CITY OF PITTSBURGH

# THREE RIVERS HERITAGE TRAIL MAINTENANCE & MANAGEMENT PLAN

MARCH 2026

evolve environment :: architecture
IVICMAPPER
ethos collaborative water-energy-climate-community

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**APPENDIXES**

The following appendixes have been compiled in a separate document.

# INTRODUCTION

The City of Pittsburgh Department of Mobility and Infrastructure (DOMI) lead a process to plan improvements to maintenance and management (M&M) of the Three Rivers Heritage Trail (TRHT). The results of this process were documented in three deliverables: an existing conditions report, a best practices memo, and a recommendations report; these three elements compose the M&M plan.

With support from stakeholders, DOMI pursued and was awarded grant support for this effort from the Pennsylvania Department of Conservation and Natural Resources in 2022. The following year, DOMI released a request for proposals for a planning consultant to undertake the data collection and analysis necessary to produce the aforementioned deliverables. evolve environment::architecture leads the selected team, which further includes CivicMapper, Ethos Collaborative, and Oikos Ecology.

The geographic scope of this effort was limited to those (primarily riverfront) trails, within the City of Pittsburgh, known as the TRHT. Trail mapping completed by Friends of the Riverfront was referenced to ensure consistency.

This project was financed in part by a grant from the Community Conservation Partnerships Program, Keystone Recreation, Park and Conservation Fund, under the administration of the Pennsylvania Department of Conservation and Natural Resources, Bureau of Recreation and Conservation.

### Project Goals

Beginning with a kickoff meeting in January 2024, the consultant team met with a group of key TRHT stakeholders to discuss the project purpose. Stakeholders provided input regarding the project scope, to ensure its completeness and utility, as well as what information they could provide to facilitate the planning process.

In particular, stakeholders told DOMI and the evolveEA team what value this project offers them. Responses included:

- Defining roles and responsibilities
    - Increasing overall efficiency of trail maintenance
    - Helping individual organizations plan staffing and fundraising
    - Creating accountability
    - Clarifying ownership
- Prioritizing investments
    - Having a shared capital plan
    - Having a coordinated approach to fundraising for trail maintenance
- Protecting the past and ongoing investment of time and money into the trail
- Ensuring a safe, connected, and comfortable network

# EXISTING CONDITIONS REPORT

## 01 Getting Started

### Previous Analysis

The evolveEA team was fortunate to benefit from previous work completed in the study area within the last few years. In 2021, the Planning, Programs, & Project Management Division of the U.S. Army Corps of Engineers, Pittsburgh District, completed a Riverbank Stability Assessment and Applied Best Practices Guide, which provides a detailed assessment of riverbank conditions within the City of Pittsburgh. The city has made this information available to our team, which validated or updated the data with riverbank observations conducted by boat in April 2024.

Also completed in 2021 were the Completing the Loop Report, Riverlife Implementation Framework, and Riverlife Financial Instrument. evolveEA completed the first two of these documents for Riverlife and has been able to carry over data and lessons learned from that process to add value to this current project.

The stakeholder group for this project has been collaborative in sharing information to enhance the consultant team's work and avoid any duplication of efforts. Several partners have shared information including GIS layers, easements, surveys, etc.

Finally, our team also researched other publicly available past planning in the TRHT corridor and found 18 such plans dating back to 1998; the list can be found in Appendix M.

### Mapping Approach

CivicMapper's mapping approach involved the collection of existing geospatial data resources of the trail (e.g., feature layers from USACE's IENC Report, TRHT trail feature class, parcel layer with ownership details, contours, DEMs, etc.), and newly collected data representing current conditions including drone imagery, GPS field collected data, and calculated canopy heights. Current condition data also included leaf-on imagery of the trail and adjacent vegetated areas, shoreline views of important riverfront infrastructure, and newly generated derivative data created by the project team during their analysis work. CivicMapper prepared field data collection forms for the project team to use for assigned data collection tasks, and resultant data were accessible to team members through ArcGIS Online. CivicMapper also prepared an ArcGIS Online dashboard tool that allowed the simultaneous review of spatially linked data showing a map of field data, aerial imagery, and 360 camera video of the trail, creating a "virtual field area" for assessment support. All existing and new data resources were assembled in an ArcGIS Online web map to support project assessment tasks and to help guide project management discussion. Data collection primarily occurred over the period from February through May 2024.

# 02 Ecological Infrastructure

## Canopy and Invasive Plant Management

Oikos Ecology walked the entire trail to characterize vegetation conditions, including canopy density, major canopy tree species, opportunities for additional tree planting, and presence and density of invasive plant species within an approximately 40-foot-wide buffer on each side of the trail, within preliminary trail segments. Segments were identified based on recognizable landmarks, like bridges, or obvious changes in condition, including changes in trail materials that tend to be associated with ownership changes. Subsequently, the field-identified segments were parsed to match the final segmentation scheme, so data presented in the report pertain to the final segmentation. Detailed field notes can be found in Appendix A. Based on the field notes, canopy density was rated according to the following scale:

| | |
|---|---|
| Low: | Extensive areas with no or sparse tree cover |
| Medium: | Scattered openings or continuous tree cover with open canopy |
| High: | Continuous tree cover with closed canopy |

*Examples of low (left; Duck Hollow Trail) and moderate (right; Allegheny River Trail) canopy density. There were no areas identified as having high canopy density.*

Canopy density will also be quantified using aerial imagery, which will help identify specific areas of sparse trees where additional trees could be planted. Those data are currently being processed and results will be presented with the next deliverable.

Invasive species density was rated for the following plant habits: trees, shrubs, vines, herbaceous. Density was rated according to the following scale:

| | |
|---|---|
| Low: | Present as few isolated individuals or infrequent small patches |
| Medium: | Several small patches or individuals throughout the area |
| High: | Continuous cover, many smaller patches, or one or more large patches |

The only areas that had low invasive species density in all strata (herbs, shrubs, trees, vines) were in highly maintained sections (such as lawn or concrete). Most areas contained a combination of invasive species in different strata and densities. See photos in Appendix A.

These field-based data are aligned with the final trail segment alignment for mapping, quantification, and planning purposes.

## Tree Canopy: Sparse Canopy (for additional tree planting)

Across the entire trail system, 79% of field-identified trail segments had low canopy density (extensive areas with no or sparse tree cover) and 21% had medium canopy density (scattered openings or continuous tree cover with open canopy). While no field-identified segments had high canopy density (continuous tree cover with closed canopy), smaller areas within segments occasionally did have relatively high density, especially between Hazelwood and Duck Hollow on the north shore of the Monongahela River. Some areas of low or medium canopy have limited opportunity to establish such canopy due to surrounding infrastructure, including most of the Eliza Furnace Trail and between the Carnegie Science Center and PNC Park. Analysis of aerial imagery will further refine estimates and locations of openings and other opportunities for tree planting.

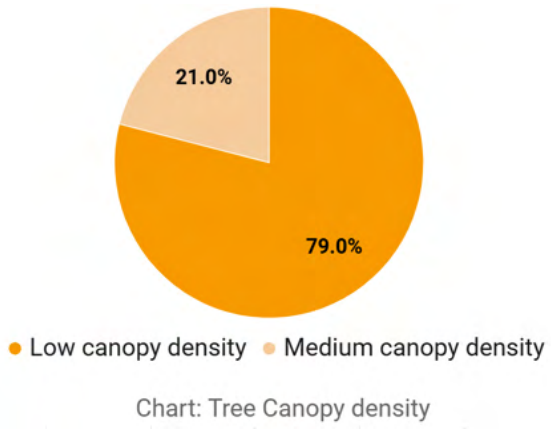



Chart: Tree Canopy density

## Invasive Conditions

Pennsylvania Department of Conservation and Natural Resources maintains a list[1] of invasive plant species, ranked by relative risk to native plant communities. Invasive species are a concern for trail sustainability because they occupy space and use resources (light, nutrients, water) that would otherwise be available for native species, which provide more value to the ecological system as a whole by providing food and habitat for native species. Additionally, some invasive species directly conflict with trail uses, including by encroaching on the trail itself, creating dense thickets that impede views and hide garbage accumulation, or are woody vines that increase risk of trees toppling or breaking large branches.

### Invasive Shrub Density

Invasive shrub density was low in 50%, medium in 10%, and high in 40% of trail segments. Invasive shrub density was highest along the Allegheny River segments, but that is mainly a function of the trailsides along the other two rivers being more dominated by maintained landscape, parking, or buildings.

The main invasive shrub species by far was Amur honeysuckle. Other species include multiflora rose and privet. Invasive shrubs conflict with trail uses because they impede views of the river, present safety concerns, encourage littering due to trash being “out of sight”, and occupy space and resources that would otherwise be available for native plants, including trees.

[1] DCNR Invasive Plant List. https://elibrary.dcnr.pa.gov/GetDocument?docId=2700788&DocName=dcnr_20033786.pdf

### Invasive Herbaceous Density

Invasive herbaceous density was low in 29%, medium in 9%, and high in 62% of trail segments. Invasive herbaceous density was highest along the Allegheny River segments, but that is mainly a function of the trailsides along the other two rivers being more dominated by maintained landscape, parking, or buildings.

The main invasive herbaceous species was knotweed (Japanese and/or hybrid), followed by mugwort. These invasive species, particularly knotweed, conflict with trail uses for the same reasons as invasive shrubs.

### Invasive Tree Density

Invasive tree density was low in 48%, medium in 21%, and high in 31% of trail segments. Invasive tree density was fairly evenly distributed across the three rivers.

Across most of the trail system, the main invasive tree species was tree of heaven, followed by white mulberry. Callery pear was prevalent as planted landscape trees on the Eliza Furnace Trail, but uncommon elsewhere. Invasive trees conflict with trail uses because they occupy space that would otherwise be available to native trees, which support more ecosystem services like wildlife habitat than do non-native species, including invasives. Additionally, tree of heaven is the main host for the spotted lanternfly, which is an invasive nuisance insect species that can decrease vigor of native tree species.

### Invasive Vine Density

Invasive vine density was low in 48% of segments, medium in 17%, and high in 36% of trail segments. Invasive vines were most prevalent along the Allegheny River, due to the other rivers being more maintained or built up.

The main invasive vine species was porcelain berry, which frequently formed extensive thickets alongside knotweed. The other main invasive vine was oriental bittersweet. When forming thickets, invasive vines combine with invasive shrubs and herbaceous species to block views and compete with native species for space and resources. When growing on trees, they greatly diminish tree vitality and increase the risk of tree mortality from overtopping or additional weight leading to blowdowns and broken branches.

Detailed invasive species information sheets are provided in Appendix B. Screenshots showing sample trail ecology data can be viewed in Appendix C.

## Riparian Zone Restoration and Preservation

Riparian condition was assessed by reviewing data collected by the US Army Corps of Engineers in their study and verified/updated from a boat-based survey conducted during the current project. During the survey, an ecologist and an engineer with the design team inspected shorelines and documented conditions

of ecological features (including potential for ecologically based restoration) and structural features like retaining walls.

## Ecological Conditions: Updated Riparian Zone Condition

The majority of the riverbanks consisted of manmade structures. The main areas where there were relatively natural sloped banks were the north shore of the Allegheny River north of the Veterans Bridge and the north shore of the Monongahela River between Hazelwood and Duck Hollow. However, the main ecological feature that could feasibly be restored in these areas is replacing non-native invasive vegetation with native species. The main values of vegetation restoration are improved habitat for other species and improved visitor experience. Opportunity to reshape river banks to a more natural floodplain condition is impeded by the short distance between the rivers and the trail or other infrastructure in most areas. The rivers' historic floodplains are largely permanently flooded due to the lock and dam system that was installed beginning in the mid-1800s and continuing into the 20th century to improve navigation. Ecologically speaking, this transformed our three rivers essentially into a series of lakes.

