Area-Wide Public Infrastructure Strategies
3.1 Multi-Modal Transportation Infrastructure

Urban Design as a Basis for an Area-Wide Transportation Infrastructure Approach

Throughout the development of the site specific reuse plans, first as part of the CURP and then refined through the AWP process, fundamental transportation infrastructure principles were established. Most importantly, the notion that establishing complete neighborhoods, including those that are truly "mixed-use," depends upon a consistently good pedestrian experience. Complete neighborhoods require a mix of land uses (residential, retail, office, civic uses, etc.) and a mix of housing types and prices (single-family detached, townhouses, duplexes, apartments, etc.) arranged to provide a variety of living and working options all within walking distance of each other. The prime determinant of the pedestrian experience is the quality of the streetscape: "complete" walkable streets are visually stimulating, while environments that are hostile or uninteresting immediately turn pedestrians away. Specifically, the most important element of a good streetscape is quality street frontage – the manner in which the public realm of the street and sidewalk meet the private line of building facades. Streets and other thoroughfares are public spaces balanced for function and character. Streets shape blocks. Larger voids in the block structure should generally only exist as public spaces such as plazas, playgrounds, and parks, not as pedestrian "dead zones." Promoting a safe and quality pedestrian experience; however, does not mean that efficient vehicular traffic circulation must suffer. Instead, it advocates the desire of a high-quality pedestrian environment not be immediately sacrificed for the sake of the automobile; instead transportation design decision-making is made using a balanced approach between all modes, considering that a minimum base-line of pedestrian services be achieved that are above the typical norm. This multi-modal approach is the fundamental basis for all transportation recommendations in the CURP and as the AWP initiative was used to advance the preliminary transportation recommendations from the CURP into schematic design and engineered plans, the approach was used as evaluation tool to determine the best design approach.

Through the AWP project for the Borough of Carlisle's brownfields study area, specific transportation improvements were explored for several key streets and intersections within the boundary of the study. Specifically, B Street between College Street and Carlisle Springs Road/PA Route 34, Fairground Avenue between B Street and Penn Street, and North Hanover Street between Penn Street and Carlisle Springs Road/PA Route 34 were all explored in detail, along with any intersections and some cross streets associated with those segments. These street segments were identified as most critical in supporting the needs of the projected first phases of actual private-sector redevelopment on the key brownfield sites and also provide desirable inter-neighborhood connections that were severed by the former industrial facilities; therefore they are the primary focus of this AWP initiative.

The focus of the overall AWP transportation plan is to improve mobility for people moving throughout the northern quadrant of the borough and to Carlisle's downtown, as well as to accommodate the increased volume projected to be generated by new development. Through the establishment of new connections (and reestablishment of old ones), increased consideration for all modes of transportation, and the overhaul of roads and intersections, a full plan was assembled which both improves upon current levels of service and increases the borough's ability to deal with future development.

The Importance of the "Grid" for Circulation and Urban Infill Development Patterns

The proposed redevelopments at the former Carlisle Tire & Wheel and IAC/Masland sites provide opportunities to reestablish a full grid in these areas of the borough. As currently configured, many of the roads within the AWP boundary have segments "cut off" by the industrial sites. At Carlisle Tire & Wheel, both B Street and C Street were closed and cut off between College and Factory Streets as historic industrial activities expanded at the site. At the larger IAC/Masland site, Streets A through D, between Fairground Avenue and Carlisle Springs Road/PA Route 34 were never established since the site was the original fairgrounds and later developed for industrial use. The plan proposes to (re)establish all of these broken or missing connections, as well as introduce a new through connection for Lincoln Street from Pitt Street to Carlisle Springs Road/PA Route 34.

Making these (re)connections will improve connectivity for the community as a whole and make the northern quadrant neighborhoods in Carlisle, negatively impacted by the industrial activities, more inter-connected. These connections will also improve access between existing neighborhoods and the new development proposed at the brownfields sites and at the same time, aid in dispersing traffic in a manner that does not rely on one road to handle all of the area's vehicular traffic. Establishment of the full grid of the "lettered" east-west streets, along with the expansion of Fairground Avenue, will help to provide plenty of pedestrian, bicycle and vehicular options, including support for mass transit routes. The formation of traditional gridded urban blocks also serves as a logical framework to define land use patterns. The borough's adopted Urban Mixed Use zoning district/land use ordinance requires that entrances to buildings front streets, with maximum setbacks not to exceed 20', with no off-street parking to be located in the front yards of any building parcel. These requirements reinforce the value of a strong urban streetscape component of the public realm which is directly tied to the design of complete streets, both from the perspective of the land use pattern and transportation infrastructure urban design and engineering.
**Transportation Infrastructure Guiding Principles**

- The existing street grid of the Borough provides the basis for a sound transportation network. Creating an inter-connected network of street and thoroughfares that extends the borough’s existing street grid and block structure through redevelopment sites will fundamentally link new development with the overall transportation framework of the borough.

- Typical intersection spacings in the existing street pattern should be replicated as much as possible in the redevelopment area, especially on major thoroughfares. This will serve as a method of maintaining the established framework of block structures within neighborhoods and ensures that thoroughfares do not become too auto-centric. Creating an interconnected network of streets and thoroughfares that form human-scaled blocks can be regulated by maximum lengths (versus only minimums) ensuring that the typical “walk-able” block structure of the borough is maintained. All roads and streets should connect to other roads and streets at either end unless they are prohibited by difficult topography.

