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Appendix C: Noise and Vibration Analysis Report
1.0 Introduction

The Virginia Railway Express (VRE) system is currently operating near capacity, and ridership demand is forecasted to continue growing. VRE is exploring ways to meet that growth. Lengthening existing peak period trains to add capacity is one of the primary near- to medium-term strategies being considered to meet future commuter rail demand. VRE will need to make improvements to some of their existing stations, including the VRE Crystal City Station, to accommodate those longer trains.

VRE has begun the process to identify a preferred alternative for a station location in Crystal City and develop a conceptual design for the expansion of the VRE Crystal City Station. The station expansion will feature:

▪ Platform extension to accommodate up to 10-car trains
▪ Platform relocation to provide two platform edges that accommodate VRE trains
▪ Up to two grade-separated access points to the platform
▪ Optimized multimodal connectivity in the station area

This report describes existing and future conditions in the VRE Crystal City Station area, the proposed station location concepts to address the anticipated changes, the process for evaluating the concepts in relation to the Project goals and objectives, and the results of the evaluation.
2.0 Summary of Existing Conditions

VRE System Overview

VRE operates weekday commuter rail service between Washington, DC, and Northern Virginia on two lines that run between Union Station in the District of Columbia to Fredericksburg and Manassas, respectively. VRE serves a total of 19 stations, with 17 located in Virginia and two in Washington, DC. The two lines share tracks and serve four common stops—Union Station, L’Enfant, Crystal City, and Alexandria—at the northern end of the system, with the lines diverging south of the Alexandria station. VRE’s system and stations are illustrated in Figure 1.

Figure 1: VRE System and Stations

Source: VRE, 2040 Report
VRE provides service on approximately 90 miles of railway and carries an average of 19,500 daily trips, near the system’s capacity. A 2013 Metropolitan Washington Council of Governments (MWCOG) report indicated VRE transported 11 percent of the morning peak hour trips from Virginia to Washington, DC, across the 14th Street Bridge corridor. With most of VRE’s ridership living in suburban Northern Virginia communities and working in the urban cores of Alexandria, Arlington, and Washington, DC, nearly all of VRE’s service is focused on peak-hour trips in the peak direction (i.e., inbound in the morning peak, outbound in the evening peak). VRE runs 32 revenue trains each weekday—16 on the Fredericksburg Line and 16 on the Manassas Line. Trains operate on approximately 20- to 30-minute headways on each line in the peak direction. Boardings and alightings at each of VRE’s stations are shown in Figure 2.

Figure 2: VRE Station Boardings and Alightings

1 The 14th Street Bridge corridor includes the vehicles traveling across the 14th Street Bridge and passengers riding Metrorail, VRE, and Amtrak across the river.
Crystal City VRE Station
Almost 840,0002 trips originate or terminate at the VRE Crystal City Station each year, making it one of the most heavily used stations in the VRE system. Based on the October 2016 VRE rider survey, the vast majority of riders who alight at this station head to destinations in Arlington County. The majority (69 percent) of riders walk to their destination, while 18 percent connect to their destination via Metrorail, and 6 percent connect via bus (see Figure 3). Riders who walk primarily head to destinations in Crystal City. Some riders walk as far as Pentagon City and the Pentagon, approximately 1 mile from the station. (Figure 4)3

Figure 3: 2016 Crystal City VRE Station Egress Mode

The VRE Crystal City Station is located on the eastern edge of the Crystal City neighborhood of Arlington County. Crystal City is an urban neighborhood and a major regional employment center. VRE trains run on the CSX Transportation (CSXT) railroad which lies between Reagan National Airport and Crystal City. The station itself is approximately 200 feet east of Crystal Drive, between 15th Street South and 18th Street South. The station is the northernmost VRE station in Virginia, and is located approximately 1 mile south of the Long Bridge, the CSXT bridge across the Potomac River.

The existing platform is about 400 feet long, and is not of sufficient length to accommodate all VRE trains. Currently, passengers disembarking at the VRE Crystal City

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2 Source: 2017 Virginia Railway Express Ridership Survey
3 Source: 2016 Virginia Railway Express Master Agreement Survey Destinations
Station need to alight from the forward-most four cars only. The existing platform is a side platform and is served by only one of three tracks (Track 3). The current platform location does not allow for northbound and southbound trains to serve the platform at the same time.

Pedestrians access the station by a sidewalk connected to Crystal Drive, just north of the Water Park between 15th and 18th Streets South. There is no dedicated parking available at the station, although numerous privately owned garages with parking available to the public and metered street parking spaces are located throughout Crystal City. Multimodal connections available within close proximity of the station include Metrorail, Metroway, local bus, car share, bikeshare, bike racks, and trail and sidewalk connections. The sidewalk network is well developed in Crystal City.

Figure 4: Crystal City Destinations

Source: 2016 VRE Rider Survey
Near the VRE Crystal City Station, the curb-to-curb width of Crystal Drive is about 58 feet. The cross-section from west-to-east features: a parking lane; a southbound bike lane; a southbound travel lane; a two-way turn lane; a northbound travel lane; a northbound peak period bus-only lane; and a northbound bike lane.

There are three high-visibility crosswalks on Crystal Drive near the VRE station. The first is located approximately 270 feet to the north of the VRE station, at the intersection of Crystal Drive and 15th Street South. The second is a midblock crosswalk with a pedestrian-activated signal, located adjacent to the VRE station entrance. This crossing gives pedestrians access to the Crystal City Underground and indoor connections to the Metrorail Crystal City Station 0.2 miles away. The third is located nearly 550 feet to the south of the VRE station, at the intersection of Crystal Drive and 18th Street South.

During field observations conducted in February 2017, 30 percent of pedestrians leaving the VRE Crystal City Station headed south. The greatest number of pedestrians (45 percent) crossed at the midblock crossing. Some of these pedestrians likely headed to transit connections at the Metrorail Crystal City Station. Pedestrians traveling north, representing about 25 percent of all pedestrians, tended to use the sidewalk along the east side of Crystal Drive. Some of these pedestrians then used the marked crosswalk at the intersection of Crystal Drive and 15th Street South to reach the west side of the street (see Figure 5).
Crystal City Neighborhood

The Crystal City Metro Station Area is located along the Blue and Yellow Metrorail corridor in Arlington County, and is generally bounded by the Potomac River and Pentagon Reservation to the north, South Fern Street and South Eads Streets to the west, Four Mile Run to the south, and the George Washington Memorial Parkway to the east. The area's mixed-use development pattern initially emerged in the 1960s, and since then the area has been predominantly developed with medium- to high-density office, residential, hotel and retail development. While it was originally built with an automobile-oriented and pedestrian hostile street grid, more recent augmentations have incrementally made the area a more walkable place.

Crystal City is notable for its large blocks with multiple mid-rise office, residential, and hotel towers rising from unifying plinths, which stand in contrast to the low-rise character of surrounding neighborhoods nearby. The heart of Crystal City – between US Route 1 and Crystal Drive – is zoned primarily for a mix of high-density office, residential and hotel uses, with some first-floor retail uses fronting Crystal Drive. The area east of Crystal Drive is primarily zoned for low-density commercial, residential, and hotel uses, and existing development includes several privately owned public spaces.

With more than 38,000 jobs located in Crystal City, the neighborhood is a major regional employment center. Federal agencies, trade associations, and private-sector firms supporting government functions are in the neighborhood. The VRE Crystal City Station is

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4 Source: MWCOG Cooperative Forecast Round 9.0 Crystal City 2015 Employment
also located near multiple other major employment centers, including the Pentagon (~1 mile), the Rosslyn-Ballston corridor (~3 miles), and downtown Washington, DC (~3 miles).

Crystal City is home to more than 10,000 residents, most living in one- or two-person households in one of the neighborhood’s many high-rise residential buildings. The largest share of residents fall in the 25- to 34-year-old age group. More than 75 percent of housing units in Crystal City are rentals.

To support the tenants of the high-density office and residential development in Crystal City, the neighborhood also has a considerable level of commercial retail activity. Historically, most of Crystal City’s retail could be found in “the Underground”, a climate-controlled, interior pedestrian concourse that is subterranean in places. Highly valued by the community, the Underground is embraced by the Sector Plan vision and is planned for retention, although it is expected to evolve over time. More recently, property owners have focused on adding street-facing retail spaces where possible, which has allowed spaces in the Underground to support a more diverse range of tenants, such as maker space, art, and gallery space uses. Based on the County’s plans, the future or retail in Crystal City will involve a strategic balance between vibrant street-level commercial uses and diverse neighborhood serving uses in the Underground, both of which will promote and support multimodal connectivity.
Station Area Transportation Network

Crystal City has a comprehensive multimodal transportation system that, in addition to commuter rail, includes Metrorail, Metroway (bus rapid transit), local bus, bikeshare, car share, and trail and sidewalk connections (see Figure 6).

Figure 6: Multimodal Station Connectivity

Metrorail

The entrance to the Metrorail Crystal City Station is located at the intersection of 18th Street South and South Bell Street, approximately two blocks from the VRE Crystal City Station. The Metrorail Crystal City Station is served by the Blue and Yellow lines, which provide a one-seat ride to the Pentagon, Rosslyn, and Washington, DC. The current VRE Crystal City Station is a 5-minute walk from the Metrorail Crystal City Station, making it a relatively convenient transfer between both systems.

Metroway

Metroway is the region’s first bus rapid transit (BRT) service operating within the Crystal City Potomac Yard Transitway connecting the Metrorail Pentagon City and Braddock Road Stations. The service operates on a 12-minute frequency during daytime hours, and every 15 minutes in the evening. There are seven Metroway stops in Crystal City. These include stops at 18th Street South and Crystal Drive near the existing VRE Crystal City Station, and the Metrorail Crystal City Station.
MetroBus
Metrobus provides two regional service routes near the VRE Crystal City Station.
- 23A & 23B – McLean-Crystal City
- 10N – Pentagon-DCA late night and weekend service

ART Bus
Arlington Transit provides two local bus service lines near the VRE Crystal City Station.
- ART 43 – Courthouse – Rosslyn – Crystal City
- ART 92 – Crystal City – Long Bridge Park/Boeing - Pentagon

Other Bus
Fairfax Connector provides an express bus connecting Reston with the Pentagon, Pentagon City, and Crystal City. The Department of Defense also operates several shuttles that pick-up riders from the Metrorail and VRE stations and takes them to various locations within the area. Both Loudoun County Transit and OmniRide commuter buses serve the Crystal Drive corridor, with stops near the VRE station.

All the above ART and Metrobuses stop at the Multimodal Center, making it a hub for connectivity in the neighborhood.

Bicycle
Commuters that travel to Crystal City have the option of using a bicycle to reach their destination. Collapsible bicycles are allowed on all VRE trains and full size bicycles are conditionally allowed on some trains. There are bike lanes, marked shared lanes (sharrows), and several Capital Bikeshare stations throughout Crystal City. There are bike lanes on Crystal Drive and Capital Bikeshare stations near the VRE Crystal City Station at Crystal Drive and 15th Street South and in front of the Metrorail Crystal City Station.
Car Share

Three car sharing companies operate in Crystal City and Pentagon City:
- Zipcar – There are 13 Zipcars at six nearby locations (13th & Eads, 18th & Eads, 15th & Fern, 12th & Elm, 20th & Bell, and 20th and Crystal Drive)
- Enterprise CarShare – one vehicle in Crystal City (20th & Eads)
- Car2go – Car2go vehicles may park in any legal parking space in Arlington and Washington, DC. Participants use a smart phone to find an available car.

Reagan National Airport

Reagan National Airport is located very close to Crystal City, but the existing CSXT tracks and George Washington Memorial Parkway create a physical barrier that makes access difficult. An existing sidewalk connects Crystal Drive to the airport using the ramp from the Airport Access Road and the airport access road itself. This connection is circuitous, and involves traveling south along the trail for a short distance before taking a tunnel below the airport West Entrance Road to arrive at Parking Garage B/C on airport property. Additionally, there is a pedestrian and bicycle connection from the 1700 block of Crystal Drive to the Mount Vernon Trail, which leads to airport access trails. The trail passes through a tunnel under the tracks just south of the VRE station and a path under the parkway on the side of one of its exit ramps.

Trail Connection

The Mount Vernon Trail has a connection to Crystal Drive just north of 18th Street South. The Trail is an 18-mile off-street hard surface trail that extends from Mount Vernon to Theodore Roosevelt Island. The trail connects to other trails in Arlington, Fairfax County, and the District of Columbia.

Sidewalk and Pedestrian Connections

Crystal City has a well-developed sidewalk network that allows VRE riders to easily reach most areas of Crystal City, Pentagon City, and the Pentagon. Crystal City is also notable for a series of public interior pedestrian concourses provided within private developments. These interior routes enable pedestrians to access different sections of Crystal City in a covered and climate-controlled environment.
3.0 Anticipated Changes

The following section provides a review of some of the pertinent planning reports that describe the future changes proposed for the Crystal City geographic area and VRE service. These proposed changes will be taken into consideration as part of the expansion of the VRE Crystal City Station.

VRE System Plan 2040

The VRE System Plan 2040 identifies a variety of investments and actions that will allow VRE to best meet regional travel needs over the next 25 years. Those actions range from near-term investments in equipment, station improvements, and storage to longer-term investments in expanded service and system growth.

The VRE System Plan 2040 lists several recommendations that would directly impact service and operations at the VRE Crystal City Station, including:

- Relocation and reconfiguration of the VRE Crystal City Station
- Expansion of the two-track Long Bridge Potomac River crossing to accommodate four tracks
- Construction of a fourth main track between the Potomac River and Alexandria

Expansion of the Long Bridge and construction of a fourth mainline track are not VRE projects, but would play a major role in VRE’s ability to grow service. The Long Bridge expansion is necessary to accommodate more VRE and possibly Maryland Transit Administration (MTA) MARC Rail Service trains traveling between Virginia and the District. The fourth mainline track would also provide needed rail capacity in the heavily-trafficked corridor.

VRE Ridership Growth

According to the VRE System Plan 2040, the Washington, DC metropolitan region’s population is forecasted to increase by approximately 2 million people between 2010 and 2040, and the region is expected to add 1.6 million new jobs. More than half of the region’s forecasted population increase is slated to occur in Virginia, and a third of the additional jobs will be in the region’s inner jurisdictions, including Washington, DC and Arlington County. Given this projected population and employment growth in the VRE service area, commuter rail demand in Northern Virginia is expected to increase as well.

Sustained VRE ridership growth depends on increasing carrying capacity. Increasing capacity depends on planned station improvements, track expansions, and service changes.
VRE estimates that by adding two additional trains per direction (to the maximum number of trips currently allowed on CSXT tracks) and using eight-car trains for every trip, system ridership would grow by 1,920,000 trips annually (41 percent) to 6,600,000 per year in 2040.\(^5\) With expanded track capacity, VRE will be able to implement additional service along with station improvements. Under these assumptions, ridership would grow more than 136% to 11,064,000 trips per year.

**Changes in VRE’s Market**

Even without changes to service, tracks, and station configurations, demand for commuter rail in Northern Virginia is expected to grow due to significant growth in population and employment. The Fredericksburg Line is anticipated to see a greater increase in demand than the Manassas Line due to greater forecasted population growth along the I-95 corridor.

Implementing recommendations for service changes, track expansion, and station improvements would expand VRE’s market significantly by 2040. Those changes may include:

- **Reverse-peak travel.** Future job growth outside the urban core is expected to exceed growth inside the core by 2040. Some of the greatest regional job growth is forecasted to occur in the VRE service area, in locations such as Fort Belvoir, Quantico, and the Route 1 corridor in Fredericksburg, Prince William County, and Stafford County (Fredericksburg Line), and in western Prince William County (Manassas Line). This service could provide a new means for DC residents to access jobs in Crystal City, or Arlington County residents to access jobs further south in Virginia. VRE 2040 estimates that reverse-peak service could generate 672,000 new weekday trips over the course of a year.

- **Off-peak travel.** The addition of midday and off-peak evening trips would serve both work-related and non-work trips, and would attract a new market segment in addition to the traditional commuters who may be inclined to use VRE due to increased options and flexibility. Off-peak service could add an estimated 1,224,000 new weekday trips annually.

- **Short-haul trips within the inner core (Alexandria to Union Station).** Capacity on VRE trains is set based on the maximum load point at Alexandria Station, so there are typically open seats in the morning north of the Alexandria station, and travel times between Alexandria and Union Station (including Capitol Hill and NoMA) are competitive with Metrorail. VRE operates on average 15-minute headways into the District in the morning.

\(^5\) As described on its System Plan 2040, VRE intends to use eight-car trains in the near term (2015-2020) and ten-car trains in the long term (2031-2040).
The current fare to ride from Crystal City to L’Enfant or Union Station is $6.75. If VRE fares between inner core stations were adjusted to be more competitive with Metrorail fares, VRE 2040 estimates those short-haul trips would generate approximately 345,600 new weekday trips each year. The price for that same trip via Metrorail or Metrobus is between $2.00 and $2.25 from Crystal City to L’Enfant during peak hour service, and between $2.00 and $2.75 from Crystal City to Union Station during peak hour service.

