

TRANSFORMING FLOODPLAINS INTO ECOLOGICAL AND COMMUNITY ASSETS: RESTORATION OF THE FOUR MILE RUN CORRIDOR, VIRGINIA

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Abstract

The lower Four Mile Run corridor, 2.3 miles along the border of the City of Alexandria and Arlington County, Virginia, represents an untapped and largely forgotten resource. In spite of its lingering beauty, today's stream corridor functions largely as a flood control channel -- an in-between space defined by concrete banks, utility infrastructure and buildings that turn their backs to the stream. Yet, the two jurisdictions have begun to rediscover the potential of the Four Mile Run corridor as envisioned by community leaders who have sparked renewed energy and creativity into imagining the stream's glorious potential. The resulting Four Mile Run Restoration Master Plan represents a bold community-based vision to revitalize the stream corridor, and to enhance the urban vitality of the communities along its shore, by improving its environmental, recreational, and open space resources. The master plan provides an overall blueprint for the transformation and identifies an initial demonstration project as well as the next steps in the implementation process.

Community input was sought throughout the 14 month process. Public outreach included an extensive Visioning Event that brought over 150 people to a one-day session during which groups collaborated on developing individual and shared visions for the future of the corridor and a series of Open House events that provided opportunities to review and respond to concepts as they were being developed. The plan was approved unanimously by both the Alexandria City Council and the Arlington County Board of Supervisors in 2006.

The Four Mile Run Restoration Master Plan provides a planning and conceptual design framework for dramatically transforming the stream corridor in ways that reflect the project vision that was developed early in the planning process:

Four Mile Run will become a model of urban ecological restoration. Through the sensitive and sustainable integration of natural areas with active urban nodes, the Four Mile Run corridor will be a place along which the communities of Arlington County and the City of Alexandria can gather, recreate, and celebrate a shared waterfront legacy.

The core of the Plan is focused on maintaining and enhancing flood protection while, at the same time, restoring the natural stream processes and improving habitat within the corridor. The aesthetic, recreational, and urban life enhancements contained

within the Plan are organized around the central principles of ecological restoration and enhanced flood protection.

The Four Mile Run Restoration Master Plan is a model of inter-jurisdictional and multidisciplinary collaboration. It illustrates the strength that communities, working together, can bring to developing a long-term vision that focuses on environmental and community enhancement. A stream that once served to divide communities has now become a means of uniting and renewing them.

1.0 Introduction

Four Mile Run (which is actually 9 miles long) and its watershed comprise one of the most heavily urbanized drainage basins in the Northern Virginia region (Figure 1). Although the watershed covers less than 20 square miles, it is home to approximately

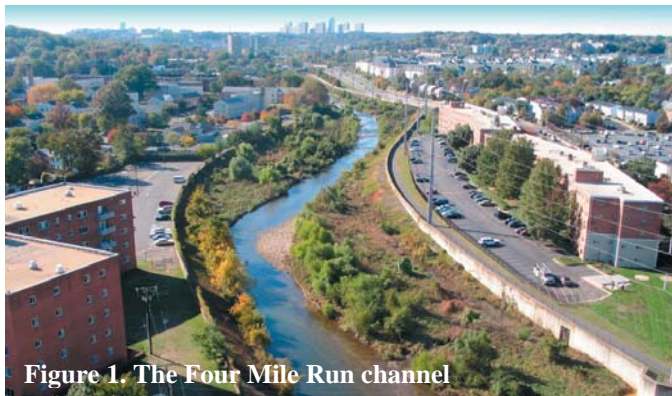


Figure 1. The Four Mile Run channel

183,000 people in adjacent portions of four localities: the counties of Arlington and Fairfax and the cities of Alexandria and Falls Church. Approximately 85 percent of the watershed's land area has been developed and nearly 40 percent of the watershed is covered with impervious surfaces associated with this development (i.e., buildings

and pavement). Wherever present, these man-made impervious surfaces prevent the natural process of groundwater infiltration from occurring. As a result, there is a significant increase in the volume of surface water runoff that Four Mile Run and its few remaining tributaries must carry downstream. The urbanization process has replaced most of the watershed's natural stream channels with an elaborate network of storm drains. These drains carry the increased volume of surface runoff, along with the many pollutants generated by urban life, much more quickly downstream than would the natural channels that have been replaced. The resulting flows are "flashier" and larger than natural channel flows. Runoff from the Four Mile Run watershed quickly makes its way into the Potomac River, and eventually drains into the Chesapeake Bay.