- Street and thoroughfare typologies should be determined in relation to both multi-modal transportation needs and urban design guidelines based on the uses of the buildings that front them. Employing a “complete street” approach to the design of all streets and thoroughfares to ensure that they are constructed to include appropriate number and width travel/parking lanes, bicycle and pedestrian facilities as well as supporting streetscaping and green infrastructure elements such as street trees, landscaping, street fixtures, flow-through stormwater planters, etc.

- Transportation infrastructure decision-making should consider multi-modal needs, including current and future transit services. Maximizing interconnectivity and providing transit supportive elements such as transit shelters and stop locations, or the adequate space for future facilities, ensures that full transit mobility is not precluded now or in the future.

- Area-wide traffic calming strategies should be considered for new and existing streets as they are designed. While transportation efficiency is a goal, it should not be achieved at the cost of safety. Existing streets and thoroughfares should be evaluated to determine the need “calm” traffic to an appropriate speed. This is especially important as new streets are creating by extending existing terminus streets.

- Strategic intersections within and adjacent to the study area should receive special design consideration since these intersections will funnel concentrated volumes of new traffic generated by the redevelopment. Improving key intersections along major thoroughfare corridors into and exiting the downtown and the study area ensures that maximum transportation connectivity (for all modes) is achieved along with mitigating future impacts to the transportation network, as new developments are constructed.

- Pedestrian and bicycle trail connections should be constructed to provide dedicated interconnections between schools, parks and commercial/employment centers and downtown. Providing multi-use paths along new streets and through parks, public spaces and interconnected stormwater management greenways provides the opportunity to create a spine for neighborhoods and commercial areas to connect, via adjacent sidewalks, bike lanes and sharrows.

- Plan neighborhood streets and thoroughfares to converge at the center of pedestrian sheds and neighborhood centers. Coordinate these centers so the most intensely developed hubs support transit and not preclude it now or in the future.

- Complete Streets

In addition to addressing the level of service for vehicular traffic on local roads, the objective of the transportation component of the AWP is to incorporate broad multi-modal transportation options within public rights-of-way. This multi-modal approach is known as building “complete streets.” By allowing for safe interactions between pedestrians/cyclists and vehicular traffic, people can freely choose different modes of transportation without worrying about unsafe conditions or inaccessibility. In essence complete streets are about urban design and mobility choices.

To implement complete streets within the AWP study area, several elements were included within the proposed transportation improvements. To accommodate pedestrian activity, full sidewalks are included within the right-of-way on both sides of all proposed streets. Creating a comprehensive sidewalk network allows for free movement of pedestrians around neighborhoods and prevents people from reaching dead ends or having to walk within vehicular cartways. Features like planters, plantings, rain gardens, and street trees are provided along many roads and, in addition to potentially also serving as stormwater management features, they create a buffer between vehicular and pedestrian traffic. Various traffic calming measures are also included to improve safety for everyone using the roadway.
For cyclists, the proposed transportation designs include several elements to improve bicycle accessibility to the area. One of the major linked elements is the inclusion of a “cycle track” and multi-use trail along Fairground Ave from N. Hanover Street/U.S. Route 11 all the way up to D Street. This cycle track is specially two-way bike lane separate from the roadway which allows cyclists to travel the route without having to merge in and out of traffic. Proposed road crossings are clearly marked and much of the cycle track runs parallel to the proposed stormwater management park along Fairground Avenue, allowing for easy access to public amenities. Where dedicated bike lanes are not feasible, “sharrows” are proposed to help ensure drivers are aware of the presence of cyclists.

A significant aspect of creating complete streets has to do with implementing the proper and complimentary traffic calming techniques to allow for the safe travel for pedestrians and bikes, as well as vehicles. One technique included within much of the AWP study area is maintaining narrow (minimum allowable based upon accepted standards) travel lanes for vehicles. Keeping lanes narrow keeps speeds low and creates safer streets, especially at crossings. Curb bulb-outs are considered at many intersections to aid in this traffic calming effect and reduce crossing distances for pedestrians as well. Along B Street, a chicane (a slight jog in the carway) is proposed between Factory and Pitt Streets to help further reduce traffic speeds. B Street includes the most aggressive traffic calming measures in order to maintain the character of a local community street even with an increase in traffic volumes.

A component of complete streets that has not yet been touched upon is the easy access to public transit options in the area. Clearly marked bus stops and shelter areas at stops help encourage the use of transit options. The important consideration is to allow access, and integrate transit in a way that has minimal impediment to other modes of transportation. Within the scope of the transportation improvements for the AWP, specific designs for bus stops have yet to be included, but space to provide them within the streetscape has been allocated. They are a feature that should be considered in future, where applicable, especially with the new Capital Area Transit Carlisle Circulator line in effect. The goal of the AWP recommendations is to provide the maximum opportunity to provide and ultimately expand transit ridership as one of the multi-modal choices within the AWP study area and connect to the entire borough and broader region without the need to rely on the automobile as the only options.

Intersection Improvements

The introduction of new development will result in the generation of new traffic and trips, including traffic volumes in locations well beyond the individual redevelopment

INTERSECTION ANALYSIS SUMMARY

### North College Street/PA Route 74 and B Street
- The intersection of North College Street/PA Route 74 & B Street is much more efficient when utilizing a roundabout rather than a stop controlled intersection. The stop controlled intersection recorded an overall intersection LOS “F” for an approach turning movement, and the roundabout had a volume to capacity ratio of 0.64 (utilizing just over half of the ultimate capacity of the intersection).

