Athens Alley
Stormwater Infrastructure Improvements Project

Existing Conditions and
Evaluation of Potential Improvements Report

Prepared For

Borough of Dormont
1444 Hillsdale Avenue
Dormont, PA 15216

Prepared By

Hazen and Sawyer, P.C.
11 Stanwix Avenue
Suite 1440
Pittsburgh, PA 15222

June 2013

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

Nature and Intent of the Study

The purpose of this report is to present the findings and recommendations of a study of the stormwater system within the watershed roughly bounded by West Liberty Avenue, Kelton Avenue, Annex Avenue, and Wisconsin Avenue. The primary focus of the study is the drainage system that contributes to the roadway and building flooding in and adjacent to Annex Alley.

The intent of the study is to:

- Evaluate the existing conditions of the drainage system.
- Develop and evaluate alternatives and their associated costs for addressing undersized and/or failing drainage systems.
- Recommend the most appropriate alternate.

Analysis Overview

The analysis primarily focused on the drainage system that contributes to the flooding of Athens Alley. Drainage systems in the watershed that do not contribute to the Athens Alley flooding were not assessed. The drainage system analyzed includes approximately 1,800 feet of closed pipe system. The drainage system analyzed includes the Texas Avenue pipe system which connects to the Athens Alley pipe system and then to the Kelton Avenue pipe system which discharges to the Keystone Oaks High School property.

The contributing watershed area is approximately 32 acres consisting of predominantly urbanized area including commercial and residential land uses. The study was extended to a location downstream with an area of 162 acres to assess potential increased discharges associated with installing upstream improvements. The watershed and sub-basin delineations are presented in Figure 2, later in the technical memorandum.

The inlets in the contributing watershed were assessed qualitatively. Green infrastructure opportunities were also studied for the entire watershed upstream from the flooding area.

The following models were used for the hydrologic and hydraulic analysis:

- A HEC-1 model was developed and used to determine the amount of discharge at key watershed locations. The HEC-1 model determines runoff based on rainfall, combines runoff from each tributary, and routes the runoff through the system. The Athens Alley flooded area was modeled as storage so that potential downstream impacts due to improving the drainage system could be assessed.
- Capacity of the pipe systems were determined using the hydraulic gradeline and manning's equation computations described in the PennDOT Drainage Manual.

Source data for the analyses described above are developed from the following:

- Field surveys: Detailed field surveys were performed for the drainage system and other features that affect the analysis, recommendations, and conclusions. Culvert/pipe sizes and inverts, overtopping road elevations, first floor elevations, etc. were collected.
- LIDAR topographic data: LIDAR topographic data were used to delineate drainage basin boundaries, delineate flow paths for lag time computations, and determine any appropriate routing parameters. Storm drainage system data provided by the Borough was used to assist in understanding watershed flow patterns, runoff velocity, etc.
- Field reconnaissance: Field reconnaissance was performed to develop model input parameters, verify survey information, and to select historical flooding assessment for model validation.

Hydrologic Analysis

The HEC-1 model, using the NRCS Unit Hydrograph method, was used to determine the estimated 2-, 10-, 25-, 50-, and 100-year, 24-hour storm event peak discharges for input into a manning's equation and hydraulic gradeline computation. The watershed was divided and digitized into eight (8) sub-basins using the LIDAR topographic data and storm drainage inventory. The area and weighted NRCS Curve Number (CNs) for each sub-basin were determined using a GIS algorithm. Flow paths and times of concentration (T_c's) were computed using a spreadsheet based on NRCS TR-55 methods. Resulting discharges at the key confluences are provided in Table 1. The attenuation associated with the Athens Alley flooding and storage volume was shown to decrease

discharges in the range of 4 percent to 20 percent for the 100-year and 2-year storm event, respectively. The Athens Alley attenuation and associated discharge decrease was removed in the later modeling efforts of possible improvements to determine how far downstream potential improvements should be extended to avoid downstream impacts.

Table 1: HEC-1 Flow Data (cfs)

Location	Drainage Area (acres)	2-yr (cfs)	10-yr (cfs)	25-yr (cfs)	50-yr (cfs)	100-yr (cfs)
Intersection of Texas Avenue and Athens Alley	27.7	79	117	141	158	176
Entering Athens Alley sag	31.9	91	134	161	182	202
Leaving Athens Alley sag	31.9	76	124	154	175	195
Intersection of Annex Avenue and Kelton Avenue	38.4	92	147	184	208	232
Base of watershed – entering Keystone Oaks High School	161.9	413	638	798	919	1037

Hydraulic Analysis

The project pipe system capacity was determined using Manning's equation and hydraulic gradeline computations as described in the PennDOT Drainage Manual. Input parameters for the Manning's equation and hydraulic gradeline computations include HEC-1 discharge values, field survey data, and field investigations for other model parameters (pipe elevations and lengths, ground elevations, pipe material, etc.).

Existing Conditions Assessment

Table 2 presents the results of the Manning's equation analysis. Bolded red font highlights pipe segments that are under capacity. The majority of the drainage system does not carry the runoff associated with the 2-year and more intense storm events (10- and 100-year storm events). The design standard is that all pipe segments should be able to carry the 10-year storm event with a hydraulic gradeline elevation below the ground elevation. Protection provided by the existing floodwalls was not considered to be effective and therefore not included in the analysis.

Table 2: Manning's Equation Pipe Capacities

Up. Struct.	Down. Struct.	Location	Slope	Dia. (in)	Capacity (cfs)	2-year Q (cfs)	2-year %	10-year Q (cfs)	10-year %	100-year Q (cfs)	100-year %
9	10	Texas	34.4 %	24	133	24	18%	37	28%	55	41%
10	16	Athens	2.2%	24	34	**79**	**231%**	**117**	**342%**	**176**	**514%**
16	18	Athens to Kelton	1.6%	30	52	**76**	**146%**	**124**	**238%**	**195**	**375%**
18	19	Athens to Kelton	-6.9%	30	0	**76**	**0%**	**124**	**0%**	**195**	**0%**
19	21	Kelton	5.2%	24	51	**76**	**148%**	**124**	**241%**	**195**	**379%**
21	22	Kelton	5.2%	30	93	76	82%	**124**	**133%**	**195**	**210%**
22	24	Kelton	2.2%	30	60	**76**	**126%**	**124**	**206%**	**195**	**324%**
24	29	Kelton	1.5%	30	50	**76**	**152 %**	**124**	**248 %**	**195**	**390 %**
29	outfall	Kelton	8.0%	42	285	109	38%	174	61%	278	98%

Table 3 presents the results of the hydraulic gradeline analysis. The hydraulic gradeline computations indicated that the pipe system surcharges during storm events more frequent than the 2-year storm event. Therefore, the existing pipe system is failing during all design storm events. Roadway flooding occurs on Texas Avenue, Athens Alley, and Kelton Avenue at all manholes and catch basins for the 2-year and more intense storm events. Ignoring the floodwalls that have been constructed by the residents, lowest adjacent grade (LAG) flood occurs for the building at 1230 Kelton Avenue and 1232 Kelton Avenue for the 2-year storm event. First floor flooding occurs for the building located at 1230 Kelton Avenue for the 2-year storm event. First floor flooding does not occur for the building located at 1232 Kelton Avenue for storm events up to the 100-year storm event.

Table 3: Surcharge Discharges

Structure	Location	Roadway Elev.	LAG Elev.	First Floor Elevation	2-year HGL
9	Texas	**1188.01**			1188.21
10	Texas	**1186.57**			1186.77
16	Athens	**1175.55**			1177.50
18	Athens to Kelton		**1171.80**	**1175.20**	1175.20
19	Athens to Kelton	**1174.87**	**1171.80**	1175.20	1175.07
21	Kelton	**1163.29**			1163.49
22	Kelton	**1162.19**			1162.39
24	Kelton	**1161.83**			1162.03
29	Kelton	**1159.13**			1154.78

Alternative Analysis

The PennDOT Drainage Manual requires that pipe systems be designed to pass the 10-year storm without roadway flooding. The PennDOT Drainage Manual does not provide standards to protect buildings from flooding. The industry standard for building flooding protection is typically the 100-year flood event with a minimum of one foot freeboard. Lowest adjacent grade flooding is allowed by some design standards as long as emergency access is provided for the building. The 100-year industry building flooding standard is used for this analysis.

Based upon the results of the existing conditions analysis, four conveyance alternatives for alleviating street and building flooding were evaluated. Each alternative was evaluated based on level of service standards; the PennDOT design standard for roadway flooding (10-year), and the industry standard for building flooding (100-year). In addition, a relaxed standard for roadway flooding (2-year) was assessed. These alternatives are shown in Figure 1 and described below.

- Alternative 1 – Install overflow pipe system along Texas Avenue and Kelton Avenue
  - Three sub-alternatives
    - 1a – Alleviate roadway flooding only (10-year event)
    - 1b – Alleviate roadway and building flooding (100-year event)
    - 1c – Alleviate roadway flooding only for the 2-year storm event
- Alternative 2 – Install overflow pipe system along Kelton Avenue to intercept runoff from West Liberty Avenue
- Alternative 3 – Install overflow pipe system along Athens Alley and Annex Avenue
  - Three sub-alternatives
    - 3a – Alleviate roadway flooding only (10-year event)
    - 3b – Alleviate roadway and building flooding (100-year event)
    - 3c – Alleviate roadway flooding only for the 2-year storm event
- Alternative 4 – Replace the existing pipe system along the same alignment

Borough of Dormont, PA

Athens Alley Stormwater Improvements Alternative Routes

Legend

- Texas to Kelton
- Athens to Kelton
- Athens to Annex
- Proposed Catch Basins
- Proposed CB Connectors
- Storm_Structure
- Storm_Pipe

FIGURE 1
June 2013

HAZEN AND SAWYER
Environmental Engineers & Scientists

For alternative 1 and 3, where the existing pipe system capacity is utilized and flow is split between the existing system and proposed system, an iterative process of computing hydraulic gradelines was performed. The iterative process began by assuming a percentage of discharge that is carried by each leg of the system. Based on the assumed percentage, the hydraulic gradeline elevations were computed for each leg starting at the downstream manhole. The hydraulic gradeline at the upstream node is the same for both computation legs if the correct flow distribution was assumed.

Alternative 1a Summary

- Hydraulic Design: To alleviate roadway flooding for the 10-year event, Alternative 1a included supplementing the existing pipe (Texas Avenue to the low point on Athens Alley and then between 1230 and 1232 Kelton Avenue) by an overflow pipe system along Texas Avenue and Kelton Avenue. A 36-inch diameter pipe was shown to be required to pass the 10-year storm event and protect the roadway from flooding. At this location, the 10-year storm event was 134 cfs of which approximately 27 cfs (20 percent) flows through the existing pipe and 107 cfs (80 percent) flows through the overflow pipe.
- Constructability: We offer the following observations of potential challenges associated with installation of the overflow pipe system.
  - The depth of the overflow pipe system was computed to be approximately six (6) feet at the location where it connects to the existing pipe system (Texas Avenue and Kelton Avenue). The depth of the overflow pipe was computed to be approximately twenty-four (24) feet in the Kelton Avenue and Texas Avenue intersection.
  - The existing Texas Avenue and Kelton Avenue pavement width is approximately twenty-four (24) feet. The top of trench width for a six (6) foot deep installation will be approximately ten (10) feet unless a special shoring or trench box system is used. The top of trench width for twenty-four (24) foot installation is approximately forty-five (45) feet unless special shoring or a trench box system is used. Complete roadway closure for Texas Avenue and Kelton Avenue may be needed in addition to special shoring and/or trench box systems. Driveway and pedestrian access will be impacted during construction.
  - Existing parking is located on the east side of Kelton Avenue and the north side of Texas

Avenue. An alternative parking location may be needed during construction.

- There are numerous existing utilities located along the proposed overflow pipe alignment. Extensive utility protection, support, relocation, etc. may be required.
- A manhole is needed to be installed in the Texas Avenue and Kelton Avenue intersection to change the pipe system direction. Installation of a twenty-four (24) foot deep manhole may require three to four days if the structure is pre-cast. However, a pre-cast structure may not be feasible because of the adjacent utilities and other potential conflicts. A cast-in-place manhole may require up to two (2) weeks for installation, concrete curing, etc. prior to re-opening the roadway to traffic.

- Cost: The preliminary construction cost for Alternative 1a was determined to be $431,000. Itemized preliminary construction cost estimates for this and other alternatives are included in Appendix A.

Alternative 1b Summary

- Hydraulic Design: To alleviate roadway and building flooding for the 100-year event, Alternative 1b included supplementing the existing pipe (Texas Avenue to the low point on Athens Alley and then between 1230 and 1232 Kelton Avenue) by an overflow pipe system along Texas Avenue and Kelton Avenue. A 42-inch diameter pipe was shown to be required to pass the 10-year storm event and protect the roadway from flooding and the pass 100-year storm event without impacting surrounding buildings. At this location, the 100-year storm event is 202 cfs of which approximately 26 cfs (13 percent) flows through the existing pipe and 176 cfs (87 percent) flows through the overflow pipe.
- Cost: The estimated construction cost for Alternative 1b was determined to be $464,000.

Alternative 1c Summary

- Hydraulic Design: To alleviate roadway flooding for the 2-yr event, Alternative 1c included supplementing the existing pipe (Texas Avenue to the low point on Athens Alley and then between 1230 and 1232 Kelton Avenue) by an overflow pipe system along Texas Avenue and Kelton Avenue. A 30-inch diameter pipe was shown to be required to pass the 2-year storm

event and protect the roadway from flooding. At this location, the 2-year storm event is 91 cfs of which approximately 29 cfs (32 percent) flows through the existing pipe and 62 cfs (68 percent) flows through the overflow pipe.

- Cost: The estimated construction cost for Alternative 1c was determined to be $412,000.

Alternative 2 Summary

- Hydraulic Design: Alternative 2 was developed to determine if removing a portion of the tributary drainage area could eliminate flooding by intercepting the storm drainage from a section of West Liberty Avenue and watershed north of West Liberty Avenue so that it bypasses along Kelton Avenue and does not enter the Athens Alley flooding area. The proposed pipe system intercepts the West Liberty system in the West Liberty Avenue/Kelton Avenue intersection and reconnects to the existing system downstream from the flooding area. Seventy-nine (79) cfs was available to be intercepted which reduces the 134 cfs discharging to the Athens Alley flooding area. The discharge that enters the Athens Alley flooding area was reduced to fifty five (55) cfs. The existing pipe capacity was shown to be approximately twenty-six (26) cfs flows. Therefore, alternative 2 does not meet design standards and was not analyzed in more detail.

Alternative 3a Summary

- Hydraulic Design: To alleviate roadway flooding for the 10-year event, Alternative 3a included supplementing the existing pipe (the low point on Athens Alley between 1230 and 1232 Kelton Avenue and then along Kelton Avenue to the Kelton Avenue/Annex Avenue intersection) by an overflow pipe system along Athens Alley and Annex Avenue. A 36-inch diameter pipe was shown to be required to pass the 10-year storm event and protect the roadway from flooding. At this location, the 10-year storm event was 134 cfs of which approximately 15 cfs (10 percent) flows through the existing pipe and 119 cfs (90 percent) flows through the overflow pipe.
- Constructability: We offer the following observations of potential challenges associated with installation of the overflow pipe system.
  - The depth of the overflow pipe system was computed to be approximately seven (7) feet at the location where it connects to the existing pipe system (the Athens Alley sag). The depth

of the overflow pipe was computed to be approximately twenty-three (23) feet in the Athens Alley and Annex Avenue intersection.

- The existing Athens Alley pavement width is approximately ten (10) feet. The existing Annex Avenue pavement width is approximately twenty (20) feet. The top of trench width for a seven (7) foot deep installation of a 36-inch pipe is approximately twelve (12) unless a special shoring or trench box system is used. The top of trench width for twenty-three (23) foot installation of a 36-inch pipe is approximately forty-three (43) feet unless special shoring or trench box system is used. Complete roadway closure for Athens Alley and Annex Avenue may be needed in addition to special shoring and/or trench box systems. Driveway and pedestrian access will be impacted.
- There are numerous existing utilities located along the proposed overflow pipe alignment. Utility protection, support, relocation, etc. may be required.
- A manhole is needed to be installed in the Athens Alley and Annex Avenue intersection to change the pipe system direction. Installation of twenty-three (23) foot deep manhole may require three to four days if the structure is pre-cast. However, a pre-cast structure may not be feasible because of the adjacent utilities and other potential conflicts. A cast-in-place manhole may require up to two (2) weeks for installation, concrete curing, etc. prior to re-opening the roadway to traffic.

- Cost: The estimated construction cost for Alternative 3a was computed to be $303,000.

Alternative 3b Summary

- Hydraulic Design: To alleviate roadway and building flooding for the 100-year event, Alternative 3b included supplementing the existing pipe (the low point on Athens Alley between 1230 and 1232 Kelton Avenue and then along Kelton Avenue to the Kelton Avenue/Annex Avenue intersection) by an overflow pipe system along Athens Alley and Annex Avenue. A 42-inch diameter pipe was shown to be required to pass the 10-year storm event and protect the roadway from flooding and the 100-year storm event without impacting surrounding buildings. At this location, the 100-year storm event is 202 cfs of which approximately 16 cfs (8 percent) flows through the existing pipe and 186 cfs (92 percent) flows through the overflow pipe.