VRE saw a spike in ridership during certain periods of the Metrorail SafeTrack project. During a surge in summer 2016, VRE set single-day records up to 23,309 individual trips (up from 19,500 on a typical day) due to riders switching to VRE from Metrorail. This increase indicates that Metrorail riders can view VRE as a viable alternative to access the District, if fares were more equivalent to Metrorail and riders knew how to access VRE service. If VRE fares were revised for these shorter trips, new riders may be attracted to fill seats that have been vacated by the large number of riders alighting in Crystal City. Reverse commute trips might also increase with a similar fare change, making outbound morning trips from Union Station more productive than they are currently.

- **Gainesville-Haymarket Extension.** Improving Manassas Line service has been studied for several years. An alternatives analysis determined that the goals could be achieved most cost effectively by terminating service at the existing Broad Run Terminal. In the short term, VRE is looking to add cars to existing trains. VRE is looking to add additional trains in the long term. The expansion of service on the Manassas Line is forecasted to generate 744,000 new weekday trips each year.

- **Run-through MARC rail service.** Implementing run-through MARC service would require expanded CSXT corridor capacity, especially in the Long Bridge corridor, and existing railroad operating agreements. The market for run-through service would be largely for weekday trips, but the actual potential volume of ridership is unknown at this time.

These proposed service modifications have the potential of expanding the residential market for Crystal City jobs and maximizing the economic competitiveness of Arlington County beyond the forecasted growth in ridership. Some of these changes would likely have a larger impact on ridership growth at the VRE Crystal City Station specifically. Extension of MARC Rail Service introduces the potential for a one-seat ride to Virginia for District and Maryland residents. Facilitating short-haul trips by modifying fares to make them more competitive with Metrorail would likely shift some riders from Metrorail VRE service, making the VRE Crystal City Station more attractive as an origin station in addition to a destination station. Understanding the specific impacts of these changes to Crystal City requires more analysis, but it appears that growth in ridership at this station is likely
given the future growth in regional and local demographics and employment as well as expansion of VRE service.

Changes Associated with Crystal City
Substantial changes to population and employment are envisioned for the future of Crystal City. Based on the Crystal City Sector Plan vision, the area is anticipated to accommodate a net increase of approximately 15 million square feet of new development (totaling approximately 40 million square feet of development), through 2050. Immediately to the south, the City of Alexandria has approved a master plan for the North Potomac Yard area that envisions significant redevelopment potential associated with the future opening of the Potomac Yard Metrorail Station. Crystal City (including Arlington’s portion of Potomac Yard) and Alexandria’s portion of Potomac Yard are both located along US Route 1 and well connected with WMATA’s Metroway service.

The regional MWCOG forecast for 2040 estimates that population in Crystal City will grow by 77 percent and employment will grow by 30 percent. Expanding this area to include Pentagon City and North Potomac Yard would result in more than a doubling of the population (108 percent) and 53 percent growth in employment by 2040. Other transit and transportation projects are planned to expand the number of transportation options, and the quality of those options available to residents, employees, and visitors.

Planning Documents Impacting Crystal City
Planning documents specific to Crystal City recommend substantial changes to the area’s current land use profile. The Crystal City Sector Plan and other plans propose improvements that will make the area much more walkable. These improvements would make the area more attractive to residents and employees.

Crystal City Sector Plan
The Crystal City Sector Plan proposes substantial changes to the area over a 40-year period, providing recommendations for land use, transportation, and public open spaces. This plan was a response to the Defense Base Closure and Realignment (BRAC) Commission’s 2005 recommendation to realign and close defense facilities, including those in Arlington, VA, which would result in 3 million square feet of vacant office space in Crystal City. The Sector Plan attempts to promote new infill development and increase open spaces, while also transforming the existing streets into more complete and pedestrian-friendly spaces.
Figure 7: Future Districts Envisioned by the *Crystal City Sector Plan*\(^6\)

The Sector Plan establishes guidelines for new developments in the neighborhood to substantially increase density and activity in Crystal City. The plan promotes mixed-use infill development, increased density in exchange for community benefits, and redevelopment of existing buildings. The new urban fabric will be complemented by open spaces and streets designed to meet demand. The main transportation and community features of the sector plan, represented as the numbers in Figure 7 above, include:

1. Jefferson Davis Highway/Route 1. These improvements will convert the road into an urban boulevard.
2. Clark and Bell Streets. These streets will be merged to create a new north-south street to reduce traffic.
3. New surface transitway. The plan envisions a transitway connecting Columbia Pike, Pentagon City, Braddock Road, and the proposed Metrorail Potomac Yard Station.
4. A new two-acre central park. The plan calls for this park to serve as the center of the community.
5. A new plaza (Metro Market Square). This square on 18th Street South will serve as a retail destination with visual connections to transit options including VRE.
6. Transforming the highway access ramps to Reagan National Airport with a new circle at 26th Street. This project will create a traffic circle where the Airport Access Road meets Route 1. This circle will create a gateway between the airport and Crystal City and facilitate the new urban boulevard.
7. Improvements to the existing Water Park. The Park will be enhanced in the plan.
8. Two new plazas along Clark and Bell Streets. Plazas are proposed at 23rd and 25th Streets South.
9. Several new neighborhood parks. Improvements to existing neighborhood parks, and construction of new parks are proposed throughout the plan area.

Arlington General Land Use Plan
Arlington County’s General Land Use Plan dedicates a section to Crystal City. The goals for the neighborhood are described as follows:

- Create a high quality public realm (and open spaces) that strengthens the sense of place
- Provide a mix of uses by balancing office, residential, retail, cultural, and civic uses among several defined neighborhood centers
- Relate architectural and urban design to the human scale
- Enhance multimodal access and connectivity
- Incorporate sustainable and green building principles into all urban and architectural design
- Preserve the integrity of the single-family neighborhoods to the west
- Ensure Crystal City’s long-term economic sustainability

The goals developed for Arlington’s General Land Use Plan for Crystal City are tied to the Crystal City Coordinated Redevelopment District, a special district established in 2010 that provides for implementation tools to facilitate the sector plan’s vision.
**Arlington Transportation Master Plan**
Within Arlington County’s Transportation Master Plan, Crystal City is specifically mentioned when describing Arlington’s policy of integrating transportation with land use. The plan covers the development and operation of high capacity surface transit lines such as the Crystal City/Potomac Yard corridor.

**Reagan National Airport Planning Documents**
Nearby Reagan National Airport continues to attract increased air traffic and passengers. Projects are planned to accommodate this demand and ease connections, including:
- New North Terminal and Concourse. This new terminal and concourse will be constructed north of Terminal C to accommodate existing and future demand, and eliminate the need for shuttles to transport passengers to their planes on the tarmac; and
- Securing National Hall. This expansion will allow passengers to move between the different sections of Terminals B and C without rescreening, making connections between flights easier.

**Key Sites and Projects Proposed in Crystal City**
At the time of this study, several development projects are entitled and approved for future construction (or currently under construction) within the Crystal City and Pentagon City areas. In total, these yet to be built development projects total approximately: 3.7 million square feet of office space, nearly 4,000 residential units, 500 hotel rooms, and 500,000 square feet of retail space. These developments are listed in Table 1 and illustrated in Figure 8.
### Table 1: Crystal City Development Projects (as of May 2017)

<table>
<thead>
<tr>
<th>Site ID</th>
<th>Development</th>
<th>Address</th>
<th>Office (SF)</th>
<th>Retail (SF)</th>
<th>Residential (units)</th>
<th>Hotel (rooms)</th>
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</thead>
<tbody>
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<td>Metropolitan Park 6</td>
<td>1400 S. Eads St.</td>
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<td>4</td>
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<td>1770 Crystal Drive Expansion</td>
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<td>Long Bridge Park Aquatics and Fitness Facility</td>
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<td>11</td>
<td>Potomac Yard - Land Bay D-East</td>
<td>Jefferson Davis Highway</td>
<td>16,503</td>
<td>360</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Lofts at Crystal Houses</td>
<td>1900 S. Eads St.</td>
<td></td>
<td></td>
<td>252</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Airport Plaza IV</td>
<td>2600 Crystal Dr.</td>
<td></td>
<td></td>
<td>198</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>The Altaire</td>
<td>400 Army Navy Dr.</td>
<td></td>
<td></td>
<td>453</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Century Center Residential</td>
<td>2450 Crystal Dr.</td>
<td>21,836</td>
<td>286</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL**

|                   | 3,721,978 | 505,862 | 3,987 | 500 |
Figure 8: Proposed Crystal City Development Sites (as of May 2017)
In 2010, the City of Alexandria approved the *North Potomac Yard Small Area Plan*. This plan provided the foundation for future investment and redevelopment of this portion of Potomac Yard. On June 13, 2017, the City of Alexandria approved the Planning Commission’s recommendation to adopt the North Potomac Yard Small Area Plan (SAP) Update, amending the previous plan approved in 2010. The revised plan calls for approximately 1.1 million square feet of residential, 930,000 square feet of retail, approximately 1.6 million square feet of office, and an additional 170,000 square feet of hotel space. This is a significant redevelopment that, despite its distance from the existing VRE Crystal City Station, will benefit from the robust multimodal transportation system in the City of Alexandria and Crystal City neighborhood of Arlington.

**Enhanced Public Transportation Connections in Crystal City**

People are more likely to use transit and transfer across modes if the service is fast, direct, and reliable. VRE offers a reliable service, but transferring to or from another mode can be a challenge. For this reason, improvements to multimodal connections are envisioned in Crystal City by various agencies. Several improvements are proposed to improve the connections between Metrorail, Metroway, and other bus services that will encourage people to use more transit:

- Metrorail
- Metroway
- Metrobus and ART bus

**Metrorail**

A new entrance is planned for the Metrorail Crystal City Station on Crystal Drive at 18th Street South. This new entrance will improve connectivity by shortening the walking distance between Metrorail and VRE stations. This new entrance will also be more integrated into Crystal City’s pedestrian network and urban street grid.

One of the initial concepts studied looked at placing the second station entrance on the east side of Crystal Drive. This would have eliminated the need to cross the street to access Metrorail for VRE riders. While this concept was considered cost-prohibitive for the County and Metrorail, it may provide value to VRE to consider a more direct connection between the two systems.

**Metroway**

The Metroway currently travels to Pentagon City, every other trip, in mixed traffic using South Hayes Street. The County plans to construct an extension to the Crystal City-

---

Potomac Yard Transitway that will give the Metroway a dedicated lane\(^9\) from Crystal City to Pentagon City, improving the service of the Metroway and providing a faster connection from Pentagon City through Crystal City to Potomac Yard and the Braddock Road Metro. This dedicated BRT lane shortens transit travel time from the Crystal City VRE to Pentagon City.

The extension calls for new stations in Crystal City. The proposed locations are Crystal Drive and 15\(^{th}\) Street S, 12\(^{th}\) Street South and Long Bridge Drive, and Clark Street and 12\(^{th}\) Street South. New stations would have a design similar to existing Metroway stations.

**Metrobus and ART bus**

Several bus routes provide service to Crystal City. To facilitate transfers across modes, Arlington County has constructed a new Multimodal Transportation Center is on 18\(^{th}\) Street South under US Route 1. The multimodal center provides four additional bus bays, a designated zone for private shuttles, a kiss-n’-ride area, carsharing, and bike sharing. It supplements the existing bus bays on South Bell Street, and facilitates transfers between VRE, Metrorail, Metrobus, ART bus, and regional commuter buses by increasing the availability of mode transfers, centrally locating transportation options, and creating a safer environment for pedestrians.

---

\(^9\) As part of the Transitway extension to Pentagon City, Transitway lanes along Crystal Drive and South Clark Street, from 15\(^{th}\) Street S to 12\(^{th}\) Street South, are peak-hour bus lanes. The Transitway segment along 12\(^{th}\) Street South will be 24-hour dedicated bus lane.
4.0 Evaluation Process

This section describes the process through which a Preferred Alternative for the station location will be selected so that a concept design may be developed for that location. The evaluation framework developed for this project was based on a set of design objectives established by VRE at the outset of the effort. These design objectives are listed in Table 2 below.

Table 2: VRE Crystal City Station Improvements Design Objectives

<table>
<thead>
<tr>
<th>No.</th>
<th>Design Objective</th>
<th>Screening Criterion</th>
<th>Site Assessment Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Build a new island platform between Tracks 2 and 3 that serves up to 10-car trains and can provide up to two grade-separated access points</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Accommodate room for a future 4th track (Track 0, to be constructed as part of a separate effort)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Build station platform within existing CSXT right-of-way</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Enhance local and regional connectivity, including connections to Metrorail, Metroway, buses, shuttles, and bicycle and pedestrian networks</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>5.</td>
<td>Support Crystal City’s vision for growth</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>6.</td>
<td>Build a sustaining relationship with the community</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

VRE evaluated all possible station locations using a two-step evaluation process, described below:

**Step 1: Screening** – The first step of the framework identified a range of practical and feasible station location options that met screening criteria. Screening criteria were minimum thresholds a station must meet to be evaluated. Concepts that passed these screening criteria were carried forward to the next step, Site Assessment.

**Step 2: Site Assessment** – In the second step of the framework, the station location concepts were evaluated by how effectively they performed against the site assessment criteria, which were based on the project’s goals and objectives. The evaluation process was intended to help identify one preferred station location concept.
As illustrated in Table 2, each station location option developed for the Crystal City Station Improvements effort was evaluated against the project’s design objectives. Some design objectives were identified as critical and mandatory elements of any station to be considered feasible, and were therefore shown as screening criteria. Screening criteria are either met or not met – station locations that do not meet all of the screening criteria are considered infeasible. Other design objectives were identified as important to the success of the project, but are evaluated on a scale, with performance compared to other station location options.

The evaluation process integrated public outreach and stakeholder coordination. A technical Working Group comprised of staff at stakeholder organizations provided feedback on key decisions. Public meetings were held to share information and solicit feedback on the technical analysis. A project website provided ready access to current information and past events.

This phase of the study began by establishing the necessary parameters for a future commuter rail station in Crystal City based on findings from the existing and future conditions analyses described in previous sections. The station would need to be long enough to serve all cars in a VRE trainset and be located in an area where track curvature would allow a station to be feasibly constructed between the westernmost two tracks (Tracks 3 and 2). The station would need to fit within existing railroad right-of-way with no permanent impact on freight operations, and coordinate with the design and construction of a proposed fourth track as part of the separate DC to Richmond (DC2RVA) High Speed Rail effort.

The first step of the evaluation process, Screening, yielded three potential locations for a station between the CSXT siding track to the north and Airport Access Road to the south, including reconstruction at its current location and two locations further south. The locations were based on previous VRE efforts including a station assessment and a track alignment study (VRE, Crystal City Track Alignment Study for New Passenger Platform, 2016). These potential station locations were reviewed by the Working Group in early spring 2017. Evaluation criteria to be used in the next step, Site Assessment, were also discussed at this time. The potential station locations, the design objectives and the Site Assessment criteria were presented at public events in March 2017. Outreach to VRE riders was conducted at a pop-up event at the VRE Crystal City station. A public meeting that included an open house and a presentation by VRE staff was attended mainly by residents of Crystal City. Feedback from the March 2017 outreach was documented in a Public Meeting Summary attached as Appendix A. The March 2017 meeting was attended by over 40 individuals. The most significant concerns expressed by residents were the potential noise and vibration impacts due to the project. VRE riders, on the other hand, voiced general support of the possible station improvements. Participants sought to understand how riders...
would access the station under each Option, and each concept’s visual impact. Follow up comments received after the public meeting from residents voiced concerns with potential noise and vibration disruptions associated with Options 1 and 2 due to their proximity to residential areas, whereas emailed comments received from VRE riders generally supported Option 2, due to its central location.

Community feedback was taken into account during the technical analysis in the next step. Evaluation of the three proposed station locations against the Site Assessment criteria featured use of available spatial data augmented with data collected at the site. The scope and timeline of the study were expanded to conduct more detailed analysis on topics of interest to stakeholder and the community, especially noise and vibration. The Working Group helped to provide data and input for the technical analysis. The technical analysis and preliminary findings of the evaluation were shared with the public in June 2017. Feedback from the June 2017 outreach was documented in a Public Meeting Summary attached as Appendix B. The June 2017 public meeting was attended by over 80 individuals, most of whom were Crystal City residents. They posed questions about the evaluation methods and ratings and concerns about train noise and vibration. Of the options, they voiced support for Option 3. The comments were documented and systematized into a Comment Response Matrix.