In response to a history of flooding affecting adjacent communities, the U.S. Army Corps of Engineers partnered with Alexandria and Arlington to build a flood control channel in the lower portion of Four Mile Run. The flood control channel, constructed during the 1970s and early 1980s, has safely conveyed the high storm flows through the two jurisdictions. When the channelization project was conceived in the 1960s, the sole objective of the project was flood protection and, in this respect, the project has been a success; no floods have breached the banks along the 2.3-mile channel since its construction. Although successful in flood control, however, the channelized portion of Four Mile Run leaves much to be desired in terms of aesthetic

and environmental attributes. The Corps of Engineers straightened and narrowed the channel, removed vegetation, and hardened the stream banks in many areas. The nearly uniform trapezoidal shape of the channel does not offer many of the natural characteristics of streams—such as riffles, pools and shady areas—that are needed to sustain much of the aquatic and riparian life once found in Four Mile Run.

The Four Mile Run Master Plan was born out of a realization that physical, ecological and aesthetic improvements to the stream corridor need not compromise the level of flood protection called for as part of the flood control project implemented in the 1970s. With this knowledge and a vision of Four Mile Run becoming a community amenity, the leaders of Arlington County and the City of Alexandria began to explore funding opportunities to enable both jurisdictions to jointly study the corridor. These ambitions came to fruition through the interest and support of Congressman James Moran. Congressman Moran's efforts resulted in a \$1 million grant from the U.S. Environmental Protection Agency for a joint Arlington-Alexandria study of the corridor. Following this grant, Congress appropriated funds for the U.S. Army Corps of Engineers to conduct a feasibility study for the entire Four Mile Run watershed and to participate in the Agency Coordinating Group (ACG) overseeing this effort. This Master Plan serves as the foundation for the more detailed feasibility study currently underway by the Corps of Engineers, which has authority over what happens within the flood control corridor.

A consultant team consisting of Rhodeside & Harwell (design and planning), CH2M HILL (technical analysis), Biohabitats (ecological restoration), and Waterscape (design) worked jointly with members of the project partners and the public to develop the Master Plan.

The core of the Four Mile Run Restoration Master Plan is focused on maintaining and enhancing flood protection while, at the same time, restoring the natural stream processes and improving aquatic and riparian habitat within the corridor. This paper will focus primarily on those themes, as well as a general description of the planning process.

2.0 Methods

The master-planning process involved a series of public outreach efforts, existing conditions assessments, alternatives development, and draft and final plan development, according to the following steps:

- A Public Visioning Session
- Assessing existing conditions and developing alternatives
- Selecting the preferred alternatives with the Joint Task Force (JTF made up of community members from Arlington and Alexandria) and the Agency Coordinating Group (ACG composed of members of the project partners and the JTF).
- Open House #1

- Development of the Draft Master Plan
- Open House #2
- Finalize Master Plan and estimate costs
- Master Plan approval

2.1 Public Participation

To begin the brainstorming and information-gathering, the project team organized a series of initial public-outreach opportunities. Activities included several roundtable discussions, which brought together individuals representing environmental and community groups and local businesses; meetings with civic associations in both jurisdictions; and a roundtable discussion with members of the Latino community to gather further input. The centerpiece of these efforts was a major public event to bring together the Arlington and Alexandria communities for a one-day visioning workshop (Figure 2).

The Four Mile Run Restoration visioning workshop included approximately 150 individuals. Initially, participants were asked to complete and return an eight-question survey to gauge the level of importance that participants assigned to particular goals for Four Mile Run. Next, the consultant team presented an analysis of existing conditions and highlighted potential opportunities throughout the project study area. These presentations included a discussion and demonstration on the nature, characteristics and properties of water that would be important to consider in developing options for the Four Mile Run corridor.