- Cost: The estimated construction cost for Alternative 3b was computed to be $331,000.

Alternative 3c Summary

- Hydraulic Design: To alleviate roadway flooding for the 2-yr storm event, Alternative 3c included supplementing the existing pipe (the low point on Athens Alley between 1230 and 1232 Kelton Avenue and then along Kelton Avenue to the Kelton Avenue/Annex Avenue intersection) by an overflow pipe system along Athens Alley and Annex Avenue. A 30-inch diameter pipe was shown to be required to pass the 2-year storm event and protect the roadway from flooding. At this location, the 2-year storm event is 91 cfs of which approximately 26 cfs (29 percent) flows through the existing pipe and 65 cfs (71 percent) flows through the overflow pipe.
- Cost: The estimated construction cost for Alternative 3c was computed to be $289,000.

Alternative 4 Summary

- Hydraulic Design: Alternative 4 included replacing the existing pipe (the low point on Athens Alley between 1230 and 1232 Kelton Avenue and then along Kelton Avenue to the Kelton Avenue/Annex Avenue intersection) with a new pipe system along the same alignment. A 36-inch pipe was shown to be required to pass the 2-year storm event. A 42-inch diameter pipe was shown to be required to pass the 10-year storm event and meet PennDOT roadway design standards. A 48-inch diameter pipe was shown to be required to pass the 100-year storm event, meet PennDOT roadway design standards and industry-standards building protection for the 100-year storm event.
- Constructability: We offer the following observation of potential challenges associated with installation of the overflow pipe system.
  - The depth of the new pipe system along the existing alignment was computed to be approximately seven (7) feet. The standard trench width for a 42-inch pipe system, seven (7) feet deep was computed to be ten (10) feet. The distance between the two buildings (1230 and 1232 Kelton Avenue) was measured as approximately five (5) feet. Therefore, alternative construction methods would be required.
  - The 100-year protection alternative includes connecting a 48-inch diameter pipe into the

existing system where the existing pipe diameter is 30-inches at a location downstream from the flooding area. A larger pipe connected to a smaller pipe can create a condition where frequent clogging occurs. In addition, if flooding occurs at this location for storm event more intense than the design storm, public perception can be that the design is not appropriate. Additional discussion regarding the potential downstream impacts of the alternatives is presented in the Downstream Impacts section of this document.

- Cost: The estimated construction cost for Alternative 4a (10-year design storm) was computed $306,000. The estimate construction cost for Alternative 4b (100-year design storm) was computed to be $357,000.

Contributing Watershed Inlets

The Athens Alley flooding is due to two conditions, the pipes are too small (and installed on a negative slope at some locations) and there are not enough inlets in the contributing watershed to intercept the surface/gutterline flow to fill the pipe system. The PennDOT inlet design standard focus on intercepting gutterline flow frequently enough so that the gutterline flow is limited to less than eight (8) foot width into the travel lane to reduce the potential for a vehicle to hydroplane. The majority of the roadways in the contributing watershed serve residential areas, have posted speed limits of twenty-five (25) mph, and have features such as on-street parking, small travel lane width, etc. that reduce the traffic speed. Therefore, hydroplaning probability is less than expected for major transportation corridors for which the PennDOT design standards are more important.

A storm drainage system that meets the PennDOT standards requires installing pipes and catch basins along many roadways where no drainage system currently exists. Meeting PennDOT inlet design standards would result in significant community disruption and construction cost that we do not feel is warranted. Therefore, a relaxed inlet design standard is proposed that takes the following considerations into account:

- Gutterline flow should be eliminated through intersections, if possible, to limit the locations where vehicles stop in gutterline flow and/or ice.
- New inlets that require the installation of long lengths of new pipe are cost prohibitive.

Therefore, inlet locations will be limited to areas where new pipe runs are less than fifty (50) feet.

- The gutterlines of roadways north of West Liberty Avenue are intercepted by the West Liberty Avenue inlets and therefore do not contribute the Athens Alley flooding. No new inlets are proposed for the gutterlines north of West Liberty Avenue for this project.

Based on the above qualitative screening factors, we recommend installing new inlets at:

- Complement the existing inlets in the Wisconsin Avenue and Texas Avenue intersection with five (5) additional inlets.
- Complement the existing inlets in the Hillsdale Avenue and Texas Avenue intersection with three (3) additional inlets.
- Install a new inlet in the northwest gutterline of Kelton Avenue and Texas Avenue, only if Alternative 1 is selected for the pipe system improvements because Alternative 1 includes adding a pipe system near the Kelton Avenue and Texas Avenue intersection. The other Alternatives do not include adding pipe systems near the subject intersection.
- Proposed inlet locations are shown in Figure 1. Construction cost for the inlet improvements is estimated to be $76,000.

Green-Infrastructure Opportunities

In addition to the standard flood control (pipe replacement) alternatives, opportunities to implement green infrastructure (GI) throughout the entire contributing watershed were assessed. According to the US EPA, green infrastructure is a general name given to an approach using environmentally friendly techniques to manage stormwater.

Benefits of Green Infrastructure

The benefits of implementing green infrastructure for the subject project includes:

- Green infrastructure intercepts runoff associated with the more frequent storm events (typically, less than one-inch of rainfall) and has a small but cumulative benefit on controlling larger storm events associated with flood damage.

- Green infrastructure controls are generally distributed throughout a watershed, managing runoff near the source and thereby restoring more natural hydrology.
- Green infrastructure elements such as rain gardens, reduced imperviousness through natural features, tree boxes, etc. can have positive aesthetic and environmental benefits.
- Green infrastructure elements such as pocket rain gardens can be integrated into the community roadway system to provide a traffic calming element and therefore meet multiple community goals.
- Green infrastructure elements such as green roofs, blue roofs, rain barrels, cisterns, etc. provide other benefits in addition to the stormwater system benefits. One of the additional benefits includes storing runoff for later use for landscaping.
- The majority of stormwater pollution occurs during the washoff of pollutants from impervious areas during relatively small storm events (less than one inch of rainfall) and most annual runoff volume is associated with these smaller events. Green infrastructure intercepts and treats the pollution associated with the small storm events. The Athens Alley project watershed is located in the Sawmill Run watershed. The Sawmill Run watershed is listed on Pennsylvania's 303(d) list as impaired. The impairment sources are different for different stream segments and include biological oxygen demand, low dissolved oxygen, nutrients, metals, organic enrichment, siltation, sediment, and acid mine drainage. The sources are due to combined sewer overflow, urban runoff, and storm sewers. A total maximum daily load (TMDL) has been developed for acid mine drainage and sediment. Additional TMDL's may be implemented to control other sources of impairment. Green infrastructure captures and treats many of these sources of impairments and therefore contributes to addressing the existing TMDLs and possible future TMDLs.
- The Borough of Dormont has an NPDES stormwater permit. Standard requirements of an NPDES stormwater permit include Public Education and Public Involvement. Implementing green infrastructure can be integrated into the Borough's Public Education and Public Involvement requirements and also help achieve post-construction stormwater management goals.

- Green infrastructure is one of the key tools to eliminate or reduce waste water system overflows because the green infrastructure reduces the more frequent storm event (1- and 2-year storm event) peak and volume that can infiltrate into the waste water system. The 1- and 2-year storm event runoff volume is typically one of the primary contributors of waste water system overflows.
- Many low interest or grant funding opportunities are earmarked for green infrastructure projects, increasing the availability of alternative funding sources for the Borough.

Green Infrastructure Flood Control Benefits

As discussed below, we identified sixty-one (61) green infrastructure (GI) opportunities in the contributing watershed. Each of these opportunities may or may not prove to be viable due to numerous factors including property owner support, constructability, funding, etc. Also, a detailed modeling analysis of the flood control benefits associated with green infrastructure was beyond the scope of the project and therefore detailed modeling of each opportunity was not performed. However, to understand an order of magnitude of the potential cumulative benefit of watershed-wide green infrastructure, Hazen and Sawyer implemented a conceptual hydrologic analysis by adjusting the initial abstraction value in the HEC-1 model for three conditions:

- The existing watershed conditions,
- The watershed with green infrastructure installed to intercept and infiltrate all watershed runoff associated with the 0.5 inch storm event, and
- The watershed with green infrastructure installed to intercept and infiltrate all watershed runoff associated with the 1 inch storm event.

Each of the models assumed that the entire watershed was intercepted by a green infrastructure feature. Complete watershed interception may not be an alternative that is achieved in the near future, but the purpose of the modeling effort is only to define an order of magnitude of possible flood reduction associated with green infrastructure. The result of the watershed-wide analysis is presented in Table 4, which reports the modeled discharge at the Athens Alley flooding area under each of these scenarios. As shown, watershed-wide green infrastructure that intercepts and controls

all areas of the watershed resulted in minimal flood control benefits for the more intense storm events (larger than the 10-year storm event). These results are consistent with expectations because green infrastructure is typically designed to capture the first 0.5 or 1.0 inches of rainfall/runoff and design storm events consist of 2.92, 5.10, and 6.83 inches of rainfall for the 2-, 25-, and 100-year storm events, respectively. Similarly consistent with expectations, the analysis showed that for the 2-year storm event, watershed-wide green infrastructure that intercepts and controls all areas of the watershed would reduce the peak flow at Athens Alley from 103 cfs to 85 cfs (18 percent). As shown in the table, green infrastructure intercepts a higher percentage of the runoff from smaller, more frequent events but doesn't have much impact peak flows for larger events. Thus, aggressive implementation of green infrastructure would not have a significant impact on the grey infrastructure alternatives presented at the beginning of this technical memorandum, but would still provide the other benefits listed earlier in this section.

Table 4: Potential Green Infrastructure Flood Control Benefits

	2-year storm event discharge (cfs)	25-year storm event discharge (cfs)	100-year storm event discharge (cfs)
Existing watershed	103	169	209
Existing watershed – intercept 0.5 inch	100	168	208
Existing watershed – intercept 1.0 inch	85	163	204

Green Infrastructure Opportunity Analysis

Hazen and Sawyer conducted an analysis to identify potential green infrastructure opportunities within the Athens Alley Stormwater Improvements Project study area in order to determine the extent to which GI can be feasibly implemented. First, field visits were conducted to better understand the study area characteristics and identify locations where GI could be implemented. The results of the field visits were cataloged using the sub-basins developed during the hydrologic analysis. For each sub-basin, photographs were taken of the overall configuration of each basin and of the specific areas where physical features would allow for GI implementation. The project area is highly impervious, highly traveled (both by vehicles and pedestrians), and to have relatively small

property lots with buildings constructed in close proximity to one another. Additionally, much of the area has challenging topography characterized by steep slopes,

Next, available GI best management practices (BMPs) were evaluated against field conditions to determine the types of BMPs that would work best within the project area. From this analysis seven (7) BMP types emerged as potential candidates for successful implementation of GI.

The opportunity analysis identified sixty-one (61) potential GI opportunities in the project area. These opportunities are identified by type in Table 5 and their location (by type) is shown on Figure 2. Additional details on specific types and locations of GI are presented in Appendix B.

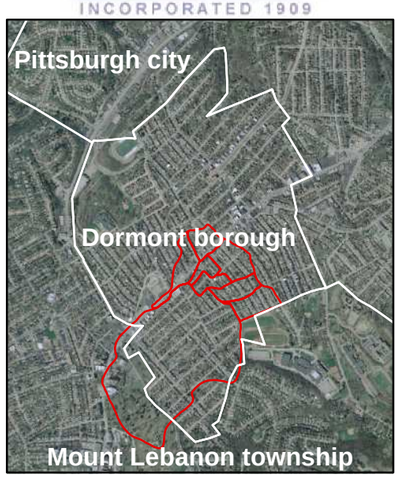
Table 5: Number of Opportunities per BMP Type

Type of Opportunity	Number of Opportunities
Bioretention	7
Blue and/or Green Roofs	10
Cisterns	2
Country Lanes	11
Permeable Pavement	21
Bump-out Street Bioretention (Tiered or Flat)	9
Enhanced Tree Boxes	1

Once the various opportunities were identified, each opportunity was further evaluated to consider the barriers to implementation, including:

- Obvious Constructability Barriers
- Private Property Acquisition Issues
- Obvious Lack of Benefit vs. Cost (considers of planned roadway replacement)
- Inconvenient Location
- Unlikely DOT or Regulatory Approval

Borough of Dormont. PA



Athens Alley Stormwater Improvements Green Infrastructure Opportunities by Type

Legend

- Bioretention
- Blue or Green Roof
- Cistern
- Country Lane
- Pervious Pavement
- Pocket Rain Garden (Bump-Out Street Retention)
- Tree Box
- Watershed Sub-Basins
- Storm_Structure
- Storm_Pipe

FIGURE 2
February 2013

HAZEN AND SAWYER
Environmental Engineers & Scientists

Evaluating each opportunity against the barriers to implementation, the identified opportunities were grouped into priority rankings of high, medium and low, with high being those that would have the least barriers to implementation and provide the most anticipated benefits relevant to the current project. While the application of these barriers in the analysis is subjective, they provide a basis for developing a ranking of the identified opportunities that will provide guidance to the further analysis that is required prior to any potential implementation. The number of opportunities, by ranking, is shown in Table 6. Figure 3 shows the location of each opportunity by ranking.

Table 6: Number of Opportunities by Priority Ranking

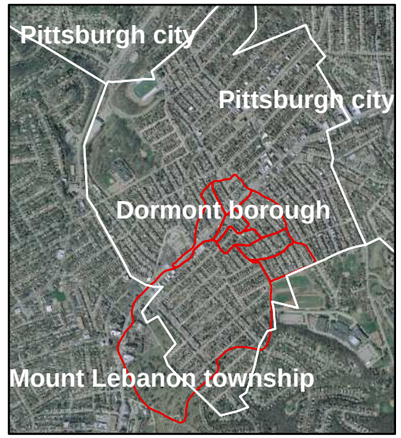
Rank	Number of Opportunities
High	9
Medium	28
Low	24

Green Infrastructure Funding Opportunities

Green infrastructure undoubtedly provides many benefits to the community as well as collection system operations and effectiveness. Unfortunately, funding GI projects that won't completely solve the stormwater management issues at hand in lieu of or in addition to proven grey infrastructure solutions is often not desirable. However, if considered, the myriad of benefits provided by green infrastructure make a green project or a green plus gray project more beneficial than a gray project alone. These additional community benefits have been acknowledged and as noted above, green infrastructure set asides and grants have made funding for green infrastructure more accessible than funding for grey only infrastructure. Acknowledging this, we have identified a number of potential grant funding sources that may be available to the Borough should the project include green infrastructure. Ultimately, it is important to recall that implemented GI will have a positive effect on the project if placed and maintained appropriately, not only through direct water quantity and quality impacts, but also by promoting awareness of stormwater impacts in the community. Potential grant funding opportunities that become available if green infrastructure opportunities are implemented are described below.

Borough of Dormont, PA

THE BOROUGH OF DORMONT
INCORPORATED 1909



Athens Alley Stormwater Improvements Green Infrastructure Opportunities by Priority

Legend

- High
- Medium
- Low
- Reconstruction
- Watershed Sub-Basins
- Storm_Structure
- Storm_Pipe

FIGURE 3
February 2013

HAZEN AND SAWYER
Environmental Engineers & Scientists

Hazen and Sawyer has already assisted the borough with submission of an application for the *Local Government Academy Multi-Municipal and Community Sustainability Grant* (http://www.localgovernmentacademy.org/main.asp?ID=40) as of October 26th, 2012 and the grant application was approved. The Borough has been awarded $8,500 that can be applied towards the cost of this study.

The *Allegheny County Conservation District Grant Fund* is offering grant money to projects supporting their vision. Should green infrastructure project be implemented as part of the Athens Alley Project, the project would align nicely with that vision. Hazen and Sawyer has assisted the Borough in developing the pre-application which is due February 20, 2013. Those approved to submit a full application must do so by March 31, 2013, and will know by May 1st, 2013.

The Charrette Program is an EPA funded grant that has been issued to the Green Infrastructure Network in Pittsburgh. Together with 3RWW, the GIN has been tasked with selecting candidates for funding to vibrant, enthusiastic communities who have shown interest and energy towards the green infrastructure movement. Hazen and Sawyer has discussed this funding with 3RWW and awaiting additional information from 3RWW about its applicability to the Athens Alley improvements and the process for application.

The Commonwealth Financing Authority (CFA) is an independent agency of the Commonwealth to administer Pennsylvania's economic stimulus packages. The CFA holds fiduciary responsibility over the funding of programs and investments in Pennsylvania's economic growth. There is one current program under which green infrastructure projects may qualify:
The Watershed Restoration Protection Program aims to restore, and maintain restored stream reaches impaired by the uncontrolled discharge of nonpoint source polluted runoff, and ultimately to remove these streams from the Department of Environmental Protection's Impaired Waters List. The Athens Alley Stormwater Management Project, should it implement green infrastructure best management practices, would meet the second of three eligibility requirements as set forth by the Department of Community and Economic Development (DCED), which is the agency that selects

qualified applicants. To apply, the Borough would have to submit an electronic application for assistance at www.esa.dced.state.pa.us. Then, seven copies of the printed application, along with 10 additional exhibits, must be sent to PA DCED via US Mail. The full list of exhibits, as well as all other program details can be viewed in attachment on the CFA's website for this particular grant at: http://www.newpa.com/find-and-apply-for-funding/funding-and-program-finder/watershed-restoration-and-protection-program-wrpp.

