C-6. DSIR Identification Methodology Technical Memorandum

TECHNICAL MEMORANDUM

Methodology to Identify Direct Stream and Large Natural Area Inflows

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DATE:	December 15, 2017
TASK:	2.b Identify Potential Projects and Methodology

Contents

Introduction and Background

Through the completion of 8 stream inflow removal projects and the evaluation of several others, ALCOSAN has determined that Direct Stream Inflow Removal (DSIR) projects may have a significant impact on reducing sewer overflows, minimizing inflow of sediments to the regional conveyance system and may be a cost-efficient source control management strategy. As part of a larger effort to identify potential Green Stormwater Infrastructure and Source Control (GSI-SC) projects in the ALCOSAN service area, the purpose of this Technical Memorandum (TM) is to detail a methodology to identify additional direct stream and large natural area inflows into the Regional Conveyance System, prioritize field investigations and outline a process for evaluating the feasibility and cost-effective implementation opportunities of DSIR projects working in collaboration with partner municipalities. CH2M has developed a pilot application of the stream inflow identification and prioritization process which is described in this TM. Once DSIR opportunities are identified, confirmed, and prioritized, resources can be targeted to assessing the feasibility of these projects, re-prioritizing them, and identifying potential funding sources to support the construction of DSIR projects.

Stream Inflow Removal Program Status

Prior to the development of this methodology, ALCOSAN and its partners have identified many stream inflow locations and has completed several successful removal projects. Table 1 summarizes the status to date of previously identified stream inflow locations for the major planning areas in the ALCOSAN service area shows and Table 2 provides a detailed listing of the information.

Table 1.
Summary of previously identified stream inflow removal locations by Planning Basin

Planning Basin	DSIR Project Status	Project Count	Drainage Area (AC)*	Annual Inflow Removed (MG/YR)
Chartiers Creek				
	Previously identified inflow locations			
	Under evaluation	1	24.8	
	Concept prepared	2	26.1	
	Under Construction	1	57.3	
	Project Complete/Known point of inflow removed	5	519.2	
	Totals	**9**	**627.4**	
Lower Ohio River				
	Previously identified inflow locations			
	Under evaluation	1	41.6	
	Project Complete/Known point of inflow removed	4	1147.3	
	Totals	**5**	**1188.9**	
Main Rivers				
	Previously identified inflow locations			
	Under evaluation	10	792.9	
	Concept prepared	1	215.7	
	Totals	**11**	**1008.6**	
Upper Allegheny / Pine Creek				
	Previously identified inflow locations			
	Planned Project	2	191	
	Totals	**2**	**191**	
Upper Monongahela				
	Previously identified inflow locations			
	Concept prepared	1	355.6	
	Totals	**1**	**355.6**	
	GRAND TOTALS	36	3601.8	

*Note: Drainage Area information sourced from ALCOSAN GIS data provided to CH2M in September 2017

Table 2.
Status of all potential and confirmed stream inflow removal locations in the ALCOSAN Service Area identified to date

Planning Basin	Site ID	Site Name	Sewershed	Source	Desktop Status	Desktop Notes	Drainage Area (AC)	Field Visit Priority	Field Notes	Implementation Status
CC	CC-01	CC-01 Carnegie Park	C-40-00/C-41-00	ALCOSAN	Previously identified inflow location		100.8			Known point of inflow removed
CC	CC-02	CC-02	C-27	CH2M	Candidate Inflow location for field review	Sigf surface flow to woodland area; appears to enter CSS through rear yard structure	36.7	High		Under evaluation
CC	CC-03	CC-03 Pine Hollow	C-09-00	ALCOSAN	Previously identified inflow location		46.1			Known point of inflow removed
CC	CC-04	CC-04	C-25	CH2M	Candidate Inflow location for field review	low point DS of wooded area with likely surface water flow. appears to be SW system for rec field	28.4	High	Definitely a potential DSIR	Under evaluation
CC	CC-05	CC-05 Pine Hollow	C-09-00	ALCOSAN	Previously identified inflow location		256.0			Known point of inflow removed
CC	CC-06	CC-06 Pine Hollow	C-09-00	ALCOSAN	Previously identified inflow location		105.8			Known point of inflow removed
CC	CC-07	CC-07 Carnegie Park	C-40-00/C-41-00	ALCOSAN	Previously identified inflow location		10.5			Known point of inflow removed
CC	CC-08	CC-08	O-13	CH2M	Candidate Inflow location for field review	Open channel stream converts to piped stream. Near Corks Run SI points ID'd in PWSA report.	26.2	Medium		Under evaluation

Planning Basin	Site ID	Site Name	Sewershed	Source	Desktop Status	Desktop Notes	Drainage Area (AC)	Field Visit Priority	Field Notes	Implementation Status
CC	CC-09	CC-09 Corks Run	O-13	PWSA	Previously identified inflow location	PWSA 2010 Report ID'd Location - determined not cost effective. Low estimated vol. of SI.	13.9			Concept prepared
CC	CC-10	CC-10 Corks Run	O-13	PWSA	Previously identified inflow location	PWSA 2010 Report ID'd Location - determined not cost effective. Low estimated vol. of SI.	12.2			Concept prepared
CC	CC-11	CC-11 Ella St. SW Retention Pond McK	O-06	ALCOSAN	Previously identified inflow location		24.8			Under evaluation
CC	CC-12	CC-12	C-45/B-04	CH2M	Candidate Inflow location for field review	likely stream valley, possible adjacent to buried CSS pipes;	42.6	Low		Under evaluation
CC	CC-13	CC-13 Sheraden Park	C-07-0	ALCOSAN	Previously identified inflow location	Dec 2017 notes: Removal is under construction, nearly complete.	57.3			Under Construction
CC	CC-24	CC-24	C-05	CH2M	Candidate Inflow location for field review	Lost stream line in woods at top of system; not likely but worth field review	3.6	Medium		Under evaluation
CC	CC-28	CC-28	O-13	CH2M	Candidate Inflow location for field review	Surface flow, lost stream, woods. W/i ALCOSAN Inflow Area that was deemed N/A but no Inflow Pt.	30.7	Low		Under evaluation
CC	CC-29	CC-29	C-15	CH2M	Candidate Inflow location for field review	Surface flowpath and lost streams upstr of newdev. historic strm mapped; Field Investigate	33.5	High		Under evaluation

