BUFFALO
SEWER AUTHORITY

SPDES Permit No. NY0028410

Long Term Control Plan Semi-Annual Status Report
Reporting Period: *January through June 2021*
Amended Administrative Order
CWA-02-2014-3033
(Amends CWA-02-2012-3024)

September 2021

Long Term Control Plan Semi-Annual Status Report

Table of Contents

ATTACHMENT:

1. INTRODUCTION

The Buffalo Sewer Authority (Authority) received approval of its Long Term Control Plan (LTCP) from the United States Environmental Protection Agency (USEPA) and New York State Department of Environmental Conservation (NYSDEC) on March 18, 2014. The Authority entered into an Amended Administrative Order on April 16, 2014 (herein after referred to as the AO), with the USEPA. This AO establishes a schedule for implementation of the Authority's LTCP, approved by the USEPA and NYSDEC.

The AO in part requires that the Authority submit written Semi-Annual Status Reports to the USEPA and NYSDEC by September 1st for current year January 1– June 30 reporting period, and March 1st for the previous calendar year July 1 – December 31 reporting period. The AO requires that the following be provided in each Semi-Annual Status Report:

- The project milestones, deadlines and other terms that the Authority is required to meet since the date of the last Semi-Annual Status Report, whether and to what extent the Authority has met those requirements, and the reason for any anticipated delays and/or noncompliance.
- A general description of the work completed during the reporting period and the applicability of the work to meet indicated design criteria, as well as the projection of work to be performed during the next reporting period and any anticipated delays for the upcoming work. Any changes in key personnel must also be noted.
- Enclosure of public meeting (if held) materials including: advertisements, handouts, formal meeting notes, and a summary of the meeting (see Attachment C).
- Copies (to USEPA only) of all monthly monitoring reports or other reports pertaining to combined sewer overflows (CSOs) and bypasses that Authority submitted to the NYSDEC during the reporting period. Please note DMRs are now submitted electronically directly to the USEPA and no dry weather overflows occurred during this period, so this item does not apply during this reporting period.

This report covers January through June 2021 which serves as Semi-Annual Report No. 15.

2. REQUIREMENTS DUE IN REPORTING PERIOD

Attachment A provides the current status of all projects listed in the Administrative Order. Issues with implementing these projects are detailed in Section 4 of this document.

This document serves as the September 1, 2021 semi-annual report.

No Certificates of Acceptance and Occupancy were issued during this reporting period for LTCP related projects.

Enclosed with this report is also the Annual PCM Report.

3. WORK COMPLETED IN CURRENT REPORTING PERIOD AND PROJECTION OF WORK TO BE PERFORMED NEXT REPORTING PERIOD

A general description of the work completed on LTCP projects during the current reporting period and the work projected to be performed during the next reporting period is provided in Attachment A. Items that have been completed have been highlighted orange.

A more detailed description of each project including the location and the goal to be achieved through each project is provided in Attachment B.

4. IMPLEMENTATION ISSUES

The ongoing COVID-19 pandemic has affected Authority operations, as well as those of consultants and contractors working on LTCP projects. While the Authority is currently operating with its full workforce, the Authority continues to experience decreased revenues due to the pandemic, and some consultants and contractors have experienced reduced staff capacity. Nevertheless, the Authority has been, and will continue to, work with internal staff and all necessary outside parties to facilitate the timely completion of LTCP projects.

4.1 CSO 013

As Buffalo Sewer awaits final approval of the updated hydraulic model, the anticipated CSO 013 project is being reevaluated. The updated model indicated a significant reduction in effectiveness of the proposed CSO 013 satellite storage, conveyance, forcemain, and pumping system project.. Additional cost-effective opportunities to better control CSOs in this area are currently being investigated and evaluated.

4.2 Hamburg Drain Optimizations

Preliminary design for the Hamburg Drain Optimizations was begun prior to January 1, 2014; however, detailed design was delayed due to high water levels in Lake Erie. As a result of this delay the March 18, 2016 Notice to Proceed deadline was exceeded. The Authority completed a model recalibration and submitted the model calibration report to the EPA and DEC on January 8, 2019. The Authority is moving forward with conducting new SWMM modeling and until this modeling is completed, the Authority is unable to set a deadline for completing the Hamburg Drain Optimizations. Updated deadline dates will be requested via formal request following the additional modeling of this area. Design of the Mill Race In-Line Storage project is in progress with Engineering Completion and Notice to Proceed expected in the next reporting period.

4.3 Broadway at Oak RTC

Engineering Completion and Notice to Proceed of the Broadway at Oak RTC is anticipated to be awarded during the next reporting period.

4.4 Remaining Real Time Control Projects

The Authority is realizing greater reduction in combined sewer overflows due to the installed Real Time Control projects. In an effort to capitalize on the efficiencies of our Real Time Control projects, the Authority is deploying sensors to better characterize flow dynamics system-wide to further prioritize specified Long Term Control Plan projects. There are currently 58 sensors deployed in the collection system and the Authority is collaborating with the Erie County Division of Sewerage Management to create an expanded rain gauge network. Additionally, the Authority is working toward globally coordinated control to balance flows with underused portions of the system during wet weather events and is working to identify the next Real Time Control Projects to begin design.

4.5 WWTP Improvement Project Alternative C2

Comments regarding the Secondary System Rehabilitation Project Engineering Report were received on June 11, 2020 and responses to those comments were submitted to USEPA and NYSDEC on July 10, 2020. Contract documents for this project were released in August 2020 with bids due in December 2020. Unfortunately, only one bid was received for this contract. In January 2021, the Board of the Buffalo Sewer Authority expressed concerns with limited opportunity for the contracting community and rejected this bid. It was determined that the project needed to be rebid as multiple separate, but inter-linked contracts to more closely match expertise and capacity of the local contracting community.

In February 2021, the Board approved a change order to the consulting engineer's contract to redevelop the contract documents into several separate contracts to be put out to bid in the first half of 2021. The five contracts were put out to bid and recommended Contractors were awarded the projects at the June 23rd, 2021 Board Meeting. A consultant Engineering Firm was also selected to move forward for the oversite of construction for the Secondary System Rehabilitation and Upgrade Project.

In October 2020, Buffalo Sewer awarded a $1,700,000.00 design services to provide design services for the primary system NFA project. In addition to the installation of a new primary bypass chlorine contact tank, this work will involve retrofitting of the existing primary settlement tanks and sludge pumping station. Work on this project began during this past reporting period with construction documents expected to be issued for bid in 2022.

In a letter dated February 6, 2020, USEPA and NYSDEC requested a detailed financing plan for remaining work under the approved LTCP. The Authority submitted the financial assessment on January 7, 2021.

4.6 North Relief-Interceptor

Preliminary subsurface investigation in conjunction with the North Relief-Interceptor concept has revealed concerns with the location of bedrock and the feasibility of the proposed tunnel location. Due to the noted concerns, the Authority has phased the proposed project. The initial phase, the Bird Avenue Underflow Sewer Project has been completed. Engineering analysis for additional phases is currently focused on the implementation of real time control technology and short circuit methodologies with the intention of reducing the scale of a North Relief-Interceptor project. The Authority is exploring additional projects that have a potential reduction in the scope of the North Relief-Interceptor project.

5. CHANGES IN KEY PERSONNEL

Kevin Meindl and Allison Lack left the Authority during this reporting period. On June 24, 2021, Rosaleen Nogle, P.E. was appointed as Principal Sanitary Engineer and Alex Emmerson was appointed as Treatment Plant Superintendent.

6. PUBLIC MEETINGS

Taylor Brown presented "Maximizing the Return on Investment (ROI) of a Smart Sewer Program" virtually for the New York Water Environment Association Annual Meeting on February 11, 2021. Rosaleen Nogle presented "History of Buffalo's Sewers and Impacts on Modern Projects" at the New York State Society of Professional Engineers' Annual Conference in Saratoga Springs, NY on June 4, 2021. Taylor Brown presented "Engaging the Private Sector in Green Infrastructure Development & Financing" virtually for the Western New York Urban Land Institute Women's Leadership Initiative on June 17, 2021. The slides used in all of the presentations are included in Attachment C.

Rosaleen Nogle's article "Buffalo's Sewers: A History of the Queen City from Below" was published in the Winter 2021 Edition of Western New York Heritage. Taylor Brown's article "Buffalo Sewer Authority's Smart Sewers are Going to College" was published in the Spring 2021 Edition of Clear Waters.

7. MODEL MODIFICATIONS

The Authority is moving forward with utilizing the January 2019 model for LTCP project planning purposes. All projects that were implemented or designed and underway for implementation in 2019 were added into the model during the first half of 2020. On Monday September 21st, 2020 the Authority received a draft memorandum regarding review of the model update report and included comments from the EPA/DEC. The Authority provided a response to this memorandum on December 8th, 2020. A meeting was held with EPA/DEC on January 19th, 2021 to discuss the Authority's response. On May 13th, 2021 the EPA/DEC confirmed that the Authority has provided all information requested and the report could be formally revised and submitted for approval

8. GREEN INFRASTRUCTURE

On June 3rd, 2021 the board of the Authority issued the Environmental Impact Bond (EIB) up to $54,000,000 to support green infrastructure projects on public property. The EIB is designated to go towards the design and construction of green infrastructure within the opportunity basins identified in Buffalo Sewer's Rain Check 2.0 report. The EIB includes an innovative link between outcome threshold subject to external verification and bond maturity. The EIB includes an option to refinance or retire the bonds in seven years or more if 200 new acres of impervious surface area financed with the bond proceeds is built.

Construction has continued on Niagara St. phase 3 with anticipated construction completion in Fall 2021. Notice to proceed has been issued on construction of Niagara St. phase 4A with anticipated completion in 2022. Notice to Proceed for Niagara Street phase 4B is tentatively scheduled for the second reporting period. A private property green infrastructure grant program is anticipated to be issued during the next reporting period.

9. CERTIFICATION STATEMENT

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Oluwole A. McFoy, P.E., General Manager

30 Aug 21
Date

Attachment A to the Semi-Annual Status Report: September 2021

Work Completed in Current Period/ Projection of Work to be Performed in Next Reporting Period

Project Name	Project Milestone	AO Project Deadline	Actual Completion Dates	Project Status
Phase I Projects				
CSO 060 GI Project	---	---	Prior to 1/1/2014	Complete.
Bird/Lang RTC Projects	Construction Start	3/17/2014	2/24/2014	Complete
	Completion Date	9/2/2014	5/9/2016	Complete
	Operations/ Optimization (RTC)	9/3/2014 – 9/3/15	10/1/2016	Complete
Bird RTC Project	Construction Start	3/17/2014	2/24/2014	Complete
	Completion Date	9/2/2014	5/6/2016	Complete
	Operations/ Optimization (RTC)	9/3/2014 – 9/3/15	10/1/2016	Complete
Lang RTC Project	Construction Start	3/17/2014	2/24/2014	Complete
	Completion Date	9/2/2014	5/9/2016	Complete
	Operations/ Optimization (RTC)	9/3/2014 – 9/3/15	10/1/2016	Complete
Foundation Projects				
Foundation 1 - Smith Street Storage	Engineering Start	3/18/2014	Prior to 1/1/2014	Complete
	Engineering Completion	3/18/2015	6/10/2015	Complete
	Notice to Proceed	3/18/2015		Complete
	Substantial Completion	3/18/2017	10/9/2017	Complete
CSO No. 026 Sewer Separation	Engineering Start	3/18/2014	Prior to 1/1/2014	Complete
	Engineering Completion	3/18/2015	4/3/2015	Complete
	Notice to Proceed	3/18/2015	7/8/2015	Complete
	Substantial Completion	3/18/2017	6/22/2016	Complete
CSO No. 026 RTC Structure	Engineering Start	3/18/2014	Prior to 1/1/2014	Complete
	Engineering Completion	3/18/2015	6/10/2015	Complete
	Notice to Proceed	3/18/2015	7/13/2016	Complete
	Substantial Completion	3/18/2017	10/9/2017	Complete

Project Name	Project Milestone	AO Project Deadline	Actual Completion Dates	Project Status
Foundation 2 - SPP Optimization (20 projects)	Engineering Start	3/1/2014	Prior to 1/1/2014	Complete
	Engineering Completion	3/18/2015	4/20/2015	Complete
	Notice to Proceed	3/1/2014	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2017		
SPP 180 Optimization	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	4/20/2015	Complete
	Notice to Proceed	---	9/8/2015	Complete
	Substantial Completion	3/18/2017	12/16/2015	Complete
SPP 331 Optimization	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	3/18/2015	4/20/2015	Complete
	Notice to Proceed	---	9/8/2015	Complete
	Substantial Completion	3/18/2017	12/16/2015	Complete
SPP 036 Optimization	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	1/20/2014	Complete
	Notice to Proceed	---	5/30/2014	Complete
	Substantial Completion	3/18/2017	8/4/2014	Complete
SPP 217 Optimization	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	4/3/2015	Complete
	Notice to Proceed	---	7/8/2015	Complete
	Substantial Completion	3/18/2017	12/21/2015	Complete
SPP 318 Optimization	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	4/3/2015	Complete
	Notice to Proceed	---	7/8/2015	Complete
	Substantial Completion	3/18/2017	12/21/2015	Complete
SPP 097A Optimization	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	4/20/2015	Complete
	Notice to Proceed	---	9/8/2015	Complete
	Substantial Completion	3/18/2017	12/16/2015	Complete

Project Name	Project Milestone	AO Project Deadline	Actual Completion Dates	Project Status
SPP 122 Optimization	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Notice to Proceed	---	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2017	Prior to 1/1/2014	Complete
SPP 163 Optimization	Engineering Start	---	3/1/2014	Complete
	Engineering Completion	---	11/25/2014	Complete
	Notice to Proceed	---	3/1/2015	Complete
	Substantial Completion	3/18/2017	8/6/2015	Complete
SPP 165 Optimization	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Notice to Proceed	---	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2017	Prior to 1/1/2014	Complete
SPP 165A Optimization	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	4/4/2014	Complete
	Notice to Proceed	---	7/25/2014	Complete
	Substantial Completion	3/18/2017	11/3/2014	Complete
SPP 178 Optimization	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Notice to Proceed	---	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2017	Prior to 1/1/2014	Complete
SPP 335B Optimization	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Notice to Proceed	---	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2017	Prior to 1/1/2014	Complete
SPP 336A Optimization	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	4/20/2015	Complete
	Notice to Proceed	---	9/8/2015	Complete
	Substantial Completion	3/18/2017	12/16/2015	Complete

Project Name	Project Milestone	AO Project Deadline	Actual Completion Dates	Project Status
SPP 341A Optimization	Engineering Start	---	1/1/2014	Complete
	Engineering Completion	---		This project is on hold pending the results of post-construction monitoring of Lang and Hazelwood RTCs.
	Notice to Proceed	---		
	Substantial Completion	3/18/2017		
SPP 342B Optimization	Engineering Start:	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Notice to Proceed	---	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2017	Prior to 1/1/2014	Complete
SPP 001 Optimization	Engineering Start:	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	3/27/2014	Complete
	Notice to Proceed	---	6/16/2014	Complete
	Substantial Completion	3/18/2017	12/12/2014	Complete
SPP 183 Optimization	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Notice to Proceed	---	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2017	Prior to 1/1/2014	Complete
SPP 283 Optimization	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Notice to Proceed	---	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2017	Prior to 1/1/2014	Complete
SPP 211 Optimization	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Notice to Proceed	---	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2017	Prior to 1/1/2014	Complete

Project Name	Project Milestone	AO Project Deadline	Actual Completion Dates	Project Status
Foundation 3 - Remaining RTC (14 sites)	Engineering Start	3/18/2016	8/9/2016	Ongoing
	Notice to Proceed	3/18/2017		
	Engineering Completion	3/18/2023		
	Substantial Completion	3/18/2024		
Hertel Northwest In-Line Storage	Engineering Start	---		
	Engineering Completion	---		
	Notice to Proceed	---		
	Substantial Completion	3/18/2024		
Hertel South (Hertel at Deer) In-Line Storage	Engineering Start	---	1/19/2018	Complete
	Engineering Completion	---	12/13/2018	Complete
	Notice to Proceed	---	2/9/2019	Complete
	Substantial Completion	---	5/6/2020	Complete
Hertel Northeast In-Line Storage	Engineering Start	---		
	Engineering Completion	---		
	Notice to Proceed	---		
	Substantial Completion	3/18/2024		
Bird East In-Line Storage	Engineering Start	---		
	Engineering Completion	---		
	Notice to Proceed	---		
	Substantial Completion	3/18/2024		
East Ferry In-Line Storage	Engineering Start	---		
	Engineering Completion	---		
	Notice to Proceed	---		
	Substantial Completion	3/18/2024		
Colorado In-Line Storage	Engineering Start	---		
	Engineering Completion	---		
	Notice to Proceed	---		
	Substantial Completion	3/18/2024		

Project Name	Project Milestone	AO Project Deadline	Actual Completion Dates	Project Status
North Bailey In-Line Storage	Engineering Start	---	12/8/2017	Complete
	Engineering Completion	---	6/5/2018	Complete
	Notice to Proceed	---	10/16/2018	Complete
	Substantial Completion	---	5/27/2020	Complete
South Bailey In-Line Storage	Engineering Start	---		
	Engineering Completion	---		
	Notice to Proceed	---		
	Substantial Completion	3/18/2024		
Roslyn In-Line Storage	Engineering Start	---		
	Engineering Completion	---		
	Notice to Proceed	---		
	Substantial Completion	3/18/2024		
Hazelwood (Kay) In-Line Storage	Engineering Start	---	8/9/2016	Complete
	Engineering Completion	---	9/22/2017	Complete
	Notice to Proceed	---	2/2/2018	Complete
	Substantial Completion	3/18/2024	6/19/2019	Complete
Amherst Quarry Off-Line Storage	Engineering Start	---		
	Engineering Completion	---		
	Notice to Proceed	---		
	Substantial Completion	3/18/2024		
Fillmore North In-Line Storage	Engineering Start	---		
	Engineering Completion	---		
	Notice to Proceed	---		
	Substantial Completion	3/18/2024		
Gibson CSO Line Storage	Engineering Start	---		
	Engineering Completion	---		
	Notice to Proceed	---		
	Substantial Completion	3/18/2024		

Project Name	Project Milestone	AO Project Deadline	Actual Completion Dates	Project Status
Montgomery CSO Line Storage	Engineering Start	---		
	Engineering Completion	---		
	Notice to Proceed	---		
	Substantial Completion	3/18/2024		
Babcock Pump Station In-Line Storage	Engineering Start	---	6/19/2019	Complete
	Engineering Completion	---	5/15/2020	Complete
	Notice to Proceed	---	7/24/2020	Complete
	Substantial Completion	3/18/2024		Expected to be completed in the next reporting period.
Smith St. and Eagle St. In-Line Storage	Engineering Start	---	4/4/2019	Complete
	Engineering Completion	---	2/27/2020	Complete
	Notice to Proceed	---	7/13/2020	Complete
	Substantial Completion	3/18/2024		Expected to be complete in 2022.
Broadway at Oak In-Line Storage	Engineering Start	---	4/4/2019	Complete
	Engineering Completion	---		Expected to be complete in the next reporting period.
	Notice to Proceed	---		
	Substantial Completion	3/18/2024		

Project Name	Project Milestone	AO Project Deadline	Actual Completion Dates	Project Status
Foundation 4 - Hamburg Drain Optimizations	Engineering Start	3/18/2015	Prior to 1/1/2014	Complete
	Engineering Completion	3/18/2017	2/23/2017	Complete
	Notice to Proceed	3/18/2016	5/16/2017	Complete
	Substantial Completion	3/18/2018		
Mill Race In-Line Storage	Engineering Start	---	4/4/2019	Complete
	Engineering Completion	---		Expected to be complete in the next reporting period.
	Notice to Proceed	---		
	Substantial Completion	3/18/2032		
Foundation 4 - Hamburg Drain Storage	Engineering Start	3/18/2028		
	Engineering Completion	3/18/2030		
	Notice to Proceed	3/18/2030		
	Substantial Completion	3/18/2032		
WWTP				
WWTP Improvement Project Alternative C2	Engineering Start	11/26/2019	4/1/2021	See 4.5. As requested on Nov. 8, 2018, BSA submitted a written Request for Extension that reflects these amended dates. Completion dates are still under review.
	Engineering Completion	10/15/2024		
	Notice to Proceed	5/30/2022		
	Substantial Completion	6/30/2027		
Green Infrastructure Projects				
Green 1 - Pilot Projects – 267-acres of GI control SEE DETAILS FOLLOWING	Engineering Start	3/1/2014	Prior to 1/1/2014	Complete
	Engineering Completion	3/18/2016		Complete
	Substantial Completion	3/18/2018	12/31/2016	Complete.
2001-2016 Residential (traditional) Demolitions	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2018	12/31/2016	Complete.
2001 - 2016 Commercial and Industrial Demolitions	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2018	12/31/2016	Complete.