### North Hanover Street/US Route 11, Fairground Avenue and Penn Street
- The intersection of North Hanover Street/US Route 11, Fairground Avenue and Penn Street presented difficulties, especially due to the increase of traffic from the proposed development and the existing intersection alignment. Alternative 2 presented a roundabout at the intersection, and although this location is expected to operate at a volume to capacity ratio greater than 1.0, safety is greatly improved by selecting the roundabout over the signalized option. Volume to Capacity could be improved by converting Fairground Avenue to one-way northbound (see public meeting feedback in Appendix A). The Alternative 1 option requires relocating an approach which may cause unsafe operating conditions; however, the intersection is anticipated to operate at an overall LOS “C”.

### North Hanover Street/US Route 11 and Carlisle Springs Road/PA Route 34
- Both alternatives studied realigned and signalized the intersection of North Hanover Street/US Route 11 and Carlisle Springs Road/PA Route 34. The realignment and signalization of this intersection is a crucial improvement as the current intersection crosses an existing railroad line at the center of the intersection. The proposed realignment of this intersection corrects this safety hazard and provides safer operations due to the installation of a traffic control signal that keeps queued traffic off of the at-grade rail crossing.

**Note:** A signalized intersection records a Level of Service (LOS) based on the average delay in seconds each vehicle experiences at that intersection. The LOS of an intersection can range from A to F, with A being the best and F the worst. In contrast, a volume to capacity ratio (V/C) is used for roundabouts, when the volume of vehicles utilizing the roundabout exceeds the capacity of the roundabout (V/C >1.0), the intersection may not operate efficiently.
sites. A major component of the transportation plan focuses on the improvement of key intersections to try to better manage traffic volumes with a complete streets approach, addressing both short- and long-term concerns. When regulating the flow of traffic at any intersection, there are numerous options to consider. From two-way stops, four-way stops, traffic signals and possibly other devices such as roundabouts. Numerous factors are considered when deciding on the proper way to direct traffic and which device will be the most effective. Recommendations in this AWP report evaluated ways to maximize the vehicular level-of-service (LOS) for the studied intersections, while also considering safety for the vehicles, the bicyclists and the pedestrians who will be using them.

The planning process included conducting traffic turning movement counts at the key intersection in December 2013. A series of transportation alternatives were presented at a day-long public workshop in February 2014. The proposed intersection improvements include the introduction of roundabouts at the B/College Streets and Fairground Avenue/N. Hanover Street/Penn Street intersections and a mini-roundabout at the B Street/Fairground Avenue intersection. Roundabouts are proposed at these locations for the level of vehicular service they provide, as well as the benefits of roundabouts as a traffic calming measure and a pedestrian safety improvement. In these locations, roundabouts will manage traffic effectively by allowing for a continuous flow of vehicles in multiple directions and by eliminating the awkward alignment of roadway approaches at these intersections. Roundabouts also help to manage traffic speeds by forcing people to slow down as they navigate them. From a pedestrian safety perspective, roundabouts provide the benefit of pedestrians needing to be cognizant of traffic coming from only one direction at a time, in addition to the aforementioned traffic calming measures.

Other locations within the plan feature more basic four-way intersections regulated by stop signs. Many of these intersections, along B Street and Fairground Avenue in particular, include "bulb-outs" or widened sidewalks/narrowed pavement at the corners of intersections. These bulb-outs provide traffic calming benefits as well as the added safety of a shorter crossing for pedestrians. Bulb outs have become a popular feature in many modern streets for their safety as well as aesthetic benefits. Where they are necessitated, turning lanes are also considered at intersections regulated by stop signs or traffic signals. This is particularly prominent at the intersection of Carlisle Springs Road/PA Route 34 and North Hanover Street/US Route 11, where a traffic signal is proposed with multiple turning lanes to accommodate projected traffic volumes that are expected to greatly increase over current rates. This may lead to wider than typically desirable roadways, but is necessary to handle the queuing that an intersection with a traffic signal will generate. The AWP also proposes the jogging of Carlisle Springs Road/PA Route 34 to create a 90-degree "T" intersection at this location. This has the dual benefit of eliminating one of the at-grade railroad crossings while creating an intersection with much more navigable angles and greatly improved lines of sight.

**Roundabouts**

According to PennDOT’s "Guide to Roundabouts" (Publication 414, May 2001), "The roundabout is a successful form of traffic calming and a pedestrian safety improvement. Roundabouts also help to manage traffic speeds by forcing people to slow down as they navigate them. From a pedestrian safety perspective, roundabouts provide the benefit of pedestrians needing to be cognizant of traffic coming from only one direction at a time, in addition to the aforementioned traffic calming measures.

**NEXT STEPS**

The Borough of Carlisle is currently pursuing multiple state and federal funding sources as well as possible tax increment financing districts (TIFs) to advance the urban design, engineering, permitting and pre-bid packaging of the proposed AWP transportation improvements. Assuming the required funding is obtained the follow key steps would be required to proceed to construction.

- **Step 1 – Consultant Selection:** The borough needs to select a qualified engineering and urban design consultant that is well-versed with PennDOT’s Highway Occupancy Permit (HOP) application and Transportation Impact Study process.

- **Step 2 – PennDOT HOP Process Initiation:** The borough’s consultant will initiate the Department’s HOP process that begins with a Pre-application Meeting with the District’s Permit Unit and Traffic Unit staff. This meeting includes project scoping with District staff and local officials and a discussion about the Transportation Impact Study that would be required for the borough’s proposed transportation improvements.

