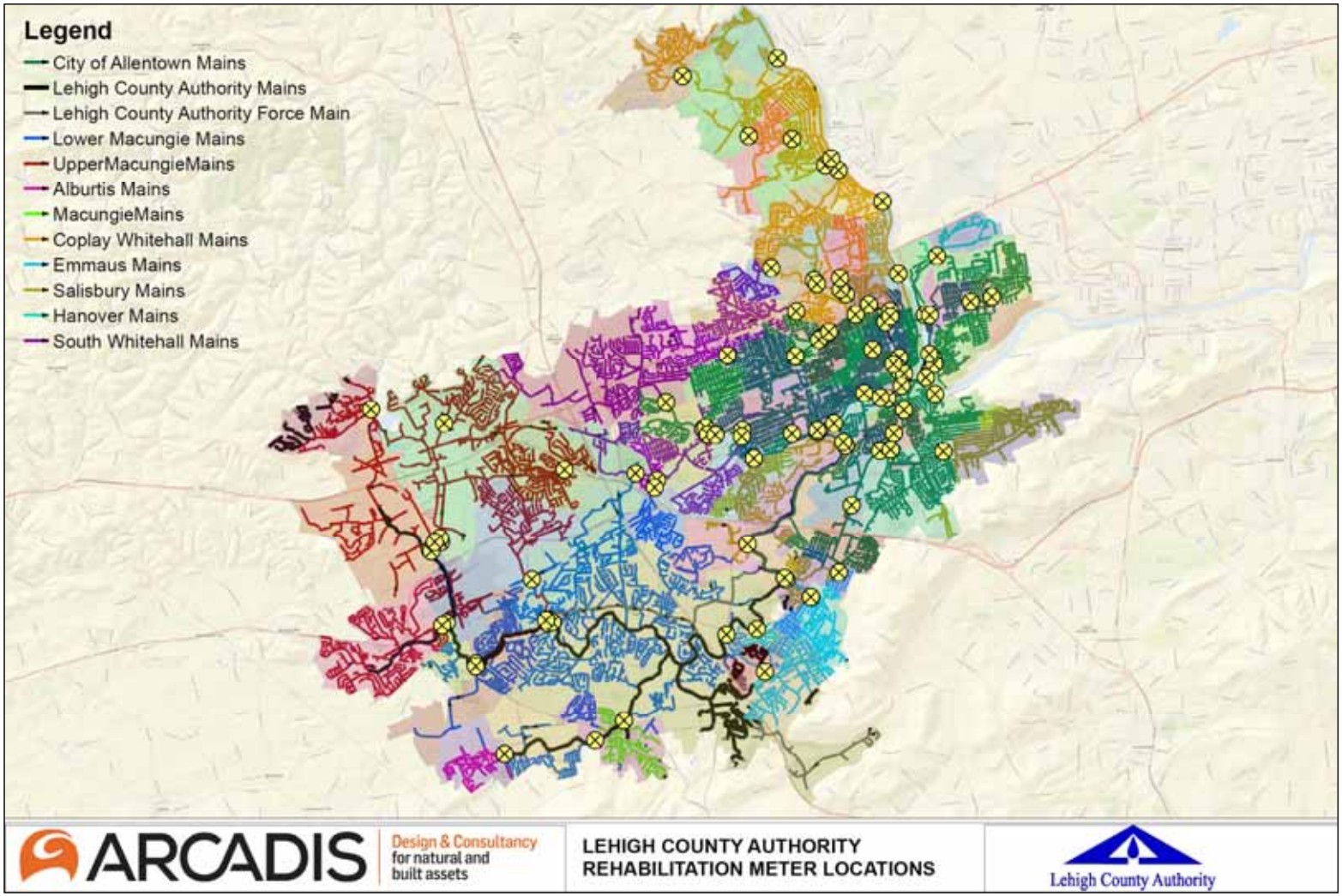
KISS INFLOW AND INFILTRATION ANALYSIS

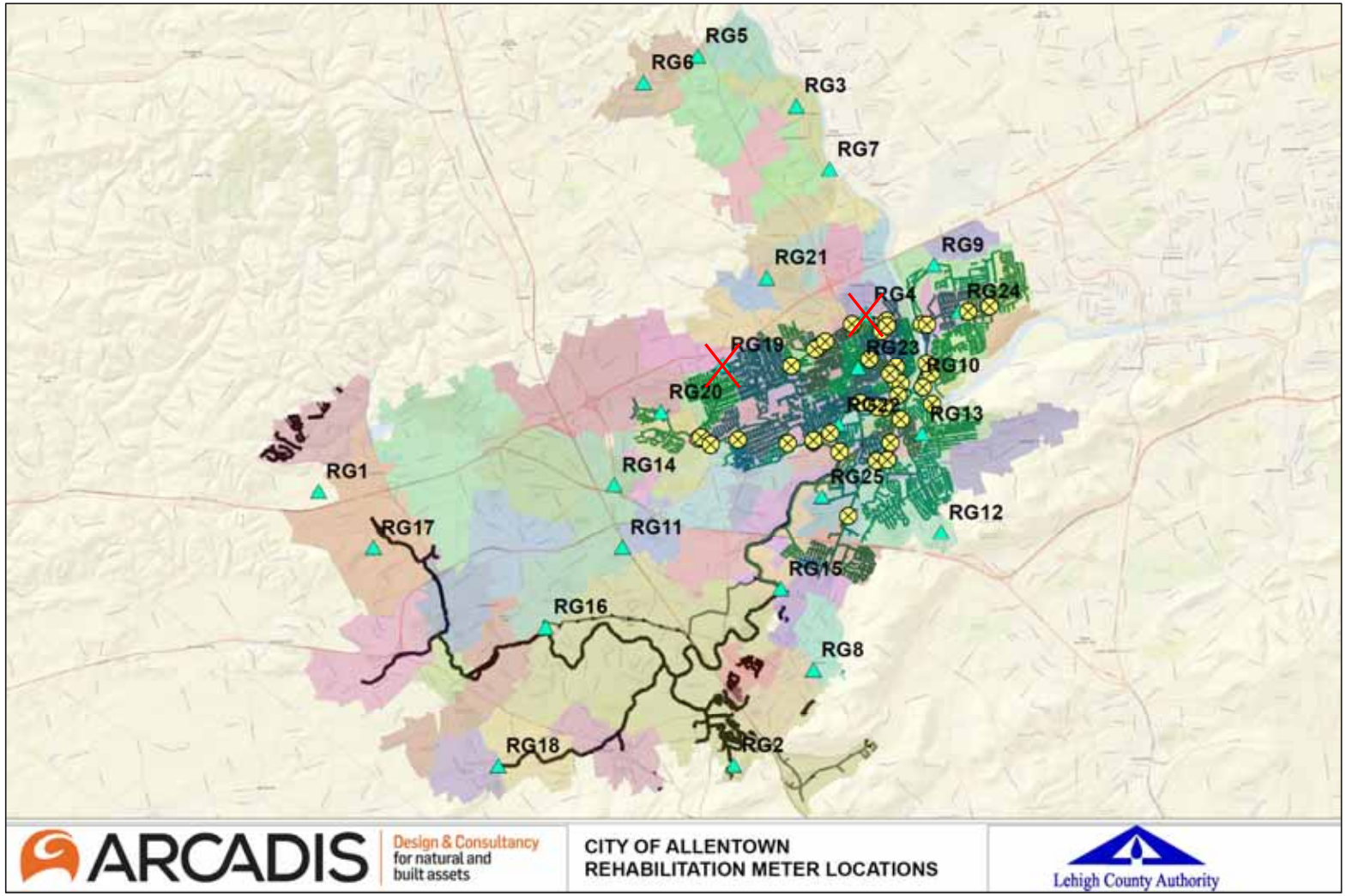
Overview

May 9, 2022

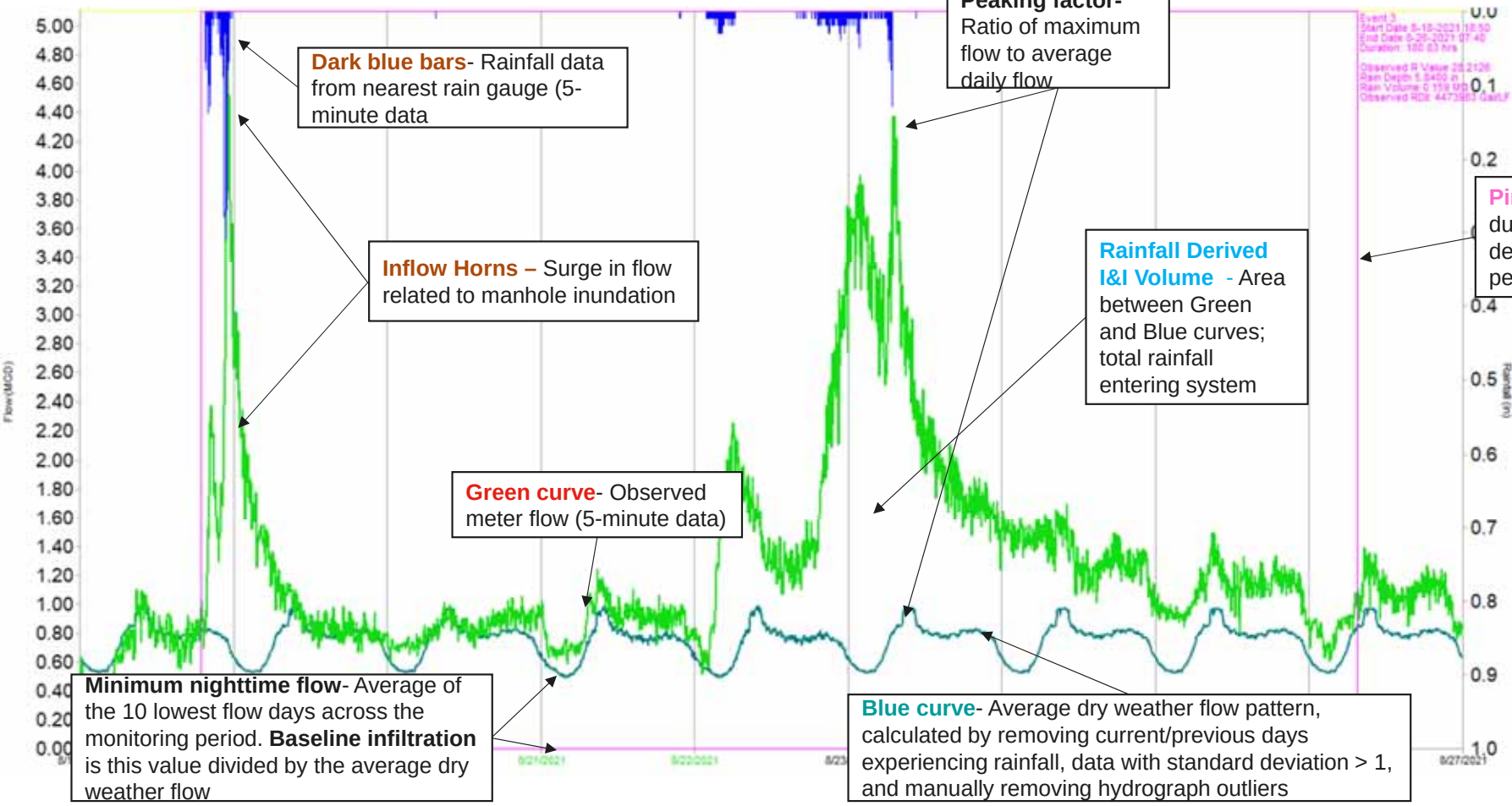
2021 Flow Monitoring – Meter Locations



2021 Rain Gauge Locations



Explanation of hydrograph features
(Calculated using EPA SSOAP toolbox)