Project Name	Project Milestone	AO Project Deadline	Actual Completion Dates	Project Status
Green 2 – 410 acres of GI Control	Engineering Start:	3/18/2019	Prior to 1/1/2014	Complete
	Engineering Completion:	3/18/2023		
	Substantial Completion:	3/18/2024		
2017 - 2024 Demolitions	Engineering Start		Prior to 1/1/2014	Complete.
	Engineering Completion:			
	Substantial Completion:	3/18/2018		
Green Demolition Pilot Project	Engineering Start		Prior to 1/1/2014	Complete
	Engineering Completion			Complete
	Substantial Completion		7/31/2017	Complete.
PUSH Blue Projects	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2018	7/1/2015	Complete.
Carlton Street Porous Asphalt	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2018	7/25/2014	Complete.
Fillmore Avenue Porous Parking and Green Lots	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2018	4/23/2015	Complete.
Ohio Street	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2018	12/1/2014	Complete.
Kenmore Avenue	Engineering Start	---	4/30/2014	Complete
	Engineering Completion		4/20/2015	Complete
	Substantial Completion	3/18/2018	3/1/2017	Complete.
Genesee Street	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	6/8/2015	Complete
	Substantial Completion	3/18/2018	6/1/2017	Complete.
Allen Street	Engineering Start	---	Prior to 1/1/2014	Green infrastructre will no longer be implemented as part of the Allen Street streetscape project due to site constraints.
	Engineering Completion	---		
	Substantial Completion	3/18/2018		

Project Name	Project Milestone	AO Project Deadline	Actual Completion Dates	Project Status
Willert Park	Engineering Start	---	6/1/2016	Complete
	Engineering Completion	---	2/1/2017	Complete
	Substantial Completion	3/18/2018	4/26/2019	Complete
Northland Ave	Engineering Start	---	7/1/2016	Complete
	Engineering Completion	---	3/1/2017	Complete
	Substantial Completion	3/18/2018	12/17/2019	
612 Northland Ave	Engineering Start	---	1/1/2019	Complete
	Engineering Completion	---	6/1/2019	Complete
	Substantial Completion	---	12/1/2019	Complete
Niagara Street Phase 1: Elmwood Street to Virgina Street	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	3/19/2014	Complete
	Substantial Completion	3/18/2018	12/1/2016	Complete.
Niagara Street Phase 2: Virgina Street to Porter Avenue	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	6/3/2015	Complete
	Substantial Completion	3/18/2018	11/16/2017	Complete.
Niagara Street Phase 3: Hampshire Street to Scajaquada Expy	Engineering Start	---	10/28/2015	Complete
	Engineering Completion	---	3/21/2018	Complete
	Substantial Completion	3/18/2024		Expected to be complete in the next reporting period.
Niagara Street Phase 4a: Scajaquada Expy to Hertel Ave	Engineering Start	---	10/28/2015	Complete
	Engineering Completion	---	6/13/2018	Complete
	Substantial Completion	3/18/2024		Expected to be complete in 2022.
Niagara Street Phase 4b: Hertel Ave to Ontario St	Engineering Start	---	10/28/2015	Complete
	Engineering Completion	---	6/13/2018	Complete
	Substantial Completion	3/18/2024		

Project Name	Project Milestone	AO Project Deadline	Actual Completion Dates	Project Status
Niagara Street Phase 5: Porter Avenue to Hampshire Street	Engineering Start	---	10/28/2015	Complete
	Engineering Completion	---		
	Substantial Completion	3/18/2024		
Green 3 – 375 acres of GI Control	Engineering Start:	3/18/2023		
	Engineering Completion:	3/18/2028		
	Substantial Completion:	3/18/2029		
Green 4 – 263 acres of GI Control	Engineering Start:	3/18/2028		
	Engineering Completion:	3/18/2033		
	Substantial Completion:	3/18/2034		

Project Name	Project Milestone	AO Project Deadline	Actual Completion Dates	Project Status
Gray Projects				
CSOs 014/15 – Erie Basin In-line storage and optimization projects	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Notice to Proceed	3/18/2014	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2015	12/29/2014	Complete
SPPs 206A&B	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Notice to Proceed	---	5/30/2014	Complete
	Substantial Completion	3/18/2015	12/29/2014	Complete
SPP 035	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Notice to Proceed	---	Prior to 1/1/2014	Complete
	Substantial Completion	3/18/2015	5/31/2014	Complete
SPP 036	Engineering Start	---	Prior to 1/1/2014	Complete
	Engineering Completion	---	Prior to 1/1/2014	Complete
	Notice to Proceed	---	5/30/2014	Complete
	Substantial Completion	3/18/2015	12/5/2014	Complete
CSO 013 – Satellite storage, conveyance, FM & PS	Engineering Start	1/1/2020	3/12/2020	Complete
	Engineering Completion	1/1/2021		This project is on hold; see 4.1
	Notice to Proceed	1/1/2021		
	Substantial Completion	1/1/2023		
North Relief – Interceptor	Engineering Start	3/18/2019	5/15/2015	Complete; See 4.6.
	Engineering Completion	3/18/2022		
	Notice to Proceed	3/18/2022		
	Substantial Completion	3/18/2026		
CSOs 010, 008/010, 061, 004 – Underflow capacity upsizing	Engineering Start	3/18/2021	6/15/2021	Complete
	Engineering Completion	3/18/2023		
	Notice to Proceed	3/18/2023		
	Substantial Completion	3/18/2024		

Project Name	Project Milestone	AO Project Deadline	Actual Completion Dates	Project Status
SPP 337 (CSO 053) – Satellite storage, conveyance, FM & PS	Engineering Start	3/18/2023		
	Engineering Completion	3/18/2025		
	Notice to Proceed	3/18/2025		
	Substantial Completion	3/18/2027		
SPP 336A&B (CSO 053) – Satellite storage, conveyance, FM & PS	Engineering Start	3/18/2024		
	Engineering Completion	3/18/2026		
	Notice to Proceed	3/18/2026		
	Substantial Completion	3/18/2029		
Jefferson Avenue & Florida Street (CSO 053) – Satellite storage, conveyance and FM	Engineering Start	3/18/2025		
	Engineering Completion	3/18/2027		
	Notice to Proceed	3/18/2027		
	Substantial Completion	3/18/2030		
CSO 055 – Satellite storage, conveyance, FM & PS	Engineering Start:	3/18/2027		
	Engineering Completion:	3/18/2030		
	Notice to Proceed:	3/18/2030		
	Substantial Completion:	3/18/2034		
CSOs 028/044/047 - Satellite storage, conveyance, FM & PS	Engineering Start:	3/18/2028		
	Engineering Completion:	3/18/2031		
	Notice to Proceed:	3/18/2031		
	Substantial Completion:	3/18/2034		
CSO 052 – Satellite storage, conveyance, FM & PS	Engineering Start:	3/18/2030		
	Engineering Completion:	3/18/2032		
	Notice to Proceed:	3/18/2032		
	Substantial Completion:	3/18/2034		
CSO 064 – Satellite storage, conveyance, FM & PS	Engineering Start:	3/18/2030		
	Engineering Completion:	3/18/2032		
	Notice to Proceed:	3/18/2032		
	Substantial Completion:	3/18/2034		

Attachment B to the Semi-Annual Status Report: September 2021

Detailed Project Descriptions

Project Name	Project Description	Project Purpose*
Phase I Projects		
CSO 060 GI Project	This project consisted of the construction of 4768 CF of rain garden on Windsor, Parkdale and Elmwood Avenues between Bird and Forest Avenues and 39,600 SF of permeable pavement on Clarendon and Claremont Avenues between Bird and Forest Avenues, installation of a Stormceptor unit at Bird Avenue and Granger Place and a total of 6,125 LF of 12-30 inch sewer designed to carry street flow to the existing storm overflow sewer on Forest Avenue from the above mentioned street segments. Additionally, weirs were raised in SPPs 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, and 240.	This project was designed to treat 13,600 cf of stormwater runoff from the 0.9 inch water quality storm event and remove 49.5 cfs of peak flow from the combined sewer system. Thereby reducing overflows through SPPs 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, and 241 to CSO 060. Together with other LTCP projects, this project is projected reduce CSO 060 discharges to Scajaquada Creek based on the 1993 Modified Typical Year (TY) to negligible activations and flow.
Bird/Lang RTC Projects	These RTC projects utilize available capacity of large sewers to provide flow control measures during wet weather events through the use of gates which allow continuous dry weather underflow.	
Bird RTC Project	The Bird RTC Project is located on Bird Avenue between Parkdale Avenue and Hoyt Street.	The Bird RTC project is designed to provide 1.01 MG of storage volume, thereby reducing discharges through SPP 013 to CSO 004. Together with other LTCP projects, this project is projected reduce CSO 004 discharges to the Black Rock Canal based on the TY to 3 activations.
Lang RTC Project	The Lang RTC Project is located on Lang Avenue between Courtland Avenue and Hagen Street.	The Lang RTC project is designed to have a storage volume of 0.84 MG, thereby reducing discharges through SPP 340 to CSO 053. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the 1993 Modified Typical Year (TY) to 4 activations.

Project Name	Project Description	Project Purpose*
Foundation Projects		
Foundation 1 - Smith Street Storage	Originally envisioned as a single project, these two projects have been separated to realize cost advantages due to the different levels of skill required for the projects and to expedite the sewer separation component.	
CSO No. 026 Sewer Separation	This project consisted of the installation of collection sewers for street receiver flows on Leddy Street, South Park Avenue, Owahn Place, Prenatt Street, Bolton Place, St. Stephen's Place, and Buffalo River Place, tributary to to SPP 88 and 90, in order to discharge these storm flows downstream of regulators, in conjuction with the optimization projects for SPP 217 and SPP 318.	Together with the Smith Street in-line storage project, the Smith Street partial sewer separation project is designed to divert storm flows directly to the Smith Street Drain thereby reducing CSO 026 discharges. Together with other LTCP projects, this project is projected to reduce CSO 026 discharges to the Buffalo River based on the TY to 6 activations or less.
CSO No. 026 RTC Structure	The second contract consists of an in-line storage project which is designed to detain wet weather flows along the western side of Smith Street using a weir structure between the I-190 and the I-190 off ramp within the Smith Street Drain for discharge to the South Interceptor thereby diverting combined sewer flows from CSO 026.	Together with the Smith Street partial sewer separation project, the Smith Street in-line storage project is designed to divert and detain the equivalent of a storage volume of 1.94 MG, thereby reducing CSO 026 discharges. Together with other LTCP projects, this project is projected to reduce CSO 026 discharges to the Buffalo River based on the TY to 6 activations or less.

Project Name	Project Description	Project Purpose*
Foundation 2 - SPP Optimization (20 projects)	Project consists of multiple smaller projects that will overlap in engineering and construction. SEE DETAILS FOLLOWING FOR SPECIFIC PROJECTS	In general, these projects will reduce discharges to the CSOs by detaining flows within the BSA's system through the modification of existing control structures.
SPP 180 Optimization	This project consisted of raising of the weir associated with SPP 180 by 2.0' along its entire length. SPP 180 is located on Delaware Avenue at the intersection with West Delavan. As part of the revised SPP 331 Optimization, this weir will be raised an additional 1.75' along its entire length.	The SPP 180 Optimization project was designed to increase the capacity of the CSS at SPP 180 thereby decreasing CSO 006 discharges. Together with other LTCP projects, this project is projected to reduce CSO 006 discharges to the Black Rock Canal based on the TY to 4 activations.
SPP 331 Optimization	SPP331 is located at the intersection of Elmwood Avenue and West Delavan Avenue. Preliminary plans were for the diversion of flows from this point through a new sewer to Bird Avenue along the centerline of Elmwood Avenue. This would have required major disruption of a very high traffic commercial area and was deemed impractical. Plans have been developed to instead divert the same flow that was to have been diverted through this project through a system of localized weir modifications rather than extensive pipe installation. These modifications include raising the weir at SPP 180 by 1.75' and the bench located in SPP 332 on the northeast quadrant of Gates Circle which currently directs dry weather flows into the interceptor will be removed and replaced with a 6.2' weir and restored sewer trough which will direct dry weather flows into the Bird Avenue trunk sewer.	The SPP 331 Optimization project is designed to increase the underflow capacity at SPP 331 thereby decreasing CSO 006 discharges. Together with other LTCP projects, this project is projected to reduce CSO 006 discharges to the Black Rock Canal based on the TY to 4 activations.
SPP 036 Optimization	This project consisted of the reconstruction of 35' of 30" sewer associated with SPP 036 to reverse the slope. It was located on Church Street between the off and on ramps of the Skyway (State Route 5).	The SPP 036 Optimization project was designed to increase the underflow capacity at SPP 036 thereby decreasing CSO 015 discharges. Together with other LTCP projects, this project is projected based on the TY to reduce discharges to the Erie Basin through CSO 015 to 0 activations.

Project Name	Project Description	Project Purpose*
SPP 217 Optimization	In association with the Smith Street partial sewer separation project, this project consisted of the removal of two bottom orifice plates totaling 1.42' in height, increasing the orifice size and conveyance capacity of the Emslie Street Sewer. SPP 217 is located on Emslie Street at its intersection with Eagle Street.	The SPP 217 Optimization project is designed to increase the underflow capacity at SPP 217 thereby decreasing CSO 026 discharges. Together with other LTCP projects, this project is projected to reduce CSO 026 discharges to the Buffalo River based on the TY to 3 activations.
SPP 318 Optimization	In association with the Smith Street partial sewer separation project, this project consisted of the removal of an orifice plate, increasing the orifice size and conveyance capacity of the Clinton Avenue Sewer. SPP 318 is located east of the intersection of Fillmore Avenue and Clinton Street.	The SPP 318 Optimization project is designed to increase the underflow capacity at SPP 318 thereby decreasing CSO 026 discharges. Together with other LTCP projects, this project is projected to reduce CSO 026 discharges to the Buffalo River based on the TY to 3 activations.
SPP 097A Optimization	This project consisted of abandoning an inactive combined sewer, converting another to a storm sewer and abandoning the underflow connection. SPP 097A is located at the intersection of the extension of Prenatt and Orlando Streets.	The SPP 097A Optimization project is designed to eliminate SPP 097A thereby decreasing CSO 026 discharges. Together with other LTCP projects, this project is projected to reduce CSO 026 discharges to the Buffalo River based on the TY to 3 activations.
SPP 122 Optimization	This project consisted of raising of the weir associated with SPP 122 by 0.5' along its entire length. SPP 122 is located on South Legion Drive just north of the intersection with Meriden Street.	The SPP 122 Optimization project was designed to increase the flow volume conveyed by the CSS at SPP 122 thereby decreasing CSO 037 discharges. Together with other LTCP projects, this project is projected to reduce CSO 037 discharges to the Buffalo River based on the TY to 3 activations.
SPP 163 Optimization	The SPP 163 Weir Optimization project consisted of replacing the existing weir with a new weir 0.75' higher. It is located to the East of the intersection of Fillmore Avenue and Northland on Northland Avenue.	The SPP 163 Optimization project is designed to increase the flow volume conveyed by the CSS at SPP 163 thereby decreasing CSO 053 discharges. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the TY to 4 activations.
SPP 165 Optimization	This project consisted of raising of the weir associated with SPP 165 by 0.5' along its entire length. SPP 165 is located on Fillmore Avenue just north of the intersection with East Delavan Street.	The SPP 165 Optimization project was designed to increase the capacity of the CSS at SPP 165 thereby decreasing CSO 053 discharges. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the TY to 4 activations.

Project Name	Project Description	Project Purpose*
SPP 165A Optimization	The weir associated with SPP 165A located at the intersections of Fillmore and Kensington Avenues.	The SPP 165A Optimization project was designed to increase the capacity of the CSS at SPP 165A by raising the weir by 0.75' and upsizing 675' of 15" pipe to 18" pipe to reduce CSOs in association with CSO 053. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the TY to 4 activations.
SPP 178 Optimization	This project consisted of raising of the weir associated with SPP 178 by 0.5' along its entire length. SPP 178 is located on Masten Avenue just north of the intersection with Northland Avenue.	The SPP 178 Optimization project was designed to increase the flow volume conveyed by the CSS at SPP 178 thereby decreasing CSO 053 discharges. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the TY to 4 activations.
SPP 335B Optimization	This project consisted of raising of the weir associated with SPP 335B by 1.0' along its entire length. SPP 335B is located on Hager Street just south of the intersection with Florida Street.	The SPP 335B Optimization project was designed to increase the flow volume conveyed by CSS at SPP 335B thereby decreasing CSO 053 discharges. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the TY to 4 activations.
SPP 336A Optimization	This project has been constructed in association with the SPP 331 optimization. The project consist sof removing a sluice gate and orifice plate and modifying the existing structure by changing the existing side channel opening from 24" to 30". SPP 336A is located on Humboldt Parkway North of the Scajaquada Drain.	The SPP 336A Optimization project is designed to increase the underflow capacity of the CSS at SPP 336A thereby decreasing CSO 053 discharges. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the TY to 4 activations.
SPP 341A Optimization	SPP 341A is located on Genesee Street east of Kerns Avenue. This project is on hold pending the results of post-construction monitoring of Lang and Hazelwood RTCs.	The SPP 341A Optimization project would increase the flow volume conveyed by the CSS at SPP 341A thereby decreasing CSO 053 discharges. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the TY to 4 activations. Field conditions may require modification to this planned optimization.