- **Step 3 – Transportation Impact Study (TIS) and HOP Application:** The consultant engineer would undertake a TIS in conformance with the Policies and Procedures for Transportation Impact Studies Related to Highway Occupancy Permits (latest edition). This would include submission of the TIS, conceptual land development plan, and the HOP application to the District through PennDOT’s E-Permitting System (EPS).

- **Step 4 – Permit Issuance:** Following review and approval of the TIS, the engineering and design plans for the proposed transportation improvements are submitted for approval. Once approved, the District will issue the permit that will need to be recorded with the County Recorder of Deeds. This step especially would include a public involvement process focused on addressing potential issues and additional opportunities explored through the AWP process and would include detailed information on how the proposed improvements would function, how they would meet the urban design and complete criteria established through the CUPR and AWP processes and any potential impacts, including the need for additional rights-of-way.

- **Step 5 – Bid Documentation and Letting:** Bid Documentation and Letting: The consultant will then proceed with preparing the Plans, Specifications and Estimates (PS&E) for the borough’s project bid package and ultimate project letting (District 8-0 will deem this as a locally let project.)

- **Step 6 – Construction and Inspection:** The consultant will assist with the construction monitoring and inspection activities that will be required by the HOP process and the borough’s own permitting requirements.
Roundabouts also provide a number of advantages over traditional signalized stop controlled designs. These advantages include the following:

Increased Safety
- Roundabouts have fewer vehicle-vehicle conflict points than conventional four-leg intersections (8 vehicle-vehicle conflict points in a roundabout vs. 32 vehicle-vehicle conflict points in a conventional intersection).
- Roundabouts require vehicles that are entering or exiting to travel at lower speeds in a single direction, providing overall safer conditions.
- The geometric layout of a roundabout eliminates hazardous conflicts such as left-turn, head-on, and right-angle crashes. Roundabouts have been shown to reduce fatal crashes by 90 percent, injury crashes by 75 percent, pedestrian crashes by 30-40 percent, and bicycle crashes by 10 percent. These decreases are due to the entry angle being reduced from 90 degrees to 60 degrees, lower speeds, and the elimination of vehicles traveling in opposite directions.

Increased Capacity/Reduced Delay
- During peak periods roundabouts typically carry 30 percent more vehicles than comparable signalized intersections.
- Roundabouts do not require yellow and red signal intervals, resulting in higher capacity and lower delays than signalized intersections, particularly during off-peak periods.
- Vehicles are able to enter roundabouts from each leg simultaneously.

Traffic Calming
- Reduced vehicle speeds in roundabouts have a traffic calming effect.
- Improving pedestrian safety by directing traffic in one direction; roundabouts provide the benefit of pedestrians needing to be cognizant of vehicular traffic coming from only one direction at a time.

Environment & Aesthetics
- Roundabouts can lower noise and air pollution through reductions in the number of acceleration/deceleration cycles and vehicle idling
- Fuel consumption is reduced.

Reduced Maintenance
- Roundabouts are self-regulating, whereas a signal requires periodic adjustments to its timing sequence.
The Value of Roundabouts - A Summary

- Reduce fatalities up to 90% (Source: FHWA)
- Reduce injury crashes 76% (Source: FHWA)
- Reduce pedestrian crashes 30-40% (Source: FHWA)
- Greatly reduces the severity of injuries sustained in crashes
- Reduce greenhouse gases (carbon footprint) and toxic emissions
- Reduce gas consumption
- Reduce queue lengths (in many instances)
- Creates a pedestrian/child/older/bike/skate-friendly intersection by providing improved opportunities for dedicated and enhanced facilities for each mode of travel
- Promotes a stronger sidewalk network, with friendly nodes (intersections)
- Preserve/enhance/celebrate local character and community context while accommodating motorized traffic flow (Context Sensitive Solution)
- Provides a storm-proof intersections that continue to operate after hurricanes and tornados
- Supports the principles of Smart Growth and Active Living
- Provides 20-30% increase in capacity during peak hours (in many instances)
- Creates a gateway to a district, such as business district or residential neighborhood
- Replaces "no-man's lands," and seas of asphalt, with beauty
- Allows sidewalk conversations among pedestrians or sidewalk cafe patrons or persons sitting on benches
- Revitalizes a depressed district
- Creates a roundabout corridor with safe, efficient access management
- Creates a scenic corridor with speed management
- Perfectly complements other traffic calming and streetscaping measures

Overall Plan Key for Phase I Transportation Implementation Improvements
Green Technologies

In addition to complete streets, the construction of “green streets” is also important when designing modern transportation improvements. Projects such as roundabouts allow for municipalities to include features like rain gardens, street trees, and other stormwater elements within the public right-of-way. Including green technologies within these envelopes can reduce runoff, help cut down pollutant loads, and provide redundancy for the overall stormwater management conveyance systems. Many of the features, which are further discussed in the stormwater management chapter of this document, can also add aesthetic value and other environmental benefits to the community, making them a valuable part of any transportation plan.
3.11 Infrastructure Strategy | Carlisle Brownfields Area-Wide Planning Strategy
3.13

Infrastructure Strategies | Carlisle Brownfields Area-Wide Planning Strategy
3.20

