CONCEPTUAL DESIGN REPORT

Wissahickon Reach Restoration

Wissahickon Creek at Chestnut Hill College
Philadelphia, Pennsylvania

April 16, 2024

Pictured: Severe streambank erosion along project reach, February 7, 2024.

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1. PROJECT OVERVIEW

Aterra Solutions, LLC (Aterra), in partnership with SJS Consulting (SJS), has prepared this Conceptual Design Report for Responsible Preservation, Inc. (RPI). The Conceptual Design Report is a key deliverable for Task 1 - Concept Design and Feasibility Package of the Wissahickon Reach Restoration Project. This project encompasses efforts for design and permitting only. Following completion of design, a separate project or amended contract will be needed for construction and engineering services during construction.

1.1. Background

The Wissahickon Reach Restoration project builds off previous efforts to understand existing stream conditions. In 2022, Aterra conducted a hydrologic, hydraulic, and geomorphologic assessment for the reach of Wissahickon Creek bordered by the property of the Sisters of St. Joseph, six private residential properties, and the University of Pennsylvania's Morris Arboretum (Aterra Solutions, 2022). These assessments were initiated by RPI in response to concerns regarding observed degradation of the Wissahickon stream channel. The scope of the initial assessments covered the reach of Wissahickon Creek between Whitemarsh Valley Country Club and approximately 900 feet downstream of the Germantown Avenue bridge. The general objective of the assessment was to identify potential historical and contemporary factors causing the degradation, appropriate restoration techniques, grant/funding programs, and collaborative partners with a common interest in improving the overall health and stability of lower Wissahickon Creek and further downstream into the Schuylkill River.

Following the stream assessment report, RPI retained Aterra to prepare a Pennsylvania Department of Environmental Protection (PADEP) Growing Greener Grant (GGG) application for the design costs associated with restoration project. RPI was awarded the GGG in January 2023 and the final award was negotiated and approved on August 15, 2023. The project includes four primary tasks as listed below:

Task 1 - Concept Design and Feasibility Package
Task 2 - 30% Preliminary Engineering Package
Task 3 - 70% Detailed Design Package
Task 4 - 100% Construction Documents Package

The project competition date for this grant is August 14, 2026.

1.2. Location

The project is located along the Wissahickon Creek in the Chestnut Hill section of Philadelphia, Pennsylvania. The project vicinity consists primarily of suburban development along the Philadelphia and Montgomery County border. Significant open space in the surrounding area includes the Morris Arboretum and Whitemarsh Country Club upstream of the project and a portion of Fairmount Park, owned by the city of Philadelphia, downstream of the project. The closest stream crossings are bridges at Northwestern Avenue between Germantown Avenue and Stenton Ave, the southern half in Philadelphia and the northern half in Montgomery County and Germantown Ave, which is entirely in Philadelphia and is located between Hillcrest Avenue and Northwestern Ave. Figure 1 shows the project location and its surroundings.