## Structural Conditions: Retaining Wall, Steep Slopes, and Fences

Because the Three Rivers Heritage Trail generally travels along the river, there are numerous areas where the trail itself is in close proximity to aging engineered river walls, conventional retaining walls of varying construction, and steep slopes - both naturalized and reinforced. Because these structural features generally pre-date the trail's construction or adoption by the City, the ownership and maintenance responsibilities of these walls and slopes typically falls to private property owners. Based on our field observations, there are numerous areas where these walls and slopes rate in Poor to Fair condition and pose non-trivial risks to the trail and the general public. As part of this trail assessment, a number of these wall and slope segments have been identified as potential risk factors. Because full structural evaluation of these walls is outside of the scope of this project, it is our recommendation that any wall or slope determined to be a potential risk be evaluated under a separate contract by a qualified professional geotechnical or structural engineer. Please refer to the trail assessment appendices for additional information.

### Wall and Fence Types, Visible from Trail

The walls and fences described below include those that were observed along or adjacent to the trail, and are specifically visible from the trail itself. These include both free-standing walls, fences, and retaining walls.

1. Intentional Breaches, meaning apparent evidence that the fence had been cut or damaged to gain access at a specific location that was otherwise inaccessible (coded as point data or line data, depending on extents)
2. Fallen Tree Damage (coded as point data or line data, depending on extents)
3. Failed / Missing Sections (coded as point data or line data, depending on extents)

### Walls and Steep Slopes, Not Necessarily Visible from Trail, but Visible via Boat

Additional assessment of retaining walls, engineered river walls, stabilized and naturalized slopes was conducted during a related boat trip, and includes walls that are not necessarily visible from the trail, but would potentially impact the trail should they fail. Because the areas were not easily accessed, the data collected for these walls and shorelines include georeferenced photos, with direction areas, but not high-accuracy GPS data. As such, the linear wall and shoreline features shown on the assessment web map for this project are derived from the previously-performed Army Corp of Engineers (ACOE) Shoreline Assessment Study, using a 40-foot buffer from the trail centerline to determine which walls and shorelines are most critical to the safety and operations of the Three Rivers Heritage Trail network. The detailed observations, risk assessments, and recommendations provided by the Project Team were derived from direct visual assessment, combined with the original ACOE condition assessments (Poor, Fair, Favorable). More importantly, where direct correlations were observed between walls and shorelines in questionable conditions and actual defects of the trail, these correlations were noted in the trail assessment reporting. Below are some select photos of locations where walls or slopes in questionable condition come in close proximity to the trail edge.

## 03 Mobility Infrastructure

During the field survey for vegetation condition, trail attributes were also recorded, including trail material, width, and condition. Condition was rated according to the following scale:

Good: no major faults



Fair: minor cracks and potholes that have been filled, minor tripping hazards, wayfinding issues



Poor: major cracks, uneven surface, tripping hazards, unfilled potholes, wayfinding issues



## Trail Surface Condition

Forty-eight percent (48%) of trail segments were asphalt, 24% concrete, 10% crushed limestone, and 19% another material or a combination of materials.

Ten percent of trail segments (2.6 miles) were in poor condition, 40% (10.4 miles) in fair condition, and 50% (13 miles) in good condition (see page 36 for a map of these conditions). The main problems indicating a fair or poor condition were large cracks, potholes, and transitions that caused tripping hazards. That said, there are also several areas of noteworthy concern and potential risk along the Three Rivers Heritage Trail network, generally noted as 'Severe' defects on the web map. There are stretches of trail, for instance, where severely deteriorating walls are located immediately adjacent to and supporting trail segments that are in otherwise Good to Excellent condition. The trails in these locations often show just subtle defects at the surface - edge cracking, longitudinal slippage cracking, and transverse cracks. It is only when assessing the areas visible from the river and those visible from the trail in tandem that the potential cause-effect relationships between failing walls and global and localized movement of the trail above become apparent. These areas should be a high priority for future assessment, monitoring and remediation.

The trail width was highly variable. Most segments were approximately between 8 and 12 feet wide. Crushed limestone segments were more irregular in width. The narrowest trails were on Herrs Island, being only 2-4 feet wide in most places.

Trail conditions were assessed based on overall visual observations, as well as using a more detailed, segment-by-segment evaluation of pavement and trail surface defect data collected via GPS. The data was generally collected at a 10-cm accuracy, although the GPS signal was variable during the data collection period. When possible, the severity of the defects (Minor, Moderate, Severe) was also coded, with photos and detailed descriptions generally included for moderate, severe, or otherwise noteworthy defects. Non-defective and defective features other than pavement - such as lighting fixtures, walls / fences, and drainage structures - were also collected during this process. Feature and defect information collected includes:

### Asphalt Trail Segments

- Transverse Cracks (coded as point data assuming they spanned the trail width)
- Heaving / Dimpling - from tree roots, for example (coded as point or polygon data, depending on extents and severity)
- Pavement Depressions (coded as point or polygon data, depending on extents and severity)
- Potholes (codes as point data)
- Longitudinal Cracks (coded as line data, so as to capture the extent)
- Edge Cracking (coded as line data)
- Rutting (coded as line data)
- Alligator Cracking (coded as polygon data);
- Patching (coded as polygon data)
- Raveling (coded as polygon data)

### Concrete Trail Segments

- Transverse Cracks (coded as point data assuming they spanned the trail width)
- Corner Cracks (coded as point data)
- Popouts (coded as point data)
- Pavement Depressions (coded as point or polygon data, depending on extents and severity)
- Potholes (codes as point data)
- Longitudinal Cracks (coded as line data, so as to capture the extent)
- Edge Cracking (coded as line data)
- Rutting (coded as line data)
- Slippage (coded as line data)
- Sunken / Heaved Slab Edge (coded as line data)
- Crazing (coded as polygon data)
- Spalling (coded as polygon data
- Efflorescence (coded as polygon data)
- Crumbling / Broken Pavement (codes as polygon data)
- Heaving (coded as polygon data)

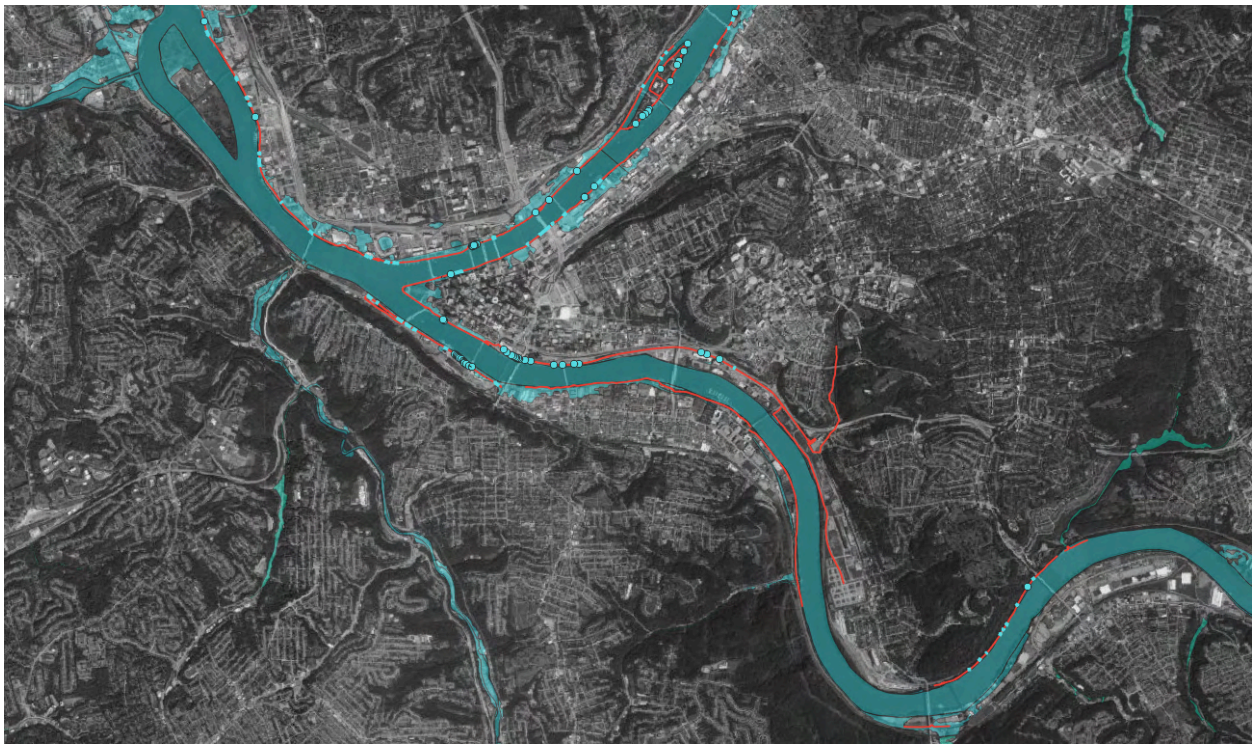
### Aggregate Trail Segments

- Potholes (coded as point data)
- Erosion / Material Loss (coded as point data, line data or polygon data, depending on extents and severity)
- Sediment Deposit (coded as point data or polygon data, depending on extents and severity)
- Rutting (coded as line data or polygon data, depending on extents and severity)
- Slippage (coded as line data)
- Edge Deterioration (coded as line data)
- Soft Areas / Ponding (coded as point data, line data or polygon data, depending on extents and severity)
- Extensive Vegetation (coded as polygon data)
- Brick / Paver Trail Segments
- Missing (coded as point data)
- Chipped / Broken (coded as point data)
- Linear Settlement (coded as line data)
- Faulting (coded as line data)
- Horizontal Displacement (coded as line data)
- Rutting (coded as line data)
- Joint Weeds (coded as line data)
- Widespread Settlement (coded as polygon data)
- Horizontal Displacement (coded as polygon data)
- Widespread Missing (coded as polygon data)
- Widespread Cracked / Broken (coded as polygon data)
- Extensive Vegetation (coded as polygon data)

## Drainage Features and Defects

1. Drainage Structures - including type and condition (coded as point data)
2. Flood and Ponding Evidence - mud and debris (coded as line data or polygon data, depending on extent and severity)
3. Erosion (coded as line data or polygon data, depending on extent and severity)
4. Soft Spots and Muddy Areas (coded as polygon data)

See map below for data listed above. Screenshots showing sample trail surface data can be viewed in Appendix D.



# BEST PRACTICES MEMO

## 01 Network-Wide Best Practices

The evolveEA team assessed the entire Three Rivers Heritage Trail network within the City of Pittsburgh, as described in the TRHT Maintenance & Management Plan: Existing Conditions Report (July 2024). In doing so, the team observed several opportunities for improvement across the network that could be best addressed by establishing network-wide standards. Those observations and recommended standards are outlined below.

### Trail Design Standards

#### Guiding Principles

1. Do not assume to replace in-kind.

   The Three Rivers Heritage Trail and its related infrastructure evolved over the course of decades, with various trail segments constructed incrementally as funding, land availability, and community needs converged. It was not necessarily a haphazard process historically and much of the trail already meets well-known Best Management Practices, but it was certainly not a master-planned process with consistent standards. Going forward with the ongoing maintenance, expansion, and periodic replacement of trail segments, it would arguably be a mistake to simply maintain, repair, and replace all existing trail segments as originally designed. (For example, if site conditions permit, more naturalized streambank stabilization and bioengineering solutions should be considered over more conventional solutions.) Instead, a more intentional and planned approach is recommended.

2. Consistent design standards.

   Developing comprehensive design standards, and ensuring maintenance is conducted to those standards, is vital for the sustainability and success of the Three Rivers Heritage Trail. By establishing clear guidelines for conditions of the trail, the city can ensure that every segment adheres to high-quality benchmarks that enhance safety, accessibility, and user satisfaction. These standards should cover critical aspects of the trail, including width, surface materials, drainage, signage, lighting, and amenities. A unified approach to design and maintenance not only creates a cohesive and aesthetically pleasing environment but also simplifies management efforts and reduces long-term costs. Implementing consistent standards ensures that the trail remains a reliable and enjoyable asset for the community, providing a seamless experience that encourages ongoing use and supports the trail's identity as a premier recreational resource. While this document establishes maintenance protocols, it primarily responds to existing conditions; design standards would advance protocols for regular maintenance by upholding a uniform and best practice condition.

