2. ESTABLISH TARGET GREEN INFRASTRUCTURE MANAGEMENT LEVEL GOALS

To establish combined sewer overflow (CSO) control targets for the 30 priority combined sewersheds evaluated during the City-Wide project, it was necessary to establish the baseline CSO performance and what influence other system factors, such as ALCOSAN'S Woods Run Wastewater Treatment Plant (WWTP) and ALCOSAN's existing interceptors, have on the potential performance of green infrastructure (GI) and the degree of GI investment needed to meet CSO control goals.

2.1 Review of Hydrologic and Hydraulic Models from ALCOSAN

At the initiation of the City-Wide GI Assessment, PWSA obtained the most up-to-date regional baseline hydrologic and hydraulic (H&H) models from ALCOSAN to use for this project. ALCOSAN uses EPA's SWMM software for H&H system modeling. ALCOSAN provided seven separate Basin-level models that reflected the way the system currently operates. The seven basin models included the following:

- Chartiers Creek
- Lower Ohio/Girty's Run
- Main Rivers
- Saw Mill Run
- Turtle Creek
- Upper Allegheny
- Upper Monongahela

Figure 2-1 shows the locations of the seven ALCOSAN planning basins as described in ALCOSAN's 2013 Wet Weather Plan, Section 3 Existing Conditions.

Rather than run the individual basin models in sequence, the seven basin models were compiled into a single comprehensive system wide model of the ALCOSAN modelled sewers (system model). This model allows seamless system hydraulic response to the applied flow conditions.

Each basin model uses an external inflow file that loads dry weather flow time series into the model at defined loading points. These time series were derived directly from flow monitoring performed by ALCOSAN and 3 Rivers Wet Weather (3RWW) in 2008-2009 as part of a large scale flow monitoring effort across the entire ALCOSAN service area. Since each basin model had an inflow file, the data from each was extracted and then reformatted to create a single inflow file to use with the system model. There were no changes to the time series data, loading point locations or rainfall input files. The conveyance and overflow system outputs from running the system model were similar to the results from the individual basin models.

Another difference between the ALCOSAN basin models and the PWSA-developed system wide model is the version of SWMM used. At the time the original ALCOSAN basin models were developed the then-current SWMM version was 5.0.013. The ALCOSAN basin models were all developed using this version and they have remained in that version to today. For the PWSA-developed system wide model, the current

version of SWMM was used (5.1.009). This newer version is the most up-to-date and presumably most reliable version and also has GI modeling capabilities that the older 5.0.013 version does not. The GI modeling capabilities permit assessment of the peak flow rates resultant from stormwater detention and retention within both the combined and separated sewersheds.