VRE worked through the summer of 2017 to incorporate community feedback in the review and revision of the technical analysis as appropriate. Working with Arlington County staff, VRE provided briefings to the Arlington County Transportation Commission and the County Board. The evaluation was also reviewed by other stakeholders on the Working Group including JBG Smith and Equity Residential (property owners of land adjacent to the railroad), the Crystal City Business Improvement District, the Metropolitan Washington Airports Authority, the National Park Service, and the Department of Defense Transportation Management Program Office at the Pentagon (significant destination for VRE riders).

During September 2017, VRE plans to present the staff recommendation for the preferred alternative to the Arlington County Planning Commission, Transportation Commission, Transit Advisory Committee, and the County Board. The VRE Operations Board is anticipated to adopt a Preferred Alternative in the Fall 2017. Selection of a Preferred Alternative for the station location will be followed by more detailed study and development of a concept design for the new station at that location. At this time a more detailed environmental assessment will occur, along with refinement of the conceptual design. Identification of the preferred connection (overhead or underground) can be accomplished as a better understanding of the design constraints will be available. As the design advances, VRE will continue to incorporate feedback from the community and area stakeholders.
5.0 Screening Criteria

The screening criteria used to develop the three station location concepts are described in Table 3. The entire study area between the CSXT siding to the north and the Airport Access Road to the south was reviewed against each of the screening criteria below. Only those station locations that met all threshold criteria were developed into concepts. In this step, station locations are screened against the criteria below, not compared against one another. More detailed engineering standards related to station design are described in the *Crystal City Station Improvements Basis of Design* (VRE 2017).

Table 3: Crystal City Station Improvements Screening Criteria

<table>
<thead>
<tr>
<th>No.</th>
<th>Criteria Topic Area</th>
<th>Criteria Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Platform Parameters</td>
<td>Concepts must be able to accommodate the following:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Minimum length of 700’ with ability to expand in the future to 850’</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Minimum average width of 24’ (some tapering at ends acceptable)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Located between Tracks 2 and 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Platform curvature less than 1° 45’</td>
</tr>
<tr>
<td>2.</td>
<td>Track Speeds</td>
<td>Concept must accommodate for the following (in Maximum Authorized Speed (MAS) below):</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 60 mph for passenger (55 for freight) CFP(^{10}) 108.6 to CFP 107.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 45 mph for both passenger and freight CFP 108.8 to CFP 108.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 40 mph for both passenger and freight CFP 110.1 to CFP 108.8</td>
</tr>
<tr>
<td>3.</td>
<td>Right-of-Way</td>
<td>• Concept must fit within existing CSXT right-of-way, and not unduly change existing leases or easements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Concept must provide space for DC2RVA “fourth track”</td>
</tr>
<tr>
<td>4.</td>
<td>Freight Operations</td>
<td>• Concept must have no permanent impact on freight operations</td>
</tr>
<tr>
<td>5.</td>
<td>Ability to Serve Passengers During Construction</td>
<td>• Concept must be able to provide for the continuation of VRE service during construction</td>
</tr>
</tbody>
</table>

\(^{10}\) CFP is a code referring to CSXT’s RF&P Subdivision, Baltimore Division.
6.0 Station Location Options

Three location concepts were developed for VRE’s Crystal City Station through a review of the study area in the context of a set of minimum threshold criteria (described in Section 5). These three concepts were discussed with Crystal City community members, VRE riders, and stakeholders through a series of meetings and public events during spring 2017. The locations of these three options are displayed in Figure 9 below. Sketch-level designs and visualizations were also prepared for each of the options to illustrate how they would connect with existing land uses, as well as how the stations would appear from various existing view points. These images are also included below.

Figure 9: Crystal City Station Location Options

Existing Station Location

The existing VRE Crystal City station consists of an approximately 400-foot side platform between Crystal Drive and the CSXT tracks, located north of the Crystal City Water Park and in the rear of Water Park Towers. The CSXT tracks in this location consist of three tracks (Tracks 3, 2, and 1 in a west to east direction). The current side platform is located west of Track 3. The Crystal City station platform as it exists today is not of sufficient length to accommodate all VRE train cars. Currently, passengers disembarking at the Crystal City Station need to alight from the forward-most four cars only.
Proposed Options

Each of the three station location options change the station from a side platform to a center island platform located between Tracks 3 and 2. Each platform would be about 850 feet long and able to serve up to ten-car trains. The locomotive is usually positioned at the south end of the train and is located beyond the platform when it stops at the station.

All concepts assume that a fourth track – referred to as Track 0 – would be constructed as part of the DC2RVA High Speed Rail project. Track 0 is shown in all sketch plans developed for the Crystal City Station Improvements project.

Each option also assumes two grade-separated access points between the station platform and Crystal Drive. Each concept also presumes that connections would be made from Crystal Drive to the northern and southern ends of the platform. Pedestrian bridges and pedestrian tunnels were considered, and pedestrian bridges will include an elevator to provide accessibility to individuals with disabilities. All station options would maintain service at the current station location during construction, and would demolish the existing station platform when the new platform is complete and in service.

Option 1

Option 1 is located in the same general area as the existing station platform, except it provides a center island platform between tracks 2 and 3 extending approximately 375 feet north of the existing platform location. This station concept crosses two existing culverts. It requires minor modifications to CSXT’s existing siding track, and requires the relocation of an existing electric lock turnout.

The evaluation assumed a tunnel connecting to Crystal Drive at 12th Street South from the northern edge of the platform. Two options were considered for connections to the southern edge of the platform. Option 1A consists of a pedestrian bridge over the tracks connecting to the walkway to Crystal Drive at the current VRE station access location, between Water Park Towers and the Crystal City Water Park (Figure 10).

Cross section visualization for all proposed concepts were developed to illustrate the position of the tracks, platform, and pedestrian tunnels relative to the existing land use. Figure 11 reflects the pedestrian bridge proposed under Option 1A looking south. The pedestrian bridge crosses over the tracks at a height of 26 feet above ground, and the distance from the platform to the stairway connecting to Crystal Drive is 50 feet. The height of the pedestrian bridge is only slightly higher than the height of the pool deck.

---

11 Amtrak envisions operating high speed rail service from Washington, DC, to Richmond, VA, under the DC2RVA High Speed Rail project. The project would be part of a larger initiative to implement high speed rail service between Washington, DC, and Atlanta, GA (also known as the Southeast High Speed Rail corridor).
(represented by a red line in the image). With the pool deck surrounded by plantings (as seen in Figure 12) and the roughly 400-foot distance between the bridge and the pool deck area, there is a low probability that pedestrians using the bridge would be able to view the pool deck or pool. Figure 12 offers a northward view of the same concept. It shows a 25-foot separation between the tracks and the pool, and a 40-foot separation between the platform and the pool. The pool is elevated 24 feet above the platform, making visibility improbable.

**Figure 10: Crystal City Station Location Option 1A**
Figures 13 and 14 illustrate how the platform and the bridge connection could appear. Figure 13 provides a bird’s eye view looking southwest from and Figure 14 provides a view from Crystal Drive. The connection to Crystal Drive would utilize the existing sidewalk and easement.
Figure 13: Crystal City Station Location Option 1A, South Access - Bird’s Eye View

Figure 14: Crystal City Station Location Option 1A, South Access - From Crystal Drive
Option 1B, shown as Figure 15, consists of a pedestrian tunnel connecting to Crystal Drive at the current VRE station access location, between Water Park Towers and the Crystal City Water Park. All other aspects of Options 1A and 1B are identical.

**Figure 15: Crystal City Station Location Option 1B**

No cross-sections of Option 1B were developed since the concept is identical to Option 1A with respect to the horizontal distances at the southern end of the platform. Figures 16 and 17 provide additional views of Option 1B. The tunnel connection would need to extend further along the sidewalk connecting to Crystal Drive to provide the appropriate slope to meet ADA standards.
Figure 16: Crystal City Station Location Option 1B, South Access - Bird’s Eye View

Figure 17: Crystal City Station Location Option IB, South Access - From Crystal Drive
Option 2
Option 2 is centered about ¼ mile south of the existing station, at a location between Tracks 2 and 3 located between 1801/1805 Crystal Drive and 2121 Crystal Drive. A tunnel is assumed for the northern pedestrian connection to Crystal Drive just north of 18th Street, between 1801 Crystal Drive and Crystal City Water Park. This tunnel would be located adjacent to, but separate from, the existing bicycle/pedestrian underpass under the CSXT tracks that connects the bicycle lanes on Crystal Drive to the Mount Vernon Trail. A pedestrian bridge is assumed for the southern platform connection, and two potential bridge connection concepts are under consideration. One option would connect the platform to the 2nd level of 2121 Crystal Drive via a pedestrian bridge, with connections to Crystal Drive made via a connection to the lobby on the building’s first floor (Figure 18). The second option would have the bridge provide a direct connection to the plaza.

Figure 18: Crystal City Station Location Option 2

Figure 19 is a cross section of Option 2 looking South. The image shows the pedestrian bridge crossing over the tracks at a height of 28 feet above ground. This height is nearly level with the height of the pool deck (represented by a red line), making visibility into the pool deck area by pedestrians on the bridge highly improbable. Any visibility would be further hindered by the location of the bridge (430 feet from pool deck), building placement, and plantings surrounding the pool deck. Figure 20 offers a northward view of the station. It shows the existing 10-foot separation between the tracks and the building.
wall, and a 25-foot separation between the platform and the wall. The pool area is elevated about 34 feet above the platform.

**Figure 19: Crystal City Station Location Option 2, Looking South**

![Diagram](image)

**Figure 20: Crystal City Station Location Option 2, Looking North**

![Diagram](image)

Figures 21 and 22 illustrate visuals of Option 2 from a bird’s eye view looking southwest and from Crystal Drive near 2011 Crystal Drive. Details about whether the connection to Crystal Drive would be provided through the lobby of 2011 Crystal Drive or a direct connection down to the plaza will be developed in later phases of the project.
Figure 21: Crystal City Station Location Option 2, South Access - Bird’s Eye View

Figure 22: Crystal City Station Location Option 2, South Access - From Crystal Drive
Option 3
Option 3 (Figure 23) is the southernmost of the three station location options. It is located east of 2345 Crystal Drive, approximately ½ mile south of the current VRE station. The northern pedestrian access for Option 3 is identical to the southern pedestrian access for Option 2. The southern pedestrian access for Option 3 is assumed to be a pedestrian bridge, connecting to the 2nd level of the building connection between 2345 Crystal Drive and 2451 Crystal Drive.

Figure 23: Crystal City Station Location Option 3

Figure 24 is a cross section of Option 3 looking North toward the northern pedestrian bridge. The dimensions and relationship to the surrounding built environment are the same as those illustrated in Figure 19 for Option 2.

Figures 25 and 26 show bird's eye views of the two pedestrian bridge connections. Figure 25 looks northwest toward 2011 Crystal Drive. Figure 26 provides an illustration looking southwest toward 2121 Crystal Drive.
Figure 24: Crystal City Station Location Option 3, Looking North

Figure 25: Crystal City Station Location Option 3, North Access - Bird’s Eye View
Figure 26: Crystal City Station Location Option 3, South Access - Bird’s Eye View
7.0 Site Assessment Criteria

This section describes the site assessment criteria, data sources, and ratings.

Site Assessment Criteria

There were four categories of site assessment criteria for the Crystal City Station Improvements effort, and an additional subject area (economic development and land use) which was considered separate from the site assessment. These site assessment criteria directly relate to the following design objectives:

- Enhance local and regional connectivity
- Support Arlington’s vision for Crystal City’s future
- Build a sustaining relationship with the community

The site assessment criteria were shared with stakeholders, VRE riders, and the community in spring 2017. Based on feedback collected they were revised. The pages that follow describe each of the site assessment criteria, the measures of effectiveness, and data sources, organized by criteria category

Category: Local Transportation Connections

Goal: The station should be located to serve the greatest number of current and potential (largely employment-focused) VRE rider destinations, while also providing easy access to the existing pedestrian and bicycle network.

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Measure of Effectiveness</th>
</tr>
</thead>
</table>
| Proximity to Local Destinations      | • Number of jobs within ½ mile from center of platform (ACS 2015, rounded to nearest 10 jobs)  
• Number of VRE rider destinations within ½ mile from center of platform (VRE 2016 rider survey)  
• Number of residents within ½ mile from center of platform (ACS 2015, rounded to nearest 10 residents)  
• Distance to bicycle network from closest point on VRE station platform, using local street network |

Data Sources: The number of jobs within a ½ mile, and the number of residents within a ½ mile, were obtained from the United States Census Bureau, from the 2015 American Community Survey (ACS), and the 2014 Longitudinal Employment Household Data (LEHD). Self-reported VRE rider destinations were obtained from the 2016 VRE annual rider survey. The bicycle network and street network was pulled from Arlington County GIS. Station platform locations were obtained from the Crystal City Station Improvements sketch-level design. All analyses were conducted using GIS.
Category: Regional Transportation Connections
Goal: Because approximately one-quarter of all VRE riders transfer to bus or Metrorail in Crystal City, the station location should optimize these connections. The station should minimize walking distance, and optimize the walking experience, between the VRE Crystal City station and the nearest Metrorail and Metroway (bus) stations.

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Measure of Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximity to Metrorail</td>
<td>• Distance to existing Metrorail station entry from closest point on VRE station platform, using local street network</td>
</tr>
<tr>
<td></td>
<td>• Distance to expected future Metrorail station entry from closest point on VRE station platform, using local street network</td>
</tr>
<tr>
<td></td>
<td>• Number of street crossings to Metro station</td>
</tr>
<tr>
<td>Proximity to Metroway</td>
<td>• Distance to Metroway station from closest point on VRE station platform, using local street network</td>
</tr>
</tbody>
</table>

Data Sources: The locations of the existing Metrorail station and Metroway stations, as well as the street network, were pulled from the Arlington County Geographic Information Systems (GIS). The expected future Metrorail station entry location was provided by Arlington County staff. Station platform locations were obtained from the Crystal City Station Improvements sketch-level design. Analyses were done in GIS.

Community and Environmental Impacts
Goal: The station should avoid or minimize impacts to the built and natural environment.

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Measure of Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes to Existing Conditions – Built and Natural Environment</td>
<td>• Impacts on sensitive noise and vibration receptors</td>
</tr>
<tr>
<td></td>
<td>• Property acquisition impacts to residential property</td>
</tr>
<tr>
<td></td>
<td>• Impacts on historic, cultural, and/or recreational resources</td>
</tr>
<tr>
<td></td>
<td>• Impacts to environmental justice populations</td>
</tr>
<tr>
<td></td>
<td>• Impacts to visual resources</td>
</tr>
<tr>
<td></td>
<td>• Impacts to water resources and floodplains</td>
</tr>
</tbody>
</table>

Data Sources: Sensitive environmental features were obtained from a review of the Arlington County GIS, field-verified, and compared to the footprint of the sketch-level design of the station location concepts. Presence of environmental justice populations was obtained by analysis of the 2015 ACS from the United States Census Bureau. Property data were obtained from Arlington County GIS, and property impacts used an overlay of the sketch-level design. Impacts to sensitive noise and vibration receptors featured 24-hour noise and vibration monitoring near the three options, and an assessment of the net impact of the station relocation when compared to a future no build alternative. Appendix
C is the Noise and Vibration Impact Assessment. Impacts to visual resources are based on visualizations of the viewsheds from the various station concept locations.

**Cost**

*Goal:* The project should minimize cost where practicable.

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Measure of Effectiveness</th>
</tr>
</thead>
</table>
| Expected Cost Relative to Other Options | • Length of track relocation (rounded to nearest 10 feet)  
• Grade-separated access to the local roadway network  
• Construction sequencing  
• Impacts to railroad infrastructure  
• Crossing/replacement of culverts |

**Data Sources:** MicroStation files of the existing project area, as well as design drawings from the DC2RVA project, were used with sketch-level design of the three station location concepts.

**Economic Development and Land Use**

In addition to the four criteria categories used to evaluate the proposed station location options described above, a fifth category, Economic Development and Land Use, was examined. This element was assessed to satisfy stakeholder interest in the subject but lacks reliable quantitative data. It was not included as a formal evaluation criteria because the purpose of Norther Virginia Transportation Authority (NVTA) grant funding for this project was to expand capacity of transportation infrastructure.

*Goal:* The station location should promote economic development consistent with Crystal City’s vision of its future growth.

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Measure of Effectiveness</th>
</tr>
</thead>
</table>
| Consistency with vision for Crystal City | • Fits within Crystal City Sector Plan  
• Distance to National Airport (rounded to nearest 10 feet)  
• Potential development within ½ mile |

**Data Sources:** The Crystal City Sector Plan, and analysis details used to develop that plan, were received from Arlington County. Distance from proposed station improvement locations to Reagan National Airport was determined using GIS. Distances were reported as straight-line distances from the center of the proposed platform to the north entrance of the Metrorail station at the airport.
Ratings
The site assessment evaluation was conducted on a qualitative scale considering the criteria categories, goals, evaluation criteria and measures of effectiveness discussed above. The evaluations were performed by specialists in each of the technical disciplines reflected in the evaluation criteria categories, and included track engineers, noise and vibration engineers, environmental planners, and transportation planners. Ratings were assigned to each criteria category per the general scale below, and are based on each Option’s effectiveness in each category relative to the other Options.