3. Enhance safety and accessibility for all users.

   Ensuring the safety and accessibility of the Three Rivers Heritage Trail is paramount for creating an inclusive environment that welcomes people of all abilities. This principle acknowledges the goal of designing and maintaining trail segments to meet or exceed ADA (Americans with Disabilities Act) guidelines, ensuring that everyone—whether they are pedestrians, cyclists, wheelchair users, or families with strollers—can navigate the trail safely and comfortably. Additionally, safety features such as adequate lighting, signage, railings, and clear sightlines should be prioritized across all trail segments to reduce the risk of accidents and enhance user confidence, especially in high-traffic or more secluded areas.

4. Prioritize data collection and use for long-term decision-making.

   Implementing a robust and continuously updated system for collecting data on trail usage, surface conditions, maintenance needs, and environmental impact is essential for making informed, long-term decisions. Frequency of trail inspections may vary based on usage or various environmental factors that affect surface longevity. Or, it may be performed more organically, incorporated into regular trail maintenance activity or as-needed. The general idea should, however, be to re-assess each trail segment in its entirety every 3-5 years. By making regular, normalized data collection and management a priority, and utilizing various technologies to collect critical data on trail use, environmental factors and similar, the city can gather critical insights into how different trail sections are performing under various conditions. This data-driven approach allows for predictive maintenance, targeted interventions, and more efficient allocation of resources based on actual trail usage and deterioration patterns. Over time, this practice will help ensure the longevity of the trail, optimize maintenance schedules, and support strategic planning efforts for future expansions and enhancements. Additionally, capturing environmental information–drainage, erosion, flooding, vegetation–in the ongoing trail assessment efforts can inform decisions that balance trail preservation with ecological sustainability.

   Looking to other similar sized cities can offer additional guidance and best practices for trail data management and informed decision-making. The City of Des Moines, Iowa, for instance, implemented a GIS-based trail maintenance program to manage its 70-mile multiuse trail network. Faced with limited resources and a backlog of deferred maintenance, the city developed a system for annual audits, using GIS tools to track surface conditions, erosion, and other issues, similar to the methods used in this project but on an annual basis. In 2023, leveraging this detailed analysis, park planners proposed a $3.9 million increase over 10 years for trail operations and capital repairs. Despite new financial constraints, city leaders approved the budget increase, recognizing the value of proactive maintenance. Additionally, the city allocated a one-time $1 million from the American Rescue Plan funds to address the most critical trail sections.

### Trail Material and Cross Section

The Three Rivers Heritage Trail consists of trails segments that serve a variety of use cases, informed by location, traffic volume, context, space constraints, and connectivity between various city neighborhoods. Below is a brief description of the driving factors that influence trail materials and cross-section, from a Best Management Perspective:

1. Intended Use, Traffic Volume, and Modality

   The trail segment Monongahela North section 1: segments 1–5 and Monongahela North section 2: segments 1–12 between Downtown and Hazelwood, for example, is intended for walking and cycling, and supports both recreation and commuting uses. As such, it should ideally be maintained as a smooth surface of asphalt or concrete, with minimal tripping or bicycling hazards. By comparison, the trail segments in Allegheny North section 2: segments 1–9 that wind through the largely residential portion of Washington's Landing are much less traveled, with less of a commuter focus, and a higher emphasis on the walking experience than cycling. As such, it is reasonable that this portion of trail be maintained as an aggregate surface, rather than paved.

2. Design Service Life

   - Except perhaps in high-flood and particularly high-use areas, the service life of various trail segments are fairly well predictable and should inform the M&M plan overall. This will vary, of course, on other factors, such as the surface thickness, construction methods, and material mixes, but can be generalized as follows:

     Concrete: 30 years or more
     Brick or Pavers: 20 to 30 years
     Asphalt: 20 to 25 years
     Gravel or aggregate surfaces: 7 to 10 years

   - It is not recommended at this time that investments be made by the city to increase the service life of any particular trail segments - for instance, replacing asphalt or aggregate segments with concrete. Instead, we recommend the following Best Management Practices to help better inform future decisions related to service life.

     - For each unique trail segment, we recommend that the city go through the due-diligence to capture from past construction and maintenance records the following information. The date of construction is the most critical data point, as it will largely inform the anticipated end-of-service date, based on the service life ranges provided above. This data will also, however, help to create a baseline understanding of how service life might vary based on actual field conditions, and help to differentiate between segments that might look the same at the surface, but will vary

considerably in terms of durability due to differing construction methods, materials or environmental factors.

- Date of construction
- Trail cross-section data, such as width, thickness, material mix
- Subsurface and drainage conditions during construction
- Whether constructed by Public Works or a contractor
- Overall construction cost per linear foot of trail
- Bicycle and pedestrian traffic volume, both assumed for design and based on historical data collection, if available

- Given that the service lives listed above are generalized, it is strongly recommended that future construction, maintenance, and replacement activities be tracked by the city on a per-segment basis. Doing so will effectively help the city to better understand which segments are prone to accelerated deterioration due to environmental or use factors, as well as track which construction methods, pavement sections, and maintenance practices are most cost-effective for long-term trail upkeep.

- Over time and with the data collected above, more detailed deterioration models could be developed for the Three Rivers Heritage Trail to better predict and project future trail replacement needs. The model would ideally be calibrated based on actual observations over time. A very simple but effective deterioration model, for example, might include common sense adjustments to the baseline service life, as following:

  - Base Layer Thickness: A thicker, well-compacted base layer could add 10-20% to service life, whereas insufficient base material might reduce the lifespan by 20-30%.

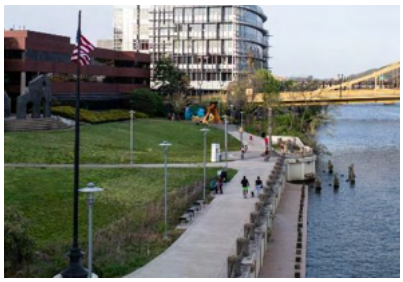
  - Soil Type: Poor subsurface conditions could shorten service life by 10-25% without mitigation. Stabilizing treatments or geotextiles could minimize this effect.

  - Drainage Conditions: Poor drainage could lead to a 30-40% reduction in service life, especially in freeze-prone climates like Pittsburgh. Effective drainage design can mitigate these issues.

  - Surface Treatments: Applying surface treatments to asphalt or concrete every 3-5 years can increase the service life by 10-15%.

- Location and Context: Asphalt is arguably the most commonly used trail material due to the cost-effectiveness, above-average durability, and ease of placement and maintenance. Concrete is more durable, of course, but

requires higher capital costs and is more difficult to maintain periodically as needed. That said, the historical use of concrete on the Three Rivers Heritage Trail appears to follow specific contextual patterns that are worth noting.



- Celebrated Civic Spaces: such as Allegheny South Section 1 and Monongahela North Section 1 along the Point State Park Plaza, Allegheny North Section 1 serving PNC Park and Allegheny Landing, as well as the Ohio North section 1: segments 12–15 next to Carnegie Science Center, and Rivers Casino. These locations are typically maintained to a high level of aesthetics and service, with significant ongoing financial support from local government, philanthropy, and private industry.

- Flood-Prone Areas: such as along the Monongahela Wharf Landing and the 10th Street Wharf Marina. These areas are often less visible to the public and do not necessarily enjoy the same level of financial support as more celebrated civic spaces. They are also under much more environmental pressure due to frequent flooding, sedimentation, and clean-up activities, which ultimately impacts the surface condition substantially. Concrete is a natural choice for these areas, due to the high durability to water forces and clean-up equipment traffic, when needed.

Of course, there are flood-prone areas along the Three Rivers Heritage Trails that are not surfaced with concrete - for instance, the Monongahela North Section 3: segments 1–3 from the Allegheny County Jail Parking Lot to the 10th Street Bridge. This area is not subject to flooding from the river, but does appear to be poorly drained with a relatively large drainage area, few stormwater catch basins, and positioned within a localized sump area. It is not surprising, given these conditions, that this trail segment was rated in poor condition, as part of this study. In this case, as well as flood prone areas, the use of concrete is recommended.

### Trail Width

Similar to trail material, trail width is also largely informed by various factors. Below is a brief description of the driving factors that influence trail width, from a Best Management Perspective:

1. Intended Use, Traffic Volume, and Modality

The width of the various trail segments should be adequate for their intended use, traffic volume, and modality. Revisiting the previous examples, the trail stretch Monongahela North section 1: segments 1–5 and Monongahela North section 2: segments 1–12 along I-376 from Downtown to Hazelwood should be substantially wide, maybe 10-12 feet, so as to facilitate comfortable, two-way, moderate to heavy bike and pedestrian traffic. Conversely, in areas like Allegheny North section 2: segments 1–9 in Washington's Landing, where traffic volume is lower and the environment is more constrained, a narrower width of 4-5 feet may be sufficient and appropriate.

2. Trail Site Constraints

   In width-constrained areas, which are common in Pittsburgh due to its urban environment and natural topography, trail design must balance functionality with spatial limitations. Narrower trails than that which is ideal are often necessary where available land is restricted by steep slopes, existing infrastructure, or waterways. In these cases, careful consideration must be given to maintaining user safety and comfort, particularly in areas of mixed modality use. While narrower trails can still accommodate pedestrian traffic, using signage to manage flow, incorporating passing zones where feasible, and other measures can help mitigate potential conflicts between users. Additionally, integrating adjacent open spaces or wider trail sections at regular intervals can provide users with opportunities to rest or safely pass others. Prioritizing these approaches ensures that width-constrained trails remain functional, safe, and enjoyable for all users, even in challenging environments.

3. Maintenance Access

   Trail segments that need to accommodate maintenance vehicles or emergency access require additional width. This is especially true for trails in remote or difficult-to-reach areas where regular maintenance is essential for safety and usability. This is generally a self-correcting need, as the vehicles needed to construct the trail are often the same ones needed to maintain or replace the trails. However, it should be an explicit design consideration regardless.

4. Additional Factors

   There are several less critical and case-specific factors that should be considered going forward. These include:

   - Safety Requirements
     Adequate space must be provided to ensure safe separation between different types of users, such as pedestrians, cyclists, or maintenance vehicles. Wider trails may be necessary in areas with sharp curves or poor visibility to prevent crashes. For trail segments that are immediately adjacent to steep slopes or retaining walls, additional buffers or realignment may be beneficial, if feasible.

- Multi-Use Considerations
  Trails designed for mixed uses (e.g., pedestrians, cyclists, and equestrians) may require additional width to safely separate different user groups. In these cases, wider paths or separate lanes may be needed to prevent conflicts between slower and faster users. The trail segment Monongahela South Section 1: segment 1 and Monongahela South Section 2: segments 1–7 from the South Side Flats to Station Square, for example, already features separate lanes for slower and faster users.

- ADA Compliance and Accessibility
  To ensure trails are accessible to users of all abilities, including wheelchair users, certain minimum widths must be met to comply with the Americans with Disabilities Act (ADA) standards. This often necessitates wider paths in high-use or public areas.

- Aesthetic and User Experience
  Wider trails can enhance the user experience by creating a more open, inviting feel. This is especially important in scenic or recreational areas, where a sense of spaciousness may be part of the trail's appeal.

- Anticipated Future Growth
  If a trail is expected to see increased use over time, especially in growing communities, it may be advisable to plan for a wider trail initially to accommodate future expansion rather than having to widen the trail later.

**Lighting and Visibility**

Presently, less than 20% of the Three Rivers Heritage Trail segments are intentionally lit with light standard poles, pedestrian lighted bollards, and similar. In general, the lighting appears to be located in formally designed and well-funded civic spaces, such as Monongahela North Section 2: segments 10–11 at the Southside Works and Allegheny North Section 1: segments 1–3 along PNC Park. There seems to be less emphasis on providing lighting specifically for general safety purposes. This may be due to limitations in funding or it may be a conscious choice on the city's part to discourage use of the trails after dark, similar to how public parks are managed from a safety perspective. That said, we recommend the following approach for further assessing lighting needs and planning for implementation:

1. Given that lighting is largely an elective amenity, before expanding or altering lighting along the trail, we recommend that the city assess priorities and policies to determine the goals for lighting the trail and public spaces. The assessment should explore the following questions, at minimum:

   - Does the city intend to encourage trail use during evening hours, or explicitly discourage it through lack of lighting and signage?