Dark blue bars- Rainfall data from nearest rain gauge (5-minute data

Peaking factor- Ratio of maximum flow to average daily flow

Inflow Horns – Surge in flow related to manhole inundation

Pink box- Defined event duration, max duration is defined as 72 hours after peak flow rate

Rainfall Derived I&I Volume - Area between Green and Blue curves; total rainfall entering system

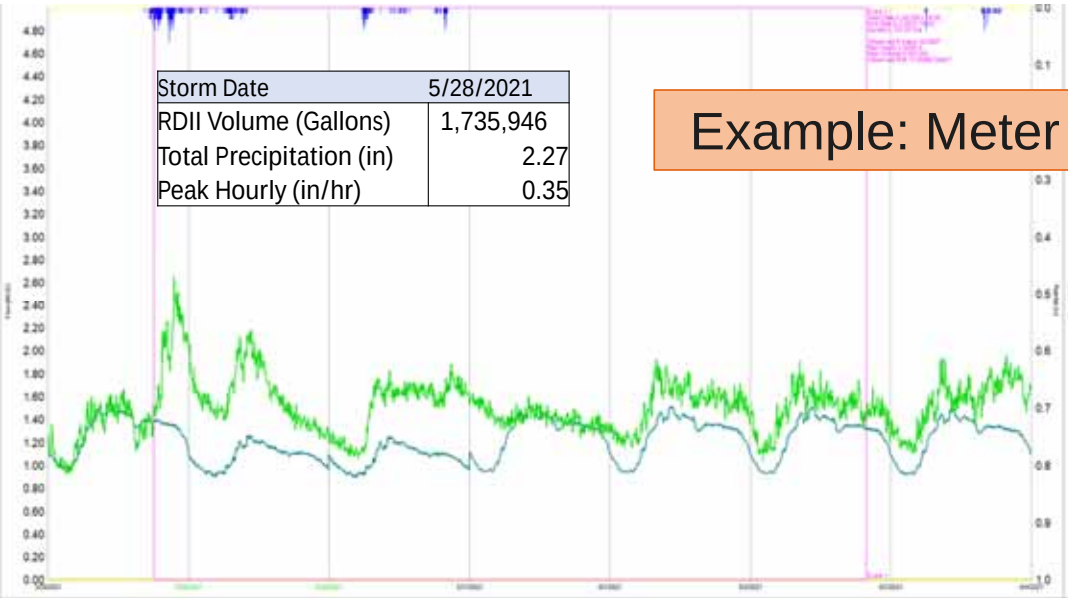
Green curve- Observed meter flow (5-minute data)

Minimum nighttime flow- Average of the 10 lowest flow days across the monitoring period. **Baseline infiltration** is this value divided by the average dry weather flow

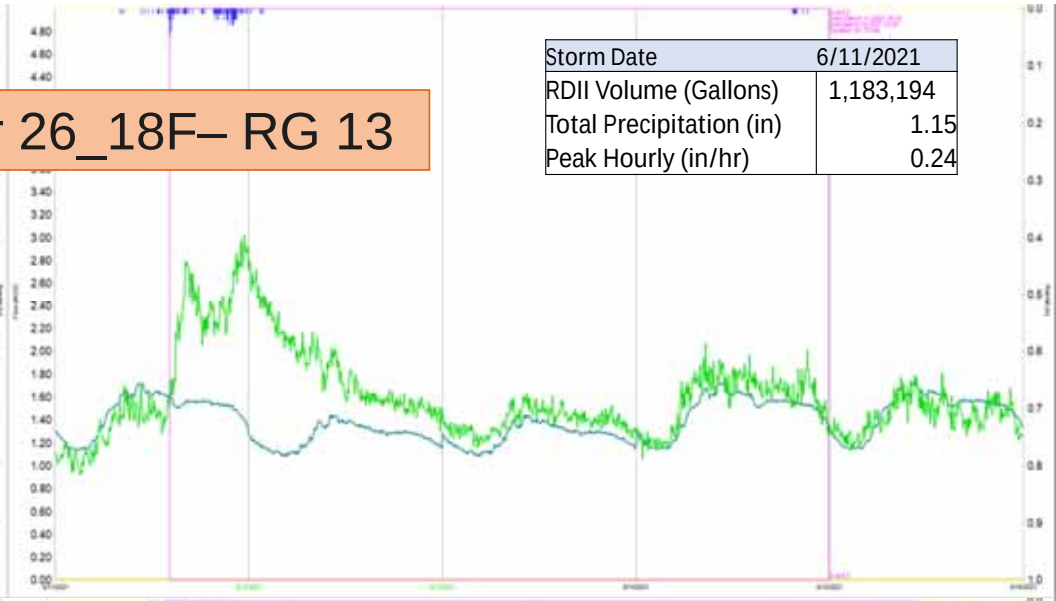
Blue curve- Average dry weather flow pattern, calculated by removing current/previous days experiencing rainfall, data with standard deviation > 1, and manually removing hydrograph outliers