- Low: concept impacts sensitive criteria, and/or does not meet goals
- Medium: the concept contains neutral or some moderate impacts, may not fully achieve goals
- High: concept minimizes impacts to sensitive criteria or high cost items and achieves goals
8.0 Findings

The following section provides a description of the evaluation findings for each of the station location options. Findings are organized by criteria category.

Local Transportation Connections

Summary: Option 2 has the maximum number of existing jobs within a 10-minute walk. Option 3 has about 50 percent more jobs compared to Option 1. There are minor differences in existing VRE rider destinations within a ½ mile.

Table 4: Assessment Results for Local Transportation Connections Criteria

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Measure of Effectiveness</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximity to Local Destinations</td>
<td>Jobs within ½ mile[^12]</td>
<td>10,760</td>
<td>18,460</td>
<td>17,000</td>
</tr>
<tr>
<td></td>
<td>Self-reported VRE rider destinations within ½ mile[^13]</td>
<td>530</td>
<td>555</td>
<td>530</td>
</tr>
<tr>
<td></td>
<td>Number of residents within ½ mile[^14]</td>
<td>8,670</td>
<td>6,960</td>
<td>7,620</td>
</tr>
<tr>
<td></td>
<td>Distance to bicycle network[^15]</td>
<td>240</td>
<td>420</td>
<td>450</td>
</tr>
</tbody>
</table>

Why it Matters: VRE surveys show that almost 70 percent of VRE riders alighting at Crystal City use VRE to access jobs and other destinations in Crystal City or Pentagon City. The number of jobs within walking distance of the future station location is an excellent indicator of VRE’s ability to serve its existing and future customers. Option 2 serves 70 percent more jobs within a ½ mile of its location than Option 1, and nearly 1,500 more jobs within a ½ mile distance than Option 3. Interestingly, the difference is substantially smaller when looking at just the subset of existing VRE riders – there is no difference between Options 1 and 3, and a difference of under 5 percent for Option 2.

VRE’s adopted goals as part of the System Plan 2040 address “emerging ridership markets” and “advance VRE’s role as part of a multimodal regional mobility network” which encourage the agency to look beyond its existing rider base.\[^16\] Although very few of VRE’s current riders are reverse commuters, or commuters that choose VRE over Metrorail to access jobs in the District, these are potentially future markets for VRE and therefore the proximity to residents is a consideration. While Option 1 has almost 25 percent more

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\[^12\] Data obtained from the United States Census Bureau, 2014 Longitudinal Employment Household Data (LEHD).
\[^13\] Data from 2016 VRE annual rider survey.
\[^14\] Data obtained from the United States Census Bureau, from the 2015 American Community Survey (ACS).
\[^15\] Data from Arlington County GIS.
residents living within ½ mile of the station than Option 2, Options 2 and 3 will serve a significant number of residents as well.

There is a real difference (almost twice the distance between Options 1 and 3) in the distance to the local bicycle network. Although bicyclists are currently a small segment of VRE’s ridership, being part of an active multimodal network is a priority for the agency. While not a deciding factor in selecting a station location, the difference in distance to the bicycle network is an interesting consideration.

Regional Transportation Connections

**Summary:** Options 1 and 2 offer a shorter and easier connection to the existing and future access points of the Metrorail station and the Crystal City Multimodal Center on 18th Street South under the U.S. Route 1 bridge than Option 3, by almost ¼ mile. Option 2 also offers the shortest distance to a Metroway Station of all three concepts, and it also provides access to two Metroway stations.

**Table 5: Assessment Results for Regional Transportation Connection Criteria**

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Measure of Effectiveness</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximity to Metrorail¹⁷</td>
<td>Distance to existing Metrorail Station entrance &amp; Crystal City Multimodal Center</td>
<td>1,470 feet (6 min)</td>
<td>1,330 feet (5 min)</td>
<td>2,350 feet (9 min)</td>
</tr>
<tr>
<td></td>
<td>Distance to potential future Metrorail Station entrance</td>
<td>860 feet (3 min)</td>
<td>750 feet (3 min)</td>
<td>1,780 feet (7 min)</td>
</tr>
<tr>
<td></td>
<td>Number of street crossings to access Metrorail</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Proximity to Metroway¹⁸</td>
<td>Distance to existing Metroway Station</td>
<td>700 feet (18th Street)</td>
<td>430 feet (18th Street)</td>
<td>800 feet (23rd Street)</td>
</tr>
</tbody>
</table>

*Why it Matters:* A travel option that reduces travel time benefits a traveler because it promotes efficient use of time. According to VRE rider survey data, 24 percent of VRE riders arriving at Crystal City require a transfer to Metrorail or bus to complete their trip, adding time to their trip. Most of these individuals are transferring as part of a home-to-work commute, where travel time savings can be valuable. Based on data provided by

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¹⁷ The location of the existing Metrorail station, as well as the street network, were pulled from the Arlington County Geographic Information Systems (GIS). The expected future Metrorail station entry location was provided by Arlington County staff.

¹⁸ The location of the existing Metroway station, as well as the street network, were pulled from the Arlington County Geographic Information Systems (GIS).
USDOT about the value of travel time savings as part of a commute, a five-minute reduction in travel time can equate to several dollars saved for the individual.¹⁹

Another reason proximity to Metrorail and Metroway was evaluated is the concept of out-of-vehicle wait time. The theory asserts that the average passenger perceives their out-of-vehicle wait time as longer than it is in reality, creating a magnified sense of the loss of time. While the evaluation sought Options that generally reduced travel time, it also prioritized Options that would minimize this phenomenon as much as possible. The additional roughly 1000 feet between the existing Metrorail Crystal City Station and Option 3 when compared to either Options 1 or 2 was viewed as a negative given this consideration. The future relocated Metrorail entrance could reduce walking distances from today by over 500 feet, making this future improvement important to both Arlington County and VRE.

For these reasons, the proximity of each Option to Metrorail and Metroway was considered, because it could affect the total travel time of a VRE commuter.

Arlington County has invested in transforming 18th Street South into a multimodal hub for Crystal City. The recent completion of the Crystal City Multimodal Center provides improved safety and accessibility for transit users transferring between modes and increased bus stop capacity. Locating the VRE station improvements near 18th Street South further strengthens the connection between VRE and other transportation options in Arlington County.

**Community and Environmental Impacts**

*Summary:* All three station locations are in an urban environment and are within existing railroad right-of-way, save for the connections to Crystal Drive. No impacts to the natural environment were identified, and because the station options are largely situated close to one another, the Options’ effect on the built environment (including noise and visual compatibility) were highly similar. None of the three station locations met the FTA criteria for having a noise or vibration impact. For all Options, the pedestrian bridge may be visible from the George Washington Memorial Parkway but further evaluation during a later stage would be needed. Overall, community and environmental impacts were not

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¹⁹ According to the USDOT, intercity commute travel time (defined as trips of 50 miles or more) is generally valued at 70% of an individual’s hourly wage, and local travel (within a metropolitan area) is valued at 50% of an individual’s hourly income. The length of a VRE rider’s trip falls between the two categories, meaning that a five-minute travel time savings for the average salaried worker could amount to several dollars. Data sourced from: USDOT, The Value of Travel Time Savings: Departmental Guidance for Conducting Economic Evaluations Revision 2 (2016 Update), Table 1. Available at https://www.transportation.gov/sites/dot.gov/files/docs/2016%20Revised%20Value%20of%20Travel%20Time%20Guidance.pdf (last accessed July 14, 2017).
shown to be a differentiating criteria category. Additional analyses will be conducted during the design phase to evaluate visual impacts to the community and environment.

Table 6: Assessment Results for Community and Environmental Impacts

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Measure of Effectiveness</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes to Existing Conditions – Built and Natural Environment</td>
<td>Noise and Vibration(^{20})</td>
<td>Impacts are not significant according to FTA impact criteria(^{21})</td>
<td>Impacts are not significant according to FTA impact criteria</td>
<td>Impacts are not significant according to FTA impact criteria</td>
</tr>
<tr>
<td></td>
<td>Property Acquisition(^{22})</td>
<td>No impacts to residential properties; may require easements from JBG Smith</td>
<td>No impacts to residential properties; may require easements from JBG Smith</td>
<td>No impacts to residential properties; may require easements from JBG Smith</td>
</tr>
<tr>
<td></td>
<td>Historic, Cultural, and/or Recreational Resources</td>
<td>No direct impacts</td>
<td>No direct impacts</td>
<td>No direct impacts</td>
</tr>
<tr>
<td></td>
<td>Environmental Justice(^{23})</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Visual Resources</td>
<td>Pedestrian bridge may be visible from George Washington Memorial Parkway</td>
<td>Pedestrian bridge may be visible from George Washington Memorial Parkway</td>
<td>Pedestrian bridge may be visible from George Washington Memorial Parkway</td>
</tr>
<tr>
<td></td>
<td>Water Resources and Floodplains</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

Why it Matters: Placement of a train station within an established community must be done with sensitivity to the existing built and natural environment and the current residents and business owners, and done in a way so negative impacts are avoided or minimized. This portion of the alternatives evaluation focused on elements that could eventually be considered under the National Environmental Policy Act (NEPA).

For most environmental and community resources, analysis was limited to a planning level to determine differentiators between the three station location options. This was done by:

\(^{20}\) Based on Noise and Vibration Impact Assessment.
\(^{22}\) Property data were obtained from Arlington County GIS.
\(^{23}\) Data for analysis came from 2015 ACS from the United States Census Bureau.
1. Identifying the sensitive environmental features
2. Determining whether they overlapped or were adjacent to any of the three station location options
3. Documenting where potential impacts occurred

Findings in relation to each of the environmental disciplines are highlighted below. Of special note is that in response to a request from the community, VRE produced a greater detailed noise and vibration analysis than would typically be done in planning, before initiation of NEPA. The full Noise and Vibration Impact Analysis is provided as Appendix C to this report.

**Noise and Vibration**
The analysis included an impact study of any noise and vibrations generated by trains at each of the proposed sites. This analysis goes beyond what is typically done for an Alternatives Analysis, but it was added in response to comments received at the March 2017 public meeting. The study followed the FTA process for assessing Noise and Vibration impact. Sensitive noise receptors in the study area included:

- Crystal City Lofts
- Gateway Park
- 1300 Crystal Drive
- Water Park Towers (1501 and 1505 Crystal Drive)
- Crystal City Water Park
- Crystal Place (1801 and 1805 Crystal Drive)
- Crystal City Workout Park

The study included the collection of noise measurements over a 24-hour period to evaluate the level of noise emitted from all sources including freight and passenger rail trains, cars, and airplanes. Detailed noise measurements were also conducted to determine train noise emissions for different VRE train operations (pass-by, station stop, and horn soundings).

The study found that the proposed station options did not result in any significant changes in noise or vibration, according to FTA impact criteria. The study revealed that in general, the existing noise conditions would not be significantly changed by the operation of trains at any of the proposed station locations, based on FTA assessment methods. The only noise impacts were generated by the use of train horns. The study found that the noise level at station platform ends and within approximately a ¼-mile of the station would increase due to horn sounds from VRE trains, which are required by CSXT and GCOR operation rules. Vibration levels were not found to be an issue and would be below the FTA criteria for any of the proposed station options.
Property Acquisition
None of the three station location options are anticipated to require acquisition or relocation of residential property. Easements on private property may be required for pedestrian access to and from the north and south ends of the platform and Crystal Drive.

Impacts to Historic, Cultural, and Recreational Resources
The analysis focused on historic and cultural resources within 500 feet of the project footprint. No Determinations of Eligibility were performed on any buildings that could be eligible but are not currently listed. For the analysis, the following sites were classified as either a park, open space, or other recreational facility in the project study area and were used as subjects of the impact assessment:

- Gateway Park
- Crystal City Water Park
- Crystal City Workout Park
- George Washington Memorial Parkway
- Roaches Run Waterfowl Sanctuary
- Mt. Vernon Trail
- Mt. Vernon Trail Connector

Ownership of parks, open space, and other recreational facilities was identified to determine whether a parcel would trigger a Section 4(f) review. Overall, the analysis found that none of the proposed station sites would directly impinge on historic, cultural, or recreational resources. The results for each specific Option are provided below:

- Option 1 - No direct impacts to historic, cultural, or recreational resources were identified. Option connects to existing Gateway Park at its north end and the Crystal City Water Park on the south end. Neither of these appear to be a 4(f) property. No direct impacts to the George Washington Memorial Parkway were identified.

- Option 2 - No direct impacts to historic, cultural, or recreational resources were identified. This option connects to the existing Mt. Vernon Trail and the Crystal City Water Park on its north end. The Mt. Vernon Trail is potentially a 4(f) resource, but the option does not touch or impact the use of the trail. The Water Park does not appear to be a 4(f) property. No direct impacts to the George Washington Memorial Parkway were identified.

24 Section 4(f) of the U.S. Department of Transportation Act of 1966, requiring consideration of park and recreational lands, wildlife and waterfowl refuges, and historic sites in transportation project development.
Option 3 - No direct impacts to historic, cultural, or recreational resources were identified. This option does not connect to any existing resources. No direct impacts to George Washington Memorial Parkway were identified.

**Environmental Justice Populations**
Executive Order 12898 signed in 1994 requires each Federal agency to incorporate environmental justice as part of its mission. The Executive Order states that, “Each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.” Within the context of transportation planning, agencies have the responsibility to ensure that low-income and minority populations will not be disproportionately burdened by the negative impacts of a transportation project (i.e., noise, vibration, pollution, etc.).

To evaluate each Option’s compliance with the environmental justice policy, census block groups near the three station location options were analyzed to identify whether they contained any regionally significant concentrations of minority and/or low-income populations. The regional significance of Environmental Justice populations was determined by comparing census block groups near the proposed VRE Crystal City Station sites to all census block groups in the VRE service area. If regionally significant concentrations were identified, the Project would analyze whether moving the station location would create any disproportionate negative impacts to these populations.

No regionally significant concentrations of Environmental Justice populations were found to be present within the study area. Therefore, it is estimated that no disproportionate impacts to Environmental Justice populations will result from any of the three station location options.

**Visual Resources**
The Visual Resources analysis explored whether the project would disrupt or obscure any existing viewsheds or view corridors, built or natural. Viewsheds in the study area include:

- George Washington Memorial Parkway
- Mt. Vernon Trail

Only a cursory visual analysis was conducted at this phase of the project. A more detailed visual analysis will be performed at a later phase as part of the NEPA process because of the project’s proximity to the George Washington Memorial Parkway and the Mt. Vernon Trail.
In response to comments received from public outreach activities in March 2017, VRE requested the development of visualizations for each of the three station location options. The visuals developed can be found in Section 6.0, as Figures 13, 14, 16, 17, 21, 22, 25, and 26. These visualizations illustrate:

- Option 1 - Overpass at southern end of platform located closest to the Mt. Vernon Trail.
- Option 2 - Overpass at southern end of platform may be visible from the Mt. Vernon Trail. (NOTE the location of this pedestrian bridge is identical to the location of the one at the northern end of the platform for Option 3).
- Option 3 - Overpass at northern end of platform may be visible from the Mt. Vernon Trail (NOTE the location of this pedestrian bridge is identical to the location of the one at the southern end of the platform for Option 2).

**Water Resources and Floodplains**
No sensitive water resources or floodplains were identified in study area.

**Major Cost Elements**

*Summary:* Option 1 is the least expensive to construct primarily due to shorter lengths of track relocation and more direct connections to Crystal Drive. While Options 2 and 3 include a pedestrian bridge that passes over or through the office building at 2011 Crystal Drive, the second entrance to Option 3 will also require a connection over or through an office building. Option 3 was deemed the most expensive to construct (as well as operate).
### Table 7: Assessment Results for Major Cost Elements Criteria

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Measure of Effectiveness</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of track relocation (rounded to nearest 10 feet)</td>
<td>6,380 feet</td>
<td>10,300 feet</td>
<td>10,710 feet</td>
<td></td>
</tr>
</tbody>
</table>
| Connections to Crystal Drive | • North: Direct access over or under tracks (Assume: TUNNEL)  
• South: Direct access over or under tracks (Assume: BRIDGE) |  |  |  |
| Construction sequencing | Build Track 0; Throw Tracks 1, 2; Build Station with Track 3 out of service; Throw Track 3  
Build Track 0; Throw Tracks 1, 2; Build Station with Track 3 out of service; Throw Track 3  
Build Track 0; Throw Tracks 1, 2; Build Station with Track 3 out of service; Throw Track 3 |  |  |  |
| Impacts to railroad infrastructure | CSX Siding Track; Electric Lock Turnout Relocation | None | None | None |
| Crossing of culverts | 2 | 0 | 0 | 0 |

**Why it Matters:** Construction cost can be a major differentiator between project options. Many of the major cost elements did not prove to be a cost differentiator for the Crystal City Improvements project – construction sequencing was the same and impacts to railroad infrastructure and crossing of culverts were not anticipated to be significant. Two elements did make a difference:

- Length of track relocation was far less for Option 1 than it was for Options 2 and 3 – of a magnitude of approximately 4,000 feet.
- Connections to Crystal Drive – although in general pedestrian bridges are assumed to be less expensive than pedestrian tunnels, this is only true for pedestrian bridges that have stairs and an elevator that go directly to a public sidewalk, and less certain

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25 MicroStation files of the existing project area, as well as design drawings from the DC2RVA project, were used with sketch-level design of the three station location concepts.
for pedestrian bridges that, especially for Option 3 – require connecting to an existing building at both the north and south ends.