- Are there additional celebrated civic areas along the trails that should be better lit, similar to Monongahela North Section 2: segments 10–11 at the Southside Works?
- Are there existing patterns in crime incidents or trail user safety that are known and can be addressed with better lighting?
- Are there preferences with regard to overhead pole standards, lighted bollards, or other light types?
- Are there preferences with regard to consistent style or light standard manufacturers that should be followed explicitly?
- Should LED or solar-powered lighting systems be prioritized over conventional lighting to reduce energy consumption and operational costs, as well as installation costs, both from a new construction and more incremental replacement perspective?

2. If the above city assessment efforts prescribe more intensive lighting throughout the trail network, one Best Management Practice to consider is whether or not it would be beneficial to classify trail sections into specific archetypes, each of which is given a target performance standard in foot-candles. This may include measurement of natural ambient light at night, preferably during a New Moon, to be augmented with additional lighting as needed. The following, for example, may be a starting point for additional lighting, safety, and best practices conversation, and is based loosely on several published sources, listed below:

    - City Park / Civic Space - 2.0 to 3.0 foot-candles
    - Critical Safety Zones - 2.0 to 3.0 foot-candles
    - Urban Commuter Corridor - 1.5 to 2.0 foot-candles
    - Residential Connector - 1.0 to 1.5 foot-candles
    - Scenic / Nature Trail - 0.5 to 1.0 foot-candles
    - Low-Traffic Areas - 0.30 to 0.50 foot-candles
    - Intentionally Unlit Areas - No standard

    Sources:
    https://www.lightingdesignlab.com/sites/default/files/pdf/Footcandle_Lighting%20Guide_Rev.072013.pdf

    https://www.elliottelectric.com/StaticPages/ElectricalReferences/Guides/indoor-outdoor-lighting-level-foot-candle.aspx

    https://www.nyc.gov/assets/planning/downloads/pdf/our-work/plans/citywide/privately-owned-public-spaces/popd_rules.pdf

### Fall Protection and Critical Safety Risks

Both for bicyclists and pedestrians, effective fall protection is a critical safety consideration for the Three Rivers Heritage Trail, particularly in areas where the trail runs alongside steep slopes, retaining walls, or elevated structures such as bridges. Ensuring user safety through effective fall protection measures is essential, especially in urban areas and sections of the trail with significant elevation changes or proximity to hazardous drop-offs. Below are key recommendations for best practices in fall protection:

1. Risk Assessment and Prioritization

   The trail assessment performed as part of this project identified numerous locations where steep, potentially unstable slopes or retaining walls in various states of disrepair are located within close proximity to the Three Rivers Heritage Trail. In some cases, there were indicators in the trail segment–edge and longitudinal cracking, significant traverse cracking, trail surface displacement, etc.–that seemed to directly correlate with failing slopes or walls immediately adjacent. These were identified in the trail scoring as being in 'poor' condition with regard to safety risks, and should be treated as high priority for additional evaluation and remediation by the city, if needed.

   Unfortunately, some of the failing wall sections are not located on city property, and so the priority should be on engaging and working with the landowners to remediate public safety risks to trail users. Regardless of ownership, the city is encouraged to consider alternatives to in-kind replacement of riverbank retaining walls and hard steep slope revetments. If site conditions permit, more naturalized streambank stabilization and bioengineering solutions may offer ecological, resilience, and lifecycle cost benefits over more conventional solutions.

   In addition to more global trail failure concerns, there are also several areas along the trails where additional fall protection is needed or repairs to existing fall protection should be performed. These should also be given high priority, and addressed as soon as identified. Areas with above-average risk of falls, such as sharp elevation changes, narrow pathways near steep slopes, or trail edges that run adjacent to steep slopes and walls should also be identified for more frequent visual assessment and installation of new barriers, signage and similar fall protection measures.

2. Planned and Regular Safety Audits

   Regular safety audits should be conducted to identify and address potential hazards such as uneven surfaces, overgrown vegetation, inadequate lighting, or poor visibility around corners. Critical areas like intersections with roadways, underpasses, or bridges should be equipped with clear signage and barriers to protect users. Ideally, the audit should be conducted at regular intervals with frequency based on overall trail segment usage. More

frequently used segments should be audited more regularly, but all trail segments should ultimately be audited within a reasonable time frame.

**Trailside Vegetation**

Appropriate, healthy, native vegetation supports the primary trail functions of providing connectivity, recreation, and respite. Trailside vegetation also relates to several city priorities, including supporting habitat, reducing urban heat island, supporting biophilia, equitable access to nature, and carbon sequestration, among others. As such, trailside vegetation should:

- Be comprised of diverse plant communities of native species, so that they provide the best habitat for other species that rely on native vegetation for food and shelter and best supports biophilia;
- Be comprised of species that are adapted to site conditions as well as the projected future climate, to create self-sustaining, resilient plant communities that provide ecosystem services far into the future;
- Lack sizable populations of invasive plant species that contribute to reservoirs of invasive propagules that threaten nearby areas and compete for light and nutrients that would otherwise be available for native, desirable species;
- Provide high degree of tree canopy cover, to provide shade, contribute to carbon sequestration, and improve bank stability; and
- Lack dense, continuous thickets of shrubs that block views of the river, impede access to the water's edge, encourage dumping and accumulation of garbage, and decrease sense of safety for trail users.

In summary, where possible, trailside vegetation should consist of a dense and diverse native tree canopy, a relatively open shrub layer with a low density of native shrubs, and native, diverse, mostly low-growing ground cover. Additional details are provided in the next sections.

1. Invasive Species

   While an ideal condition would be no invasive species at all, completely eradicating all invasive species is not practicable. Rather, we propose a more realistic goal of controlling invasive species populations where they pose the most risk and then maintaining them at a low level through ongoing monitoring and adaptive management. We applied the following decision process to determine areas to prioritize for invasive species management:

   a. As described in the Existing Conditions Report, PA DCNR maintains a list of invasive plant species, ranked by relative risk to native plant communities. We propose an acceptable baseline to be:

- No species from Rank 1 (Severe Threat) or 2 (Significant Threat) at more than low density OR
- No species from Rank 3 (Lesser Threat) or Watch List at medium or low density

b. Combining density (low, medium, high; see Existing Conditions Report) and species threat ranking from DCNR, an unacceptable condition can be defined. Areas identified as being "unacceptable" would trigger an invasive species management project:

- Any species from Rank 1 or 2 at medium or high density.
- Any species from the list regardless rank at high density.

2. Reference Plan Communities

Removing invasive species is not sufficient to the restoration of a desired future condition. The invasive community must be replaced with a desirable native community that is capable of resisting re-invasion by invasive species with appropriate monitoring and adaptive management.

We used Pennsylvania Natural Heritage's Pennsylvania Community Prediction Tool for Site Restoration (https://www.naturalheritage.state.pa.us/RestorationTool.aspx) to recommend appropriate native communities that could serve as targets for management of trailside vegetation. This tool matches site conditions based on selected data points in a geographic information system to a large sample of vegetation communities throughout the state. Based on this tool, the best-matching, native-dominated, forested reference communities are as follows:

a. Sycamore floodplain forest (most flooded)
https://www.naturalheritage.state.pa.us/Community.aspx?=16025

b. Silver maple floodplain forest (somewhat less flooded)
https://www.naturalheritage.state.pa.us/Community.aspx?=16026

c. Sugar maple - mixed hardwood floodplain forest (less frequently flooded, or for shorter durations)
https://www.naturalheritage.state.pa.us/Community.aspx?=30017

d. Red oak - mixed hardwood forest (never to rarely flooded)
https://www.naturalheritage.state.pa.us/factsheets/16060.pdf

There is a large amount of overlap in the species present in each of these communities. In practice, for a given restoration project, species should be selected from across these communities, taking into consideration factors such as availability from native plant

nurseries, past experience with success rates, ability to protect browse sensitive or deer-preferred plants from deer, among other practical considerations.

Tree species generally have a wide range of climate conditions in which they thrive. Thankfully, many of the native plant species already present in the Pittsburgh region are predicted to continue to perform well in the changing climate we are experiencing. When preparing plant lists, consult with the USDA Forest Service Climate Change Tree Atlas (https://www.fs.usda.gov/nrs/atlas/tree/) to see how provisionally chosen tree species are predicted to fare in the future climate. Shrubs and herbaceous species have not been modeled by this tool. Therefore, consult online range maps and avoid selecting species where Pittsburgh is near the southern to southwestern edge of its range, because Pittsburgh is predicted to become more similar to areas that are currently to our southwest.

When planting day comes, a knowledgeable ecologist, forester, arborist, or landscape architect should direct individual plants to be placed based on the species site preferences.

3. Canopy Cover

Along most areas of the trail, a closed tree canopy is the desired condition. Therefore, areas currently lacking or depauperate in tree canopy should be planted. Oftentimes, these areas are currently occupied by invasive shrub or knotweed thickets. These can be managed to remove the invasive species and plant native trees, low-density shrubs, and herbaceous communities.

Other areas currently consist of mowed trail margins where additional tree planting is possible. A staggered tall tree - small tree approach is recommended (for example, sycamores with pawpaws planted between).

Some areas currently contain invasive tree species. In more wild areas, the main culprit is Tree of Heaven, the primary host of the invasive pest, spotted lantern fly. In cultivated areas, the main culprit is Callery Pear. These should be removed and replaced with native trees.

Occasional open areas diversify the trailside experience and provide opportunities for sun-loving plants, animals, and humans. Location of open areas should be intentionally selected to support specific uses, but overall they should be reduced in prevalence. Wherever possible, areas of mowed lawn should be replaced with a low-growing “no mow” mix of low grasses and forbs. These are not maintenance-free, but can generally be mowed only once to a few times a year.

## Trail Network Standards

### Wayfinding

Our team observed opportunities for improvement regarding wayfinding, or signage that helps trail users to navigate to and through the TRHT network. We recommend that DOMI and its partners clarify trail wayfinding design and placement standards to ensure that those aspects of trail wayfinding are consistent across the network, regardless of who is funding or installing the signage.

### Identification Signage

The TRHT network is an important transportation asset and recreational amenity for city residents and visitors alike. While trail network owners and stewards use the legislatively designated Three River Heritage Trail consistently, appropriately, and with pride, there may not be the same level of clarity among the public given the various formal and informal names used for overlapping portions of the TRHT, including Eliza Furnace Trail and Great Allegheny Passage. Commonly used navigation tools like Google Maps and AllTrails use less formal names, including Strip District Trail and North Shore Riverfront Trail. An effort to work with partners (e.g. GAP Conservancy) and navigation providers (e.g. Google, AllTrails) to communicate a clear, consistent naming convention is needed.

To support maintenance and management, we also recommend installing segment markers that will provide reference points in the field for all of those partners working to ensure the safe and sustainable condition of the TRHT network.

The Pennsylvania Department of Conservation and Natural Resources offers guidance regarding signage design and placement in the following documents:

1. Guidelines for Marking Recreational Trails (2008, https://elibrary.dcnr.pa.gov/GetDocument?docId=1738093&DocName=Trail_Marking_Final.pdf)
2. Pennsylvania Trail Design & Development Principles (2013, https://cdn2.assets-servd.host/material-civet/production/images/documents/Pennsylvania_Trail_Design_and_Development_Principles.pdf)

# 02 Segment Analysis and Prioritization

There are many factors that could influence prioritization of portions of the TRHT for maintenance and management. In order to target and prioritize maintenance and management, the consultant team devised a methodology for segmenting the trail and then prioritizing those segments according to relevant metrics.