The program opened and has been accepting applications as of January 29, 2013. The application deadline for the program is July 31, 2013 for consideration at the November 13, 2013 CFA Board meeting.

PENNVEST offers the *Growing Greener Grant II* program which is now closed until the summer of 2013 when a new application booklet package will be opened on the Pa DEP website (http://www.depweb.state.pa.us/portal/server.pt/community/growing_greener/13958). Based on the outdated booklet posted on the website, Dormont Borough can be considered for funding. However, applications should not be sent in until the new application package is made available online. The 2012 selections will be revealed within the next few weeks.

The Redevelopment Authority of Allegheny County (RAAC) offers 3 potential funding options that may be available to the Borough:

1. *Grants from Gaming Economic Development Fund (GEDF)* is an option, but the project budget must be at least $500,000. The eligibility requirements make no specific mention of green infrastructure and therefore, the full project cost, including new storm piping, watershed inlets, and possibly roadway rehab could be eligible. The 2012 eligibility cycle closed as of October 26, 2012, and the next cycle will not open until summer of 2013, according to Bailey Conroy of RAAC. The RAAC reviews projects and makes recommendations from the pool of applicants for the CFA. Ultimately, the CFA approves the RAAC recommended projects.
2. The *Community Infrastructure and Tourism Fund*'s (CITF) primary objective is to fund construction, development, improvement, and maintenance of infrastructure projects, and

may be the most applicable of the three RAAC funding opportunities. Applications are available online at http://www.alleghenycounty.us/citfund.aspx. The Application Deadline is March 15th, 2013. This is a 22 page application plus exhibits.

3. The PA Dept of Community & Economic Development Programs *Community Development Block Group Funding* (CDBG) has funding available for Water and Sewer projects. Additionally, Stormwater/GI may fall under another category called "Public Improvements". A pre-application for CDBG grand funding has been submitted by the Borough. If the project qualifies for submittal, the full application must then be completed by July 31, 2013. The website containing information on the application requirements is http://economic.alleghenycounty.us/resources/block_grants.aspx.

Oil & Gas Impact Fee (Act 13) Grants are provided through the Pennsylvania Public Utility Commission (PUC). PUC is the authority which disperses this money to both DCED (H20 PA Program – which is closed), and PaDEP (PA Infrastructure Investment Authority). The money was dispersed in October of 2012, and will not be dispersed again until July 1st of 2013 in approximately the same amount to each program. These programs are made available through the PA Infrastructure Investment Authority (PENNVEST) (Growing Greener II) and the CFA (H20 PA Program). The PENNVEST and CFA websites should be visited regularly to check for funding updates. Please refer to the paragraphs above for more information on *Growing Greener II* and *H20 PA*.

Downstream Impacts

The Athens Alley flooding area consists of a topographical depression that stores runoff and releases the runoff at a rate determined by the existing pipe capacity. Improving the outflow pipe capacity allows a higher discharge to exit the topographical depression. The modeling effort included determining the potential downstream discharge associated with each of the above-described alternatives and assessed the changes in flood damages associated with the potential higher discharge. Conceptual solutions to offset the increased discharges are also assessed.

The increased discharges are determined by revising the hydrologic model with the proposed pipe system and new alignment. Watershed timing associated with the new pipe system alignments is also considered. For each alternative condition, the watershed timing did not change the result significantly. Therefore, increased discharge associated with only one of the alternatives is presented. Table 7 presents discharges associated with existing conditions and proposed conditions to Athens Alley and at key downstream locations.

Table 7: Downstream Discharges (cfs)

Location	2-yr existing	2-yr proposed	10-year existing	10-year proposed	100-year existing	100-year proposed
Athens Alley inflow	91	91	134	134	202	202
Athens Alley outflow	76	91	124	134	195	202
Annex/Kelton intersection	92	106	147	158	232	239
Delwood/Kelton intersection	109	129	174	192	278	292
Entrance to Keystone High School	413	438	638	677	1037	1061

As a result of the proposed improvements, discharges increase between 5 to 15 percent along Kelton Avenue drainage from Annex Avenue to Delwood Avenue. Under existing conditions, the pipe system does not meet design standards and surcharge overflows onto Kelton Avenue. The proposed improvements may increase the frequency and depth of roadway flooding, therefore, we recommend improving the Kelton Avenue pipe system to offset the potential increased discharges. Shaping the inside floor of the structure (catch basins and manholes) inverts so that manhole loses are reduced is an option that provides additional capacity to offset the potential increased discharges. Construction costs of improved inlet inverts are included in each alternative's construction cost estimate.

Discharges increase between 2 to 7 percent along the pipe system serving the Keystone High School recreational fields. Protecting recreational fields from flooding is typically not a high priority or industry standard for drainage design. Therefore, we believe that the slight increase (2 to 6 percent) in discharge may be acceptable.

Public Involvement

A key aspect of the evaluation of Stormwater Infrastructure Improvements for Athens Alley was to engage the Dormont community, educate them on the nature of the stormwater problem in the Athens Alley area, and to provide opportunities to participate in developing solutions to this problem.

The scope of the public outreach was to educate and inform stakeholders, including elected officials and Dormont residents, homeowners, and business owners within the watershed, about the alternatives analysis process and allow community members to provide input to the process. Two public meetings were held. The meetings were noticed on the Borough website and through media contacts. For the second meeting, a mailer was also distributed to more directly communicate with affected residents.

Hazen and Sawyer lead both meetings, presenting similar material at each using a slide presentation and several graphical boards. The slides and boards from the second meeting are included in Appendix C for reference. Introductions were made at the start of the meeting and information was presented identifying the purpose of the study and existing conditions. Flooding that has been occurring in Athens Alley is due to undersized storm conduits, too few and poorly located storm system inlets, and a segment of reversed slope storm sewer. Next, the detailed alternatives analysis performed by H&S was presented and the group discussed the four feasible grey alternatives (augmented conveyance capacity), proposed additional catch basin inlets, and identified green infrastructure source control opportunities. Constructability concerns were also presented by H&S and cost estimates were provided for each of the grey alternatives for three different levels of service; the 2-yr, 10-yr, and 100-yr design storms, as well as for the additional catch basins. Lastly, downstream impacts were discussed, and the green infrastructure analysis and potential costs were explained in detail.

The first public meeting was held Monday, March 18, 2013. A meeting notification was generated and the meeting was noticed starting in February on the Borough's website. A notice was also

posted to the Borough's Facebook site and accompanied by a twitter feed with a link to the site. Additionally, the notice was published in the Dormont Newsletter and several newspapers including the Dormont-Brookline Patch, and the Pittsburgh Post-Gazette. Notice of the public meeting was also provided at the March 4th Borough Council Meeting.

The March 18th, meeting had a turnout of six citizens in addition to several Dormont Council members, the Borough Engineer and the Borough Manager.

Interaction by all participants was encouraged and questions and concerns were discussed and addressed throughout the meeting. At the end of the presentation the audience was polled about their preference regarding the alternatives presented, including the potential for no action by the Borough. The feedback received at the meeting included an overall consensus that the Borough should move forward with implementing a project to address the chronic flooding. The stakeholders present were generally in favor of implementing the alternative that includes constructing a bypass storm sewer from the location of the sag in Athens Alley southeast to Annex Avenue and then southwest where it connects back to the existing storm sewer in Kelton Avenue (Alternative 3). However, two of the stakeholders present own a home near the corner of Athens Alley and Annex Avenue, and were opposed to the alternative preferred by others due to the proximity of proposed construction to their home. They were concerned about potential damage to their structure. Hazen and Sawyer discussed techniques used to avoid damage to existing structures, including prohibitory language in the construction contract documents, pre- and post-construction photographic/video surveys, vibration monitoring, shoring techniques, and other contractor means and methods. Regarding green infrastructure source reduction, comments received at the meeting suggest that the community is not in favor of installing green infrastructure source controls. This is mainly due to the limited benefit expected from installing green infrastructure, however, there was also a concern that infiltrating water may lead to water entering nearby basements.

The second public meeting was held on April 24th, 2013, and was attended by 13 citizens in addition to 3 council members and the Borough Manager. The increase in participation was likely due to the

additional public outreach by the Borough which included sending out mailers to 166 addresses within the Athens Alley drainage area. The meeting format was similar to the first meeting, providing opportunity for public comment throughout. Several of the homeowners most affected by the flooding were present and shared stories of property damage to retaining walls, staircases, homes, and vehicles. A video of recent flooding captured by one of the resident's was shown that clearly documented how quickly and how high the water can rise in the alley. During this second meeting, stakeholder questions focused more on constructability issues, construction impacts, and overall construction schedule. The predominant concern was diminished parking availability during construction with commenter's noting that the area is already parking starved.

There were also a number of questions during the meeting regarding how the project would be funded. The Borough Manager described several alternative funding scenarios, but also noted the project is not at a point that Council has thoroughly considered the funding details. The Borough has identified potential grant sources that may be available, in addition to the Local Government Academy Grant that had already been awarded for the project, should the project move forward. Ultimately, the focus of the meeting was to inform the stakeholders and gather consent around which alternative is the most acceptable to the community. As was the case during the first meeting, the majority agreed that the Borough should initiate a project to correct the drainage issue and that the alternative providing additional conveyance from the sag in Athens Alley to Annex Avenue and over to Kelton Avenue (Alternative 3) would be preferred. Alternatively, one stakeholder from Hillsdale Avenue with a garage entrance on Athens Alley indicated a preference for the "do nothing alternative". Reasons given included the potential cost of the project, the limited number of residents actually being affected by the flooding, and the potential impact the project may have on parking within the alley. In response, several of the affected stakeholders noted that the localized flooding was a result of runoff from a much larger area that starts north of West Liberty Avenue and East of Wisconsin Avenue.

In addition to the meetings, two separate letters were submitted to the borough from concerned citizens. Scans of the letters are included in Appendix D. The first of the letters proposed the "Do

Nothing" alternative, incorrectly reasoning that only one homeowner is affected and that flooding is due to a build-up of leaves causing the problem. There are approximately a dozen homes on the downhill side of the Alley affected by runoff generated over a 32 acre area, and as has been determined by the analysis described above, there are several issues contributing to the flooding, including the high flows generated due to the size of the drainage area, an undersized storm drainage system to handle those flows, too few and incorrectly placed storm inlets, and a reverse grade storm sewer segment. The second letter indicates that the sight of the flooding is "quite shocking" and that the water was "raging". The author proposes a low cost alternative using an additional storm inlet, as well as cordoning off the intersection of Athens Alley and Lima Alley with road barriers and traffic signs to prevent thru traffic. Based on the information provided, it appears that the concept is to store water at this location. The flooding volume for each level of control was calculated as part of this analysis and it was determined that storage is not a feasible alternative for addressing this issue.

Conclusions and Recommendation

A detailed analysis of the drainage system that contributes to the flooding of Athens Alley was conducted using a HEC-1 model and the NRCS Unit Hydrograph method. This analysis incorporated available GIS, field survey data, LIDAR topographic data, and information gathered through additional field reconnaissance. The evaluation defined existing conditions and evaluated alternatives for addressing the chronic flooding. The analysis was presented to stakeholders and their input was sought on the preferred alternative, including the "do nothing" alternative. Conclusions from the analysis and our recommendations follow.

Conclusions

The PennDOT Drainage Manual requires pipe systems be designed to pass the 10-year storm without roadway flooding. However, it does not provide standards to protect buildings from flooding; however, the industry standard for building flooding protection is typically the 100-year flood event with a minimum of one foot freeboard. The analysis found that the majority of the drainage system is undersized and cannot convey even the flows generated from the 2-year storm event. Additionally,

desk top and field evaluations identified that the system has too few and poorly placed storm inlets that results in significant overland flow to the Athens Alley sag. As a result, stormwater runoff generated from the tributary area that ranges north of West Liberty Avenue and East of Wisconsin Avenue causes localized flooding in Athens Alley. The flooding occurs due to the combination of overland flow and storm drainage surcharging from inlets located within the Athens Alley sag.

Based upon the results of the existing conditions analysis, four conveyance alternatives for alleviating street and building flooding were developed and evaluated. An evaluation was also conducted to determine where additional storm inlets could be easily added to the existing system to address overland flow issues. In addition, storage and green infrastructure source control measures were also considered. Each alternative was evaluated based on its ability to meet level of service standards and three conveyance alternatives were found to be feasible. Storage was not found to be feasible, as it would be too costly to provide the volume required within the available rights-of-way. Similarly, even a high level of green infrastructure source reduction will not eliminate the need for additional conveyance or significantly reduce the size of the required conveyance. However, source controls could offset increased flows to areas downstream of the project area due to conveying peak flows that are currently attenuated by flooding in Athens Alley.

Recommendation

The intent of this study was to identify potential solutions to reduce or eliminate drainage issues leading to localized flooding in Athens Alley and to present them to the Borough Council. The Council will decide whether or not implementation of stormwater drainage improvements is in the best interest of the Borough. Should the Council decide to move forward with implementation of stormwater drainage improvements, we recommend installation of a 42-inch relief pipe along Athens Alley and Annex Avenue to Kelton Avenue (Alternative 3B), as well as installation of additional storm inlets upstream to address overland flow issues. This alternative is depicted in Figure 4. Select implementation of green infrastructure source controls should also be considered to provide peak flow attenuation to minimize downstream impacts. Green Infrastructure source reduction could be implemented over time as streets are repaved or when grant monies become available.

Borough of Dormont, PA

Athens Alley Stormwater Improvements Recommended Alternative

Legend

- Athens to Annex
- Proposed Catch Basins
- Proposed CB Connectors
- Storm_Structure
- Storm_Pipe

FIGURE 4
June 2013

HAZEN AND SAWYER
Environmental Engineers & Scientists

Installing a 42-inch relief pipe from the Athens Alley sag to the intersection of Annex Avenue and Kelton Avenue is recommended over the other implementation alternatives for the following reasons:

- This alternative has the lowest estimated construction cost of the three feasible alternatives.
- The majority of the construction for this alternative will occur within Athens Alley, with a short portion on Annex Avenue, a tertiary street. The other two feasible alternatives would require more (linear feet) construction on a well travelled through way, Kelton Avenue, a collector street.
- The other two feasible alternatives are anticipated to have greater neighborhood impacts such as traffic and parking interruptions (Texas to Kelton) or constructability challenges due to proximity of the construction to existing homes (Athens to Kelton).
- The Athens to Kelton Alternative (Alternative 4) is a replacement alternative that would require significantly more by-pass pumping than the other two alternatives, which are relief alternatives. By-pass pumping will likely not be required for the relief alternatives as it is expected that connections to the existing storm drains can be completed during dry weather.
- The feedback received at the two public meetings generally indicated a preference for the Borough to implement stormwater drainage improvements to address the flooding problem in Athens Alley. Similarly, the general consensus was to construct a relief sewer from the sag in Athens Alley over to Annex Avenue and connect back into the existing storm drain in Kelton Avenue. However, there were several stakeholders in opposition to either moving forward with implementation, or with the proposed route.

Should the Council decide to proceed with installation of the recommended alternative, it is further recommended that the design provide a level of service consistent with the 100-year event, the industry standard for building protection. For the recommended alternative, this equates to a 42-inch diameter pipe. Alternatively, the Borough could consider a level of service consistent with the PennDOT Drainage Manual standard for passing the 10-year storm to protect against roadway flooding, which would still significantly relieve the flooding issue in Athens Alley. However, based on the preliminary construction cost estimate, the additional protection is estimated to only add about 10% to the construction cost.