Carlisle Brownfields Area-wide Planning Strategy | Infrastructure Strategies

B Street Proposed
At Tire & Wheel
Facing West

B Street Proposed
At IAC
Facing West

Scale: 1"=10'-0"
3.21

B Street Existing
Near Maple Ave
Facing West

B Street Proposed
Near Maple Ave
Facing West

Scale: 1"=10'-0"
Carlisle Springs Rd Existing
Between Hamilton and Hanover
Facing South

Carlisle Springs Rd Proposed
Between Hamilton and Hanover
Facing South

Scale: 1"=10'-0"
Fairground Ave Existing
Between Penn & RR Tracks
Facing North

Fairground Ave Proposed
Between Circle & RR Tracks
Facing North
Fairground Ave Existing
Between Penn & RR Tracks
Facing North

Fairground Ave Proposed
Between Circle & RR Tracks
Facing North

Scale: 1"=10'-0"
3.2 Stormwater Management and Public Space

Watershed Background

The Borough of Carlisle resides within the large portion of Pennsylvania belonging to the expansive Chesapeake Bay watershed. The Chesapeake Bay watershed includes portions of six states (New York, Pennsylvania, Maryland, Delaware, West Virginia, Virginia) as well as the District of Columbia. Per the Chesapeake Bay Program, the watershed covers around 64,000 square miles, as well as almost 11,700 miles of shoreline, and is populated by over 17 million people. A vast number of rivers and streams are contained within the Chesapeake Bay watershed, including the Potomac, James, and Susquehanna Rivers. The Chesapeake Bay was the first estuary in the nation targeted by Congress for restoration and protection in 1983, with an emphasis on pollution reduction and ecosystem restoration efforts.

The Susquehanna River is the largest river among those which outlet into the Chesapeake Bay. Its watershed, which includes the area of the Borough of Carlisle, contributes about 50 percent of the Bay's total fresh water. The Susquehanna, starting from its upper reaches in Cooperstown, New York for the Main Branch and Cambria County, Pennsylvania for the West Branch, flows southward through east-central Pennsylvania after the confluence of its two branches near Sunbury. The Susquehanna passes by the City of Harrisburg, where the Conodoguinet Creek, a moderately sized tributary, which includes Carlisle Borough within its watershed, flows into it. Beyond Harrisburg, the river runs south and east, crossing into northern Maryland before terminating where it flows into the northern reaches of the Chesapeake Bay.

The Borough of Carlisle itself has all of its runoff enter the Conodoguinet Creek, either via smaller tributaries or direct overland flow to the Conodoguinet itself. The majority of the Borough's stormwater, including most of the downtown area and the AWP study area, runs into the LeTort Spring Run, with areas to the north and west flowing straight into the Conodoguinet and a small portion of the westernmost edge of the borough entering the Alexander Spring Run.
The LeTort Spring Run is one of the finest limestone trout streams in the nation, but it is also much more than a great place for fly casting. The LeTort, and the groundwater system that feeds it, are especially vulnerable to pollution because of their limestone geology. Pollutants may originate at a specific site such as a leaking underground storage tank, or a chemical spill ("point" sources), or they may be caused by a widespread land use such as soil erosion from construction and agriculture, heavy metals and salts from roads, or fertilizers and pesticides from lawns and farms ("non-point" sources). The LeTort has suffered point source pollution over the last three hundred years, but so far has shown a remarkable ability to recover once the contaminating source is eliminated. During the mid-1800’s, tan yards and mills along the Run had so fouled its waters that, at one point, citizens of Carlisle attacked the offending businesses, knocking down dams and clearing the river bed. Continued expansion of the area’s economy, while benefiting almost everyone, unfortunately has also increased the likelihood of stream degradation from the cumulative effect of both "point" and "non-point" sources and the increased risk of industrial pollution. The LeTort Regional Authority was formed as a local body with the commitment to help protect this unique natural resource, and is the only municipal authority in the Commonwealth incorporated with specific watershed responsibilities. The Authority is focused on reducing damage to resource by promoting the adoption of appropriate standards to ensure that new development is sensitive to the particular character of the stream and its fragile karst geology.

Broad Concepts for Stormwater Management

A central tenet of how the CURP and the AWP proposes to approach stormwater management is through decentralization of the stormwater management system via a wide palette of stormwater elements that can capture and treat runoff at different scales. Rather than rely solely on “upsizing” pipes or pumps to deal with additional flow, the goal is to remove as much stormwater as possible from the system before it reaches the conveyance lines. This includes the use of bio-retention, permeable pavements, and other pre-treatment strategies which can be tailored to fit a wide range of areas and scales. Also, tied into this particular strategy of decentralization is maximizing open space and reducing impervious surface coverage wherever possible. Particularly in the context of the redevelopment sites such as IAC/Masland and Carlisle Tire & Wheel, there is an opportunity to decrease the amount of runoff being generated and conveyed into local streams during storm events.
A valuable component of a comprehensive stormwater and flood management plan is the inclusion of pre-treatment elements. Elements such as flow-through planters, green roofs, bio-retention swales, and micro-pool/terrace wet meadows can be used to intercept and treat water before it enters the main conveyance system. Engineered soils can filter out pollutants and proper plantings can help remove excess nutrients produced by runoff flowing over impervious surfaces. During storm events, pre-treatment structures can also help to reduce peak flows by temporarily storing water and reducing overall volume.