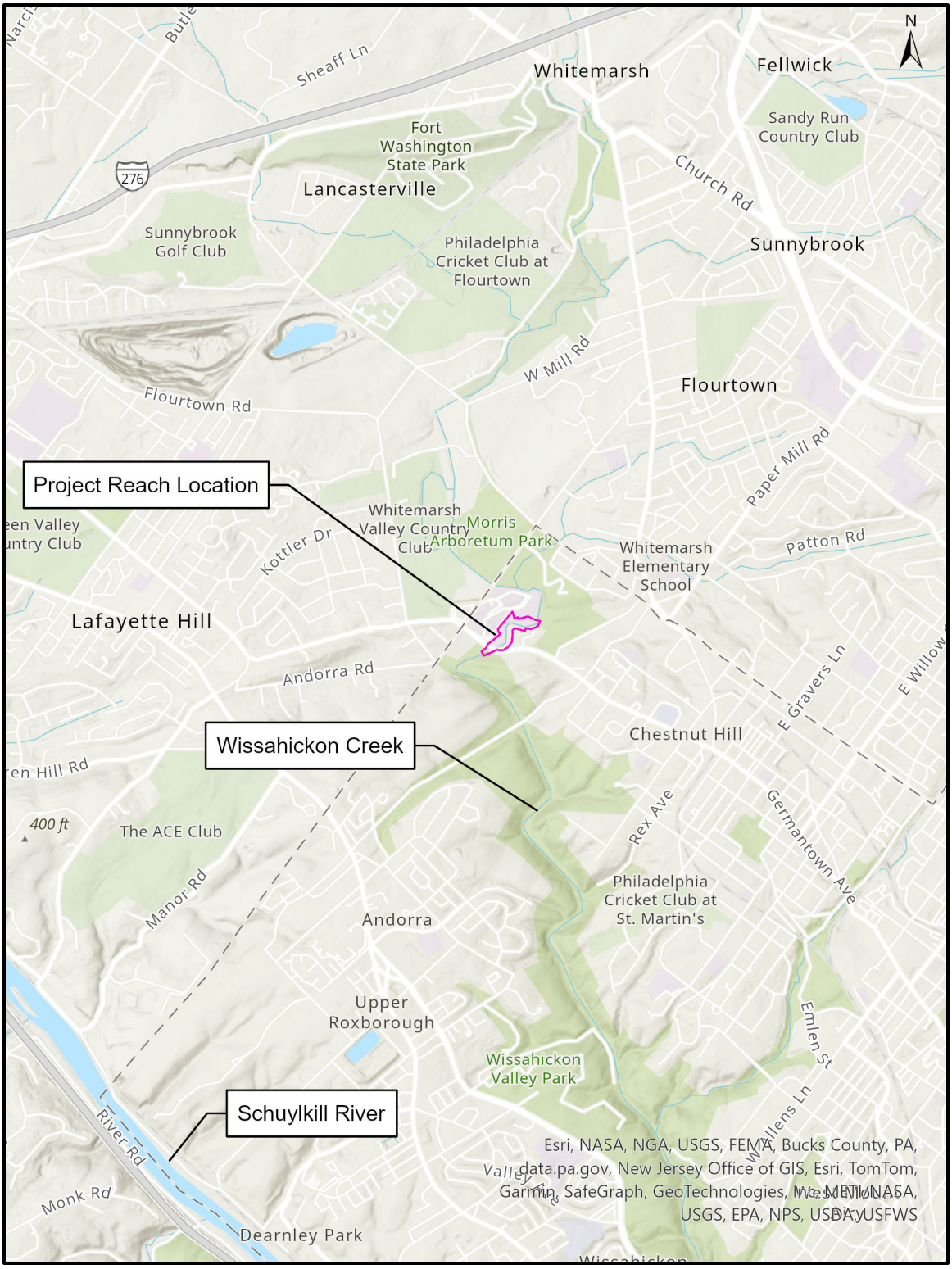

Figure 1: Project Location Map

1.3. Goals

The primary goal of the project is to address existing stream degradation. Measures that arrest current erosion and mitigate future degradation have the auxiliary benefit of improved stream habitat throughout the impaired reach. A secondary goal of the project is to reduce flood frequency. As discussed in Section 1.4, some measures that address stream degradation also have inherent flood mitigation benefits. Additional site improvements to alleviate nuisance flooding are also being explored as part of on-site disposal of excavated materials, also known as spoil.

1.4. Design Approach

The proposed design aims to address existing stream degradation by adjusting the stream channel and floodplain to a naturally stable endpoint. The proposed adjustments include grading of steep streambanks to reconnect the stream to its floodplain and lowering the channel gradient at key riffle locations to artificially advance existing headcuts as the stream seeks equilibrium. The adjustments, however, are balanced with efforts to preserve high quality trees and wetlands, limit disturbances to existing development, and maintain the aesthetics of the stream corridor. Therefore, streambank stabilization measures are proposed where site constraints make geometric adjustments impractical or detrimental. Additional details on specific restoration measures and site constraints are discussed in Section 4.0.

2. EXISTING CONDITIONS

The existing site is primarily located on land owned by the Convent of the Sisters of Saint Joseph (SSJ), who are a key project partner. Chestnut Hill College operates on a majority of the land owned by SSJ and campus facilities account for most of the development within the project site. A small portion of the project encompasses streambank areas belonging to other private landowners (Neighbors) along the creek. The Neighbors have also been included in the design process via stakeholder outreach. With the exception of the ruins of a private dock, there is no development on the Neighbors' properties along the stream.

The project site consists of a 1,500-foot-long reach of the Wissahickon Creek immediately upstream of the Germantown Avenue bridge. This portion of the Wissahickon is severely eroding with bank heights as high as 20-feet and average lateral bank migration rates of 1.8 feet per year between 1996 and 2020. Looking downstream, the area to the left of the creek is primarily wooded with some lawns. The area to the right of the creek begins with a low-lying wooded area and transitions into developed portions of the Chestnut Hill College campus that include tennis courts, parking lots, and lawns that occupy a portion of the lands owned by the Sisters of St. Joseph's together with their convent and related facilities. The right side of the creek ultimately transitions back to a wooded area before reaching the Germantown Avenue bridge. The site primarily drains via surface runoff to the Wissahickon.

In addition to the stream assessment performed by Aterra in 2022, both a topographic survey and geotechnical investigation were performed to define existing site conditions. Utility information was also obtained as part of the topographic survey and through direct coordination with the Philadelphia Water Department (PWD) Ecological Restoration Group (ERG). Background information and results from the existing condition reconnaissance are summarized in the following sections.

The Aterra 2022 study found that in the mid-20th and early 21st century, alterations were made to the site that have exacerbated the special problems now being confronted. The first of these changes occurred in the 1960s when a portion of the Creek channel was cut off, resulting in an increase in stream slope that increases erosion. Second, between 2002 and 2003, the City of Philadelphia replaced the Germantown Avenue Bridge and, in the process, eliminated eight massive piers that functioned as a partial dam and

slowed the water movement. Research into aerial photographs and existing surveys correlate the city / state bridge project with the acceleration of creek bed and stream bank erosion.

2.1. Topographic Survey

A topographic survey of the project site was performed by Aterra's subconsultant, Cedarville Engineering Group, LLC (CEG). Survey limits were based on a request prepared by Aterra, shown in Figure 2. Actual topographic survey limits are shown on the Topographic Base Map, included as Appendix A. In the case of the Hollenbeck property, which has chosen to not participate in the project, the project boundary follows the creek bed while all other property owners between Germantown Avenue and the beginning of the Morris Arboretum are included in the survey and related property.

Figure 2: Topographic Survey Request

Topography and boundary were established by field survey made upon the ground by CEG in November 2023. Property boundary information was obtained from existing deeds and plans of record, without the benefit of a title report. Features located include existing structures, roadways, curbs, driveways, walks, utility poles and utilities, edge of woods, and other features. The Germantown Avenue bridge structure survey included bridge surface and walls, wingwalls, and low chords. Stream cross sections were field surveyed every 200 feet within the survey limits and include channel bathymetry. Note that the stream survey at the upstream end of the survey limits did not access the upland properties along the left streambank, looking downstream. The vertical and horizontal references used were the North American Vertical Datum of 1988 (NAVD88) and the Pennsylvania South State Plane Coordinate (SPC) System, respectively. A correlation to the Philadelphia City Datum as provided by the Philadelphia District Regulator is included in the Topographic Base Map (Appendix A).