APPENDIX A

PRELIMINARY CONSTRUCTION COST ESTIMATES

Appendix A - Table Alt 1a

PROJECT:	Athens Alley Stormwater Improvments - Alternative 1			
NUMBER:	50055-000			
ESTIMATE:	**$431,000**			
EST. BY:		MD	DATE:	2/15/2013
CHECK BY:		SRS	DATE:	2/18/2013

Item Description	**Quantity**	**Unit**	**Unit Price**	**Amount**
Mobilization	1	LS	$20,000.00	$20,000.00
Select Backfill Material	1,088	TN	$20.00	$21,760.00
Undercut Excavation	135	CY	$30.00	$4,050.00
Trench Rock Removal	135	CY	$100.00	$13,500.00
Removal of Existing Pavement	1,840	SY	$20.00	$36,800.00
Removal of existing curb and gutter	480	LF	$5.00	$2,400.00
4-inch sidewalk	100	SY	$30.00	$3,000.00
Bituminous Concrete Base Course, Type HB	621	TN	$103.00	$63,963.00
Bituminous Concrete Binder Course, Type H	205	TN	$103.00	$21,115.00
Bituminous Concrete Surface Course	205	TN	$103.00	$21,115.00
12 Inch DIP Casing Pipe For Gravity Sewer	80	LF	$85.00	$6,800.00
4"/5" Laterals	180	LF	$66.00	$11,880.00
Precast Traffic Bearing Junction Box	5	EA	$2,000.00	$10,000.00
Special Traffic Bearing box	1	EA	$8,000.00	$8,000.00
Manhole Frame and Cover	6	EA	$380.00	$2,280.00
RCP Class III Pipe 36"	625	LF	$80.00	$50,000.00
RCP Class IV Pipe 36"	100	LF	$110.00	$11,000.00
2'-6" Concrete Curb and Gutter	480	LF	$21.00	$10,080.00
Temporary inlet protection (5ft inlets)	4	EA	$125.00	$500.00
Temporary Silt Fence	1,200	LF	$4.00	$4,800.00
Utility protection	1	LS	$20,000.00	$20,000.00
Pavement Marking Lines - 4" Yellow Street CL THERMOPLASTIC TAPE	580	LF	$4.00	$2,320.00
Inlet invert improvements	4	EA	$500.00	$2,000.00
Roadway Safety Control		LS		$12,000.00
	Subtotal			$359,363.00
	20 percent contingency			$71,872.60
	Engineer's Estimate			$431,235.60
			SAY	$431,000

Appendix A - Table Alt 1b

PROJECT:	Athens Alley Stormwater Improvments - Alternative 1			
NUMBER:	50055-000			
ESTIMATE:	**$464,000**			
EST. BY:		MD	DATE:	2/15/2013
CHECK BY:		SRS	DATE:	2/18/2013

Item Description	Quantity	Unit	Unit Price	Amount
Mobilization	1	LS	$20,000.00	$20,000.00
Select Backfill Material	1,088	TN	$20.00	$21,760.00
Undercut Excavation	145	CY	$30.00	$4,350.00
Trench Rock Removal	145	CY	$100.00	$14,500.00
Removal of Existing Pavement	1,840	SY	$20.00	$36,800.00
Removal of existing curb and gutter	480	LF	$5.00	$2,400.00
4-inch sidewalk	100	SY	$30.00	$3,000.00
Bituminous Concrete Base Course, Type HB	621	TN	$103.00	$63,963.00
Bituminous Concrete Binder Course, Type H	205	TN	$103.00	$21,115.00
Bituminous Concrete Surface Course	205	TN	$103.00	$21,115.00
12 Inch DIP Casing Pipe For Gravity Sewer	80	LF	$85.00	$6,800.00
4"/5" Laterals	180	LF	$66.00	$11,880.00
Precast Traffic Bearing Junction Box	5	EA	$2,500.00	$12,500.00
Special Traffic Bearing box	1	EA	$10,000.00	$10,000.00
Manhole Frame and Cover	6	EA	$380.00	$2,280.00
RCP Class III Pipe 42"	625	LF	$110.00	$68,750.00
RCP Class IV Pipe 42"	100	LF	$140.00	$14,000.00
2'-6" Concrete Curb and Gutter	480	LF	$21.00	$10,080.00
Temporary inlet protection (5ft inlets)	4	EA	$125.00	$500.00
Temporary Silt Fence	1,200	LF	$4.00	$4,800.00
Utility protection	1	LS	$20,000.00	$20,000.00
Pavement Marking Lines - 4" Yellow Street CL THERMOPLASTIC TAPE	580	LF	$4.00	$2,320.00
Inlet invert improvements	4	EA	$500.00	$2,000.00
Roadway Safety Control		LS		$12,000.00
	Subtotal			$386,913.00
	20 percent contingency			$77,382.60
	Engineer's Estimate			$464,295.60
			SAY	$464,000

Appendix A - Table Alt 1c

PROJECT:	Athens Alley Stormwater Improvments - Alternative 1			
NUMBER:	50055-000			
ESTIMATE:	**$412,000**			
EST. BY:		MD	DATE:	2/15/2013
CHECK BY:		SRS	DATE:	2/18/2013

Item Description	**Quantity**	**Unit**	**Unit Price**	**Amount**
Mobilization	1	LS	$20,000.00	$20,000.00
Select Backfill Material	1,088	TN	$20.00	$21,760.00
Undercut Excavation	125	CY	$30.00	$3,750.00
Trench Rock Removal	125	CY	$100.00	$12,500.00
Removal of Existing Pavement	1,840	SY	$20.00	$36,800.00
Removal of existing curb and gutter	480	LF	$5.00	$2,400.00
4-inch sidewalk	100	SY	$30.00	$3,000.00
Bituminous Concrete Base Course, Type HB	621	TN	$103.00	$63,963.00
Bituminous Concrete Binder Course, Type H	205	TN	$103.00	$21,115.00
Bituminous Concrete Surface Course	205	TN	$103.00	$21,115.00
12 Inch DIP Casing Pipe For Gravity Sewer	80	LF	$85.00	$6,800.00
4"/5" Laterals	180	LF	$66.00	$11,880.00
Precast Traffic Bearing Junction Box	5	EA	$1,800.00	$9,000.00
Special Traffic Bearing box	1	EA	$7,000.00	$7,000.00
Manhole Frame and Cover	6	EA	$380.00	$2,280.00
RCP Class III Pipe 30"	625	LF	$65.00	$40,625.00
RCP Class IV Pipe 30"	100	LF	$80.00	$8,000.00
2'-6" Concrete Curb and Gutter	480	LF	$21.00	$10,080.00
Temporary inlet protection (5ft inlets)	4	EA	$125.00	$500.00
Temporary Silt Fence	1,200	LF	$4.00	$4,800.00
Utility protection	1	LS	$20,000.00	$20,000.00
Pavement Marking Lines - 4" Yellow Street CL THERMOPLASTIC TAPE	580	LF	$4.00	$2,320.00
Inlet invert improvements	4	EA	$500.00	$2,000.00
Roadway Safety Control		LS		$12,000.00
	Subtotal			$343,688.00
	20 percent contingency			$68,737.60
	Engineer's Estimate			$412,425.60
			SAY	$412,000

Appendix A - Table Alt 1 (Surface Inlets)

PROJECT:	Athens Alley Stormwater Improvments - Alternative 1			
NUMBER:	50055-000			
ESTIMATE:	**$76,000**			
EST. BY:	MD		DATE:	2/15/2013
CHECK BY:			DATE:	2/18/2013

Item Description	**Quantity**	**Unit**	**Unit Price**	**Amount**
Mobilization	1	LS	$4,000.00	$4,000.00
Select Backfill Material	150	TN	$20.00	$3,000.00
Undercut Excavation	10	CY	$30.00	$300.00
Trench Rock Removal	10	CY	$100.00	$1,000.00
Removal of Existing Pavement	150	SY	$20.00	$3,000.00
Removal of existing curb and gutter	100	LF	$5.00	$500.00
4-inch sidewalk	10	SY	$30.00	$300.00
Bituminous Concrete Base Course, Type HB	50	TN	$103.00	$5,150.00
Bituminous Concrete Binder Course, Type H	15	TN	$103.00	$1,545.00
Bituminous Concrete Surface Course	15	TN	$103.00	$1,545.00
4"/5" Laterals	20	LF	$66.00	$1,320.00
Precast Traffic Bearing Junction Box	12	EA	$2,000.00	$24,000.00
Manhole Frame and Cover	12	EA	$380.00	$4,560.00
RCP Class III Pipe 18"	145	LF	$40.00	$5,800.00
2'-6" Concrete Curb and Gutter	100	LF	$21.00	$2,100.00
Temporary inlet protection (5ft inlets)	9	EA	$125.00	$1,125.00
Temporary Silt Fence	200	LF	$4.00	$800.00
Utility protection	1	LS	$1,000.00	$1,000.00
Roadway Safety Control		LS		$2,000.00
	Subtotal			$63,045.00
	20 percent contingency			$12,609.00
	Engineer's Estimate			$75,654.00
			SAY	$76,000

Appendix A - Table Alt 3a

PROJECT:	Athens Alley Stormwater Improvments - Alternative 3			
NUMBER:	50055-000			
ESTIMATE:	**$303,000**			
EST. BY:		MD	DATE:	2/15/2013
CHECK BY:		SRS	DATE:	2/18/2013

Item Description	**Quantity**	**Unit**	**Unit Price**	**Amount**
Mobilization	1	LS	$10,750.00	$10,750.00
Select Backfill Material	858	TN	$20.00	$17,160.00
Undercut Excavation	105	CY	$30.00	$3,150.00
Trench Rock Removal	105	CY	$100.00	$10,500.00
Removal of Existing Pavement	1,050	SY	$20.00	$21,000.00
Removal of existing curb and gutter	320	LF	$5.00	$1,600.00
4-inch sidewalk	100	SY	$30.00	$3,000.00
Fence replacement	200	LF	$30.00	$6,000.00
Bituminous Concrete Base Course, Type HB	351	TN	$103.00	$36,153.00
Bituminous Concrete Binder Course, Type H	117	TN	$103.00	$12,051.00
Bituminous Concrete Surface Course	117	TN	$103.00	$12,051.00
12 Inch DIP Casing Pipe For Gravity Sewer	20	LF	$85.00	$1,700.00
Precast Traffic Bearing Junction Box	6	EA	$2,000.00	$12,000.00
Special traffic bearing box	1	EA	$8,000.00	$8,000.00
Manhole Frame and Cover	7	EA	$380.00	$2,660.00
Precast Catch Basin	1	EA	$2,000.00	$2,000.00
RCP Class III Pipe 18"	20	LF	$40.00	$800.00
RCP Class III Pipe 36"	465	LF	$80.00	$37,200.00
RCP Class IV Pipe 36"	100	LF	$110.00	$11,000.00
2'-6" Concrete Curb and Gutter	360	LF	$21.00	$7,560.00
Temporary inlet protection (5ft inlets)	4	EA	$125.00	$500.00
Temporary Silt Fence	1,200	LF	$4.00	$4,800.00
Utility protection	1	LS	$20,000.00	$20,000.00
Pavement Marking Lines - 4" Yellow Street CL THERMOPLASTIC TAPE	580	LF	$4.00	$2,320.00
Inlet invert improvements	4	EA	$500.00	$2,000.00
Roadway Safety Control		LS		$6,450.00
	Subtotal			$252,405.00
	20 percent contingency			$50,481.00
	Engineer's Estimate			$302,886.00
			SAY	$303,000

Appedix A - Table Alt 3b

PROJECT:	Athens Alley Stormwater Improvments - Alternative 3			
NUMBER:	50055-000			
ESTIMATE:	**$331,000**			
EST. BY:		MD	DATE:	2/15/2013
CHECK BY:		SRS	DATE:	2/18/2013

Item Description	Quantity	Unit	Unit Price	Amount
Mobilization	1	LS	$10,750.00	$10,750.00
Select Backfill Material	858	TN	$20.00	$17,160.00
Undercut Excavation	115	CY	$30.00	$3,450.00
Trench Rock Removal	115	CY	$100.00	$11,500.00
Removal of Existing Pavement	1,050	SY	$20.00	$21,000.00
Removal of existing curb and gutter	320	LF	$5.00	$1,600.00
4-inch sidewalk	100	SY	$30.00	$3,000.00
Fence replacement	200	LF	$30.00	$6,000.00
Bituminous Concrete Base Course, Type HB	351	TN	$103.00	$36,153.00
Bituminous Concrete Binder Course, Type H	117	TN	$103.00	$12,051.00
Bituminous Concrete Surface Course	117	TN	$103.00	$12,051.00
12 Inch DIP Casing Pipe For Gravity Sewer	20	LF	$85.00	$1,700.00
Precast Traffic Bearing Junction Box	6	EA	$2,500.00	$15,000.00
Special traffic bearing box	1	EA	$10,000.00	$10,000.00
Manhole Frame and Cover	7	EA	$380.00	$2,660.00
Precast Catch Basin	1	EA	$2,000.00	$2,000.00
RCP Class III Pipe 18"	20	LF	$40.00	$800.00
RCP Class III Pipe 42"	465	LF	$110.00	$51,150.00
RCP Class IV Pipe 42"	100	LF	$140.00	$14,000.00
2'-6" Concrete Curb and Gutter	360	LF	$21.00	$7,560.00
Temporary inlet protection (5ft inlets)	4	EA	$125.00	$500.00
Temporary Silt Fence	1,200	LF	$4.00	$4,800.00
Utility protection	1	LS	$20,000.00	$20,000.00
Pavement Marking Lines - 4" Yellow Street CL THERMOPLASTIC TAPE	580	LF	$4.00	$2,320.00
Inlet invert improvements	4	EA	$500.00	$2,000.00
Roadway Safety Control		LS		$6,450.00
	Subtotal			$275,655.00
	20 percent contingency			$55,131.00
	Engineer's Estimate			$330,786.00
			SAY	$331,000

Appedix A - Table Alt 3c

PROJECT:	Athens Alley Stormwater Improvments - Alternative 3		
NUMBER:	50055-000		
ESTIMATE:	**$289,000**		
EST. BY:	MD	DATE:	2/15/2013
CHECK BY:	SRS	DATE:	2/18/2013

Item Description	Quantity	Unit	Unit Price	Amount
Mobilization	1	LS	$10,750.00	$10,750.00
Select Backfill Material	858	TN	$20.00	$17,160.00
Undercut Excavation	105	CY	$30.00	$3,150.00
Trench Rock Removal	105	CY	$100.00	$10,500.00
Removal of Existing Pavement	1,050	SY	$20.00	$21,000.00
Removal of existing curb and gutter	320	LF	$5.00	$1,600.00
4-inch sidewalk	100	SY	$30.00	$3,000.00
Fence replacement	200	LF	$30.00	$6,000.00
Bituminous Concrete Base Course, Type HB	351	TN	$103.00	$36,153.00
Bituminous Concrete Binder Course, Type H	117	TN	$103.00	$12,051.00
Bituminous Concrete Surface Course	117	TN	$103.00	$12,051.00
12 Inch DIP Casing Pipe For Gravity Sewer	20	LF	$85.00	$1,700.00
Precast Traffic Bearing Junction Box	6	EA	$1,800.00	$10,800.00
Special traffic bearing box	1	EA	$7,000.00	$7,000.00
Manhole Frame and Cover	7	EA	$380.00	$2,660.00
Precast Catch Basin	1	EA	$2,000.00	$2,000.00
RCP Class III Pipe 18"	20	LF	$40.00	$800.00
RCP Class III Pipe 30"	465	LF	$65.00	$30,225.00
RCP Class IV Pipe 30"	100	LF	$85.00	$8,500.00
2'-6" Concrete Curb and Gutter	360	LF	$21.00	$7,560.00
Temporary inlet protection (5ft inlets)	4	EA	$125.00	$500.00
Temporary Silt Fence	1,200	LF	$4.00	$4,800.00
Utility protection	1	LS	$20,000.00	$20,000.00
Pavement Marking Lines - 4" Yellow Street CLTHERMOPLASTIC TAPE	580	LF	$4.00	$2,320.00
Inlet invert improvements	4	EA	$500.00	$2,000.00
Roadway Safety Control		LS		$6,450.00
	Subtotal			$240,730.00
	20 percent contingency			$48,146.00
	Engineer's Estimate			$288,876.00
			SAY	$289,000

Appendix A - Table Alt 4a

PROJECT:	Athens Alley Stormwater Improvments - Alternative 4			
NUMBER:	50055-000			
ESTIMATE:	**$306,000**			
EST. BY:		MD	DATE:	2/15/2013
CHECK BY:		SRS	DATE:	2/18/2013

Item Description	Quantity	Unit	Unit Price	Amount
Mobilization	1	LS	$11,000.00	$7,000.00
Select Backfill Material	167	TN	$20.00	$3,340.00
Undercut Excavation	52	CY	$63.25	$3,289.00
Trench Rock Removal	52	CY	$200.00	$10,400.00
Removal of Existing Pavement	240	SY	$20.00	$4,800.00
Removal of existing curb and gutter	180	LF	$5.00	$900.00
Bituminous Concrete Base Course, Type HB	80	TN	$103.00	$8,240.00
Bituminous Concrete Binder Course, Type H	30	TN	$103.00	$3,090.00
Bituminous Concrete Surface Course, Type	30	TN	$103.00	$3,090.00
Pipe Removal	100	LF	$20.00	$2,000.00
Pipe plug	5	CY	$350.00	$1,750.00
Flowable fill	20	CY	$200.00	$4,000.00
Fence Replacement	300	LF	$30.00	$9,000.00
4"/5" Laterals	120	LF	$66.00	$7,920.00
Precast Traffic Bearing Junction Box	5	EA	$2,000.00	$10,000.00
Manhole Frame and Cover	7	EA	$380.00	$2,660.00
Precast Concrete Manhole	2	EA	$2,000.00	$4,000.00
42 " R.C. Pipe Culverts, Class III	310	LF	$110.00	$34,100.00
Trenchless 42" R.C. Pipe Culverts, Class III	45	LF	$1,800.00	$81,000.00
30 " R.C. Pipe Culverts, Class III	22	LF	$40.00	$880.00
2'-6" Concrete Curb and Gutter	180	LF	$21.00	$3,780.00
4" Concrete Sidewalk	160	SY	$36.00	$5,760.00
Modular Block Retaining Wall	40	SF	$56.00	$2,240.00
Temporary inlet protection (5ft inlets)	3	EA	$125.00	$375.00
Temporary Silt Fence	1,100	LF	$4.00	$4,400.00
Plantings	1	LS	$10,000.00	$10,000.00
Utility protection	1	LS	$20,000.00	$20,000.00
Pavement Marking Lines - 4" Yellow Street CL THERMOPLASTIC TAPE	180	LF	$4.00	$720.00
Inlet invert improvements	4	EA	$500.00	$2,000.00
Roadway Safety Control		LS		$4,000.00