Carlisle is situated within a regional geologic environment that complicates the ability to utilize some common stormwater best management practices (BMPs), specifically those focused on infiltration versus detention. Specifically, the geology features limestone and similar rock types which are susceptible to rapid dissolution, leading to widening of faults and since karst (limestone) geology is prone to degradation and erosion as result of concentrated groundwater flow, sink holes can develop if stormwater management facilities are not properly engineered to take into account these special conditions. The Borough should advance a palette of recommended light imprint development BMPs for karst conditions to be used at all scales and development densities throughout the area.

In addition to the stormwater management implications, many of the options within a potential palette of BMPs provide opportunities to create aesthetically pleasing open spaces as well as potentially valuable public amenities. Elements such as street trees and rain garden planters can create attractive streetscapes in public rights of way. Other larger stormwater features can double as parks or recreational facilities for the borough. The key is that a properly executed stormwater management strategy can seamlessly integrate these utilities into the fabric of an area so people are barely aware that they are there and doing their job.

Regulations

An important consideration through the implementation of stormwater BMPs is that development projects must satisfy the requirements of state and federal laws as authorized by the Clean Water Act, the U.S. EPA Municipal Separate Storm Sewer System (MS4) as well as the Chesapeake Bay Watershed Implementation Plan. As it satisfies these requirements, the borough should lead the effort to ensure that stormwater management systems are integrated into existing and proposed development patterns and not engineered in a way that negatively impacts the urban form of the overall redevelopment. The borough should also ensure that redevelopment efforts comply with NPDES/Municipal Separate Storm Sewer System (MS4) permitting regulations as a designated MS4 community.

Stormwater Authorities

Governor Corbett signed into law Act 68 on July 9, 2013 which enables Pennsylvania municipalities to address stormwater issues with the option of creating stormwater authorities. Municipal authorities are independent agencies authorized by municipalities to manage public works services. Local and county government entities have utilized authorities to address a wide variety of public services – from sewer and water to parks and recreation. However, prior to the passage of Act 68, many municipalities believed they lacked the legal ability to create authorities specifically to address storm water issues. The Borough of Carlisle is currently exploring the concept of creating such an authority. Such an entity could serve to ensure that all new and retrofitted stormwater infrastructure functions in a truly system-wide manner and also to oversee the long-term viability of such systems, especially the smaller components advocated for by the CURP and this AWP report. A potential model for a stormwater authority is Mt. Lebanon, Allegheny County, PA’s program: http://mtlebanon.org/index.aspx?NID=2036

Pre-Treatment types

There are numerous different options within a palette of stormwater BMPs. In the public sector, smaller pretreatment facilities can be integrated into the streetscape envelope to handle stormwater without a tremendous amount of space to do so. Features fitting this description include flow-through planters, rain gardens, street trees, structural soil cells, and other elements which can be flexibly sized to fit within a streetscape. Rain gardens are typically planted areas surrounded by a curb or wall which contain specially engineered soil and drainage components which allow for the quick infiltration of rain water that is diverted to them. The soil and the plants featured in these gardens help remove pollutants before the water ultimately infiltrates back into the groundwater supply or is returned to the municipality’s stormwater conveyance system. Flow-through planters are a variation on rain gardens which are assembled with precast concrete wall segments and are designed to be bypassed by water in street gutters once they are at capacity. Street trees, while perhaps not explicitly a stormwater facility, help reduce runoff through intercepting rainwater before it hits the ground as well as removing groundwater through transpiration, particularly when coupled with a vaulted pavement, or soil cell, system to collect stormwater and foster root growth.

An important consideration when utilizing numerous smaller elements as part of a system-wide approach is the fact that stormwater and drainage are inherently part of networks. Water flows downhill into continually larger, more concentrated conveyance systems. If stormwater management systems are treated as an area-wide network of interconnected components, it ensures effectiveness while providing the benefit of overlaying other uses that also want to interconnect. This is especially true for parks, public spaces, trails and greenways that may connect from a public space function as well as serve as an inter-connected chain of stormwater management facilities if they are designed to function in that manner.

Connection to Other Green Technologies

Stormwater is often considered a liability that must be “mitigated”, but it can also be viewed as a vital asset. The creative storage and reuse of stormwater runoff from buildings and paved surfaces to irrigate civic landscapes, streetscape and urban beautification plantings, parks and community gardens can offer cost-savings and should be encouraged.

Beyond stormwater, there are other sustainable principles that the borough and developers can implement during the redevelopment of these sites and corridors. Street trees utilized as a beneficial feature for stormwater management are also helpful for improving air quality and reducing heat island effect by providing shade. The borough can also consider the use of technologies such as LED lighting to reduce energy consumption. On the private-sector side, developers should be encouraged to strive for LEED or Sustainable Sites accreditation or at least employ some principles of sustainable design to reduce energy usage and conserve resources.

AWP Study Area Specific Features

Within the AWP study area, a broad palette of the stormwater management elements discussed above are proposed within the public streetscape as well as the targeted redevelopment sites. Along B Street and Fairground Avenue, numerous stormwater management BMPs are proposed. B Street posed some significant constraints with regard to which features could be included in the design. But the realignment of Fairground Avenue as well as the additional public space produced by some of the redevelopment efforts, has allowed for the inclusion of stormwater features to be included within the public infrastructure. The existing cross-section of B Street does not allow for much in the way of stormwater infrastructure without significantly impacting existing on-street parking needs. Street trees and rain gardens have been
proposed wherever possible within bulb-outs at street corners, but much of the cross-section between Factory Street and Fairground Avenue is proposed to remain intact. Within the portions of B Street being reconnected through the redevelopment sites, the flexibility of constructing a brand new street allows for the implementation of a wider range of stormwater BMPs. Full street tree canopies are proposed for each segment running through the IAC/Masland and Carlisle Tire & Wheel sites, with some of the street trees featuring soil cell vaulted pavement systems to collect stormwater. Flow-through planters are proposed to line these blocks and help pre-treat as much water as possible from the new roads being constructed thus aiding in meeting the Chesapeake Bay TMDL requirements.