2.2. Utility Survey

As part of the topographic survey, CEG originated a Pennsylvania One Call for the project site. A One Call is an online tool that facilitates coordination between project partners and utility companies. Upon

submitting a One Call ticket, utility companies are notified that a project involving excavation is being planned and they can respond by either providing available utility mapping for the area or by sending staff to field mark underground infrastructure locations. The resulting utility information CEG obtained from the One Call is included in the Topographic Base Map (Appendix A).

In addition to the One Call, Aterra worked with PWD to identify key sanitary sewer infrastructure within the project site. PWD performed their own research and field survey in April 2023. Through this exercise, PWD located two sanitary sewer crossings and associated manholes. The information collected by PWD has been incorporated into the Topographic Base Map (Appendix A) and used to inform the stream restoration design. Additional discussion of the associated design impacts is included in Section 4.0.

2.3. Geotechnical Investigation

Geotechnical properties are an important aspect of existing site conditions, especially considering the significant excavation required for this project. As such, an investigation including boring and sampling was required to define subsurface conditions. In addition to the borings and their associated soil mechanics testing, environmental testing was also performed on stream bank samples to help quantify projects benefits resulting from reduced sediment production in restored conditions. The following sections provide a summary of investigation methods and results.

2.3.1. Borehole Drilling and Sampling

To support the restoration design effort, three locations along the stream were characterized (B-01, B-02, B-03) by drilling boreholes 20 feet below ground surface (bgs). Drilling operations occurred on December 8, 2023. Soil samples obtained at these locations were identified in the field and verified by laboratory testing performed by American Engineers Group, LLC (AEG). Borehole locations are presented in Figure 3. Boring logs detailing the soil sampling results at specified depths are presented in Appendix B.

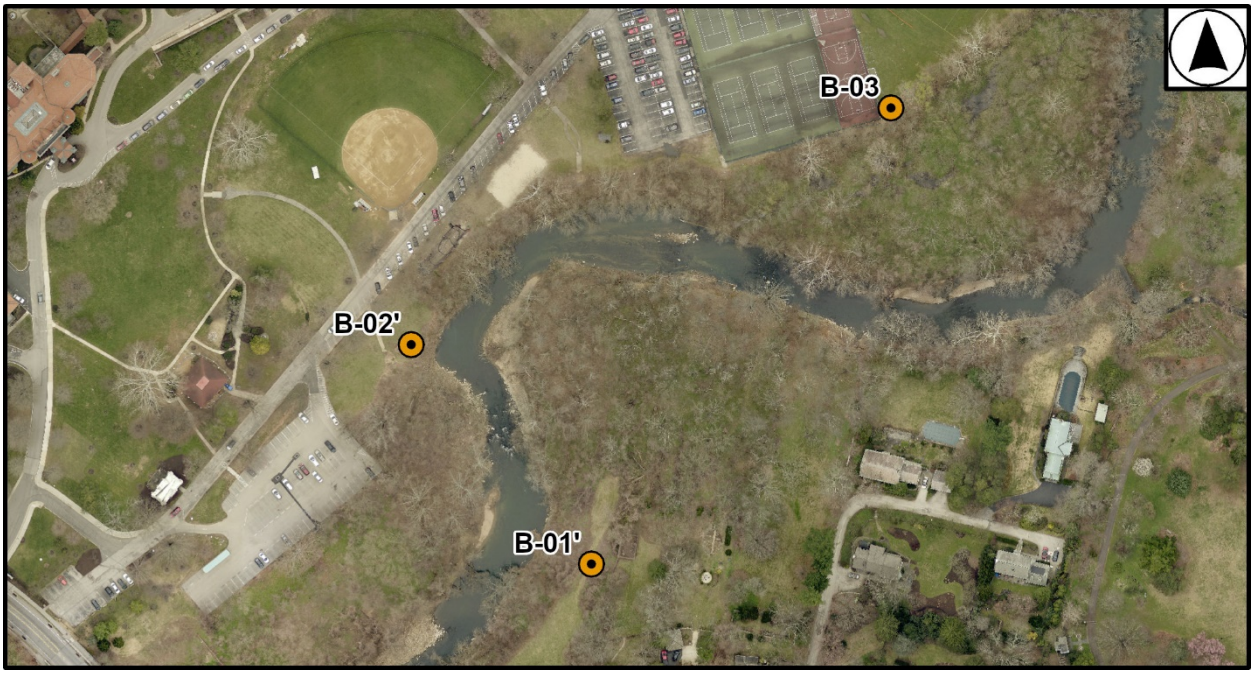

Figure 3: Borehole Locations

Additional soil sampling was performed at locations along the streambank, at the top and foot of the bank, using a manual hammer and beveled steel ring. Samples were then excavated by digging to retain their in-situ density and moisture properties and transferred to the AEG laboratory for bulk density testing of undisturbed samples. Environmental sampling was also performed for streambank soils to test for nutrient concentrations. Pace Analytical provided environmental testing services for these samples. Soil laboratory test results are presented in Appendix B.