Subtotal		$254,734.00
20 percent contingency		$50,946.80
Engineer's Estimate		$305,680.80
	SAY	$306,000

Appendix A - Table Alt 4b

PROJECT:	Athens Alley Stormwater Improvments - Alternative 4			
NUMBER:	50055-000			
ESTIMATE:	**$357,000**			
EST. BY:		MD	DATE:	2/15/2013
CHECK BY:		SRS	DATE:	2/18/2013

Item Description	Quantity	Unit	Unit Price	Amount
Mobilization	1	LS	$11,000.00	$7,000.00
Select Backfill Material	167	TN	$20.00	$3,340.00
Undercut Excavation	60	CY	$63.25	$3,795.00
Trench Rock Removal	60	CY	$200.00	$12,000.00
Removal of Existing Pavement	240	SY	$20.00	$4,800.00
Removal of existing curb and gutter	180	LF	$5.00	$900.00
Bituminous Concrete Base Course, Type HB	80	TN	$103.00	$8,240.00
Bituminous Concrete Binder Course, Type H	30	TN	$103.00	$3,090.00
Bituminous Concrete Surface Course	30	TN	$103.00	$3,090.00
Pipe Removal	100	LF	$20.00	$2,000.00
Pipe plug	5	CY	$350.00	$1,750.00
Flowable fill	20	CY	$200.00	$4,000.00
Fence Replacement	300	LF	$30.00	$9,000.00
4"/5" Laterals	120	LF	$66.00	$7,920.00
Precast Traffic Bearing Junction Box	5	EA	$2,000.00	$10,000.00
Manhole Frame and Cover	7	EA	$380.00	$2,660.00
Precast Concrete Manhole	2	EA	$2,000.00	$4,000.00
48 " R.C. Pipe Culverts, Class III	310	LF	$140.00	$43,400.00
Trenchless 48" R.C. Pipe Culverts, Class III	45	LF	$2,500.00	$112,500.00
30 " R.C. Pipe Culverts, Class III	22	LF	$40.00	$880.00
2'-6" Concrete Curb and Gutter	180	LF	$21.00	$3,780.00
4" Concrete Sidewalk	160	SY	$36.00	$5,760.00
Modular Block Retaining Wall	40	SF	$56.00	$2,240.00
Temporary inlet protection (5ft inlets)	3	EA	$125.00	$375.00
Temporary Silt Fence	1100	LF	$4.00	$4,400.00
Plantings	1	LS	$10,000.00	$10,000.00
Utility protection	1	LS	$20,000.00	$20,000.00
Pavement Marking Lines - 4" Yellow Street CL THERMOPLASTIC TAPE	180	LF	$4.00	$720.00
Inlet invert improvements	4	EA	$500.00	$2,000.00
Roadway Safety Control		LS		$4,000.00

Subtotal		$297,640.00
20 percent contingency		$59,528.00
Engineer's Estimate		$357,168.00
	SAY	$357,000

APPENDIX B

GREEN INFRASTRUCTURE

Examples of Bioretention Opportunities

Potential Locations:

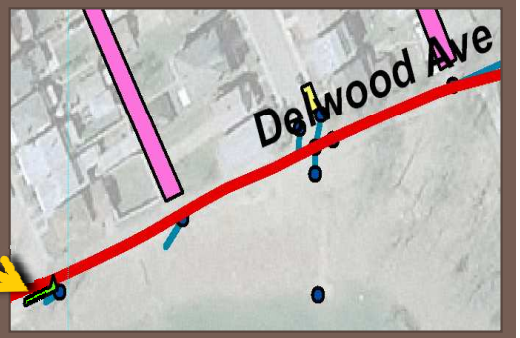
Wisconsin Ave.

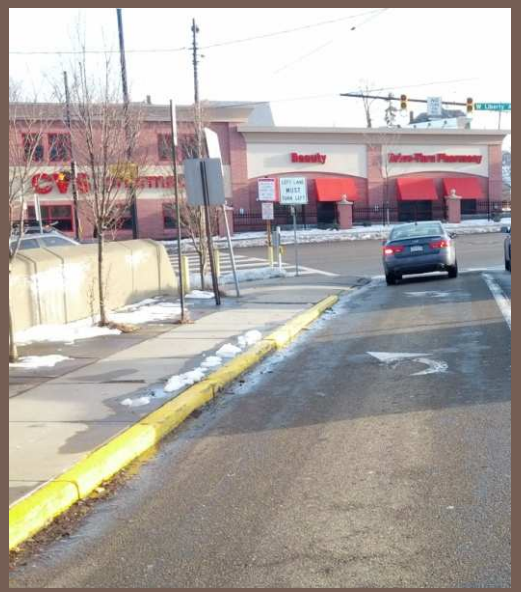
Lima Alley

Dormont Ave.

W. Liberty

Delwood Ave.





Borough of Dormont, PA

Rank - # of Opps

High - 2

Med - 3

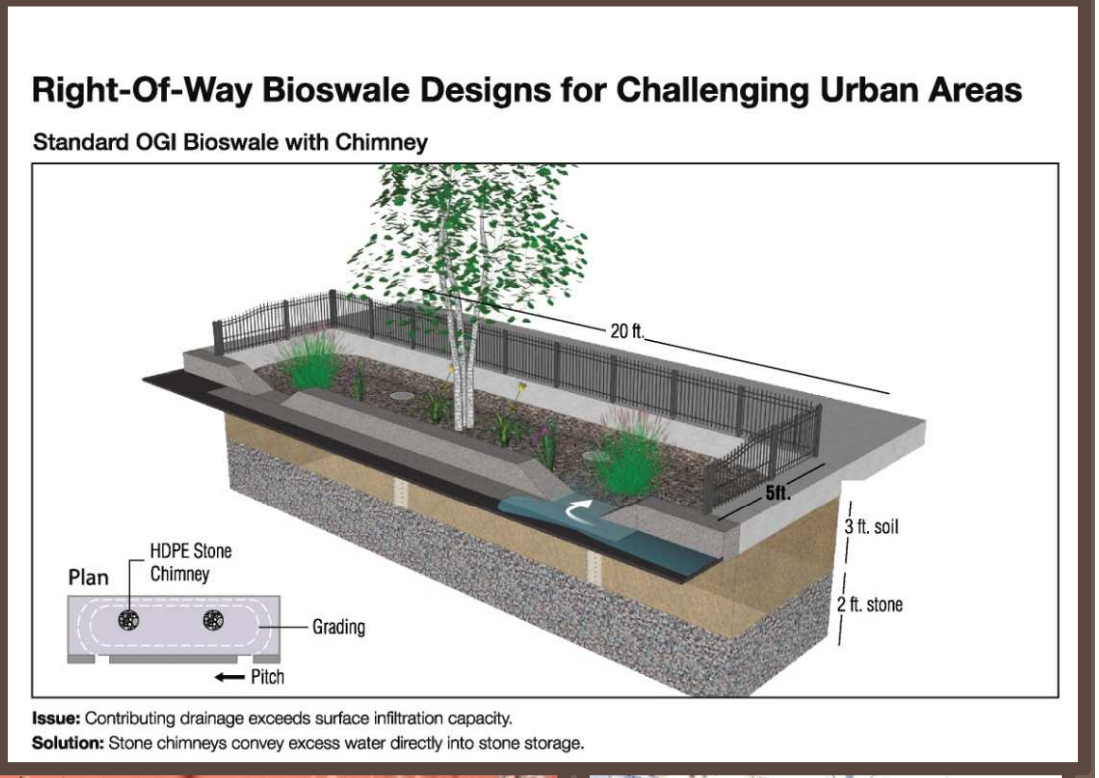
Low - 3

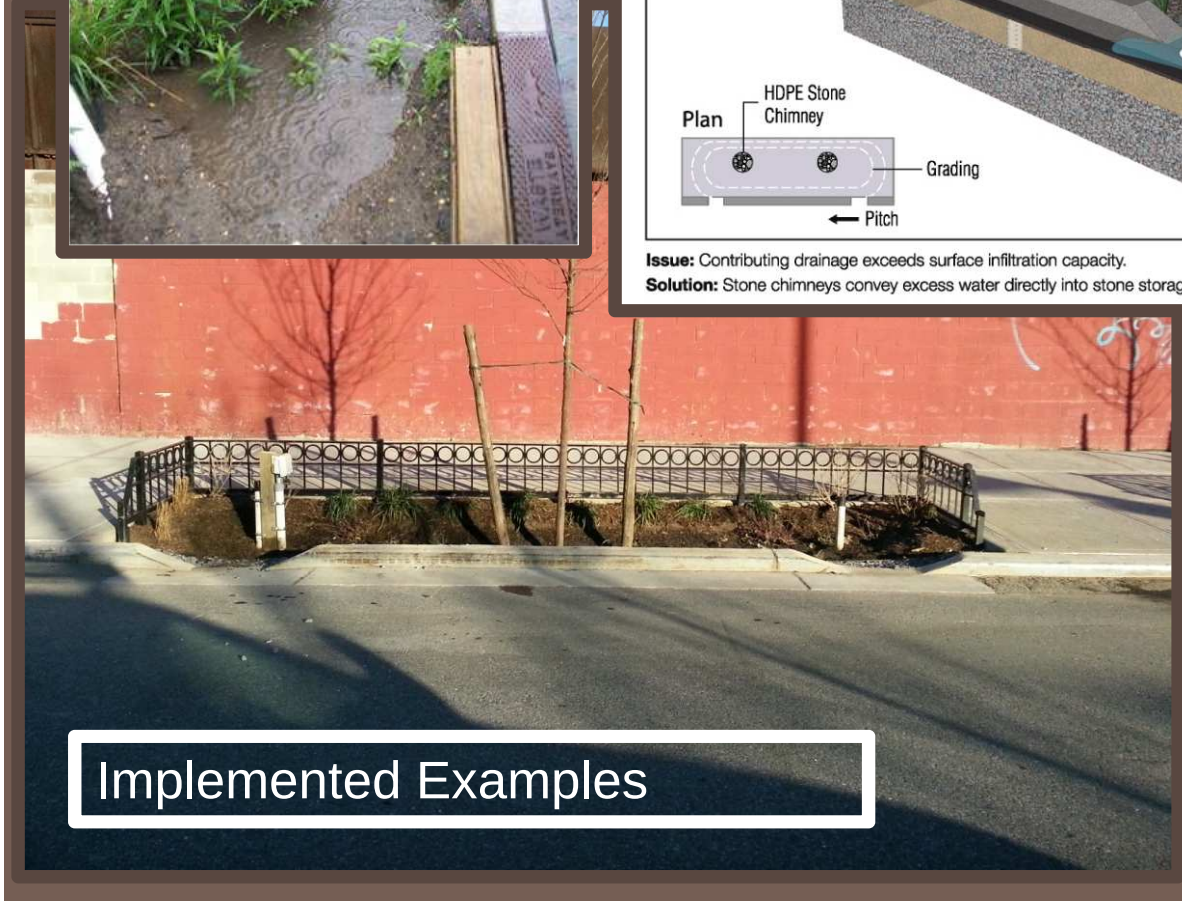
Note: Only opportunities within the "Athens Alley Stormwater Improvements" Watershed have been considered.

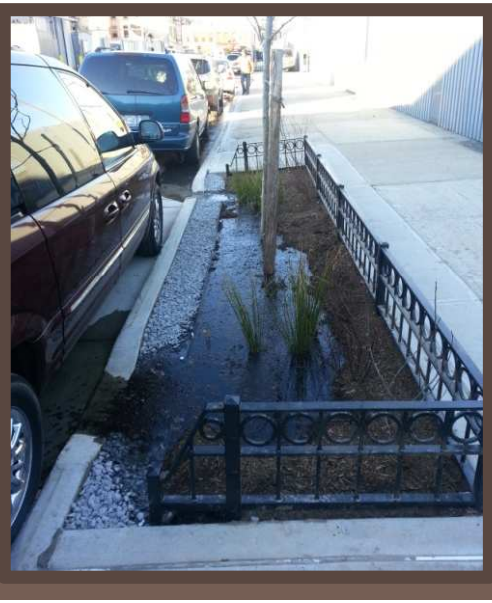
HAZEN AND SAWYER
Environmental Engineers & Scientists

BMP TYPE:
BIORETENTION

Dormont Green Infrastructure Opportunities







Implemented Examples

Borough of Dormont, PA

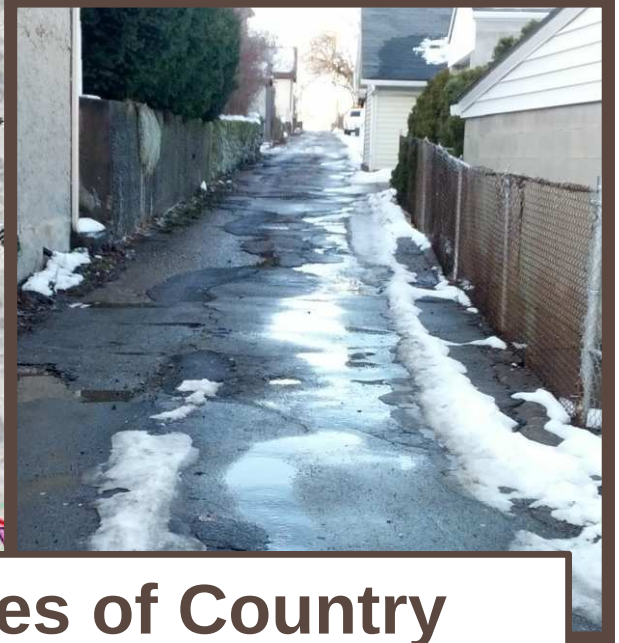
Bioretention:
is the process in which contaminants and sedimentation are removed from stormwater runoff. Stormwater is collected into the treatment area which consists of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. These structures can easily be tied into the existing storm system in several locations within the Athens Alley study area, by installing an underdrain

HAZEN AND SAWYER
Environmental Engineers & Scientists

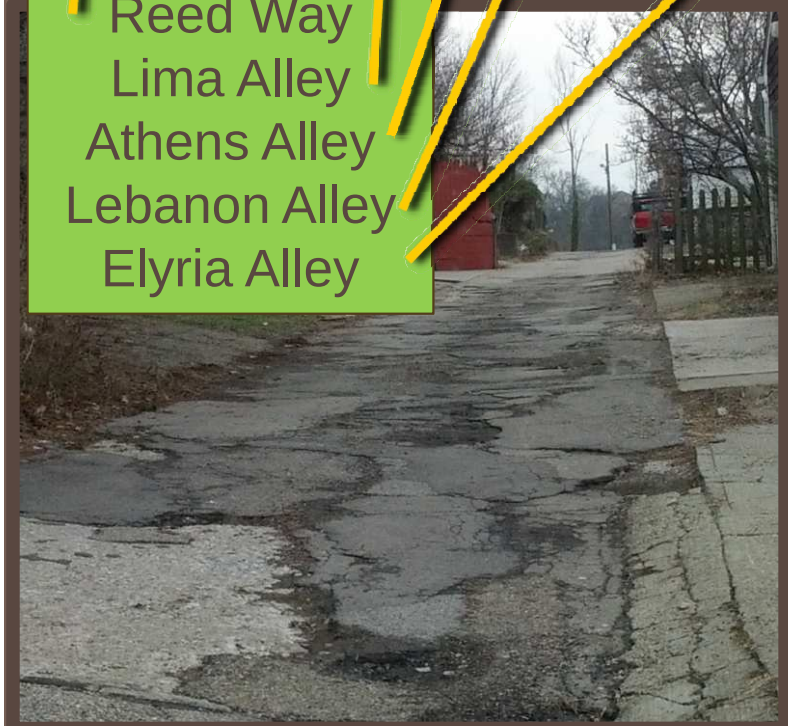
BMP TYPE:
BIORETENTION

Dormont Green Infrastructure Opportunities

Potential Locations:
Reed Way
Lima Alley
Athens Alley
Lebanon Alley
Elyria Alley



Examples of Country Lane Opportunities



Borough of Dormont, PA

Rank - # of Opps

High - 1

Med - 5

Low - 5

Note: Only opportunities within the "Athens Alley Stormwater Improvements" Watershed have been considered.

HAZEN AND SAWYER
Environmental Engineers & Scientists

BMP TYPE:
COUNTRY LANE

Dormont Green Infrastructure Opportunities

Porous Asphalt

Standard Asphalt

FilterPave

Implemented Examples

Design Concept:
While the Country Lane concept is aesthetically pleasing, there are many other types of permeable pavers that can be substituted. Permeable paver blocks/grids can reduce cost, while maintaing the functionality of the roadway and decreasing stormwater runoff entering the sewer system. Effectiveness increases when a suitable permeable sub-layer is provided, and openings in the pervious material used are maximized.

