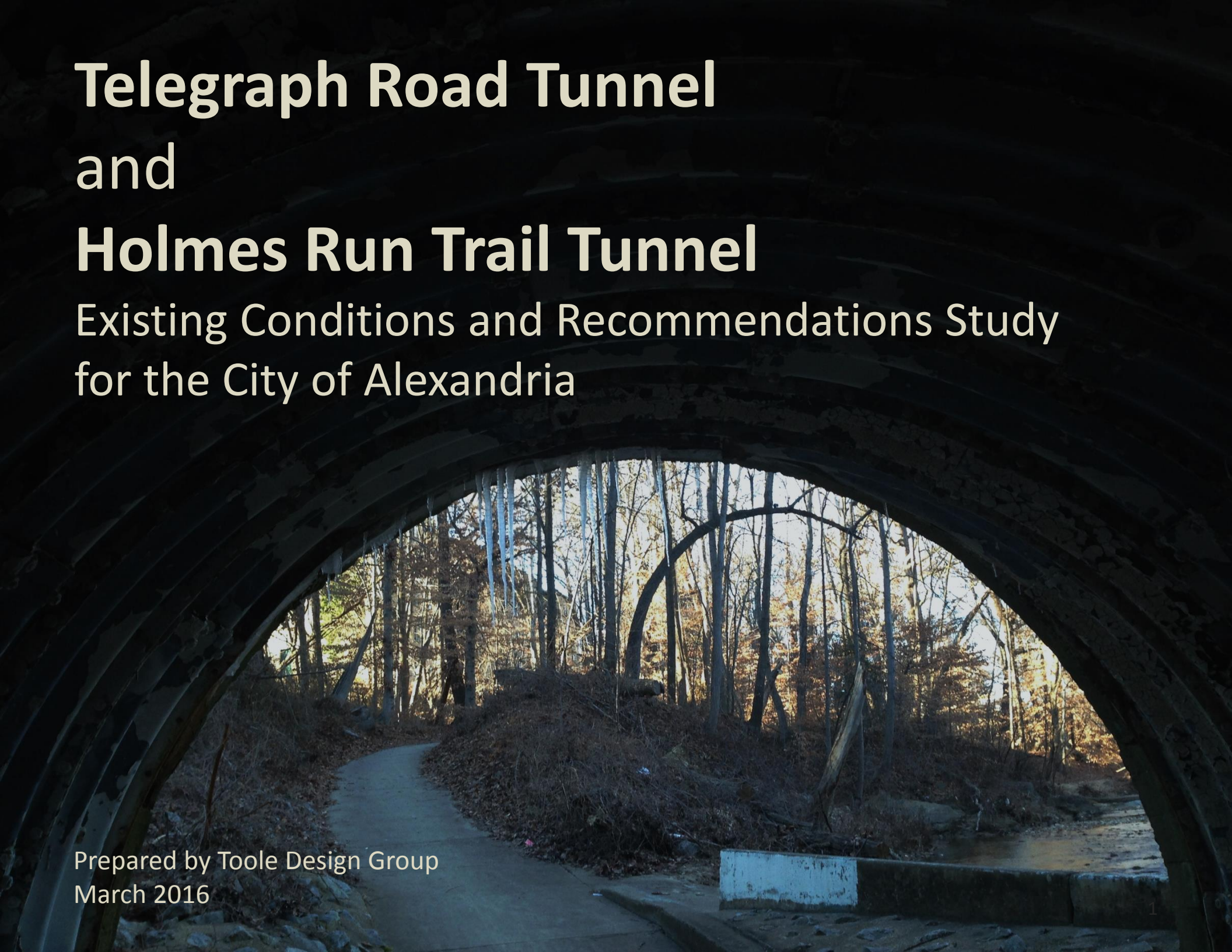
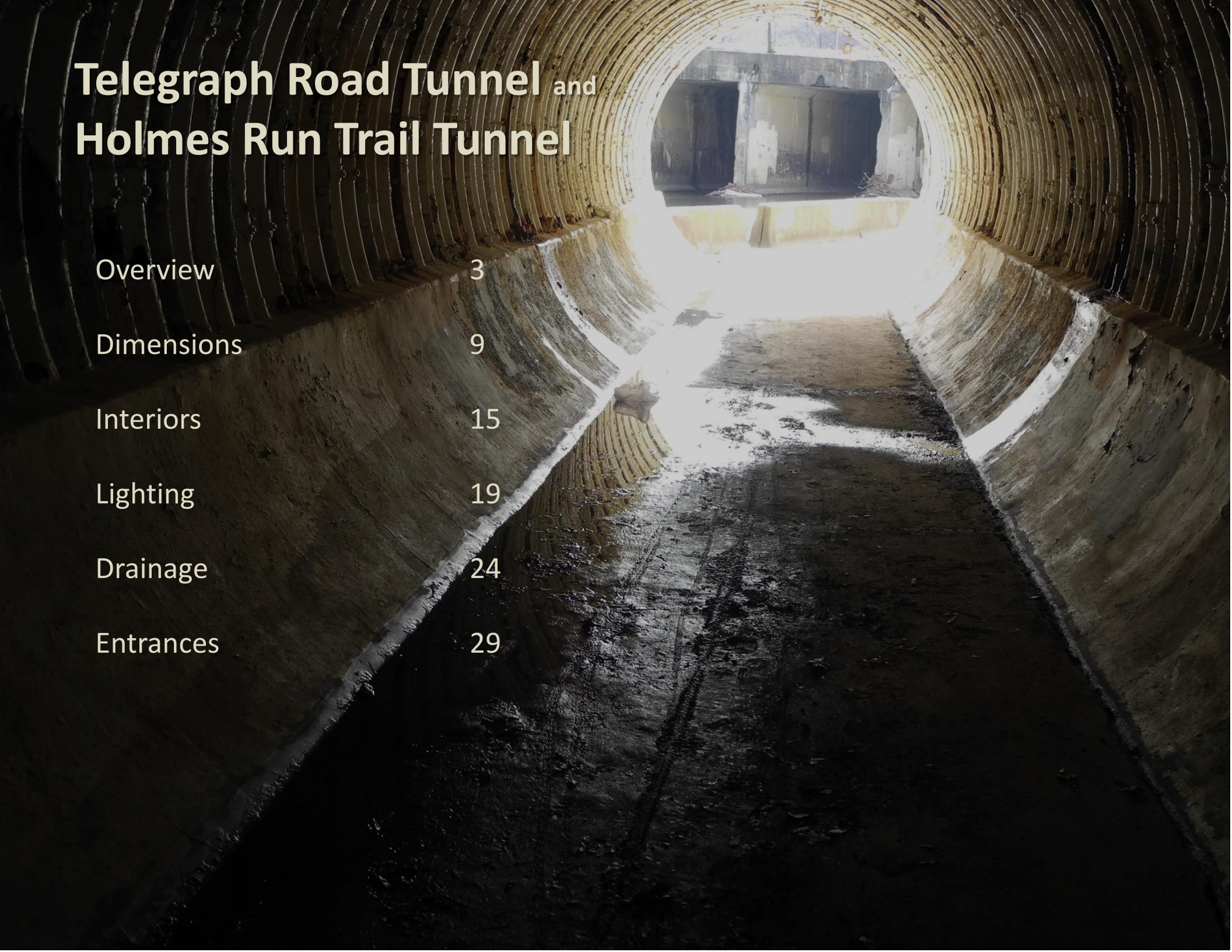
Telegraph Road Tunnel
and
Holmes Run Trail Tunnel
Existing Conditions and Recommendations Study for the City of Alexandria



Prepared by Toole Design Group
March 2016

Telegraph Road Tunnel and Holmes Run Trail Tunnel



Overview	3
Dimensions	9
Interiors	15
Lighting	19
Drainage	24
Entrances	29

Overview

This study provides a cursory review of the pedestrian tunnels under the railroad tracks along Telegraph Road near Duke Street and along the Holmes Run Trail under I-395. The study provides the location, dimensions, and a description with accompanying photos of the current materials, lighting, drainage and entrances of each tunnel. The study provides an overview of best practices and guidelines. The study also provides general short and long term recommendations to address issues of concern and create a more welcoming and attractive space for tunnel users.

The tunnels were inspected by Toole Design Group with a focus on safety and access issues. Staff visited the tunnels on Monday, January 18 and Friday, February 5, 2016 during daylight hours after a moderate rain and heavy snow respectively. During both visits the tunnels were lit. Both tunnels were being used by pedestrians. There were noticeable drainage issues, peeling paint, corrosion and dirt and debris had collected on the tunnel floor.

In addition to other guidance noted throughout the study, the following resources were used:

- The American Association of State Highway Transportation Officials *Guide for the Planning, Design, and Operation of Pedestrian Facilities* (AASHTO Pedestrian Guide)
- The American Association of State Highway Transportation Officials *Guide for the Development of Bicycle Facilities* (AASHTO Bike Guide)

Holmes Run Trail Tunnel

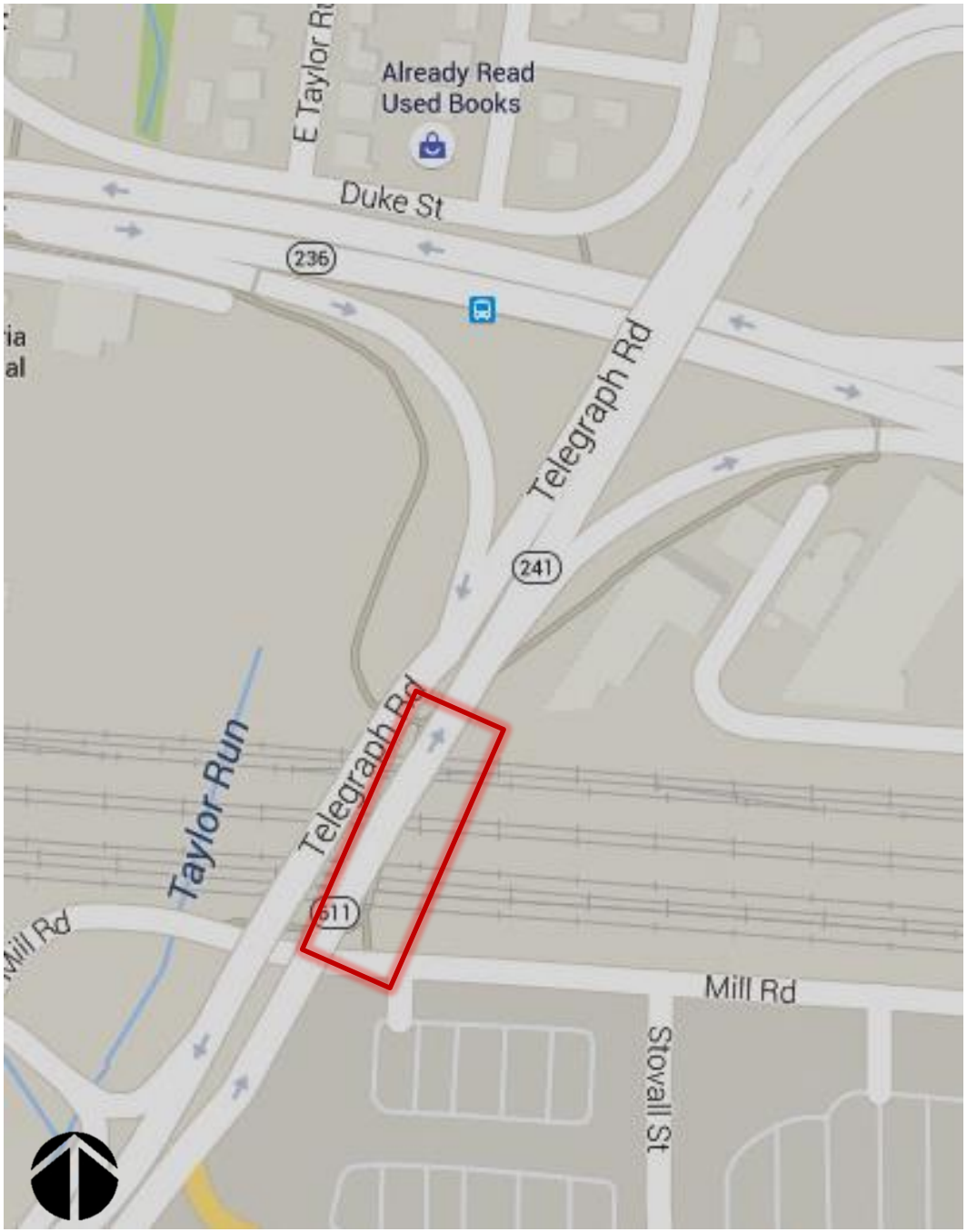
Telegraph Road Tunnel Location

The Telegraph Road tunnel is located between Duke Street and Mill Road paralleling the east side of Telegraph Road.