Planning Basin	Site ID	Site Name	Sewershed	Source	Desktop Status	Desktop Notes	Drainage Area (AC)	Field Visit Priority	Field Notes	Implementation Status
CC	CC-31	CC-31	C-11	CH2M	Candidate Inflow location for field review	Surface flowpath and lost streams. Historic Strm Mapped; Field Investigate	28.6	High	Looks promising as a DSIR	Under evaluation
LOR	LOR-01	LOR-01 Jack's Run	O-25	ALCOSAN	Previously identified inflow location		961.6			Known point of inflow removed
LOR	LOR-02	LOR-02 Brighton Rd Tributary	O-25	ALCOSAN	Previously identified inflow location		91.6			Known point of inflow removed
LOR	LOR-03	LOR-03 Verner Ave.	O-26	ALCOSAN	Previously identified inflow location		41.6			Under evaluation
LOR	LOR-04	LOR-04 Fried and Rineman	A-66-00	ALCOSAN	Previously identified inflow location		68.5			Known point of inflow removed
LOR	LOR-05	2LOR-05 Orr Street	O-03-00	ALCOSAN	Previously identified inflow location		25.6			Known point of inflow removed
MR	MR-01	MR-06 Woods Run Valley	O-27-00	ALCOSAN	Previously identified inflow location	Also noted in PWSA GreenFirst Plan.	59.9			Under evaluation
MR	MR-02	MR-05 Woods Run Valley	O-27-00	ALCOSAN	Previously identified inflow location	Also noted in PWSA GreenFirst Plan.	91.2			Under evaluation
MR	MR-03	MR-08 Woods Run Valley	O-27-00	ALCOSAN	Previously identified inflow location	Also noted in PWSA GreenFirst Plan.	52.9			Under evaluation
MR	MR-04	MR-04- Woods Run Valley	O-27-00	ALCOSAN	Previously identified inflow location	Also noted in PWSA GreenFirst Plan.	12.2			Under evaluation

Planning Basin	Site ID	Site Name	Sewershed	Source	Desktop Status	Desktop Notes	Drainage Area (AC)	Field Visit Priority	Field Notes	Implementation Status
MR	MR-05	MR-07 Woods Run Valley	O-27-00	ALCOSAN	Previously identified inflow location	Also noted in PWSA GreenFirst Plan.	67.8			Under evaluation
MR	MR-06	MR-06 Spring Garden	A-60-0	ALCOSAN	Previously identified inflow location	Also noted in PWSA GreenFirst Plan.	390.4			Under evaluation
MR	MR-07	MR-07 Panther Hollow	M-29-00	ALCOSAN	Previously identified inflow location	ACSA WWP: ALCOSAN pursuing funding with PWSA/PPC. Also noted in PWSA GreenFirst Plan.	215.7			Concept prepared
MR	MR-08	MR-09-Woods Run Valley	O-27-00	ALCOSAN	Previously identified inflow location	Also noted in PWSA GreenFirst Plan.	36.9			Under evaluation
MR	MR-09	MR-03-Woods Run Valley	O-27-00	ALCOSAN	Previously identified inflow location	Also noted in PWSA GreenFirst Plan.	6.7			Under evaluation
MR	MR-10	MR-02-Woods Run Valley	O-27-00	ALCOSAN	Previously identified inflow location	Also noted in PWSA GreenFirst Plan.	59.0			Under evaluation
MR	MR-11	MR-01-Woods Run Valley	O-27-00	ALCOSAN	Previously identified inflow location	Also noted in PWSA GreenFirst Plan.	15.9			Under evaluation
UA	UA-01	UA-01 Sharpsburg	A-69-00	ALCOSAN	Previously identified inflow location	ACSA WWP: Engineering feas study completed. Implementation with SR 28 widening project.	96.1			Planned Project
UA	UA-02	UA-02 Delafield Ave.	A-78-00	ALCOSAN	Previously identified inflow location	ACSA WWP: ACE CW Project. Completion pending funding.	94.9			Planned Project
UM	UM-01	UM-01 Tassey Hollow	M-51-00	ALCOSAN	Previously identified inflow location	Preliminary feasibility assessments	355.6			Concept prepared

Stream Inflow Identification Workflow

The basic identification process consists of a GIS-based analysis to identify potential direct stream inflow (DSI) locations followed by a desktop prioritization process to efficiently target field evaluation of the most viable potential locations. Once the potential stream inflow locations are field verified, these locations will be further prioritized based on the overflow reduction efficiencies (OREs) being developed by CH2M in a parallel effort along with other criteria (e.g. distance to receiving water, distance to storm sewer, GSI potential, etc.) to be determined working with ALCOSAN and relevant municipalities. Figure 1 below provides an overview of the process. Each step of the Workflow is described in further detail below.

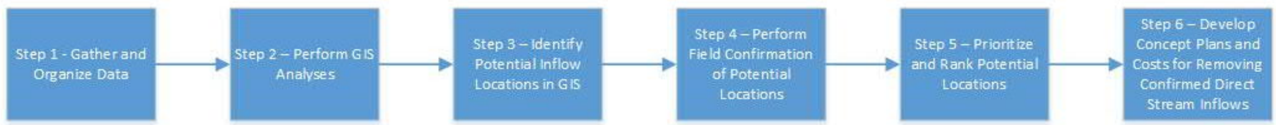

Figure 1.
Stream Inflow Identification Workflow

Step 1. Gather and Organize Data

Initial steps of the process rely on existing GIS data provided by ALCOSAN and other entities. CH2M has identified and organized the required base data layers and prepared a corresponding ESRI ArcMap 10.4.1 MXD file that will be provided to staff and subconsultants performing this task. Critical data layers that are needed for the analysis are described in Table 3. In addition to the GIS data, the 3RWW Sewer Atlas is also an important resource to refer to during this analysis.

Historic Stream Mapping:

Since the region does not have a comprehensive mapping of true historic streams, the USGS historic quad maps should also be referenced throughout the process to determine locations where streams existed prior to development.

Prepare a Study Area Boundary

ALCOSAN's service area spans seven planning basins within the county. This analysis is to be performed at the planning basin scale, focused on those sewersheds that are classified as "combined" or "draining to combined". Therefore, the user should prepare a Study Area Boundary file based on the Planning Basin of focus. To create the study area boundary, intersect the Sewersheds with the Planning Basin and query out the "Combined" and "Draining Towards Combined" catchment areas (sewersheds), and export to a new layer.