Project Name	Project Description	Project Purpose*
SPP 342B Optimization	This project consisted of raising of the weir associated with SPP 342B by 1.0' along its entire length. SPP 342B is located on Sprenger Avenue adjacent to Schiller Park.	The SPP 342B Optimization project was designed to increase the flow volume conveyed by the CSS at SPP 342B thereby decreasing CSO 053 discharges. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the TY to 4 activations.
SPP 001 Optimization	The weir associated with SPP 001 located at the discharge of Cornelius Creek into the Niagara River and tributary to CSO 055 has been raised 1.0' to reduce CSOs.	The SPP 001 Optimization project was designed to increase the flow volume conveyed by the CSS at SPP 001 thereby decreasing CSO 055 discharges. Together with other LTCP projects, this project is projected to reduce CSO 055 discharges to the Niagara River based on the TY to 9 activations.
SPP 183 Optimization	This project consisted of raising of the weir associated with SPP 183 by 2.0' along its entire length. SPP 183 is located at the intersection of Bradley Avenue and Dewitt Street.	The SPP 183 Optimization project was designed to increase the flow volume conveyed by the CSS at SPP 183 thereby decreasing CSO 059 discharges. Together with other LTCP projects, this project is projected to reduce CSO 059 discharges to Scajaquada Creek based on the TY to 0 activations.
SPP 283 Optimization	SPP 283 is located in the median between the I-190 South ramp to Porter Avenue and a service road near the West Side Rowing Club. This project consisted of removing an orifice plate which restricted flows from entering the Swan Trunk and the installation of a new 1.0' tall weir to restrict flows from discharging through CSO 063.	The SPP 283 Optimization project was designed to increase the underflow capacity of the CSS at SPP 283 thereby decreasing CSO 063 discharges. Together with other LTCP projects, this project is projected to reduce CSO 063 discharges to the Niagara River based on the TY to 4 activations.
SPP 211 Optimization	This project consisted of constructing a weir to an elevation above the overflow raised pipe invert at SPP 211. SPP 211 is located at the South East corner of the intersection of Clinton and South Ogden Streets.	The SPP 211 Optimization project was designed to increase the flow volume conveyed by the CSS at SPP 211 thereby decreasing CSO 066 discharges. Together with other LTCP projects, this project is projected to reduce CSO 066 discharges to the Buffalo River based on the TY to 4 activations.

Project Name	Project Description	Project Purpose*
Foundation 3 - Remaining RTC (14 sites)	These RTC projects propose to utilize available capacity in the CSS to provide flow control measures during wet weather events through the use of active controls.	In general, these projects are designed to reduce discharges to the CSOs through the detention of flows within the BSA's CSS system.
Hertel Northwest In-Line Storage	This RTC project is proposed to utilize available capacity of a large sewer to provide flow control measures during wet weather events while allowing continuous dry weather underflow. The proposed project location is within the northern portion of the two large combined sewers which are located under Hertel Avenue.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 055 discharges to the Niagara River based on the TY to 9 activations.
Hertel South (Hertel at Deer) In-Line Storage	This RTC project is proposed to utilize available capacity of a large sewer to provide flow control measures during wet weather events while allowing continuous dry weather underflow. The proposed project location is within the southern portion of the two large combined sewers which are located under Hertel Avenue.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 055 discharges to the Niagara River based on the TY to 9 activations.
Hertel Northeast In-Line Storage	This RTC project is proposed to utilize available capacity of a large sewer to provide flow control measures during wet weather events while allowing continuous dry weather underflow. This project will be located within the northern portion of the two large combined sewers which are located under Hertel Avenue.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 055 discharges to the Niagara River based on the TY to 9 activations.
Bird East In-Line Storage	This RTC project is proposed to utilize available capacity of a large sewer to provide flow control measures during wet weather events while allowing continuous dry weather underflow. This project will be located to the east of the above mentioned Bird RTC project along the same Bird Avenue sewer.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 004 discharges to the Black Rock Canal based on the TY to 3 activations.

Project Name	Project Description	Project Purpose*
East Ferry In-Line Storage	This RTC project is proposed to utilize available capacity of a large sewer to provide flow control measures during wet weather events while allowing continuous dry weather underflow. The proposed project location is along the Ferry Street sewer upstream of its leaping weir overflow to the Scajaquada Drain north of Florida Street.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the TY to 4 activations.
Colorado In-Line Storage	This RTC project is proposed to utilize available capacity of a large sewer to provide flow control measures during wet weather events while allowing continuous dry weather underflow. The proposed project location is along the Colorado Avenue sewer which runs underneath the manufacturing facility located at 1001 East Delavan Avenue.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the TY to 4 activations.
North Bailey In-Line Storage	This RTC project is proposed to utilize available capacity of a large sewer to provide flow control measures during wet weather events while allowing continuous dry weather underflow. The proposed project location is along Bailey Avenue north of Scajaquada Street.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the TY to 4 activations.
South Bailey In-Line Storage	This RTC project is proposed to utilize available capacity of a large sewer to provide flow control measures during wet weather events while allowing continuous dry weather underflow. The proposed project location is along Bailey Avenue north of Scajaquada Street and south of the afore mentioned North Bailey In-Line Storage project.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the TY to 4 activations.
Roslyn In-Line Storage	This RTC project is proposed to utilize available capacity of a large sewer to provide flow control measures during wet weather events while allowing continuous dry weather underflow. The proposed project location is near Roslyn Street on Lang Avenue.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the TY to 4 activations.

Project Name	Project Description	Project Purpose*
Hazelwood (Kay) In-Line Storage	This RTC project, now known as Hazelwood, is proposed to utilize available capacity in the CSS capacity of a large sewer to provide flow control measures during wet weather events while allowing continuous dry weather underflow. The proposed project location is on Hazelwood Avenue between East Delavan and Easton Avenues.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the TY to 4 activations.
Amherst Quarry Off-Line Storage	This RTC project proposes to utilize available capacity within the active Amherst Quarry to provide flow control measures during wet weather events, once downstream capacity is available, flows will then be pumped back into the system. The Amherst Quarry is located in an area bounded by Parkridge Avenue, East Amherst Street, and Hewitt Avenue.	This RTC project is proposed to utilize available capacity of the quarry to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 053 discharges to Scajaquada Creek based on the TY to 4 activations.
Fillmore North In-Line Storage	This RTC project is proposed to utilize available capacity of a large sewer to provide flow control measures during wet weather events while allowing continuous dry weather underflow. This project is proposed to be located on Fillmore Avenue, however pending the results of post-construction monitoring, it may be eliminated depending on the efficancy of the Smith Street Storage project.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 026 discharges to the Buffalo River based on the TY to 3 activations.

Project Name	Project Description	Project Purpose*
Gibson CSO Line Storage	This project is proposed to utilize the available capacity of the CSO pipe downstream of the SPP, but before the discharge point or outfall. It would be designed to convey water to prevent surface flooding and overflows through upstream SPPs. Once the storm event has subsided, it would be designed to dewater back into the combined system. The dewatering rate would be controlled so that it would not cause overflows downstream from the control structure. The proposed project location is on Gibson Street, however pending the results of post-construction monitoring, it may be eliminated depending on the efficancy of the Smith Street Storage project.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 026 discharges to the Buffalo River based on the TY to 3 activations.
Montgomery CSO Line Storage	This project is proposed to utilize the available capacity of the CSO pipe downstream of the SPP, but before the discharge point or outfall. It would be designed to convey water to prevent surface flooding and overflows through upstream SPPs. Once the storm event has subsided, it would be designed to dewater back into the combined system. The dewatering rate would be controlled so that it would not cause overflows downstream from the control structure. The proposed project location is along the railroad right-of-way near Montgomery Street, however pending the results of post-construction monitoring, it may be eliminated depending on the efficancy of the Smith Street Storage project.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 026 discharges to the Buffalo River based on the TY to 3 activations.

Project Name	Project Description	Project Purpose*
Babcock Pump Station In-Line Storage	This RTC project is proposed to modify the function of an existing pump station to utilize available capacity of a large sewer to provide flow control measures during wet weather events. The proposed project location is at the existing pump staion on New Babcock Street at Howard Street.	This RTC project is proposed to utilize available capacity within the collection system to reduce the peak flow into the Swan Trunk. Together with other LTCP projects, this project is projected to reduce CSO 027 discharges to the Buffalo River based on the TY to 6 activations.
Smith at Eagle In-Line Storage	This RTC project is proposed to utilize available capacity in the Smith St Drain to provide flow control measures during wet weather events while allowing continuous dry weather underflow. The proposed project location is upstream of the existing CSO 026 RTC project on Smith St. and Eagle St.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 026 discharges to the Buffalo River based on the TY to 6 activations.
Broadway at Oak In-Line Storage	This RTC project is proposed to utilize available capacity in the collection system to provide flow control measures during wet weather events while allowing continuous dry weather underflow. The proposed project location is on Broadway St. at Oak St.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 017 discharges to the Buffalo River based on the TY to 6 activations.
Foundation 4 - Hamburg Drain Optimizations	This project will entail several in-system optimizations, e.g. rerouting of flows, installation of weirs, partial sewer separations etc. and/or green infrastructure to reduce the overflow events at a number of upstream SPPs in order to control flows through CSOs 017, 022, and 064. These optimizations would be located within the Hamburg Basin.	These optimization projects are proposed to increase the flow volume conveyed by the CSS upstream of the SPPs and diverting stormwater flows out of the CSS thereby decreasing CSO 017, 022, and 064 discharges. Together with other LTCP projects, this project is projected based on the TY to reduce discharges to the Buffalo River through CSO 017 to 4 activations, CSO 022 to 5 activations, and CSO 064 to 3 activations.

Project Name	Project Description	Project Purpose*
Foundation 4 - Hamburg Drain Storage	Together with the Hamburg Drain Optimizations, this project would be designed to provide the equivalent of 5 MG of offline storage. This facility would be located within the Hamburg Basin and may involve the installation of RTCs.	This storage project is proposed to provide off-line storage thereby decreasing CSO 017, 022, and 064 discharges. Together with other LTCP projects, this project is projected based on the TY to reduce discharges to the Buffalo River through CSO 017 to 4 activations, CSO 022 to 5 activations, and CSO 064 to 3 activations.
Mill Race In-Line Storage	This RTC project is proposed to utilize available capacity of a large sewer to provide flow control measures during wet weather events while allowing continuous dry weather underflow. The proposed project location is on Larkin Street near Roseville Street.	This RTC project is proposed to utilize available capacity within the collection system to detain flows until downstream capacity becomes available. Together with other LTCP projects, this project is projected to reduce CSO 017 discharges to the Buffalo River based on the TY to 6 activations.
WWTP		
WWTP Improvement Project Alternative C2	The proposed project is expected to rehabilitate the existing primary clarifiers by adding high rate disinfection and provide additional secondary clarifiers at the Bird Island WWTP.	This project would be designed to provide treatment of wet weather flows and increased secondary treatment capacity.
Green Infrastructure Projects		
Green 1 - Pilot Projects – 267-acres of GI control	Projects consist of multiple green infrastructure projects that will overlap in engineering and construction.	In general, this phase is designed to control stormwater flow from 267 acres of impervious area in the various sewer sheds within the targeted areas.
2001-2016 Residential Demolitions	This project consists of the demolition of vacant houses thereby replacing impervious with pervious surfaces.	This project is designed to remove 256 total acres of impervious area and manage stormwater on site.
2001-2016 Commercial and Industrial Demolitions	This project consists of the demolition of commercial and industrial structures thereby replacing impervious with pervious surfaces.	This project is designed to control stormwater flow from 78 total acres of impervious area.

Project Name	Project Description	Project Purpose*
Green 2 – 410 acres of GI Control	These projects will consist of multiple green infrastructure projects that will overlap in engineering and construction. Details will be provided in future reports.	In general, these projects would be designed to retain stormwater flow from 410 acres of impervious area in the various sewer sheds in the targeted areas.
2017 -2024 Demolitions	This project consists of the demolition of vacant and dilapidated structures thereby replacing impervious surface with pervious surface	This project is designed to control stormwater flow for each post demolition vacant lot. Total acreate TBD on a rolling basis depending upon demolitions completed.
Green Demolition Pilot Project	A three year pilot study where the City of Buffalo's demolition specifications were altered to allow for the use of shallow bioretention to increase onsite infiltration	Over the course of the pilot project the revised demolition specifications/bioretention approach was applied to 221 sites impacting a total of 19.03 acres.
PUSH Blue Projects	PUSH-Buffalo will install rain gardens, porous pavement and a green roof and distribute rain barrels within the CSO 012 sewershed.	This project is designed to control stormwater flow from 1 acre of impervious area.
Carlton Street Porous Asphalt	This project consisted of the installation of pervious pavement to retain stormwater from the area tributary to the Right-of-Way on Carlton Street between Michigan and Jefferson Avenues in the City of Buffalo as part of the City's streetscape project.	This project is designed to control stormwater flow from a 5.9 acre sewershed.
Fillmore Avenue Porous Parking Lots and Green Lots	This project consisted of the installation of porous pavement parking lots and modified rain gardens to retain stormwater from the area tributary to the Right-of-Way of Fillmore Avenue in the City of Buffalo as part of the City's streetscape project.	This project is designed to control stormwater flow from 0.4 total acres of impervious area.
Ohio Street	This project consisted of the installation of green infrastructure to retain stormwater from the area tributary to the Right-of-Way on Ohio Street in the City of Buffalo as part of the City's streetscape project.	This project is designed to control stormwater flow from 6.1 total acres of impervious area.
Kenmore Avenue	This project consists of the installation of green infrastructure to retain stormwater from the area tributary to the Right-of-Way on Kenmore Avenue in the City of Buffalo as part of the City's streetscape project.	This project is designed to control stormwater flow from 5.17 total acres of impervious area.

Project Name	Project Description	Project Purpose*
Genesee Gateway Project	This project consists of the installation of green infrastructure to retain stormwater from the area tributary to the Right-of-Way on Genesee Street in the City of Buffalo as part of the City's streetscape project.	This project is designed to control stormwater flow from 2.8 total acres of impervious area.
Allen Street	This project will consist of the installation of green infrastructure to retain stormwater from the area tributary to the Right-of-Way for the portion of Allen Street between Main Street and Elmwood Avenue in the City of Buffalo as part of the City's streetscape project.	This project is designed to control stormwater flow from 2.5 total acres of impervious area.
Willert Park	This project will consist of the installation of green infrastructure to retain stormwater from the area tributary to the Right-of-Way for the portion of William Street between Michigan and Jefferson in the City of Buffalo.	This project is designed to control stormwater flow from 13.9 total acres of impervious area.
Northland Ave	This project will consist of the installation of green infrastructure to retain stormwater from the area tributary to the Right-of-Way for the portion of Northland Avenue between Fillmore and Grider in the City of Buffalo.	This project is designed to control stormwater flow from 6.1 total acres of impervious area.
612 Northland Ave	The project consists of a rain garden, permeable gravel pavement, and conversion of impervious pavement to lawn/shrubs.	The project is designed to control stormwater flow from 0.26 acres of impervious area.
Niagara Street Phase 1: Elmwood Street to Virgina Street	This project consists of the installation of green infrastructure to retain stormwater from the area tributary to the Right-of-Way for the length of Niagara Street in the City of Buffalo as part of the City's streetscape project.	This project is designed to control stormwater flow from 2 total acres of impervious area.
Niagara Street Phase 2: Virgina Street to Porter Avenue	This project consists of the installation of green infrastructure to retain stormwater from the area tributary to the Right-of-Way for the length of Niagara Street in the City of Buffalo as part of the City's streetscape project.	This project is designed to control stormwater flow from 7.3 total acres of impervious area.

Project Name	Project Description	Project Purpose*
Niagara Street Phase 3: Hampshire Street to Scajaquada Expressway *Niagara Street Phase 4a: Scajaquada Expy to Hertel Ave* *Niagara Street Phase 4b: Hertel Ave to Ontario St* *Niagara Street Phase 5: Porter Avenue to Hampshire Street*	This project consists of the installation of green infrastructure to retain stormwater from the area tributary to the Right-of-Way for the length of Niagara Street in the City of Buffalo as part of the City's streetscape project.	This project is designed to control stormwater flow from 15 total acres of impervious area in MS4 drainage areas and 25.5 in CSO drainage areas.
Green 3 – 375 acres of GI Control	These projects will consist of multiple green infrastructure projects that will overlap in engineering and construction. Details will be provided in the Phase 2 Green Infrastructure Master Plan.	In general, these projects would be designed to retain stormwater flow from 375 acres of impervious area in the various sewer sheds in the targeted areas.
Green 4 – 263 acres of GI Control	These projects will consist of multiple green infrastructure projects that will overlap in engineering and construction. Details will be provided in the Phase 2 Green Infrastructure Master Plan.	In general, these projects would be designed to retain stormwater flow from 263 acres of impervious area in the various sewer sheds in the targeted areas.

Project Name	Project Description	Project Purpose*
Gray Projects		
CSOs 014/15 – Erie Basin In-line storage and optimization	**SEE DETAILS FOLLOWING FOR SPECIFIC PROJECTS**	
SPPs 206A&B	A new 113,000 gallon in-line storage facility was constructed in association with SPPs 206A&B to reduce CSOs at CSO 014. This site is located at Trenton Road/ Village Court north east of Fourth Street.	This project was designed to provide in-line storage thereby decreasing CSO 014 discharges through SPPs 206A&B. Together with other LTCP projects, this project is projected based on the TY to reduce discharges to the Erie Basin through CSO 014 to 2 activations.
SPP 035	A new 50,000 gallon in-line storage facility was constructed between the Genesee Trunk and Swan Trunk sewers to create additional storage capacity in association with SPP 035 (CSO 015). This project is located to the north west of the intersection of South Elmwood Avenue and West Genesee Street.	This project was designed to provide in-line storage thereby decreasing CSO 015 discharges through SPP 35. Together with other LTCP projects, this project is projected based on the TY to reduce discharges to the Erie Basin through CSO 015 to 0 activations.
SPP 036	This project consisted of the reconstruction of 35' of 30" sewer associated with SPP 036 to reverse the slope. This site is located on Church Street between the off and on ramps of the Skyway bridge (State Route 5).	This sewer reconstruction project was designed to increase the underflow capacity of the CSS thereby decreasing CSO 015 discharges. Together with other LTCP projects, this project is projected based on the TY to reduce discharges to the Erie Basin through CSO 015 to 0 activations.
CSO 013 – Satellite storage, conveyance, FM & PS	CSO 013 is located at the extension of Virginia Street, in LaSalle Park, into the Black Rock Canal, the structure is tentatively planned to be built between the last SPP structure and the Canal. The proposed satellite storage facility would consist of a covered, concrete, underground tank. This project is currently on hold pending the Model Recalibration.	This storage project would provide off-line storage thereby decreasing CSO 013 discharges. Preliminary design is for a 0.3 MG offline storage facility. Together with other LTCP projects, this project is projected based on the TY to reduce discharges to the Black Rock Canal through CSO 013 to 4 activations.