Segments were identified according to the following criteria:

1. Numbering starts at 1 closest to The Point and segments are labeled according to which river and bank they're located on (e.g. Allegheny River South 1).
2. Length was limited to a range of 1,000 to 1,500 feet so that issues could be easily identified, even with analog measurement methods (e.g. measuring wheel).
3. Segments are drawn to combine properties that share an owner as frequently as possible.
4. Groups of segments were created to allow users to reference geographies at the most useful scale for a given task.

Field data collected throughout this process are provided on the accompanying map by segment so that users can understand conditions and undertake improvements at that scale. Those data also allow us to prioritize segments for maintenance and management.

During this planning process, a few prioritization schemes were tested and vetted with city staff but were ultimately dismissed. Prioritization was later revisited at the TRHT M&M Plan Implementation Workshop held in May 2025; details of that discussion can be found in Appendix K.

# RECOMMENDATIONS REPORT

This recommendations report consists of a maintenance action plan and a management plan. The former utilizes the primary existing conditions data collected through this process as well as best practices to provide segment-level information that will help DOMI and its trail partners to make the most productive investments in trail maintenance. The latter is built around a roles and responsibilities matrix that parses how all partners contribute to trail maintenance and elaborates on opportunities to further develop communication and capacity for future productivity.

## 01 Maintenance Action Plan

The maintenance action plan consists of the set of deficiencies identified in each trail segment and associated costs to correct them. These costs are broken down by trail segments so as to better understand the needs for specific operations and maintenance activities, but are also aggregated to provide a more practical means of capital improvements planning, budgeting of resources, and fundraising, with different groupings for ecology and for trail-related engineering needs, such as pavement surface, lighting, and structural walls, slopes and fences. The approach to developing these segments, groups, and associated costs are described below.

### Approach

The development of trail segments, groupings, and associated cost estimates was designed to provide a practical and scalable framework for managing the maintenance and improvement of the Three Rivers Heritage Trail (TRHT). This process involved segmenting the trail into manageable lengths, collecting

detailed field data, and categorizing segments based on ecological and engineering needs. The following outlines the key components of the approach:

**Segment Development**

Trail segments were established using a baseline length of approximately 1,000 to 1,500 feet. This metric balances precision with practicality, allowing for effective field data collection using tools such as GPS-enabled devices and measuring wheels. Segment boundaries were adjusted to reflect notable changes in trail conditions, ownership, or adjacent features. This segmentation ensures that localized deficiencies can be documented and addressed systematically, with a focus on actionable outcomes.

**Data Collection**

Fieldwork involved walking the trail network to collect detailed observations, photographs, and GPS data. Notes were taken on surface conditions, structural features such as retaining walls and slopes, lighting, fencing, and ecological factors. By combining this hands-on approach with precise geospatial data, the project team documented nuanced conditions and specific deficiencies that may not have been evident in existing datasets.

**Grouping Methodologies**

Segments were grouped based on distinct criteria to address different aspects of trail management, with tailored strategies developed for ecological needs and trail condition assessments:

- Ecology Groupings: Ecological groupings were determined by adjacency and similarity in features such as vegetation type, canopy cover, and the prevalence of invasive species. By clustering segments with similar ecological characteristics, the city can coordinate restoration and vegetation management efforts more effectively, ensuring continuity across contiguous areas. This approach also allows for prioritization based on ecological risks, such as the invasive species threatening native habitats, or opportunities, such as areas where native species restoration can provide multiple environmental benefits, including improved bank stabilization and enhanced biodiversity.

- Trail Condition Groupings: Groupings for trail condition assessments were determined by evaluating risk factors and overall surface condition in parallel. Risk assessments considered observed correlations between surface degradation and external factors. For instance, a trail segment in overall good condition which is showing early signs of cracks or movement due to a failing adjacent retaining walls, slopes, or drainage issues might still be given a “High” risk factor, despite the trail. This is a natural grouping for prioritizing action and funding. Likewise, a trail segment in poor condition through a flat terrain with no associated safety risks except those posed by the trail condition is another natural grouping. The first group - Good Condition, High Risk - is a high priority segment, with the first action being geotechnical and/or structural inspection. The second group - Poor Condition, Low Risk - is also a high priority, with the logical action being pavement

restoration, either milling and overlay or full depth replacement.

Segments with similar conditions and risks were effectively grouped together to streamline maintenance and repair planning. This method ensures that restoration, maintenance, and capital improvement projects can be efficiently coordinated, addressing both safety concerns and long-term trail performance. By focusing on groupings that combine related conditions and needs, the city can target resources where they will have the greatest impact.

### Risk Assessment

Risk assessments were performed to identify potential correlations between surface conditions and adjacent structural elements, such as retaining walls or slopes. These assessments were observational in nature, as full structural or stability evaluations were outside the scope of this project. Observed risks were categorized as “low,” “moderate,” or “high,” with recommendations for additional inspections where risks were rated as moderate or high. This ensures that areas of potential concern receive further evaluation to support long-term safety and trail sustainability.

### Cost Estimation

Costs to correct deficiencies were estimated for each trail segment by combining:

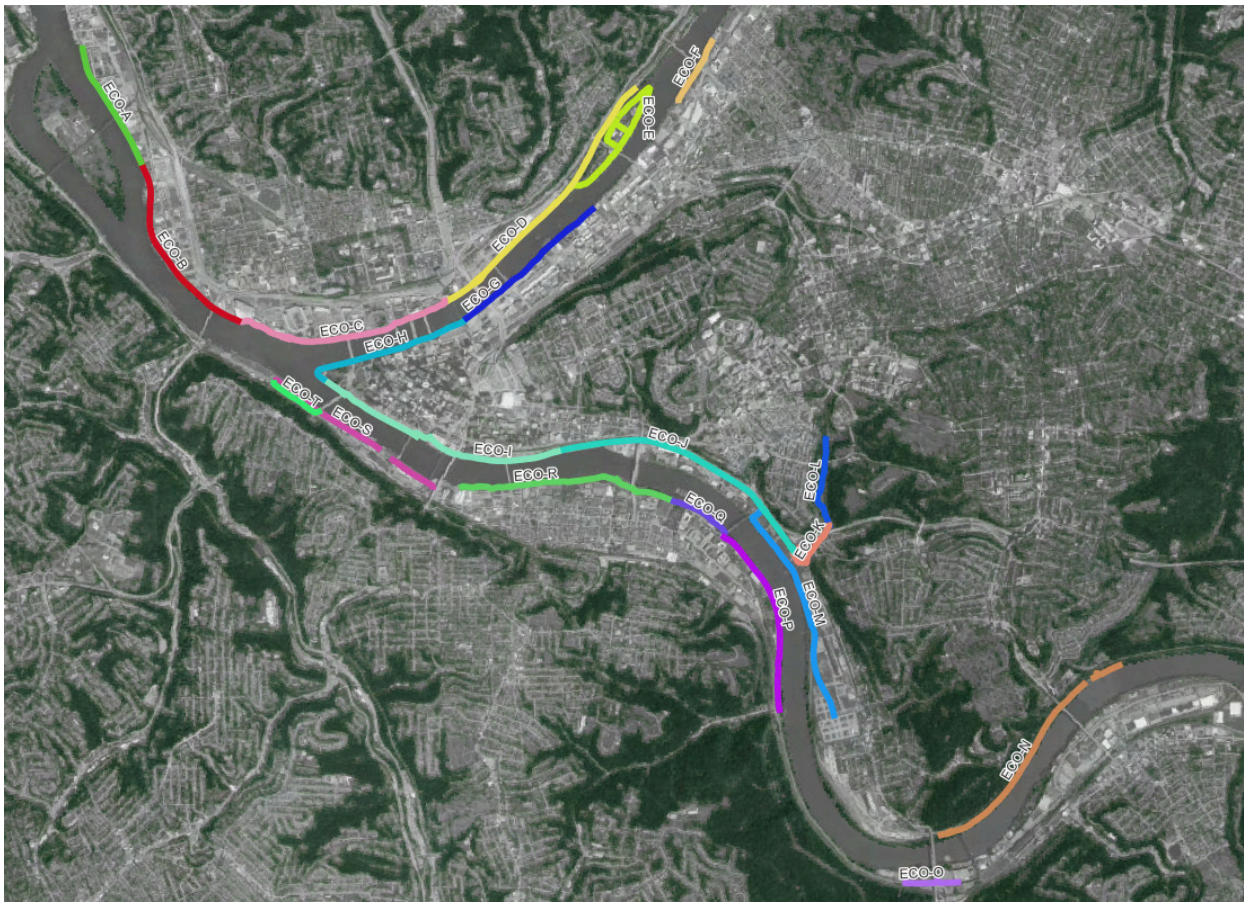
- The quantity of the deficiency (e.g., square feet of pavement requiring resurfacing);
- A condition multiplier, reflecting whether the deficiency was rated as good, fair, or poor; and
- A unit cost, based on industry standards or comparable previous projects.

These cost estimates for both ecology and for trail conditions are detailed for each trail segment in Appendices F and G. Aggregated group costs are also provided here. Please note that cost estimates are not provided for walls or structures as the scope of evaluation in this project was limited to visual assessment and that level of information is insufficient for cost estimation.

If the city chooses to divide these groupings into smaller projects, re-evaluation priorities, or mix-and-match, the individual segment cost estimates provide a clear roadmap for doing so.

## Ecology Groupings

As mentioned earlier, ecological groupings were determined by adjacency and similarity in features such as vegetation type, canopy cover, and the prevalence of invasive species. Based on field observations, aerial mappings, and GIS-based tree canopy assessment, the following map depicts the ecology groupings that were developed for this project. As the map indicates, the grouped trail lengths vary, but typically involve 5-10 segments on average and corresponding lengths from 5,000 to 10,000 linear feet per group. Narrative descriptions of the various Ecological Groupings are provided on the following pages. A more detailed map of each grouping along with the segments comprising it are contained in Appendix E.




### Group A - Ohio River ALCOSAN to Island Avenue

This grouping is defined by a narrow strip of vegetation on the landward side of the trail and a wider strip of vegetation on the river side of the trail, with occasional river access points. There is overall low canopy density with a high density of invasive trees (mainly tree of heaven and white mulberry). Invasive shrub density is low, vines medium (oriental bittersweet, porcelain berry, grape), and invasive herbs high (knotweed). The trail surface is in relatively good condition.

### Group B - Ohio River Island Avenue to Casino

This grouping is defined by a narrow strip of vegetation on the landward side of the trail and inaccessible, steep walls on the river side. There is overall medium canopy cover with a medium density of invasive trees (mainly tree of heaven and white mulberry). Invasive shrub density is medium (Amur honeysuckle), vines low, and invasive herbs high (knotweed, mugwort). The trail surface is in fair condition.

### Group C - North Shore (Casino to Bracken House)

This grouping is defined by a mostly concrete trail (good condition) traversing public and private institutional spaces. There is for the most part very little vegetated buffer, although there are some invasive species in front of the casino and office/apartment buildings on the eastern side of the grouping.

### Group D - Allegheny River Trail

This grouping is defined by a well vegetated buffer extending along the north shore of the Allegheny River from Bracken House to the city limits. There is a narrow, variably vegetated strip between the trail and River Avenue and a wider strip of vegetation between the trail and the river with multiple access points. Canopy density is medium to low, with a medium density of invasive trees (tree of heaven, white mulberry), high density of invasive shrubs (Amur honeysuckle), high density of vines (oriental bittersweet, porcelain berry), and high density of invasive herbs (knotweed, poison hemlock, crown vetch). The trail is asphalt (except a concrete floating section opposite Herrs Island) in good condition.

### Group E - Herrs Island

The trail on Herrs Island is variable width crushed limestone in variable condition due to erosion and vegetation overgrowth. Canopy density is medium to low, with a medium to high density of invasive trees (tree of heaven, white mulberry), high density of invasive shrubs (Amur honeysuckle), high density of vines (oriental bittersweet, porcelain berry, winter creeper), and high density of invasive herbs (knotweed, teasel).