Example: Meter 26_18F– RG 13

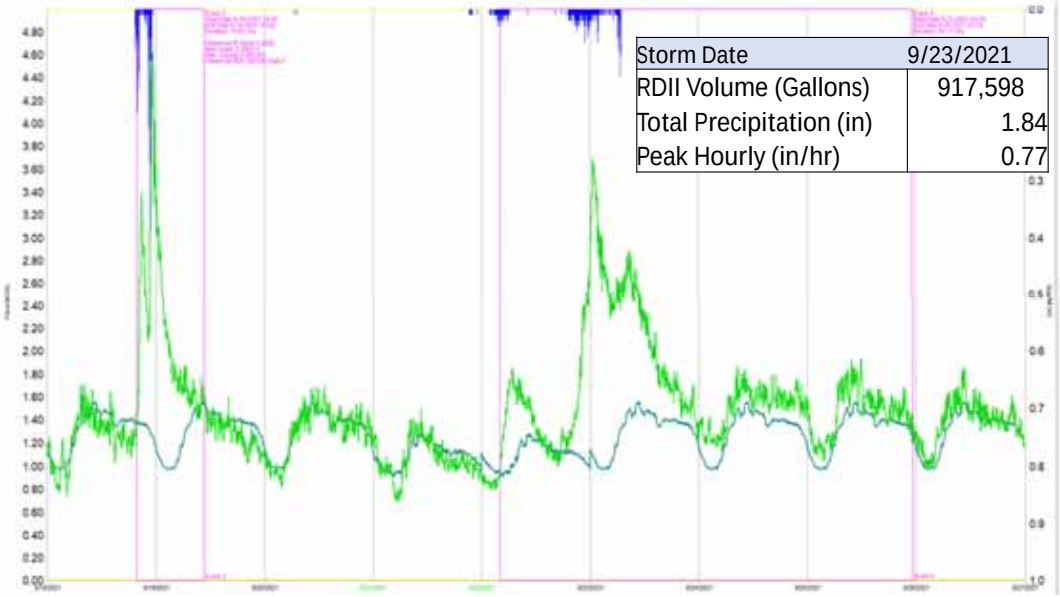
Storm Date	5/28/2021
RDII Volume (Gallons)	1,735,946
Total Precipitation (in)	2.27
Peak Hourly (in/hr)	0.35



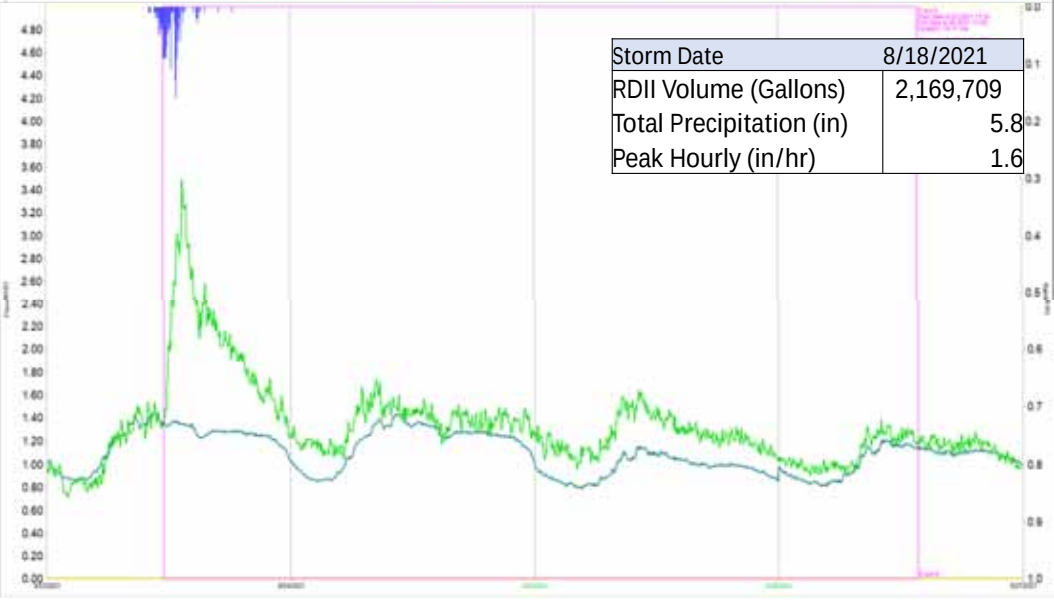
Storm Date	6/11/2021
RDII Volume (Gallons)	1,183,194
Total Precipitation (in)	1.15
Peak Hourly (in/hr)	0.24



Storm Date	9/23/2021
RDII Volume (Gallons)	917,598
Total Precipitation (in)	1.84
Peak Hourly (in/hr)	0.77