Project Name	Project Description	Project Purpose*
North Relief – Interceptor	The original conception of this project was of a deep tunnel relief sewer to run in the vicinity of Niagara Street between Bird Avenue and Albany Street with an additional line connecting the tunnel to the WWTP influent siphon. Preliminary design is for 5,310' of 96"pipe and 571' of 120" pipe. Due to site constraints this project may be redesigned.	The purpose of this project is to reduce discharges through CSOs 004, 011, and 012, by creating a new relief sewer thereby creating offline storage capacity capacity in the CSS. Together with other LTCP projects, this project is projected based on the TY to reduce discharges to the Black Rock Canal through CSO 004 to 3 activations, CSO 011 to 4 activation, and CSO 012 to 2 activations.
CSOs 010, 008/010, 061, 004 – Underflow capacity upsizing	This project will consist of upsizing of underflow piping to maximize flow to the interceptors. This project is tentatively proposed for between Breckenridge Street and Brace Street along the I-190 with an extension along Brace Street across Niagara Street.	This underflow capacity upsizing project would increase the capacity of the CSS thereby decreasing CSO 010, 008, 061 and 004 discharges. Together with other LTCP projects, this project is projected based on the 1993 Modified Typical Year to reduce discharges to the Black Rock Canal through CSO 004 to 3 activations, CSO 010 to 1 activations, CSO 008 to 0 activations, and CSO 061 to 4 activations.
SPP 337 (CSO 053) – Satellite storage, conveyance, FM & PS	SPP 337 is located at Colorado Street North of Scajaquada Street. The proposed satellite storage facility would consist of a covered, concrete, underground tank.	The purpose of this project is to reduce discharges through CSO 53 to the Scajaquada Creek. Preliminary design is for a 0.7 MG off-line storage facility. Together with other LTCP projects, this project is projected reduce CSO discharges to Scajaquada Creek based on the TY to 4 activations.
SPP 336A&B (CSO 053) – Satellite storage, conveyance, FM & PS	SPP 336A&B are located on Humboldt Parkway on each side of the Scajaquada Drain. The proposed satellite storage facility would consist of a covered, concrete, underground tank.	The purpose of this project is to reduce discharges through CSO 53 to the Scajaquada Creek. Preliminary design is for a 4.2 MG off-line storage facility. Together with other LTCP projects, this project is projected reduce CSO discharges to Scajaquada Creek based on the TY to 4 activations.
Jefferson Avenue & Florida Street (CSO 053) – Satellite storage, conveyance and FM	The proposed location for this facility is in the vicinity of the intersection of Jefferson Avenue and Florida Street. The proposed satellite storage facility would consist of a covered, concrete, underground tank.	The purpose of this project is to reduce discharges through CSO 53 to the Scajaquada Creek. Preliminary design is for a 2.6 MG off-line storage facility. Together with other LTCP projects, this project is projected reduce CSO discharges to Scajaquada Creek based on the TY to 4 activations.

Project Name	Project Description	Project Purpose*
CSO 055 – Satellite storage, conveyance, FM & PS	For CSO 055, the proposed storage facility would be located upstream of the regulator, near Military Road. At this location, an offline facility would be constructed and flows above 26 MGD (instantaneous peak) would be diverted from the South Hertel Trunk sewer into the storage facility. The proposed satellite storage facility would consist of a covered, concrete, underground tank.	The purpose of this project is to reduce discharges through CSO 55 to the Niagara River. Preliminary design is for a 7.5 MG off-line storage facility. Together with other LTCP projects, this project is projected reduce CSO discharges to the Niagara River through CSO 55 based on the TY to 9 activations.
CSOs 028/044/047 - Satellite storage, conveyance, FM & PS	The proposed location for this facility is underneath the Tops parking lot between South Park Avenue and the Buffalo River. The proposed satellite storage facility would consist of a covered, concrete, underground tank.	The purpose of this project is to reduce discharges through CSO 28 to the Buffalo River and through CSOs 047 and 044 to Cazenovia Creek. Preliminary design is for a 2.3 MG off-line storage facility. Together with other LTCP projects, this project is projected reduce CSO discharges based on the TY to 6 activations through CSO 028, 2 activations through CSO 044 and 3 activations through CSO 047.
CSO 052 – Satellite storage, conveyance, FM & PS	The proposed location for this facility is in the vicinity of South Ogden Street between Mineral Springs Road and Cazenovia Creek. The proposed satellite storage facility would consist of a covered, concrete, underground tank.	The purpose of this project is to reduce discharges through CSO 52 to the Buffalo River. Preliminary design is for a 0.6 MG offline storage facility. Together with other LTCP projects, this project is projected reduce CSO discharges to the Buffalo River through CSO 052 based on the TY to 3 activations.
CSO 064 – Satellite storage, conveyance, FM & PS	The proposed location for this facility is in the vicinity of the confluence of Ohio, Louisiana and Saint Claire Streets. The proposed satellite storage facility would consist of a covered, concrete, underground tank.	The purpose of this project is to reduce discharges through CSO 064 to the Buffalo River. Preliminary design is for a 0.1 MG off-line storage facility. Together with other LTCP projects, this project is projected reduce CSO discharges to the Buffalo River through CSO 064 based on the TY to 3 activations.

***Note:** Black Rock Canal Performance Criterion is 4 Activations in the Typical Year
Buffalo River Performance Criterion is 6 Activations in the Typical Year
Cazenovia Creek - B Performance Criterion is 4 Activations in the Typical Year
Cazenovia Creek - C Performance Criterion is 6 Activations in the Typical Year
Erie Basin Performance Criterion is 2 Activations in the Typical Year
Niagara River Performance Criterion is 9 Activations in the Typical Year
Scajaquada Creek - Performance Criterion is 4 Activations in the Typical Year

Attachment C to the Semi-Annual Status Report: September 2021

Public Meeting Materials

Buffalo Sewer Authority's Smart Sewers are Going to College

by Kristina Macro, Taylor Brown and Rich Loeffler

The Buffalo Sewer Authority (Buffalo Sewer) is one of the pioneers in "smart sewer" management and control. Buffalo Sewer's real-time control (RTC) structures have prevented over 3 billion gallons of combined sewer overflows and over 200 sewer patrol point (SPP, Buffalo Sewer's term for their combined sewer overflow regulator structures) activations since reporting began in 2017.

The smart sewer management program began in 2010 with the initial selection of up to 16 RTC in-line storage sites for inclusion in Buffalo Sewer's Combined Sewer Overflow Long Term Control Plan. The first RTC structures were installed at Bird Avenue and Lang Avenue in 2014. Buffalo Sewer has implemented projects on an adaptive management basis since then, and there are currently six RTC sites in operation with four more in an advanced stage of design or under construction at the time of publication submission ***(Figure 1)***. Buffalo Sewer is monitoring system performance to improve RTC operations and respond quickly to issues to minimize downtime. The lessons learned at each stage of RTC implementation have helped Buffalo Sewer maximize their return on investment in these structures.

Buffalo Sewer is now exploring how coordinated control and a distributed sensor network can turn their "smart sewers" into "genius sewers".

Globally Coordinated Control Strategy

Currently, Buffalo Sewer's RTC sites primarily utilize local programmable logic controller (PLC) where the control decisions are based on local sensors and sites that operate individually. As the program grows, Buffalo Sewer has begun implementing coordinated remote control of RTC sites, so that sites communicate with each other during wet weather events to locate and signal capacity in the system. Buffalo Sewer first applied this concept in 2019 when the Hazelwood RTC site was constructed upstream of the Lang RTC site. These two sites coordinate during storm events so that the in-line storage at Lang is utilized first. The Hazelwood site serves as a secondary source of storage when the Lang site indicates it will likely need relief. In this way, the Hazelwood site can store additional volume that would have previously overflowed at the downstream SPP. The addition of the Hazelwood site with coordinated control is expected to provide an additional 60% reduction in overflow volume at the downstream SPP compared to Lang operating independently.

A natural evolution of this coordinated operation between sites is a globally coordinated control strategy. In this scheme, all RTC structures communicate with each other and critical assets throughout the network to decide where and when to store or dewater by activating gates, valves or pumps. The decisions are driven by market-based optimization, a type of operational control strategy that treats RTC structures as commodity brokers. The "brokers" talk to each other every few minutes to make the optimal "buy" and "sell" decisions to manage flow. The commodity being traded is wastewater capacity in the form of conveyance and storage. Each RTC site is a consumer of downstream capacity as well as a seller of capacity to upstream consumers. They are each provided supply and demand curves of prices and quantities at which to buy and sell wastewater capacity and make control decisions.

Applying this approach empowers the entire system to work as a well-tuned machine, optimally adjusting operations in response to each unique wet weather event.

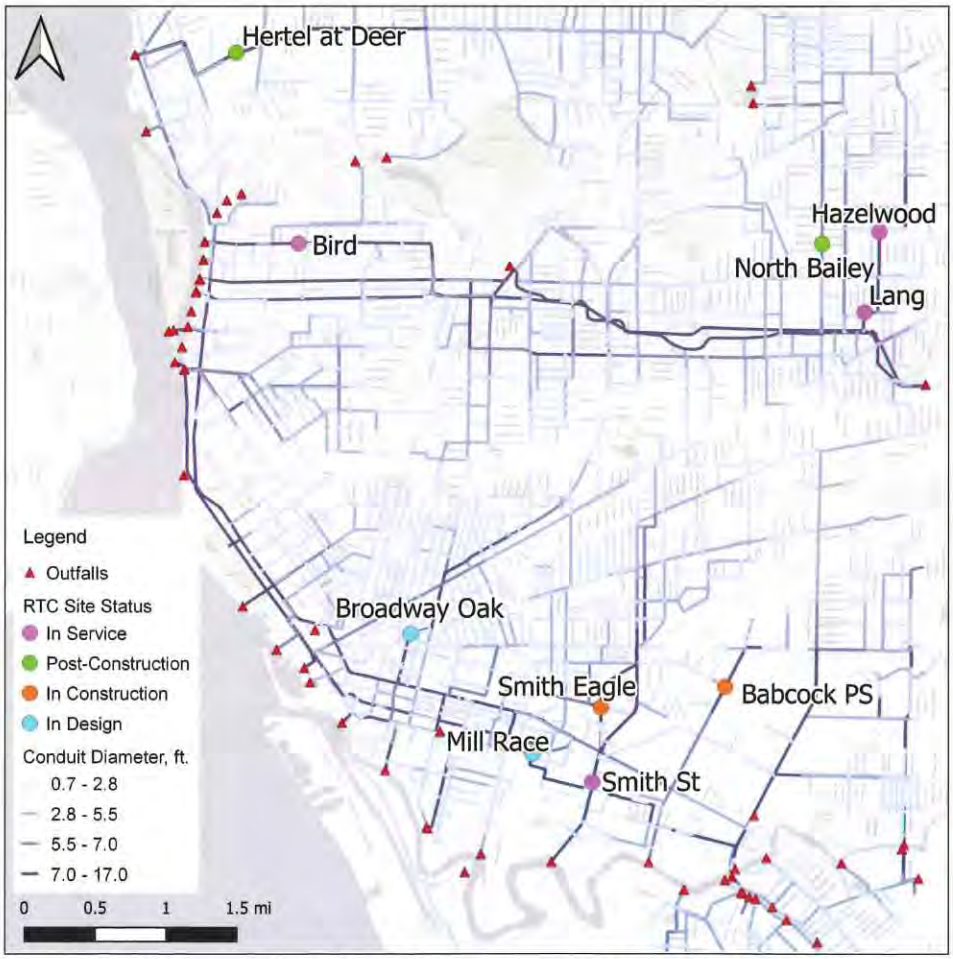


Figure 1. Buffalo Sewer Real-Time Control Project Status as of March 15, 2021. Purple indicates sites in service, green indicates completed sites undergoing post-construction tuning, orange indicates sites in construction, and blue indicates sites in design. *Xylem Inc.*

Putting Theory into Practice

Initial analysis of operational RTC sites shows that this novel approach can help achieve the highest value results for overflow capture and create a cohesive system-wide strategy between the collection system and the treatment facility. Since the implementation of RTC sites across the system changes the behavior of flow coming into the treatment facility, a globally coordinated control strategy will unlock the potential for operational behavior such as dewatering at each RTC site based on conditions

continued on page 47

continued from page 45

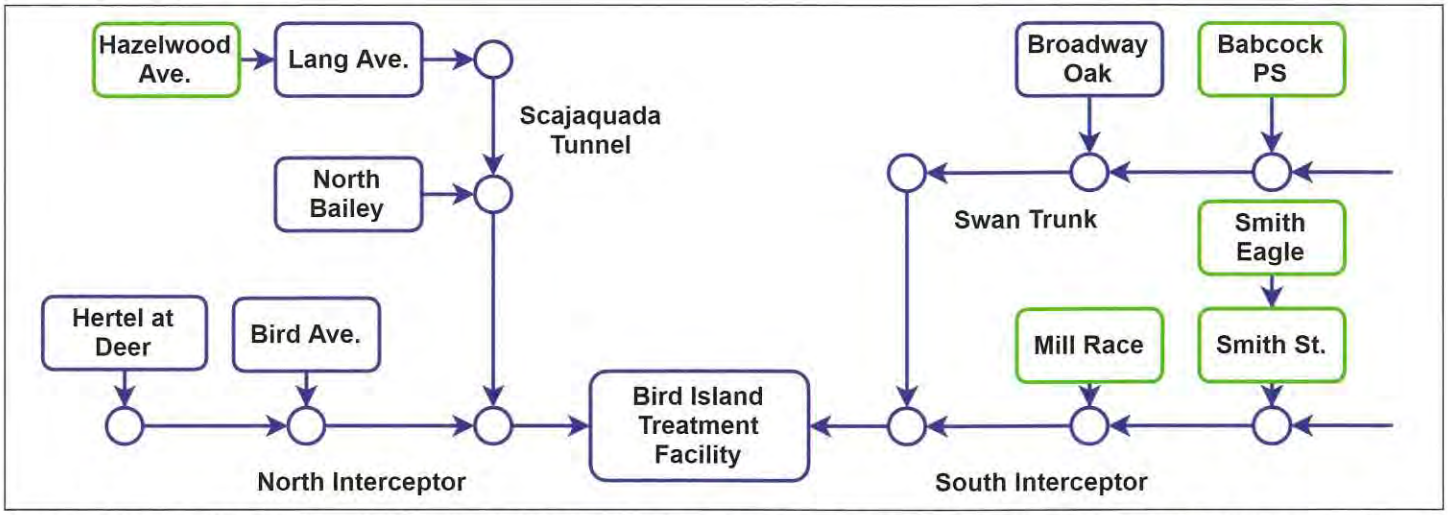


Figure 2. Schematic of Buffalo Sewer's RTC network, with sites that are designed to make coordinated control decisions highlighted in green. *Xylem Inc.*

at the facility. For example, RTC sites could continue to store flows even after local conditions have returned to normal, to allow for increased flows from surrounding suburban municipalities and other parts of the city into the facility.

The RTC sites that are operational and in design are closely related to the main interceptors into which they drain. The schematic diagram of RTC structures ***(Figure 2)***, shows how each site is connected for use in a global control strategy. Like Hazelwood and Lang, the new Smith Eagle RTC site will use coordinated control to store based on downstream conditions at the existing Smith Street RTC site. The Broadway Oak RTC in-line storage and Babcock Pump Station RTC upgrade will make control decisions based on the capacity available downstream in the Swan Trunk. Like the existing Smith Street site, Mill Race RTC will send flows that have already overflowed upstream SPPs into the South Interceptor when it has available capacity.

In the current phase of RTC implementation, half of the RTC sites make local reactive control decisions, while the other half make coordinated control decisions. Applying a globally coordinated control strategy for all 10 RTC sites will close this gap, maximize systemwide storage utilization, and balance flows coming to the Bird Island Treatment Facility. Orchestrating storage based on systemwide conditions will reduce overflows, while controlling the sequence of dewatering will reduce peak flows coming to the facility. These watershed-scale, coordinated, operational decisions are built into the market-based optimization approach.

Managing Localized Storm Events

A globally coordinated strategy often yields the most impact during intense storm events that only impact one area of the city. These types of short duration, high intensity storms are becoming more common compared to long duration, low intensity events *(Shaw et al., 2011)*. Buffalo's proximity to Lake Erie also poses a risk for unique, localized weather patterns during "lake effect" storms and flooding during seiche events.

Consider a hypothetical storm that only covers neighborhoods that contribute to the North Interceptor in Buffalo ***(Figure 3)***. In-line storage sites that contribute to the North Interceptor ("North RTC sites") would fill, and SPPs along the North Interceptor would be at risk for overflow. In the market analogy, the price per gallon of capacity would be high. Meanwhile, the South Interceptor would remain virtually unaffected by the storm, and the price per gallon of storage at in-line storage sites that contribute to the South Interceptor ("South RTC sites") would be low. In a globally coordinated system, South RTC sites could receive the message that the North RTC sites are starting to fill – the market prices would be increasing. The North could "buy" capacity from the South by triggering storage at South RTC sites. This would reduce South Interceptor flows and allow more flow to get to the treatment facility from the North Interceptor, reducing overflows at northern SPPs.

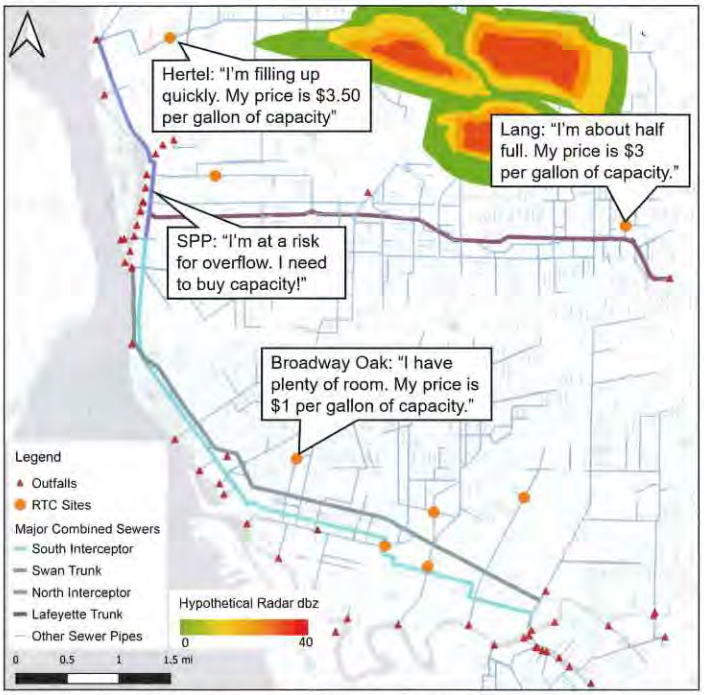


Figure 3. Hypothetical storm and responses from "brokers" in the market-based optimization approach. *Xylem Inc.*

While this localized storm in the North district of the collection system is a hypothetical scenario, it is a common occurrence that the North Interceptor peaks before the South Interceptor. This phenomenon was observed for multiple storms during a short-term monitoring effort ***(Figure 4)***. Given the sewer length and number of tributaries to North Interceptor compared to the South Interceptor, it makes sense that the North peak flows would reach the treatment facility first. Estimating the timing difference between the North and South peaks for different storms will allow for the optimization

continued on page 49

continued from page 47

of peak flow timing in each interceptor. For example, if flows contributing to the South Interceptor are held back longer, the combined peak flow reaching the treatment facility will be lower. This can reduce the amount of time the facility is operating under wet weather conditions. ***Figure 5*** demonstrates that by simply delaying the South Interceptor measured peak flows by one or two hours, the combined flow peaks can decrease by as much as 20 million gallons per day in the beginning of the storm event. This delay in South flow peaks can be accomplished by starting storage earlier and/or dewatering storage later at South RTC sites.