From the north side, the tunnel is accessible via a trail that runs along Duke Street turning south to travel under (but perpendicular to) Telegraph Road. From the south side, the tunnel is accessible via Mill Road.

The tunnel travels under a series of railroad tracks and includes one windowed shaft that appear to be on the property held by the railroad. The tunnel provides one of very few locations where pedestrians are able to cross the railroad tracks and pedestrians were seen the tunnel during each site visit.

Aerial View



Map View, courtesy of Google.com

Holmes Run Trail Tunnel Location

The Holmes Run Trail tunnel is part of Holmes Run Trail as it travels under I-395. The tunnel is accessible on both the north and south sides via the Holmes Run Trail, which is itself accessible via neighborhood streets.

The tunnel was in continuous use by pedestrians and people on bicycle during site visits.

Aerial View

Map View, courtesy of Google.com

FEMA Flood Risk maps

Telegraph Road Tunnel, courtesy of FEMA

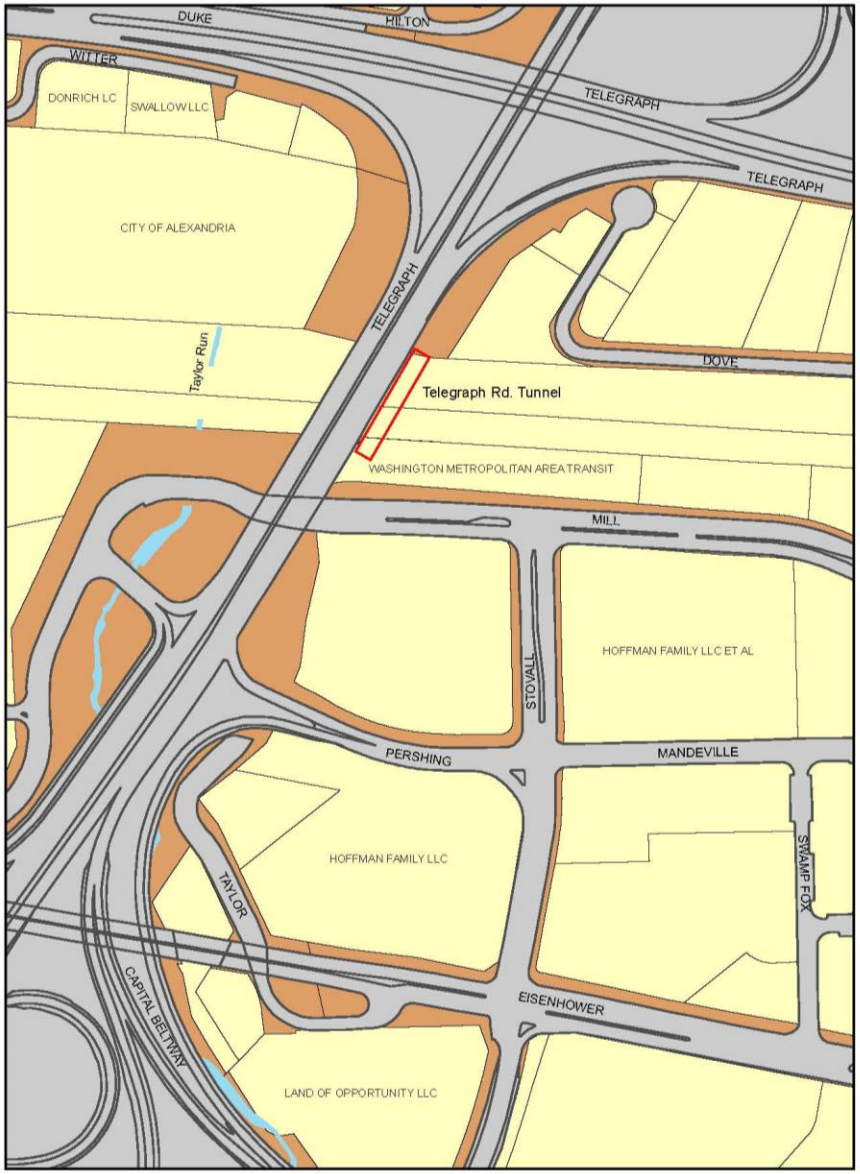
Holmes Run Tunnel, courtesy of FEMA

Legend

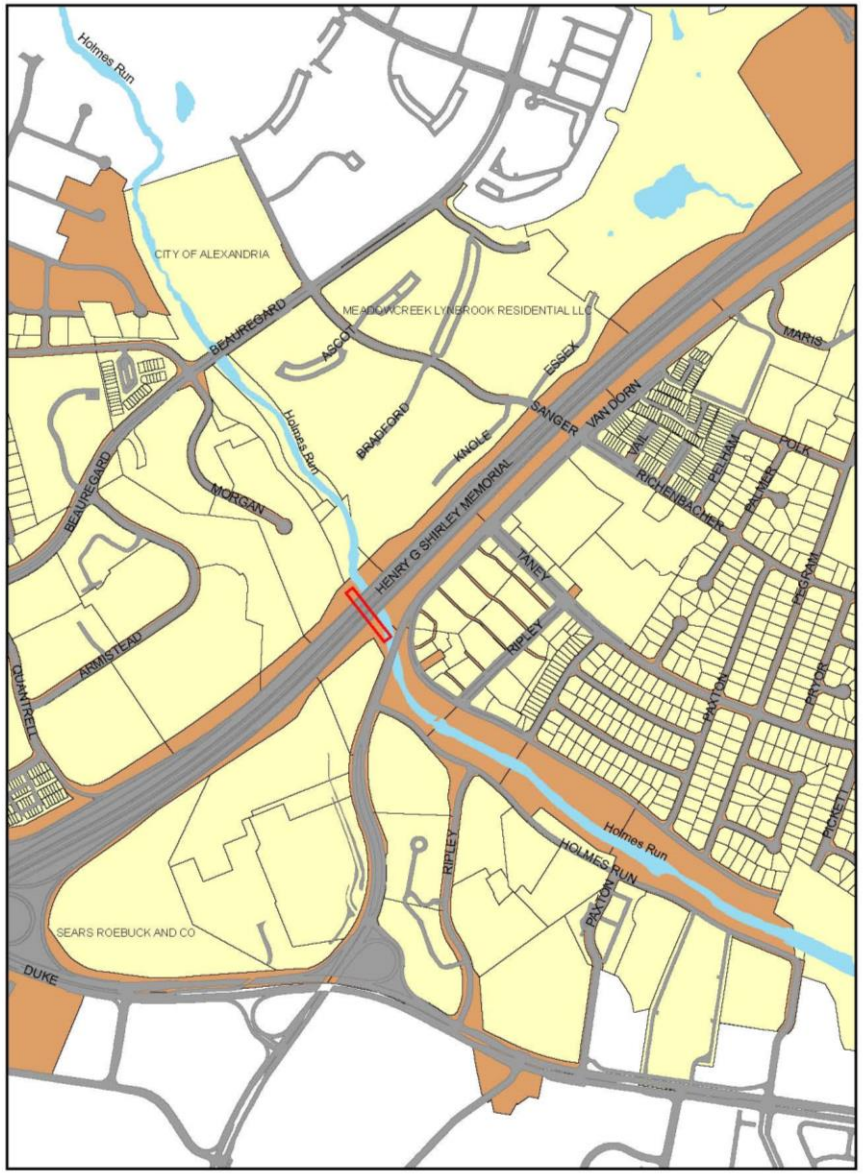
- 0.1 % Annual Chance Flood Hazard
- 0.2 % Annual Chance Flood Hazard
- LOMR
- Tunnel Location

LAND RECORD MAPS

Telegraph Road Tunnel



Holmes Run Tunnel



Legend

- Road
- Parcels
- Blocks
- Hydrology

0 0.0150.03 0.06 0.09 0.12 Miles

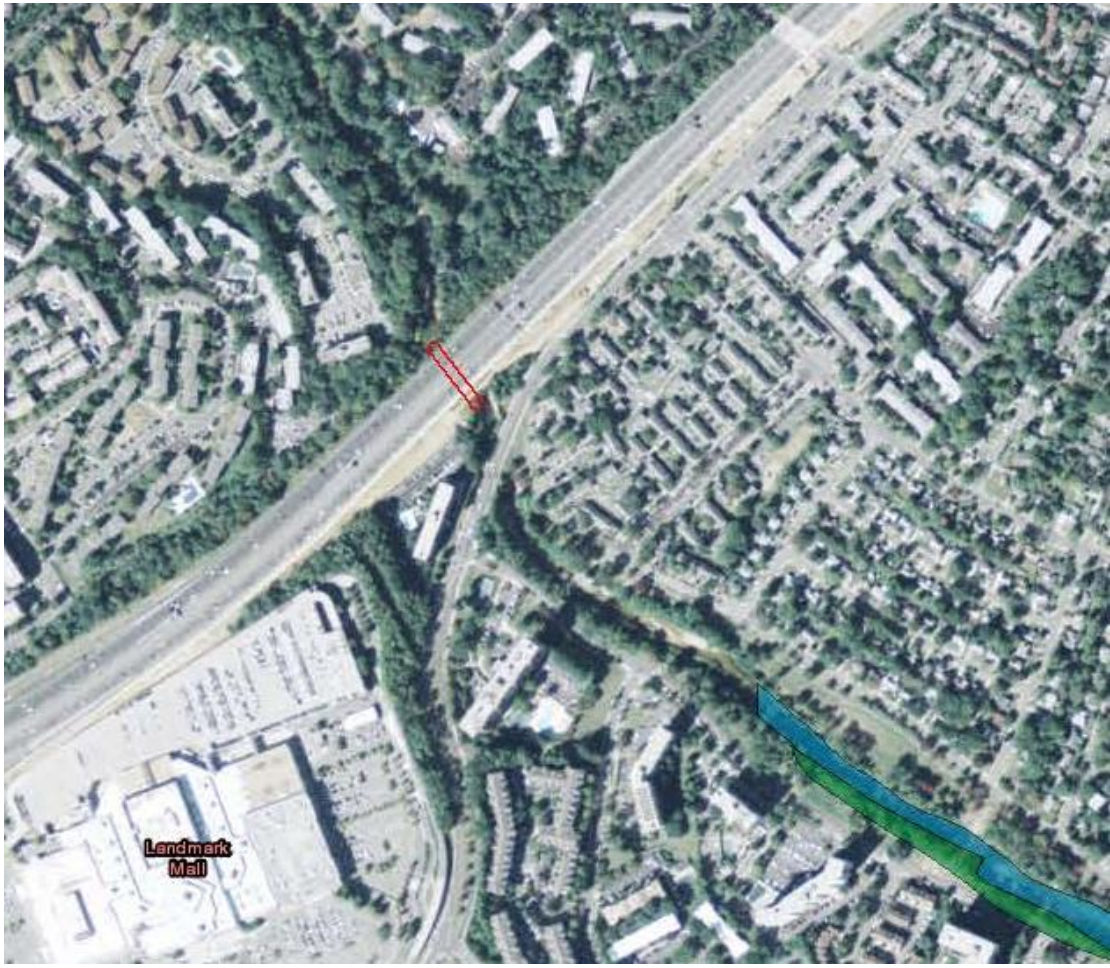
GIS data, Courtesy of the City of Alexandria