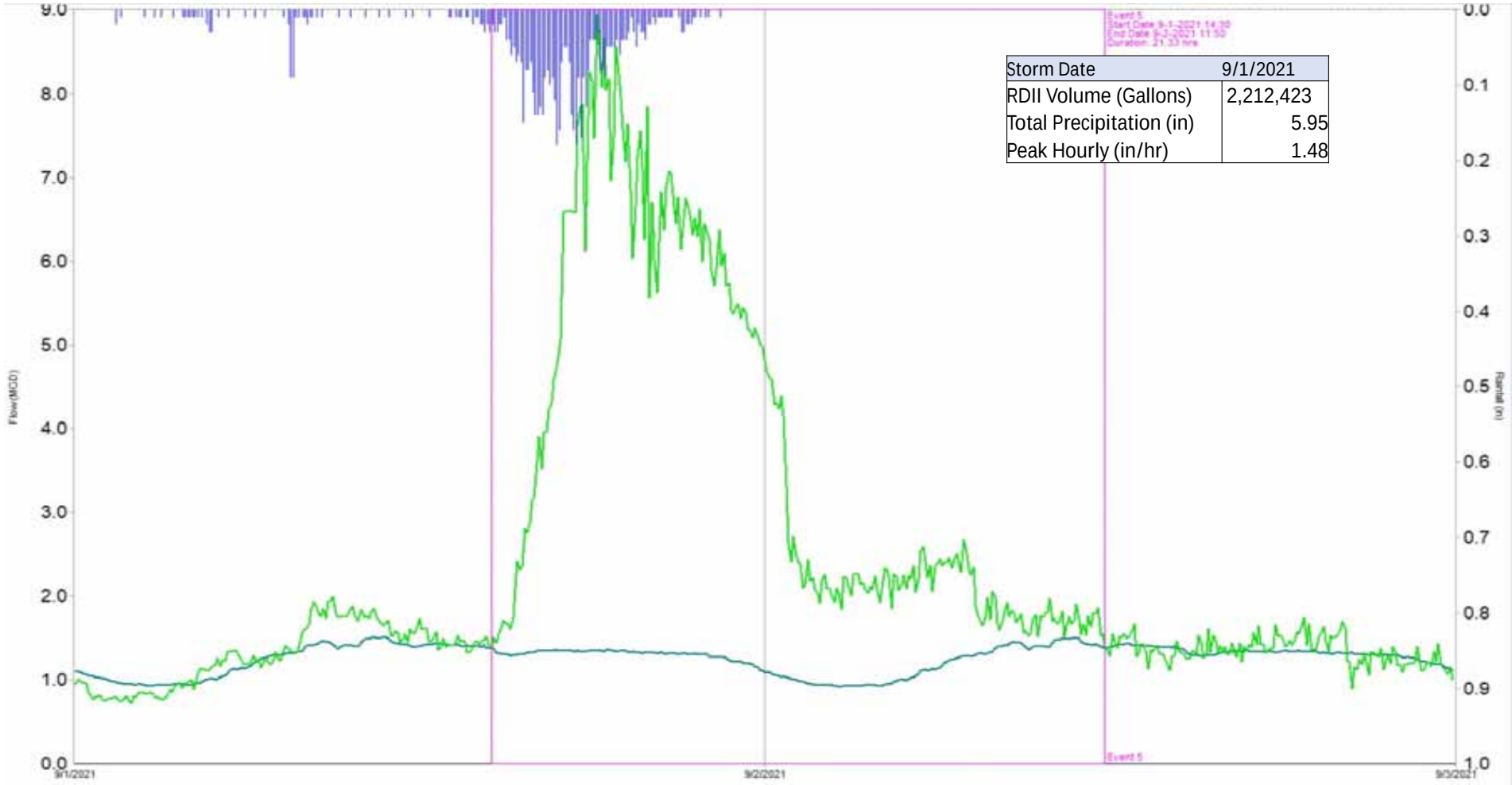


Storm Date	8/18/2021
RDII Volume (Gallons)	2,169,709
Total Precipitation (in)	5.8
Peak Hourly (in/hr)	1.6



9/1/21 Storm

Example: Meter 26_18F– RG 13



Manhole ID	Net LF of Pipe	Net Parcel Count	Gross Parcel Count
26_18F	26,815	3,227	4,727

Meter	Total	Net
RDII Statistics Summary		
Dry Weather GPD/EDU	255	273
Average Dry Weather Flow, DWF (MGD)	1.206	0.880
Baseline Infiltration %	56%	70%
Average Peaking Factor- Average Daily DWF	3.4	2.6
Average Peaking Factor- Actual Time of Day	3.2	2.9
Max Peaking Factor- Average Daily Flow	6.6	4.6
Max Peaking Factor- Actual Time of Day	6.3	6.8
Average RDII Flow Rate (MGD)	0.809	0.423
Length Normalized RDII Flow Rate (GPD/LF)	9.8	15.8

Hydrograph Conclusions:

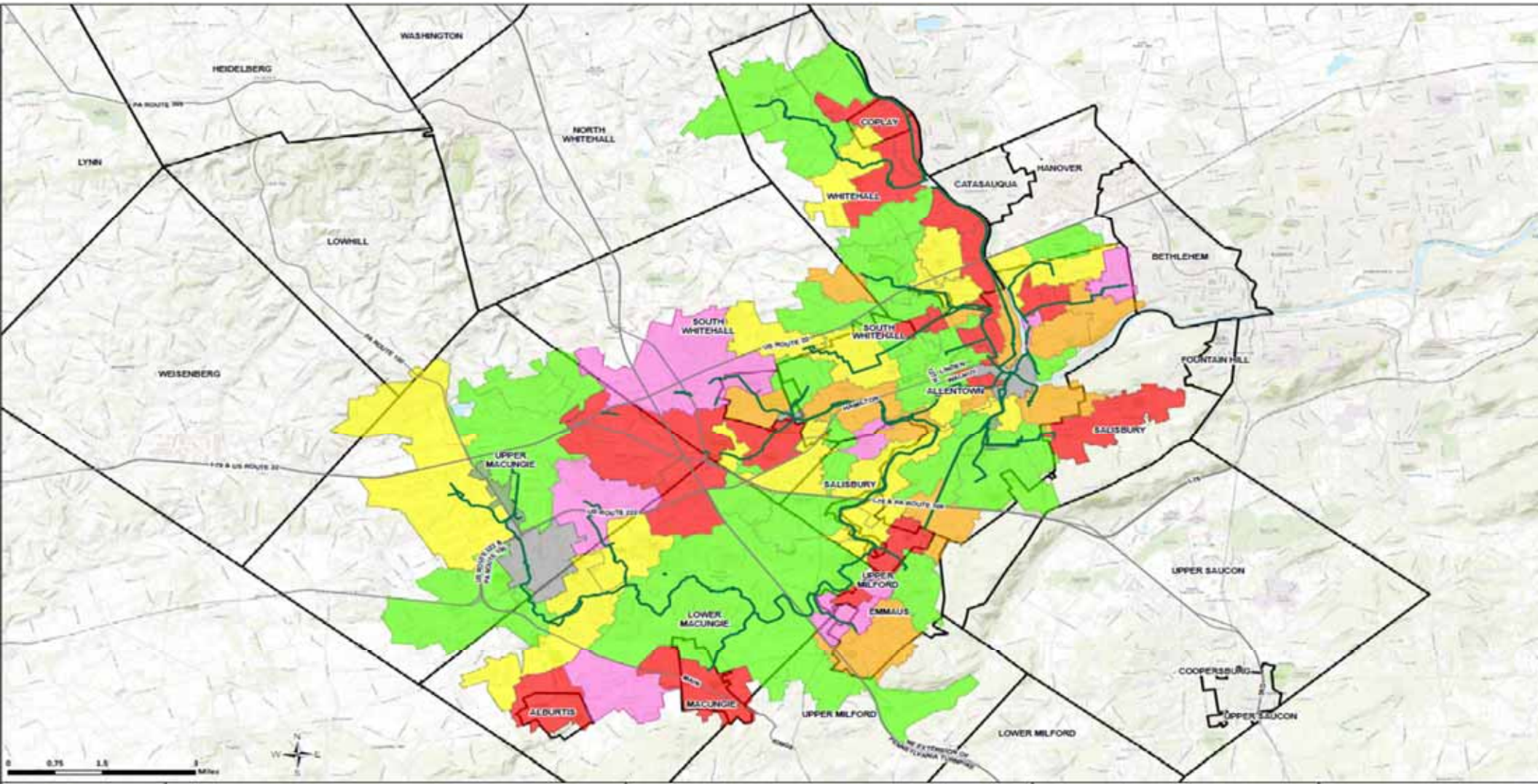
- Manholes F&C leakage from sheet flow
- High RDII (2-3 days to recover)