Following the presentations, the group convened for a water-themed exercise in which they were asked to imagine the various meandering patterns that flowing water might produce, the artistic qualities of those patterns, and the opportunities that such patterns presented for the Four Mile Run experience. Participants then divided into smaller, facilitated groups and were asked to respond to four key questions:

- What are the positive features and qualities of the Four Mile Run corridor today?
- What are the negative aspects and features of the corridor that should be changed?
- How do you envision the Four Mile Run corridor in 25 years?
- Specifically, how do you think Four Mile Run can achieve this vision?



For the final session of the day, each group presented a short summary of its discussion and the key ideas identified.

Participants offered a wealth of insights and a high degree of passion in outlining their vision

Figure 2. Developing ideas at the Visioning Workshop

for the future of Four Mile Run. From the perspectives articulated, a number of key themes emerged. These themes would drive the next stage of the master plan process.

During the visioning session and other public outreach, community members had the opportunity to respond to comment on the proposed vision statement for the restoration project. Based on these comments and subsequent revisions, the master planning team refined the document that would become the project's "Vision and Guiding Principles."

Just as the planning team had reached out to the Arlington and Alexandria communities earlier in the Master Planning process, the team once again called upon members of the community to review and comment on draft versions of the Master Plan and alternatives during two Open House events that occurred at key points in the plan development process.

2.2 Existing Conditions Assessment and Alternatives Development

A comprehensive assessment of existing conditions in the project area was performed to obtain a baseline dataset on which to base the Master Plan and restoration design. This included a community profile; history of the development of the area; analysis of in-stream conditions, including hydrologic and hydraulic modeling and geomorphic assessment; characterization of the natural environment including vegetation, wetlands, and species of concern; and a profile of near-stream conditions including land use, zoning, future development, transportation, infrastructure, and arts and culture.

The existing geomorphic condition assessment serves as a foundation for the development of restoration designs for Four Mile Run. The methods used to provide a basic level of geomorphic understanding of the Four Mile Run channel are:

- review of existing datasets,
- analysis of historical discharge data,
- assessment of historical conditions using historical aerial photographs,
- delineation of the channel into geomorphic reaches,
- description of channel geometry,
- longitudinal profile,
- channel bed sampling.

These datasets were used to develop an initial set of opportunities and constraints for the restoration of the Four Mile Run corridor. A set of alternatives was created that emphasized a wide range of elements that could be realized by the Master Plan; from habitat restoration, to improved connections, to a focus on sports and recreation.

These alternatives were presented to the public for comment at the Open House sessions (Figure 3).