### Group F - Lawrenceville

The Lawrenceville grouping has an overall medium canopy density with medium density of invasive trees (tree of heaven, white mulberry), high density of invasive shrubs (Amur honeysuckle), high density of vines (oriental bittersweet, porcelain berry, wintercreeper), and high density of invasive herbs (knotweed, mugwort). The trail is crushed limestone in good condition.

### Group G - Strip District

Trail composition and condition through the strip, down to the Convention Center is highly variable. On the landward side of the trail, there are occasional narrow strips of somewhat natural vegetation with potential for management. On the river side, the bank mainly consists of relatively inaccessible

retaining walls. Canopy density is variable with medium to high density of invasive trees (tree of heaven, white mulberry, Norway maple), medium to high density of invasive shrubs (Amur honeysuckle), high density of vines (oriental bittersweet, porcelain berry, vinca), and high density of invasive herbs (knotweed).

**Group H - Allegheny River Downtown**

Between the Convention Center and the Point, the trail is concrete without a vegetated buffer on either side.

**Group I - Mon River Downtown**

Between the Point and the Second Avenue Parking Plaza, the trail is concrete or asphalt in variable condition without a vegetated buffer on either side.

**Group J - Eliza Furnace Trail**

Between the Second Avenue Parking Plaza and Eliza Furnace Trailhead Parking Lot, there is a narrow strip of vegetation on each side of the trail. Canopy density is low with high density of invasive trees (tree of heaven, callery pear), high density of invasive shrubs (Amur honeysuckle), low density of vines , and high density of invasive herbs (knotweed, narrowleaf cattail, teasel). The trail is asphalt in good condition.

**Group K - Panther Hollow Connector**

Between the Eliza Furnace Trailhead Parking Lot and Schenley Park (to the parking lot), the trail consists mainly of sidewalks along roads and asphalt connectors through neighborhood parks. Patches of vegetation on the uphill side (between the trail and railroad) are characterized by low canopy density, low density of invasive trees, shrubs, and vines, and high density of invasive herbs (knotweed).

**Group L - Panther Hollow**

The trail in Schenley Park is asphalt in good condition. Canopy density is low with low density of invasive trees and shrubs. Invasive vine density is high (porcelain berry) and invasive herb density is high (knotweed). It is assumed that vegetation management along this section of trail within Schenley Park is the responsibility of DPW Parks Division, not DOMI, so costs are not calculated for vegetation management.

**Group M - Hazelwood Trail**

The Hazelwood Trail consists mainly of crushed limestone between Hot Metal Street and Blair Street and sidewalk along Blair Street to Second Avenue. Canopy density is low with low density of invasive trees. Invasive shrub density is high, but only adjacent to the parking lot at Hot Metal Street, where there is an extensive hedge of burning bush (aka winged euonymus). Invasive vine density is low and invasive herb density is high (knotweed, mugwort).

### Group N - Duck Hollow Trail

The Duck Hollow Trail extends from Sickle Street to Nine Mile Run in Duck Hollow. It is characterized by an asphalt trail in variable condition with wide vegetated buffers on both sides of the trail (defined by the river on one side and a railroad on the other). Despite extensive wooded reaches, overall canopy density was rated as low with high invasive tree density (tree of heaven, white mulberry), high density of invasive shrubs (Amur honeysuckle, medium to high density of vines (porcelain berry, oriental bittersweet), and high density of invasive herbs (knotweed, mugwort).

### Group O - Hayes

The small section of trail in the City of Pittsburgh's Hayes neighborhood lacks a vegetated buffer.

### Group P - Water Street

This grouping extends from Hot Metal Street to the city limits at Becks Run Road. It is characterized by an asphalt trail in good condition, narrow vegetated strip between the trail and Water Street, and variable vegetated strip on the river side. Overall canopy density is low with high density of invasive trees (tree of heaven, white mulberry), high density of invasive shrubs (Amur honeysuckle), medium to high density of vines (porcelain berry, oriental bittersweet), and high density of invasive herbs (knotweed, mugwort).

### Group Q - South Side Works

The trail through South Side Works is concrete with a minimal vegetated buffer except in maintained landscape plantings. Overall canopy density is low with medium density of invasive trees (tree of heaven), low density of invasive shrubs, medium density of vines (porcelain berry), and medium density of invasive herbs (knotweed).

### Group R - South Side

This grouping consists of the trail from the Marina at South Side Works to the Color Park. The river side of the trail mainly consists of a narrow vegetated buffer defined by high retaining walls and the landward side is defined by the railroad. Overall canopy density is medium with high density of invasive trees (tree of heaven, white mulberry), high density of invasive shrubs (Amur honeysuckle), low to high density of vines (porcelain berry), and high density of invasive herbs (knotweed).

### Group S - Station Square

This grouping consists of the trail of variable composition and condition mostly without a vegetated buffer.

### Group T - Duquesne Incline connector

This grouping consists of the sidewalk connecting the Duquesne Incline to the Fort Pitt Bridge.

## Trail Condition Groupings

Trail condition groupings were developed to address the specific maintenance and repair needs of the trail, focusing on observed surface conditions and associated risks. Unlike the ecology grouping, trail condition groups are not adjacent, but instead represent differing priority ratings and next step actions. These groupings allow for efficient coordination of resources, ensuring that segments with shared maintenance priorities are addressed together, whether in the same fiscal year, under the same grant funding, or by the same structural inspection contractor. Factors influencing these groupings include pavement condition ratings (e.g., good, fair, poor), visible defects such as cracking or displacement, and external risk factors like poor drainage or adjacent slope or wall instability.

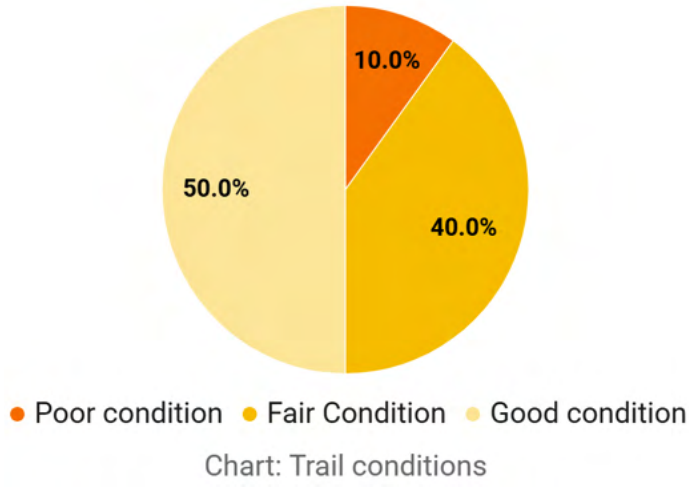


Chart: Trail conditions

The resulting map illustrates the trail condition groupings developed for this project, highlighting areas with similar needs for surface repairs, drainage improvements, or slope stabilization. A narrative description of each grouping and its specific maintenance priorities is provided on the following pages, detailing how these groupings contribute to a more targeted and efficient approach to trail management.

### Poor to Fair Condition, High Risk

Trail segments categorized as Poor to Fair, High Risk tend to have worn or uneven surfaces that may show cracks, potholes, or drainage issues. Despite already suboptimal pavement or gravel conditions, the overarching concern here is geographic or structural risk factors—steep slopes, unstable soils, eroded embankments, failing retaining walls, or other hazards that jeopardize both the trail and user safety.

Even though the surface condition by itself warrants repairs or resurfacing, the greater priority is mitigating the high-risk environment, which may include the potential for landslides or collapses. Because these risks could have costly or dangerous consequences, dedicated geotechnical or structural engineering inspections are strongly recommended. Those evaluations should identify immediate stabilization measures—such as reinforcing embankments, improving drainage, or repairing retaining walls—before any routine surface or aesthetic upgrades occur.

### Fair to Good Condition, High Risk

For Fair to Good, High Risk sections, the trail's actual riding or walking surface is relatively serviceable—users may notice only mild cracks or infrequent rough patches. However, 'high risk' still signals significant underlying geotechnical or structural vulnerabilities that outweigh the decent surface condition. Slopes, bedrock conditions, and retaining walls in these areas may be susceptible to failure, or there may be a documented history of landslides, streambank erosion, or flood risk. Because such factors can rapidly degrade even a good trail surface, proactive measures are a must.

Engineering inspections should focus on identifying critical concerns that could undermine the trail's foundation or endanger users. Repair priorities might include stabilizing embankments, reinforcing culverts or drainage ditches, and scheduling frequent monitoring to detect early warning signs of slope movement or erosion.

### Good to Excellent Condition, High Risk

Even on a Good to Excellent, High Risk segment—where the pavement or trail bed is smooth, well-maintained, and offers a comfortable user experience—the surroundings may contain significant geotechnical and/or structural threats. These might include steep or unstable hillsides looming over the trail, aging or undersized retaining structures, or areas with known landslide histories. Although users will appreciate the superior riding and walking conditions, those conditions can deteriorate quickly if a slope fails or if heavy rains cause unexpected erosion. Accordingly, these stretches require prompt geotechnical assessment and possibly preventive measures, such as installing rockfall barriers, strengthening retaining walls, or improving drainage

to mitigate flood or runoff risks. The key message is that excellent surface quality does not negate an elevated hazard posed by the environment itself.

### Poor to Fair Condition, Moderate Risk

Segments rated Poor to Fair, Moderate Risk have noticeable surface defects—small cracks, unevenness, or suboptimal pavement—but the overall threat from geology or structures is less severe than in high-risk areas. Still, 'moderate risk' suggests either initial observations or potential for slope instability, minor retaining wall movement, or moderate erosion that could worsen over time.

Periodic inspections are advisable, although they may not be as urgent or frequent as in high-risk segments. In many cases, the recommendation involves scheduling geotechnical and structural checks on a routine basis—perhaps annually—while also addressing surface deterioration. By combining targeted repairs (e.g., patching holes, grading gravel) with preventive slope management (e.g., clearing vegetation, improving ditching), these areas can often be stabilized in a cost-effective manner.

### Fair to Good Condition, Moderate Risk

In the Fair to Good, Moderate Risk category, the trail surface requires only modest attention—perhaps sealing small cracks, ensuring proper drainage, or refreshing signage. Although the risk from steep slopes or structural failures is not deemed high, there are still enough geographical or environmental factors (e.g., mild slope, partial erosion) to warrant occasional monitoring. Ideally, staff or consultants would conduct scheduled geotechnical reviews to confirm that retaining walls, slopes, or river embankments remain stable. If early indicators of trouble—like hairline cracks in concrete or small landslides—are identified, the trail can be proactively reinforced. By addressing moderate hazards before they escalate, you maintain user safety and avoid more expensive emergency interventions later.

### Good to Excellent Condition, Moderate Risk

A Good to Excellent, Moderate Risk trail is inviting for users: its surface is typically smooth, with good drainage and few visible flaws. Nevertheless, certain environmental or structural conditions—perhaps moderate slopes or creek embankments—pose some risk of damage over time. While the area does not demand immediate large-scale stabilization, the prudent course is to keep up routine inspections and remain vigilant for telltale signs of slope shifts or erosion. Occasional surveying and minor preventive work (e.g., shoring up small washouts, clearing debris from culverts) can help maintain both the high-quality trail surface and the underlying stability. Compared to high-risk zones, the urgency is lower, but the commitment to periodic checks remains vital to sustain excellent conditions into the future.

### Poor to Fair Condition, Low Risk

Where a segment is labeled Poor to Fair, Low Risk, the most pressing issues tend to be surface-level. Potholes, cracking asphalt, worn gravel, and inconsistent grading are common, but the broader environmental and structural setting is relatively stable—there are no major steep slopes or failing retaining walls. Consequently, there is not a significant safety or infrastructure hazard looming, but these poor conditions can still hamper users' experience. The recommended approach is to prioritize surface repairs or resurfacing—improving the ride quality, drainage, and aesthetic.

Geotechnical monitoring may be minimal here; however, standard best practices (like ensuring drainage ditches are clear or that small banks remain stable) still apply. A proactive maintenance schedule can effectively raise the trail to a fair or better condition without high-cost engineering interventions.