Statistics Conclusions:

- Slightly high GPD/EDU (related directly to very high BI)
- Very High Baseline Infiltration (Industrial component is thought to be small but is contributing to nighttime flow
- Low Peaking Factor (Peaking factor is suppressed because of very high BI)
- Very high RDII/LF

SSES Recommendations:

- Nighttime weiring – Priority 1 (Very high RDII/LF with long return to normal and very high BI)
- Manhole frame and cover and clipped CO inspection/puddling investigation - Priority 1



Lehigh County Authority

Average Peaking Factor

- < 4
- 4 - 5
- 5 - 6
- 6 - 10
- > 10
- No Study Conducted
- Interceptor Main 18" and Over

LEHIGH COUNTY AUTHORITY

KISS I&I SUMMARY

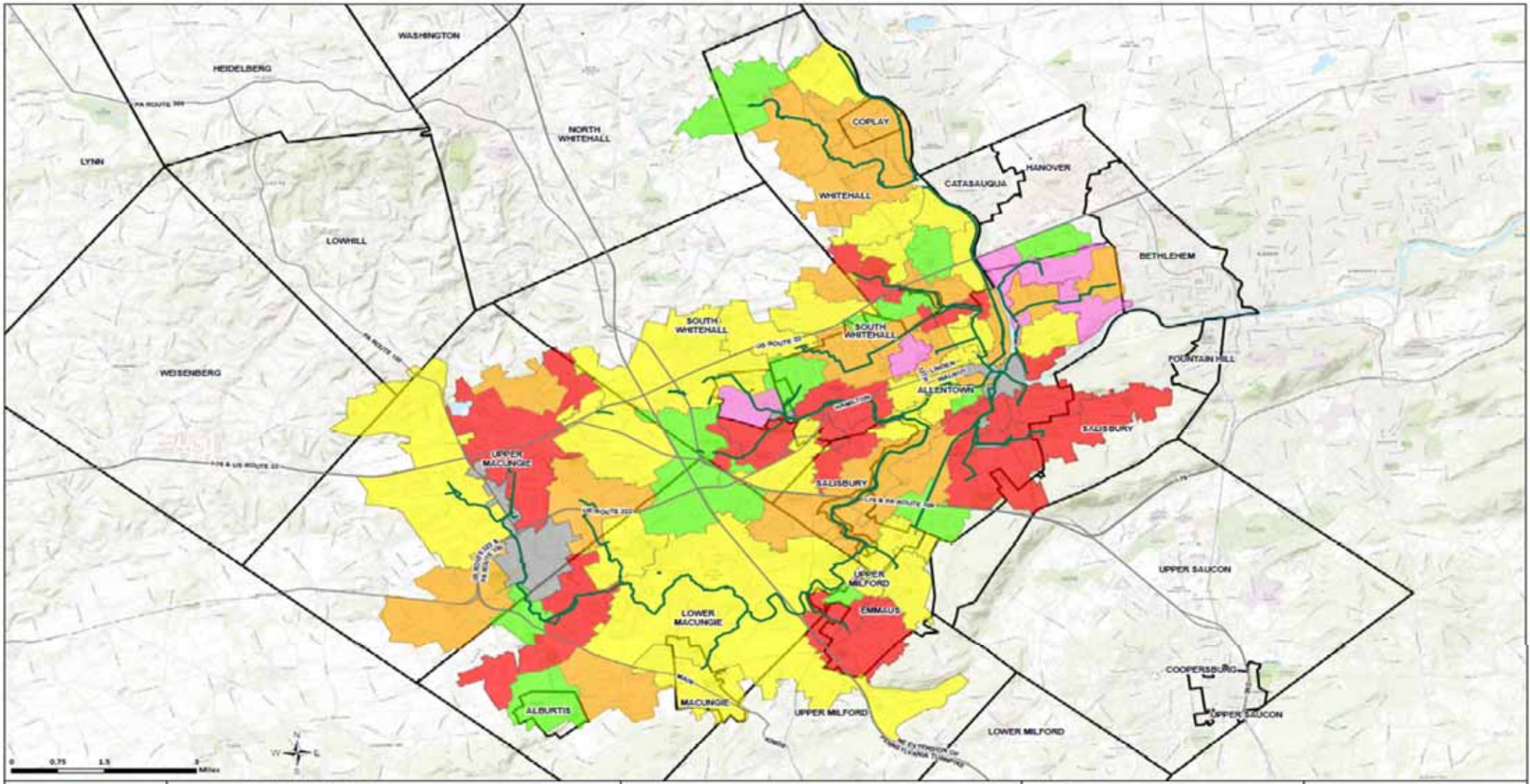
LEHIGH COUNTY, PENNSYLVANIA

Remarks:
I&I studies were not able to be conducted in gray boundary areas

LEHIGH COUNTY AUTHORITY GIS

DATE: 4/5/2022 SCALE: 1:44,000

CREATED: CHECKED:



Lehigh County Authority

Baseline Infiltration %

- < 20%
- 20 - 33%
- 33 - 45%
- 45 - 60%
- > 60%
- No Study Conducted
- Interceptor Main 18" and Over