Table 3.
Required GIS data layers to be used in the Stream Inflow Identification Analysis

Data Type	Description / Original Source
Digital Elevation Model (DEM) clipped to study area	Digital model of surface elevation; provided by PASDA
CSS, SSS, MS4 System data – structures	Inlets, manholes, outfalls and other structures for the CSS (Combined Sewer System), SSS (Sanitary Sewer System) and MS4 (Municipal Separate Stormwater System). Separate storm sewer data is helpful to confirm that Inflows are not already piped to Creek; provided by ALCOSAN
CSS, SSS, MS4 System data – pipes	Conveyance pipes, symbolized by System type. Separate storm sewer data is helpful to confirm that Inflows are not already piped to Creek; provided by ALCOSAN
Inflow Points	All inflow points identified by ALCOSAN, PWSA, and CH2M from previous activities. This data set includes potential inflow points as well as those points that have a removal project already in place; created by CH2M
Inflow Areas	Drainage Areas to all inflow points identified by ALCOSAN, PWSA, and CH2M from previous activities. This data set includes potential inflow points as well as those points that have a removal project already in place; created by CH2M
Existing Surface Waterways	Hydrology data layers which represent open stream channels; provided by Allegheny County
3R2N Lost Streams	Digital representation of culverted streams as created by Three Rivers 2N that may offer potential for daylighting per their 2001 Stream Restoration & Daylighting Report; created by 3R2N
USGS historic topo quads	In the absence of a readily available historic stream linework layer, CH2M has found that the historic USGS quad maps are an effective resource to identify historic surface flow patterns; provided by the National Geologic Map Database Project (USGS topoView)
Aerial Imagery	Aerials are available from PASDA or ESRI. When 2017 aerials are made available, they will be provided to the team.
Sewersheds/Catchments	This analysis focuses only on "combined" and "draining to combined" catchments
Basemap data (Municipal Boundaries, Parcels, Edge of Pavement, Road Labels, Parks, etc.)	Allegheny County GIS Data

Step 2. Perform GIS Analyses

ArcGIS geoprocessing tools are applied to generate surface flow lines and to analyze the existing combined, sanitary and storm sewer network relative to natural surface flow and drainage patterns. The GIS reveals the drainage pattern based on surface topography and the corresponding low points in the topography are compared to the locations of sewers. Once the Flowlines are generated, they should be simplified using symbology to group them according to the stream threshold ID. This is due to the large nature of the file, and the need to simplify for the DSIR analysis. Figure 2 shows the flowlines generated from this step for the Chartiers Creek pilot basin.

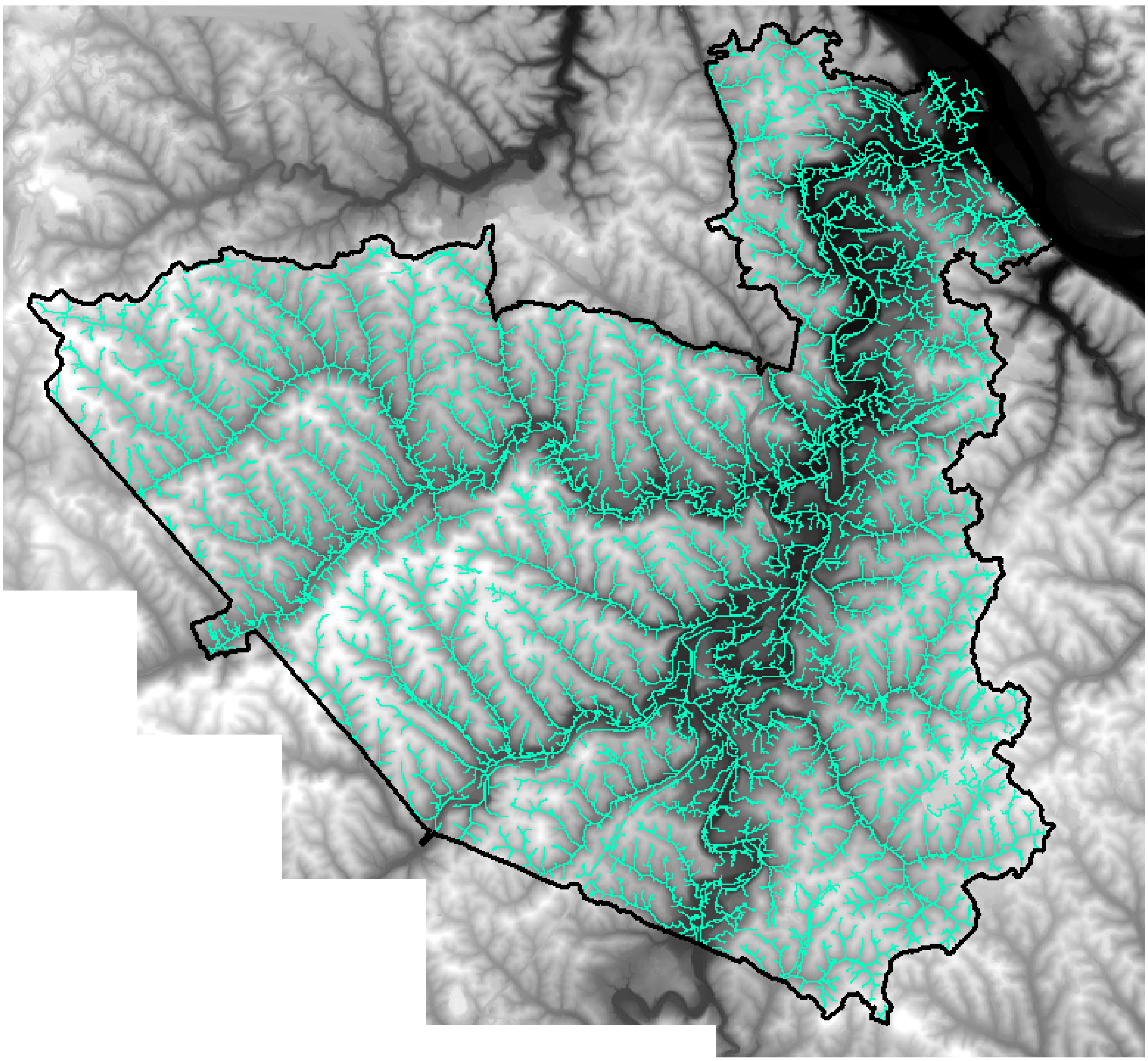

Figure 2.
ArcGIS geoprocessing tools are used to generate surface flowlines for the Chartiers Creek basin

Step 3. Identify Potential Stream Inflow Locations in GIS

Using the data layers identified and generated in Steps 1 and 2, the next step is to overlay these layers and work directly in ArcGIS to begin to identify potential stream inflow locations. This step requires a high level of familiarity with GIS including the ability to turn data layers on and off while panning around the study area, as well as a technical understanding of the GIS data itself. In general, this step should be accomplished by a technical analyst with oversite by a senior professional, and should not be a very time-consuming effort.

All data layers from Step 1 and Step 2 should be added to a working MXD. Specific key data layers should be grouped into their own ArcMap group layer ("Overlay Group") in the working MXD. The features contained in this Overlay Group are key geospatial indicators of a potential stream inflow.