N

0 0.05 0.1 0.2 0.3 0.4 Miles

Wetland Inventory

Telegraph Road Tunnel, courtesy of The National Wetlands Inventory



Holmes Run Tunnel, courtesy of The National Wetlands Inventory

Legend

- Riverine
- Freshwater Forested/ Shrub Wetland
- Tunnel Location

DIMENSIONS

Recommended guidelines for tunnel height and width are provided by numerous entities. AASHTO Pedestrian Guide notes that:

Underpasses should be wide enough to invite use by all persons. The longer the tunnel, the wider the tunnel should be to give people a feeling of security when passing one another…In urban areas, a desirable minimum width is 14 to 16 feet, with wider widths suggested for lengths over 60 feet. These widths also work well for bicycles on shared-use facilities.

The same perception phenomenon…also applies to vertical clearances. While an 8-foot vertical clearance can suffice for short distances, longer distance may require a vertical clearance of 10 feet or more to maintain a feeling of openness and security for pedestrians.

The Washington Metropolitan Area Transit Authority (WMATA), which designs pedestrian tunnels connecting to subway stations, recommends tunnels height be a minimum 18 feet wide for visibility and user comfort.[1]

Because it is likely that Virginia Department of Transportation (VDOT) would provide funding for any major tunnel reconstruction or replacement, tunnel dimensions should comply with VDOT's horizontal vertical clearance requirements, which are more stringent than AASHTO. The VDOT Road Design Manual requires 3 feet of horizontal separation between the edge of pavement and trailside obstacles (e.g. signs). The VDOT manual also includes a 10-foot desired vertical clearance (8-foot minimum), and states that additional vertical clearance may be needed for passage of emergency or maintenance vehicles.

Amsterdam Central Station Tunnel showing separated paths for pedestrians and bicyclists. The tunnel is 110 meters long, 10 meters wide and 3 meters high. Photo, bicycledutch.wordpress.com

The AASHTO Pedestrian Guide notes that the most common examples of grade-separated crossings are at freeways and railroads as is the case for the tunnels reviewed in this study. It also notes that access must be provided by a ramp that meets Americans with Disabilities Act Accessibility Guidelines. Ramps should be designed for a maximum of 5% longitudinal slope. Where switchback ramps are proposed, consideration should be given to configuration of the curves of the switchback so they can be comfortably traversed by cyclists.

[1]WMATA Station Site and Access Planning Manual www.wmata.com/pdfs/planning/Station%20Access/SSAPM.pdf

Telegraph Road Tunnel Dimensions

The Telegraph Road tunnel comprises a large-diameter corrugated metal pipe with a poured concrete floor. The trail width differs on the northern and southern ends with the change occurring at the center of the tunnel. On the northern end, the tunnel is elliptical in shape, with a narrower width than height.

Length: 250 feet

Northern end:

Trail width: 4.5 feet

Height: 7.5 feet

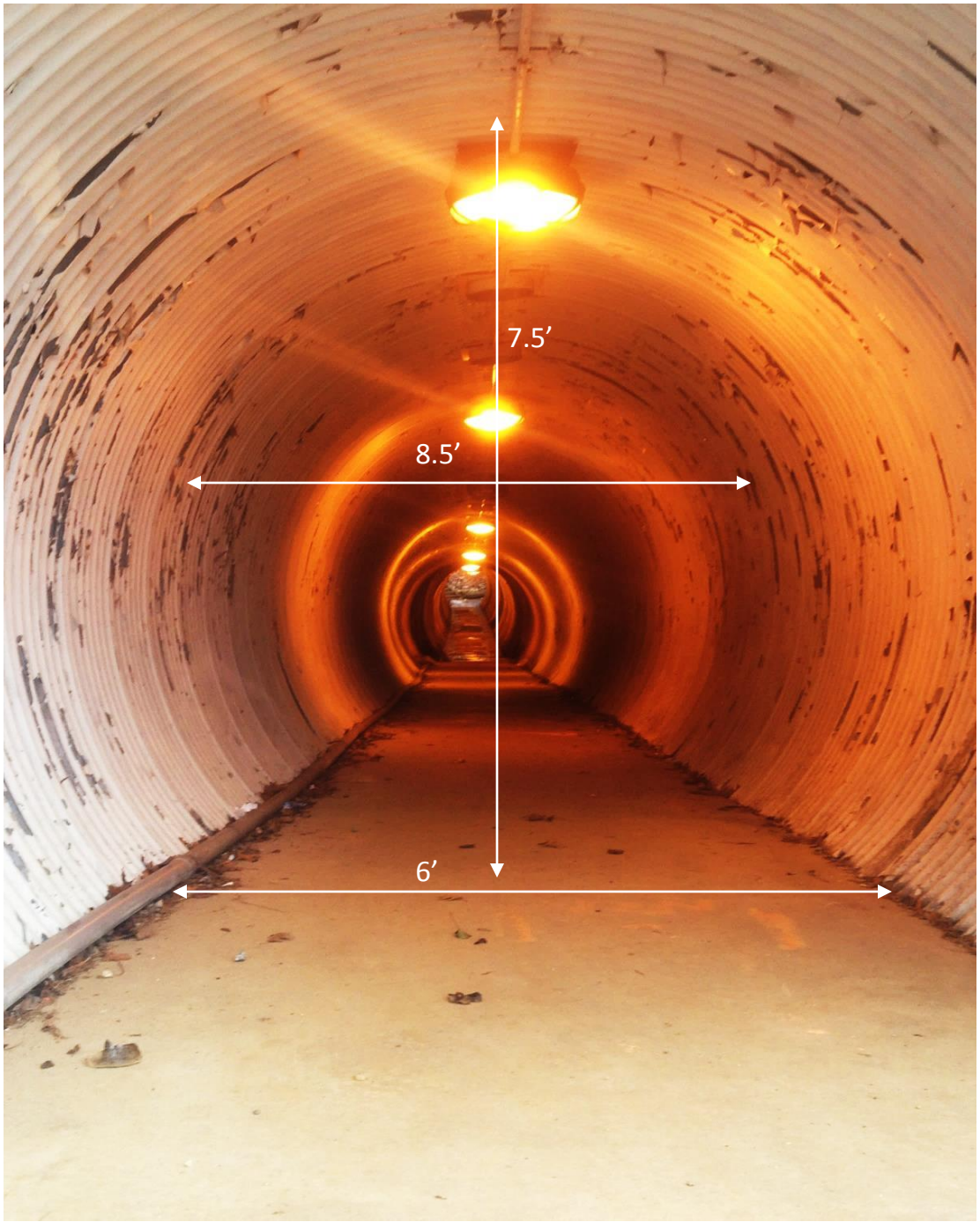
Width (at widest point): 6.75 feet

Southern end:

Trail width: 6 feet

Height: 7.5 feet

Width (diameter): 8.5 feet



Telegraph Road tunnel looking north

Holmes Run Trail Tunnel Dimensions

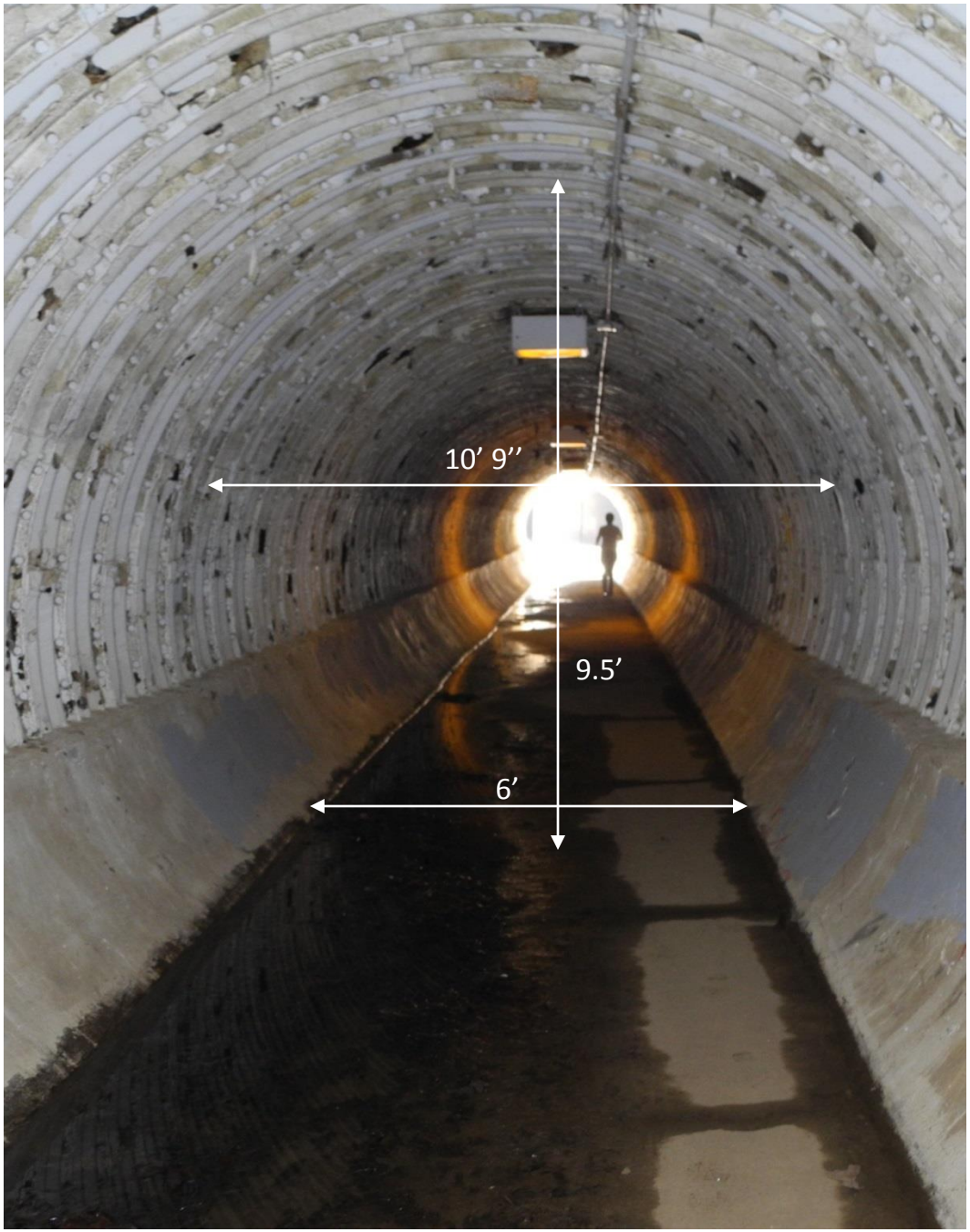
Holmes Run Trail Tunnel includes a large-diameter corrugated metal pipe with cast concrete floor and cast concrete walls up to approximately 2.5 feet in height and approximately 6 inches in depth at the base of both walls of the tunnel. The floor is consistently 6 feet wide throughout the length of the tunnel.