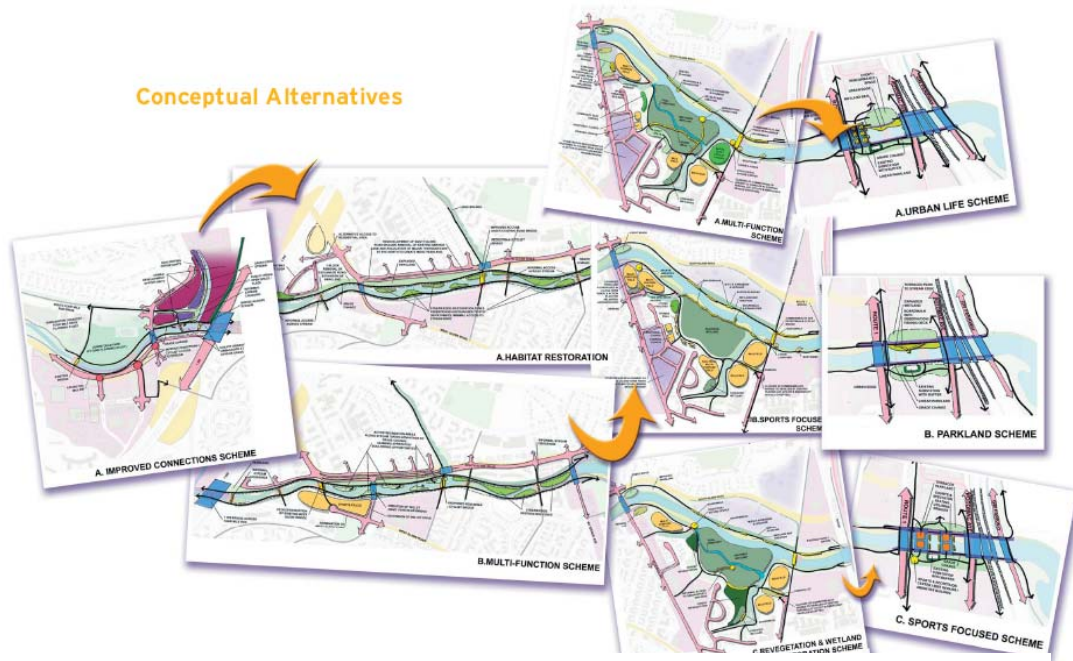


Figure 3. Conceptual Alternatives developed for the Four Mile Run Master Plan

3.0 Results

The input received during the public outreach events, along with analysis of the stream corridor, allowed the master planning team to begin the design phase of the Master Plan. Also critical to the development of the Master Plan was the outcome of the first round of hydrologic and hydraulic modeling (H & H modeling), the findings of which would determine the necessary channel capacity, level of flood protection and the associated opportunities and constraints.

The Final Master Plan consists of a series of “layered” plans which address specific design elements, and when integrated provides comprehensive restoration for the in-stream and near stream corridor. The In-stream Plan includes a channel design and flood control plan, stormwater management plan, and vegetation and habitat restoration plan. The Near Stream Plan includes a circulation and connection plan, urban form and neighborhoods plan, recreation plan, and an interpretation and education plan.

Because the comprehensive Master Plan is extensive, the following subsections summarize the results of the visioning and guiding principles development, as well as the in-stream and floodplain restoration design elements.

3.1 Vision and Guiding Principles

The Master Plan envisions that the *Four Mile Run corridor will become a model of urban ecological restoration. Through the sensitive and sustainable integration of*

natural areas with active urban nodes, the Four Mile Run corridor will be a place along which the communities of Arlington County and the City of Alexandria can gather, recreate and celebrate a shared waterfront legacy.

The guiding principles for the project, derived from community and governmental input, encompass eight key focus areas: flood protection, environment, aesthetics and design, recreation and urban life, integration and balance, access and connectivity, education and interaction, and the planning horizon. The Flood Protection and Environment principles are included below.

Flood Protection:

- Provide a minimum 100-year event flood protection.
- Examine the current extent of the 100-year flood-prone area.
- Consider flood protection for areas not currently protected.

Environment:

- Create a “dynamically stable stream channel” using natural stream channel design techniques.
- Improve corridor habitat and ecology to support native terrestrial and aquatic plant and animal species.
- Develop upstream strategies to improve water quality in the stream and the environmental quality and long-term viability of a restored levee corridor.

3.2 Stream Restoration Design Process

The stream restoration is grounded in the flood protection and environment principles outlined above, and informed by the geomorphic assessment, vegetation assessment, and hydraulic and hydrologic modeling.

Elements of the restoration design will include:

- **A multistage channel configuration** to achieve the second goal of creating a “dynamically stable stream channel” through natural stream channel design techniques. A dynamically stable channel is defined as a channel that has an appropriate channel cross-section to transport sediment during normal flow conditions; however, it is designed to adjust laterally within this basic form in response to large flows in order to minimize hard stabilization and maintenance. Under a natural condition, storm flows would typically have access to a wide floodplain so that the high energy from large events could be dissipated. In an urban setting, such as Four Mile Run, the limited floodplain area and high storm-related discharge result in high flow velocity and shear stress. In the proposed dynamically stable channel, the low-flow channel and inset floodplain could adjust to a moderate extent in response to the high flows. The flood control levee walls, however, will be stabilized in place to prevent adjustment. The inset floodplain acts as a release valve for forces in the low-flow channel. As flow increases, water will spread laterally onto the floodplain surfaces, limiting the

forces that develop in the low-flow channel and protecting the low-flow channel (and stream habitat) from damage. The design of the low-flow channel will be refined based on sediment transport analyses to ensure that the dimensions are appropriate for the channel-forming flows that occur in this reach of Four Mile Run. The multistage channel design also minimizes the amount of local maintenance required to achieve the goals described above. The final dimensions selected for the channel will ensure efficient sediment transport through the low-flow channel, thereby minimizing the need for frequent maintenance.