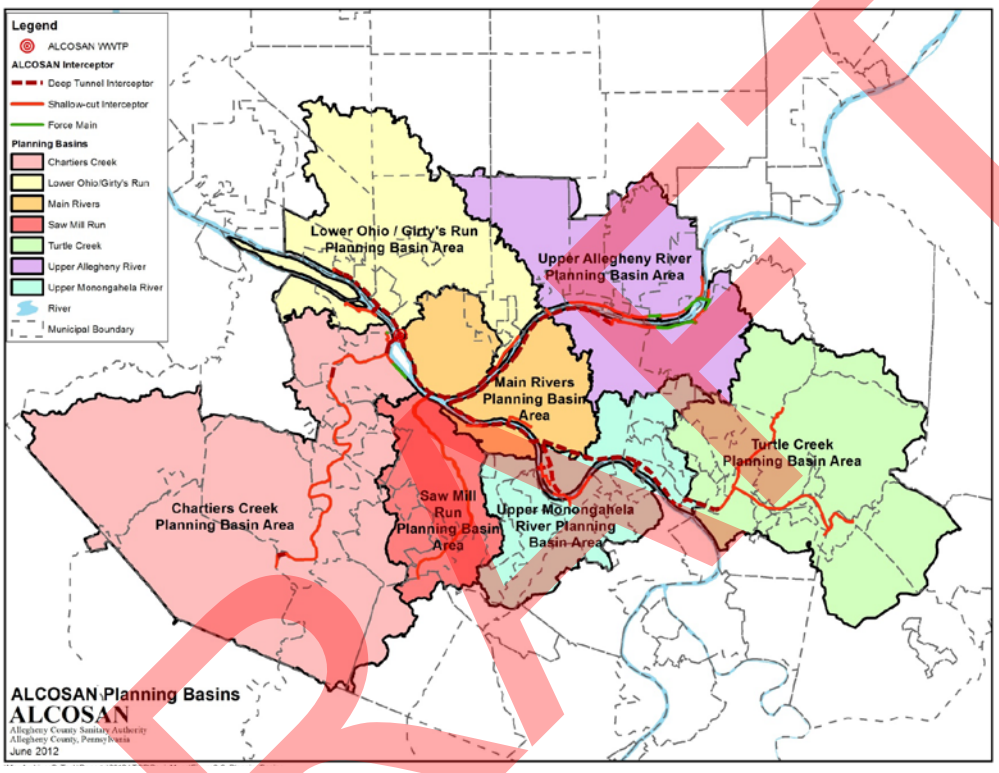

Figure 2-1: Locations of ALCOSAN Planning Basins, WWTP, and Interceptors
(Source: ALCOSAN Wet Weather Plan, 2013)

2.2 Quantify Existing Baseline Conditions and CSO Statistics

After PWSA developed the system wide model, it was used to simulate ALCOSAN's typical year flow conditions to calculate baseline CSO statistics. ALCOSAN uses a modified version of the precipitation measured during calendar year 2003 as their typical year (TY) and this analysis used the same precipitation data. Table 2-1 details the overflow volume results for the City-Wide project's 30 high priority sewersheds using values included in ALCOSAN's Wet Weather Plan (WWP) and updated overflow volumes calculated by the PWSA system wide model for the "typical year". With all of the accumulated software updates between these SWMM versions, some differences in the results were expected. The overflow volume differences are generally minor and the aggregate overflow volume difference between the two models is less than 1.0%. These comparative results are well within the acceptable range for comparable models.

However, it is important to note the differences between the ALCOSAN WWP results and this project's results. The A-41 and A-58 sewersheds each contain multiple outfalls which can discharge combined sewer flow, but the results in Table 2-1 only include the

A-41-OF and A-58-OF outfalls as per ALCOSAN's reporting. However, for subsequent analyses and tables, the total volume for the multiple outfalls is reported, resulting in a higher total volume. The existing conditions, typical year results including wet weather combined sewage flows, CSO volumes, and percent capture results for the system wide model are summarized in Table 2-2.

TABLE 2-1
SWMM VERSION AND MODEL INTEGRATION IMPACTS ON TYPICAL YEAR OVERFLOW VOLUMES

Sewershed	Overflow Volumes (MG)		Model Differences	
	ALCOSAN WWP (SWMM 5.0.013)	PWSA System Wide Model (SWMM 5.1.009)	Volume (MG)	% Difference
A-22-OF	593	580	-12.5	-2.1%
A-41-OF [1]	256	254	-1.7	-0.7%
A-42-OF	777	783	6.0	0.8%
A-47-OF	0.74	0.92	0.2	25.0%
A-48-OF	47.9	49.1	1.2	2.6%
A-51-OF	12.8	13.1	0.3	2.1%
A-58-OF [1]	82	72.8	-9.2	-11.2%
A-60-OF	198	210	11.8	5.9%
A-61-OF	5.32	5.10	-0.2	-4.0%
A-62-OF	8.20	8.41	0.2	2.6%
A-63-OF [2]	0.16	0.18	0.0	12.8%
A-64-OF	3.86	4.05	0.2	4.9%
A-65-OF	19.8	20.9	1.1	5.5%
M-15-OF	4.04	4.65	0.6	15.0%
M-15Z-OF	0.61	0.61	0.0	0.2%
M-16-OF	102	103	0.9	0.9%
M-17-OF	0.38	0.54	0.2	42.0%
M-18-OF	0.60	0.72	0.1	20.1%
M-19A-OF	84.5	83.5	-1.0	-1.2%
M-19B-OF	17.1	17.0	-0.1	-0.8%
M-19-OF	150	146	-4.0	-2.6%
M-20-OF	1.29	1.70	0.4	31.6%
M-21-OF	10.9	11.1	0.2	2.2%
M-22-OF	6.31	6.47	0.2	2.5%