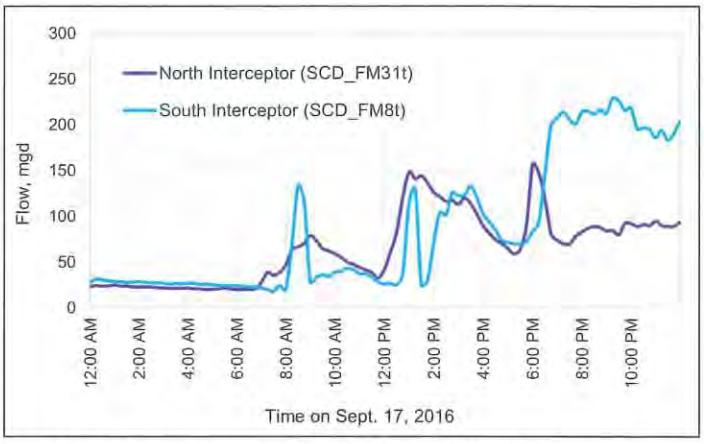


Figure 4. Timing Differential: Flow Meter Data. North Interceptor and South Interceptor flows observed at flow meters during the Sept. 17, 2016, storm event. *Xylem Inc.*

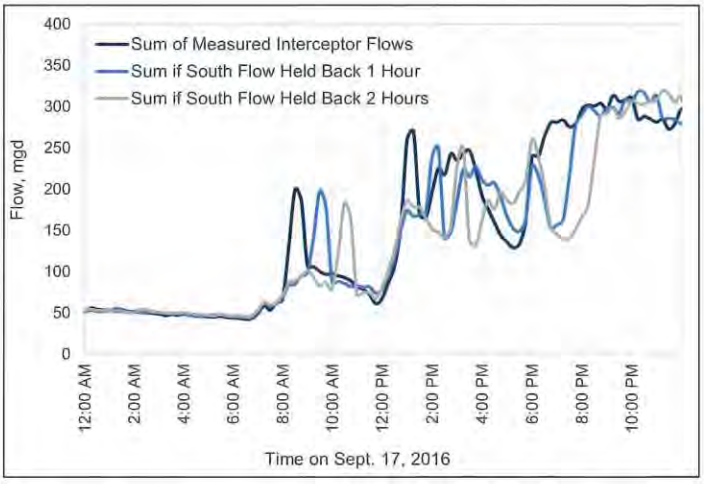


Figure 5. Combined North and South Interceptor Flow. Sum of measured data for North Interceptor and South Interceptor flows during the Sept. 17, 2016, storm event, with additional scenarios for South Interceptor flow data being delayed one hour and two hours. *Xylem Inc.*

Real-time Information is Key

To accomplish this optimal systemwide control, real-time information and data are needed about the rainfall intensity and accumulation, as well as additional information about level and flows inside the collection network itself. As a result, the market-based optimization strategy will be informed by a distributed sensor network. These sensors will measure flow, level, and rainfall throughout Buffalo Sewer's service area. Each RTC site will have substantially more information to make informed, intelligent local decisions that have watershed-scale benefits once the network is combined with the RTC sites' supply and demand curves.

Having this real-time information and visibility for the collection network provides additional benefits to Buffalo Sewer's teams. Along with RTC system management, the flow and level data can help identify causes of surface and basement flooding, characterize flow dynamics and performance, and optimize sewer cleaning schedules. Being able to track, monitor, and identify silt or grit buildup will help Buffalo Sewer clean sewers when they need to, rather than sending out crews for maintenance on an arbitrary schedule, only to have them find clean pipes. This will help BSA deploy their resources more effectively while reducing service issues.

Oh, The Places Buffalo Sewer Will Go!

Buffalo Sewer's collection system is already "smart," but it is ready for higher education through globally coordinated control and a distributed sensor network. While the design and deployment of this innovative system is still in the beginning phases, the relationships among Buffalo Sewer's sewer districts observed in previous RTC modeling efforts show there is great potential for market-based optimization to minimize overflows. The globally coordinated control strategy will help Buffalo Sewer realize additional benefit from existing RTC sites and will help inform their adaptive management approach to select and prioritize future projects, to benefit both the utility and the communities that Buffalo Sewer serves.

Kristina Macro, EIT, is a Hydroinformatics Engineer with Xylem and may be reached at kristina.macro@xylem.com. Taylor Brown, EIT, is a Junior Sanitary Engineer with the Buffalo Sewer Authority and may be reached at tbrown@buffalosewer.org. Rich Loeffler IV, EIT, is a Client Solutions Manager with Xylem and may be reached at richard.loeffler@xylem.com.

Reference

Shaw, S., R. Schneider, A. McDonald, S. Riha, L. Tryhorn, R. Leichenko, P. Vancura, A. Frei, and B. Montz. 2011. "Chapter 4: Water Resources." in *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation.* Final Report No. 11-18. Editors C. Rosenzweig, W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, and P. Grabhorn. New York State Energy Research and Development Authority (NYSERDA), Albany, New York. ISBN: 978-1-936842-00-1. Retrieved from: https://www.nyserda.ny.gov/About/Publications/Research-and-Development-Technical-Reports/Environmental-Research-and-Development-Technical-Reports/Response-to-Climate-Change-in-New-York.

Maximizing the Return on Investment (ROI) of a Smart Sewer Program

NYWEA ANNUAL MEETING

FEBRUARY 11, 2020

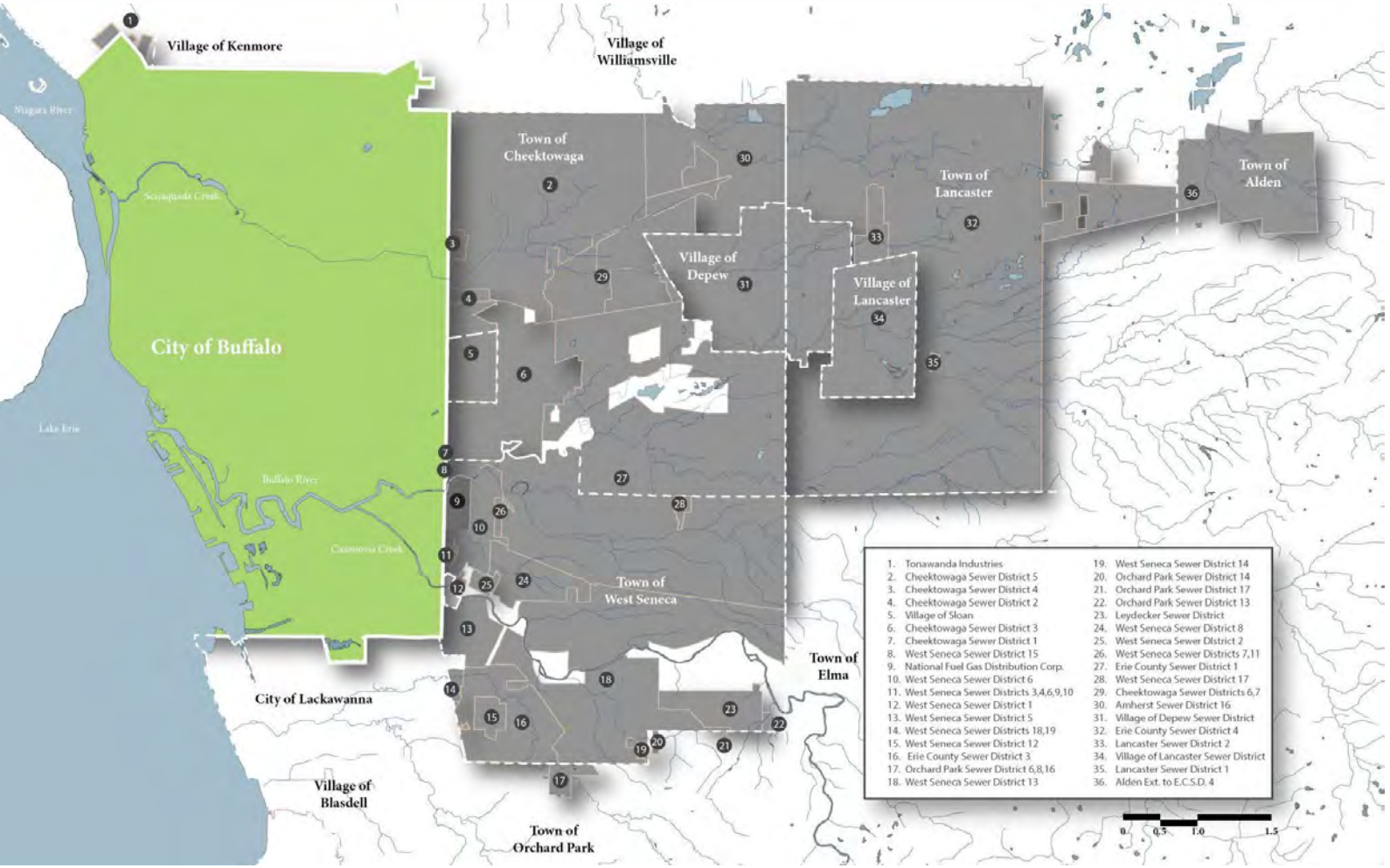
Kristina Macro, Hydroinformatics Engineer, Xylem

Taylor Brown, Junior Sanitary Engineer, Buffalo Sewer Authority

Agenda

1. Intro to BSA's Smart Sewer Program
2. BSA Real-Time Control Projects Impact to Date
3. Lessons Learned

Buffalo Sewer Authority Overview



- Established in 1938
- Services the City of Buffalo, NY and 11 surrounding municipalities (> 550,000 people)
- 110 sq. mi of coverage, 850 mi of sewer pipe
- Annual operating budget of $54.9 million
- Undertakes over $20 million in capital projects annually
- Long Term Control Plan (LTCP) approved in 2014 to be completed in 20 years, 97% of wet weather flows to be captured upon completion

Buffalo Sewer Authority's Wet Weather Operational Optimization Program Objectives

1. To enable BSA to control every ounce of collection system storage
2. Identify new real-time control (RTC) opportunities
3. Continuous system improvement

Buffalo Sewer Authority's Wet Weather Operational Optimization Program

2010

Up to 16 RTC projects were recommended as part of BSA's LTCP.

2014

With promising model results for RTC and green infrastructure improvements, BSA was able to negotiate $145 million out of their LTCP.

2016

Lang Ave. & Bird Ave. in-line storage structures become the first operational RTC sites in BSA's system.

2020

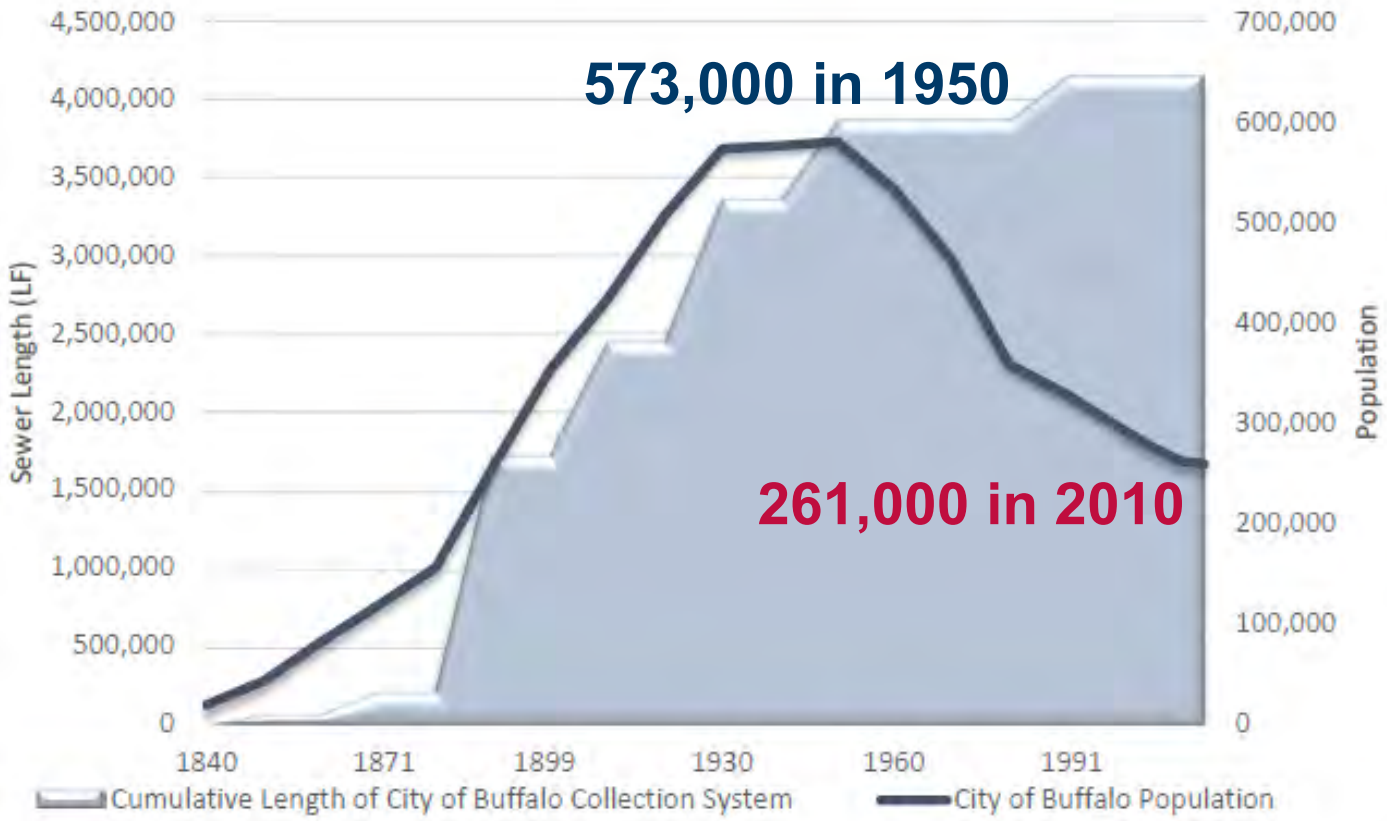
With 6 operational RTC sites, BSA prevented 108 Sewer Patrol Point (SPP) activations in 2020.

2024

BSA plans to build and commission the remaining RTC sites by 2024 on an adaptive management basis.

Why Real Time Control?

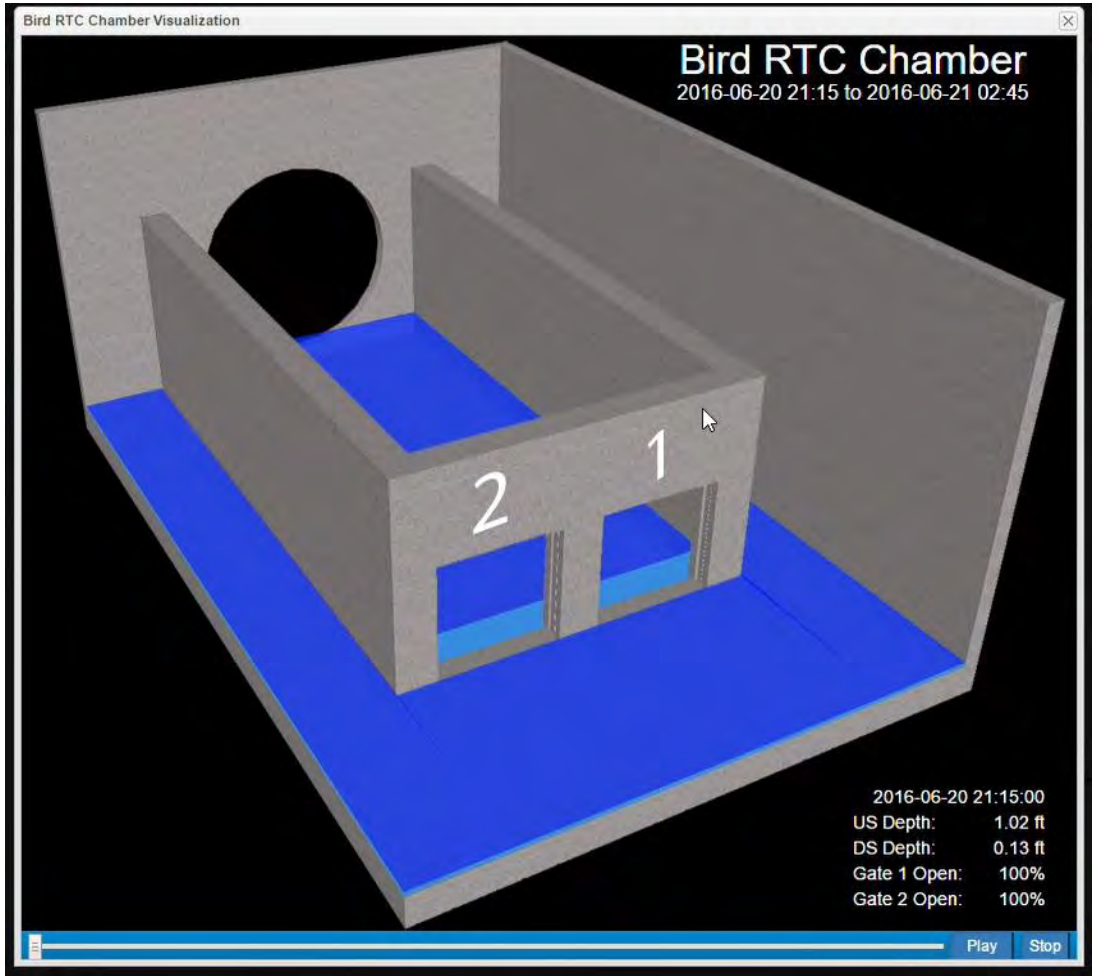
55% Population decrease
Industry decrease