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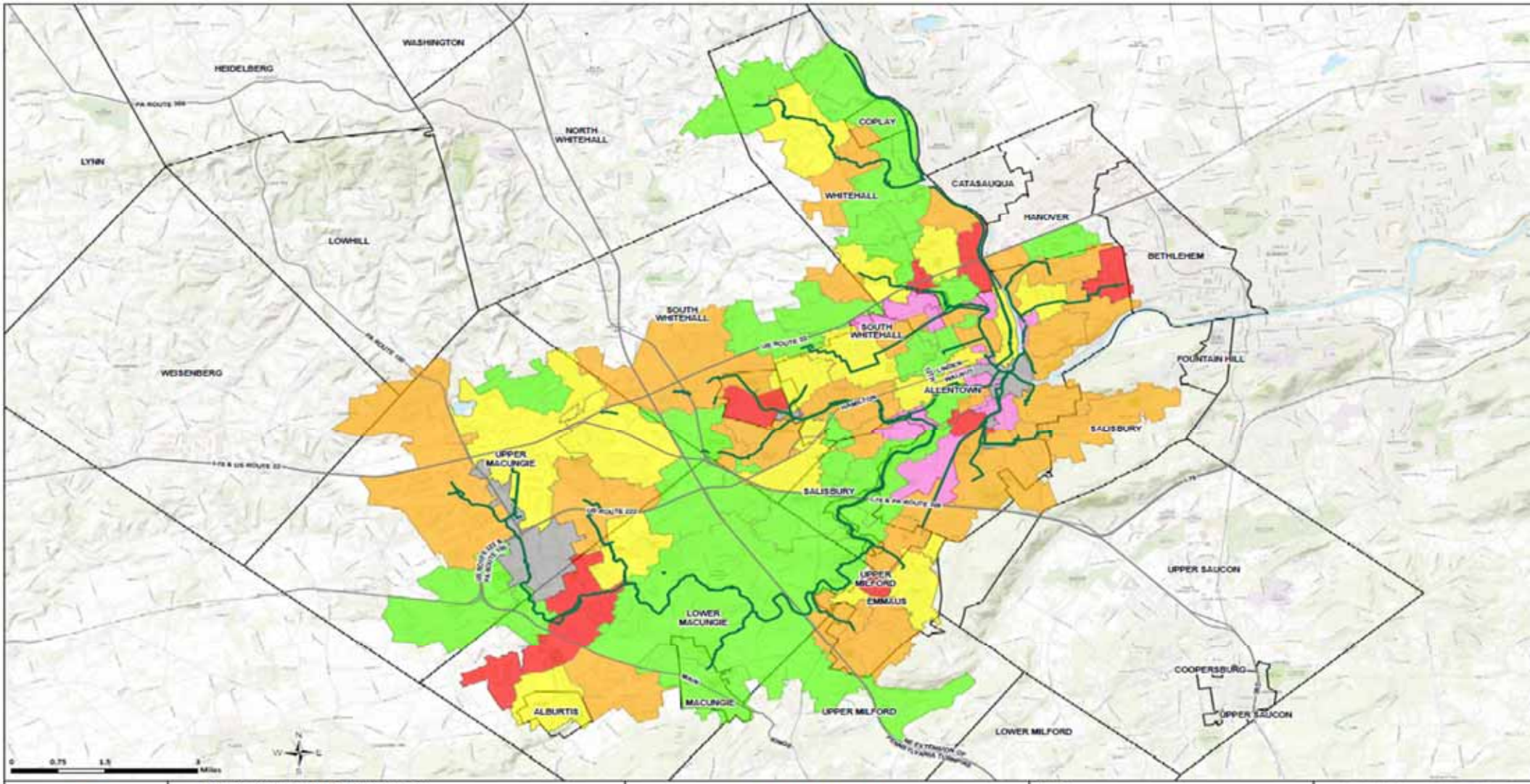

Lehigh County Authority

Length Normalized RDII (GPD/LF)

- < 2
- 2 - 4
- 4 - 8
- 8 - 15
- > 15
- No Study Conducted
- Interceptor Main 18" and Over

LEHIGH COUNTY AUTHORITY

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LEHIGH COUNTY AUTHORITY
GIS

DATE: 4/5/2022 SCALE: 1:44,000
CREATED: CHECKED:

ARCADIS Design & Consultancy for natural and built assets

Statistics by Basin

Meter	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Signatory	City	City	City	City	City	City	City	City	City	City	City	City	City	City	City	City	City	City	City	City	City	City+IT	City	City	City	City	City	City	City	City	City	City+IT	City+IT	City	City	City
Parcels	426	1,223	584	627	263	582	1,707	832	1,134	329	1,916	516	412	448	752	432	57,919	447	1,876	630	204	1,365	629	227	1,104	780	649	388	1,095	187	1,241	442	157	1,919	426	353
Basin Length (LF)	48,643	59,779	25,186	36,318	9,059	11,653	66,042	41,999	124,546	14,633	48,093	10,369	23,509	12,585	19,914	16,509	57,919	10,851	49,094	27,723	11,426	63,689	55,879	26,819	141,708	32,229	39,222	40,306	75,410	15,894	83,094	35,373	20,987	59,512	30,064	8,685
Dry Weather GPD/EDU	347	268	299	294	440	540	260	235	205	322	177	232	641	501	170	377	242	412	127	242	378	310	213	273	364	603	676	1593	201	488	338	303	4346	270	1408	227
Average Dry Weather Flow, DWF (MGD)	0.772	0.328	0.175	0.72	0.116	0.319	0.443	0.195	0.647	0.106	0.348	0.12	0.264	0.222	0.128	0.163	0.63	0.184	0.239	0.304	0.077	0.424	0.327	0.88	1.293	0.47	0.676	0.62	0.22	0.14	0.42	0.14	0.682	0.55	0.6	0.08
Baseline Infiltration % adjusted for data issues	65%	36%	65%	44%	65%	51%	30%	35%	40%	40%	61%	38%	38%	60%	57%	55%	39%	33%	33%	31%	31%	46%	19%	40%	58%	51%	58%	76%	18%	47%	47%	47%	30%	31%	25%	13%
Baseline Infiltration (MGD)	0.502	0.118	0.114	0.317	0.075	0.163	0.133	0.068	0.259	0.042	0.209	0.046	0.100	0.133	0.073	0.090	0.246	0.061	0.079	0.094	0.024	0.195	0.062	0.352	0.750	0.240	0.358	0.471	0.040	0.066	0.197	0.066	0.205	0.171	0.150	0.010
Average Peaking Factor adjusted for data issues	5.0	12.7	6.0	7.9	27.6	3.0	6.6	6.9	4.1	3.4	2.3	2.3	6.7	7.8	5.1	7.7	2.4	2.2	7.3	3.2	3.8	5.5	5.1	2.9	4.0	3.4	4.6	6.8	4.5	4.0	6.4	13.4	5.8	3.4	3.0	3.2
Length Normalized RDII (GPD/LF)	4.3	3.7	5.1	2.8	58.4	7.1	5.1	2.3	2.6	6.6	1.3	1.9	4.8	20.3	4.2	18.4	1.6	1.6	5.1	2.5	32	5.4	5.6	15.8	4.7	6.3	19.8	10.1	2.1		4.7	7.1	36	3.8		7.9