Length: 300 feet

Trail width: 6 feet

Height: 9.5 feet

Width (diameter): 10 feet, 9 inches



Holmes Run Trail tunnel looking south

Recommendations for Increasing Tunnel Dimensions

Increasing tunnel dimensions to meet design guidelines is a significant undertaking and will require complete reconstruction of the tunnels. Therefore, short-term recommendations focus on those items that that will help prepare the way for a future reconstruction, or that can be implemented to make short-term repairs to the existing tunnels. Long-term recommendations include alternatives for complete replacement of the existing tunnels.

Short Term Recommendations

Short-term recommendations include:

Begin preliminary discussions with rail companies – Telegraph Road tunnel traverses a series of 7 active and 2 apparent inactive railroad tracks contained in an approximately 250-foot right-of-way. Multiple rail companies operate in this corridor, including WMATA, Virginia Railway Express, Amtrak, and several freight rail lines including Norfolk Southern and CSX. It will be important to identify which company owns the right-of-way (thus having leasing rights), and which will have approval authority over any plans for tunnel modifications. Rights to rail corridors are also often leased to utility companies, primarily electric and communications, because it is convenient to collocate these facilities within the uninterrupted rail corridor. It will also be important to ascertain which utilities may have facilities in the corridor that maybe impacted by tunnel construction.

Begin coordination with utility companies – As noted above, discussions should begin with the affected utility companies as early as possible. Utility relocation is typically a long-lead-time activity (often requiring several years from initial contact to completion of relocations). These utility companies typically require that relocation design and construction be performed by their own licensed consultants and contractors, and will not allow construction by the City's contractor. Early coordination will be essential.

Contact VDOT to discuss incorporating tunnel widening with existing or future projects – VDOT's lit of upcoming projects does not currently show major work in the vicinity of either tunnel, but there may be opportunity to reconstruct the tunnel in conjunction with roadway improvement projects that are still several years out.

Determine remaining service life of tunnels – Both tunnels are showing signs of corrosion, and structural evaluation is recommended to determine remaining service life and aid in the selection process for short-term improvements. It is believed that both tunnels are currently maintained by VDOT, and recent structure inspection reports may shed some light on the condition of each tunnel and the expected lifespan for planning purposes.

Line tunnel - If immediate structural rehabilitation is necessary, a cured-in-place pipe lining system is a lower-cost alternative to replacing the tunnel, and can be performed in a very short period of time. VDOT's approved materials list includes several cured-in place pipe liner systems. Benefits of this type of system are quick installation, minimal disruption to roadway or rail operations during construction, and significant improvements to the structural stability of the tunnels. However, the pipe lining will add a 2-3-inch thick layer of material to the inside of the tunnel, slightly reducing its diameter. In addition, treatment of the trail surface would be required to ensure a non-skid surface for pedestrians and cyclists such as concrete surface or asphalt placed over the liner. Approximate costs for pipe lining are included in Appendix A

Recommendations for Increasing Tunnel Dimensions

Long Term Recommendations

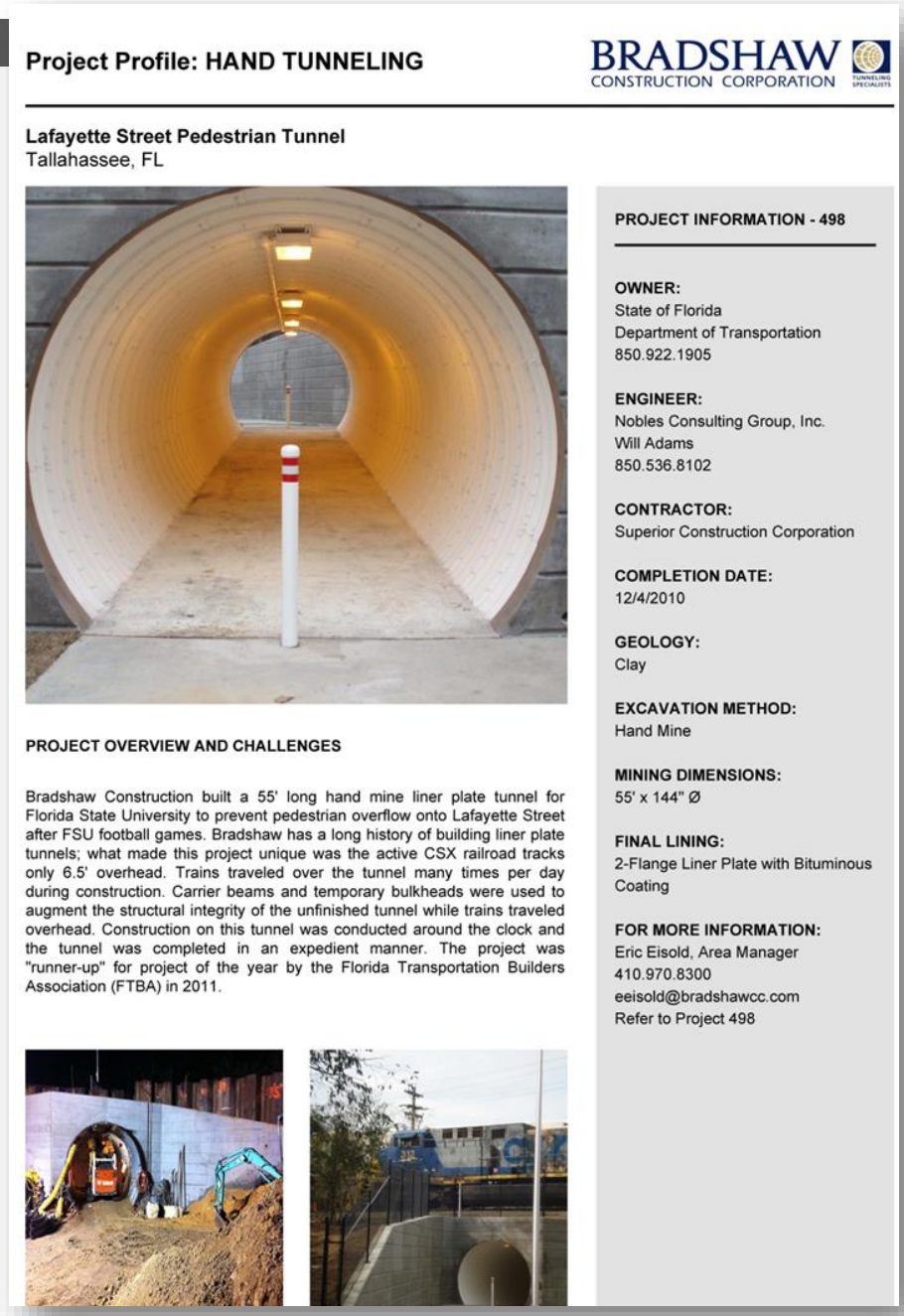
Long term recommendations should focus on increasing the width and height of the tunnels, or in the case of the Telegraph Road tunnel, providing new direct and comfortable locations to cross the railroad. Innovative techniques in tunnel construction are constantly evolving and may be applicable to either tunnel project. In addition, hand-digging is still a commonly used technique.

All alternatives would require right-of-way acquisition; formal abandonment (and likely filling) of the existing tunnel; consideration of environmental and utility impacts, and drainage.

Alternatives for replacing each tunnel include:

Reconstruct Larger Tunnels

Replacement of the Telegraph Road tunnel involves the added complexity of constructing the tunnel under an active railroad right-of-way. Additional geotechnical monitoring for vibration and settlement will be required to ensure that construction operations have no adverse impacts to tracks, and all work will be required to comply with the WMATA Adjacent Construction Manual, American Railway Engineering and Maintenance of Way (AREMA) requirements, and local railroad standards and specifications as appropriate. In addition to normal project costs, there are specific costs related to working on railroad property, such as maintenance of railroad traffic and construction inspection by railroad employees. The railroad companies also typically require a large contingency fund be set aside by the project owner for a minimum of 5 years post-construction. Based on similar recent projects in the DC metro area, Flagging and inspection costs are anticipated to be approximately $1 million to $1.5 million, and contingency amounts are anticipated to be $2 million to $4 million, $2 million, all or a portion of which may be requested set aside during the design phase of the project.



Project Profile: HAND TUNNELING

BRADSHAW CONSTRUCTION CORPORATION

Lafayette Street Pedestrian Tunnel
Tallahassee, FL

PROJECT OVERVIEW AND CHALLENGES

Bradshaw Construction built a 55' long hand mine liner plate tunnel for Florida State University to prevent pedestrian overflow onto Lafayette Street after FSU football games. Bradshaw has a long history of building liner plate tunnels; what made this project unique was the active CSX railroad tracks only 6.5' overhead. Trains traveled over the tunnel many times per day during construction. Carrier beams and temporary bulkheads were used to augment the structural integrity of the unfinished tunnel while trains traveled overhead. Construction on this tunnel was conducted around the clock and the tunnel was completed in an expedient manner. The project was "runner-up" for project of the year by the Florida Transportation Builders Association (FTBA) in 2011.

PROJECT INFORMATION - 498

OWNER:
State of Florida
Department of Transportation
850.922.1905

ENGINEER:
Nobles Consulting Group, Inc.
Will Adams
850.536.8102

CONTRACTOR:
Superior Construction Corporation

COMPLETION DATE:
12/4/2010

GEOLOGY:
Clay

EXCAVATION METHOD:
Hand Mine

MINING DIMENSIONS:
55' x 144" Ø

FINAL LINING:
2-Flange Liner Plate with Bituminous Coating

FOR MORE INFORMATION:
Eric Eisold, Area Manager
410.970.8300
eeisold@bradshawcc.com
Refer to Project 498

Example of a dug pedestrian tunnel under a roadway.

Recommendations for Increasing Tunnel Dimensions

Long Term Recommendations

Replacement of the Holmes Run Tunnel is somewhat less complex, but would include a significant environmental permitting effort due to the tunnel's proximity to Holmes Run. Wetland mitigation will likely be necessary as a part of any reconstruction project, and the tunnel's effects on the hydraulics of the Holmes Run floodway must be considered.

Tunnel costs can be highly variable, depending on geotechnical conditions (soft soils, presence of rock, etc.), and unique site constraints. Based upon review of project costs for tunnels of similar diameter and scopes summary of anticipated costs at each tunnel location is provided in Appendix A.

Replace with Pedestrian Bridge

A bridge replacement for the Telegraph Road tunnel would have a similar degree of complexity related to work over the active railroad right-of-way, and would be subject to similar requirements, restrictions, and costs from the rail companies.

In both locations, multiple spans would be required to traverse the underlying roadway or railway, and long ADA compliant ramps will be required between the bridge and the surrounding grade. AASHTO Load Factor Resistance Design requirements for bridges stipulates 23 feet of vertical clearance for pedestrian bridges over rail facilities and 17 feet over roadways, thus a bridge at the Telegraph Road location would be approximately 6 feet higher than a bridge at the Holmes Run location. In either case, use of a prefabricated superstructure is recommended to minimize the need for road closures, railroad service outages, and work over these facilities. Due to the length of the individual bridge spans, a prefabricated steel truss bridge will be the least costly.