- **Programming of recreational opportunities** in, and public access to, the stream.
- **Removal of as many of the existing gabions and flood walls as possible** without compromising flood control and bank protection. In place of the gabions, the Master Plan recommends more natural stabilization solutions, including a variety of bioengineering techniques and appropriate bank reconfiguration.
- **Bioengineered toe protection** to protect the bottom (i.e., the “toe”) of the slope that connects the low-flow channel to the inset floodplain and the slope at the lateral limits of the inset floodplains. Toe protection may also be used to stabilize the low-flow channel in places where channel adjustments would compromise project amenities.
- **Vegetated stream bank stabilization** using similar bioengineering approaches in areas where the erosion risk is relatively high. In Four Mile Run, high risk areas for erosion will occur where the corridor is most confined, and where structures such as bridge piers and utility line crossings present obstructions to flow that could induce significant local bed scour and bank erosion. Vegetated bank stabilization will be applied in areas with relatively low risk of excessive erosion. These areas are generally where the flood corridor is at its widest.
- **Step-pool grade control structures** will provide several ecological and aesthetic benefits to the Four Mile Run project area. A step-pool grade control structure is a naturally inspired design that mimics the rock jams and plunge pool sequences typical of steep rivers to maintain bed elevations in impaired systems. These structures will replace the unnatural grade control structures in Four Mile Run and will likely be constructed of large rock native to the area. These structures will allow easier upstream and downstream movement of fish and other aquatic organisms, and will also aerate the water in visually appealing small waterfalls.

4.0 Discussion

The process that was used to develop the Four Mile Run Master Plan was rooted in three primary principles:

1. **Effective coordination and communication between project partners.** The level of communication and cooperation between the diverse project partners was

instrumental in bringing the level of funding necessary to support a comprehensive Master Planning project of this nature and magnitude. Throughout the planning process, a well-organized system of participation by key members from each partner ensured an adequate level of oversight, and allowed participants to weigh in on critical decisions.

2. Extensive, ongoing community involvement in the planning process.

Community participation was initiated at an early phase, and continued to guide and inform the planning team throughout plan development. In particular, the Visioning Workshop allowed interested community members a chance to voice their ideas and concerns about the project. As plans developed, the Open Houses were a forum where community members could learn about the process, ask questions, and actively participate.

This deep level of community engagement was central to the success of the planning process. It allowed community ‘buy-in’ at an early stage, which helped local jurisdictions in the plan approval process, and even more importantly, community members provided direct input which became the foundation of the design elements in the Master Plan.

3. Rigorous technical analyses to inform the design and planning processes.

The consultant team in cooperation with the project partners performed the geomorphic, hydraulic, hydrologic, and ecological assessments which allowed a restoration design process to be articulated. In order to achieve a viable balance between the flood protection and ecosystem restoration objectives, it was imperative that the geomorphic assessment and hydraulic and hydrologic modeling analyses be used to determine the initial set of restoration opportunities, and be fundamental to the design of in-stream and near-stream elements.

The environmental assessments also provided information that informs the restoration of wetlands areas in the tidal reaches of Four Mile Run, and provided the necessary data to develop a stormwater management plan that emphasizes source control, stream daylighting, and stormwater capture and reuse.

5.0 Conclusion

The Four Mile Run Master Plan was approved in March 2006. The demonstration project design and construction process began in late 2007, and will be ongoing through 2008. Given the scope and breadth of the effort, implementation of the Master Plan vision will occur over an extended period of time, and will require the establishment of an effective management structure that can “champion” all phases of this effort and can ensure that the vision and goals established for the stream corridor are, indeed, brought to fruition.

The Master Planning process has established an inspiring model of jurisdictional collaboration for the improvement of a significant local and regional resource. The future of the Four Mile Run corridor depends on the continuation of this collaborative effort. The degradation of the Four Mile Run corridor has been a gradual process, occurring over many years. So, too, will be its progressive restoration. As such, it will need the ongoing guidance, support and commitment from both County and City leadership.

Eventually, the community vision established for Four Mile Run will be realized: Four Mile Run will become a model of urban ecological restoration. It will be a place along which the communities of both Arlington County and the City of Alexandria can gather, recreate and celebrate a shared waterfront legacy. The Master Plan is the first step toward realizing the vision.

6.0 Acknowledgements

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7.0 References

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