2.3.2. Soil Mechanics Testing and Results

Split-spoon soil samples obtained during borehole drilling were assigned the following laboratory tests, performed by AEG:

- USCS Classification with Moisture Content, Sieve with Hydrometer, and Atterberg Limits (ASTM D2487, D2216)

Undisturbed samples obtained manually with hammer and sampling rings were assigned the following laboratory tests, performed by AEG:

- Natural / Bulk Density (ASTM D7263)

Tested soils from boreholes classified as SILT with sand, silty SAND with gravel, and silty SAND according to the USCS criteria. Water contents ranged from 17.52% to 31.41%. Detailed stratigraphy and results are presented in the boring logs.

Bulk density testing results are presented below for soil samples obtained at the top and foot of the streambank in two locations.

Table 1: Bulk Density Test Results

Sample Location	Water Content (%)	Dry Density (pcf)	Wet Density (pcf)
SB-1, Top of Bank	18.72	97.6	115.9
SB-1, Foot of Bank	27.82	92.6	118.4
SB-2, Top of Bank	18.42	97.8	115.8
SB-2, Foot of Bank	34.19	70.9	95.2

For reference, the Growing Greener application had assumed a wet bulk density of 120 pcf. Having laboratory results is crucial for determining pollutant removal credits and quantifying water quality benefits of the proposed project. The results from this testing will be used as part of sediment loading calculations during Preliminary Design. Ultimately, prevented sediment credit can be used to demonstrate projects benefits when pursuing construction funding from regulatory agencies interested in reducing sediment pollution in both the Wissahickon and Schuylkill watersheds.

2.3.3. Environmental Testing and Results

Soil samples were also taken from the top and foot of the streambank at the same two locations for environmental testing. The following tests were assigned to these samples and performed by Pace Analytical:

- Total Phosphorous
- Kjeldahl Nitrogen (TKN)
- Nitrate-Nitrite

Environmental laboratory testing results are presented below:

Table 2: Environmental Testing Results

Sample Location	Total Phosphorous (mg/kg)	TKN (mg/kg)	Nitrate-Nitrite (mg/kg)
SB-1, Top of Bank	222	205	ND
SB-1, Foot of Bank	209	89.1	ND
SB-2, Top of Bank	214	420	ND
SB-2, Foot of Bank	314	1150	ND

For reference, crediting guidelines developed for the nearby Chesapeake Bay watershed reported an average Total Phosphorus concentration of 613 mg/kg and an average TKN concentration of 1548 mg/kg for three streambanks sampled in Pennsylvania. Although the samples from the project reach are lower than those reported, the crediting guidelines note that phosphorus and nitrogen concentrations are highly variable between sites and project specific testing must be done for any credit considerations (Wood, Schueler, & Stack, 2021). As discussed in the previous section, the testing results will be used to quantify project benefits during Preliminary Design and strengthen grant applications for construction funding.

2.3.4. Groundwater Observations

Boreholes were backfilled immediately after drilling; therefore, longer-term stabilized water levels were not recorded. Groundwater levels were estimated by noting the depth at which wet soil samples were encountered during drilling. These water levels are presented in Table 3.

Water levels in the boreholes appeared to be consistent with stream elevations based on the observed (not surveyed) ground surface elevations at each borehole. Any excavation activities at the project site will likely encounter groundwater at or below streambank elevations while digging in the vicinity of the creek.

Table 3: Estimated Groundwater Levels

Borehole Location	Ground Surface Elevation (ft NAVD88)*	Depth to Estimated Groundwater Level (ft below ground surface)	Elevation of Estimated Groundwater Level (ft NAVD88)*
B-01	142.0	18.0	124.0
B-02	127.0	10.0	117.0
B-03	132.0	10.0	122.0

*Exact borehole locations were not surveyed. Field locations were approximately located on survey plan to obtain approximate ground surface elevation.

2.3.5. General Stratigraphy and Anticipated Material Behavior

The soil materials encountered in the three borings drilled at the project site were generally consistent, classifying primarily as either silt with sand or silty sands. These classifications are representative of a loamy material that supports vegetative growth and displays apparent cohesive properties under semi-saturated to saturated conditions. Excavating this material should require standard machine effort, although larger bundled root structures and some gravel pockets may require additional effort in some locations. If this material is compacted properly during re-grading activities, it should support moderately graded slopes without needing additional reinforcement.

Random debris and fill material was encountered from 2' to 8' depth in borehole B-02. This is consistent with the history of this area of the Sisters of St. Joseph's property, where roadway demolition materials consisting of concrete slabs and brick materials were used to fill the former creek bed. This work effectively armors the northern (right) side of the creek. The work was performed in the 1960s as evidenced in dated aerial survey photographs. Excavation activities at this location and anywhere else across the project site where random fill materials may be encountered will require more substantial machine effort. This material will not be suitable as backfill for compaction and re-grading of the streambanks and where necessary should be relocated or disposed of off site.

2.3.6. Bedrock

Bedrock was not encountered during drilling at the project site. Based on the termination criteria for the three boreholes, depth to bedrock should be assumed in most locations to be at least deeper than 20 feet below ground surface.

3. ENVIRONMENTAL AND CULTURAL RESOURCES

In the context of this project, environmental resources refer to existing wetlands, waterways, flora and fauna. These resources were defined through both field observation and desktop analysis. Cultural resources refer to historical structures, districts, and institutions. Only a desktop analysis of cultural resources has been performed at the conceptual design stage. Methodology and findings for identifying both environmental and cultural resources for the project site are discussed in the following sections.