Fairground Avenue Stormwater Park

Fairground Avenue will also feature numerous street trees and flow-through planters lining its edges. However, the major undertaking along Fairground Avenue will be the construction of the large stormwater park covering a portion of the land formerly occupied by the IAC/Masland facility. The stormwater park will run from the Norfolk Southern rail line up to the proposed D Street connection at the north end of the existing IAC/Masland site. The park will total between 2 and 2.5 acres of open space on the former industrial site, posing an immediate stormwater management benefit through impervious surface reduction. Beyond the open space benefits, the park will be designed as a fully integrated stormwater management facility, including rain gardens, underground storage, and various bio-retention swales/micro-pools to capture and treat runoff during storm events. The stormwater park will take some water from the public right-of-way along Fairground Avenue and mostly from the proposed development throughout the IAC/Masland site. To properly manage all stormwater, the developers will have to supplement the stormwater park with some additional facilities, but the park will be available to take on a significant amount of runoff from the sites and reduce the impact it has on the watershed, both from a volume and pollutant loading standpoint.
Streetscape Vaulted Paving Stormwater capture and Irrigation System

Flow-Through Rain Garden Planters
Flow-Through Rain Garden Planters

Bio-Filtration Stormwater Swales and Plazas

source: Eliza Pennypacker

Infrastructural Strategies
Bio-Filtration Stormwater Swales and Plazas

Permeable Paving and Gray Water Capture, Retention, and Park Irrigation System

Canopy Interception

Permeable Paving and Gray Water Capture, Retention, and Park Irrigation System

Permeable Paving and Gray Water Capture, Retention, and Park Irrigation System

Permeable Paving and Gray Water Capture, Retention, and Park Irrigation System

Permeable Paving and Gray Water Capture, Retention, and Park Irrigation System

Canopy Interception
The stormwater park would provide the needed stormwater detention capacity to serve run-off from the majority of the adjacent Phase I redevelopment, including a 110 room hotel and mixed-use commercial/entertainment center. The extent of the project is from the active Norfolk Southern railroad line, north to a newly constructed B Street extending through the IAC/Masland site to Carlisle Springs Road/PA Route 34.

The propose stormwater park would be both an interconnected series of stormwater BMPs and detention elements and a series of park and recreation facilities connected via a multi-use trail. The following is summary of how the proposed stormwater park is envisioned and how it would function from a stormwater management perspective.

The programming of the public space was derived from an analysis of borough-wide needs, the neighborhood’s needs and extensive feedback and brainstorming developed through a week-long community design charrette in 2013 and follow-up topic meetings held in February 2014. The proposed detention elements were developed using preliminary capacity calculations and will require for engineering analysis determine their final capacity.

The following is a description of inter-related stormwater park elements based on the direction of flow:

**D Street to C Street** – As the widest block and the block with most significant grade change this park block focuses on passive recreation with opportunities for seating, sun bathing, and a picnic green. The abrupt grade change of the park provides a backdrop for observation of the birds, the bees, temporary art installations and people. The large retaining wall with a stepped series of perched rain gardens and spillways and micro pools deadens the noise of the surrounding blocks creating a quiet area for meditation and self-reflection. The depressed park provides the feeling of enclosure when looking west toward the stepped retain walls and rain gardens but
3.38  

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directly adjacent to the proposed retail anchor within the mixed-use redevelopment, this portion of the stormwater park would function as a terraced gathering/events space and outdoor farmers’ market area. In addition to a constructed wet meadow, the gathering space is planned to accommodate regularly flooding during mid-level storm events. It is located at the point of connection to the existing conveyance line that flows directly into the LeTort Spring Run, with the outfall just east of the redevelopment area.

**Stormwater Park Specific Pre-Treatment Facilities** - There are numerous stormwater BMPs that provide pre-treatment of stormwater and address TMDL requirements within the stormwater park. These include a series of pretreatment facilities such as: flow-through planters; rain gardens; street trees, structural soil cells. These features are integrated into the Fairground Avenue streetscape along the park’s frontage. In this case, flow-through planters are a variation on rain gardens which will be assembled with precast concrete wall segments and are designed to be bypassed by water in street gutters once they are at capacity. The park proposes to utilize various types of vegetated rain gardens many of which are surrounded by a curb or wall which contain specially engineered soil and drainage components to allow for the quick infiltration of rain water. The soil and the plants featured in these gardens help to remove pollutants before the water ultimately infiltrates back into the groundwater supply or is returned to the municipality’s stormwater conveyance system, in this case the LeTort Spring Run. The stormwater park is planned in such a manner that each small element is part of a drainage network. The flow of stormwater is designed to be retained during all types of storm events, include peak levels and slowly released as an area-wide network of interconnected components.

Methods that private developers can use to supplement the public stormwater facilities include techniques such as incorporating green roofs and capturing stormwater for irrigation purposes. Through the use of construction options such as pervious paving for parking areas and privately constructed rain gardens/retention facilities, owners can create a facility that can be used as a model for other people hoping to benefit their communities by creating low-impact development.

openness when looking outward back toward Carlisle Springs Road.