Once the map is set up and the layers are symbolized appropriately, the next step is to review the map, and identify potential inflow locations. All potential locations should be documented in the point feature class called Inflow Locations. This layer should be edited and a description of the attributes to add to each point is described below.

The general workflow in Step 3 includes:

1. Examine headwaters (upper topographic boundaries) of CSS system for spatial intersection of key data layers.

- Viable stream inflow locations will generally occur where both Surface Flowlines and Lost Streams Intersect (or nearly intersect as the Lost Streams locations are only approximate) near the "end" or "upper limit" of a Sewer Pipe or Sewer Structure
    - It is important to refer to the Surface Stream layer throughout the process, but it should be noted that many mapped Surface Streams continue to larger receiving waters and do not enter the sewer system. Therefore, more weight should be given to the Surface Flowlines and Lost (historic) Streams.
- Pay attention to where a Sewer Pipe or Structure may be receiving flow from a natural drainage path. Stream inflow can be ephemeral or perennial and would likely follow the natural drainage path (i.e., surface flow lines).
- Often the drainage to a suspected inflow point is outside the subcatchment area to the sewer system in the GIS.
- Viable stream inflow potential locations are typically located at the top of a CSS catchment, near where a historic stream intersects the boundary or a surface water feature "disappears" on the map typically because it may be draining into the sewer system.
- Pay attention to wooded areas, where surface waterways may still flow in an open channel.
- Look for separate storm sewers and storm outfalls (e.g., PWSA or other MS4 storm sewer data) in the vicinity that could be conveying the flows to a receiving water without entering the Regional Collection System.
- Look closely at sites near railroads, where streams may have been culverted under a railroad and potentially connected to the sewer system.

While conducting this analysis, it is important to show the existing/previously documented stream inflow locations layer in the map, so that the user is not identifying any previously noted or removed locations. Take note of existing ALCOSAN, PWSA, or other municipally-identified points and/or drainage areas either found in reports such as Municipal Source Reduction Plans or other references.

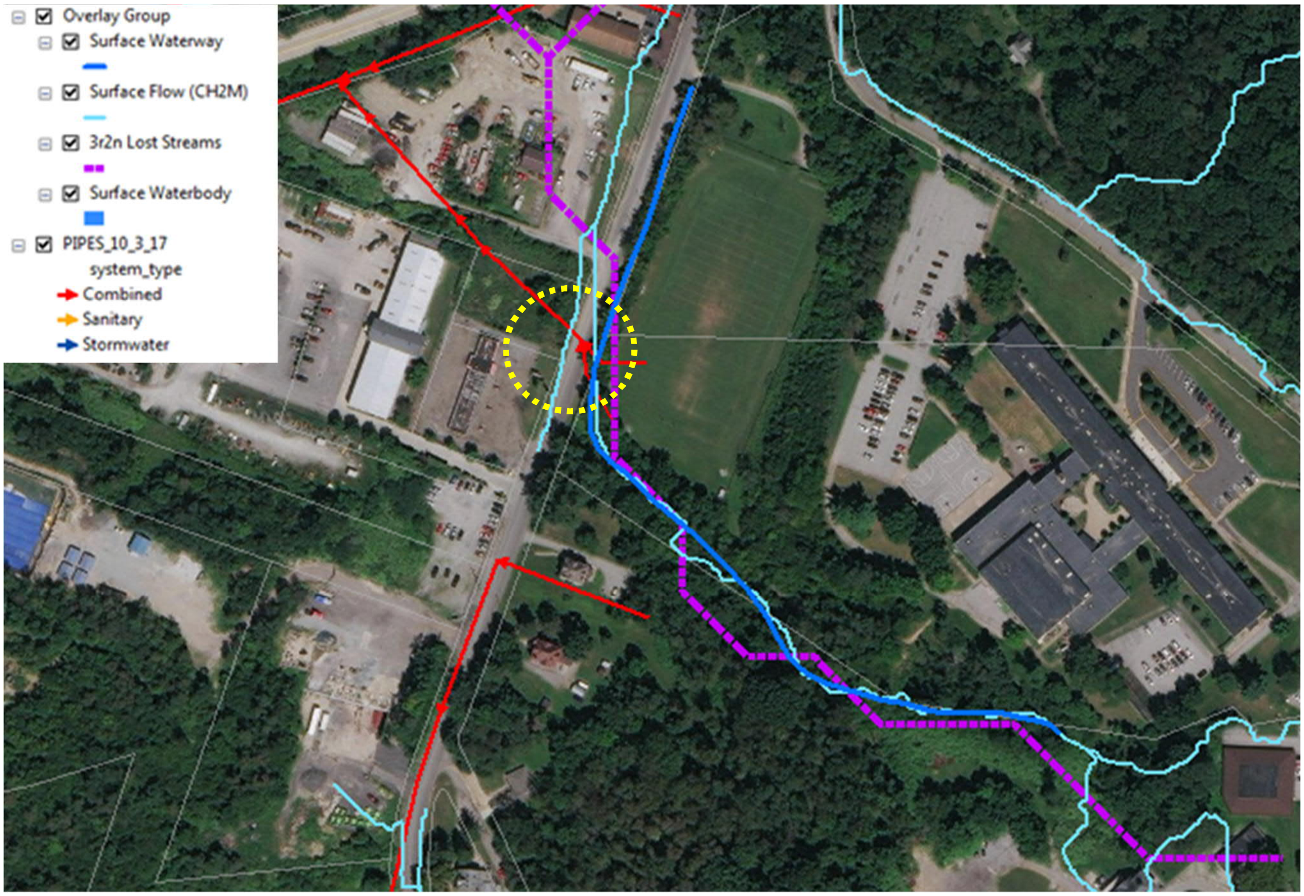

Figure 3.
Pay attention to where a Sewer Pipe or Structure may be receiving flow from a natural drainage path (represented by Surface Flowlines or Lost Streams)

2. Use aerial photography and Google Earth street view (if potential location is near road) to review topographical and street level conditions; review historical aerials for additional evidence of a potential inflow location.

Figure 4.
Conduct a virtual site visit using Google Earth and investigate available Google Earth historical imagery for additional evidence as to whether a stream inflow may exist.

3. Place a Point at each potential inflow location.

Once a potential inflow location has been identified following the process described in 1 and 2 above, the user should add a point to the Inflow Locations data feature class. Note that the point feature should be snapped and placed directly on the nearest Surface Flow Line to the desktop-identified inflow location (Figure 5). This is a critical step to generate the drainage areas to the inflow point. In some cases, the Surface Flow Line may not be immediately in the location of the suspected inflow point – it might be 10 to 20 yards away. In this case, it will help to note this in the GIS attribute (e.g., suspected inflow location in woods behind XXYY address, etc.) to guide the fieldwork staff to the more realistic location they should be investigating.