There are a number of prefabricated bridge manufacturers, all of whom manufacture similar products at similar pricing. Manufacturers include Big R Bridge, Excel Bridge Manufacturing Co., and Contech. A summary of anticipated costs for each bridge alternative is included in Appendix A.

Provide alternative on-road route

Finding viable alternative routes for the Telegraph Road tunnel may be difficult given the long detour distances required to get to the nearest adjacent rail crossing location. The nearest crossing to the west is more than 1.5 miles away, and the nearest to the east is more than 0.5 miles away, which may serve as a deterrent to pedestrians. It may be possible to reconfigure the lanes and median on the existing VDOT bridge at Telegraph Road. The bridge currently contains (7) 12-foot travel lanes, a 5-foot concrete median, and a 5 to 7-foot sidewalk. If lane width and median widths could be reduced, it may be possible to accommodate a shared use path connection across the bridge with ramps at each abutment connecting to the trail below.

At the Holmes Run Tunnel location, the City is currently undertaking a project to design and construct a new pedestrian bridge across Holmes Run just south of the existing tunnel site. This will also provide a connection to the local street network, however detour lengths would also be in excess of 1.5 miles for the Holmes Run tunnel location.

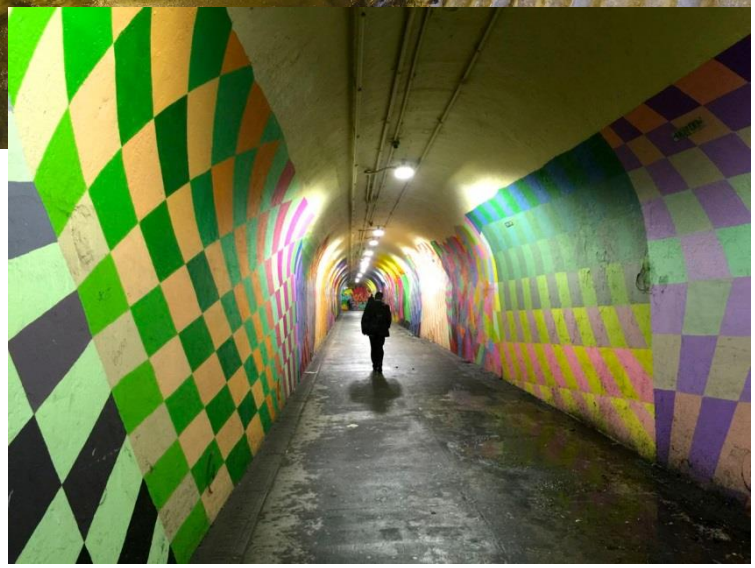
Due to the length and potential variability of the detour routes, costs were not analyzed for site specific detour route, but general per-mile unit costs for on-road bike lanes and off-road shared use paths are provided in Appendix A.

INTERIORS

Tunnels can be intimidating to pedestrians because there are limited means of escape if a user feels under threat. Consequently, it is important to design pedestrian tunnels to be attractive to users and to make them feel safe. This can be done through lighting, ensuring the tunnel is well-maintained, and designing the tunnel to allow users to see through to the other side. Additionally, anything that attracts more people to use the tunnel, such as public art, can improve safety.

"Well-designed grade-separated crossings minimize slopes, feel open and safe, and are well lit. Underpasses might invite crime if insufficiently lit and seldom traveled. …Tunnels are more inviting to use when they are brightened with skylights or artificial lighting and are wide and high enough to feel open and airy.[2]"

Telegraph Road Tunnel



191st Street Station Tunnel, NY
Photo: walkingoffthebigapple.com

Designing Sidewalks and Trails for Access, Federal Highway Administration
https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalks/chap4b.cfm

Telegraph Road Tunnel Interiors

The interior of the Telegraph Road tunnel is of corrugated metal with a concrete floor. The metal has been painted and the paint is visibly peeling. There is a minor amount of graffiti. On the day of the site investigation, water was present on the floor of the tunnel, and there is evidence that continued exposure to moisture has corroded the metal at the base of the tunnel walls.

The tunnel is constructed with a low point at the center, and the grades surrounding both tunnel entrances slope toward those entrances. Any precipitation that falls near the entrance of the tunnel naturally flows inside, and must be pumped out.

The low point of the tunnel includes a drainage grate inlet on the western side with metal bars in place of the corrugated metal wall. There appears to be a pump in behind the grate, which pumps any water collected to a point outside the south tunnel entrance The metal bars correspond to a shaft (approximately five feet by five feet) which rises up to the surface and includes four small windows on their exterior sides. It is likely these windows are for ventilation and/or light

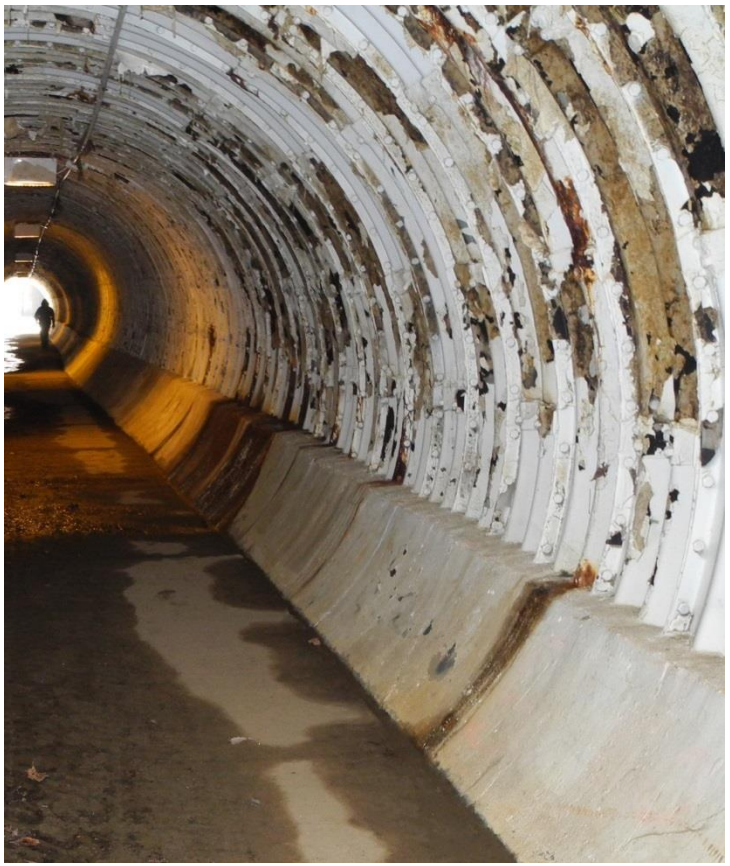
Corrosion at base of the tunnel

Shaft at the center of the tunnel (looking up)

Center of the tunnel (facing south). Grate Inlet visible on right (west) behind metal bars. Small pipe along western edge of tunnel connects grate inlet in the center of the tunnel to a culvert south of the tunnel.

Holmes Run Trail Tunnel Interiors

The interior of the Holmes Run Trail tunnel is corrugated metal with cast concrete floor and cast concrete walls up to approximately 2.5 feet in height. . Rust is visible on the metal walls of the tunnel. The depth of the corrosion and the material behind the metal (dirt, cement, etc.) could not be discerned. The corrugated metal has been painted and the paint is visibly peeling.



Recommendations for Interiors

Short Term Recommendations

Although neither tunnel meets national guidelines for width and height, the tunnels are both well used and are not likely to be replaced in the short term. It is recommended that an evaluation be performed to determine whether the corrosion in the tunnel is affecting the tunnel's structural integrity and whether an abrasive means of cleaning the tunnel could be used. Both tunnels would benefit from being cleaned of peeling paint. It is not clear whether the current paint is lead-based. The paint should be tested for lead prior to removal. Once the tunnels are cleaned, it is recommended they be repainted with light, bright, attractive colors, and maintained regularly Use of lighter colors can also be used to enhance the effectiveness of the tunnel lighting.

The following are recommendations for short-term repairs and routine maintenance activities. A summary of anticipated costs is included in Appendix B.

Perform initial lead paint testing

Clean tunnels of peeling paint and corrosion (based on findings from structural and lead paint analyses)

Apply new paint

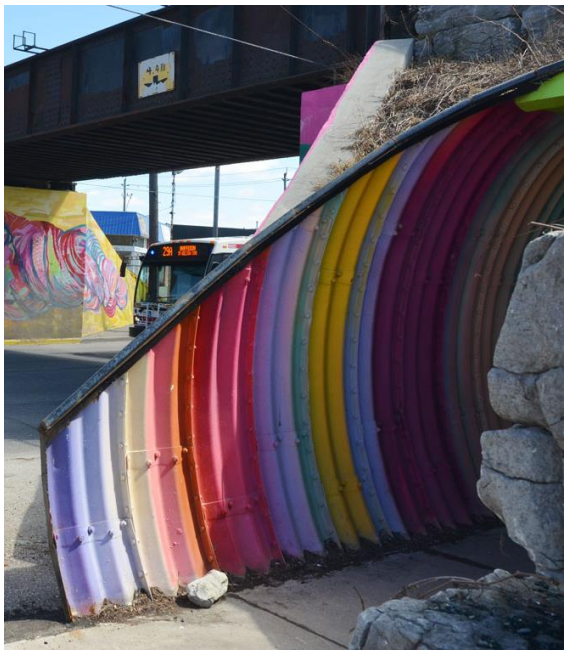
Annual paint touch-up (assumes 5-10% of painted surface must be cleaned and repaired)

Medium Term Recommendations

Tunnels provide a net-positive for communities. The more attractive they are, the more they are used. Tunnels can also provide excellent locations for local artists to highlight their skills and communities to come together. In the long term for both tunnels, consider establishing a design competition for the tunnel interiors (and entrances) that may also include lighting. Include a long-term maintenance element for the artwork as well.

Conduct design competition (including community groups) for design, installation, lighting and maintenance.