**C Street to B Street** — This small block consists of a multi-age play area and plaza that is placed on a vaulted paving system. The vaulted play area and plaza provide opportunities for stormwater storage creating an irrigation reservoir for other park segments during dryer periods of the year. A system of stormwater runnels, weir spillways, micro pools and rain gardens make stormwater management and treatment a visible process that is intertwined with the play area creating opportunities for discovery, observation and interaction that adds creativity and education to the play area.

**B Street south to A Street** — This block includes a mini-amphitheater and series of low-lying landscape meadows that would provide for significant stormwater detention capacity. The amphitheater especially provides for a land form that is conducive to creating an accentuate depression on the site allowing for increase storage capacity. This block of the park includes a network of multi-use and pedestrian trails linking to surrounding complete streets, on-road bicycle and pedestrian facilities and to the adjacent redevelopment.

**A Street to Lincoln Street** — As a longer block within the borough’s street grid system and due the fact that this block includes the center of the commercial mixed-use redevelopment on the IAC/Masland site, this portion of the stormwater park includes a high-activity program from a parks perspective. The core of this block includes a spray park and adjacent great lawn area. Surrounding this recreational element is a series of depressed and walled or “perched” stormwater detention facilities, some of which are actually elevated to create additional stormwater capacity and are fed by roof runoff from adjacent commercial buildings. The creation of constructed facilities of varying heights will create a park that is visually interesting and will remove the issue of each park space looking like it is a located within a pit, especially when compared to the elevation of the surrounding development and streets. This block of the park includes a network of multi-use and pedestrian trails linking to surrounding complete streets, on-road bicycle and pedestrian facilities and to the adjacent redevelopment.

**Lincoln Street to the Railroad and Conveyance to LeTort Spring Run** — Located
Proposed Fairground Avenue Stormwater Park Section Between C & D Streets Facing North

Proposed Fairground Avenue Stormwater Park Section Between C & B Streets Facing North
Proposed Fairground Avenue Stormwater Park Section Between A & B Streets Facing North

Proposed Fairground Avenue Stormwater Park Section Between A Street and Lincoln Avenue Facing North
STORMWATER RECAP

- Discussion of Chesapeake Bay Watershed
  - Covers six states plus Washington, D.C.
  - Rivers such as James, Potomac, and Susquehanna
- Chesapeake Bay program
- Carlisle lies within the extents of the Susquehanna River watershed
  - Conodoguinet Creek
  - Letort Springs Run
  - Letort runs into the Conodoguinet Creek
- Broad stormwater management concepts for Carlisle
  - Decentralization of SWM systems
    - Remove runoff from system and/or delay its entry
    - Capture more water rather than upsizing pipes
  - Reduction of impervious surfaces
    - Avoid superfluous paved/impervious areas where possible
    - Value open/green space as an important component of a site
  - Stormwater pretreatment
    - Small stormwater elements spread throughout an area rather than one oversized remedy
    - Many different methods can achieve same goals
  - Considerations for karst geology
    - Sinkhole concerns under limestone and similar rock types
    - Do not want to exacerbate conditions
    - Consider best options: should systems be lined?
  - Integrating concepts into landscape design
    - Make stormwater elements part of community rather than sterile detention pits
    - Can add aesthetic value rather than detract
  - Pretreatment methods
    - Public Sector
  - Flow-through stormwater planters
  - Rain garden elements
  - Stormwater Park – Decentralized system that relies on resilient treatment train/stepped management approach
    - Perched rain garden planters and underground storage
    - Micro-pool bioretention swales and basins
    - Underground storage/irrigation system
    - Stormwater irrigation runnels from street
    - Street trees and plantings
    - Canopy interception
    - Heat Island reduction techniques
    - Vaulted Paving and underground storage/irrigation systems
    - Private Sector
      - Rain gardens
      - Pervious paving methods
      - Green roofs / green walls
      - Gray water collection and reuse
      - Connections to public pretreatment infrastructure
      - Stormwater credit/allowance system
  - Other Private and Public Green Technologies and Techniques
    - Energy conservation techniques
      - Development scale closed loop geothermal systems for the IAC/ Masland site.
      - Civic space and streetscape LED lighting.
      - Building insulation practices
      - Green roof / green wall
      - Photovoltaic systems / Electric car charging stations
      - Multi-modal transportation (car, bus, bike, walk, etc.)
      - Local source and reclaimed building materials
- Regulated
  - Bluestone, sandstone and limestone
  - Clay brick
  - Other/ developing list
  - Local source/grown produce
  - Stormwater Park community garden
  - Farmers market pavilion and green
  - Brownfields reclamation
    - Concrete and demolished building rubble materials digested and reused as engineering control material.
    - Strategic contaminated soils placement/on-site relocation.
  - Specific Locations
    - B Street
    - Street trees
    - Flow-through planters
    - Rain garden bumpouts
    - Fairground Ave
      - Stormwater Park
      - Runnels to connect street to park
      - Flow-through planters
    - Within IAC/Masland and Tire & Wheel Sites
      - Connecting to SWM Parks
      - IAC pervious parking lot
      - Incorporate elements into site strategy
      - Work with town to properly coordinate SWM elements and make sure that systems properly mesh
  - Regulations
    - Considerations for the borough’s SWM ordinance
    - Chesapeake Bay TMDL regulations
    - MS4 issues for the Borough