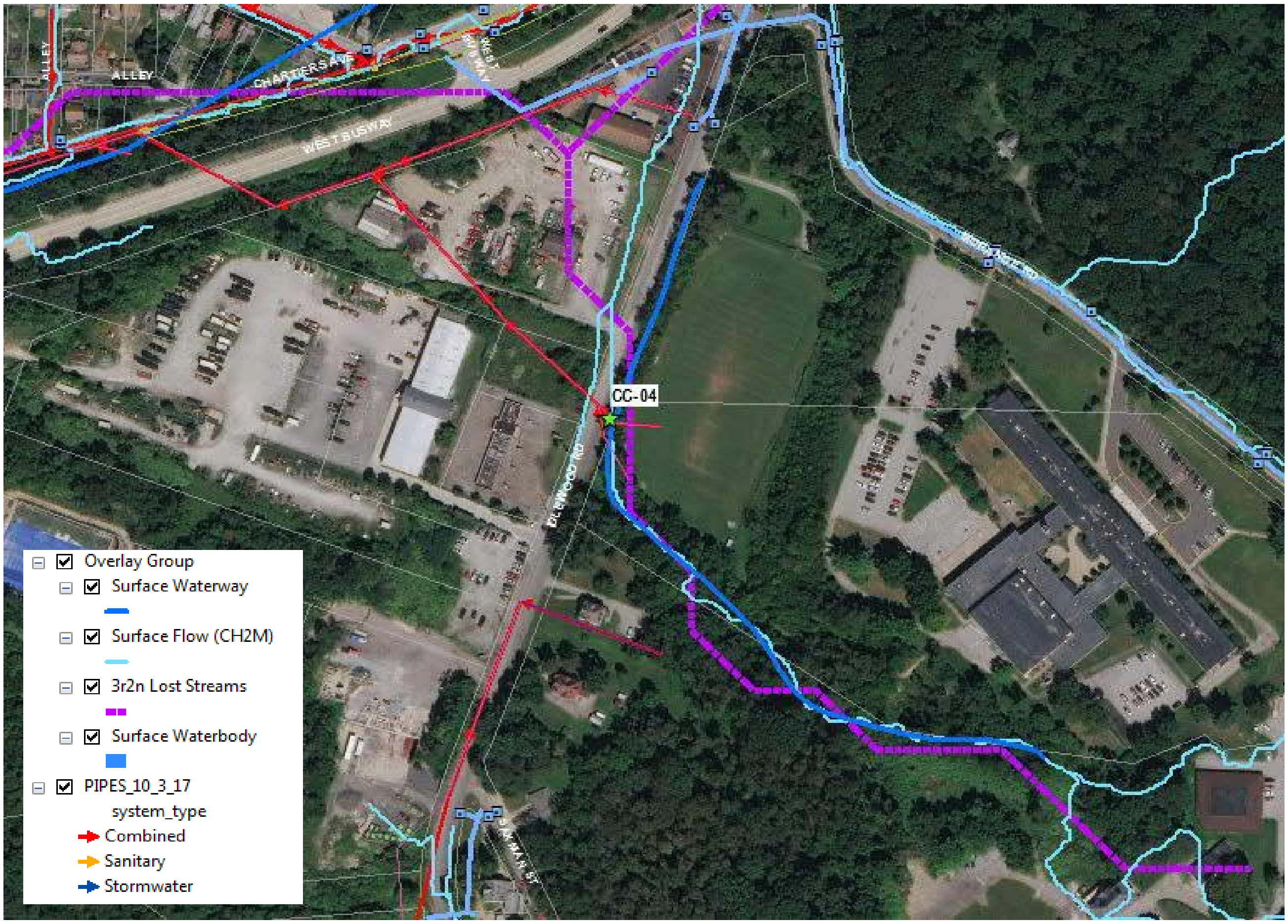

Figure 5.
Place a point approximately where the potential stream inflow location may exist.

4. Update attributes for each point.

Data to be updated in the Desktop Phase is shown in Table 4 below. The specific data options are described.

Table 4.
Summary of attributes and data entry required for DSIR task

Attribute	Phase to enter data	Data options
Basin Name	Desktop	Select from one of seven ALCOSAN Planning Basins: Chartiers Creek Lower Ohio River / Girty's Run Main Rivers Saw Mill Run Turtle Creek Upper Allegheny / Pine Creek Upper Monongahela

Attribute	Phase to enter data	Data options
Planning Basin ID	Desktop	Short name of planning basin: CC LOGR MR SMR TC UA UM
Site ID	Desktop	Enter a two-digit number starting at 01 and increase sequentially, only working within the basin of interest
Sewershed ID	Desktop	Enter the sewershed ID using ALCOSAN basin data
ID Source	Desktop	User to enter the consultant name as the source of identified location. Note - Previously identified locations and their sources have been loaded into the database.
Drainage Area (Acres)	Desktop	Enter the desktop-delineated drainage area tributary to the inflow point, in Acres.
Field Visit Priority	Desktop	Result of user-analysis to determine priority based on the data indicating the likelihood of an inflow being present and its priority for a field visit): High: Suspected DSI likely connected to sewer; field visit and confirmation should occur. Medium: Suspected DSI possible; field visit should occur after high priority locations are completed and if time/budget permits Low: Suspected DSI possible, but not likely and /or tributary area is small; consider field verification at a later time and recommend follow-up during continued municipal outreach.
Field Status	Desktop and Field	User to select either “Not Required” or “Planned” during Desktop Phase; User to select “Completed” during Field Phase Not Required Planned Completed
Desktop Notes	Desktop	User to enter any notes of interest/use for the field team

5. Determine drainage areas to each potential stream inflow point.

Delineating drainage areas (DAs) to each inflow location is one way of vetting potential stream inflow locations. It is expected that locations with small corresponding DAs (less than approximately 20 acres) may not result in cost-effective projects, so sites with relatively small corresponding DAs will be a lower priority. DAs can be delineated using a number of methods, using ArcToolbox geoprocessing tool, ArcHydro geoprocessing tool, or through onscreen delineation. Automated delineations will typically require some manual adjustment and refinement to consider the site-specific sewer system drainage network and major roads that will impact surface drainage patterns (see Figure 6).