3.1. Wetlands and Waters Delineation

CEG conducted a wetland and water delineation in support of the project on November 2, 2023. The area of interest (AOI) for the wetlands and water delineation was coincident with the survey limits shown in Figure 1. The delineation identified the location, extent, and characteristics of regulated wetlands and waters in accordance with Corps of Engineering Wetland Delineation Manual (USACE Environmental Laboratory, 1987) and the United States Army Corps of Engineers Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region (USACE, 2012). Vegetation, soils, and hydrology were examined for evidence of wetland characteristics. Top of bank/ ordinary high-water mark (OHWM) were field identified to delineate regulated waterways. All field delineation was compared against background data as part of a complimentary desktop analysis.

Four streams and three wetlands were identified within the AOI. Given the nature of the project, impacts to the primary stream, Wissahickon Creek, are inevitable and required coordination with regulatory agencies is discussed in Section 6.0. The design currently avoids all impacts to the identified wetlands

and has potential to create even more wetland areas as part of floodplain reconnection. Regardless of impacts, the presence of wetlands in the vicinity of the project site will require coordination with regulatory agencies as discussed in Section 6.0. A copy of the Wetlands and Waters Delineation Report has been included as Appendix C.

3.2. Pennsylvania Natural Diversity Inventory

Another aspect of determining environmental resources on site is a review of the Pennsylvania Natural Diversity Inventory (PNDI). PNDI information is accessed through the Pennsylvania Conservation Explorer, an online tool maintained by the Pennsylvania Natural Heritage Program (PHNP). PHNP itself is a partnership between Pennsylvania Department of Conservation and Natural Resources (DCNR), the Pennsylvania Fish and Boat Commission (PFBC), the Pennsylvania Game Commission (PGC), and the Western Pennsylvania Conservancy (WPC) in cooperation with the U.S. Fish and Wildlife Service. The Pennsylvania Conservation Explorer facilitates environmental review for project planning, allowing users to screen a project area for potential impacts to threatened, endangered, and special concern species.

PNDI review is a requirement of the project permitting process, as discussed in Section 6.0. PNDI information pertinent to a project area is summarized in a document known as a PNDI receipt. A PNDI review has been initiated using the survey limits shown in Figure 2. The review revealed the potential presence of sensitive species under the jurisdiction of PFBC. This is only a preliminary determination and further coordination with PFBC is required to determine if the project will impact sensitive species. Follow up with PFBC is handled within the Pennsylvania Conservation Explorer interface. The project team will finish the PNDI review process in the Preliminary Design stage. A copy of the draft PNDI receipt with preliminary agency responses is included as Appendix D.

3.3. Tree Survey

In addition to identifying flora as part of wetland characterization, a separate tree survey was conducted by arborist John Verbrugee, a certified arborist for Arader Tree Service, on March 4, 2024. Trees within approximately 100 feet of the creek banks and greater than 20 inches in diameter at breast height (DBH) were assigned a number and marked with metal discs. Trees in questionable health were omitted from the survey with the exception of a red oak close to the creek on the Beyer property and an extremely rare American elm on the southern creek bank along SSJ property. Neither are in optimal positions, but their high value makes them candidates for protection.

In general, the tree survey identified various trees of high value on the Neighbors' and SSJ property. There are some clusters of large hickories on the Rubin and Thomas/Snyder properties. From observation outside the Hollenbeck property, 10 additional important trees were noted along the project reach. On the Chestnut Hill College/SSJ side of the creek there are a number of London planes and American sycamores along the creek. Approximate tree locations with numbers will be referenced onto the design plans during the Preliminary Design Stage.

3.4. Pennsylvania Historical and Museum Commission Review

The primary screening tool for identifying cultural resources on site is the PA-SHARE database, an online tool provided by the Pennsylvania Historical and Museum Commission (PHMC). Using this tool, project planners can initiate an Environmental Review as required by PADEP permitting guidelines. At this point in the design process, the design team has created a project in PA-SHARE to screen for potential resources in the project area. Preliminary resources in the project vicinity include the Chestnut Hill National Register Historic District (NRHD), Chestnut Hill College that is a part of the NRHD, the remains

of the Germantown Avenue Bridge that was demolished c. 2002 with PHMC advice and archaeological testing along Germantown Ave, and finally, on the opposite side of Germantown Ave, the Fairmount Park National Register District and the Wissahickon Creek National Natural Landmark District. The present Germantown Avenue Bridge was built after 2000 and thus is listed as “Not Eligible” for the National Register in the PA-SHARE mapping tool. Other above ground resources older than 45 years in age include the ruins of a pump house that supplied water from the creek for the Mount St. Joseph’s School on the SSJ property. The resource is labeled as “Pump House Ruin” on the Topographic Base Map (Appendix A). The concept design avoids the pump house ruin and research into this structure is ongoing. The project team will advance the Environmental Review of cultural resources using PA-SHARE in the Preliminary Design Stage.

4. CONCEPT DESIGN

The concept design utilizes various restoration measures to achieve the project goals of slowing stream degradation and reducing flood frequency. First, the design will flatten the channel slope by lowering the channel invert, or thalweg, at key riffle locations. Second, the design will stabilize actively eroding banks with both boulder toe revetment and channel geometry modification. Third, the design will reconnect the channel with an expanded floodplain, which both increases flood conveyance and improves stream habitat. These three measures will be implemented in seven unique combinations referred to as “regions,” which subdivide the project reach. The surveyed stream thalweg is used for linear referencing, with values increasing from upstream to downstream. All descriptions in this section are oriented left to right looking downstream.

The seven regions of the surveyed stream thalweg are described in the following sections. In addition to the stream restoration measures, the concept design also includes low berms built from project spoil for local flood mitigation benefits. The berms and other on-site disposal methods are further explained in the Spoil section below. Corresponding Conceptual Design Plans are included as Appendix E. Following discussions with RPI, the boundary lines shown on the Conceptual Design Plans were adjusted to account for known issues with plans of record. Boundary research is ongoing, and the boundary lines shown on design documents are subject to change as the project progresses.