Economic Development and Land Use

*Summary*: Although each of the options fits within the vision of the Crystal City Sector Plan, Option 2 is the best fit because of its central location near future development and transportation infrastructure, including the connection to the airport and the planned second entrance to the Metrorail Crystal City Station, to be located along Crystal Drive.

**Table 8: Assessment Results for Economic Development and Land Use Criteria**

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Measure of Effectiveness</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistency with vision for Crystal City</td>
<td>Fits within Crystal City Sector Plan</td>
<td>Moderate fit</td>
<td>Best fit</td>
<td>Moderate fit</td>
</tr>
<tr>
<td>Distance to Reagan National Airport</td>
<td>1,960 feet</td>
<td>1,030 feet</td>
<td>940 feet</td>
<td></td>
</tr>
<tr>
<td>Potential development within ½ mile</td>
<td>32 million s.f. of office, residential, hotel, and retail</td>
<td>35 million s.f. mix of office, residential, hotel, and retail</td>
<td>32 million s.f. of office, residential, hotel, and retail</td>
<td></td>
</tr>
</tbody>
</table>

*Why it Matters:* The VRE train station is an important land use in Crystal City. The station brings workers into Crystal City without bringing additional vehicles to the area. The train station is therefore part of the urban fabric and is most successful when connections are seamless. The Crystal City Sector Plan proposes substantial changes to the area over a forty-year period. The plan attempts to promote new infill development and increase open spaces while also transforming the existing streets into more complete and pedestrian-friendly spaces.

Options 1 and 2 are sited in the Sector Plan’s identified Central Business District, while Option 3 is located in the identified Entertainment District. Option 2 has a slightly greater potential to be closer to more mixed-use development within a ½ mile radius compared with Options 1 and 3, but the difference is fewer than 10 percent of the total potential development.
9.0 Conclusions and Next Steps

The Crystal City Station is currently one of the busiest stations in the VRE system. VRE plays an important role in supporting reliable and convenient commutes to Crystal City and other parts of Arlington while reducing the number of vehicle-miles traveled on local and regional roadways, especially during peak hours. Selection of a station location for the expanded VRE Crystal City station must take these existing conditions into account.

The Crystal City area and the VRE system are both planning for significant changes in the next 25 years. As VRE and Arlington County plan for 2040, it is important to note how the developments can be mutually supportive. Increased multimodal connections and mixed-use development in Crystal City can produce an environment with employment opportunities attractive to future VRE ridership. Mixed-use and residential developments will produce increased demand for inner core VRE travel between Crystal City and downtown Washington, DC. The long-term growth and economic success of both the area and the VRE system are intertwined. Development projects and future transportation projects should consider the impacts to all modes of transportation in this compact space: air travel, bus, Metrorail, Metroway, bicycle, pedestrian, and commuter rail. VRE’s expansion or relocation of the VRE Crystal City Station may be a key element in facilitating these changes.

The results of the two-step evaluation of the three proposed station locations described in previous chapters are summarized below in Table 9.

Table 9: Summary Evaluation Table

<table>
<thead>
<tr>
<th>Goal Area</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Transportation Connections</td>
<td>✗</td>
<td>×</td>
<td>●</td>
</tr>
<tr>
<td>Regional Transportation Connections</td>
<td>●</td>
<td>●</td>
<td>×</td>
</tr>
<tr>
<td>Community and Environmental Impacts</td>
<td>●</td>
<td>●</td>
<td>×</td>
</tr>
<tr>
<td>Major Cost Elements</td>
<td>●</td>
<td>●</td>
<td>×</td>
</tr>
<tr>
<td>OVERALL RATING</td>
<td>●</td>
<td>●</td>
<td>×</td>
</tr>
</tbody>
</table>

Legend:
- ● = High (Most Favorable)
- ○ = Medium
- ✗ = Low (Least Favorable)
The technical evaluation of the proposed station options shows that Option 2 had the Highest overall rating (Most Favorable). This option provides a high level of local and regional transportation connections, was rated the same as the other options for community and environmental impacts, and is expected to have a moderate cost.

Option 1 received a Medium rating because although it provides a high level of regional transportation connections and ranked most favorably with respect to cost, it provides the lowest level of local transportation connections.

Option 3 was rated Low (Least Favorable) because it was ranked least favorable for regional transportation connections as well as cost, and provides a moderate level of local transportation connections.

Based on the technical evaluation results, the VRE staff recommendation for the Preferred Alternative for the station location is Option 2.

As described in Section 4, the VRE Operations Board is expected to select the Preferred Alternative in October 2017. Feedback from Arlington County, stakeholder organizations, VRE riders, VRE member jurisdictions and the public is likely to be weighed into the balance while making a decision. The Alternatives Analysis report will be updated once a decision is made by the VRE Operations Board.
Appendix A
VRE Crystal City Station Improvements
Public Meeting #1 Summary

March 30, 2017
1 INTRODUCTION

1.1 PURPOSE OF THE MEETING

The purpose of this meeting was to present to the public the purpose of the effort, the objectives served by station expansion efforts, and solicit public feedback on station options that should be considered and the evaluation criteria that will be used to select one preferred location for further study.

1.2 EVENT INFORMATION

Two events were held the week of March 27, 2017.

1. A pop up event at the existing Crystal City VRE station March 29th from 3:00-6:30 PM to discuss the station relocation and expansion project with current VRE riders; and

2. A community meeting and open house March 30th from 5:00-7:30 PM to discuss the project with members of the Crystal City community.

The presentation slides were posted on the project website on March 27, 2017 so that they could be reviewed prior to the outreach events.

The public meeting was held at 2011 Crystal Drive, 11th Floor, Arlington, VA 22202. The location was selected based on its general proximity to the existing VRE station and its accessibility. The meeting location was easily accessible for those within walking distance. Parking was available in the underground garage located beneath the building. Transit options included Metrorail, Metroway, and local Metrobus and ART bus.

The pop-up style event on the approach to the Crystal City VRE Station was held to engage with VRE riders. Since many station users do not live in Crystal City, a traditional after work meeting may not afford them the opportunity to learn about the project, ask questions, and provide feedback. The pop-up event included many of the same boards and information that were used during the public meeting.

1.3 FORMAT

The pop-up event was informal, with participants talking to VRE staff and consultants around boards displaying information about the project. Participants could engage staff on a one-on-one basis, asking questions and providing feedback. Flyers were also passed out that provided information about the community meeting on March 30th as well as contact information for providing feedback.

The community meeting format included a short (20-minute) overview presentation of the project followed by a question and answer session (20 minutes) and an open house where meeting participants could view boards and have one-on-one discussions with staff and consultants. The schedule was:

- 5:00-5:30 – sign in, open house
- 5:30-6:10 – presentation and Q&A
- 6:10-7:30 – open house, submit comments

1.4 BOARDS AND INFORMATIONAL MATERIALS

Boards were designed to give attendees an overview of the project, as well as help the public better understand the benefit of the project and its purpose. The following boards and graphics were presented:

- **Welcome**: This board included the meeting date, time, and location.
- **VRE Overview**: This board provided an introduction to VRE and the service characteristics they are known for.
• **VRE Statistics and Benefits:** This board provided information about the ridership patterns and the benefits to regional traffic.

• **Existing Conditions:** This board showed a map of the destinations for Crystal City VRE riders based on the 2016 rider survey and a map highlighting the existing transportation network around the station.

• **Future Conditions:** This board included information about approved development projects in the Crystal City, Pentagon City, and Potomac Yard areas of Arlington County and proposed transportation improvements.

• **Station Sketch Planning:** Three boards showed the three different options under consideration. Each option showed the location of the proposed platform, locations of grade-separated access, track realignment, and area transportation services.

• **Alternative Selection Considerations:** This board listed the proposed design objectives for the project and the evaluation factors under consideration.

• **Proposed Schedule:** This board displayed a diagram of the project schedule.

A one-page handout was available that provided a high-level overview of the project for meeting participants to take home, and could be available on the project and County websites. The handout provided the project’s website address and contact information for providing comments via email. It was distributed at the open house.

A comment form was available to attendees at the public meeting. It provided space for attendees to write their comments, with information on how to submit comments at or following the meeting. It included questions on demographic information for Title VI purposes.

## 2 OUTREACH EFFORTS

### 2.1 NOTIFICATIONS

An announcement inviting the public to attend the meeting was prepared for VRE. This announcement included the public meeting purpose and the date, time, and location of the meeting, as well as providing contact information for further questions and comments. VRE and Arlington County posted the public meeting announcement through the following channels:

- Project website posting
- County website posting
- Train Talk e-blast
- Crystal City Business Improvement District e-newsletter
- Social media posts (Facebook and Twitter)

VRE forwarded the public meeting announcement to the members of the Project Working Group as well as the Crystal City Civic Association, with an invitation to participate in the meeting and a request that information be distributed to organization membership:

- Crystal City Business Improvement District
- Arlington County
- National Park Service
- Metropolitan Washington Airports Authority
2.2 POSTERS
A large version of the meeting flyer was printed and placed in a display box at the Crystal City VRE station to alert riders about the upcoming pop-up event and community meeting.

2.3 WEBSITE
VRE created a project specific webpage within the main VRE website. This page includes a brief description of the project, a project timeline, and links to various project materials, such as presentations and flyers. The presentation slides were posted to the webpage on March 27, 2017 in advance of the community meeting. Information about webpage traffic was collected:

• Between February 1 and May 4, 2017, the webpage was visited 1,125 times
• The largest number of visits occurred April 26, 2017 (35)
• The average visitor spent approximately 3 minutes on the webpage

3 ATTENDANCE

3.1 ATTENDEES
Forty-four people attended the meeting per the sign-in sheets. Eleven comment forms were submitted at the end of the meeting. The charts below represent the demographic makeup of meeting attendees taken from Title VI forms that were completed and submitted to the project team (Total = 11 responses).
4 COMMENTS

Comments were received at both the pop-up event and the community meeting. The section below summarizes the input received from those in attendance.

4.1 KEY TAKEAWAYS

- **VRE riders are supportive of the project**: Most riders were supportive of the station improvement project. Many voiced a preference for the option that placed the platform closest to their destination, but did not have strong feelings about one option over the others.
- **Explore and explain the benefits and impacts that each alternative will have on residential areas**: The community expressed concerns about the noise that the tracks currently produce and how that would change if the station moves. They also wanted to better understand the visual impacts as well.
- **Be clear about the different access points to each alternative**: Participants requested clarification on how riders will access the stations through the parks and how access to the parks themselves may be affected.

4.2 ACTIVITY SUMMARIES

4.2.1 Meeting Q&A Discussions- Summary

- **Clarifying Questions**
  - Question about who is responsible for the 4th track.
  - Questions about how people would access the park from the northern end of Option1.
  - Question about the option that is closest to the airport.
  - Questions requesting more details about the project and potential impacts to make a better decision.
- **Interagency and Involvement**: 
  - Question about who is paying for the project cost? *Response – VRE has submitted to DRPT for design funding and some portion from NVTA.*
- **Project Process**: 
  - Questions about timing of start of development.
• **Community Involvement:**
  - Is VRE collecting feedback on rider preference?

• **Site Selection and Design:**
  - Question about the area that was analyzed when selecting the proposed and planned developments in Arlington County.
  - Question about considering existing underground infrastructure.
  - Has VRE explored expanding ROW to expand options?
  - Concern about tunnels being scrapped because of the higher cost in favor of overhead pedestrian bridges.
  - Look at continuing to use existing platform and construct narrower single track platform.

• **Benefit and Impact Concerns:**
  - Questions about specific actions to mitigate noise.
  - Questions about activating street.
  - Comments about community impacts and locations on residential development.
  - What is VRE’s philosophy on green space? Is it a factor when assessing options? Would like VRE to treat parks/green space as a resource when considering factors. Concern about northern park.

4.2.2 Comment Form / Title VI Form Comments

The Title VI and comment forms allowed participants to write comments about the project for the project team to take back and consider. They closely mimic the discussion in the Q&A session. They have been edited for grammar and clarity without changing the spirit of the comment.

- Those living here want info from our perspective - impact on neighborhood, commuters are not the only affected group.
- We appreciate your presentation to keep us informed with the project. Option #3 is my recommendation.
- Concerned about the need for air horn mitigation & noise abatement.
- Need additional detail to tell the difference between options. Look forward to the next meeting. Thanks!
- Great presentation. I’m very excited to see what option your team chooses. I love the VRE and like the idea of an improved crystal city station.
- Against option #2; pro options #1 or #3. Please consider that freight trains use the eastern most track (closest to the airport).
- Option 3 looked promising.
- Option 3 (southernmost option) in my opinion represents the best balance between the consideration of the Crystal City residents and VRE commuters.
- I think the preferable option is #3 principally because it will not disturb residential areas as much as the other areas. Option #2 should not even be considered: either stay where you are (option #1) or go behind commercial buildings (option #3). You could also consider option #4, going to the area of Potomac Yard. I would like to congratulate VRE for meetings like this one and hope you consider seriously to minimize impact to residential communities.
- Option 3 is best, especially to encourage business & commuters in the area.
- Option 1 could work if you mitigate noise & green space impact.
- Option 2 won’t work - there are underground structures & car/bike traffic that will mix badly with the commuters. Also, consider split platform rather than island - it may be more feasible.

4.2.3 Comments Received via Email

Participants were also able to submit comments electronically via email to ssoneji@vre.org. These comments mirrored many of those received via the comment form, but also include perceptions from VRE riders, many of whom were not able to attend the evening community meeting in person. The comments have been summarized below.
In general, residents oppose the construction of platforms at Options 1 and 2. They are concerned with the noise and vibration that these platforms would add near residential areas due to the train whistle, the train brakes, and the increase in pedestrian and car traffic. They have concerns about the possibility of damage to existing structures and the obstruction of green spaces with new access points to the station. There was a desire for more detailed information about pedestrian access for each option. Concerns relating to air pollution, the appearance of the station, and safety were also voiced.

Residents support Option 3 because it will be located behind office buildings as opposed to residential areas in Crystal City. They believe that Option 3 could revitalize the south/central part of Crystal City and that it is the best option because it balances the desires of businesses, residents, and commuters. Since Option 3 will be the furthest away from the Metrorail station, it was suggested that a direct connection be made under Crystal Drive between the VRE platform and the Crystal City Metrorail station. Residents mention that if Option 2 is chosen, measures should be considered to mitigate the noise (e.g. large trees) and mechanical arms should be placed to keep people from using the residential driveways for the pick-up and drop-off of passengers.

The VRE riders that wrote email comments favor Option 2. They believe that it would be beneficial to move the station further south to a more centralized location, but not at the expense of access to the Metrorail station. In addition, they would like the station to be close to a Capital Bikeshare station and encourage the construction of an underground tunnel between the VRE station and the Metrorail station.

5 THE PATH FORWARD

Based on the comments from participants, the following represents recommended next steps for the project in terms of public involvement:

1. Identify a location with better acoustics. Nobody provided a written comment, but some attendees commented that it was difficult to hear. If the same location is chosen, the project team should provide an audio system to amplify the speakers.
2. The project team should provide more advance notice for the next community meeting.
3. The project team should have materials available that clearly document the benefits and impacts of the project for both commuters and residents. Where possible, visual aids should be provided to communicate impacts.
Appendix B
VRE Crystal City Station Improvements
Public Meeting #2 Summary

June 27, 2017
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1 INTRODUCTION

1.1 PURPOSE OF THE MEETING

The purpose of the June 7, 2017 Public Meeting was to present the preliminary evaluation results for three station location options to the community and to VRE riders. This meeting is important as a mechanism to obtain public input in advance of recommending one preferred station location alternative.

1.2 EVENT INFORMATION

Two meetings were held on June 7th:

1. Midday (12:00 - 1:30 PM), with a presentation at 12:30 PM
2. Evening (6:00 - 7:30 PM), with a presentation at 6:30 PM

Meeting materials were posted to the project website (http://www.vre.org/development/crystal-city-station-improvements/) one day prior to the public meetings, to allow interested members of the public to review material prior to the outreach events.