TABLE 2-1
SWMM VERSION AND MODEL INTEGRATION IMPACTS ON TYPICAL YEAR OVERFLOW VOLUMES

Sewershed	Overflow Volumes (MG)		Model Differences	
	ALCOSAN WWP (SWMM 5.0.013)	PWSA System Wide Model (SWMM 5.1.009)	Volume (MG)	% Difference
M-29-OF	400	402	2.0	0.5%
O-27-OF	96.6	79.6	-17.0	-17.6%
O-39-OF	6.71	7.48	0.8	11.5%
O-40-OF	0.13	0.20	0.1	51.3%
O-41-OF	13.6	14.5	0.9	6.9%
O-43-OF	0.39	0.15	-0.2	-60.3%
Totals	**2,900**	**2,881**	**-18.7**	**-0.6%**

[1] Includes one outfall only.
[2] The SWMM Model of Lower Ohio-Girty's Run Basin received from ALCOSAN in 2015 included A-63, so the City-Wide analysis included this sewershed. It was found that this sewershed does not require GI to meet 85% combined sewage capture. In June 2016, PWSA received information from ALCOSAN that PennDOT's work on State Route 28 may have resulted in A-63 abandonment. ALCOSAN is working to confirm this with testing.

Table 2-2
CSO Statistics for 30 High Priority Sewersheds, Typical Year, Existing Conditions

Sewershed	Combined Flow Volume (MG)				85% Combined Flow Capture Goal (MG)	
	Inflow to Regulator	Underflow to WWTP	Overflow (CSO)	% WW Capture	CSO Volume Target	Additional CSO Capture Needed
A-22-OF	1,594.8	1,014.3	580.5	63.6%	240.0	340.5
A-41-OF [1]	664.5	325.9	338.6	49.1%	87.0	251.6
A-42-OF	2,175.9	1,392.9	783.0	64.0%	326.4	456.6
A-47-OF	32.7	31.8	0.9	97.2%	4.9	0
A-48-OF	546.0	496.9	49.1	91.0%	81.9	0
A-51-OF	119.8	106.7	13.1	89.1%	18.0	0
A-58-OF [1]	1,007.8	833.6	174.2	82.7%	151.2	23.0
A-60-OF	801.5	591.7	209.8	73.8%	120.2	89.6
A-61-OF	14.1	9.0	5.1	63.8%	2.1	3.0
A-62-OF	8.3	-0.1	8.4	-1.3%	1.2	7.2

Table 2-2
CSO Statistics for 30 High Priority Sewersheds, Typical Year, Existing Conditions

Sewershed	Combined Flow Volume (MG)				85% Combined Flow Capture Goal (MG)	
	Inflow to Regulator	Underflow to WWTP	Overflow (CSO)	% WW Capture	CSO Volume Target	Additional CSO Capture Needed
A-63-OF [2]	2.9	2.7	0.2	93.8%	0.4	0
A-64-OF	30.3	26.3	4.0	86.6%	4.6	0
A-65-OF	11.8	-9.1	20.9	-77.1%	1.8	19.1
M-15-OF	7.9	3.3	4.6	41.2%	1.2	3.4
M-15Z-OF	10.4	9.8	0.6	94.1%	1.6	0
M-16-OF	249.0	146.1	102.9	58.7%	37.4	65.5
M-17-OF	8.8	8.3	0.5	93.9%	1.3	0
M-18-OF	8.9	8.2	0.7	91.9%	1.3	0
M-19A-OF	318.2	234.7	83.5	73.8%	47.7	35.8
M-19B-OF	75.5	58.5	17.0	77.5%	11.3	5.7
M-19-OF	265.9	119.9	146.0	45.1%	39.9	106.1
M-20-OF	13.4	11.7	1.7	87.3%	2.0	0
M-21-OF	62.6	51.5	11.1	82.2%	9.4	1.7
M-22-OF	72.0	65.5	6.5	91.0%	10.8	0
M-29-OF	1,426.3	1,024.3	402.0	71.8%	213.9	188.1
O-27-OF	696.9	617.3	79.6	88.6%	104.5	0
O-39-OF	29.3	21.8	7.5	74.5%	4.4	3.1
O-40-OF	3.2	3.0	0.2	93.9%	0.5	0
O-41-OF	33.3	18.8	14.5	56.3%	5.0	9.5
O-43-OF	35.3	35.1	0.2	99.6%	5.3	0
Totals	**10,327**	**7,260**	**3,067**	**70.3%**	**1,537**	**1,609**

[1] Reflects all outfalls in the sewershed.

[2] The SWMM Model of Lower Ohio-Girty's Run Basin received from ALCOSAN in 2015 included A-63, so the City-Wide analysis included this sewershed. It was found that this sewershed does not require GI to meet 85% combined sewage capture. In June 2016, PWSA received information from ALCOSAN that PennDOT's work on State Route 28 may have resulted in A-63 abandonment. ALCOSAN is working to confirm this with testing.