Borough of Dormont, PA

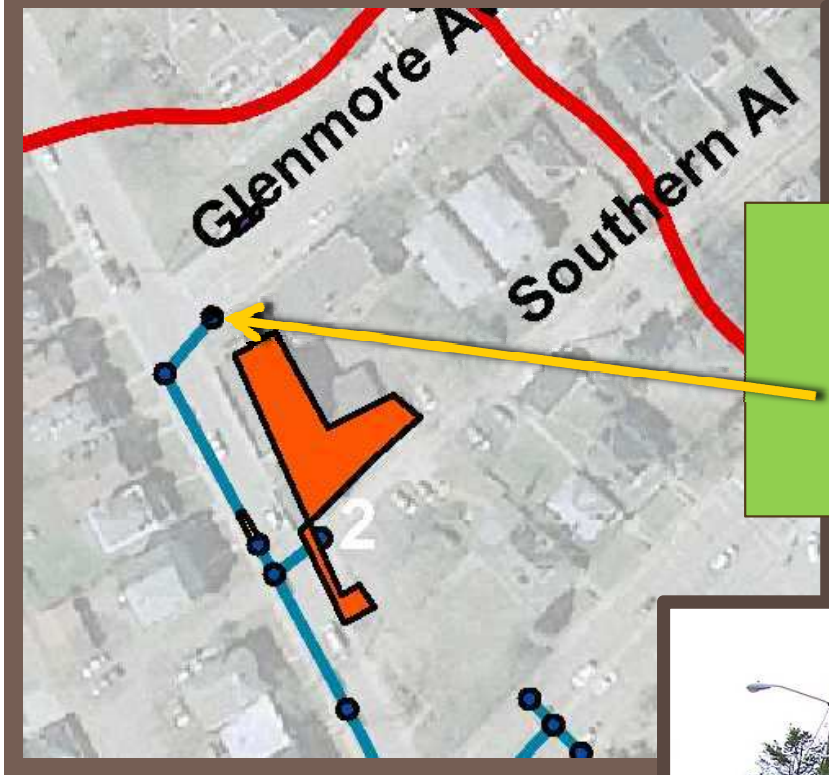
THE BOROUGH OF DORMONT
INCORPORATED 1909

Country Lane:
Asphalt lanes are replaced with two concrete or gravel strips surrounded by structural grass (structural grass is supported by a grid and soil structure that prevents soil compaction and root damage). Connections from the country lane to residences are constructed of permeable materials, including paving blocks, broken concrete sections, and structural grass or gravel.

HAZEN AND SAWYER
Environmental Engineers & Scientists

BMP TYPE:
COUNTRY LANE

Dormont Green Infrastructure Opportunities



Potential Location: Glenmore Avenue

Tree Box Opportunity

Implemented Example

Borough of Dormont, PA

Rank - # of Opps

Low – 1

Note: Only opportunities within the “Athens Alley Stormwater Improvements” Watershed have been considered.

Tree Box:
A minor opportunity to provide bio-retention and promote the use of green infrastructure, while providing aesthetic benefit to the community. Sub-drains can be conveniently connected to the storm sewer network beneath.

HAZEN AND SAWYER
Environmental Engineers & Scientists

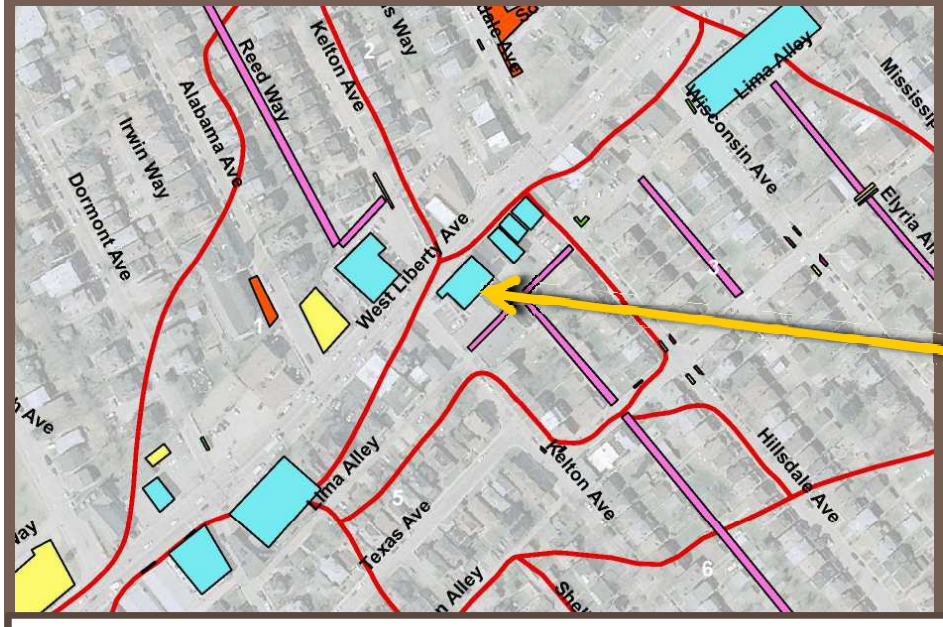
BMP TYPE:
TREE BOX

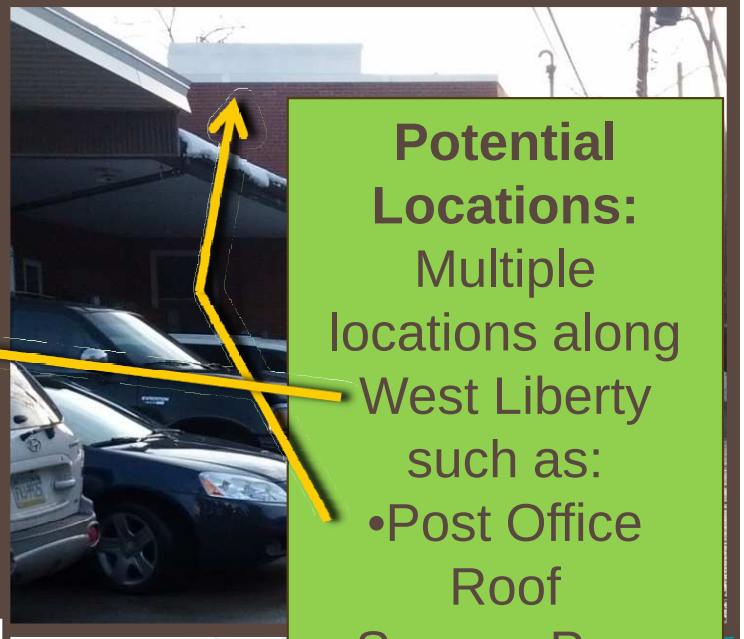
Dormont Green Infrastructure Opportunities

Dormont Green Infrastructure Opportunities

BMP TYPE:
BLUE/GREEN ROOF

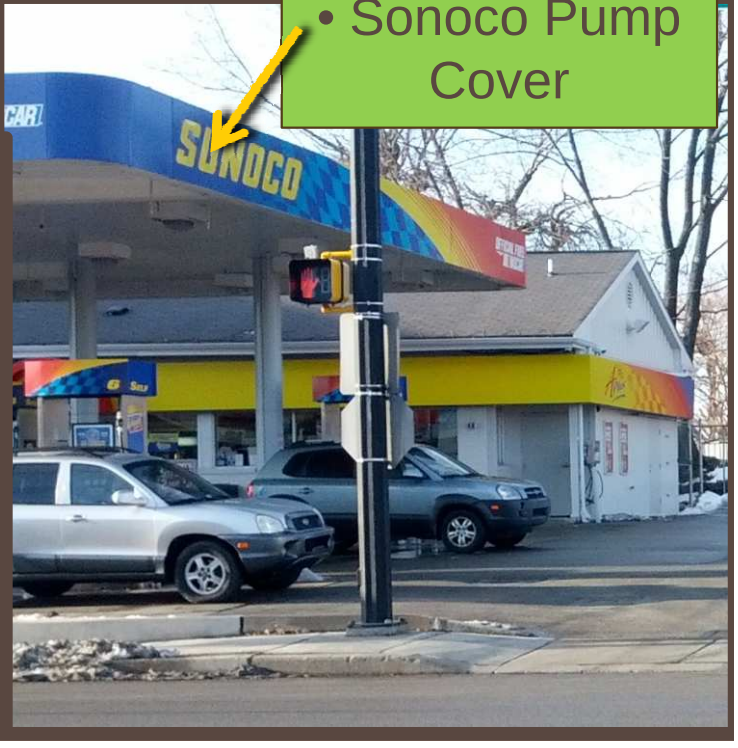
Borough of Dormont, PA





Potential Locations:
Multiple locations along West Liberty such as:
- Post Office Roof
- Sonoco Pump Cover

Examples of Blue Roof or Green Roof Opportunities



Rank - # of Opps

Med - 2

Low - 8

Note: Only opportunities within the "Athens Alley Stormwater Improvements" Watershed have been considered.

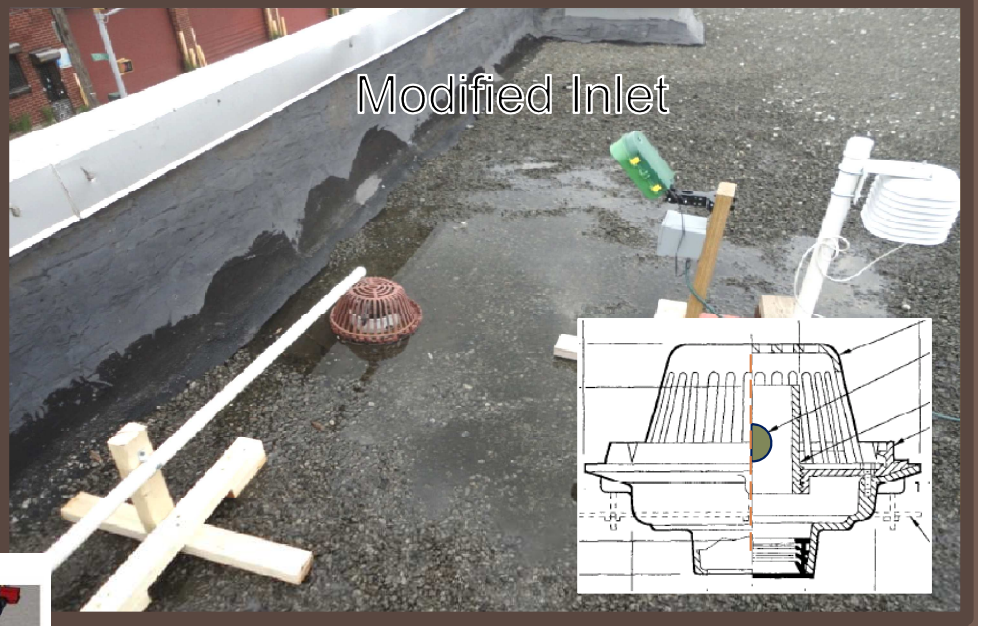
HAZEN AND SAWYER
Environmental Engineers & Scientists

Dormont Green Infrastructure Opportunities

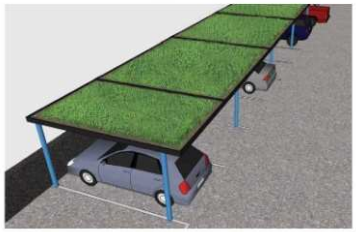
BMP TYPE:
BLUE/GREEN ROOF

Borough of Dormont, PA

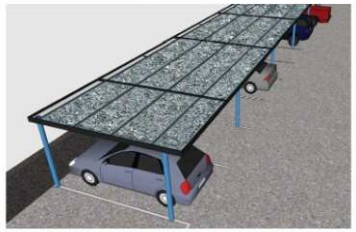
Implemented Examples

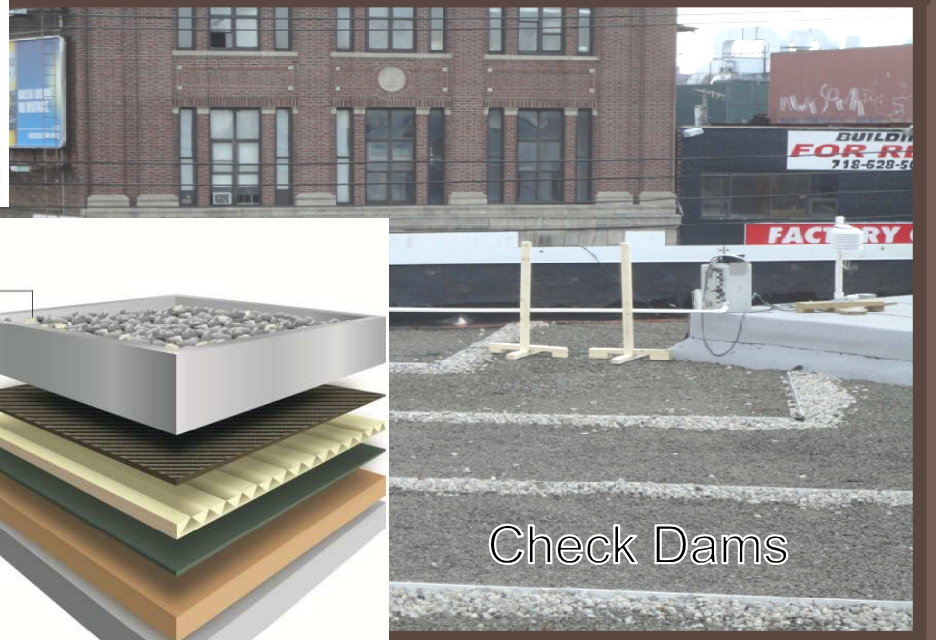


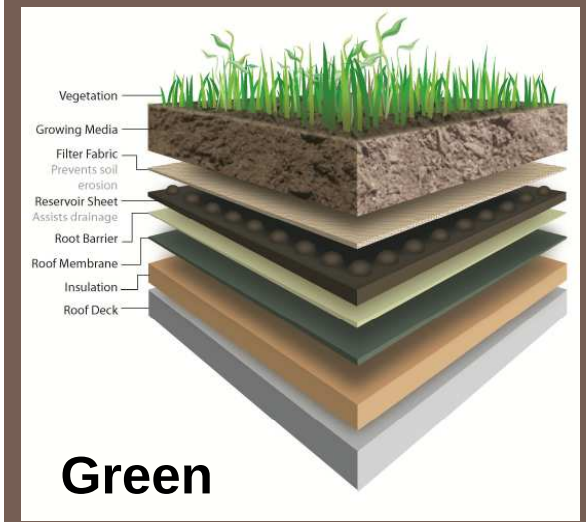
Green Roof Canopy



Blue Roof Canopy







THE BOROUGH OF DORMONT
INCORPORATED 1909

Green or Blue Roofs:
Are a method of attenuating peak storm runoff, and in the case of a green roof, providing evapotranspiration via a growing media from which plants and light vegetation can thrive. Blue roofs can be slightly lighter and require less maintenance, but lack the aesthetic and thermal benefits offered through green roofs. Green roofs also provide added benefits of reducing pollutants in stormwater runoff, and providing a natural habitat for wild life in urban areas.

HAZEN AND SAWYER
Environmental Engineers & Scientists

Dormont Green Infrastructure Opportunities

BMP TYPE:
PERVIOUS PAVEMENT

Examples of Pervious Pavement Opportunities

Potential Locations:
- Alabama Ave (Church Parking)
- Wisconsin Ave (Typical Example)

Borough of Dormont, PA

Rank - # of Opps

Hi - 3

Med - 9

Low - 9

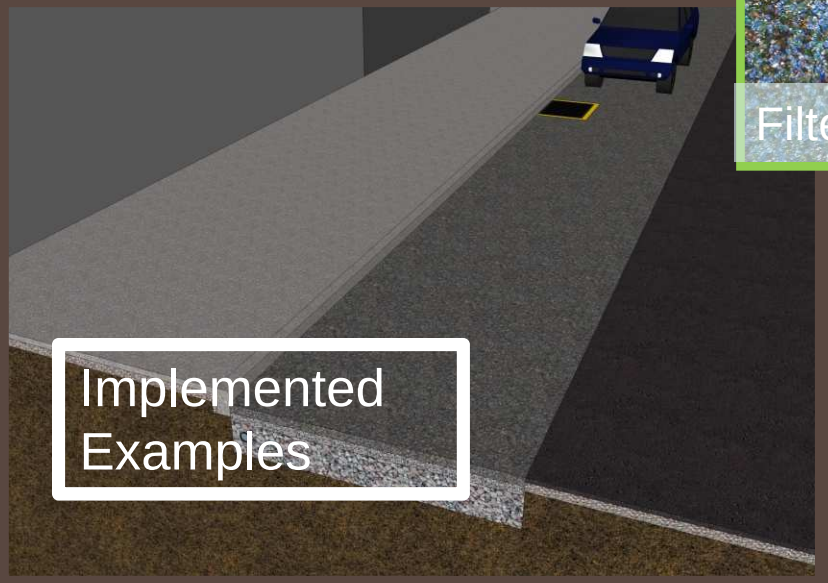
Note: Only opportunities within the "Athens Alley Stormwater Improvements" Watershed have been considered.