Meter	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Signatory	City	City	SWT	SWT	SWT	SWT	SWT	SWT	SWT	SWT	HT	ST	ST	ST	ST	ST	CWSA	CWSA	CWSA	CWSA	CWSA	CWSA	CWSA	CWSA	CWSA	CWSA	CWSA	CWSA	CWSA	CWSA	CWSA	SB	SB	SB	SB	SB
Parcels	1,055	251	-	1,063	667	1,029	1,311	2,418	800	467	237	1,667	566	398	1,003	1,055	1,535	1,454	625	802	672	701	745	757	708	646	647	864	87	966	613	253	557	1,310	227	1,957
Basin Length (LF)	44,778	20,274	15,526	22,964	44,592	65,444	73,963	168,942	71,744	31,156	20,266	104,982	22,861	40,863	34,414	48,511	73,788	83,645	42,100	56,778	46,901	40,455	53,472	47,770	43,946	32,089	29,896	40,087	8,192	47,742	49,937	11,444	17,727	68,562	15,447	99,644
Dry Weather GPD/EDU		1673	4350	268	281	165	188	298	330	381	277	599	264	649	258		148	128	431	339	199	168	327	126	179	239	298	204	1006	273	217	268	327	280	220	258
Average Dry Weather Flow, DWF (MGD)		0.42	0.065	0.28	0.19	0.17	0.246	0.72	0.27	0.442	0.066	0.637	0.15	0.258	0.661		0.228	0.186	0.261	0.282	0.134	0.118	0.248	0.096	0.127	0.154	0.193	0.176	0.088	0.264	0.138	0.068	0.107	0.367	0.05	0.5
Baseline Infiltration % adjusted for data issues	35%	35%	100%	50%	46%	29%	30%	25%	26%	44%	17%	51%	47%	34%	32%	35%	35%	18%	43%	41%	41%	27%	27%	27%	27%	31%	48%	18%	40%	18%	47%	30%	29%	21%	20%	48%
Baseline Infiltration (MGD)	-	0.147	0.065	0.140	0.087	0.049	0.074	0.180	0.070	0.194	0.011	0.325	0.071	0.091	0.212	-	0.080	0.033	0.113	0.116	0.055	0.032	0.066	0.026	0.034	0.048	0.069	0.032	0.035	0.048	0.062	0.020	0.031	0.077	0.010	0.240
Average Peaking Factor adjusted for data issues	5.0	7.0	5.0	4.5	8.0	4.3	4.0	16.0	4.3	5.2	3.8	10.0	2.1	4.0	10.0	5.0	6.1	2.9	2.2	4.6	10.0	3.8	2.9	10.0	9.6	2.8	2.4	4.7	5.0	3.4	5.0	6.0	13.1	4.0	6.0	3.4
Length Normalized RDII (GPD/LF)		49.4		4.3	4.7	1.4	1.9	6.3	2.7	7.3	1.2	4.8	1	1.4	4.5		1.5	0.7	2.2	4.2	1.3	1.2	1.3	6.6	5.7	1.3	2.2	2.2	11.5	15.6	1.2	2.5	2.2	3.6	3.3	4.2

Meter	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Signatory	SB	UMT	UMT	UMT	UMT	UMT	UMT	UMT	Alburtis	Macungie	UMT	UMT	UMT	UMT	UMT	UMT
Parcels	367	1,751	945	1,379	523	4,362	9,513	2,525	999	1,312	778	974	843	503	1,547	3,070

City Stats	CWSA Stats	Salisbury Stats	Emmaus Stats	South Whitehall Stats	Hanover	Upper Macungie	Alburtis	Macungie	Lower Macungie	WLSP Stats
90,126	11,869	4,699	4,431	7,751	237	20,792	995	1,311	9,534	32,632
288	132	50	49	93	3.9	137	9	17	151	314

Conclusions

- Older systems (City, Salisbury, and Emmaus) are generally leakiest sewers, but all Signatories have bad areas
- Western Lehigh municipalities have made good progress in I&I reductions, especially Macungie and Alburtis
- There is ~11 MGD of baseline infiltration that, if removed, can be turned into dry weather capacity
- Wet weather flow issues are driven by leaking sewers
- Wet weather overflows are driven by manhole cover inflows

No amount of I&I removal will eliminate need to expand conveyance for LCA… But it can reduce it considerably.

Next Steps – 2022

Complete sewer system nighttime weiring

KISS municipalities develop I&I Source Reduction Programs

Design storm selection to be used for system modeling & alternatives evaluation

Baseline model runs based on current system configuration, current and future flows, dry and wet-weather scenarios

Preliminary screening of alternatives

ARCADIS Design & Consultancy for natural and built assets

Discussion / Questions?