The columns in Table 2-2 are defined as follows:

- **Inflow to Regulator** represents the total combined sewage flow during the typical year that is influent to the regulator or diversion structure during the "wet weather windows". The "wet weather windows" are portions of where the influent hydrograph to the diversion structure deviates from the expected dry weather flow in response to rainfall. The end of the window is when the influent hydrograph returns back to within 5% of the typical dry weather flow. The starting or ending times of the "wet weather windows" may be adjusted to ensure that all overflow occurs within these windows. The inflow represents the entire flow volume within the starting and stopping times of the "wet weather window" and then summed for the entire typical year.
- **Underflow to WWTP** is the total combined sewage flow within the "wet weather windows" that is conveyed to the interceptors and eventually to the WWTP.
- **Overflow (CSO)** is the total flow within the "wet weather windows" that is diverted at the regulator or diversion structure through an outfall pipe and discharged to receiving waters.
- **% Wastewater Capture** is calculated as the underflow divided by the inflow and it represents the portion of the flow that stays in the sewer system for conveyance to the WWTP.
- **CSO Volume Target** is the CSO discharge reduction needed for a sewershed to achieve 85% combined sewage capture.
- **Additional CSO Capture Needed** is the additional amount that the existing conditions CSO volume needs to be reduced to meet the 85% combined sewage capture target. If this column is blank it means that 85% combined sewage capture is already achieved under existing conditions and no further reduction is needed.

Figure 2-2 graphically depicts the various flow components listed in Table 2-2.

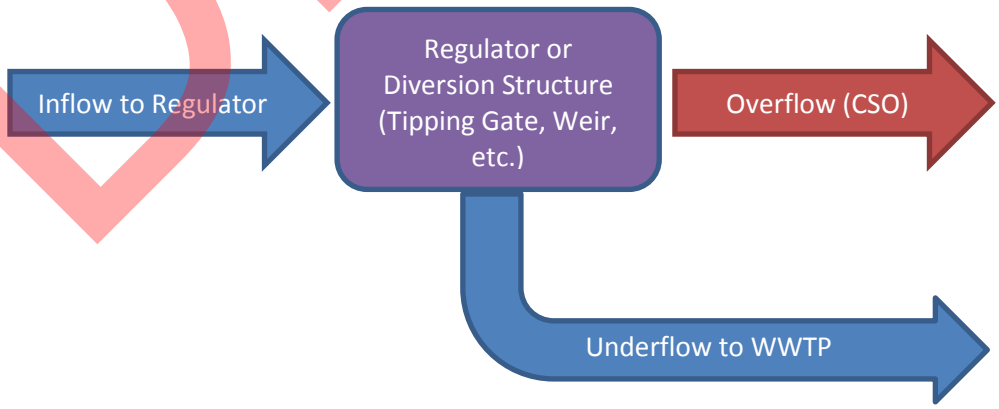

Figure 2-2: Illustration of Combined Sewage Flow Components

The 30 high priority sewersheds account for just over 3 BG of CSO discharge, which represents about one-third of the overflow discharge from the entire collection system tributary to the ALCOSAN conveyance and treatment system. Sewersheds that have negative percent captures indicate situations where CSOs are influenced by either reverse flows or other interconnected CSOs.

2.3 Impervious Surface Reduction Analysis

The GI Assessment approach was to evaluate the potential volume of GI stormwater management needed to meet specific performance and regulatory goals across the 30 high priority sewersheds. The number of GI Best Management Practices (BMPs) to be deployed was based on the necessary impervious area runoff managed by GI within each sewershed, and simply defined as "GI investment". Impervious areas are defined as areas that allow all or a significant portion of the precipitation that falls on them to run off the ground (topographic) surface into entry points in the collection system or to adjacent pervious areas. Impervious areas include rooftops, sidewalks, driveways, parking lots, impervious solids and rock, and streets, unless specifically designed, constructed, and maintained to prevent or control runoff.

The EPA's CSO Control Policy requires at least 85% combined sewage capture be achieved within combined sewer systems as part of a CSO long-term control plan. For this project 85% capture was the target selected for the GI Assessment, as it is consistent with the CSO Control Policy and other approved long term control plans across the United States. The existing ALCOSAN WWP was developed assuming a standard of no more than four overflows per year at each combined sewer outfall. This 85% combined sewage capture target is not meant to presume a final level of control for the region's CSOs, but simply to define a target that has been required as a presumptive compliance goal for other cities like Pittsburgh. This approach allows flexibility to scale the eventually required amount of GI investment, in conjunction with necessary gray infrastructure, to meet whatever CSO target is ultimately agreed upon with regulators.