HAZEN AND SAWYER
Environmental Engineers & Scientists

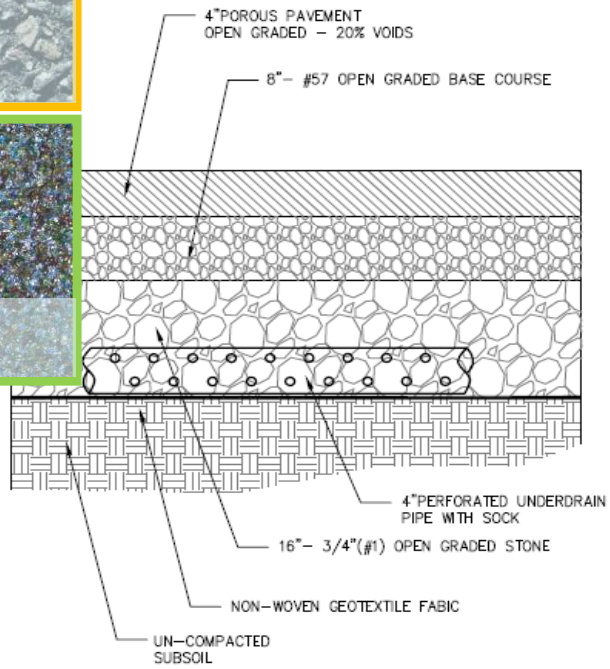
Porous Asphalt

Standard Asphalt

FilterPave



Implemented Examples



POROUS PAVEMENT DETAIL

Borough of Dormont, PA

Pervious Pavement:
Is a growing method of reducing surface runoff by infiltration of the soils in place beneath paved areas which are otherwise not effectively used in their full capacities when typical paving is in place. By constructing underdrains as illustrated in the detail provided, the pervious pavement systems can be easily connected to adjacent storm sewer catch basins, and thereby maximizing inlet capacity of the existing storm systems in addition to reducing runoff. Several streets within the study area are good candidates, having minimal slopes, recognizably sized contributory areas, and easy connection locations to the existing storm network.

HAZEN AND SAWYER
Environmental Engineers & Scientists

BMP TYPE:
PERVIOUS PAVEMENT

Dormont Green Infrastructure Opportunities

Potential Locations:

- Glenmore Ave (Tiered)
- Wisconsin Ave (Typical Examples)
- Hillsdale Ave

Examples of Bump Out Retention Opportunities

Borough of Dormont, PA

Rank - # of Opps

Hi - 3

Med - 3

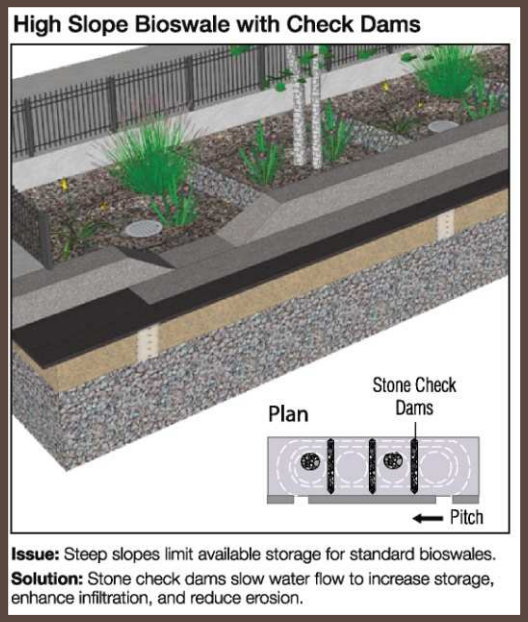
Low - 3

Note: Only opportunities within the "Athens Alley Stormwater Improvements" Watershed have been considered.

HAZEN AND SAWYER
Environmental Engineers & Scientists

BMP TYPE:
BUMP OUT RETENTION

Dormont Green Infrastructure Opportunities



Borough of Dormont, PA

Bump Out Retention:
Is more commonly seen in highly urbanized areas where there is limited surface availability due to condensed development of the existing land. In the case of Dormont, there were several recognizable opportunities within the public right of way where a bump out could be beneficial. The bumps outs provide opportunity for bio retention, while giving the community an aesthetically pleasing attraction without encroaching on private property. This technique is similar to street side retention seen in the Bioretention fact cards.

HAZEN AND SAWYER
Environmental Engineers & Scientists

BMP TYPE:
BUMP OUT RETENTION

Dormont Green Infrastructure Opportunities

Dormont Green Infrastructure Opportunities

BMP TYPE:
CISTERN

Examples of Cistern Opportunities

Potential Locations:
- Hillsdale Ave (Apartment roof/ Parkette irrigation)
- Wisconsin Ave (Church roof and yard irrigation)

Borough of Dormont, PA

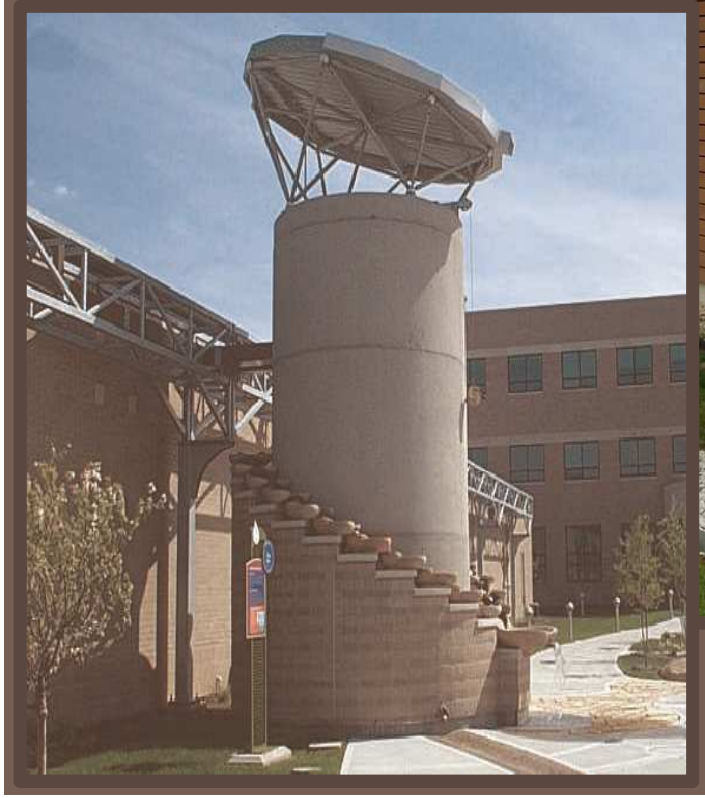
Rank - # of Opps

Med – 2

Note: Only opportunities within the “Athens Alley Stormwater Improvements” Watershed have been considered.

HAZEN AND SAWYER
Environmental Engineers & Scientists

Implemented Examples



Borough of Dormont, PA

Cistern: is a similar concept to a rain barrel. The installation of a cistern provides benefit by minimizing/eliminating storm water runoff, and allows for water storage until such time that it is needed for irrigation purposes. In the first proposed location, the borough would be able to water the vegetation at the corner parkette at W. Liberty and Hillsdale Avenue, by routing the adjacent rooftops from nearby rental properties to a cistern. Similarly, the large surface area covered by the church's roof located on Alabama Avenue would allow for watering of plants/vegetation if a cistern were to be installed.

HAZEN AND SAWYER
Environmental Engineers & Scientists

BMP TYPE:
CISTERN

Dormont Green Infrastructure Opportunities

APPENDIX C

PUBLIC MEETING SLIDES AND BOARDS

Athens Alley Stormwater Infrastructure Improvements Public Meeting 2

April 24, 2013

HAZEN AND SAWYER
Environmental Engineers & Scientists

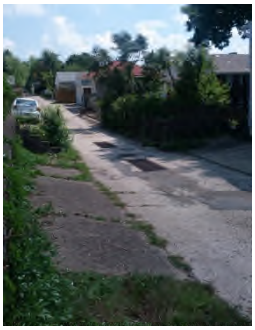
Agenda

- Background
- Alternatives Evaluation
  - Grey Infrastructure Alternatives
  - Green Infrastructure Opportunities
- Downstream Impacts
- Public Involvement
- Next Steps

HAZEN AND SAWYER
Environmental Engineers & Scientists

Background

- Regular flooding occurring
  - Athens Alley between Texas & Annex



HAZEN AND SAWYER
Environmental Engineers & Scientists

- Leading to property damage

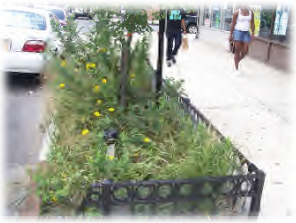
Study Objectives

- Identify potential solutions to reduce or eliminate drainage issues
- Multiple alternatives to be considered
- Council will decide **if** any alternatives are implemented

HAZEN AND SAWYER
Environmental Engineers & Scientists

Alternatives Evaluation

- Survey
- Grey Alternatives
  - Site Visits
  - H&H Modeling
  - Cost Estimates
- Green Alternatives
  - GIS Review
  - Site Visits



HAZEN AND SAWYER
Environmental Engineers & Scientists

Drainage Issues

- Existing Inlets Poorly Located
- Too Few Inlets
- Storm Sewer Undersized
- Sewer Between Athens & Kelton Reverse Grade

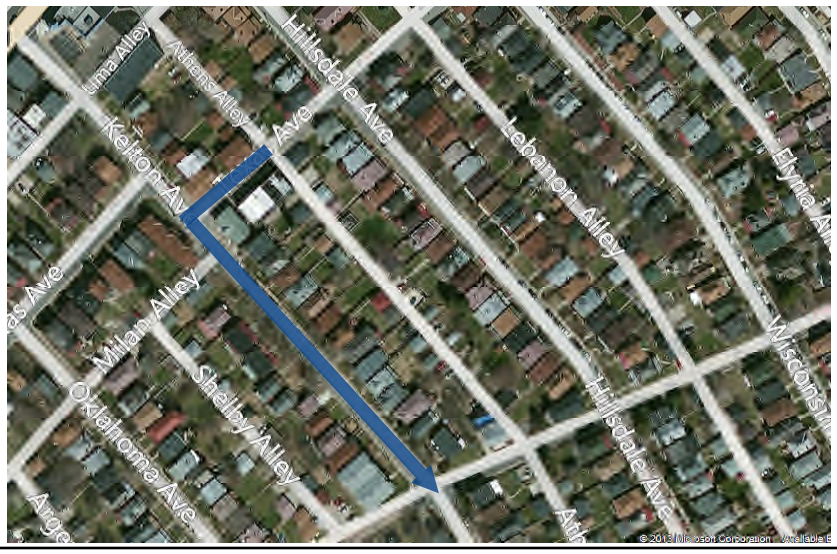
HAZEN AND SAWYER
Environmental Engineers & Scientists

Alternatives

- Developed Alternative Storm Sewer Alignments
- Evaluated Inlet Locations
- Evaluated Source Reduction (GI)

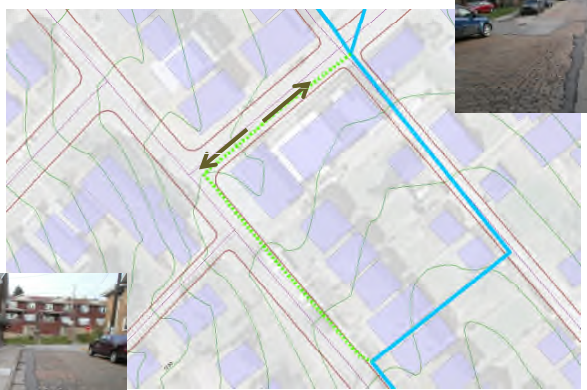
HAZEN AND SAWYER
Environmental Engineers & Scientists

Grey Alternative
Texas to Kelton



Constructability Challenges

- Neighborhood Disruption



- Traffic Control

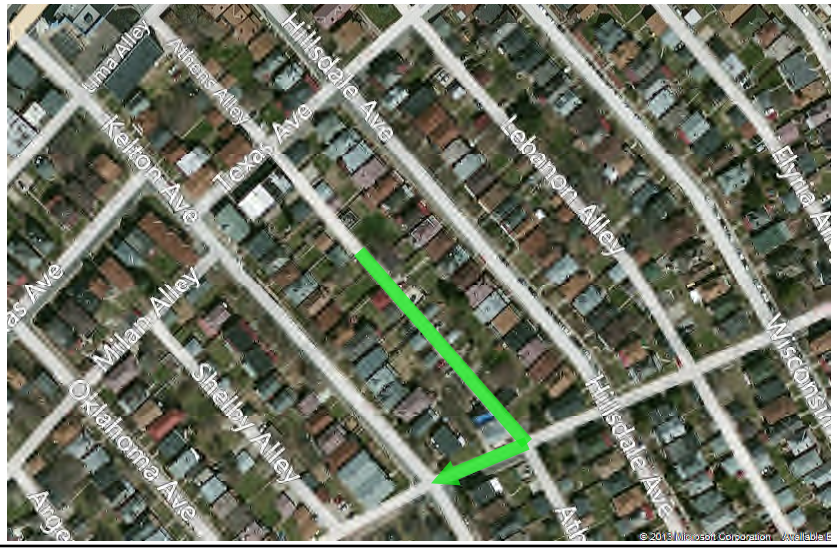
HAZEN AND SAWYER
Environmental Engineers & Scientists

Constructability Challenges

- Deep Excavation at Kelton & Texas
- Complete Closure of Texas & Kelton Likely
- Street Parking in Area of Construction will be unavailable

HAZEN AND SAWYER
Environmental Engineers & Scientists

Grey Alternative
Athens to Annex

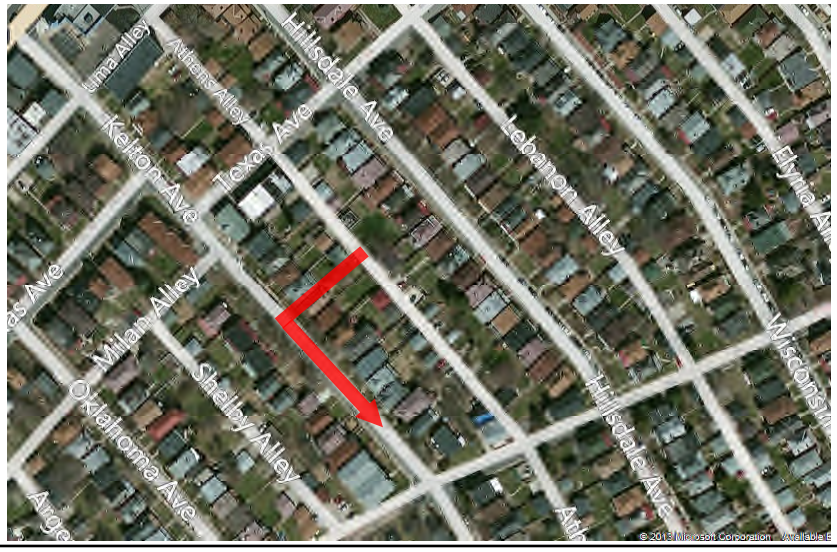


Constructability Challenges

- Deep Excavation at Athens & Annex
- Complete Closure of Athens & Annex Likely
- Access to Garages on Athens Will be Affected for Some Residents
- Utility Protection Will be a Concern

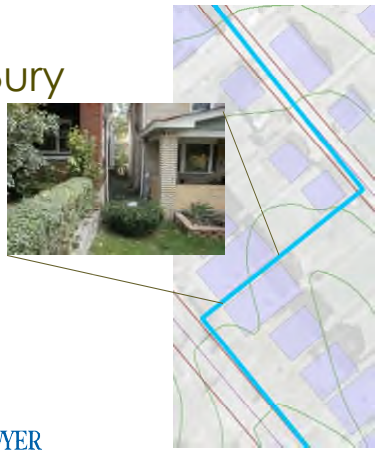
HAZEN AND SAWYER
Environmental Engineers & Scientists

Grey Alternative
Athens to Texas



Constructability Challenges

- Distance Between Houses is Approximately 5-feet
- Cannot Utilize Direct Bury
- Moves Bottleneck Downstream
  - 48-Inch Pipe Required
  - 30-Inch Pipe in Kelton



HAZEN AND SAWYER
Environmental Engineers & Scientists

Grey Infrastructure Costs

- Preliminary Estimate

	10-YR	100-YR	2-YR
Texas to Kelton	$431k	$464k	$412k
Athens to Annex	$303k	$331k	$289k
Athens to Texas	$306k	$357k	$276k

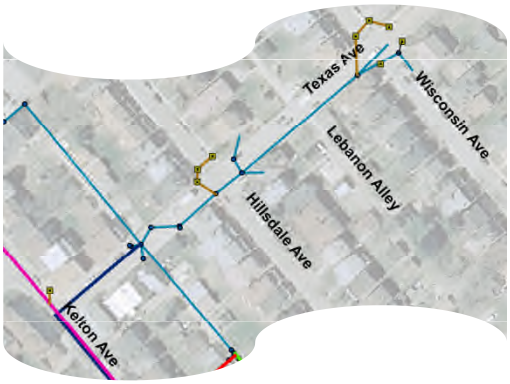
- Prelim. Estimate w/o Roadway Costs

	10-YR	100-YR	2-YR
Texas to Kelton	$242k	$275k	$223k
Athens to Annex	$192k	$220k	$178k
Athens to Texas	$276k	$328k	$247k

HAZEN AND SAWYER
Environmental Engineers & Scientists

Grey Infrastructure Costs

- Catch Basins & Yard Inlets:
  - Additional $76k



HAZEN AND SAWYER
Environmental Engineers & Scientists

Downstream impacts

HAZEN AND SAWYER
Environmental Engineers & Scientists

Green Infrastructure Opportunities

- Runoff Reduction (Water Quantity)
  - Particularly Smaller Events
- Water Quality Improvements
  - Saw Mill Run on 303(d) List
- Aesthetic and Environmental Benefits
- Green Infrastructure Funding Ops
- But… Minimal Reduction in Athens Alley Flooding