Berwyn Mural Project, Chicago, IL
Photo: http://bcochicago.org/berwyn-mural-project-you-will-be-inspired



Dufferin Street Underpass, York, Toronto
Photo: mcfcrandall.wordpress.com

LIGHTING

The amount of light recommended for trail tunnels depends on location, safety concerns, and trail usage. Most lighting guidance is provided for trails and pedestrian/bicycle travelways, not specifically for pedestrian tunnels. Some examples include:

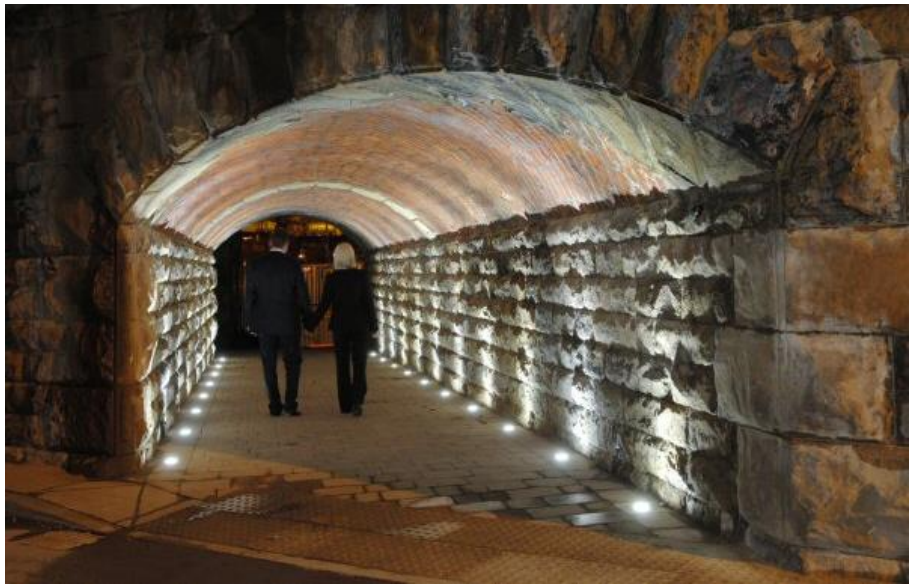
- AASHTO Bike Guide: average maintained horizontal illumination levels of .5 to 2 foot-candles
- AASHTO Roadway Lighting Design Guide: 1.4 foot-candles for pedestrian and bikeways with concrete surfaces (referenced in the VDOT Road Design Manual)
- Maryland State Highway Administration[5]: .2 to 0.4 foot-candles for mixed-use areas.
- Minneapolis, MN[3]: 0.8 to 1.2 foot-candles for pedestrian areas
- Wisconsin DOT[4]: .8 foot-candles for sidewalks, walkways and paths
- Sacramento, CA[6]: 0.2 foot-candles for trails

The Maryland *SHA Bicycle and Pedestrian Design Guidelines* recommends at least 10 foot-candles in pedestrian tunnels. In addition, it recommends "variable level lighting (to match outdoor lighting closely) should be used in pedestrian underpasses to accommodate persons whose eyes adapt slowly to lighting changes".

Light Emitting Diodes (LED) bulbs are more and more frequently being used. They produce more light, use much less power, and need to be replaced far less frequently than standard incandescent bulbs. LEDs have a greater initial cost and common complaints include uneven or unnatural lighting, flickering and change in color over time.

Other important tunnel design elements related to lighting include providing natural light wherever possible, such as the inclusion of overhead shafts and creating visibility between one end of the tunnel and the other.

Combining lighting and art is also popular in tunnels, as art attracts additional users thus enhancing safety.



LED lighting by Philips in Gateshead, UK

Lighting as Art in Birmingham, AL

3 "Minneapolis Street Lighting Policy" City Council, January 9, 2009. http://www.minneapolismn.gov/www/groups/public/@publicworks/documents/webcontent/convert_280924.pdf
4 *Wisconsin Guide to Pedestrian Best Practices,* Wisconsin Department of Transportation, http://wisconsindot.gov/Documents/projects/multimodal/ped/guide-chap5.pdf
5 "Maryland State Highway Administration Lighting Guidelines" Maryland Department of Transportation, June 2013.
https://partners.skanska.com/usa/clients/MMTA/TPL/Outreach/RM/Final%20RFP/Contract%20Documents/Book%205%20-%20Engineering%20Data/11%20Traffic/MDSHA/MDSHA%20Lighting%20Guidelines_2013.06.27.pdf
6"Best Practices for Pedestrian Master Planning and Design" Sacramento Transportation and Air Quality Collaborative, October 2005. http://nacto.org/docs/usdg/best_practices_ped_master_planning_design_sacramento.pdf

Telegraph Road Tunnel Lighting

There are currently seventeen lights in the Telegraph Road tunnel approximately 8.5 feet on center, though the spacing of the lights vary. Currently, three lights are not working. The lights are fitted with protective cages. On the southern end there are a series of junction boxes located between the lights.

There is poor visibility between one end of the tunnel and the other. There is a shaft at the center of the tunnel with four small windows.

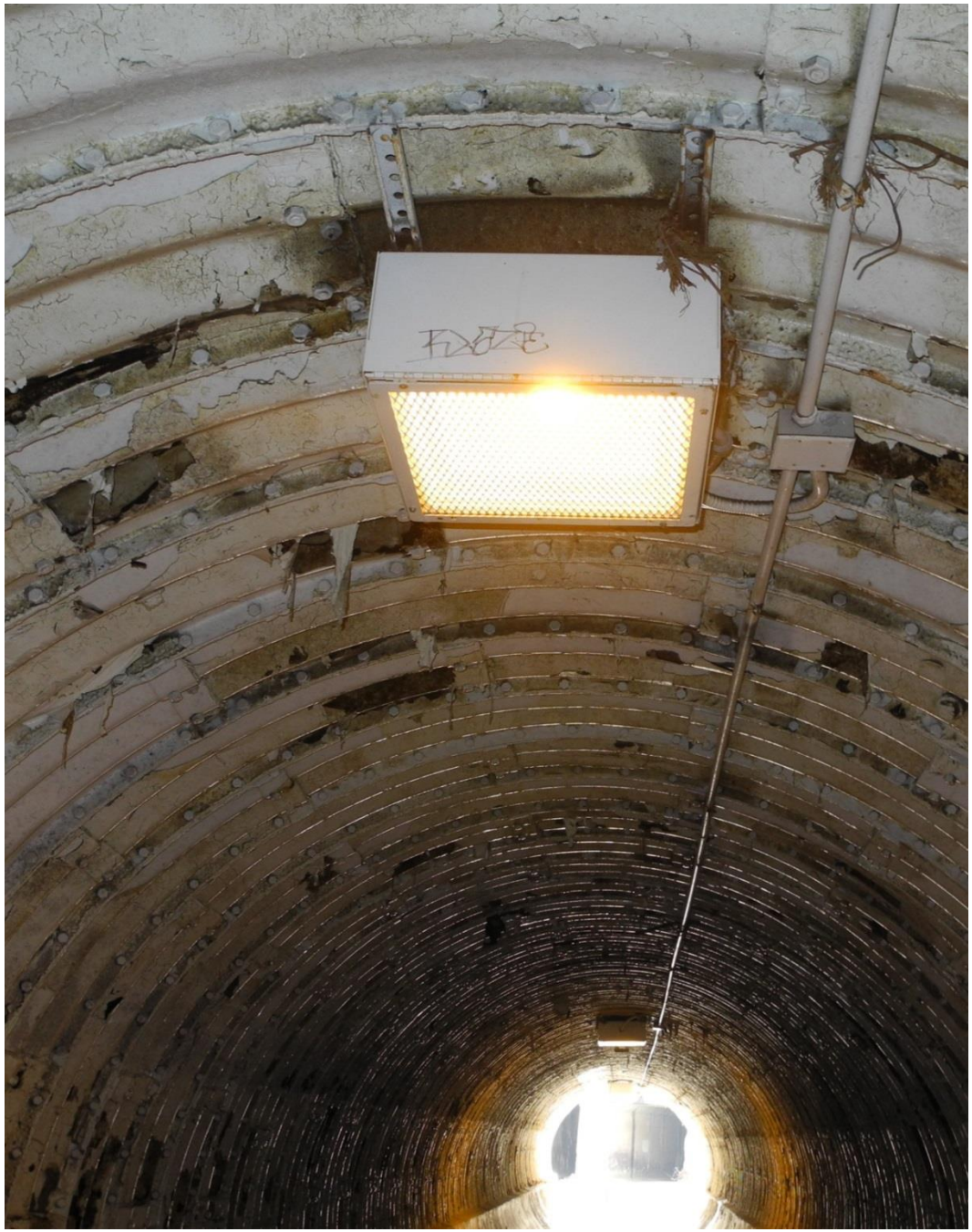
Shaft at center of tunnel with windows and natural light.

Typical light with protective cage and junction box in Telegraph Road tunnel.

Holmes Run Trail Tunnel Lighting

Seven lights were present in the Holmes Run Trail tunnel placed at approximately equal intervals (40 feet on center). All lights were functioning and no protective cages were present.

There is visibility between one end of the tunnel and the other.



Typical light in Holmes Run Trail tunnel.

Lighting

Short Term Recommendations

Although lighting is present and operating at all times in both tunnels, lighting levels could be enhanced. The Maryland *SHA Bicycle and Pedestrian Design Guidelines* recommend at least 10 foot-candles in pedestrian tunnels. This level should be considered in relation to the entranceway lighting to ensure users are able to adapt to the tunnel lighting. For best results, photometric analyses should be performed to determine existing lighting levels and the number, strength, and location of a new lighting system. A lighting designer can further enhance the tunnels. In the Telegraph Road Tunnel, natural light can also be enhanced on the northern end. At this location, vegetation has grown up in front of the tunnel reducing site lines.

- Reduce vegetation overgrowth at Telegraph Road Tunnel north entrance and maintain on a quarterly basis
- Conduct photometric analysis of existing lighting (in tunnel and at entranceways) and determine with lighting specialist the best lighting levels for the tunnel
- Upgrade existing lights with additional lights, brighter luminaires

Vegetation at Telegraph Road Tunnel

Lighting

Long Term Recommendations

Depending on the cost and power supply, among others, upgrading the existing lighting or installing a new lighting system may be a long term recommendation. Natural light during the day could also be enhanced in the Telegraph Road Tunnel by increasing the percent of fenestration in the existing shaft. Currently, the existing windows are small. Increasing the size of the windows would increase the amount of natural light in the tunnel during the day. Changes to the shaft would need to be coordinated with the railroad and other owner/user entities in the vicinity. Additional recommendations include the use of artistic lighting, which can attract new users while also enhancing safety.

- Install new lighting
- Increase the amount of light coming through the Telegraph Road Tunnel shaft
- Use lighting design firm or work with artists to include light as part of a tunnel design project
- Improve tunnel entrance lighting, particularly at north entrance to Telegraph Road tunnel.

Color lighting in cable car tunnel in Wellington, NZ.

Lighting design firm Côté Lumière designed this lighting in Nimes, France

Lighting

Products

The following companies provide outdoor commercial-grade lighting and have been recommended by Washington metropolitan area commercial developers.

- Philips: www.lightingproducts.philips.com
- General Electric Commercial Outdoor Lighting: www.gelighting.com/LightingWeb/na/solutions/outdoor-lighting
- Hubbell Outdoor Lighting: www.hubbelloutdoor.com
- Kim Lighting: www.kimlighting.com
- Grainger: www.grainger.com/category/outdoor-led-light-fixtures/lighting/ecatalog/N-imc
- B-K Lighting http://www.bklighting.com/images-navigation/project-gallery.html#!
- Bega Lighting http://www.architonic.com/pmpro/recessed-wall-lights-facade-lights-outdoor-lighting/3232512/2/2/1
- AAL, http://www.aal.net/
- Wagner, http://www.wagnerarchitectural.com/lighting/lumenrail-light-sticks/

Costs for tunnel lighting improvement options are included in Appendix C.

Bridge Lighting, Arizona Avenue Trestle, DC: The National Park Service added overhead lights to a the Arizona Avenue Trestle Bridge along the Capital Crescent Trail. Fixture type: Vintage Down Lighting Fixtures, Lake Bluff Series. 70 Watt, High Pressure Sodium, 120 Volts.

Trail Lighting, Metropolitan Branch Trail, DC: After the failure of the original solar-LED system, Daniel Consultants performed a lighting assessment of the trail, ultimately recommending the 60W King Luminaire fixture to be used on the existing poles.

DRAINAGE

Drainage design is important for all construction projects. Improper drainage design can cause a variety of adverse conditions which can be a determent to pedestrians, the environment and city maintenance crews.