4.1. Region 1

Region 1 extends from thalweg Station 1+90 to 3+75. The left side of the region borders the Rivollet/Looi and Hollenbeck properties. The right side of the region borders a low-lying wooded area on the SSJ property. The thalweg will be lowered a maximum of 2.5 feet and shifted right towards the SSJ property in order to avoid excavation on the Neighbors side of the creek. Engineered rock channel lining will function as grade control at the upstream end of the region to hold the proposed channel invert. The left streambank looking downstream appears stable in existing conditions, so no bank armoring is proposed. Floodplain enhancement planting is proposed on the right side of the stream to manage invasives, improve biodiversity, and ensure long term stability.

4.2. Region 2

Region 2 extends from thalweg Station 3+75 to 5+50. The left side of the region borders the Rubin and Beyer properties. The right side of the region borders the same low-lying wooded area as Region 1. A 20” vitrified clay pipe (VCP) sanitary sewer crossing is present in this region, with orientation and cover confirmed by PWD during their April 2023 survey. The thalweg will be lowered a maximum of 2.0 feet, leaving approximately 3.5 feet of cover over the VCP crossing. Engineered rock channel lining will be used in the vicinity of the crossing to deter headcutting at this location. The thalweg will also shift right to

avoid excavation into the Neighbors side, which has been severely eroded in recent years since the construction of the new Germantown Avenue Bridge. Significant streambank erosion has been observed on the Neighbors side. It has destroyed a concrete and stone paved dock built in the early 1950s behind the Rubin property and is now undercutting an important tree on the Beyer property. As a remediation strategy, boulder toe revetment is proposed for stabilization. The floodplain enhancement planting from Region 1 will continue into the right side of Region 2.

4.3. Region 3

Region 3 extends from thalweg Station 5+50 to 6+25.The left side of the region borders the Thomas/ Snyder property which has lost approximately 50 feet in the last twenty years including significant tulip poplars and is seeing undercutting of significant trees along the bank. The right side of the region borders a wetland area identified by CEG. Thalweg lowering is no longer required in this region so channel grading will transition from Region 2. Minor grading on the right side of the stream will begin in this region to transition into more significant floodplain excavation for Region 4. The wetland area will be protected with temporary fencing, and no grading shall occur within 10 feet of the flagged limits. Boulder toe revetment along the left side will continue from Region 2.

4.4. Region 4

Region 4 extends from thalweg Station 6+25 to 7+50. The left side of the region borders an upland wooded area now largely overtaken by invasive vines that are strangling the valuable trees. Both sides of the creek from Region 4 onward are SSJ property. The downstream portions of the streambank in this region were armored with concrete roadway debris when the creek was shortened. These materials have generally resisted erosion but nonetheless have taken on a relatively steep profile. The armored side is better able to remain stable in the modified stream configuration, causing erosion to occur on the left streambank. The right streambank borders various Chestnut Hill College facilities, including a parking lot. The over-steepened left streambank will be regraded and excavation into the upland wooded area will provide important floodplain connection. Precise excavation will be required on the right side of the stream to create floodplain conveyance without impacting the college facilities.

4.5. Region 5

Region 5 extends from thalweg Station 7+50 to 10+00. The left side of the region borders the same upland wooded area as Region 4 and includes a gravel point bar. The right side of the region borders an upland lawn area with additional college facilities including a shed and parking lot. Significant excavation is proposed on both sides of the stream to create floodplain conveyance. The excavation will start at the approximate bank full height of 4.5 feet along the existing streambank and will encounter materials from the 1960s bank armoring and stream modification. New bank armoring will be employed as needed on the right bank in locations with high predicted shear in the hydraulic model and where severe erosion is observed in existing conditions. Flattening the creek bed and allowing flood flows to access the floodplain in these areas will help resolve this issue, but some erosion hotspots are likely to remain. For example, outer bends of a stream meander typically experience high shear stress as part of naturally occurring geomorphic processes. Therefore, bank armoring will be proposed at points where the hydraulic model predicts high shear stress during floods.

4.6. Region 6

Region 6 extends from thalweg Station 10+00 to 11+50. The left side of the region borders the upland wooded area and contains the remnants of a stone wall. The right side of the region also borders an

upland wooded area. Both sides of the stream feature cobble bars with significant concrete and brick debris. The channel contains a significant riffle, resulting from the increase in grade caused by the previously noted shortening of the creek bed, that will be lowered by a maximum 1.5 feet in order to reduce effective stream slope of the project reach in conjunction with Regions 1 and 2. Back from the left bank are dump piles consisting of removed boulders and construction and building demolition debris that appear to have been left behind from the 1960s stream modification. Engineered rock channel lining will function as grade control at the downstream end of the region to reinforce the transition between proposed and existing grade. Excavation will occur on both sides of the stream to increase floodplain conveyance. The stone wall will remain in place.

4.7. Region 7

Region 7 extends from thalweg Station 11+50 to 15+50. The left side of the region borders an upland area with significant invasive plant species growth and few remaining trees. The right side of the region borders a low-lying wooded area with remnants of a modern concrete retaining wall and debris from a former parking lot. This region contains the most severe instances of streambank migration along the left streambank with massive erosion on the bank of approximately 50 feet in the last five to ten years (pictured on the cover sheet). Excavation will occur on both sides of the stream and boulder toe revetment will be employed along the severely eroded bank. In areas along the right side where excavation is impractical due to lower existing ground elevation, floodplain enhancement will occur via invasive management and native planting. The remnants of the recently constructed non-historic concrete wall will be demolished as part of the excavation and enhancement efforts to remove the minor impediment to flow. Region 7 includes a 24” VCP sanitary sewer crossing and associated manholes on either side of the creek. No channel work is proposed in this region so the crossing itself will not be impacted. The manholes in the floodplain will be protected and stabilized as part of the excavation work.