2.3.1 Development of Scenarios to Define Range of GI that May be Required

To define the range of GI implementation that will need to be implemented in the 30 high priority sewersheds to meet the 85% combined sewage capture goal, it was necessary to conduct an analysis to determine a minimum amount of GI and a maximum amount of GI (to be expressed as acres of impervious area management) to meet the 85% goal. It was anticipated that the capacities of the ALCOSAN interceptors and WWTP will both influence the degree of GI needed to meet the goal, so an understanding of ALCOSAN existing infrastructure and expansion plans was derived from ALCOSAN's 2013 Wet Weather Plan report. As part of their Recommended Plan, ALCOSAN plans to increase the WWTP treatment capacity to 480 million gallons per day (MGD). ALCOSAN considered other alternatives involving a WWTP treatment capacity increase to 600 MGD, but those were not recommended.

ALCOSAN's actions are anticipated to have an impact on overall conveyance system performance and ultimately the amount of GI required to achieve an 85% combined sewage capture goal. On the basis of existing information, four scenarios were

developed for H&H modeling simulations to determine the degree to which existing and potential future infrastructure can influence the amount of GI that would need to be implemented to achieve the 85% combined sewage capture goal. The scenarios attempted to estimate the most hydraulically favorable conditions for existing infrastructure, but these scenarios have not been evaluated for feasibility. The scenario with the most hydraulically favorable condition for existing infrastructure essentially represents the minimum level of GI that would need to be implemented to meet the 85% combined sewage capture goal. Conversely, the existing condition scenario represents the maximum level of GI that would need to be implemented to meet the goal. Four system configuration scenarios were identified as described in Table 2-3, and these conditions were simulated with the H&H model.

Table 2-3
Various System Configurations Evaluated to Determine GI Sensitivity

Existing Conditions	This represents the current state of the conveyance system and the WWTP treatment capacity. The WWTP has a 250 MGD treatment capacity and its influent pump station wet well operates at a hydraulic grade line (HGL) level of 670 feet. The existing interceptors have the sediment levels as defined in the current ALCOSAN model.
480 MGD (WWTP Expansion)	This system state is the same as the existing conditions, except the capacity of the WWTP has been expanded to 480 MGD and its operating wet well HGL level reduced to 660 feet.
600 MGD (WWTP Expansion & System Improvements)	This system state is the same as the existing conditions, except the capacity of the WWTP has been expanded to 600 MGD and its operating wet well HGL level reduced to 660 feet. Also, the existing interceptors are modeled with their sediment removed to maximize wastewater conveyance to the WWTP and regulator structures for 19 of the 30 high priority sewersheds have modified tipping gate settings to allow more flow to enter the interceptors.
Lowered HGL Operation During Wet Weather Conditions	This system state represents an attempt to maximize the performance of the existing infrastructure. This alternative is not currently planned to be implemented by ALCOSAN. In this scenario, the WWTP is modeled as a free outfall to represent lowering the water level at the existing pump station during wet weather conditions such that it is below the crown of the connecting deep tunnel. This provides for the existing conveyance capacity to be maximized. This scenario also assumes that the necessary high rate treatment infrastructure is constructed at the WWTP to process any flows above 600 MGD (modeling results indicate peak flows at or above 600 MGD occur 29 hours in a typical year). The necessary infrastructure to accomplish this scenario is discussed in Section 3.3. The technical feasibility of all potential treatment plant wet weather capacity scenarios is currently under discussion between PWSA and ALCOSAN. The existing interceptors are modeled with their sediment removed and regulator structures for 19 of the 30 high priority sewersheds have modified tipping gate settings to allow more flow to enter the interceptors.

Table 2-4 lists the annual CSO and SSO discharges from the entire ALCOSAN service area (including municipal CSO and SSO discharges) for these four system configurations. The model allows calculation of overflow reductions and assessment of differing and required levels of GI implementation only within the 30 sewersheds based upon the system-wide calculation of flows.