Examples include:

- Erosion
- Structural Damage
- Stagnant Water – ice and rust
- Stagnant Water – pests
- Sediment
- Trash

In general, the goal is to provide a path for water to drain in both small and large storm events. Water will flow along the path of least resistance and if uncontrolled, will erode surfaces and carry sediment and trash. If a low spot exists, water will pool, collect sediment and trash, deteriorate most surfaces, create icy patches in the winter, and may serve as a breeding ground for pests in the warmer months.

Drainage within a tunnel can be more problematic than other areas due to the difficulty in conveying storm water from an underground location to the storm drain system outside of the tunnel. In addition, pedestrians are unlikely to use a tunnel that appears dirty, wet or deteriorating.

Examples of issues due to poor drainage

Telegraph Road Tunnel Drainage

Water was noted both on the eastern and western sides of the Telegraph Road tunnel, with additional standing water and debris on the northern end. Corrosion and rust on the corrugated metal due to water was noted on the base on both the eastern and western walls of the tunnel.

On the western edge of the tunnel, water was noticeably flowing toward the center of the tunnel. The mid-point of the tunnel also appeared to be a low-point where any water that enters the tunnel collects. A drainage grate inlet was visible at the tunnel mid-point. An electrical cord was fed into the drainage grate and appeared to be attached to a pump (which was not visible under the grate, but was audible). A small pipe laid along the floor of the tunnel carries water from the low point back to a point outside the south tunnel entrance where it is discharged onto the sidewalk, and flows into a nearby drainage culvert adjacent to Mill Road. The informal manner in which the pumping system was installed suggests that it was an afterthought, and not part of the original tunnel drainage system.

The northern side of the tunnel is lower in elevation than the adjacent trail and must be accessed with stairs. The north side of the tunnel is a local low point and does not have any accommodations for drainage. On the day of the site visit, standing water and debris were observed just outside the north entrance to the tunnel.

Standing water within tunnel (looking south)

Grate inlet and pipe (looking south)

Pipe outfall to culvert (south side of tunnel)

Holmes Run Trail Tunnel Drainage

The Holmes Run Trail and tunnel travel along the southern embankment of Holmes Run. The tunnel and trail are well below the 100-year flood elevation, and inundation of the trail is a regular occurrence.

Upstream and downstream of the tunnel, the trail cross-slope generally slopes toward the stream channel, however there appears to be a spot immediately east of the tunnel where the trail surface slopes back toward the stream embankment. There is evidence of sediment and debris deposition at this location, as a result of past flooding. There is a concrete jersey barrier along the trail that may exacerbate this condition. In addition, the longitudinal slope of the tunnel is not steep enough to carry water out of the tunnel, and standing water and debris also collect at the north entrance of the tunnel. There are no visible drainage structures inside the length of the tunnel.

Costs for tunnel drainage improvement options are included in Appendix D.

Standing water on north side of Holmes Run Trail Tunnel (facing east)

Drainage

Short Term Recommendations

Telegraph Road Tunnel:

- Perform quarterly maintenance to remove buildup of sediment and debris at north tunnel entrance.
- Extend the sump pump piping at the south tunnel entrance to the existing culvert inlet to eliminate water pooling on the sidewalk at base of the stairway.
- Block the active electrical outlet from public

Holmes Run Trail Tunnel:

- Perform quarterly maintenance to remove buildup of sediment and debris at tunnel entrances.

Long Term Recommendations

Telegraph Road Tunnel:

- Investigate the inlet in the center of the tunnel and determine if it is clogged and where the inlet drains. Restore inlet to proper function if possible, and remove temporary pipe and pump. Relocate active electrical outlet to an area not publicly accessible.
- Provide trench drains across the tunnel entrances to prevent drainage from entering the tunnel and/or engineer a cross slope and covered scupper along one side of the trail inside the tunnel to keep drainage away from trail surface and formally channel it to the drainage inlet at the tunnel's low point.
- If restoration of the tunnels existing drainage system is not possible, replace temporary pump with permanent installation in a manner that is not susceptible to vandalism.
- Reconfigure north tunnel entrance and stairway to allow drainage to escape naturally, and/or provide piped connections to existing storm drains near each end of the tunnel. Improvements at both entrances should also consider drainage coming from above. Provide concrete channels to direct drainage away and prevent runoff from cascading over the upper edges of tunnel entrances. Costs for this item are included in the cost to reconfigure tunnel entrances.

French drain grate. Photo, www.landscapingnetwork.com

Drainage

Long Term Recommendations

Holmes Run Trail Tunnel:

- Investigate upstream/uphill areas and permanently stabilize any areas which may be contributing to sediment deposition along the trail and in the tunnel.
- Provide trench drain across west tunnel entrance to prevent drainage from entering the tunnel and/or engineer a cross slope and covered scupper along one side of the trail inside the tunnel to keep drainage away from trail surface and formally channel it out of the tunnel. Outfall drains into the stream channel.
- Reconfigure tunnel entrances to improve drainage diversion. Improvements should also consider drainage coming from above the tunnel entrances. Provide concrete channels to direct drainage away and prevent runoff from cascading over the upper edges of tunnel entrances. Costs for this item are included in the cost to reconfigure tunnel entrances.

ENTRANCES

Tunnel entrances are important because they are the first interaction users have with a tunnel, and thus are directly related to a user's feeling of safety.

Tunnel entrances that are well lit, well maintained, and attractive encourage more use, which enhances safety. Entrances can be enhanced with art, paint, landscaping or just regular and apparent maintenance.

Ideally, tunnel entrances should be very visible and users should be able to see from one end of the tunnel to the other. The tunnel's entrances and routes to nearby destinations should be clear to users through the use of wayfinding and maps.

Although tunnel design often conforms to existing grade changes, it is important to design tunnels to be accessible to all users and to retrofit them to be accessible where possible.

191 St Subway, NY

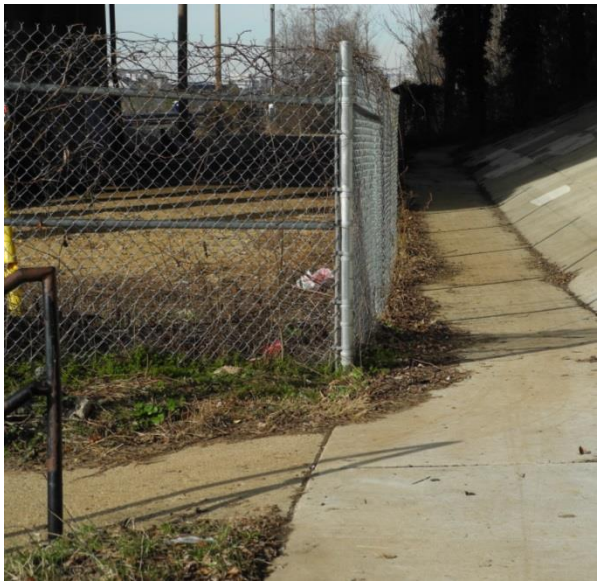

Pedestrian Tunnel Entrance Retrofit, Washougal, WA, Photo: walliseng.net/projects/washougal-ped-tunnel

Telegraph Road Tunnel – North Side Entrance

Currently, the Telegraph Road Tunnel entrances on both the north and south sides are obscure and without signage. Because the tunnel is very narrow and the tunnel has a low point at the middle, it is not possible to see from one end to the other.

On the north side, the tunnel is connected via a staircase to a trail paralleling Duke Street. The angle of the staircase hides the tunnel entrance from view and the steep slope reduces natural light entering the tunnel. The stair rail is broken. The entrance is not easily accessible to people on bicycles and is not wheelchair accessible. Overgrown foliage further obscures the tunnel entrance and trash is prevalent. The adjacent trail is five feet wide and overgrown with foliage. The usable trail width is further narrowed by fencing immediately adjacent to the trail. A pedestrian desire line is present at the connection to South Dove Street and the chain link fence has been cut to allow access.

North side of tunnel obscured by angle of stair, steep slope and foliage



Narrow trail and adjacent fencing on the north side reduces usable trail width

Pedestrian desire line and cut fence connecting to South Dove Street

Tunnel entrance with water, debris, and trash on the north side

Telegraph Road Tunnel – South Side Entrance

The Telegraph Road Tunnel entrance on the south side is much more visible and is accessible via the sidewalk on Mill Road. However, the tunnel is not easily identifiable as a bicycle and pedestrian route, and no signage is present. A staircase leads to the tunnel entrance. The access point is not easily accessible to people on bicycles and is not wheelchair accessible. A pedestrian desire line is present between the Mill Road sidewalk and the tunnel entrance approximately ten feet to the east of the staircase. No overgrown foliage was noticeable at the entrance.

Both entrances showed signs of graffiti which had been painted over.

Costs for tunnel entrance improvement options are included in Appendix E.

South side of tunnel

Tunnel entrance from Mill Road (heading east)

Tunnel entrance from Mill Road (heading west) showing pedestrian desire line

Telegraph Road Tunnel – Entrances

The Telegraph Road Tunnel entrance on the south side is much more visible and is accessible via the sidewalk on Mill Road. However, the tunnel is not easily identifiable as a bicycle and pedestrian route, and no signage is present. A staircase leads to the tunnel entrance. The access point is not easily accessible to people on bicycles and is not wheelchair accessible. A pedestrian desire line is present between the Mill Road sidewalk and the tunnel entrance approximately ten feet to the east of the staircase. No overgrown foliage was noticeable at the entrance.

Both entrances showed signs of graffiti which had been painted over.

Short Term Recommendations

North entrance: Short term actions should focus on addressing maintenance needs and sight lines. Maintenance needs include landscape maintenance, stair rail repair, regular cleaning of sediment and debris, and painting the tunnel entrance and the staircase. Additional attention should be focused on the trail connecting to the tunnel, which would benefit from clearing vertical objects from the trail edge (the VDOT Road Design Manual, recommends a 3-foot clearance).

- Clear overgrown foliage and install landscaping
- Perform routine quarterly maintenance to sweep entrance of dirt and debris and prune and maintain landscaping
- Paint tunnel entrance and stairway
- Remove unnecessary fencing (along access trails) where possible and/or re-install fencing three feet from trail edge
- Install signage and wayfinding to direct users to tunnel entrance and surrounding destinations.
- A bike runnel should be added to the existing stair.

South entrance: Short term actions should focus on wayfinding as the tunnel is somewhat inconspicuous and improving the façade entrance.

- Perform routine quarterly maintenance to sweep entrance of dirt and debris, and clear storm drain grate.
- Install signage and wayfinding at the tunnel entrance and along Mill Road
- Construct a sidewalk connection at the location of the existing desire line.

Telegraph Road Tunnel – Entrances

Long Term Recommendations

Long term recommendations focus on the following major themes for both entrances:

- Make both entrances accessible for all users: the south side stair should be redesigned with ramp access. The north side connection to South Dove Street should be investigated to determine the feasibly of creating a shared use path connection in conjunction with drainage improvements recommended elsewhere in this report. This could address the steep slopes and allow the entrance to become accessible.
- Redesign access to follow existing desire lines: on both the north and south entrances desire lines are present and should be incorporated into redesigned entrances.
- Work with local community organizations or artists or to enhance the tunnel entrances: the entrance facades, access and landscaping should be holistically addressed with community input and potentially an art element.

Lyndale Tunnel Art Project, MT

Holmes Run Trail Tunnel - Entrances

The tunnel is a part of the Holmes Run Trail and therefore the entrances and exits of the tunnel are very visible to trail users.

The pedestrian tunnel appears to be a retrofitted within a larger tunnel built as part of the original bridge.

On the east side, substantial dirt and debris has collected at the entrance of the trail, likely as a result of periodic flooding of the trail during and after rain events.

