing religious, commercial, institutional, and military buildings as well as several parks.	Late 18th to mid 20th century	Listed	A, C	Adverse Effect

HISTORIC PROPERTY IDEN-TIFIER	PHOTOGRAPH	NAME/LOCATION (Washington, D.C.)	DESCRIPTION	BUILD DATE	NRHP STATUS	NRHP CRITERIA	EFFECT ASSESS-MENT
6		Christ Church, Washington Parish 620 G Street SE	2.5-story Gothic Revival style rectangular plan building, stuccoed exterior with a 3-story square bell tower; has been significantly enlarged and altered since 1806-07; the City's first Episcopal parish; designed by Robert Alexander, often attributed to Benjamin Latrobe.	1806-07, 1924	Listed	A, C; Criteria Consider-ation A	No Effect
7		United States Marine Corps Barracks and Commandant's House Bounded by I Street SE to the north, 8th Street SE to the east, G Street SE to the south, and 9th Street SE to the west	Oldest continually active Marine Corps instillation in the United States; rectangular enclosed site with a central parade ground; Contributing properties 1) Commandant's House 2) Barracks and Band Hall 4) Officers' Quarters, a row of five houses located on the west side of the post; Barracks and Band Hall and Officer's Quarters are all clad in brick.	Early 19th to early 20th century	Listed; NHL	A, B, C	No Effect

HISTORIC PROPERTY IDEN-TIFIER	PHOTOGRAPH	NAME/LOCATION (Washington, D.C.)	DESCRIPTION	BUILD DATE	NRHP STATUS	NRHP CRITERIA	EFFECT ASSESS-MENT
8		Marine Corps Commandant's House 801 G Street SE	2.5-story Federal style Flemish bond brick painted white structure; later historic alterations include the brick addition at the northeast corner (1840); mansard roof and hooded dormers (1891).	1801-06, 1840, 1891	Individually listed in the NR; Contributing resource to the NHL United States Marine Barracks and Commandant's House Historic District	A, C	No Effect
9		Marine Corps Barracks 8th and I Streets SE	Two ranges of barracks border the south and east sides of the rectangular sites; both barracks possess an arcaded loggia, uniform limestone stringcourse, and a hipped roof; 2.5-story east range of barracks feature two 2.5-story pavilions and one 3.5-story pavilion that project beyond the façade; replaced original barracks that were built in 1802.	1903-07	Individually listed in the NR; contributing resource to the NHL United States Marine Corps Barracks and Commandant's House Historic District	A, C	No Effect

HISTORIC PROPERTY IDEN-TIFIER	PHOTOGRAPH	NAME/LOCATION (Washington, D.C.)	DESCRIPTION	BUILD DATE	NRHP STATUS	NRHP CRITERIA	EFFECT ASSESS-MENT
10		Marine Corps Band Hall 8th and I Streets SE	2.5-story south range of barracks is commonly referred to as the Band Hall; first floor contains a guard shack, band offices, and the Sousa Band Hall.	1903-07	Eligible	A, B, C	No Effect
11		Washington & Georgetown Railroad Car House 770 M Street SE	Romanesque Revival style building clad in brick with concrete detailing; original façade is extremely ornate and features semi-circular arches, a parapet, blind arrow slits, and angle towers; an addition is less ornate but mimics the medieval stylistic references of the original building; only extant Washington & Georgetown Railroad Company facility.	1891, 1909	Listed	A, C	No Effect

HISTORIC PROPERTY IDEN-TIFIER	PHOTOGRAPH	NAME/LOCATION (Washington, D.C.)	DESCRIPTION	BUILD DATE	NRHP STATUS	NRHP CRITERIA	EFFECT ASSESS-MENT
12		Washington Navy Yard Historic District 8th and M streets SE (Main Entrance), bounded by the Anacostia River to the south	Late Victorian-era 42 acre district, includes approximately 45 major historic buildings and structures as well as numerous support buildings; design initiated by Benjamin Latrobe—selected by Thomas Jefferson; served as a site for naval shipbuilding and later for naval gun manufacture; individually listed properties within the district include the Main Gate, Tingey House (Commandant's House, Quarters A), and Second Officers House (Quarter's B).	19th to 20th Century	Listed, NHL	A, B, C	No Effect

HISTORIC PROPERTY IDEN-TIFIER	PHOTOGRAPH	NAME/LOCATION (Washington, D.C.)	DESCRIPTION	BUILD DATE	NRHP STATUS	NRHP CRITERIA	EFFECT ASSESS-MENT
13		Washington Navy Yard Main Gate 8th and M streets SE	Greek Revival structure that was incorporated into the façade of a three-story Late Victorian-era building (1880-81); Clad in Flemish bond brick, heavily stuccoed and painted white; designed by Benjamin Latrobe.	1805-06	Individually listed in the NR; contributing resource to the NHL Washington Navy Yard Historic District	A, C	No Effect
14		Tingey House (Commandant's House, Quarters A) East of the Main Gate and South of M Street SE within the Washington Navy Yard	2.5-story Flemish bond brick structure; originally a Late Georgian townhouse; has been altered during the Victorian era by the addition and lengthening of windows.	1804	Individually listed in the NR; contributing resource to the NHL Washington Navy Yard Historic District	A, B, C	No Effect
15		Second Officer's House (Quarters B) Charles Morris Avenue within the Washington Navy Yard	2.5-story Federal style gabled roof brick structure painted white; two flat-roof verandas project from the façade; has been substantially enlarged twice (dates unknown).	1801	Individually listed in the NR; contributing resource to the NHL Washington Navy Yard Historic District	A, C	No Effect

HISTORIC PROPERTY IDEN-TIFIER	PHOTOGRAPH	NAME/LOCATION (Washington, D.C.)	DESCRIPTION	BUILD DATE	NRHP STATUS	NRHP CRITERIA	EFFECT ASSESS-MENT
16		Washington Navy Yard East Extension Bounded by M Street SE to the north, the Anacostia River to the south, and 2nd Street SE to the west	Eastward development of the existing Washington Navy Yard beginning in 1902 with the most comprehensive building campaign dating from circa 1918-1944; work conducted in this portion of the Navy Yard was critical to naval weapons development and testing during World Wars I and II.	1902-1945	Eligible	A, C	No Effect

HISTORIC PROPERTY IDEN-TIFIER	PHOTOGRAPH	NAME/LOCATION (Washington, D.C.)	DESCRIPTION	BUILD DATE	NRHP STATUS	NRHP CRITERIA	EFFECT ASSESS-MENT
17		L'Enfant Plan of Washington, D.C. Roughly bounded by Florida Avenue from Rock Circle NW to 15 Street NE, south to C Street, and east to the Anacostia River	Baroque city plan with Beaux Arts modifications; designed by Pierre L'Enfant; regular orthogonal grid with numerically and alphabetically designated streets, intersected by diagonal avenues; historic and contemporary system of parks and medians; 1901-02 McMillan Commission recommendations resulted in physical changes for urban development Contributing features include but are not limited to avenues, parks, and reservations.	1792, 1902	Listed	A, B, C	Adverse effect

HISTORIC PROPERTY IDEN-TIFIER	PHOTOGRAPH	NAME/LOCATION (Washington, D.C.)	DESCRIPTION	BUILD DATE	NRHP STATUS	NRHP CRITERIA	EFFECT ASSESS-MENT
18		Virginia Avenue Paving-51SE062 Former Square 999	Historic paving material located beneath original location of Virginia Avenue	19th century	Eligible	D	Adverse Effect