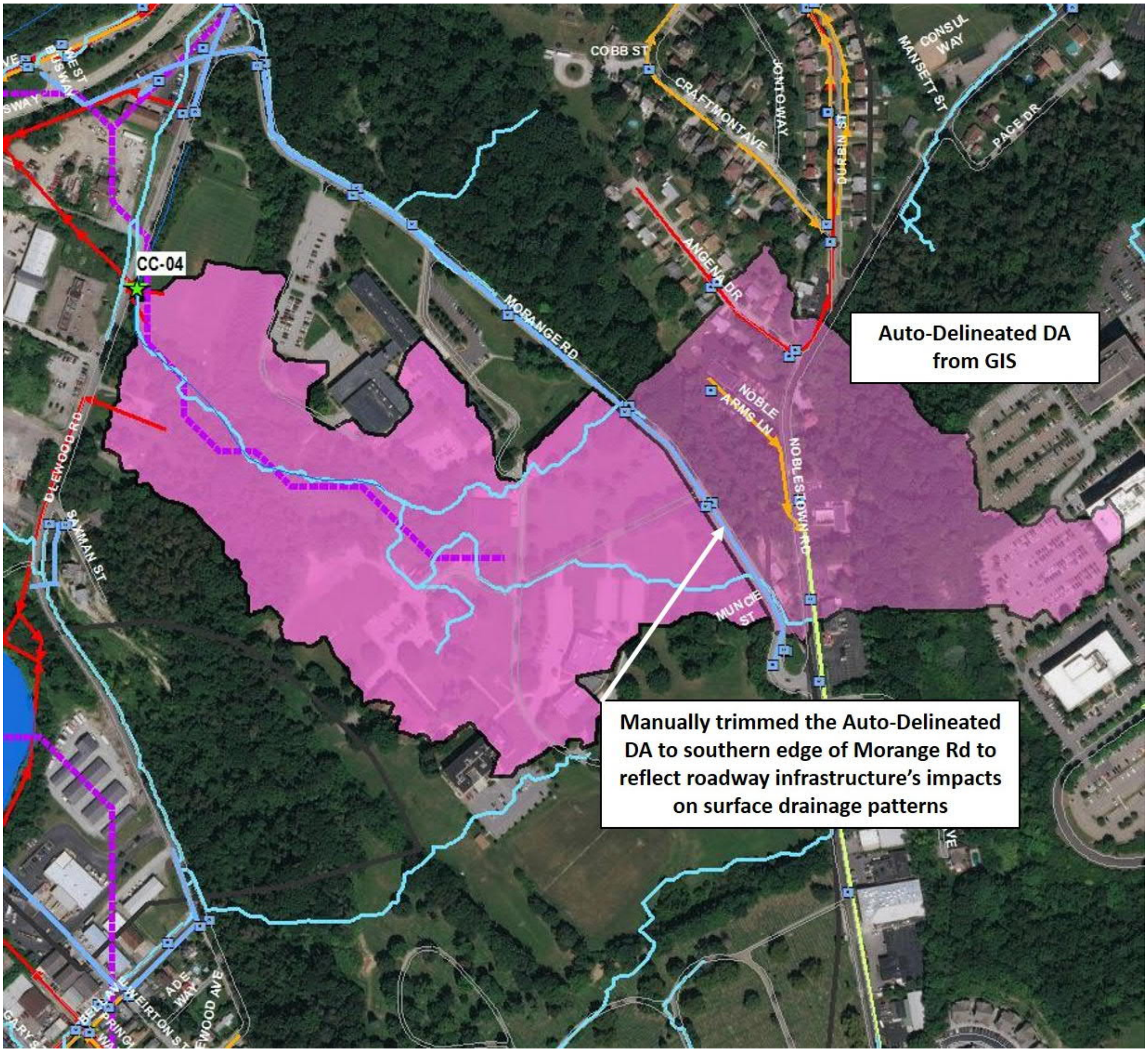

Figure 6.
ArcGIS Geoprocessing Tools are used to generate the associated catchment (drainage area) flowing towards the Potential Stream Inflow Location. The auto-delineated DA may require some manual editing to reflect roadway infrastructure's impacts on surface drainage patterns.

6. Potential locations are assigned a 3-level priority ranking to guide field inspection phase

Potential inflow locations can be sited during the Desktop Phase but after subsequent reviews (including the virtual review in Google Earth described above) it sometimes can be determined that the location is not likely an effective or viable DSIR location. Because the location could be useful in future planning efforts, it is helpful to retain it in the GIS, however, it should be de-prioritized for any field investigations. The Field Visit Priority attribute should be entered during the desktop phase.

<u>Field Visit Priority</u>:

- High: Suspected DSI likely connected to sewer; field visit and confirmation should occur.
- Medium: Suspected DSI possible; field visit should occur after high priority locations are completed and if time/budget permits
- Low: Suspected DSI possible, but not likely and /or tributary area is small; consider field verification at a later time and recommend follow-up during continued municipal outreach.

As the user is working through this task, consider the following criteria for prioritizing field investigations:

- Size of drainage area associated with potential inflow location
- Additional investigations into likelihood of an inflow location based on Google Earth Street View
- Confidence in above workflow
- Total annual overflow volume in POC
- Proximity to receiving waterbody

7. Fill in remaining attributes for Desktop Phase.

All remaining attributes should be filled out following the direction provided in Table 4.

Step 4. Perform Field Evaluation of Potential Locations

Field evaluation of candidate inflow locations will rely on the use of mobile mapping technology to view and update data in real time. To perform this task, an ArcGIS Online (AGOL) map, accessed through the ESRI Collector application loaded on mobile data collection devices (e.g., iPad Mini tablets), will be accessed by field staff who will evaluate the potential DSI locations. All field information, both existing data, newly collected data information and photographs, will be stored on a sequel server so that multi-user editing can occur.

The overall workflow for this Step includes the following activities:

a. Determine the first inflow for field investigation and review any available municipal mapping and/or any other applicable information.

b. Following all applicable safety procedures, travel to the potential DSI location and assess the field conditions to evaluate the potential DSI.

c. Fill in the data tables for each Inflow Location point as shown in Table 5, take photographs, and make any GIS adjustments to the location or the drainage area, as necessary. Note if follow up verification is required (CCTV, dye testing, flow monitoring, etc.).

d. If a new inflow location is identified, add a new point and fill in all the data attributes.