4.8. Spoil

Significant volumes of excavated material will be produced during this project. It is both economically and environmentally beneficial to reuse this material on-site to the greatest extent possible. The current concept design includes small flood mitigation berms along the lower parking lot and around the college tennis courts. However, initial earthwork volumes show that 2-foot-high berms at these locations will only use about 3% of the total excavated material. The project team is currently working with SSJ to determine additional on-site spoil areas. Placement of spoils will have substantial impacts on both flood frequency and permitting requirements, as discussed in Sections 5.0 and 6.0, respectively.

5. PRELIMINARY HYDRAULIC MODELING

In conjunction with working around site constraints and meeting benchmarks such as bankfull height, hydraulic modeling plays a key role in evaluating the performance of the conceptual design against existing site conditions. Preliminary hydraulic models of both existing and proposed conditions were developed using HEC-RAS, a hydraulic modeling software developed by the US Army Corps of Engineers (USACE). Results of these analyses will be used to inform design decisions in the preliminary design stage and ultimately help demonstrate regulatory compliance.

5.1. Hydraulic Model Set Up

HEC-RAS Version 6.4.1 was used to develop two-dimensional (2D) flow models of the project reach. Unlike one-dimensional flow (1D) models, 2D models are capable of simulating flow through a specified domain without imposing a prevailing direction, which is especially useful for riverine applications with

significant floodplain and main stem interaction. The 2D domain developed for this project starts approximately 1,000 feet upstream of the Northwestern Avenue bridge and ends in the Wissahickon Creek portion of Fairmount Park, approximately 2,000 feet downstream of the Germantown Avenue bridge. A combination of 2022 LiDAR data (OCM Partners, 2022) and topographic survey data were used to create the underlying terrain that determines the channel and overbank geometry throughout the 2D domain. Flow data was developed by transposing data from a downstream USGS gage near the confluence with the Schuylkill River (USGS gage number 01474000). At the conceptual design stage, only peak flow rates were transposed and simulated as quasi-steady state simulations for the following recurrence intervals: 2-, 5-, 10-, and 100-year floods. Note that a bankfull flow rate of 1,534 CFS had previously been developed as part of Aterra's stream assessment and was also used in the preliminary hydraulic models (Aterra Solutions, 2022). Synthetic hydrographs will be developed in later stages of the project to distribute peak flows and evaluate the rising and falling limbs of each flood for critical erosion conditions.

5.2. Hydraulic Model Results

Results for the various flood frequency events are listed in the following discussion for both existing and proposed conditions. The proposed conditions model was developed by modifying the topographic survey terrain to include the changes discussed in Section 4.0 and shown on the Conceptual Design Plans (Appendix E).

The first result analyzed was shear stress, a measure of stress associated with the force of water against the channel boundary. Shear stress is important for stream restoration design because it is used to judge incipient motion of stream bed material. The 10-year flood was selected for the conceptual design evaluation and a comparison with existing conditions is shown in Appendix F. Preliminary modeling shows that the conceptual design will decrease shear stress in the project reach upstream of Germantown Avenue until just downstream of the tennis courts in Region 3. At this point, the increase in floodplain conveyance produces a steeper slope in upstream flow profiles, which in turn produces slight increases in shear stress. The stream can't be flattened enough to counterbalance this increase in water surface slope and still maintain the pool-riffle sequence. Therefore, the preliminary design will accommodate the increase in shear through sizing of bed material and bank armoring. Beyond the shear increases in the main stem of the channel, there are also increases in areas where floodplain grading has created increased flow depths relative to the confined existing channel. For example, when floodplain is created, areas that were previously upland become part of the channel and therefore experience higher flow depths and shear stress. Bank armoring will be proposed where predicted shear exceeds the threshold for vegetative stability. The preliminary design will also explore the use of parabolic channel geometry for bank regrading where feasible to better distribute shear stress along the channel boundary.

The second result analyzed was stream power, a measure of potential energy expenditure against the bed and banks of a channel. Stream power is often used as an indicator for sediment transport potential and a reach's tendency to either aggrade or degrade. The bankfull flow, previously determined during the geomorphic assessment (Aterra Solutions, 2022), was selected for the conceptual design evaluation and a comparison with existing conditions is shown in Appendix F. Preliminary modeling results show a decrease in stream power at key locations such as the severely eroding bank on the left side of the stream in Region 7 across from the lower parking lot and along the Neighbors' property in Regions 2 and 3 in the vicinity of the dock ruin where significant bank erosion has occurred. Although some areas show slight increases in stream power for proposed condition, both the average and net stream power decrease within the project reach. The preliminary design will further investigate areas of increased stream power and evaluate if additional channel modifications are necessary.

The final result analyzed was inundation extent, which serves a graphical representation of reductions in flood depths caused by the increase in flood conveyance. The 5-, 10-, and 100-year floods were selected for the conceptual design evaluation and comparisons with existing conditions are shown in Appendix F. Preliminary modeling shows a decrease in flood depths for all modeled events (see water surface elevation profiles in Appendix F), however, proposed inundation extents do increase in some areas where the concept design proposes floodplain grading beyond existing streambanks. Notable flood frequency improvements related to the proposed berms include protection of the lower parking lot up to the 5-year flood and protection of the tennis courts up to the 10-year flood. Both berms are overtopped by the 100-year flood by design. Although not a goal of the project, the 100-year flood comparison shows minor reductions in inundation extents as well.