On the west side, debris was noted along the trail and along the northern and southern edge of the tunnel. Debris appears to have come from the adjacent natural hillside. There is also a pedestrian desire line at this location which would connect North Morgan Street to the Holmes Run Trail.

Both entrances showed signs of graffiti which had been painted over.

East side

West side

Holmes Run Trail Tunnel - Entrances

Short Term Recommendations

Short term recommendations focus on entrance enhancements and general maintenance.

- Perform routine maintenance quarterly, and after each significant rainfall event. Clear dirt and debris collected on the east and west entrances of the trail.
- Paint both entrances to the tunnel to make them more inviting. Consider reaching out to local artists to create a more enhanced gateway.

Watts Creek Pathway at March Road, Ottawa, Canada, Photo: web.ncf.ca/bf250/murala

Long Term Recommendations

Longer term recommendations focus on accessibility and addressing issues with a coordinated approach. For example, to the north of the tunnel, the trail is steep, there is a pedestrian desire line to North Morgan Street and there is substantial dirt run off.

- Design new northern connector trail alignment and landscaping to address steep slope, create access to North Morgan Street and address run-off issues.

Portland Trail Pedestrian Tunnel, MI, Photo: michigan.gov

Appendices

Appendix A - Dimension Recommendation Cost Estimates

Dimensions

Short Term Recommendations

Telegraph Road Tunnel

1	**Determine Remaining Service Life of Tunnels:**	**Structural Evalutation**	=	**$15,000.00**
	Based upon a structural engineer at 200.00/hour - 40 hour timeframe with report, minor destructive or non-destructive testing of existing tunnel wall thickness			
2	**Remove and replace existing concrete floor surfa**	**170 sy**	=	**$6,290.00**
	Based upon VDOT unit prices for concrete sidewalk demolition and reconstruction			

Holmes Run Trail Tunnel

1	**Determine Remaining Service Life of Tunnels:**	**Structural Evalutation**	=	**$15,000.00**
	Based upon a structural engineer at 200.00/hour - 40 hour timeframe with report, minor destructive or non-destructive testing of existing tunnel wall thickness			
2	**Remove and replace existing concrete floor surfa**	**200 sy**	=	**$7,400.00**
	Based upon VDOT unit prices for concrete sidewalk demolition and reconstruction			

Long Term Recommendations

Telegraph Road Tunnel

1	**Reconstruct Larger Tunnel**	**250 lf**	=	**$14,750,000.00**
	Includes railroad contingiencies, maintenance of railroad traffic, and railroad inspection services, based upon average cost of $35,000 per linear feet due to complexity of working within an active rail corridor			
2	**Replace with Pedestrian Bridge**	**13,500 sf**	=	**$12,750,000.00**
	Includes Railroad contingiencies, and permitting, based upon average cost of $500.00 per square foot due to complexity of working within an active rail corridor			
	Assumes 18 foot wide bridge (12 feet passable space with 2-foot shoulders and 1 foot on each side for railings and barriers) and a 250-foot approach ramp on each end			
3	**Provide On-Road Alternative Route**	**3 miles**	=	**$50,000.00**
	Based upon signing and marking only, no roadway reconstruction, VDOT unit prices for signing and marking			

Holmes Run Trail Tunnel

1	**Reconstruct Larger Tunnel**	**300 lf**	=	**$7,500,000.00**
	Based upon average cost of $25,000 per linear foot due to complexity of working under active interstate highway			
2	**Replace with Pedestrian Bridge**	**12,240 sf**	=	**$3,978,000.00**
	Based upon average cost of $400.00 per square foot due to complexity of working over and along active interstate highway			
	Assumes 18 foot wide bridge (12 feet passable space with 2-foot shoulders and 1 foot on each side for railings and barriers) and a 190-foot approach ramp on each end			
3	**Provide On-Road Alternative Route**			
	Off-Road Shared Use path	**3 miles**	=	**$3,000,000.00**
	Includes drainge/SWM, and partial reconststruction of adjacent curblines.			
	On-Road Bike Lanes	**3 miles**	=	**$50,000.00**
	Based upon signing and marking only, no roadway reconstruction, VDOT unit prices for signing and marking			

Costs for design, permitting,and right-of-way acquisition are not included in the costs shown above.

Appendix B - Interior Recommendation Cost Estimates

Interiors				
Short Term Recommendations				
Telegraph Road Tunnel				
1	Perform lead paint testing	Each	=	$1,000.00
	Based upon one test and report			
2	Clean Tunnels of peeling paint and Corrosion	10,300 sf	=	$103,000.00
	If lead based paint add an additional $50,000.00			
3	Apply 2 coats of new paint	10,300 sf	=	$1,740.00
	Assumes $30.00 per gallon of paint including labor, approximately 350 sf per gallon			
4	Annual Paint Touch-up (2 coats)	1,030 sf	=	$180.00
	Assumes $30.00 per gallon of paint including labor, approximately 350 sf per gallon			
5	5 - year paint Rehabilitation (2 coats)	3,090 sf	=	$540.00
	Assumes $30.00 per gallon of paint including labor, approximately 350 sf per gallon			
Holmes Run Trail Tunnel				
1	Perform lead paint testing	Each	=	$1,000.00
	Based upon one test and report			
2	Clean Tunnels of peeling paint and Corrosion	17,100 sf	=	$171,000.00
	If lead based paint add an additional $50,000.00			
3	Apply 2 coats of new paint	17,100 sf	=	$2,940.00
	Assumes $30.00 per gallon of paint including labor, approximately 350 sf per gallon			
4	Annual Paint Touch-up (2 coats)	1,710 sf	=	$300.00
	Assumes $30.00 per gallon of paint including labor, approximately 350 sf per gallon			
5	5 - year paint Rehabilitation (2 coats)	5,130 sf	=	$870.00
	Assumes $30.00 per gallon of paint including labor, approximately 350 sf per gallon			
Long Term Recommendations				
Telegraph Road Tunnel				
1	Conduct Design Competition	Each	=	$25,000.00
	estimated, varies, could be lower, between $10,000.00 - $25,000.00			
Holmes Run Trail Tunnel				
1	Conduct Design Competition	Each	=	$25,000.00
	estimated, varies, could be lower, between $10,000.00 - $25,000.00			

Appendix C - Lighting Recommendation Cost Estimates

Lighting

Short Term Recommendations

Telegraph Road Tunnel

1	Reduce Vegetation Overgrowth at Entrances and Maintain on Quarterly Basis	1 year	=	$4,800.00
	Based upon 4 maintenance visits between April-October			
2	Photogrametric Analysis	Lump Sum	=	$9,000.00
	Assumes both entrances and tunnel			
3	Upgrade existing lights	Each	=	$9,500.00
	Assumes existing fixtures can be retrofitted with new LED luminaires at a cost of approxiately $500 per fixture (17 fixtures inside tunnel)			

Holmes Run Trail Tunnel

1	Reduce Vegetation Overgrowth at Entrances and Maintain on Quarterly Basis	1 year	=	$4,800.00
	Based upon 4 maintenance visits between April-October			
2	Photogrametric Analysis	Lump Sum	=	$9,000.00
	Assumes both entrances and tunnel			
3	Upgrade existing lights	Lump Sum	=	$4,500.00
	Assumes existing fixtures can be retrofitted with new LED luminaires at a cost of approxiately $500 per fixture (7 fixtures inside tunnel)			

Long Term Recommendations

Telegraph Road Tunnel

1	Install new lighting system (only if item 3 is not feasible)	Lump Sum	=	$37,500.00
	Includes new conduit and upgraded connection to public utility			
2	Increase shaft opening	Lump Sum	=	$20,000.00
	Assumes there is an existing agreement in place with the railroad that would allow routine maintenance activities, and no rail outage is required			
3	Work with Artist to include Light as Art	Lump Sum	=	$100,000.00
4	Improve tunnel entrance lighting	Lump Sum	=	$36,000.00
	Assumes new connection to public utility			

Holmes Run Trail Tunnel

1	Install new lighting system (only if item 3 is not feasible)	Lump Sum	=	$30,000.00
	Includes new conduit and upgraded connection to public utility, assumes 5 additional fixtures would be needed inside tunnel			
2	Work with Artist to include Light as Art	Lump Sum	=	$100,000.00
3	Improve tunnel entrance lighting	Lump Sum	=	$36,000.00
	Assumes new connection to public utility			

Appendix D - Drainage Recommendation Cost Estimates

Drainage				
Short Term Recommendations				
Telegraph Road Tunnel				
1	Quarterly Maintenance for North Tunnel Entrance	1 year	=	$1,000.00
	Based upon 4 site visits in one year			
2	Extend sump pump to existing inlet	20 lf	=	$200.00
	Estimated 20 lf of pipe extenstion			
3	Block the existing electrical outlet	Each	=	$500.00
Holmes Run Trail Tunnel				
1	Quarterly Maintenance for Both Entrances	1 year	=	$4,000.00
	Based upon 4 site visits in one year			
Long Term Recommendations				
Telegraph Road Tunnel				
1	Restore clogged inlet to proper function, relocate electrical outlet	Each	=	$2,000.00
2	Install trench drains at entrances and scuppers	lump sum	=	$42,500.00
	Assumes 250 lf of scupper pipe and 2-10' long trench drains			
3	Install permanent pump	Each	=	$5,000.00
	Only if Item 2 above isn't feasible			
Holmes Run Trail Tunnel				
1	Permanently stabilize uphill areas	Each	=	$25,000.00
2	Install trench drains at entrances and scuppers	Lump Sum		$47,500.00
	Assumes 300 lf of scupper pipe and 1-10' long trench drain			

Appendix E - Entrance Recommendation Cost Estimates

Entrances

Short Term Recommendations

Telegraph Road Tunnel - North Entrance

1	Clear overgrown foliage and install new landscaping	Lump Sum	=	$80,000.00
	Assumes shurbs and trees, irrigation not included			
2	Quarterly Maintenance	1 Year	=	$1,000.00
	Includes removal of debris and pruning landscaping			
3	Clean and Paint Tunnel Entrance & Stairway	5,000 sf	=	$500.00
	Assumes $30.00 per gallon of paint including labor, approximately 350 sf per gallon,			
4	Remove excess fencing and re-install	100 lf	=	$10,000.00
	Assumes new fencing not salvaging existing fence			
5	Install signage and wayfinding	Lum Sum	=	$1,350.00
	Assumes 5 signs & wood posts			
6	Install a bike runnel to existing stairs	25 sf	=	$800.00
	Assume 25 sf of concrete			

Telegraph Road Tunnel - South Entrance

1	Quarterly Maintenance	1 Year	=	$1,000.00
	Includes removal of debris and pruning landscaping			
2	Install signage and wayfinding	Lum Sum	=	$1,350.00
	Assumes 5 signs & wood posts			
3	Construct New Sidewalk	300	=	$9,600.00
	Assume 300 sf of concrete			

Long Term Recommendations

Telegraph Road Tunnel & Holmes Run Tunnel

1	Construct new Accessible Entrances - Telegraph Road North	Each	=	$102,500.00
	Includes ramps, switch backs, up to 100 feet of shared use path, and up to 300 sq feet of retaining walls			
	Construct new Accessible Entrances - Telegraph Road South and Holmes Run North/South	Each	=	$52,500.00
	Includes ramps, shared use path, and up to 300 sq feet of retaining walls			
2	Reconstruct Access for Desire Lines	lump sum	=	$5,000.00
	Assumes shared use path construction with limited grading only			
3	Install Art at Entrances	Each	=	$20,000.00