TABLE 2-4
SYSTEM CONFIGURATION SUMMARY OF TYPICAL YEAR DISCHARGES

System Configuration	System-Wide Annual CSO and SSO Discharge Volume
Existing Conditions	10.2 Billion Gallons (BG) [1]
480 MGD (WWTP Expansion) [2]	7.3 BG
600 MGD (WWTP Expansion & System Improvements) [2]	6.0 BG
Lowered HGL Operation During Wet Weather Conditions [2]	5.5 BG

[2] The technical feasibility of all potential treatment plant wet weather capacity scenarios is currently under discussion between PWSA and ALCOSAN.

2.3.2 Impervious Surface Overflow Reduction Results

After simulating the system model to evaluate the different configurations listed in Table 2-4, it became apparent that the WWTP and interceptor conveyance system exert a significant impact on the GI investment necessary to meet the 85% wet weather capture goal across the 30 high priority sewersheds. Table 2-5 compares the required directly connected impervious area (DCIA) whose runoff must be removed from the system vs. the DCIA whose runoff must be managed by GI to reach the 85% wet weather control goal. The results for the 480 MGD and Lowered HGL Operation During Wet Weather Conditions scenarios are presented to show the range of resulting impervious area to be managed. All zero entries in Table 2-5 indicate a sewershed already achieves the 85% wet weather control goal and no GI is needed. Table 2-5 is further explained below:

- **Total DCIA** represents the impervious area that directly connects to the collection system. Examples of DCIA would include paved roadways where runoff is directed to storm grates where the flow enters the collection system. In the SWMM model, DCIA represents the impervious surfaces that contribute flow to the sewer system. Some impervious surface such as paved driveways that drain to the backyard of a house do not directly contribute flow to the collection

[1] The ALCOSAN WWP indicates a current system-wide overflow volume (CSO and SSO) of 9.67 BG. The difference between the 10.2 BG and 9.67 BG is that ALCOSAN subtracts the separated stormwater overflows (which are regulated differently by regulators) from CSO volumes to derive the reported combined sewer overflow volume. The numbers have also been adjusted to SWMM 5.0.013 for consistency with numbers previously reported by ALCOSAN.

system and although they are impervious surfaces they are not part of the model's runoff calculations.

- **DCIA Removed** represents the DCIA acres whose runoff needs to be completely removed from the collection system for a sewershed to reach the 85% wet weather capture target. This analysis was done to provide an estimate of the DCIA managed by GI acres that would be needed to reach the same goal.
- **DCIA Managed by GI** represents the DCIA acres that must be managed by GI elements in the SWMM model to achieve the 85% wet weather capture goal. The GI elements collect and slowly release runoff rather than removing it, so more DCIA acres must be managed than if the flow was completely removed from the collection system.

Table 2-6 is similar to Table 2-5, but it compares the minimum DCIA that must be managed by GI to the level of GI that is used for all of the City-Wide alternatives. If the GI managed acres are greater than the minimum required for 85% wet weather capture, it is for one of the following reasons:

- The sewershed is being targeted for potential urban planning improvements and GI managed acres were added to evaluate the level of untreated overflow reduction that may be possible.
- The sewershed had high influent flow volumes (wet weather inflow) to the diversion structure and it was determined that some GI investment was warranted to reduce the high wet weather inflows.
- GI was added to certain sewersheds to help reduce potential localized surface flooding and basement sewage backups during wet weather events. These potential areas were revealed by examining the HGLs of the primary interceptor sewers in the sewershed. The GI was added with the understanding that this would also contribute to CSO reduction.
- For the A-22 sewershed, the percentage of DCIA managed by GI was set to 30%. This level of GI investment was previously determined during an earlier study focused on reducing localized surface flooding and basement sewage backups in the A-22 sewershed.

TABLE 2-5
DCIA REMOVED VS. DCIA MANAGED BY GI 85% WW CAPTURE (EACH SEWERSHED)