Table 5.
Summary of attributes and data entry required for DSI Field Investigation phase

Attribute	Phase to enter data	Data options
Municipal Map	Field	User to review municipal mapping, if available, and track results: Select from the following dropdown options: Yes No Not Available
Field Date	Field	User to enter the date for field investigation.
Field Weather	Field	User to enter brief description of weather, noting if there is precipitation or other significant features.
Field Notes	Field	User to enter any additional notes or documentation
Field Drainage Area Review	Field	User to enter documentation, notes, etc. during the field-based drainage area review
Drainage Area Status	Field	Choose one from the dropdown to note if additional review/edits are needed: Confirmed in field Edits required Follow up needed
Inflow Confirmation	Field	Choose one from the dropdown to note field verification status: Additional field verification required Inflow location confirmed in field Monitoring planned Monitoring underway Other (see notes)
Confirmation Method	Field	Choose one from the dropdown to note confirmation method: Dye Test CCTV Visual Observation Other (see notes)

Steps to undertake after Inflows are Identified

Step 5. Prioritize and Rank Potential Locations

Once the field confirmation is complete, user should update the attributes listed in Table 6, for the Tracking phase, for confirmed locations that are Under Evaluation. Once this is complete, the results of the field observations will be updated into a final prioritization and ranking of confirmed inflow locations. This prioritization may occur outside of the GIS, in a multi-criteria assessment tool. Criteria to be considered in the prioritization analysis could include:

- Access / Constructability Considerations
- Distance to receiving water
- Potential removal approach (convey, detain, green stormwater infrastructure)
- Volume reduction potential
- Basin and Overflow Reduction Efficiency
- Project Context (Residential Area vs. Public Land)
- Estimated Cost Efficiency (qualitative high, medium, low assessment)

Table 6.
Summary of attributes and data entry required for DSI Tracking Phase

Attribute	Phase to enter data	Data options
Owner Notified	Tracking	Has the owner (municipality) been provided a notice of direct stream inflow to the regional conveyance system? Yes or No
Implementation Status	Tracking	Choose one from the dropdown to note implementation status: Under Evaluation Removal deemed infeasible/cost ineffective Concept prepared Planned Project Known point of inflow removed Other (see notes)

Step 6. Feasibility Analysis for Removing Confirmed Direct Stream Inflows

After inflow locations are confirmed, it is recommended that concept plans for removing the inflow be developed for the final high priority list of locations, along with estimated costs and overflow reduction. Removal costs and the associated inflow reduction can be compared with ALCOSAN cost effectiveness criteria.

The following criteria were used to evaluate cost-effectiveness of prior new potential municipal stream inflow locations (PWSA 2010) and is recommended as a basis for further prioritization.

Estimated Costs (Current Costs) of Stream Disconnection project scenarios (i.e. piping or other)

- Probable Installed Construction Cost
- Estimated Capital Cost

Present Worth Values

- Present Value Capital Costs
- Present Value O&M Costs
- Total Present Worth

Estimated CSO Volume Reductions (Gal)

Estimated Annual Flow Volume Reductions (Gal)

Item	Present Worth Cost	Basis of Calculation
Estimated CSO control facilities cost savings associated with CSO volume removed (present worth)	$2,937,000	430,000 gallons at $6.83/gallon
Estimated treatment cost savings associated with annual volume removed (present worth)	$34,000	18,200,000 gallons/year at $1.87/1000-gallons
Estimated total present worth cost savings	$2,971,000	
Estimated total present worth cost of stream removal	$6,784,000	Facilities cost estimate
Net cost savings	-$3,813,000	

Figure 7.
Example of Cost Effectiveness Analysis for Panther Hollow M-29 (Source: Cost-Effectiveness Analysis of Removing Stream Flow Connections to the Combined Sewer System - Pittsburgh Water and Sewer Authority -2010)

Pilot Basin Results – Chartiers Creek

The methodology described in Steps 1-4 was piloted for Chartiers Creek Basin. The desktop analysis resulted in 17 sites identified as potential DSI locations: 9 were previously identified as inflow locations (7 in ALCOSAN's GIS and 2 were identified by PWSA) and 8 new potential locations for field review were identified. Of the 8 new potential locations, 4 were considered a high priority for field investigation, 2 were considered Medium priority for field investigation, and 2 were considered Low priority for field investigation. Preliminary field verification was performed by CH2M Staff on the 4 High priority sites and DSIs were preliminarily confirmed at 2 locations (Figure 8 and 9). Table 7 shows a summary of the DSI status in Chartiers Creek to date and Table 8 shows a more detailed view of the data collected to date for the Chartiers Creek pilot DSI analysis. Figure 10 shows a map of potential locations and drainage areas.

Table 7.
Summary of DSI Status in Chartiers Creek to date

DSI Status in Chartiers Creek	Project Count	Sum of Drainage Area (AC)
Candidate Inflow locations for field review		
Under evaluation (4 - high priority, 2 - medium priority, 2 – low priority, 2- N/A for field review)	8	230.3
Candidate Inflow location for field review (Total)	8	230.3
Previously identified inflow locations		
Under evaluation	1	24.8
Concept prepared	2	26.1
Under construction	1	57.3
Project Complete/Known point of inflow removed	5	519.2
Previously identified inflow locations (Total)	9	627.4
Grand Total	17	857.7

Table 8.
Summary of the DSI data collected to date for Chartiers Creek Pilot DSI Analysis

Planning Basin	Site ID	Site Name	Sewershed	Source	Desktop Status	Desktop Notes	Drainage Area (AC)	Drainage Area Notes	Field Visit Priority	Field Notes	Implementation Status
CC	CC-02	CC-02	C-27	CH2M	Candidate Inflow location for field review	Sigf surface flow to woodland area; appears to enter CSS through rear yard structure	36.7	Follow up needed	High		Under evaluation
CC	CC-04	CC-04	C-25	CH2M	Candidate Inflow location for field review	low point DS of wooded area with likely surface water flow. appears to be SW system for rec field	28.4	Follow up needed	High	Definitely a potential DSIR	Under evaluation
CC	CC-08	CC-08	O-13	CH2M	Candidate Inflow location for field review	Open channel stream converts to piped stream. Near Corks Run SI points ID'd in PWSA report.	26.2	Follow up needed	Medium		Under evaluation
CC	CC-12	CC-12	C-45/B-04	CH2M	Candidate Inflow location for field review	likely stream valley, possible adjacent to buried CSS pipes;	42.6	Follow up needed	Low		Under evaluation
CC	CC-24	CC-24	C-05	CH2M	Candidate Inflow location for field review	Lost stream line in woods at top of system; not likely but worth field review	3.6	Follow up needed	Medium		Under evaluation
CC	CC-28	CC-28	O-13	CH2M	Candidate Inflow location for field review	Surface flow, lost stream, woods. W/i ALCOSAN Inflow Area that was deemed N/A but no Inflow Pt.	30.7	Follow up needed	Low		Under evaluation
CC	CC-29	CC-29	C-15	CH2M	Candidate Inflow location for field review	Surface flowpath and lost streams upstr of newdev. historic strm mapped; Field Investigate	33.5	Follow up needed	High		Under evaluation