6. PERMITTING OVERVIEW

It is anticipated that the permits discussed in the following sections will be required for construction. The design team has initiated contact with the appropriate regulatory agencies and will continue coordination throughout the Preliminary Design phase. Permit application packages will be submitted during the Detailed Design Phase.

6.1. Joint Permit

The proposed project will result in temporary and permanent impacts to both Waters of the Commonwealth of Pennsylvania and Waters of the United States. Thus, the project is regulated by state (25 PA Code §105) and federal statutes (Chapter 401 of the Clean Water Act) and can only be undertaken if approvals are obtained by the appropriate regulatory agencies. In Pennsylvania, major projects (of which this project would be considered) require the submission of a Chapter 105 Joint Permit Application to PADEP. Once the permit application is submitted, PADEP will perform an administrative and technical review, which may require revisions. Once PADEP determines that the project is designed in accordance with state regulations, an individual permit will be granted. Federal authorization can be issued in several ways. The most likely outcome for this project is that PADEP will issue federal authorization via the State Programmatic General Permit 6 (SPGP-6). This permit defines the relationship between PADEP and USACE with regards to issuance of Chapter 401 federal authorization. However, in some cases USACE may elect to take jurisdiction of the project directly and issue a separate permit. More straightforward projects can be covered under a USACE Nationwide Permit 27, which authorizes certain aquatic restoration activities. Larger or more complex projects may require an Individual Permit from USACE. Based on previous experience, a direct permit through USACE is a less likely outcome but cannot be ruled out at this time.

Requirements will be confirmed via a pre-application conference with PADEP and USACE, which is anticipated to be held in April, 2024.

6.2. Erosion and Sediment Control

Since the project will result in more than 15,000 sf of earth disturbance, project implementation will require an approved Erosion and Sediment Control Plan from the Philadelphia Water Department. The Erosion and Sediment Control Plan must demonstrate compliance with 25 PA Code § 102 and § 600.4 of the Philadelphia Water Department Regulations. The project will also likely result in earth disturbance exceeding 1 acre and will thus require a National Pollution Discharge Elimination System (NPDES) permit for Stormwater Discharges Associated with Construction Activities permit from PADEP. Issuance of the permit will require adherence with erosion sediment control and post construction stormwater management requirements set forth in 25 PA Code § 102.

Requirements were discussed during a pre-application conference with PWD Plan Review on March 20, 2024. PWD confirmed that the project should be considered a redevelopment and will require submission of an Erosion and Sediment Control Plan.

6.3. Post-Construction Stormwater Management

Projects exceeding 15,000 sf of earth disturbance must also comply with the Philadelphia Water Department's Post Construction Stormwater Management regulations as set forth in § 600.5 of the Philadelphia Water Department Regulations. Briefly, these regulations require the design and installation of stormwater management systems to meet the Department's water quality, channel protection, and flood control requirements. Each of these requirements is based on the increase in directly connected impervious surfaces associated with a particular project. Given that the project is not anticipated to result in an increase of directly connected impervious surfaces, compliance with the Department's requirements is unlikely to require the implementation of stormwater management systems or a formal post-construction stormwater management review.

Requirements were discussed during a pre-application conference with PWD Plan Review on March 20, 2024. PWD anticipates that the project will not require a Post-Construction Stormwater Management Plan. The exemption will be confirmed by PWD Plan review following submission of an Existing Resources and Site Analysis (ERSA) application. The design team will submit the ERSA application to PWD during the Preliminary Design phase.

6.4. Floodplain Management

The majority of the project is located in the 100 Year Floodplain as shown on the Federal Emergency Management Agency (FEMA) Flood Map Service Center, Map Number 4207570078G, Effective Date January 17, 2007. As a result, the Joint Permit will require a Floodplain Consistency Letter from the City of Philadelphia Floodplain Administrator. It is anticipated that an engineering analysis will be required to demonstrate that the proposed project will not result in a rise in Base Flood Elevation (BFE) greater than 0.00 feet at any point within the 100 Year Floodplain. The analysis will require coordination with both FEMA and the City's Floodplain Administrator. The first step in obtaining the Floodplain Consistency Letter is to request the effective hydraulic model from FEMA. Once the design team has obtained the effective hydraulic model, it will be compared against proposed hydraulic modeling results. The design team will request the data from FEMA during the Preliminary Design phase and prepare a letter report that summarizes the engineering analysis demonstrating no rise. The letter report requesting the Floodplain Consistency letter will be submitted to the City during the Detailed Design phase.

7. CONCLUSION

The concept design presented in this report meets the project goals of addressing stream degradation and reducing flood frequency. As a result, large flows will release less sediment and associated nutrients into the stream habitat. Improvements to flood frequency of the riparian properties is an auxiliary benefit of the stream restoration design, however, additional measures, such as the berms created from spoil, have the potential to provide targeted protection of infrastructure. The project team has received support for the concept design from stakeholders and will continue to involve them in the design process. In the next phase of design Aterra will prepare 30% construction drawings and a construction cost estimate in addition to advancing the hydraulic model and design report.

8. REFERENCES

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Appendix A

Topographic Base Map

Appendix B

Geotechnical Investigation Data

Appendix C

Wetland and Waters Delineation Report

Appendix D

Pennsylvania Natural Diversity Inventory
Draft Screening Report

Appendix E

Conceptual Design Plans

Appendix F

Hydraulic Modeling Results and Maps