The public meetings were held at the Gallery Underground – 2100 Crystal Drive, Arlington, VA 22202. The location was selected based on its general proximity to the existing VRE station and its accessibility. The meeting location was easily accessible for those working or living in Crystal City, with nearby parking and transit options available for those traveling from elsewhere.

1.3 FORMAT

The format included a short (30-minute) period for people to view project boards and ask questions of staff and consultants, followed by a 30-minute presentation of the project and evaluation. A question and answer session followed the presentation. The agenda for both meetings was:

- 12:00-12:30 or 6:00-6:30 – sign in, open house
- 12:30-1:00 or 6:30-7:00 – presentation
- 1:00-1:30 or 7:00-7:30 – Q&A and submit comments

A robust large group Q&A followed both the midday and evening presentations, which extended the time of both meetings by approximately an hour.

1.4 BOARDS AND INFORMATIONAL MATERIALS

Boards were designed to give attendees an overview of the project, as well as help the public better understand how each option had been advanced since the previous meeting and how each option was evaluated. The following boards and graphics were presented:

- Welcome: the meeting date and location.
- VRE Overview: an introduction to VRE and its service characteristics.
- VRE Statistics and Benefits: information about ridership patterns and benefits to regional traffic.
- Alternative Selection Considerations: proposed design objectives for the project and the evaluation factors under consideration.
- Project Timeline: project schedule.
- Station Concept Planning (4 boards): 1 board for each option with Option 1 having 2 boards ((Option 1 had a 1A and 1B). Each board provided information about the location of the proposed
platform, locations of grade-separated access, track realignment, and area transportation services. In addition, visualizations were also included to show a bird’s eye view of the platform, and the potential grade-separated connections.

- **Alternatives Evaluation (2 boards):** how each option scored in each of the four evaluation factors. One board provided a summary of the evaluation ratings. The second board showed the various measures of effectiveness analyzed within each of the four criteria categories.

A 1-page 11x17 handout was available that provided a project description, summary evaluation, project timeline, concept plan views of the three options, and the detailed evaluation ratings. The handout provided the project’s website address and contact information for providing comments via email.

A comment form was available to attendees at the public meetings. It provided space for attendees to write their comments to specific questions, with information on how to submit comments at or following the meeting. It included demographic questions for Title VI purposes.

The boards, presentation, handout, and comment form were made available on the project webpage.

### 2 OUTREACH EFFORTS

#### 2.1 NOTIFICATIONS

VRE prepared a meeting announcement which detailed the public meeting purpose and the date, time, and location of the meeting, as well as providing contact information for further questions and comments. VRE and Arlington County posted the public meeting announcement through the following channels:

- Project website posting
- County website posting
- Train Talk e-blast
- Crystal City Business Improvement District e-newsletter
- Social media posts (Facebook and Twitter)

VRE forwarded the public meeting announcement to the members of the Project Working Group as well as the Crystal City Civic Association, with an invitation to participate in the meeting and a request that information be distributed to organization membership:

- Crystal City Business Improvement District
- Arlington County
- National Park Service
- Metropolitan Washington Airports Authority
- JBG/Vornado

#### 2.2 WEBSITE

VRE updated the project webpage to announce the public meetings. Material available on the webpage included a brief description of the project, a project timeline, and links to various project materials, such as presentations and flyers. The presentation slides for the second community meeting were posted to the webpage on June 6, 2017 in advance of the community meeting.
3 ATTENDANCE

3.1 ATTENDEES

Eighty-two people attended the two meetings per the sign-in sheets (34 at the 12:00 PM and 48 at the 6:00 PM). Fifteen comment forms were submitted at the end of the two meetings. The charts below represent the demographic makeup of meeting attendees taken from Title VI forms that were completed and submitted to the project team (Total = 16 responses).
4 COMMENTS

Comments were received at both community meetings. The section below summarizes the input received from those in attendance.

4.1 KEY TAKEAWAYS

- **Disagreement over the evaluation ratings**: There was general disagreement with the evaluation ratings shown in the presentation. Participants voiced concerns about the accuracy of the data, how the data was interpreted, and the weighting given to certain measures. In particular, disagreement was voiced regarding the Local Transportation Connections and Community and Environmental Impacts ratings.

- **Concern about the measures assessed under the Community and Environmental Impacts factor**: Specific attention was focused on the Community and Environmental Impacts factor. There was concern that the factor did not address impacts to the sidewalks and pedestrian paths in the area from increased foot traffic, air quality, light pollution, and property values.

- **Questions about how feedback would be used to inform a decision**: Participants asked how comments would be used to inform a final decision, and how a final decision would be made. There was concern that the due date for comments and the VRE Operations Board meeting were the same day, not allowing sufficient time to understand the feedback and share it. Participants wanted to understand better how a decision would be arrived at, and who would be making the final decision.

- **Concerns about horn noise regardless of station location**: Residents voiced frustration with the horn noise. Many would like to see more action towards developing a solution with CSXT.

4.2 ACTIVITY SUMMARIES

4.2.1 Meeting Q&A Discussions- Summary

- **Clarifying Questions**
  - How many riders currently use the Crystal City station?
  - Will notes be made available to the public? *Response: Yes, they will be placed on the website.*
  - How likely is a second Metrorail entrance? *Response: It is very likely. The County and property owner are close to selecting a location.*

- **Evaluation Ratings**
  - Why is there a difference in the ratings for Local Transportation Connections when many of the measures are so close?
  - Why weren’t pedestrian traffic impacts considered under Community and Environmental Impacts?
  - Did you consider future projections in the evaluation? *Response: Future projections for residents and jobs were reviewed, as well as the approved developments within Crystal City and Pentagon City.*
  - Why were figures from 2015 used?
  - Were the numbers of riders whose destination is the Pentagon considered?
  - Did you assess the visual impacts to residents?
  - Did you assess air quality?
  - Did you apply a factor to the noise assessment to account for the number of people who would be impacted? *Response: No factor was applied to the noise assessment that accounts for number of persons. This is not considered as part of an approved noise assessment methodology.*
  - What does the Y-axis on the noise chart represent?
  - Was brake noise considered as part of the noise analysis? *Response: Yes, the train braking would have been assessed as part of the noise analysis.*
  - Will noise increase for 1805 Crystal Drive?
- Why does Option 3 rate so low for Local Transportation Connections and Community and Environmental Impacts?
- Were construction impacts considered?
- Was light pollution assessed for each of the options? *Response: No, lighting was not assessed at this stage.*
- Was noise associated with construction assessed?
- Are the ratings weighted? *Response: No, the ratings did not have a weight applied. They were all viewed as equally weighted.*

**Interagency and Involvement:**
- Who would be responsible for authorizing easements to provide connections between the platform and sidewalk? *Response: The connections were designed to avoid the residential properties. Easements would need to be worked out with the property owner, and in this case, most of the properties are owned by JBG.*
- Why is CSX not present to talk about noise and horn soundings?
- Could there be another meeting with a panel like the one held in the fall of 2016 with VRE, DRPT, CSX, and DDOT?

**Community Involvement:**
- Would community feedback change the decision-making process? *Response: Yes, the community feedback will be reviewed prior to making a final decision.*

**Site Selection and Design:**
- Why didn’t VRE look at an option north of Option 1 (near Long Bridge Park)?
- Would the connection for the northern end of Option 3 tie into the building where the previous catwalk over Crystal Drive was? *Response: The specific details of how the connection would work in the building are not known at this time.*
- Was any consideration given to a tunnel connection the VRE station platform and Metrorail platform? *Response: There is a large stormwater pipe that runs beneath Crystal Drive. When the County was looking at the second Metro entrance, this was considered and was found to be cost-prohibitive.*
- Was consideration given to how Metrobus, ART, and shuttle buses would reroute associated with each option? *Response: Not at this stage. Rerouting would likely occur regardless of the option selected to facilitate transfers.*

**Benefit and Impact Concerns:**
- Who would be responsible if vibrations from the trains caused damage to a building?

### 4.2.2 Comment Form Comments

The Title VI and comment forms allowed participants to write comments in response to questions about the evaluation of the options for the project team to take back and consider. There was a question asking the respondent if they agreed/disagreed with the evaluation for each option, and why if they disagreed. There was a question about whether the respondent agreed with the overall evaluation, and why if they disagreed. Lastly, there was a place to respond with any additional comments.

The comments related to the evaluation of the options closely mimic the discussion in the Q&A session. While some respondents agreed with the evaluation, many disagreed with at least one or two of the evaluations present. The following includes the comments received through the comment form in their entirety. They have been edited for grammar and clarity without changing the spirit of the comment.

1. **Do you agree with the evaluation results for Option 1?**
   - How will you keep the tunnel connecting the northern end of Option 1 through the park clean? The southern access for Option 1 will still have riders going through the Water Park. This is a major conflict with other pedestrians, cyclists, and bus riders moving through the area.
   - Option 1 is close to residential buildings and will have impacts associated with the horn noise and traffic.
   - Option 1 has significant impacts on residents and easy access to local transportation connections.
   - I do not agree with the rating of Local Transportation Connections for Option 1.
• The greater number of residents near Option 1 and proximity to the bicycle network should make Option 1 green. Option 2 should be yellow for Local Transportation Connections. The Community and Environmental Impacts factor should be the most important.
• I am totally opposed to the entire project. Option 1 is the worst option because it would have a devastating effect on green space in the 1200-1300 Crystal Drive area.
• The Local Transportation Connections associated with Option 1 are underrated. The local connections are identical to Option 2, which is rated “high”. Also, it is a longer walk, exposed to weather, from Option 2 to the Metro.
• Option 1 is the best option (Closest to Metro, Least costly, and least disruptive to the neighborhood).
• Why aren’t you considering the impact of increased traffic and noise on residents with Options 1 and 2?
• It surprised me that you would consider having a station behind a residential building.
• The evaluation vastly underestimates the impact on residents (voters) living in adjacent buildings. It overemphasizes the impact on jobs. Commuters using VRE are going to use it regardless of which option is chosen.

2. Do you agree with the evaluation results for Option 2?
• The northern access point for Option 2 could be an opportunity to solve a major conflict point between cyclists, pedestrians, and bus riders. People using the connector trail need safe access. The County needs to create a safe route around the bus station. This route could be used by VRE riders.
• Option 2 is close to residential buildings and will have impacts associated with the horn noise and traffic.
• Option 2 has significant impacts on residents and the access to local transportation connections is not as good as Option 1. Option 2 could affect property values. There appears to be a high wall planned as part of Option 2. This is a bad idea.
• There is no consideration for residents at risk of being disturbed with Option 2.
• I am totally opposed to the entire project. Option 2 is the worst option because it would have a devastating effect on green space in the 1200-1300 Crystal Drive area.
• Noise, vibration, and increased pedestrian traffic negatively impact the quality of life of Crystal Drive residents. Option 2 is the least acceptable of the options.
• The Local Transportation Connections associated with Option 1 are underrated. The local connections are identical to Option 2, which is rated “high”. Also, it is a longer walk, exposed to weather, from Option 2 to the Metro.
• Option 2 requires track relocation and does not provide easy access.
• Why aren’t you considering the impact of increased traffic and noise on residents with Options 1 and 2?
• The station would be behind a residential property. There would be more noise, dirt, and could affect our property values.
• The evaluation vastly underestimates the impact on voters living in adjacent apartments and condominiums. It does not even consider the impact on condo property values. It overemphasizes the location impact on commuters. The commuters that use the VRE will use it anyway. There will be adverse traffic patterns by the Water Park and bike tunnel.

3. Do you agree with the evaluation results for Option 3?
• Option 3 does not seem to work because of the extra cost, but this is the best option for a connection to the airport.
• Why relocate the present station when you can expand it to meet ridership needs?
• The slide showing VRE rider destinations showed that most people’s destination is near the commercial buildings around 23rd Street. This makes Option 3 ideal and preferred over Options 1 and 2. Option 3 has minimal impacts on residents since it is in front of a commercial building. I believe
• Option 3 provides the least impact on the residents of the Crystal Park Condos. It would also not result in a reduction of property values, or loss of tax revenue to the County.
• Option 3 should be preferred because it will disturb fewer residents and benefit the most local businesses.
• Option 3 is the best of the three options, but is not a good option.
• Option 3 should be rated second because it avoids residential properties.
• Option 3 is the second-best option because it is behind commercial properties and not residential.
• Option 3 is clearly the best option. Few VRE riders are going to care about Metro, which is dysfunctional. The difference in distance is negligible. If the objective is to increase commercial activity in Crystal City, then the evaluation is fine.
• This station would be behind a commercial property, and would be the best solution.
• The evaluation of Option 3 ignored the benefit to businesses on 23rd Street and Crystal Drive between 20th and 23rd. Why aren’t you considering a tunnel with Option 3? Option 3 provides the greatest space for the tracks and station.

4. Do you agree with the overall evaluation results and ranking of the three station location options?
• Option 3 is the best option because it places the station near office buildings. Option 3 also minimizes the foot traffic around the residential buildings compared to Options 1 and 2.
• The evaluation has not fully addressed the impacts to residents (property values, people leaving Crystal City, visual impact of foot traffic, loitering, litter, vibration, retaining wall fatigue, and noise).
• There is no clarity regarding each of the factors evaluated.
• I believe the impact on Crystal City residents has not been taken into consideration; at least not fully. Noise, vibration and increased pedestrian traffic is unacceptable regarding Option 2.
• If the objective is to destroy Crystal City’s livability, it sounds like you are fine with that.
• It surprised me that you would consider putting a station behind residential properties.
• The County is, as usual, ignoring the negative impact on Crystal City residents. The data is outdated, evaluation is skewed away from Option 3, and summary ratings are arbitrary. Option 3 should be green for Local Transportation Connections and Community and Environmental Impacts. The anticipated costs should be graded equally until proven otherwise.

5. Do you have any other comments about the project?
• Option 2 solidifies this location (18th Street and Crystal Drive) as the transportation hub for Crystal City. With the planned Metro access on Crystal Drive and the recently installed bus stops, 18th and Crystal become the center of Crystal City as the area densifies through redevelopment activity. The more pedestrian activity that occurs here, the more likely future retail will flourish. New retail is critical to the long-term success of Crystal City. I do not like Option 3 because it disconnects the link between VRE and Metro. Option 2 (and 1) makes it easier for VRE commuters to get on Metro and travel to the Pentagon, R-B Corridor, and beyond.
• The distance to the bike network should be the same for all three because of the bike lanes on Crystal Drive. Please create a link for pedestrians from Crystal Drive to the VRE station and then the airport. I support whichever option works to accomplish this.
• It appears that those who put together the Crystal City Station Improvements want Option 2. The evaluation factors and measures are arbitrarily skewed in favor of Option 2.
• Please make this a more transparent process. Publish a realistic summary of ALL comments and recommendations on the website. The station should at least improve the situation of noise and pollution at the location selected, and be visually integrated with the surrounding environment.
• Do not do this project. It is a waste of money and resources.
• Thanks for notification of this important meeting that impacts me. I opposed Option 2, and prefer Option 1. I recommend exploring the area north of Option 1 between Long Bridge Park and the apartments near 12th Street.
• Congratulations on completely disregarding the people who live here. Don’t you think that residents choosing to leave Crystal City will have an impact? Clearly, you don’t seem to care about that.
• Options 1 and 2 are behind residential properties. How can this be a good fit? Option 3 is behind commercial properties. Horns in the morning and evening would not be an issue with Option 3. Community impact should be separated from environmental impact.
• The number of VRE passengers impacted will be insignificant when comparing the three options. The impact on Crystal City residents (voters) will be significant.

5 THE PATH FORWARD

Based on the comments from participants, the following represents recommended next steps for the project in terms of public involvement:

1. VRE will gather all public feedback received during and after the public meetings and use it as they consider the results for the alternatives evaluation.
2. The agency will document the alternatives evaluation results, including public feedback received, and use this information to identify one preferred alternative.
3. The draft preferred alternative will be discussed with the Working Group, the VRE Operations Board, and Arlington County. Information will be available on the project website.
4. VRE will flesh out the design aspects of the preferred alternative, including access, platform location, environmental considerations, and operational considerations.
Appendix C
VRE Crystal City Station Improvements
Noise and Vibration Analysis Report

July 2017
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1.0 Introduction

Project Description

The Virginia Railway Express (VRE) Crystal City Station Improvements Project would replace the existing VRE Crystal City Station in Arlington, Virginia with an enhanced station including a longer island platform that can service two tracks. The purpose of the Project is to improve convenience and provide additional capacity at the station to serve longer trains and improve operational flexibility and capacity along the corridor. A secondary set of goals focus on Crystal City’s vision for growth and enhancing local and regional connectivity. The new station platform would be approximately 850 feet long, would facilitate VRE trains with up to 10 cars, and would have two grade-separated pedestrian access points. Three potential options have been considered for the station location - all within one half mile of the current station, as follows:

Option 1 would relocate the station platform between tracks 2 and 3, and would extend it approximately 300 feet north and 100 feet south of its existing location.
Option 2 would relocate the station between tracks 2 and 3 approximately one quarter mile south of the existing station, to a site near 2011 and 1805 Crystal Drive.
Option 3 would relocate the station between tracks 2 and 3 approximately one half mile south of its current location, to a site near 2345 Crystal Drive.