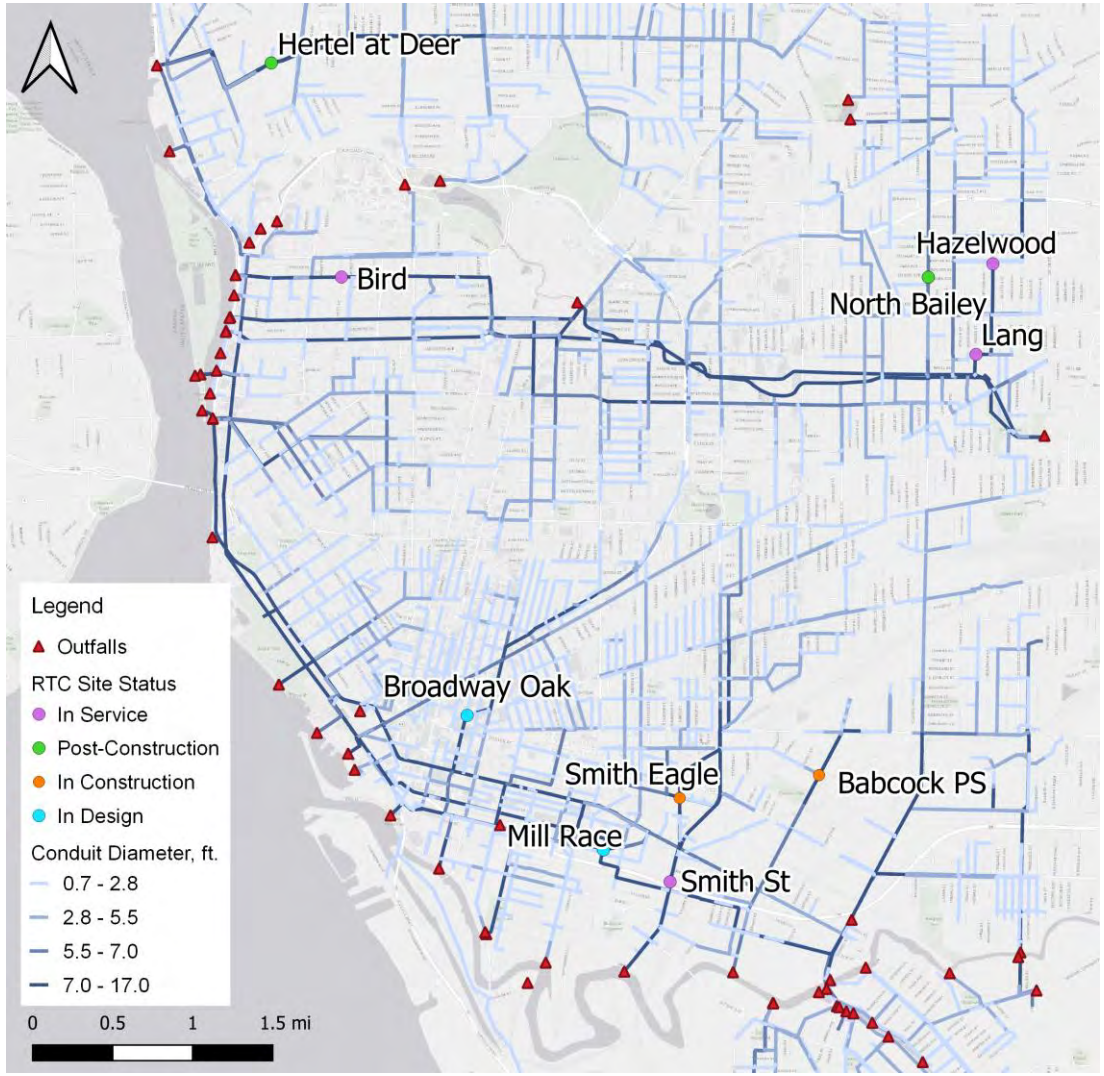
8 major trunklines were more than half empty during the peaks of the largest expected storm events in a typical year

Why Real Time Control?

- Underutilized trunklines provide a cost-effective opportunity for inline storage to reduce overflows
- Real Time Control (RTC) systems maximize the benefits of inline storage for any given storm



RTC Site Locations and Status



In Service:

- Smith St, Lang, Hazelwood, and Bird

Completed, undergoing tuning:

- North Bailey and Hertel at Deer

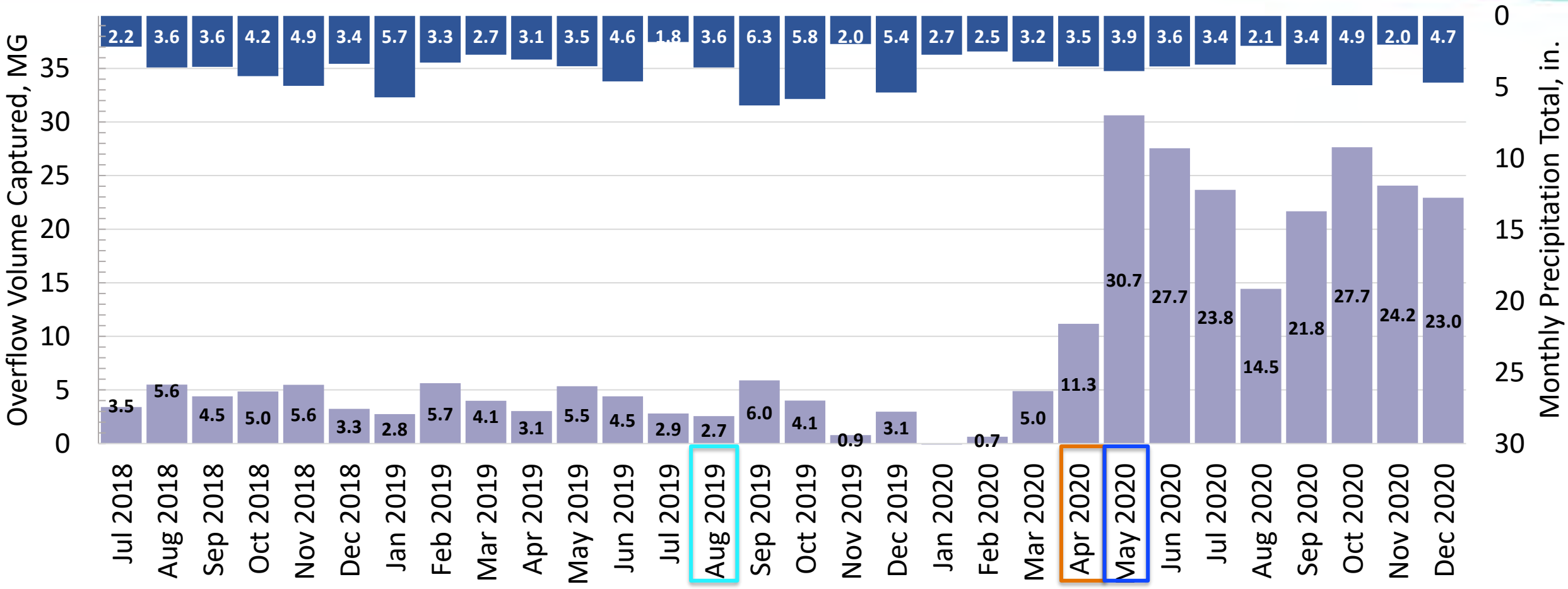
In Construction:

- Smith Eagle and Babcock Pump Station

In Design:

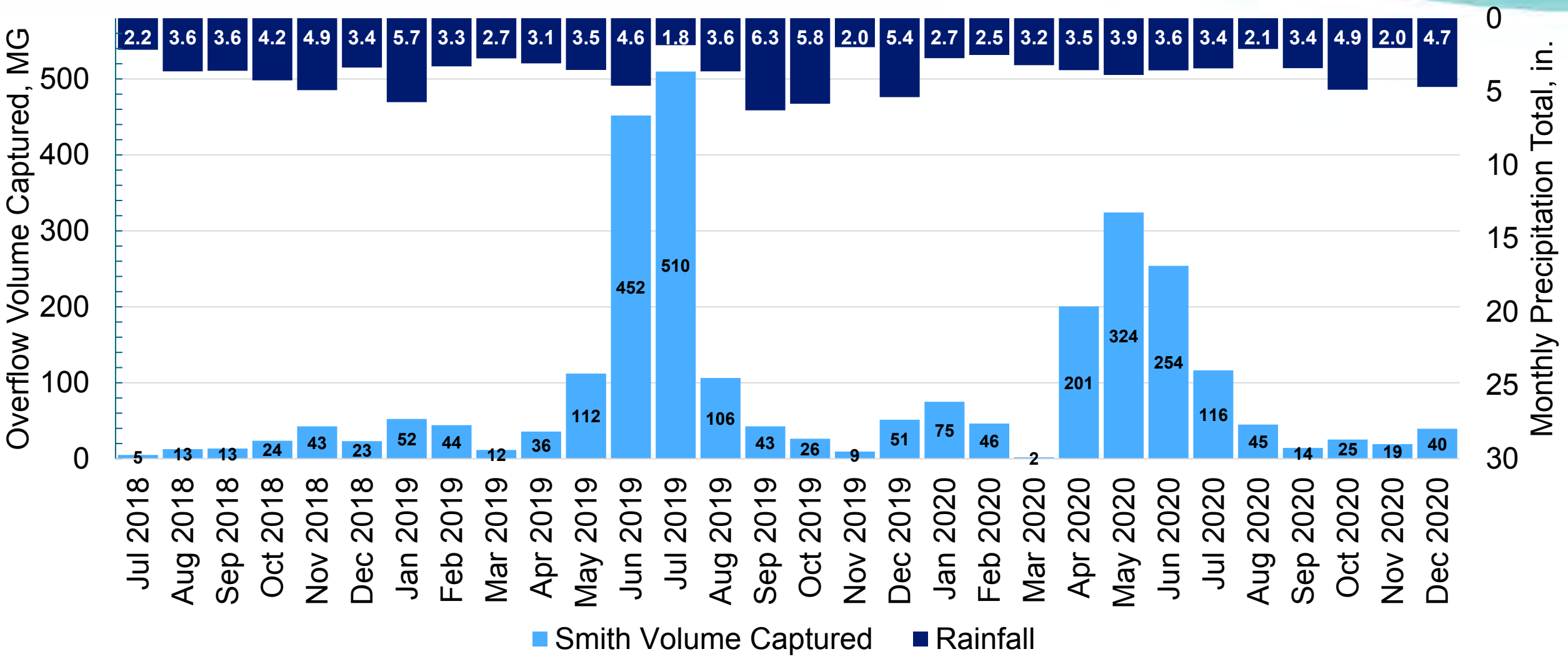
- Broadway Oak and Mill Race

RTC Program Impact

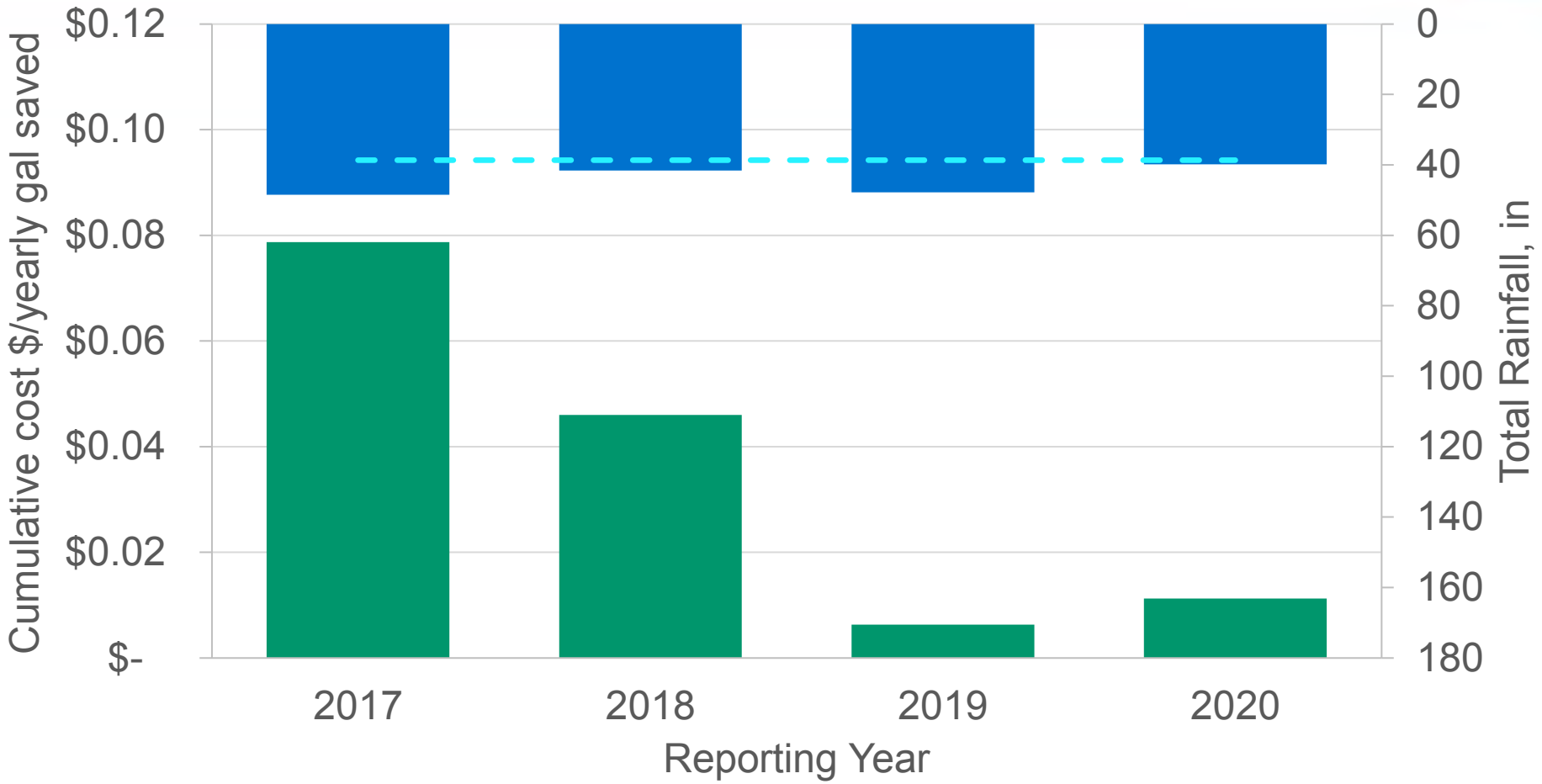


KPI reporting start months: Hazelwood | Hertel at Deer | North Bailey

RTC Program Impact



RTC Program Impact



Since 2017, BSA's RTC sites have prevented over **200** SPP activations and over **3 BG** of CSOs

Stages of RTC Implementation

Site Selection	Design	Construction	Monitoring and Maintenance
			
Structural integrity of upstream pipes Traffic & Accessibility	Consistency among sites where appropriate Improvements based on lessons learned	Coordination with programming team	Control logic updates based on post-event analysis Alerts for failures Coordination of all parties to resolve issues

Lessons Learned: Site Selection

Project delays due to permit requests from DOT	Prioritize site locations that are not on high traffic/DOT roads
Outdated version of model	Re-calibration effort, confirming site conditions with sensor data
Priorities changing compared to original LTCP	Adaptive Management

Lessons Learned: Design

BSA was unfamiliar with some equipment being used	Getting all departments of BSA involved in equipment selection process
Changes to equipment specs due to adaptive management	Equipment standardization moving forward
Each RTC site contract has a different design engineer	Sharing best practices amongst all design engineers

Lessons Learned: Design

Shifting trucking route around RTC site construction disrupted local neighborhoods	Account for local neighborhood impact in traffic control design
Unknown conditions	Note unknown conditions that could be encountered on plans and define what is contractor's responsibility
Assumed electrical supply would be available for sensors	Verify utilities in the field

Lessons Learned: Construction

Hertel at Deer RTC Construction, Fall 2020

Hertel at Deer RTC Commissioning, January 2020

Lessons Learned: Construction

Each RTC site has a different construction contractor	Sharing best practices amongst all construction contractors
Different programmers for each project create nuances in code – debugging only applies to one site at a time	More oversight and review throughout programming process
Contractors not aware of risks	Communicating risks, making expectations clear

Lessons Learned: Monitoring

Not knowing about issues until end of month during KPI review

→ Weekly RTC issue emails to alert operators and start conversation about addressing issues

Slow response time to issues

→ Coordinating with monitoring subcontractors to help reduce BSA's backlog

Additional trainings for operators and instrument technicians

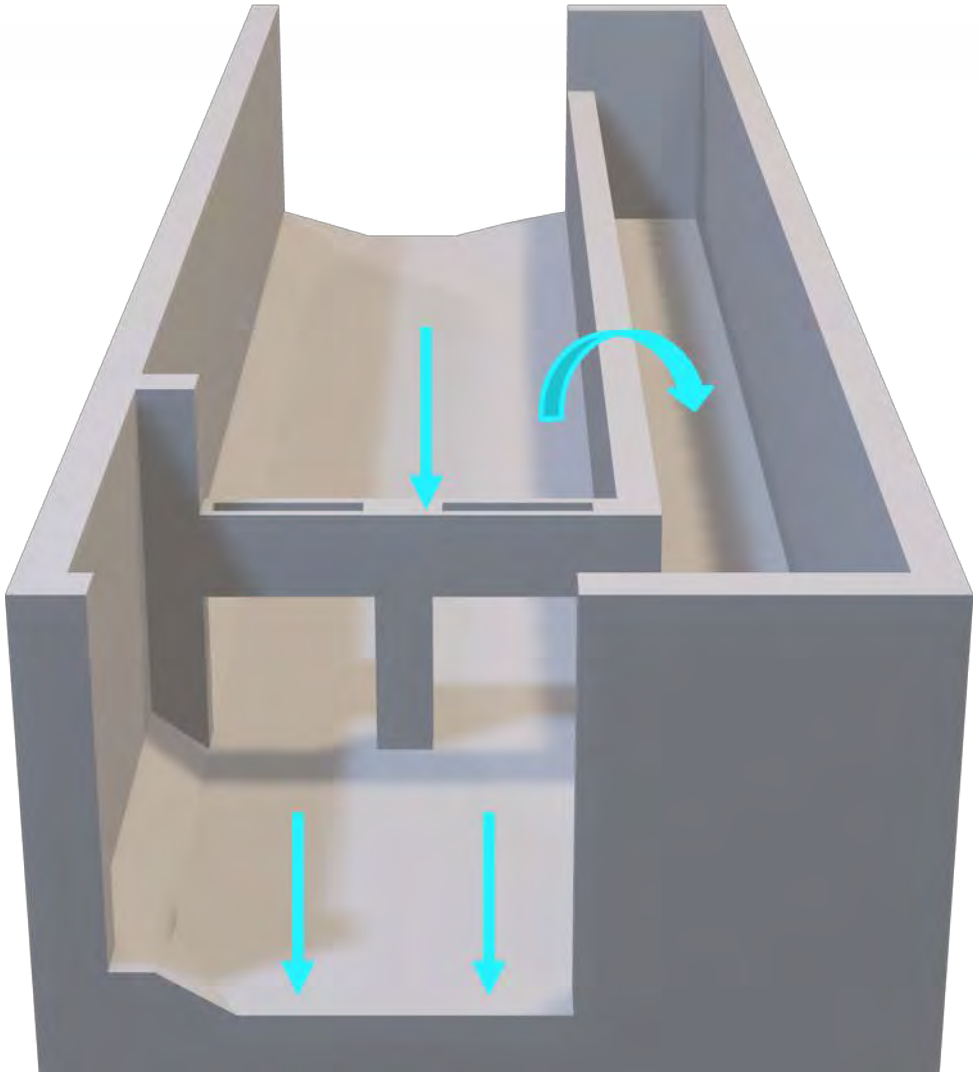
Defining roles and responsibilities: BSA, Xylem, Design Engineer