Sewershed	Total DCIA (acres)	480 MGD (WWTP Expansion)				Lowered HGL Operation During Wet Weather Conditions			
		DCIA Removed		DCIA GI Managed		DCIA Removed		DCIA GI Managed	
		%	Acres	%	Acres	%	Acres	%	Acres
A-22-OF	898.0	42.5%	382.0	43.0%	386.1	7.0%	62.9	7.0%	62.9
A-41-OF	234.7	75.0%	176.0	85.0%	199.5	57.0%	133.8	60.0%	140.8
A-42-OF	839.7	72.6%	609.3	73.0%	613.0	47.0%	394.7	58.0%	487.0
A-47-OF	9.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
A-48-OF	167.1	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
A-51-OF	34.6	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
A-58-OF	151.7	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
A-60-OF	175.2	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
A-61-OF	10.7	37.6%	4.0	37.0%	4.0	0.0%	0.0	0.0%	0.0
A-62-OF	5.7	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
A-63-OF [1]	1.0	0.0%	0	0.0%	0.0	0.0%	0.0	0.0%	0.0
A-64-OF	18.4	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
A-65-OF	4.6	14.0%	0.6	15.0%	0.7	0.0%	0.0	0.0%	0.0
M-15-OF	3.7	65.3%	2.4	65.0%	2.4	0.0%	0.0	0.0%	0.0
M-15Z-OF	3.1	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
M-16-OF	100.0	75.0%	75.0	85.0%	85.0	0.0%	0.0	0.0%	0.0
M-17-OF	6.2	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
M-18-OF	5.1	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
M-19A-OF	142.6	40.2%	57.3	41.0%	58.5	35.0%	49.9	35.0%	49.9
M-19B-OF	32.1	27.6%	8.9	28.0%	9.0	33.0%	10.6	33.0%	10.6

TABLE 2-5
DCIA REMOVED VS. DCIA MANAGED BY GI 85% WW CAPTURE (EACH SEWERSHED)

Sewershed	Total DCIA (acres)	480 MGD (WWTP Expansion)				Lowered HGL Operation During Wet Weather Conditions			
		DCIA Removed		DCIA GI Managed		DCIA Removed		DCIA GI Managed	
		%	Acres	%	Acres	%	Acres	%	Acres
M-19-OF	119.1	55.2%	65.7	55.0%	65.5	0.0%	0.0	0.0%	0.0
M-20-OF	6.2	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
M-21-OF	29.2	8.0%	2.3	8.0%	2.3	0.0%	0.0	0.0%	0.0
M-22-OF	16.4	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
M-29-OF	362.3	60.1%	217.7	60.0%	217.4	0.0%	0.0	0.0%	0.0
O-27-OF	195.6	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
O-39-OF	23.8	21.0%	5.0	21.0%	5.0	0.0%	0.0	0.0%	0.0
O-40-OF	2.8	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
O-41-OF	27.9	55.8%	15.6	56.0%	15.6	47.0%	13.1	56.0%	15.6
O-43-OF	9.8	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
Totals	**3,636**	**44.6%**	**1,622**	**45.8%**	**1,664**	**18.3%**	**665**	**21.1%**	**767**

[1] The SWMM Model of Lower Ohio-Girty's Run Basin received from ALCOSAN in 2015 included A-63, so the City-Wide analysis included this sewershed. It was found that this sewershed does not require GI to meet 85% combined sewage capture. In June 2016, PWSA received information from ALCOSAN that PennDOT's work on State Route 28 may have resulted in A-63 abandonment. ALCOSAN is working to confirm this with testing.

Table 2-6: DCIA Managed by GI (85% WW Capture each sewershed vs. City-Wide Alternatives)									
Sewershed	Total DCIA (acres)	480 MGD (WWTP Expansion)				Lowered HGL Operation During Wet Weather Conditions			
		85% WW Capture		CityWide Alternatives		85% WW Capture		CityWide Alternatives	
		%	Acres	%	Acres	%	Acres	%	Acres
A-22-OF	898.0	43.0%	386.1	43.0%	387.7	7.0%	62.9	30.0%	271.0
A-41-OF	234.7	85.0%	199.5	85.0%	199.5	60.0%	140.8	60.0%	140.8
A-42-OF	839.7	73.0%	613.0	73.0%	614.10	58.0%	487.0	58.0%	485.1
A-47-OF	9.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
A-48-OF	167.1	0.0%	0.0	25.0%	41.8	0.0%	0.0	25.0%	41.8
A-51-OF	34.6	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
A-58-OF	151.7	0.0%	0.0	25.0%	37.9	0.0%	0.0	25.0%	37.9
A-60-OF	175.2	0.0%	0.0	25.0%	43.8	0.0%	0.0	25.0%	43.8
A-61-OF	10.7	37.0%	4.0	37.0%	4.0	0.0%	0.0	0.0%	0.0
A-62-OF	5.7	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
A-63-OF [1]	1.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
A-64-OF	18.4	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
A-65-OF	4.6	15.0%	0.7	15.0%	0.7	0.0%	0.0	0.0%	0.0
M-15-OF	3.7	65.0%	2.4	65.0%	2.4	0.0%	0.0	0.0%	0.0
M-15Z-OF	3.1	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
M-16-OF	100.0	85.0%	85.0	85.0%	85.0	0.0%	0.0	25.0%	25.2
M-17-OF	6.2	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
M-18-OF	5.1	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
M-19A-OF	142.6	41.0%	58.5	41.0%	58.4	35.0%	49.9	35.0%	49.9
M-19B-OF	32.1	28.0%	9.0	28.0%	9.0	33.0%	10.6	33.0%	10.6