Under all three options, the existing platform would be removed. The existing station and Options 1, 2, and 3 are shown in Figure 1, Figure 2, Figure 3, and Figure 4, respectively. Figures 1 through 4 show the station locations as well as the approximate locations where trains would sound their horns on approach or upon departure from the station.

VRE conducted a noise and vibration assessment of the proposed station improvements following the methodology and criteria of the Federal Transit Administration’s (FTA) Noise and Vibration Impact Assessment guidance manual (report FTA-VA-90-1003-06) dated May 2006. This assessment has been conducted in support of the overall environmental review for the proposed project.

Introducing new or modifying existing sources of noise and vibration has the potential to cause impact at receptors in the study area. This report presents the noise and vibration regulatory context of the project, notes the existing noise and vibration conditions in the study area, provides noise and vibration prediction methodologies and relevant impact criteria, documents impact assessment results, and evaluates mitigation (as warranted).
Figure 1: Existing Station Location
Figure 2: Option 1 Station Location
Figure 3: Option 2 Station Location
Figure 4: Option 3 Station Location
2.0 **Noise and Vibration Background**

**Noise and Vibration Descriptors**

Noise is typically defined as unwanted or undesirable sound, whereas sound is characterized by small air pressure fluctuations above and below atmospheric pressure. The basic parameters of environmental noise that affect human response are (1) intensity or level, (2) frequency content, and (3) variation with time. The first parameter is determined by how greatly the sound pressure fluctuates above and below the atmospheric pressure, and is expressed on a compressed scale in units of decibels. By using this scale, the range of normally-encountered sound can be expressed by values between zero and 120 decibels. On a relative basis, a three-decibel change in sound level 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 sound is related to the tone or pitch 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 “dBA.” The A-weighted sound level is widely accepted by acousticians as a proper unit for describing environmental noise.

Because sound levels fluctuate, it is important to characterize the range of levels that may exist over a period of time. This is commonly done by using the following sound level metrics:

- **Lmax** is the maximum instantaneous A-weighted sound level. The Lmax represents the highest sound level generated by a source.
- **Leq** is the energy-average sound level. The Leq is a single value that is equivalent in sound energy to the fluctuating levels over a period. The Leq accounts for how loud events are during the period, how long they last, and how many times they occur. Leq is commonly used to describe environmental noise and relates well to human annoyance.
- **Ldn** is the day-night average sound level. The Ldn is a value that represents the sound level over a 24-hour period with a 10-dB penalty applied to sound that occurs between 10:00 p.m. and 7:00 a.m. when people are more sensitive to noise. Ldn accounts for how loud events are, how long they last, how many times the occur and whether they occur at night.
▪ SEL is the Sound Exposure Level of a particular noise event. The SEL represents the cumulative sound exposure during the entire noise event, and is the basis for predicting Leq and Ldn noise levels from train activity.

Because sound levels are measured in decibels, adding sound levels is not a linear operation. For example, when two equal sources of sound are added together, the overall level will increase 3 dB (for example, 60 dB plus 60 dB equals 63 dB). Additionally, research indicates the following relationships between A-weighted sound level and human perception:

▪ A 3-dB increase is a doubling of acoustic energy and is the threshold of perceptibility to the average person.
▪ A 10-dB increase is a tenfold increase in acoustic energy but is perceived as a doubling in loudness to the average person.

Many surveys have shown that Ldn and Leq correlate well with human annoyance, therefore these descriptors are widely used for environmental noise impact assessment.

Figure 5 shows typical A-weighted maximum noise levels for common noise sources including rail sources, construction equipment and indoor sources.
Ground-borne vibration is the oscillatory motion of the ground about an equilibrium position that can be described in terms of displacement, velocity or acceleration. Vibration velocity in the low-frequency range (4 to 80 Hz) corresponds well to human sensitivity and is used to evaluate ground-borne vibration from transit sources for human annoyance. Vibration velocity is characterized in terms of the “smoothed” root-mean-square (RMS) level in decibels (VdB), with a reference quantity of one micro-inch per second. VdB is used in place of dB to avoid confusing vibration decibels with sound decibels.

Figure 6 illustrates typical ground-borne vibration levels for common sources, as well as criteria for human and structural response to vibration. As shown, the range of interest is from approximately 50 to 100 VdB, from imperceptible background vibration to the threshold of damage to structures. Although the approximate threshold of human vibration perception is 65 VdB, annoyance is usually not significant unless the vibration exceeds 70 VdB.
Ground-borne vibration can also be evaluated for its potential to cause structural damage to buildings. Unlike human sensitivity to vibration, the sensitivity of buildings and structures to vibration correlates well to the “peak vibration velocity” (PPV) which is measured in inches per second (in/s).

**Regulatory Context**

This section presents relevant federal, state and local regulations, policies, ordinances and guidance applicable to the evaluation of potential noise and vibration effects.

The FTA’s “Noise and Vibration Impact Assessment” (dated May 2006) guidance manual describes the methods and criteria used to assess potential noise and vibration effects from federally-funded rail infrastructure projects that are subject to review under the National Environmental Policy Act (NEPA).

Further information about the methodology and criteria used are described in Section 3.
Construction activities have the potential to affect noise and vibration-sensitive receptors in the study area. The Arlington noise ordinance (Arlington County Code §15-2) is intended to promote public health, safety and welfare, and foster the comfort of the public of Arlington. It should be noted that sound generated by trains is exempt from this ordinance, as it is preempted by federal regulation (§15-5.F.4). It is anticipated that the contractor would meet all applicable construction noise and vibration-related requirements.

Construction noise is regulated in the Arlington noise ordinance by the zoning of the receiving property. The Project is located and adjacent to properties with zoning codes P-S, M-1, M-2, C-O, C-O-CC, and C-O-1.5. Any noise from construction activity which produces sound greater than the limits in Table 1 is permitted only during daytime hours (7 a.m. to 9 p.m. on weekdays and 10 a.m. to 9 p.m. on weekends and legal holidays). The ordinance also requires that all feasible procedures and measures customarily used in the industry shall be implemented to minimize noise. Construction noise at any time is prohibited from exceeding 90 dBA when measured at the curb of any property adjacent to a built street, a common area of any multi-unit structure, or an individual unit of any multi-unit structure, so long as the measurement is at least 50 feet from the noise source.

Table 1: Arlington County Maximum Permissible Noise Levels

<table>
<thead>
<tr>
<th>Receiving Zoning District</th>
<th>Time of Day</th>
<th>Continuous Noise (dBA)</th>
<th>Impulsive Noise (dBA)</th>
<th>Continuous Center Octave Frequency (Hz)</th>
<th>dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-1</td>
<td>All</td>
<td>70</td>
<td>120</td>
<td>31.5</td>
<td>85</td>
</tr>
<tr>
<td>M-2</td>
<td>All</td>
<td>65</td>
<td>100</td>
<td>31.5</td>
<td>80</td>
</tr>
<tr>
<td>P-S</td>
<td>All</td>
<td>65</td>
<td>100</td>
<td>31.5</td>
<td>80</td>
</tr>
<tr>
<td>C-O</td>
<td>All</td>
<td>65</td>
<td>100</td>
<td>31.5</td>
<td>80</td>
</tr>
<tr>
<td>C-O-CC</td>
<td>All</td>
<td>65</td>
<td>100</td>
<td>31.5</td>
<td>80</td>
</tr>
<tr>
<td>C-O-1.5</td>
<td>All</td>
<td>65</td>
<td>100</td>
<td>31.5</td>
<td>80</td>
</tr>
</tbody>
</table>

Source: Arlington County Code, Chapter 15, Table 1
3.0 **Methodology**

The methodology used to assess potential noise and vibration impact includes identifying noise and vibration-sensitive receptors, characterizing the existing noise and vibration conditions in the study area with measurements and modeling, predicting future noise and vibration conditions with the proposed project, assessing potential impact, and evaluating the need for mitigation.

**Train Noise Impact Assessment Methodology**

*FTA Noise Criteria*

The FTA classifies land uses sensitive to noise from rail operations into the following three categories.

- **FTA Noise Category 1:** Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, like outdoor amphitheaters and concert pavilions, and National Historic Landmarks with significant outdoor use. Recording studios and concert halls are included in this category.
- **FTA Noise Category 2:** 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.
- **FTA Noise Category 3:** Institutional land uses with primarily daytime and evening use. This category includes schools, daycares, libraries, theaters and churches where it is important to avoid interference with speeches, meditation, and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds and certain historical sites and parks with passive use are included in this category.

There are some buildings, such as television studios and theaters that can be very sensitive to noise and/or vibration but do not fit into any of the three categories. Due to the sensitivity of these buildings, they may warrant special attention.

FTA noise impact criteria are founded on well-documented research on community reaction to noise, and are based on change in noise exposure using a sliding scale. When the existing noise levels are relatively high, smaller increases in future noise level are allowed due to a proposed project since ambient conditions are already high. When existing noise levels are relatively low, a greater increase in future noise is allowed.

For projects that modify existing rail noise sources, impact is assessed by comparing the noise exposure increase due to the project to the existing noise exposure. Figure 7 shows
the noise exposure increase limits used to assess moderate or severe noise impact. For example, if the existing noise level is 65 dBA (Ldn), a 1.4-dB increase or greater would result in moderate noise impact, and a 3.6-dB increase or greater would result in severe noise impact. Conversely, if the existing noise level is 50 dBA (Ldn), a 5.0-dB increase or greater would result in moderate noise impact, and a 10.0 dB increase of greater would result in severe noise impact.

Figure 7: FTA Noise Impact Criteria

![FTA Noise Impact Criteria](source: FTA, 2006)

**Train Noise Prediction Methods**

The FTA noise screening procedure is designed to identify locations where a project may cause noise impact. If there is a noise-sensitive land use within the screening distance, then further evaluation is likely required. The screening distances are based on projects that would introduce new sources of rail noise where they do not currently exist. For projects that modify existing sources, the potential for noise impact is substantially less. The unobstructed noise screening distance for a new commuter rail station with horn blowing is 1,600 feet. Since there are receptors in the study area within this screening distance, further noise evaluation is required.

Noise conditions due to the proposed station improvements have been evaluated based on the FTA assessment methods outlined in the FTA guidance manual. This analysis takes into consideration the typical number of train operations including VRE, CSX Transportation (CSXT) and Amtrak trains, train speed, and horn sounding locations.
Current VRE commuter rail service is primarily a peak-period service, with 14 morning arrivals between 6:00 and 9:05 a.m., and 15 afternoon departures between 1:10 and 7:05 p.m. VRE operates eight daily round-trips on the Fredericksburg line and eight on the Manassas line.

It is assumed that 24 VRE trains would stop at the station during the daytime and 5 VRE trains would stop during the nighttime\(^1\). Two daytime VRE trains and 1 nighttime VRE train would travel through the station without stopping. Additionally, 12 daytime Amtrak trains and approximately 16 CSX freight trains travel through the corridor per day, including 10 during the day and six during the night\(^2\). Existing VRE trains typically include one diesel locomotive and between four and eight passenger coaches. Amtrak trains include two diesel locomotives and approximately eight passenger coaches. CSX freight trains vary in consist with some trains including two or more diesel locomotives and 100 or more rail cars.

Since the study area includes several different sources of noise including VRE operations, CSX trains, Amtrak trains, vehicular noise, aircraft noise from Reagan National Airport and other general ambient sources, it was necessary to evaluate the relative contribution of noise from sources that would or would not be impacted by the proposed Project. Noise measurements of each type of train operation were conducted and used to predict existing and future noise conditions, including changes resulting from the proposed Project.

The primary factors impacting the noise environment resulting from the proposed Project would be changing train speed and new locations where trains would sound their horn. VRE and CSX trains follow CSX operating rules which require trains approaching passenger stations to sound their horn within 1/4-mile with one short sounding. CSX operating rules also require trains that have been stationary for more than 1 minute to sound their horn with two soundings prior to moving. Although VRE trains primarily have the locomotive on the south end of the train regardless of direction of travel, the trains have a horn on both the locomotive and the coach cab, so when the horn is sounded it is always from the front of the train.

The SEL values of VRE train pass-bys have been predicted based on the distance (along the track) from a receptor to the center of the station platform. As shown in Figure 8, SEL values have been predicted including train noise at the appropriate speed and horn noise from the train approaching the station from 1/4-mile away and just prior to departing the station. The appropriate SEL values are then used to determine the peak-hour (Leq) and day-night-average (Ldn) noise levels from VRE operations. The noise from all VRE

\(^1\) Based on the most recent VRE schedules for the Manassas and Fredericksburg Lines. Effective March 6, 2017.

\(^2\) Based on the most recent Amtrak Schedule for the Northeast Corridor and field observations.
operations, Amtrak trains, and CSX trains are then combined to evaluate potential impact according to cumulative noise exposure. Further information on the noise measurement results are presented in Chapter 4 Existing Conditions.

**Figure 8: VRE SEL Values Relative to Distance from Platform Center**

![Graph showing VRE SEL values relative to distance from platform center.](image)

Source: VHB, 2017

**Train Vibration Impact Assessment Methodology**

**FTA Train Vibration Criteria**

Vibration-sensitive receptors are categorized similarly to noise receptors as they relate to human annoyance from train operations, except parks are not evaluated for vibration impact. The FTA vibration criteria account for variation in project types as well as the frequency of events, which differs widely among transit projects. The criteria reflect the relationship between frequency of vibration events and human annoyance by having lower impact criteria for frequently-travelled railway corridors.

When a detailed vibration assessment is conducted that provides the frequency content of vibration, impact is assessed based on 1/3-octave band vibration levels. The FTA detailed vibration criteria between 8 and 80 Hz correspond to the overall FTA general assessment vibration limit which is based on the type of receptor and the number of train events. The FRA detailed vibration criteria in the 4-Hz and 6.3-Hz 1/3-octave bands are 3 and 6 VdB.
higher, respectively, since people are generally less sensitive to low-frequency vibration. Although train vibration is typically within the 4 to 80-Hz range, the vibration limit is extended to higher frequencies up to 400 Hz when vibration measurements are made at these higher frequencies. The FTA general assessment vibration criterion is an overall level of 75 VdB for residences and 78 VdB for institutional uses, such as places of worship, when there are an occasional number of daily events (between 30 and 70). Therefore, the detailed vibration criteria based on 1/3-octave bands, as shown in Figure 12 is 75 VdB between 8 and 400 Hz and up to 81 VdB at 4 Hz.

For existing rail corridors, assessing vibration impact also depends on existing vibration conditions. For heavily-used rail corridors, vibration impact would occur if future vibration levels exceed the absolute vibration criterion and either exceed existing vibration levels by more than 3 VdB, or if the number of train operations are doubled. Since the proposed station improvements would not double the number of trains operating in the corridor, the applicable criteria are whether project vibration levels would exceed the vibration criterion and would exceed existing levels by more than 3 VdB.

**Train Vibration Prediction Methods**
The FTA vibration screening procedure is designed to identify locations where a project may cause vibration impact. If there are vibration-sensitive land uses within the screening distance, then further evaluation is likely required. The vibration impact screening distance for commuter train systems is 600 feet for Category 1 land uses, 200 feet for Category 2 (residential) land uses, and 120 feet for Category 3 (institutional) land uses. Since there are vibration-sensitive receptors within these screening distances, further vibration evaluation is required.

Project vibration conditions due to the proposed station improvements have been evaluated based on vibration measurements of existing train operations in the study area. Since the Project may change the train speeds, there may be a potential for vibration levels to change. To evaluate future vibration conditions, measurements were conducted of trains operating at the maximum speed through the corridor (approximately 45 mph) and assessed according to the detailed FTA vibration criteria in Section 4.
4.0 Existing Noise and Vibration Conditions

This section of the report includes a description of the existing noise and vibration conditions in the study area which extends from 6th Street South near Long Bridge Park to Potomac Avenue south of the Airport Access Road. Noise and vibration-sensitive land uses have been identified by reviewing aerial photography, the Arlington County Geographical Information System land use database, and field observations. Noise and vibration measurements were taken in the study area from May 15-16, 2017.