HAZEN AND SAWYER
Environmental Engineers & Scientists


High Slope Bioswale with Check Dams
Implemented Examples
Borough of Dormont, PA
THE BOROUGH OF DORMONT
INCORPORATED 1909
Bump Out Retention:
In more commonly seen in highly urbanized areas where there is limited surface availability due to condensed development of the existing land. In the case of Dormont, there were several recognizable opportunities within the public right of way where a bump out could be beneficial. The bumps outs provide opportunity for bio retention, while giving the community an aesthetically pleasing attraction without encroaching on private property. This technique is similar to street side retention seen in the Bioretention fact cards.
HAZEN AND SAWYER
Environmental Engineers & Scientists
BMP TYPE:
BUMP OUT RETENTION
Dormont Green Infrastructure Opportunities


Porous Asphalt
Standard Asphalt
FilterPave
Paver Blocks
Design Concept:
While the Country Lane concept is aesthetically pleasing, there are many other types of permeable pavers that can be substituted. Permeable paver blocks/grids can reduce cost, while maintaining the functionality of the roadway and decreasing stormwater runoff entering the sewer system. Effectiveness increases when a suitable permeable sub-layer is provided, and openings in the pervious material used are maximized.
Implemented Examples
Borough of Dormont, PA
THE BOROUGH OF DORMONT
INCORPORATED 1909
Country Lane:
Asphalt lanes are replaced with two concrete or gravel strips surrounded by structural grass (structural grass is supported by a grid and soil structure that prevents soil compaction and root damage). Connections from the county lane to residences are constructed of permeable materials, including paving blocks, broken concrete sections, and structural grass or gravel.
HAZEN AND SAWYER
Environmental Engineers & Scientists
BMP TYPE:
COUNTRY LANE
Dormont Green Infrastructure Opportunities

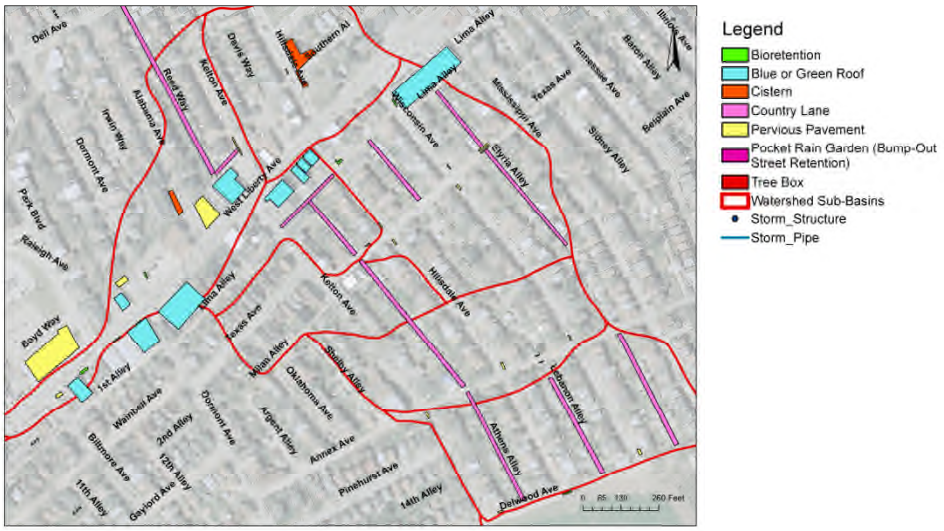

Glenmore Ave
Southern Al
Potential Location: Glenmore Avenue
Tree Box Opportunity
Implemented Example
Borough of Dormont, PA
Rank - # of Opps
Low – 1
Note: Only opportunities within the "Athens Alley Stormwater Improvements" Watershed have been considered.
Tree Box:
A minor opportunity to provide bio-retention and promote the use of green infrastructure, while providing aesthetic benefit to the community. Sub-drains can be conveniently connected to the storm sewer network beneath.
HAZEN AND SAWYER
Environmental Engineers & Scientists
BMP TYPE:
TREE BOX
Dormont Green Infrastructure Opportunities


Implemented Examples
Modified Inlet
Check Dams
Green
Blue
Borough of Dormont, PA
Green or Blue Roofs:
Are a method of attenuating peak storm runoff, and in the case of a green roof, providing evapotranspiration via a growing media from which plants and light vegetation can thrive. Blue roofs can be slightly lighter and require less maintenance, but lack the aesthetic and thermal benefits offered through green roofs. Green roofs also provide added benefits of reducing pollutants in stormwater runoff, and providing a natural habitat for wild life in urban areas.
HAZEN AND SAWYER
Environmental Engineers & Scientists
BMP TYPE:
BLUE/GREEN ROOF
Dormont Green Infrastructure Opportunities


Porous Asphalt
Standard Asphalt
FilterPave
Implemented Examples
POROUS PAVEMENT DETAIL
Borough of Dormont, PA
Pervious Pavement is a growing method of reducing surface runoff by infiltration of the soils in place beneath paved areas which are otherwise not effectively used in their full capacities when typical paving is in place. By constructing underdrains as illustrated in the detail provided, the pervious pavement systems can be easily connected to adjacent storm sewer catch basins, and thereby maximizing inlet capacity of the existing storm systems in addition to reducing runoff. Several streets within the study area are good candidates, having minimal slopes, recognizably sized contributory areas, and easy connection locations to the existing storm network.
HAZEN AND SAWYER
BMP TYPE:
PERVIOUS PAVEMENT
Dormont Green Infrastructure Opportunities


Implemented Examples
Borough of Dormont, PA
Cistern is a similar concept to a rain barrel. The installation of a cistern provides benefit by minimizing/eliminating storm water runoff, and allows for water storage until such time that it is needed for irrigation purposes. In the first proposed location, the borough would be able to water the vegetation at the corner parkette at W. Liberty and Hillside Avenue, by routing the adjacent rooftops from nearby rental properties to a cistern. Similarly, the large surface area covered by the church's roof located on Alabama Avenue would allow for watering of plants/vegetation if a cistern were to be installed.
HAZEN AND SAWYER
BMP TYPE:
CISTERN
Dormont Green Infrastructure Opportunities

GI Opportunities By Type

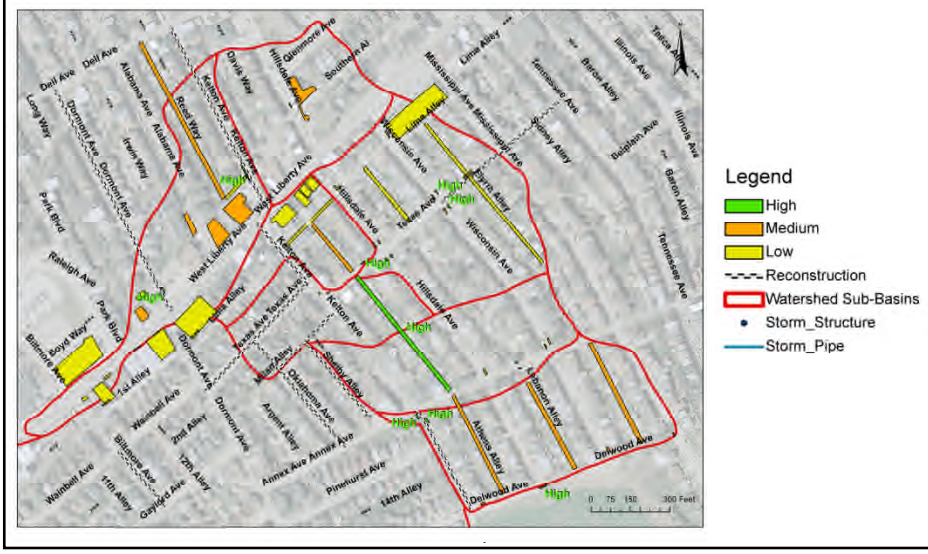


GI Ranking Factors

- Ease of Implementation
  - Flatter Slopes
  - Proximity to Existing Storm Inlets
  - Size of Contributing Area
- Planned Road Reconstruction
- Direct Impact on Flooding Area

HAZEN AND SAWYER
Environmental Engineers & Scientists

GI Opportunities By Rank



Green Infrastructure Cost

GI Type \ Priority	High	Medium	Low
Bioretention	$12k	$14k	$21k
Blue Roof	N/A	$225k	$1,305k
Cisterns	N/A	$8k	N/A
Country Lane	$328k	$1,227k	$630k
Permeable Pavement	$21k	$229k	$708k
Bump Outs	$17k	$13k	$10k
Enhanced Tree Pit	N/A	N/A	$1k

HAZEN AND SAWYER
Environmental Engineers & Scientists

GI Funding Alternatives

- LGA Community Sustainability Grant
  - $8,500 Received
- ACCD Grant Fund
  - Application Submitted
- The Charrette Program
- CFA Watershed Restoration Protection Program
- Several Others

Submitted grant requests of nearly $400k for Green Infrastructure to date

HAZEN AND SAWYER
Environmental Engineers & Scientists

Discussion

- Grey Alternatives
- Green Alternatives
- Financing

HAZEN AND SAWYER
Environmental Engineers & Scientists

Next Steps

- Finalize Tech Memo to Incorporate Borough and Public Comments
- Present Conclusions and Recommendations to Council on June 3rd

Thank You!

HAZEN AND SAWYER
Environmental Engineers & Scientists

Borough of Dormont, PA

Athens Alley Stormwater Improvements Alternative Routes

Legend

- Texas to Kelton
- Athens to Kelton
- Athens to Annex
- Proposed Catch Basins
- Proposed CB Connectors
- Storm_Structure
- Storm_Pipe

0 25 50 100 Feet

April 2013

HAZEN AND SAWYER
Environmental Engineers & Scientists

Borough of Dormont, PA

Athens Alley Stormwater Improvements Green Infrastructure Opportunities by Priority

Legend
- Reconstruction
- Storm_Structure
- Storm_Pipe
- High
- Medium
- Low

0 65 130 260 Feet

March 2013

HAZEN AND SAWYER
Environmental Engineers & Scientists

Borough of Dormont, PA

Athens Alley Stormwater Improvements Green Infrastructure Opportunities by Type

Legend

- Bioretention
- Blue or Green Roof
- Cistern
- Country Lane
- Pervious Pavement
- Pocket Rain Garden (Bump-Out Street Retention)
- Tree Box
- Watershed Sub-Basins
- Storm_Structure
- Storm_Pipe

0 65 130 260 Feet

February 2013

HAZEN AND SAWYER
Environmental Engineers & Scientists

APPENDIX D

PUBLIC COMMENT LETTERS

4-5-13

Dear Doument, (NO THRUWAY, XCEPT FOR BUSINESS)

Thank you for inviting me to your meeting about your concern for the Athens Alley Flash Flood Problem; and I'm very glad you are open to suggestions and will not place this ongoing, progressive problem on the back burner any longer... Thank God no person/animal, or car was in the path of this fast/furious flash flood... In the many years I've lived here, I've seen this happen less than a handful of times... However, each time is substantially worse than the last... I am not sure why... Maybe it is the rain itself; falling faster and harder.

Here is my low-cost suggestion... and thank you for asking...
Place 2 signs: One on Kelton side; other sign on Hillsdale side... stating "NO THRU-WAY"... Place a large screened grate where the water has been collecting... the "bath tub area." Place 3 small "guard rails" around the screened grate.
Once again, Thank God no one was in the path of this "Monster River."

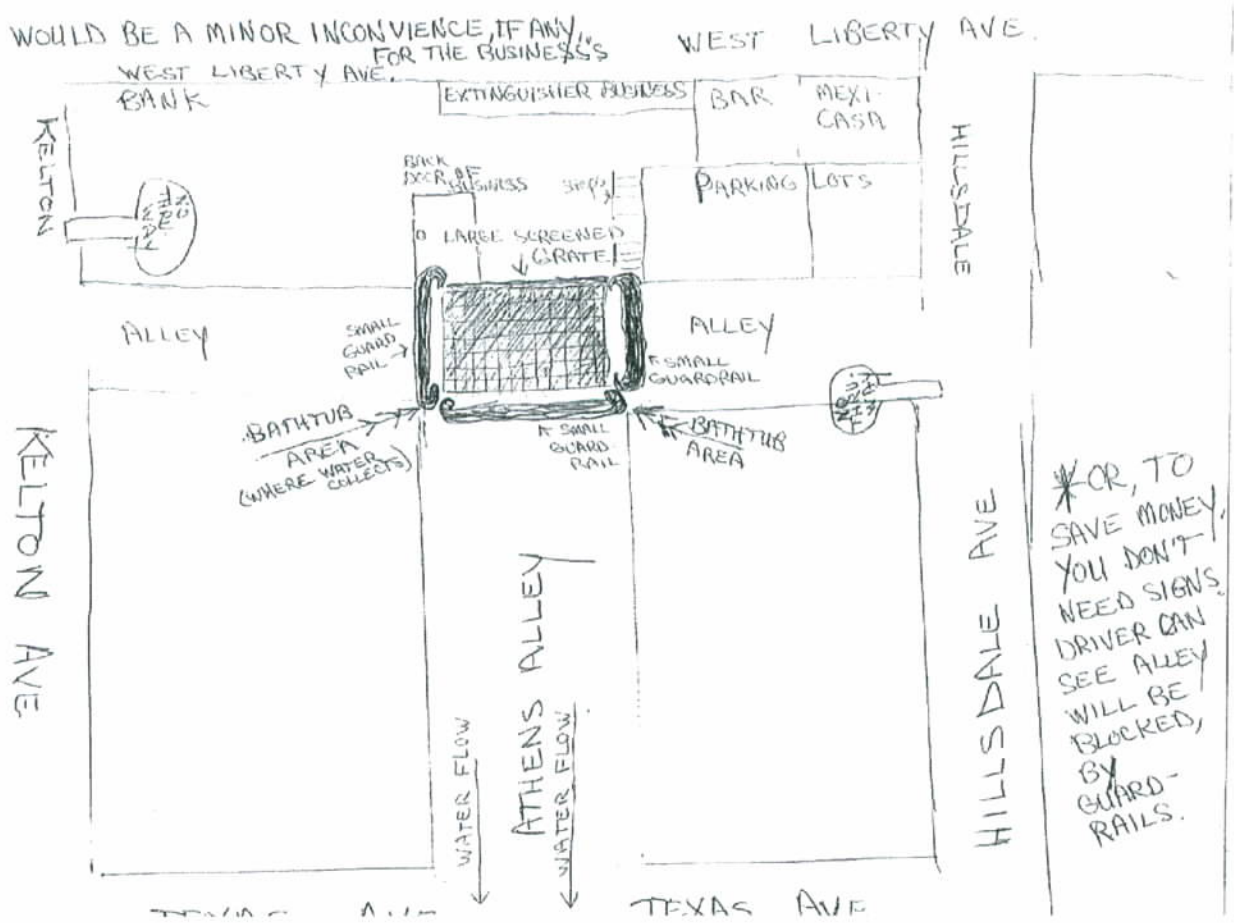
P.S. The last time this happened: seeing that water cross over Texas Ave. from upper part of Athens Alley... I have to say was shocking!! The water was raging through; and it looked to be around 4 feet high... and it seemed to never

I have an almost flat roof; it is also shared with my neighbor: Both of rain waters meet in middle so we share one little spout; As long as this spout is kept unclogged we never have a problem; However once it gets a little clogged then it just pours like a waterfall over the side of the House... What I am saying is that just to make sure that particular sewer line area where the problem or the water stands collecting (Bathtub); to make sure that sewer line is checked on often and kept clear; Maybe underneath it may help to build a type of funnel.

Good Luck
Thank you I'm sure I know you will figure out the best thing to do!

P.S. I realize I probably have no clue, so please don't mind me. ☺

THIS WOULD BE A MINOR INCONVIENCE, IF ANY, FOR THE BUSINESS'S



*OR, TO SAVE MONEY, YOU DON'T NEED SIGNS. DRIVER CAN SEE ALLEY WILL BE BLOCKED, BY GUARD-RAILS.

April 23, 2013

Dear Sir,

I am not able to attend the public meeting on April 24, 2013. Therefore this letter is being written to comment on the Athens Alley Storm Water Control Project. First of all only one house suffered water damage to their property. A very old block wall fell down and part of their wooden fence and part of a chain link fence fell also. I did not see damage done to any other property that day. I have lived here 33 years and this is the first time anything like this has occured. This has not been going on for years. In the area where the block wall fell down a very large tree was there. Shortly after the rain storm the property owner had the tree cut down and removed. When the tree was there alot of branches and leaves were also there near the storm drains. The property owner never cleaned the area nor did anyone else. Also people blow the leaves from their own yards and parking pads out into the alley causing the storm drains to get clogged. A project like this will cause alot of parking problems.

Next Page

We live on the 1200 block of Hillsdale Avenue. We use our parking pad to park our car on a everyday basis along with the 90% of the people in this alley way that also use their parking pads and garages to park their cars. We never park our car on the street because there is never anywhere to park it. Again this project will cause alot of Parking problems. As far as paying for this project we will not pay anything for it nor do we want our taxes raised because of it. In closing our opinion on the preferred alternative for this project is the "Do Nothing" alternative. We are 100% in favor of leaving athens alley the way it is. "Do Nothing" to athens alley.

Thank you for taking the time to read my letter.

Sincerely,
Paula Asturi
1223 Hillsdale Avenue
Pittsburgh, PA 15216