**Fair to Good Condition, Low Risk**

In Fair to Good, Low Risk sections, the trail is generally comfortable for most users, with only minor roughness or small cracks to address. Low risk means there are no major red flags—such as steep embankments or chronic flood zones—that require urgent geotechnical attention. Maintenance focuses on preserving the decent surface condition and preventing minor issues from compounding over time. Strategies may include crack sealing, patching isolated damage, and ensuring adequate drainage. Although this category is not prone to large-scale structural failures, standard inspections—particularly after extreme weather—help confirm that there are no emerging hazards. Maintaining these segments in fair-to-good condition is typically straightforward, requiring less capital investment than higher-risk or more heavily degraded areas.

**Good to Excellent Condition, Low Risk**

Good to Excellent, Low Risk trail segments exemplify the most favorable combination of quality and safety. The tread is smooth and stable, while the surrounding environment has no noteworthy slope or structural threats. Riders and pedestrians can fully enjoy the trail with minimal disruptions or hazards. The main management goal is routine upkeep—sweeping, checking for surface cracks, trimming vegetation—and occasionally verifying that drainage systems work as intended. Though these segments need the least intense oversight, basic monitoring ensures they remain in excellent condition for the long term. Inspectors should still watch for early signs of wear or unexpected erosion, but this category rarely requires major interventions, allowing resources to focus on more vulnerable sections elsewhere.

## Projected Time Frames

As of the conclusion of this planning process, existing conditions  are the only basis for prioritizing the different segments into short-term (0-5 years) and long-term (6-10 years) projects (i.e., the need for maintenance being inversely proportional to the severity of deterioration). Data collected throughout this process are provided on the accompanying map by segment so that users can understand conditions and undertake improvements at that scale.

As noted previously, a few prioritization schemes were tested and vetted with city staff during this process but were ultimately dismissed.

### Costs for Maintenance, Replacement, and/or Installation of New Infrastructure

Costs for repairs, replacements, and new infrastructure are provided by segment and by groupings of segments as described above (Appendix F).

In addition to these capital costs, part of the operating budget should be allocated to routine monitoring, maintenance, and adaptive management of vegetation. Adaptive management refers to modifying ongoing maintenance activities to address issues that arise as they are detected (e.g., new invasive species outbreaks, storm damage, etc.) with the aim of avoiding major capital costs in the future by addressing issues when they are still small. Vegetated buffers on one or both sides of the trail are generally limited by the river itself and adjacent infrastructure. In total, there are approximately 113 acres of vegetation across the entire TRHT system within the City of Pittsburgh. We estimate a cost of $150/acre/year for monitoring, routine maintenance, and minor adaptive management (e.g., spot treatment of small invasive species populations, reseeding small bare areas by hand, and identifying larger issues that need greater attention or funding). With all trail segments (vegetated and non-vegetated) monitored annually, this totals $16,950/year.

#### Funding Streams to Support Priorities

Historically, the City of Pittsburgh could access a number of regional, state, and federal funding sources to support its operating and capital budgets for trail-related needs. While the statuses of federal grant programs are unknown at the time this report is being drafted, several other reliable sources remain available for future TRHT investment; these opportunities are listed in Appendix G.

## 02 Management Plan

As noted in section 01, one key goal of the TRHT Maintenance and Management Plan is to clarify roles and responsibilities among trail partners. There are two City of Pittsburgh departments and two independent nonprofit organizations involved in managing the daily maintenance of the TRHT: The Department of Mobility and Infrastructure, Department of Public Works, Friends of the Riverfront, and Riverlife. There are a handful of other public property owners that contribute to the maintenance of their respective portions of the trail (e.g., Buncher, Sports and Exhibition Authority, PA Department of Conservation and Natural Resources, etc.). In addition, there are several nonprofits that contribute to trail maintenance on an ad hoc basis by providing materials, labor, or advocacy for both. Among these many entities (DOMI, DPW, FOR, Riverlife, etc.), there are well-intentioned, useful efforts to contribute to short- and long-term trail maintenance but further clarity of roles and responsibilities will contribute to greater productivity of those efforts.

This management plan lays out the trail assets that need to be maintained, the levels of responsibility that a partner may have for maintaining a particular asset, and provides a matrix indicating the level of responsibility of each partner for each asset. Importantly, our efforts to understand, organize, and articulate

a way forward for TRHT M&M revealed additional opportunities for communication and capacity that would further improve trail M&M.

## Assets Maintained

Our team identified and considered the following assets for maintenance when evaluating the recommended roles and responsibilities for trail partners:

| | | |
|---|---|---|
| Bollards | Lighting* | Trail surface* |
| Bridges | Retaining walls* | Trash / cleaning |
| Fencing * | Signing + pavement marking | Trees |
| Invasive species* | Traffic signal | |

**Existing conditions data were collected as part of this project.*

These elements of the trail environment requiring maintenance can be simplified into the following categories, which align with the technical expertise needed to support their ongoing care.

| | |
|---|---|
| CLEAN + SAFE<br>Trail surface<br>Trash / cleaning | HABITAT<br>Invasive species<br>Trees |
| STRUCTURES<br>Bridges<br>Fencing<br>Retaining walls | TRAFFIC<br>Bollards<br>Lighting<br>Signing + pavement marking<br>Traffic signals |

There are two types of maintenance activities that are necessary to preserve a high-quality trail environment: routine maintenance and remedial maintenance. American Trails defines those activities as follows[2]:

> *Routine maintenance refers to the day-to-day regimen of litter pick-up, trash and debris removal, weed and dust control; trail sweeping, sign replacement, tree and shrub trimming and other regularly scheduled activities. Routine maintenance also includes minor repairs and replacements such as fixing cracks and potholes or repairing a broken handrail.*
>
> *Remedial maintenance refers to correcting significant defects as well as repairing, replacing, or restoring major components that have been destroyed, damaged, or significantly deteriorated during the life of the project.*

[2] Searns, Robert. (2018, February). *Operations, Maintenance, and Stewardship 101.* American Trails. https://www.americantrails.org/resources/operations-maintenance-and-stewardship-101

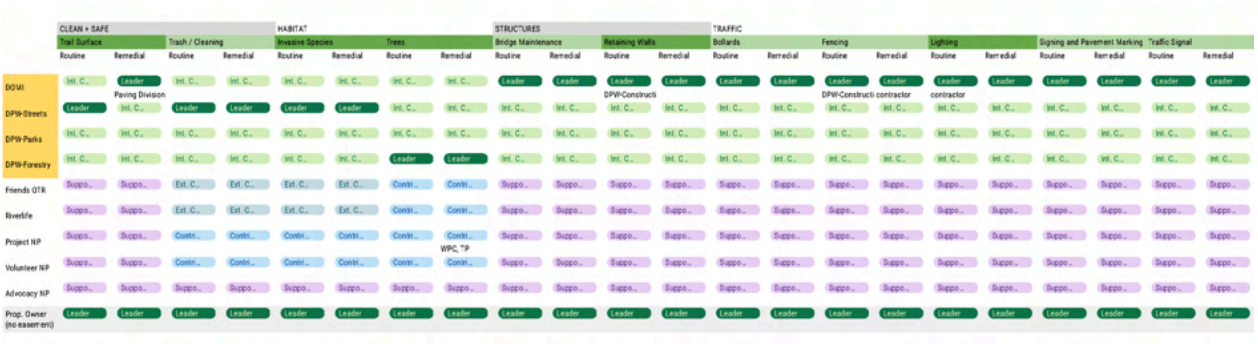
## Levels of Responsibility

| | RESPONSIBILITIES: | legal / liability | public accountability | licensed (via agreement) | funded | informed |
|---|---|---|---|---|---|---|
| **ROLES** | **description** | | | | | |
| Leader | owner-maintainer or easement-holder | X | X | n/a | X | n/a |
| Int. Collaborator | other maintainer within owner/easement-holder | X | X | n /a | X | n/a |
| Ext. Collaborator | elective maintainer - ongoing | n/a | n/a | X | X | X |
| Contributor | elective maintainer - ad hoc | n/a | n/a | n/a | X | X |
| Supporter | maintenance advocate | n/a | n/a | n/a | n/a | X |

## Roles by Items Maintained

Having defined the various roles that trail partners may fill in the ongoing or ad hoc maintenance of the TRHT, we applied those roles across the elements of the trail environment that have been identified as in need of maintenance. This resulted in a detailed chart that is provided in a larger, more legible format in Appendix H. The chart represents the recommended roles for each partner, or category of partner, based on input received from interviews with those partners.

Our team consistently heard from trail partners, including City of Pittsburgh staff, that the city should be the primary party responsible for trail maintenance. Thus, a city department or division is assigned the leader role for each maintenance activity within the following chart. (An enlarged matrix can be found in Appendix H.)



## Additional Opportunities

The research necessary to complete the roles and responsibilities matrix above revealed additional opportunities, above and beyond providing this clarity regarding roles and responsibilities, for the City of Pittsburgh and its trail partners to better coordinate and more effectively conduct the M&M of the TRHT. The low-hanging fruit among these additional opportunities is support for changes that are already under consideration and don't require many additional resources to execute.

### Process Improvement

The Pittsburgh Department of Public Works (DPW) Construction Division (CD) is already considering a formal process by which it would take requests for labor from other city departments. The CD has long been a resource for completing projects of certain scopes and scales but the lack of a specific process to operationalize that resource has led to inefficiency (e.g. department directors being pulled into routine decisions). We recommend that DPW develop this process in consultation with its peer departments to maximize its effectiveness.

### Understanding Capabilities and Capacity

It is clear from our research that there are opportunities for improved understanding of each other's capabilities and capacity among trail maintenance partners. In other words, one partner may not know all of the skills, tools, etc., that another partner possesses. In other cases, partners may over- or underestimate the capabilities or capacity of other players. These information gaps can lead to decisions or inaction based on false assumptions. Capabilities and capacity are qualities that can shift over time with staff turnover and budget changes. We recommend that DOMI make an explicit effort to ensure a deeper, shared understanding of the capabilities and capacity of trail partners on at least an annual basis.

### Understanding Communication

Communication can't be taken for granted as fundamental to the complex coordination necessary to ensure efficient and effective TRHT M&M. Nor can we take for granted that other organizations and individuals communicate most effectively in the same ways we do. To maximize the productivity of communication that facilitates TRHT M&M, we recommend that all trail partners explicitly address communication methods in an effort to achieve consensus that will create consistency in future communications. This can be confirmed or updated in the semiannual meetings recommended below.

### Communications Channels

While there are some established recurring meetings among some trail management partners, we have heard from many partners that communications channels regarding TRHT M&M could be more effective. The effectiveness of communication will certainly be enhanced by implementing some of the other recommendations here so identifying the most useful configuration of communication channels may be an iterative process. That said, we recommend that DOMI convene all trail

partners (all stakeholders from this planning process) on a semi-annual basis at minimum, with a focus on capital planning.

### Ecology Manager

In nearly all cases, the city is primarily responsible for M&M of the ecological assets (e.g., vegetation, tree canopy, habitat, etc.) along the TRHT. However, the city's capabilities are limited to forestry and its capacity in that division is limited relative to need. DPW has considered adding a landscape manager position that could support its streets, parks, and forestry teams along the TRHT. The expertise to help city staff and nonprofit partners manage invasive species would contribute to the city's overall effectiveness in M&M. This landscape manager would oversee or conduct routine monitoring as identified in this plan and coordinate the other recommended actions, such invasive species removal and replacement with native vegetation. We recommend that DPW take steps to establish this position with support from its trail maintenance partners. The person filling this position should have education and experience in ecology or natural resources management, including management of invasive species and vegetation restoration. In lieu of a city employee performing this role, the landscape manager position could be contracted to an appropriate firm or nonprofit partner.