Table 2-6: DCIA Managed by GI (85% WW Capture each sewershed vs. City-Wide Alternatives)									
Sewershed	Total DCIA (acres)	480 MGD (WWTP Expansion)				Lowered HGL Operation During Wet Weather Conditions			
		85% WW Capture		CityWide Alternatives		85% WW Capture		CityWide Alternatives	
		%	Acres	%	Acres	%	Acres	%	Acres
M-19-OF	119.1	55.0%	65.5	55.0%	65.7	0.0%	0.0	25.0%	29.8
M-20-OF	6.2	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
M-21-OF	29.2	8.0%	2.3	8.0%	2.3	0.0%	0.0	0.0%	0.0
M-22-OF	16.4	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
M-29-OF	362.3	60.0%	217.4	60.0%	217.7	0.0%	0.0	25.0%	90.5
O-27-OF	195.6	0.0%	0.0	22.0%	43.7	0.0%	0.0	22.0%	43.7
O-39-OF	23.8	21.0%	5.0	21.0%	5.1	0.0%	0.0	0.0%	0.0
O-40-OF	2.8	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
O-41-OF	27.9	56.0%	15.6	56.0%	15.6	56.0%	15.6	56.0%	15.6
O-43-OF	9.8	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
Totals	**3,636**	**45.8%**	**1,664**	**50.3%**	**1,835**	**21.1%**	**767**	**35.3%**	**1,286**

[1] The SWMM Model of Lower Ohio-Girty's Run Basin received from ALCOSAN in 2015 included A-63, so the City-Wide analysis included this sewershed. It was found that this sewershed does not require GI to meet 85% combined sewage capture. In June 2016, PWSA received information from ALCOSAN that PennDOT's work on State Route 28 may have resulted in A-63 abandonment. ALCOSAN is working to confirm this with testing.

Examining the results in Table 2-5 and Table 2-6 reveal several important insights:

- As expected, the DCIA whose runoff is managed by GI is somewhat greater (3% to 15% increase) than the DCIA whose runoff must be removed from the system to meet the 85% wet weather capture goal. This relatively small difference is partly explained because approximately 50% of the runoff in the GI management scenario infiltrates and is removed from the system while it is being detained before it is discharged back to the system. So, even the GI managed scenario removes a significant portion of the DCIA runoff.
- Under the 480 MGD (WWTP expansion) scenario, it was determined that approximately 46% of the existing impervious surface area (1,664 acres) would need to managed by GI within the 30 high priority sewersheds for each sewershed to meet the 85% wet weather capture target. For the reasons described previously in this section, a total of 1,835 impervious acres was selected to carry forward for further analysis.
- Under the Lowered HGL Operation During Wet Weather Conditions scenario, approximately 770 impervious acres would need to be managed by GI for each sewershed to meet the 85% wet weather capture target. This represents just over 21% of the total impervious area within the 30 priority sewersheds. For the reasons described previously in this section, a total of 1,286 impervious acres was selected to carry forward for further analysis.

The 600 MGD scenario (WWTP Expansion & System Improvements) is not included in Tables 2-5 and 2-6 because it is considered to be an incremental improvement beyond the 480 MGD alternative. It is included in the GI modeling results described in Section 3.

2.3.3 Project Benefits

Applying the above described approach results in the following benefits to achieving the goals of the City-Wide project:

- Enables informed discussion of the relative merits of conveyance and WWTP investments vs. GI investments and how the performance of those investments mutually interact.
- Defines a potential range of expected GI investment, rather than a single cost associated with a particular overflow reduction volume assumption.
- Allows for an understanding of offsetting costs (higher GI costs with lower conveyance and WWTP capacities costs vs. lower GI costs with higher conveyance and WWTP capacities costs) when developing integrated green-gray plans.

The results of this analysis were used to inform the detailed GI modeling simulations as described in Section 3 and subsequent overflow reduction results and cost estimates as described in Section 9 of this report.