Defining issue type (equipment failure vs. logic failure) to coordinate with appropriate party more quickly

Lessons Learned: Maintenance

Bird gates failing during events	Greasing system and schedule implemented in future designs
Many staff members are close to retirement	Train younger staff on RTC maintenance

Minimizing Equipment Failure Risk



Looking upstream from downstream end of North Bailey in-line storage chamber

RTC sites are designed with redundancies and fail safes to minimize the risks associated with equipment failures

- If gates fail closed:
  - Emergency relief weir maintains level below surcharging risk level
  - “Gate fail to move” alert is sent
- If gates fail open:
  - Flow continues on the same path it would have prior to RTC implementation
  - “Gate fail to move” alert is sent
- If sensor data is out of range/communication loss:
  - RTC PLC logic uses redundant sensor data if available
  - Automatically returns to Auto-Local mode if currently in Auto-Remote mode

Minimizing Logic Failure Risk

- Monitoring operation during events
- End of month KPI report review
  - What percent of activations is the site preventing?
  - Is the full amount of available storage being used prior to SPP activation?
- Options for addressing logic failures:
  - Remotely adjusting state change trigger depths and gate setpoints
  - Working with PLC programmer to debug larger issues

Conclusion

- **Adaptive management** is the key to the success of BSA's smart sewer program
- Communicating lessons learned among all engineers and contractors is essential
- BSA's confidence and ability to maintain RTC sites has increased as the program has progressed
- Optimizing existing assets and systems can produce powerful results – **1.4 BG** of CSOs prevented in 2020 alone
- RTC is a highly cost-effective method for achieving overflow reduction – down to a **penny per gallon**

BUFFALO'S SEWERS:

In the 18th and early 19th century, night soil, a euphemism for human excrement, was typically collected and carted away at night by workers commonly called night soil men.
FROM WILLIAM HENRY PYNE, *THE COSTUME OF GREAT BRITAIN* (1807), COURTESY OF THE BUFFALO & ERIE COUNTY PUBLIC LIBRARY

A History of the Queen City from Below

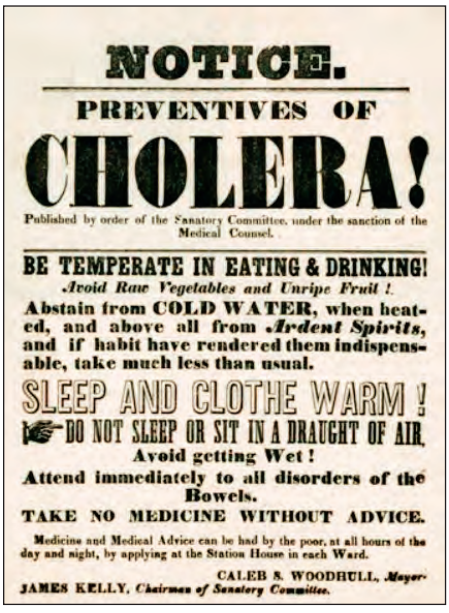
By Rosaleen B. Nogle

On October 25, 1825,

the opening of the Erie Canal linked the Atlantic Ocean to Lake Erie and New York City to the Village of Buffalo. This forever changed the destinies of the tiny frontier settlements of Black Rock, Buffalo, Cold Spring and the Buffalo Creek Reservation. Within a few short decades, the reservation had been dissolved and the remaining communities were incorporated into the City of Buffalo. What had been a collection of remote, sparsely populated communities suddenly became the hub for western expansion and raw material transport from the interior to the coastal cities. As a result, Buffalo experienced a population explosion. Businesses sprang up to serve the needs of pioneers heading west, the sailors working along the canals and Great Lakes and the infrastructure that transferred the grain, lumber and other goods from the lake ships to the smaller canal pack boats.

View of Buffalo and Harbor, 1825, around the time construction on the Erie Canal was completed.
FROM ROBERT M. PALMER, *PALMER'S VIEWS OF BUFFALO (1911).*

Unfortunately, much of this early development was haphazard at best. Housing, commerce and industry all coexisted alongside one another. There were no sewers, much less sewage treatment. Rather, early settlers made use of backyard latrines and cesspools, open pits of sewage that would be periodically cleaned out by "night soil men." Drinking water was obtained either from the open waterways or from wells. When rain or snow melt runoff struck the early city, sewage from latrines and cesspools was flushed into the drinking water sources, causing waves of cholera and typhoid.



NOTICE.

PREVENTIVES OF

CHOLERA!

Published by order of the Sanatory Committee, under the sanction of the Medical Counsel.

BE TEMPERATE IN EATING & DRINKING!

Avoid Raw Vegetables and Unripe Fruit !.

Abstain from COLD WATER, when heated, and above all from *Ardent Spirits*, and if habit have rendered them indispensable, take much less than usual.

SLEEP AND CLOTHE WARM !

DO NOT SLEEP OR SIT IN A DRAUGHT OF AIR.

Avoid getting Wet !

Attend immediately to all disorders of the Bowels.

TAKE NO MEDICINE WITHOUT ADVICE.

Medicine and Medical Advice can be had by the poor, at all hours of the day and night, by applying at the Station House in each Ward.

CALEB S. WOODHULL, *Mayor.*

JAMES KELLY, *Chairman of Sanatory Committee.*

The 1849 cholera epidemic took a toll when almost 12 percent of Buffalo's population contracted the disease, primarily due to a delay in upgrading the sewer system. Cities continued to struggle with cholera for decades, as evidenced by this poster from the 1860s.
NEW YORK CITY SANITARY COMMISSION, 1865

Buffalo's First Sewer Systems

As the city developed from mostly open marshlands to buildings connected by brick, stone and hardpacked earthen streets, the need for sewers was recognized. But in these early years, sewers were primarily for stormwater control and only incidentally for sewage management. They were laid by private citizens to protect their own assets. As such, the sewers were installed simply to take flows from local streets into the nearest waterway. At the same time, the canal system was expanded to provide direct water access for industry and power for early mills.

These earliest sewers were generally badly made, and many began to collapse within a few years of their construction, though at least one survives to this day. By the late 1840s, it had become apparent that if Buffalo was going to continue to expand, the city would need to take public ownership of the sewer system. A series of large sewers were planned to drain the major roads, which had suffered from flooding, deep mud and putrid, standing water. Unfortunately, construction was delayed due to expense and in 1849 another cholera epidemic hit the port city.

The 1849 cholera epidemic was responsible for 877 deaths and 3,555 nonfatal cases. Seventeen percent of these deaths were confined to just three small neighborhoods: the Hydraulics, the Flats and the French Block. The Hydraulics was a neighborhood surrounded by the fetid Hydraulic and Hamburg canals and the Mill Race to the north of the Buffalo River in the area around what is now Larkinville. The population of the Hydraulics neighborhood worked in the mills driven by the Mill Race and would dispose of refuse in the same stagnant canals that fed the wells from which they drew their drinking water.

The Flats was a neighborhood on the banks of the Buffalo River where it spilled into Lake Erie in the area that is now Canalside. Similar to the Hydraulics, it was surrounded by fetid canals and the heavily polluted Buffalo River and Erie Harbor. Residents of the Flats drew their water from wells which were connected to these polluted waterways.

The French Block was a small neighborhood located half a mile inland from the Erie Canal, near what is now Lafayette Park. As a low spot, stormwater, sewage from overflowing cesspools and pollution littering higher streets would collect there after storms. This pollution, in turn, would leach into the drinking water wells.

While it would be several decades before germ theory would be accepted as the cause of cholera, the prevailing miasma theory – that stenches caused illnesses – provided an impetus to embark on public sewer projects despite the 1848 financial objections. A new municipal sewer system was therefore built using state-of-the-art technologies to provide wastewater disposal for the entire city. This in turn meant that, by the time of the Civil War, "outhouses … which become so great a nuisance as population becomes dense, have nearly disappeared from the center of the city." The system, however, was less than perfect. By 1866, it was already becoming clear that it would need to be upgraded and expanded due to a lack of catch basins, manholes and traps between the public mains and homes and within homes themselves.

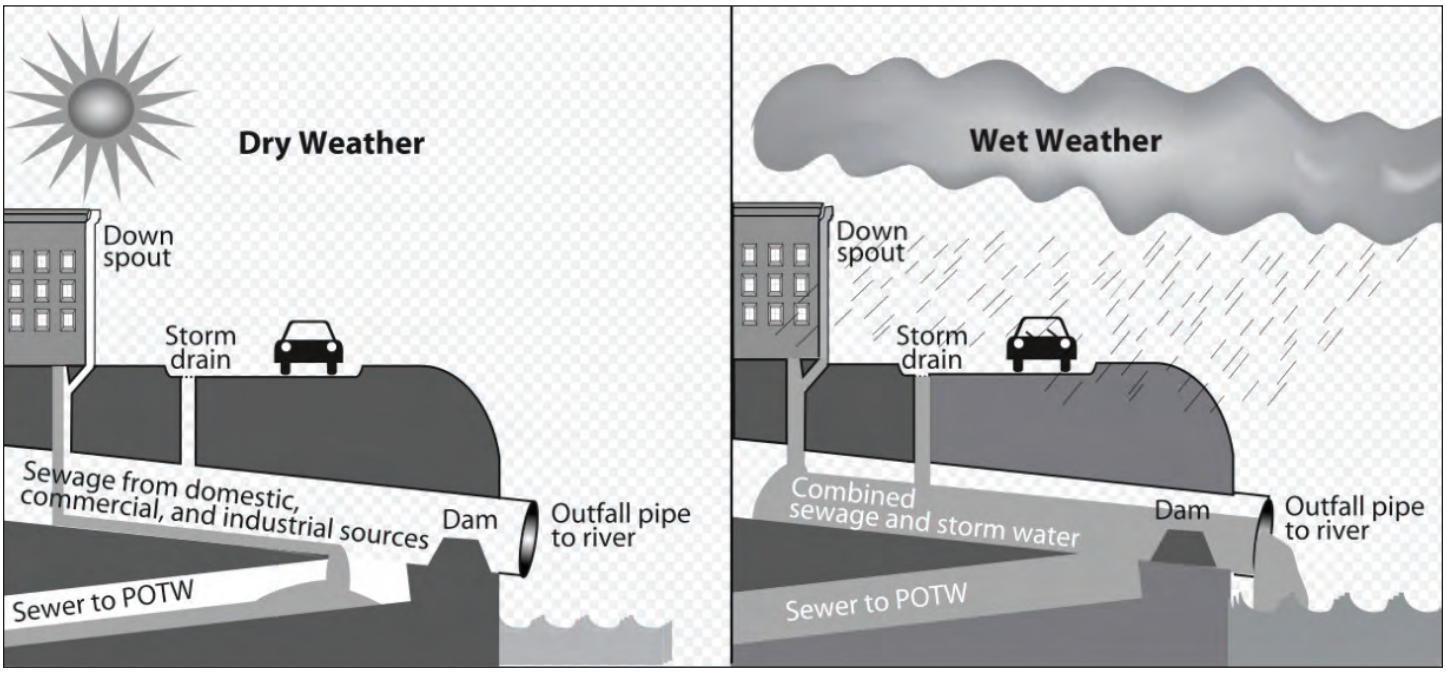


Illustration of a combined sewer system. While planning for separate storm and sanitary sewer systems is ideal, established cities find implementing a double system is typically impractical and cost prohibitive. A combined sewer system is often the most feasible option.
U.S. ENVIRONMENTAL PROTECTION AGENCY

The Trunk Sewer, indicated by the heavy black line, was primarily constructed to flush the Hamburg Canal and Wilkeson Slip, and only incidentally carried sewage to the Niagara River from inland sewers.
FROM GEORGE E. WARING JR., *THE TRUNK SEWER OF BUFFALO, NY, ITS CONSTRUCTION, COST AND OPERATION*, 1886

Emergency Work Bureau of Buffalo, N-51 Delaware Park Receiver Sewers, Nov. 6, 1933. WESTERN NEW YORK HERITAGE COLLECTION

A Growing City, An Expanding Sewer System

Following the Civil War, Buffalo expanded dramatically, showing no signs of stopping. By 1880, city government was committed to a plan to vastly expand its system to ensure that the entire city would have sewer service. As part of this expansion, wastewater treatment was considered, but rejected on the basis that if most of the wastewater could be conveyed to the Niagara River, then "… there is an end of it. Nature will provide that it never appears again to trouble your neighbors."

At this time, separation of the storm and sanitary sewer systems was considered, but also rejected. It was argued that to construct a combined system, which could carry both storm and sanitary flows, would require "no appreciable increase in their dimensions" as compared to a strictly stormwater system. To create a "double system" would require duplication of efforts, which was deemed impractical for a city the size of Buffalo.

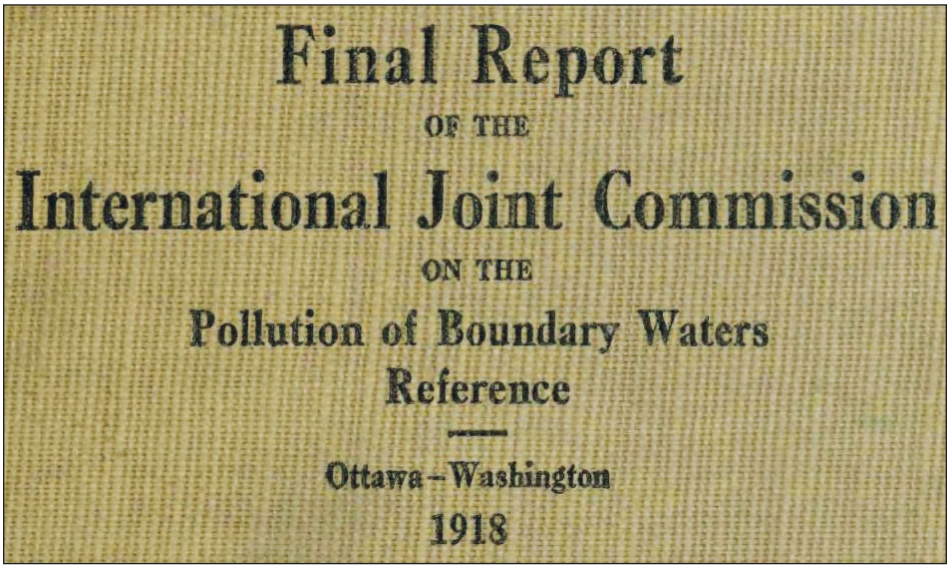
Having decided against treatment and separated sewer systems, Buffalo embarked on a major installation project throughout much of the modern limits of the city over the next two decades. Smaller sewers were connected by large trunk sewers, which also drained the many creeks that once crisscrossed the city. These trunk sewers discharged into the large waterways: the Niagara and Buffalo rivers, Scajaquada Creek and the Black Rock Canal.

The largest of the trunk sewers, the Swan Trunk, only incidentally carried sewage to the Niagara River from inland sewers; its primary purpose was to flush out the Hamburg Canal and Wilkenson Slip through a system of automatic flushing gates. During wet weather these gates would close and the Swan Trunk would be used for carrying combined sewage to the Niagara River. During dry weather, the gates would open to allow Lake Erie to flush the Hamburg Canal and Wilkeson Slip through the Swan Trunk into the Niagara River.

During this period, the former Mill Race, having lost its purpose as an energy source for the Hydraulics, was converted into a sewer. This was the first of several similar projects that would mark much of the sewer construction between 1900 and 1929. Over this period, several heavily polluted waterways, including the Ohio and Hamburg canals and Scajaquada Creek between the Cheektowaga border and Forest Lawn cemetery, were converted into sewers. While these efforts did much to eliminate the hazard posed to the city by untreated wastewater, they did nothing for communities downstream.

Buffalo's Wastewater Wreaks Havoc Downstream

While the 1880 report had assured city leaders that the Niagara River could absorb and eliminate any hazards posed by the sewage from the City of Buffalo, by 1918 it had



The International Joint Commission of the United States and Canada concluded in 1918 that the sewage spilling into the Niagara Rivers seriously jeopardized the health and welfare of the citizens of both countries.

THE INTERNATIONAL JOINT COMMISSION

become clear that Buffalo's wastewater was harming downstream communities. Despite the treaty to protect boundary waters signed a decade before, the International Joint Commission of the United States and Canada found that "in the Detroit and Niagara Rivers conditions exist which imperil the health and welfare of the citizens of both countries in direct contravention of the treaty." Further, the report concluded definitively that, "the sewage of Buffalo is polluting to a serious extent the available water supplies of the two Tonawandas and the city of Niagara Falls, New York."

This pollution was not just a hypothetical danger or nuisance, but a very real threat to the health and well-being of downstream communities. While cholera had faded from the scene, typhoid was still rampant during this period. The discharge of Buffalo's raw sewage into the Niagara River was contributing to illnesses and deaths from this disease downstream. "In 1907 the City of Niagara Falls, New York, had a typhoid death rate of 222.4 per 100,000 population, and the average for the last 10 years is 130. This is the heaviest typhoid death toll recorded anywhere in the civilized world, and does not include the death rate among visitors who contract the disease there." Not only was there a very real threat to human health, there was also an aesthetic concern, due to the fact that "1/100,000 of the water of the east channel of Niagara River consist[ed] of actual excrementitious matter

from the human and animal population of Buffalo."