Planning Basin	Site ID	Site Name	Sewershed	Source	Desktop Status	Desktop Notes	Drainage Area (AC)	Drainage Area Notes	Field Visit Priority	Field Notes	Implementation Status
CC	CC-31	CC-31	C-11	CH2M	Candidate Inflow location for field review	Surface flowpath and lost streams. Historic Strm Mapped; Field Investigate	28.6	Follow up needed	High	Looks promising as a DSIR	Under evaluation
CC	CC-09	CC-09 Corks Run	O-13	PWSA	Previously identified inflow location	PWSA 2010 Report ID'd Location - determined not cost effective. Low estimated vol. of SI.	13.9				Concept prepared
CC	CC-10	CC-10 Corks Run	O-13	PWSA	Previously identified inflow location	PWSA 2010 Report ID'd Location - determined not cost effective. Low estimated vol. of SI.	12.2				Concept prepared
CC	CC-11	CC-11 Ella St. SW Retention Pond McK	O-06	ALCOSAN	Previously identified inflow location		24.8				Under evaluation
CC	CC-03	CC-03 Pine Hollow	C-09-00	ALCOSAN	Previously identified inflow location		46.1				Known point of inflow removed
CC	CC-05	CC-05 Pine Hollow	C-09-00	ALCOSAN	Previously identified inflow location		256.0				Known point of inflow removed
CC	CC-06	CC-06 Pine Hollow	C-09-00	ALCOSAN	Previously identified inflow location		105.8				Known point of inflow removed
CC	CC-01	CC-01 Carnegie Park	C-40-00/C-41-00	ALCOSAN	Previously identified inflow location		100.8				Known point of inflow removed

Planning Basin	Site ID	Site Name	Sewershed	Source	Desktop Status	Desktop Notes	Drainage Area (AC)	Drainage Area Notes	Field Visit Priority	Field Notes	Implementation Status
CC	CC-13	CC-13 Sheraden Park	C-07-0	ALCOSAN	Previously identified inflow location	Dec 2017 notes: Removal is under construction, nearly complete.	57.3				Under construction
CC	CC-07	CC-07 Carnegie Park	C-40-00/C-41-00	ALCOSAN	Previously identified inflow location		10.5				Known point of inflow removed

Figure 8.
Photos of Potential Inflow Location CC-04

Figure 9.
Bridge over existing channel and inlet structure at Potential Inflow Location CC-31

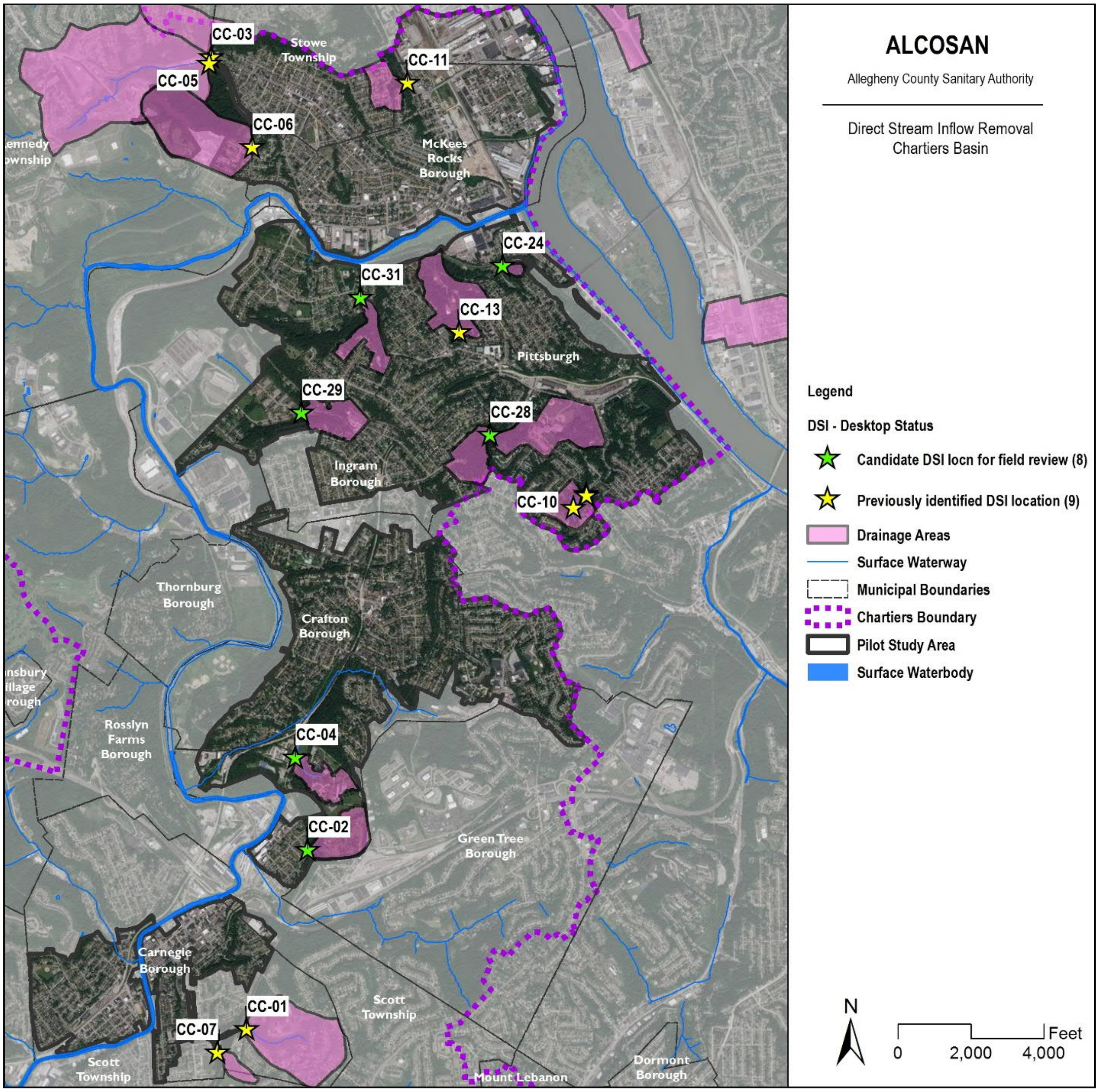

Figure 10
DSI Locations, Drainage Areas, and Status for Chartiers Creek

Funding

Once the feasibility and costs have been determined for DSIR projects, many potential funding sources are available including GROW, grants, and low-interest loans.

References

ALCOSAN Wet Weather Plan (revised August 2017)

Cost-Effectiveness Analysis of Removing Stream Flow Connections to the Combined Sewer System - Pittsburgh Water and Sewer Authority (Nov. 2010)

Stream Restoration and Daylighting: Opportunities in the Pittsburgh Region by Studio for Creative Inquiry, 3 Rivers – 2nd Nature Project, Carnegie Mellon University (2002)