### Trail Manager

The City of Pittsburgh is designated as the leader across maintenance of all TRHT assets and DOMI is the city department with the greatest number of assets under its purview. However, the variety of assets indicated in the management matrix fall to at least six different city divisions across two departments. These six city entities then must coordinate with another dozen or so external organizations involved in some aspect of TRHT M&M. There is no central point of contact or convener at the city for trail issues, nor is there anyone responsible for being informed on the full picture. Trails are currently a very small slice of a lot of different peoples' jobs, resulting in them being a priority for no one in particular. We recommend that DOMI establish a trail manager position to lead this coordination; it would be ideal for this position to supplement the capacity already in place at DOMI but designating a leader among existing staff would still be progress.

### Technology and Data

The effective maintenance and management of the TRHT would benefit greatly by embracing a modern approach to technology and data management. While legacy solutions like paper records, spreadsheets, and standalone databases have provided foundational support over the decades, they often fall short in meeting both the proactive needs—such as long-term maintenance planning, preventative repair strategies, and trail user safety assessments—and the responsive demands, including addressing immediate repairs, mitigating hazards, and fostering real-time engagement with trail users. Advances in data collection, analysis, and management tools offer the city an opportunity to transition to more integrated and efficient systems.

That said, it is not simply about adopting new technologies; the real value lies in leveraging them to enhance situational awareness and support more informed decision-making. By systematically collecting and managing data—ranging from trail usage patterns to environmental impacts—the city can proactively address maintenance needs, optimize resource allocation, and plan for future improvements. This shift toward data-driven strategies will help ensure long-term sustainability, safety, and functionality of the TRHT while delivering a better experience for all users. The recommendations below outline ways to enhance existing practices and explore new opportunities for innovation.

Towards More Systematic Record-Keeping and Data Integration

Effective management of the TRHT requires a thoughtful and coordinated approach to data collection and integration, shared among DPW, DOMI, and trusted nonprofit partners. These groups collectively play a critical role in ensuring trail operations and maintenance (O&M) activities are planned and executed efficiently. A well-structured data system can help identify the true aggregate costs and efforts associated with city staff, nonprofits, volunteers, and competitively bid contractors, offering a clearer picture of the resources needed to sustain the trail. Additionally, the city should consider a shift in tracking O&M tasks, moving away from viewing them as isolated events and instead associating them with specific trail segments. This approach, using the findings of this TRHT assessment as a foundation, can be supported by enhancements to the city's ArcGIS Online system, creating a dynamic tool for record management and future planning. Specific recommendations include:

- Auditing and Refinement of Existing Data Systems: The City should consider an audit of data collection practices within its Cartegraph system to ensure alignment with the specific needs of trail management. While Cartegraph is a powerful tool capable of managing extensive data, its effectiveness depends on the thoughtful design of data structures and relationships. Data normalization should be prioritized to ensure consistency across records, and staff should receive training to maintain data accuracy, completeness, and relevance.

- Augmenting Existing Data: Expanding data collection to include critical elements such as construction history, usage metrics, and potential vulnerabilities would enhance the city's understanding of the TRHT's long-term performance. Capturing information like construction dates, material specifications, subsurface drainage conditions, and traffic volumes for each segment creates a comprehensive baseline for maintenance planning. Additionally, documenting areas prone to adverse conditions, such as poor drainage or slope instability, would allow the city to prioritize interventions and prevent recurring issues. These enhancements ensure that data remain accessible, actionable, and aligned with long-term decision-making.

- Aggregating Costs Across All Resources on a Per-Segment Basis: Understanding the full scope of trail maintenance efforts requires comprehensive tracking of costs and contributions across all entities involved. This includes the labor and materials provided by city staff, the support of nonprofits and volunteers, and the work completed by contractors through competitive bids. Aggregating these costs into a unified system will provide greater transparency and support strategic budgeting for both operations and capital planning. Rather than documenting maintenance tasks as isolated events in Cartograph, the City should associate all activities with specific trail segments. This segment-based approach allows for a clearer understanding of patterns and trends in maintenance needs, as well as more precise planning for future interventions. The segment framework established in this TRHT assessment provides an ideal foundation for organizing O&M records going forward.

- Developing Statistical Roll-Ups for Planning and Decision-Making: To inform long-term planning, the City should implement statistical roll-ups of O&M activities. For example, being able to query specific unit costs like resurfacing, full-depth reconstruction, patching, crack repair, and other tasks over an extended time period would enable the identification of trends and calculation of metrics such as maximum, minimum, average costs, as well as help to identify outliers in future bids. This approach, similar to PennDOT's use of its ECSM system, would help guide investment priorities and optimize resource allocation.

- Enhancing ArcGIS for Trail Management: The city's ArcGIS platform and the map tools developed for this project offer an opportunity to integrate spatial data with O&M tracking over time. Upkeep and enhancement to this system could be used to track ongoing trail condition, defects, and activity, linking segment-specific data to interactive maps, and allowing stakeholders to visualize trail conditions, past maintenance efforts, and planned projects. This would create a user-friendly tool for monitoring the health of the trail network and ensuring informed decision-making - a sort of digital twin for advanced infrastructure management.

The Evolving Role of GIS and Emerging Technologies in Trail Management

The City of Pittsburgh has already made significant strides in leveraging Geographic Information Systems (GIS) as a cornerstone for managing the TRHT. Through this project, the city's existing GIS platform and data set were enhanced with trail-specific data layers, including detailed information on trail segments, adjacent walls and slopes, surface materials, geometry, ecological features, surface condition assessments, and specific defect descriptions. These enhancements provide a robust framework for visualizing and analyzing trail conditions, enabling informed decision-making about maintenance, repairs, and resource allocation. For example, these tools allow the city to identify patterns, such as clusters of deteriorating trail segments or areas vulnerable to environmental stress, including poor drainage or unstable slopes. By continuing to refine these layers and

integrating them with ongoing trail assessments, the city can use GIS as a dynamic tool for both day-to-day management and long-term strategic planning. Enhancements to the ArcGIS platform, including public-facing interactive map views, could further empower stakeholders to monitor and manage the trail network in real time, fostering transparency and collaboration.

Emerging technologies such as real-time monitoring (IoT), and digital twins offer exciting opportunities to complement and expand upon the GIS foundation over time. The city has already explored the use of sensors for specific challenges, such as understanding trail usage, supporting post-storm cleanup planning efforts, and monitoring landslide risks. These efforts could extend to other aspects of trail management, as well as for more permanent installations of pedestrian and bicycling counting systems. IoT devices such as these could provide real-time data on pavement conditions, environmental factors such as rainfall intensity or freeze-thaw cycles, and trail usage patterns, offering actionable insights into trail performance under varying conditions. To maximize the value of these technologies, the data collected should be associated with specific trail segments, creating a detailed and structured understanding of trail health.

Digital twin technology, which creates a virtual model of physical assets, represents a powerful future direction for trail management and is already being explored as part of the 2025 Pgh Lab 10.0 program. By integrating GIS data, real-time data feeds, historical maintenance records, and deterioration modeling methods into a unified system, digital twins could enable predictive maintenance, simulate the impact of environmental and usage scenarios on trail conditions, and provide insights into the long-term performance of various materials and designs. For instance, a digital twin of the TRHT could allow the city to assess increased traffic impacts on specific trail segments or test how different maintenance strategies might extend pavement life. While full-scale implementation of these technologies may take time, starting with small-scale pilot projects on high-priority or heavily trafficked segments could provide valuable proof of concept and position the city as a leader in modern infrastructure management.

# ENGAGEMENT SUMMARY

## 01 Kickoff Meeting

This project began with a kickoff meeting in January 2024, at which the consultant team met with a group of key TRHT stakeholders to discuss the project purpose. The stakeholders provided input regarding the project scope, to ensure its completeness and utility, as well as what information they could provide to facilitate the planning process.

Slides and notes in Appendix I.

## 02 Core Stakeholder Meetings

Early on in the process, DOMI and the consultant team determined that ongoing input from those stakeholders involved in the daily maintenance of the TRHT would be valuable and representatives of the following entities were invited to every other (i.e., monthly) project management meeting with the client: Department of Public Works–Streets Division, Department of Public Works–Parks Division, Friends of the Riverfront, and Riverlife.

## 03 Core Stakeholder Interviews

While not explicitly part of the scope, evolveEA engaged representatives of core stakeholder organizations in informal interviews to build a more robust understanding of the status quo. These conversations occurred at two points in the process; interviews near the beginning of planning were focused on communication and collaboration among core stakeholders and other key entities, and interviews during management plan development focused on understanding each entity's capacity and capabilities. All of this input was used to inform recommendations, primarily within the management plan section of this document, that will help stakeholders overcome existing barriers to efficiency and effectiveness.

Interview participants included:
Alex Toner, Friends of the Riverfront
Bill Crean, Department of Public Works
Chris Hornstein, Department of Public Works
Courtney Mahronich Vita, Friends of the Riverfront
Eric Setzler, Department of Mobility and Infrastructure
Gavin White, Riverlife
Mike Panzitta, Department of Mobility and Infrastructure
Pat Kelly, Riverlife

## 04 Stakeholder Meeting

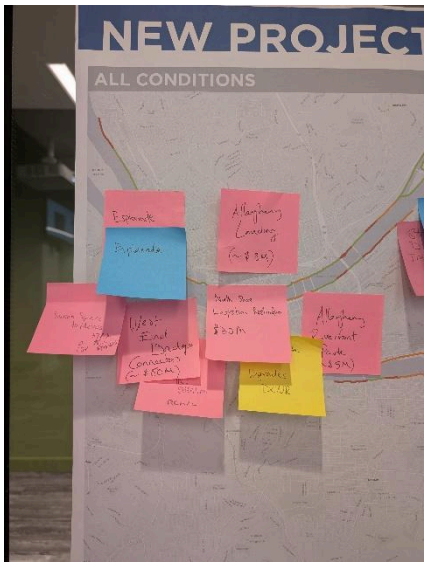
Approximately one year after the kickoff meeting, DOMI and the consultant team invited stakeholders back together in January 2025 for a presentation of the work completed on this project. In particular, the project team sought input on the recommendations and comments received were incorporated into the final report.

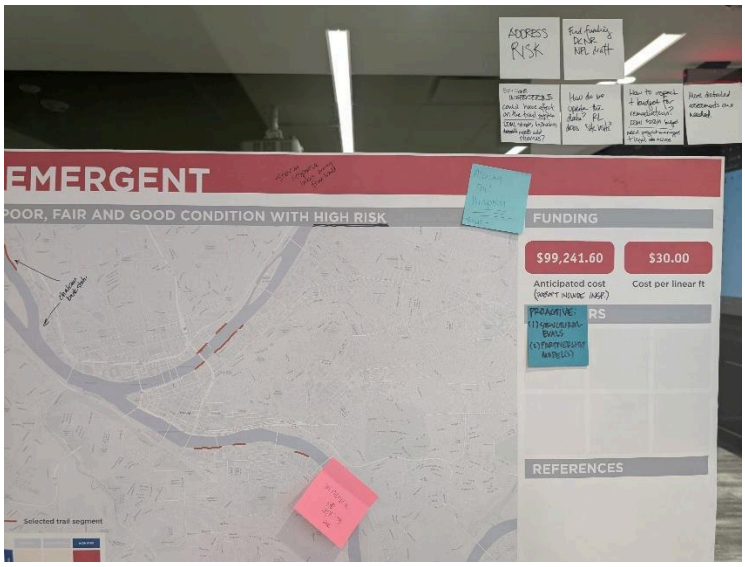
Feedback also included the suggestion of an implementation workshop to further develop how stakeholders would utilize the information provided by the Existing Conditions Report, Best Practices Memo, and Recommendations Report.

Slides and notes in Appendix J.

## 05 Implementation Workshop

In May 2025, evolveEA planned and facilitated an implementation workshop to help stakeholders improve communication, collaboration, project prioritization, and fundraising. More specifically, the event was designed to help participants understand how to use plan materials and identify any gaps that could inhibit implementation, codify a process to identify priority locations for investment, and establish communications protocols to carry forward. With the focus on implementation, stakeholders were invited who have a role in day-to-day operations. crisis decision-making, and investment planning (e.g., budgeting, capital planning, and grantwriting).




Slides and notes in Appendix K.
Coalition coordination materials in Appendix L.