Noise and Vibration Study Area

Noise and vibration-sensitive receptors in the study area primarily include residences on Crystal Drive. Parks, which have noise-sensitive use, are also included in the study area. There are no known developments in the study area that have been permitted for sensitive-use. The study area includes the following existing receptors (shown in Figure 9):

- R1 – Crystal City Lofts (305 10th Street South)
- R2 – Gateway Park
- R3 – Crystal Gateway (1300 Crystal Drive)
- R4 – Waterpark Towers (1501 Crystal Drive)
- R5 – Waterpark Towers (1505 Crystal Drive)
- R6 – Crystal City Water Park
- R7 – Crystal Place (1801 Crystal Drive)
- R8 – Crystal Place (1805 Crystal Drive)
- R9 – Crystal City Workout Park

Existing Noise Conditions

Ambient noise monitoring was conducted to characterize the existing conditions at receptors throughout the study area, including two long-term (24-hour) measurements (LT-1 and LT-2), three short-term (approximately 30 minutes) measurements at park locations (ST-1, ST-2, and ST-3) and three train pass-by reference measurement locations (PB-1, PB-2, and PB-3) as shown in Figure 9.

Table 2 summarizes the day-night average (Ldn) and hourly equivalent (Leq) noise levels at LT-1, LT-2, ST-1, ST-2 and ST-3. Figure 10 and Figure 11 present the hourly noise level measurement results for LT-1 and LT-2, respectively. Additional statistical sound levels and representative noise spectra are presented in the Appendix.
The noise measurements at LT-1 included one-second time histories which allowed each train event to be identified (for example, VRE station stop, Amtrak through-movement, or CSX operation), and the sound exposure levels (SEL) and maximum noise level (Lmax) to be calculated. Table 3 summarizes the maximum noise level (Lmax) and sound exposure level (SEL) of each type of train operation measured at the PB-1, PB-2, PB-3 and LT-1.

Long-term noise measurement (LT-1) was conducted 25 feet west of the nearest track at 1501 Crystal Drive, near the north end of the existing station platform. The predominant noise source at this location was train activity. The microphone was located at the edge of the outdoor pool area with a direct line of sight to the rail corridor and all tracks. The peak transit-hour noise levels were 75 to 78 dBA (Leq) in the morning between 6:00 a.m. and 9:00 a.m. and 66 to 70 dBA (Leq) in the afternoon between 3:00 p.m. and 6:00 p.m. The overall day-night average noise level was 75.9 dBA (Ldn). As shown in Table 3, the contribution of noise from VRE northbound, VRE southbound, Amtrak, and CSX operations was 70.5, 54.3, 54.0 and 74.2 dBA, respectively.

At LT-1, the maximum noise levels from VRE northbound and southbound station stop operations were 98 and 82 dBA, respectively. The difference in maximum noise level is attributed to the fact that northbound trains sound their horn with two short soundings just prior to departing the station. The maximum noise level from Amtrak through movements at approximately 45 mph was 85 dBA. CSX trains have an average maximum noise level of 92 dBA. The maximum noise level from CSX trains is attributed to the locomotive and rail cars and not horn soundings.

Long-term noise measurement (LT-2) was conducted on a 11th floor balcony at 1805 Crystal Drive approximately 175 feet west of the near track. The predominant noise source at this location was train activity. The peak transit-hour noise levels were 70 to 72 dBA (Leq) in the morning between 6:00 a.m. and 9:00 a.m. and 67 to 69 dBA (Leq) in the afternoon between 3:00 p.m. and 6:00 p.m. The day-night average noise level was 72.2 dBA (Ldn).

Short-term noise measurement (ST-1) was conducted at the Crystal City Workout Park approximately 175 feet from the near track. The predominant noise sources at this location were train activity and vehicles on Crystal City Drive. The measured noise level was 67 dBA (Leq).

Short-term noise measurement (ST-2) was conducted at the Crystal City Water Park approximately 50 feet from the near track. The predominant noise source at this location was train activity. The measured noise level was 72 dBA (Leq).
Short-term noise measurement (ST-3) was conducted at the Gateway Park approximately 75 feet from the near track. The predominant noise source at this location was train activity. The measured noise level was 73 dBA (Leq).

Pass-by noise measurements (PB-1) were conducted between 1805 and 2011 Crystal Drive approximately 25 feet from the near track. The microphone was elevated above an existing noise wall along the rail corridor. VRE northbound pass-bys in the morning at 45 mph with horn soundings near the microphone location were measured to be 105 dBA (Lmax) and an SEL of 109 dBA. VRE southbound pass-bys in the afternoon at 45 mph without horn soundings were measured to be 94 dBA (Lmax) and an SEL of 100 dBA.

Pass-by noise measurements (PB-2) were conducted at the existing VRE Crystal City Station approximately 25 feet from the near track and approximately 50 feet away from the southern end of the platform. The noise level from VRE southbound operations stopping at the station was 88 dBA (Lmax) and an SEL of 97 dBA.

Noise measurements at PB-3 were conducted 25 feet away from an idling VRE locomotive. The microphone was located near the mid-point of the locomotive at a height of approximately 10 feet above top of rail. The maximum noise level of the idling locomotive was 82 dBA (Lmax).
Figure 9: Measurement and Receptor Locations
### Table 2: Long-Term and Short-Term Noise Monitoring Results

<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
<th>Time Start</th>
<th>Time End</th>
<th>Leq (dBA)</th>
<th>Ldn (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LT-1</td>
<td>1501 Crystal Drive (25 feet from near track)</td>
<td>6:00 a.m.</td>
<td>9:00 a.m.</td>
<td>74.9 - 78.3</td>
<td>75.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3:00 p.m.</td>
<td>6:00 p.m.</td>
<td>65.6 - 70.2</td>
<td></td>
</tr>
<tr>
<td>LT-2</td>
<td>1805 Crystal Drive (11&lt;sup&gt;th&lt;/sup&gt; floor balcony)</td>
<td>6:00 a.m.</td>
<td>9:00 a.m.</td>
<td>69.9 - 72.3</td>
<td>72.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3:00 p.m.</td>
<td>6:00 p.m.</td>
<td>66.8 - 68.6</td>
<td></td>
</tr>
<tr>
<td>ST-1</td>
<td>Crystal City Workout Park (175 feet from near track)</td>
<td>7:02 a.m.</td>
<td>7:28 a.m.</td>
<td>67.1</td>
<td>n/a</td>
</tr>
<tr>
<td>ST-2</td>
<td>Crystal City Water Park (50 feet from near track))</td>
<td>7:39 a.m.</td>
<td>8:02 a.m.</td>
<td>72.4</td>
<td>n/a</td>
</tr>
<tr>
<td>ST-3</td>
<td>Gateway Park (75 feet from near track)</td>
<td>8:08 a.m.</td>
<td>9:02 a.m.</td>
<td>72.9</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Source: VHB, 2017

### Table 3: Train Pass-by Noise Monitoring Results

<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
<th>Train Operation</th>
<th>Train Pass-by Maximum Noise Level (dBA)</th>
<th>Train Pass-by Sound Exposure Level (dBA)</th>
<th>Day-night Average Noise Level Contribution Ldn (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PB-1</td>
<td>Between 1805 and 2011 Crystal Drive 25 feet from near track</td>
<td>VRE northbound AM operations at 45 mph with horn sounding at ¼-mile from station</td>
<td>105</td>
<td>109</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VRE southbound PM operations at 45 mph without horn sounding</td>
<td>94</td>
<td>100</td>
<td>n/a</td>
</tr>
<tr>
<td>PB-2</td>
<td>Existing VRE Crystal City Station 25 feet from near track</td>
<td>VRE southbound PM operations with station stop</td>
<td>88</td>
<td>97</td>
<td>n/a</td>
</tr>
<tr>
<td>PB-3</td>
<td>Locomotive Idling at 25 feet</td>
<td>VRE locomotive stationary</td>
<td>82</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VRE northbound station stop with horn sounding from cab coach near north end of platform</td>
<td>98</td>
<td>104</td>
<td>70.5</td>
</tr>
<tr>
<td>LT-1</td>
<td>1501 Crystal Drive 25 feet from near track Near north end of platform</td>
<td>VRE southbound station stop with horn sounding from locomotive at far south end of platform</td>
<td>82</td>
<td>92</td>
<td>54.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Amtrak through movement at 45 mph</td>
<td>85</td>
<td>93</td>
<td>54.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CSX train through-movements</td>
<td>92</td>
<td>105</td>
<td>74.2</td>
</tr>
</tbody>
</table>

Source: VHB, 2017
Figure 10: LT-1 at 1501 Crystal Drive near North End of Platform

![Graph showing sound level data for LT-1 with a night time period highlighted.](image)


Figure 11: LT-2 at 1805 Crystal Drive on 11th Floor Balcony

![Graph showing sound level data for LT-2 with a night time period highlighted.](image)

**Existing Vibration Conditions**

The most substantial source of existing vibration in the study area are train operations along the rail corridor.

Vibration measurements were conducted at one site shown on Figure 9 above (indicated with a blue dot).

Vibration sensors (accelerometers) were located at two distances from the tracks. With trains operating on various tracks throughout the rail corridor, vibration was measured at distances of approximately 35 and 90 feet. The tracks in this area are continuously welded rail which maintain a smooth rail surface and help keep noise and vibration emissions low. Jointed rail introduces gaps in the rail surface which can increase noise and vibration.

Site V-1 was located just south of Crystal Place (1805 Crystal Drive). One accelerometer was located near the eastern façade of Crystal Place and one accelerometer was located 25 feet further away from the tracks. This resulted in 35-foot and 60-foot setbacks from the nearest track for the two accelerometers, respectively. Vibration measurements were conducted on VRE, Amtrak, and CSX train events travelling at 35 to 45 mph.

Figure 12 presents the maximum overall and 1/3-octave band vibration levels at the setback of the near façade of 1805 Crystal Drive from VRE train pass-bys. This location represents the greatest potential for impact at sensitive receptors in the study area along the corridor. The average overall maximum vibration velocity from VRE trains at the façade was 64.6 VdB. The plot shows that vibration levels from VRE trains are below the FTA impact criteria even without outdoor-to-indoor attenuation considerations. Plots showing the vibration level measurement results at the location 25 feet further away are presented in the Appendix.
Figure 12: Vibration Level Spectra from VRE Train Pass-bys

Source: VHB, 2017
5.0 **Noise and Vibration Impact Assessment**

The proposed Project could affect noise and vibration conditions in the study area due to changes in the VRE Crystal City Station location. Changes in noise effects from the Project may be due to changes in train speed, new horn sounding locations, and new locomotive idling locations. This section of the report presents the potential noise and vibration effects of the proposed station improvements.

**Noise Impact Assessment**

Potential train noise impact is assessed by evaluating the potential increase in noise due to the proposed Project and comparing it to the FTA noise criteria. The results of the noise impact assessment are presented in Table 4.

This table presents the existing noise levels, moderate and severe future noise impact criteria, and future predicted noise conditions. Existing noise levels at each receptor were modeled based on contribution of noise from all sources not affected by the proposed Project, and by distance (along the tracks) to the center of the existing or future proposed station platform. Day-night average (Ldn) noise levels are reported for residential receptors and peak transit-hour (Leq) noise levels are reported for parks.

Existing noise levels ranged from 65.4 to 70.5 dBA (Leq/Ldn) at all receptors. Figures 13, 14 and 15 show the existing noise level and increase in noise due to the project for all receptors for Option 1, 2, and 3, respectively. Under Option 1, future noise levels would range from 66.4 to 70.4 dBA (Leq/Ldn). Under Option 2, future noise levels range from 65.4 to 71.4 dBA (Ldn). Under Option 3, future noise levels range from 65.4 to 70.6 dBA (Ldn). Future noise levels for all options would be below the moderate impact criteria at all receptors and there would be no impact. These data indicate there would be no significant noise impact due to the proposed station improvements.
<table>
<thead>
<tr>
<th>Receptor</th>
<th>Location</th>
<th>Existing Noise Level (Ldn)</th>
<th>Moderate Impact Criterion (Ldn)</th>
<th>Severe Impact Criterion (Ldn)</th>
<th>Option 1 Future Noise Level (Ldn)</th>
<th>Option 2 Future Noise Level (Ldn)</th>
<th>Option 3 Future Noise Level (Ldn)</th>
<th>Noise Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Crystal City Lofts (305 10th Street South)</td>
<td>67.4</td>
<td>68.5</td>
<td>70.5</td>
<td>67.3</td>
<td>67.3</td>
<td>67.3</td>
<td>None</td>
</tr>
<tr>
<td>R2</td>
<td>Gateway Park¹</td>
<td>70.0</td>
<td>72.7</td>
<td>75.8</td>
<td>69.9</td>
<td>69.9</td>
<td>69.9</td>
<td>None</td>
</tr>
<tr>
<td>R3</td>
<td>Crystal Gateway (1300 Crystal Drive)</td>
<td>65.4</td>
<td>66.8</td>
<td>69.0</td>
<td>66.4</td>
<td>65.4</td>
<td>65.4</td>
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<tr>
<td>R4</td>
<td>Waterpark Towers (1501 Crystal Drive)</td>
<td>68.2</td>
<td>69.4</td>
<td>71.2</td>
<td>67.3</td>
<td>67.4</td>
<td>67.3</td>
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<tr>
<td>R5</td>
<td>Waterpark Towers (1505 Crystal Drive)</td>
<td>70.5</td>
<td>71.5</td>
<td>73.2</td>
<td>70.4</td>
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<tr>
<td>R6</td>
<td>Crystal City Water Park¹</td>
<td>69.9</td>
<td>72.6</td>
<td>75.7</td>
<td>69.9</td>
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<tr>
<td>R7</td>
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<td>70.6</td>
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<tr>
<td>R8</td>
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<td>67.3</td>
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<td>67.3</td>
<td>67.4</td>
<td>67.3</td>
<td>None</td>
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<tr>
<td>R9</td>
<td>Crystal City Workout Park¹</td>
<td>69.9</td>
<td>72.6</td>
<td>75.7</td>
<td>69.9</td>
<td>69.9</td>
<td>69.9</td>
<td>None</td>
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</tbody>
</table>


¹  Peak-transit hour (Leq) noise levels are reported for parks.
Figure 13: Noise Impact Assessment Results (Option 1)

Figure 14: Noise Impact Assessment Results (Option 2)

Note:
Noise exposure is in terms of $L_{eq} (h)$ for Category 1 land uses, $L dn$ for Category 2 land uses.
Vibration Impact Assessment

Potential vibration impact has been assessed by comparing existing to future operations and determining the potential for future operations to increase vibration levels. Vibration was measured at the setback of the Crystal Place residential building facade, the closest sensitive receptor to the tracks in the study area. This location is approximately ¼-mile from the existing station platform and VRE trains pass-by at approximately 45 mph. Under the different station options, train speeds would either increase or decrease depending on the distance of the receptor to the station (along the track).

The vibration criterion is 75 VdB for residential uses, since there are an occasional number of train events. As indicated in Figure 12 above, vibration levels in all 1/3-octave bands are below the FTA impact criteria even without outdoor-to-indoor attenuation considerations. These data indicate there would be no vibration impacts due to the proposed Project.
6.0 Mitigation

As discussed in Section 5, there would be no significant noise or vibration impact due to the proposed Project. Therefore, noise or vibration mitigation is not warranted.

CSXT has coordinated with VRE and the community in the past to help minimize potential noise effects in the study area. Currently, when VRE is not operating revenue service trains, such as during the night and on weekends, CSXT has limited their horns as they approach the VRE Crystal City Station.

Although the proposed Project would not cause a significant change in noise impacts, VRE will continue to coordinate with Arlington County and the residents to find effective means to ensure safety within the rail corridor while minimizing effects on the community.
7.0 Appendix

Noise Monitoring Photos

Crystal Park North

Crystal Park North

Waterpark Towers

Waterpark Towers

Existing VRE Crystal City Station

VRE Train at VRE Crystal City Station
Vibration Monitoring Photos

Crystal Place Short Term Monitor

Crystal Place Short Term Monitor
Additional Noise and Vibration Monitoring Results
The figure below presents the typical sound level time history of northbound trains approaching the station, dwelling at the station, sounding the horn prior to departing and then accelerating past the microphone position. The microphone was located on the north end of the station platform.

Figure A-1: Time Histories at LT-1 for VRE Northbound Station Stops
The figure below presents the typical sound level time history of typical trains operating at 45 mph without sounding their horn. The microphone was located 25 feet from the near track. The maximum noise level was approximately 95 dBA for each pass-by.

Figure A-2: Time Histories at PB-1 for VRE Trains Southbound at 45mph without Horn
The figure below presents the typical sound level time history of typical trains operating at 45 mph with sounding their horn near the microphone. The microphone was located 25 feet from the near track. The maximum noise level was approximately 105 dBA for each pass-by.

Figure A-3: Time Histories for PB-1 for VRE Trains Northbound at 45mph with Horn
The figure below presents the maximum vibration levels of train pass-bys at 45 mph. The vibration sensor was located 25 feet from the near track at the closest setback distance of 1805 Crystal Drive. The maximum vibration levels were all below the FTA detailed vibration criteria (red line).

**Figure A-4: Vibration Level Spectra from VRE Trains, 25 Feet Setback from Crystal Place Facade**