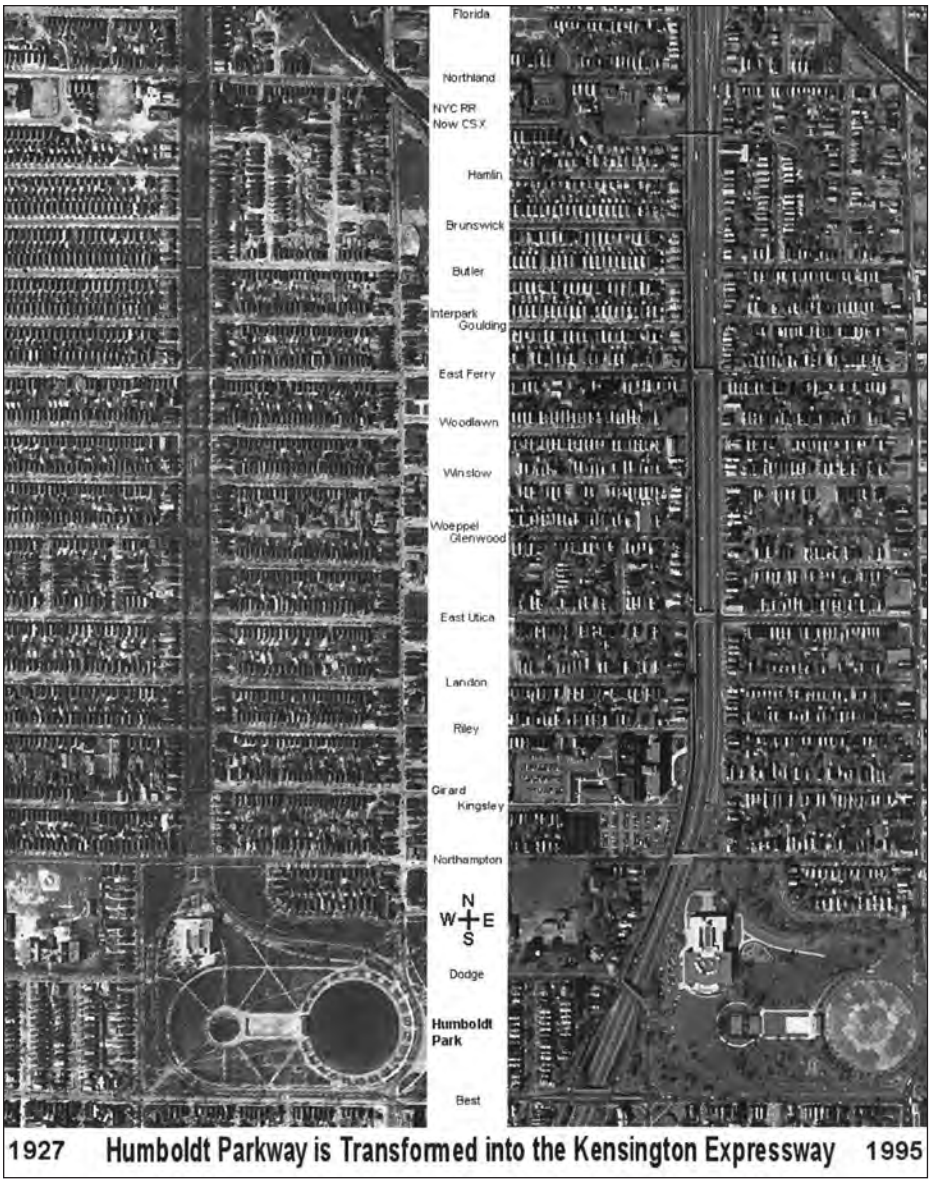
By April 1929, the City of Buffalo was well on its way to designing a new system for the treatment of wastewater and the transportation of wastewater to those proposed treatment facilities. These efforts culminated in a May 1930 report for the construction of facilities, including treatment plants in South Buffalo and on Squaw Island (today known as Unity Island) to alleviate the issue. Unfortunately, in the aftermath of the stock market crash of October 1929, more and more people found themselves out of work. With its finances ravaged by the loss of its tax base and a spike in unemployed citizens looking to the government for support, the city put any further plans for sewage treatment on hold.

Buffalo Sewer Authority Created

With the city's efforts stalled, in March 1935 the New York State Health Department stepped in. It issued a

A fleet of Buffalo Sewer Authority vehicles outside the treatment plant on December 10, 1938.
WESTERN NEW YORK HERITAGE COLLECTION

The Buffalo Sewer Authority's treatment facility on Squaw Island was completed in 1938 and cost $15 million. Curiously, it is known as the Bird Island Treatment Facility.
WESTERN NEW YORK HERITAGE COLLECTION

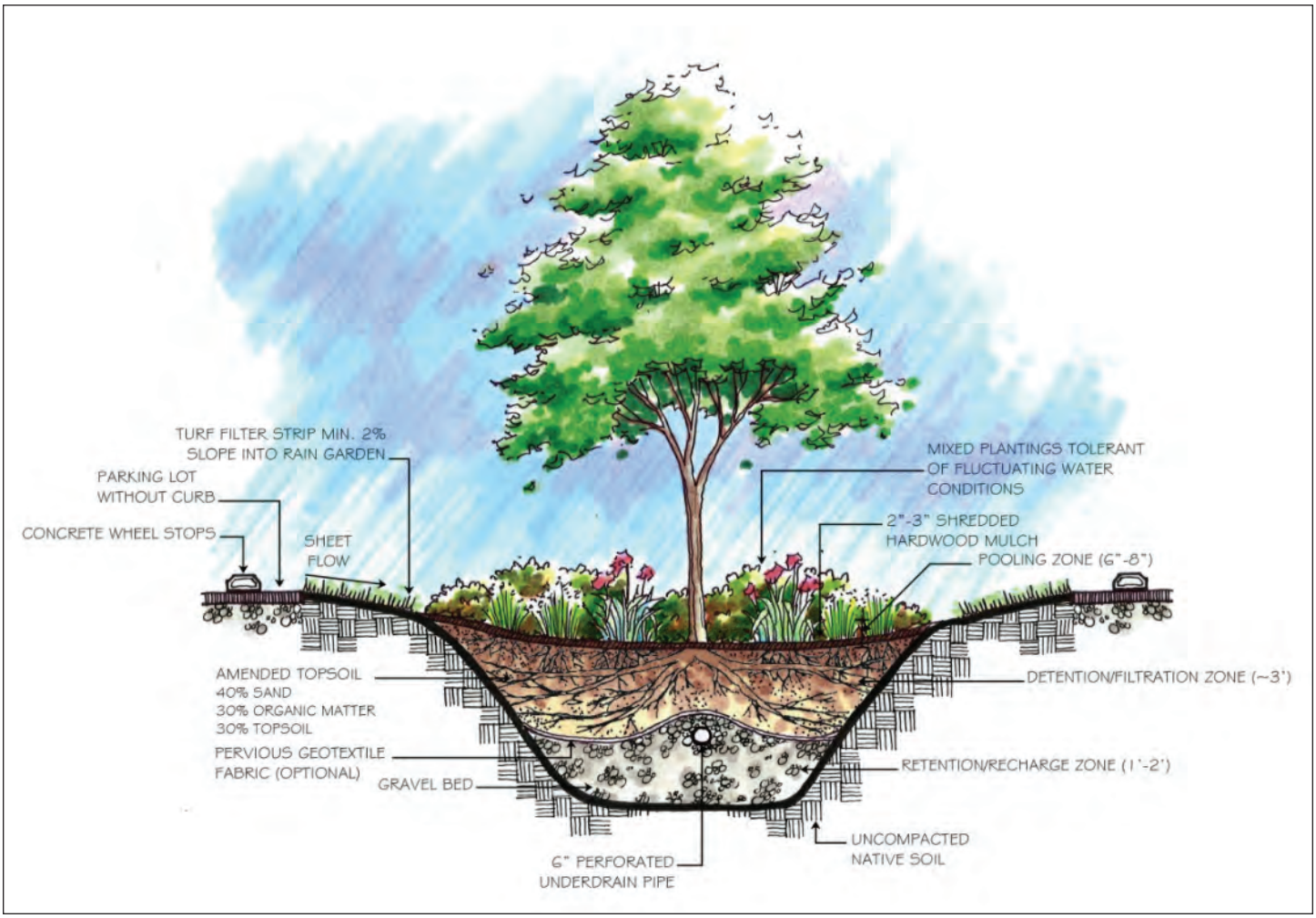


When the Kensington Expressway was constructed below-grade, the Bird-Ferry trunk had to be rerouted through downtown.
COURTESY OLMSTED PARKS CONSERVANCY

mandate to fix the public health disaster resulting from the discharge of raw sewage to the Niagara River. The city's government lacked the ability to absorb the enormous cost of this undertaking, however, so on April 8, 1935, the New York State Legislature founded the Buffalo Sewer Authority as a separate legal entity. This new institution was mandated to "provide an effectual and advantageous means for relieving the Niagara River, Buffalo River and Lake Erie from pollution by the sewage and waste of the city and relieving the city from inadequate sanitary and stormwater drainage and for the sanitary disposal or treatment of the sewage thereof."

The new authority commissioned a new design report. This report determined that a single treatment facility on Squaw Island could provide comprehensive treatment for the city. It also determined that sewer separation "was impractical from a financial standpoint and, in any event, the scope of the project." Instead, interceptor sewers were designed that could carry up to three times the dry weather flow of a city of 1,100,000 people – a population that Buffalo has never come close to achieving.

By June 1938, the $15,000,000 treatment facility project and the vast network of intercepting sewers had been substantially completed. During dry weather, the wastewater from the city was carried in its entirety to the new – and oddly named –



Since 2014, the Sewer Authority has focused on implementing a long-term control plan. Installing green infrastructure, known as a bioretention cell, allows natural systems to absorb rainwater, resulting in less stress on the existing sewer system.
CLEMSON UNIVERSITY

Bird Island Treatment Facility, which was actually located on the southern end of Squaw Island in the Niagara River. During wet weather, however, this system allowed excess flows to discharge over a system of weirs, through the pre-existing combined sewage outfalls to creeks and rivers.

Ostensibly, the provision of combined sewer overflows should have prevented flooding, even during extreme wet weather events. As soon as the original project was completed, however, the Authority commissioned the consulting engineers who had designed the Bird Island Treatment Facility and interceptor sewer system, to "establish the locations in the city where existing sewers are inadequate, and to determine the degree of inadequacy, and the proper means for filling the deficiencies, including preliminary designs and cost estimates for all feasible alternative arrangements of relief sewers." A summary report of findings was submitted to the Authority in February 1941. Some preliminary progress was made in the ensuing months, but the necessary funding, materials and labor for this project quickly dried up following the bombing of Pearl Harbor on December 7.

Postwar: Revisiting Sewer Infrastructure

Once World War II ended, the Authority again embarked on the mission of eliminating flooding within the city, which had become an ever evolving and worsening situation on several fronts. As returning veterans moved into new suburban developments the population of the city began the slow and steady decline that has persisted for decades, destabilizing the tax base. In addition, several of the suburban communities were built on higher ground than the city itself. As agricultural and forested land was turned into suburbs, the stormwater that had once been absorbed into the groundwater table or consumed by plants was drained into the city across streets and through sewers and waterways. At the same time, new highways were being constructed in and through the City of Buffalo. One of these highways, the Kensington Expressway (NY-33), was constructed as a below-grade highway along what was previously the tree-lined Humboldt Parkway. To accommodate this new highway, the Bird-Ferry trunk was severed, and flows were rerouted from the east side of Buffalo through downtown. Overall, these changes resulted in the construction of many new storm relief sewers (oversized combined

sewers constructed with additional holding capacity for stormwater) and separate storm sewers.

In consultation with the State of New York, in 1966 the Authority expanded the Bird Island Treatment Facility to add more extensive treatment. At the same time, a tunnel was bored across the city to intercept combined sewer overflows that had formerly been discharged into the Scajaquada Drain upstream from Forest Lawn Cemetery. The sewage from this tunnel was then carried into the interceptor sewers for treatment at the Bird Island Treatment Facility. This tunnel also serves as a conduit for wastewater from the Town of Cheektowaga to the treatment facility.

From 1981 to 2014, the Authority embarked on a continuous project of constructing separate storm sewers, raising and altering weirs, installing backwater gates and capping combined sewer overflows with the purpose of reducing the number of combined sewer outfalls. On March 18, 2014, the United States Environmental Protection Agency and the New York State Department of Environmental Conservation approved the Authority's Combined Sewer Overflow Long Term Control Plan. Since then, the Authority has made major progress in implementing this plan. In the first five years, it has concentrated its efforts on installing green infrastructure to restore the ability of natural systems to absorb rainwater. Using Smart Sewer technology, the goal is to use the full capacity of a collection system sized for 1,100,000 people – four times the city's current population – thus optimizing the existing system.

Eventually, the Authority will also need to construct more traditional gray infrastructure projects, but with these innovative technologies, the Buffalo Sewer Authority has been able to reduce the size, cost and need for these facilities.

Rosaleen B. Nogle, PE, BCEE, PMP, is an assistant principal engineer with the Buffalo Sewer Authority and may be reached at rnogle@buffalosewer.org.

BUFFALO

SEWER AUTHORITY

History of Buffalo's Sewers and Impacts on Modern Projects

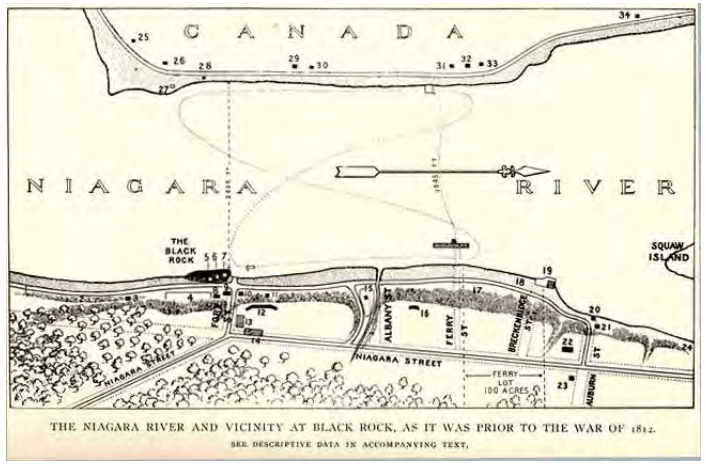
Rosaleen B. Nogle, PE, BCEE, PMP

M.S., B.S. Civil Engineering; M. Public Affairs (Public Admin Focus)

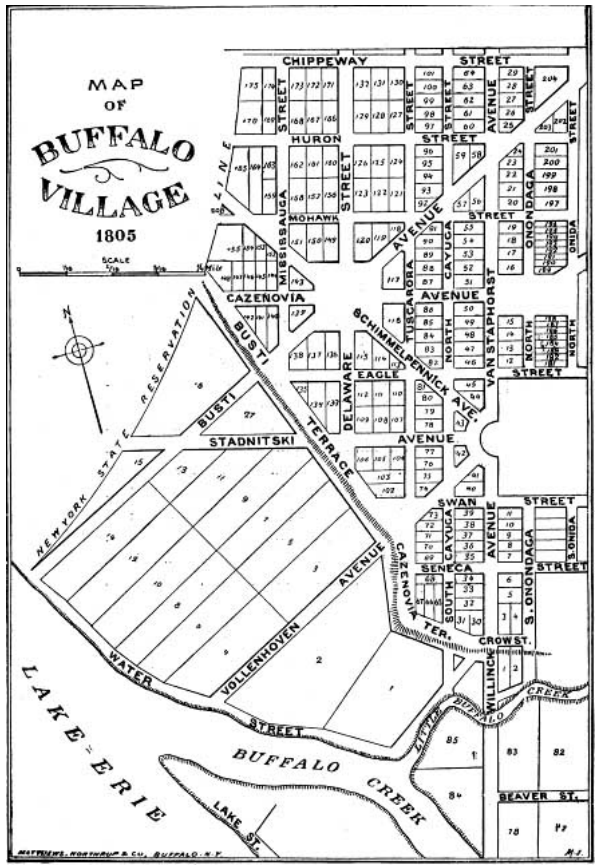
M.A. Pastoral Ministry, M. Div.,B.A. Anthropology

Pre-1785: Frontier Villages and Native Lands

1785-1825: Early Years



THE NIAGARA RIVER AND VICINITY AT BLACK ROCK, AS IT WAS PRIOR TO THE WAR OF 1812.
SEE DESCRIPTIVE DATA IN ACCOMPANYING TEXT.

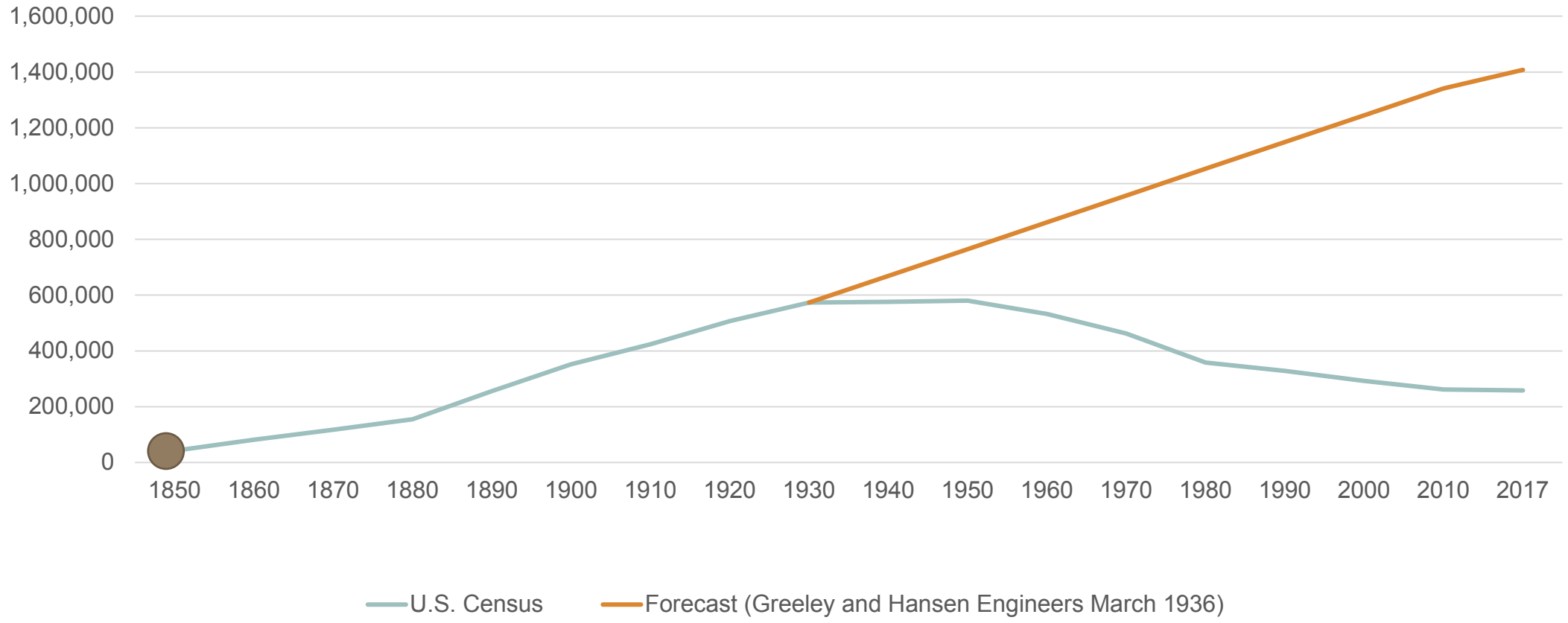


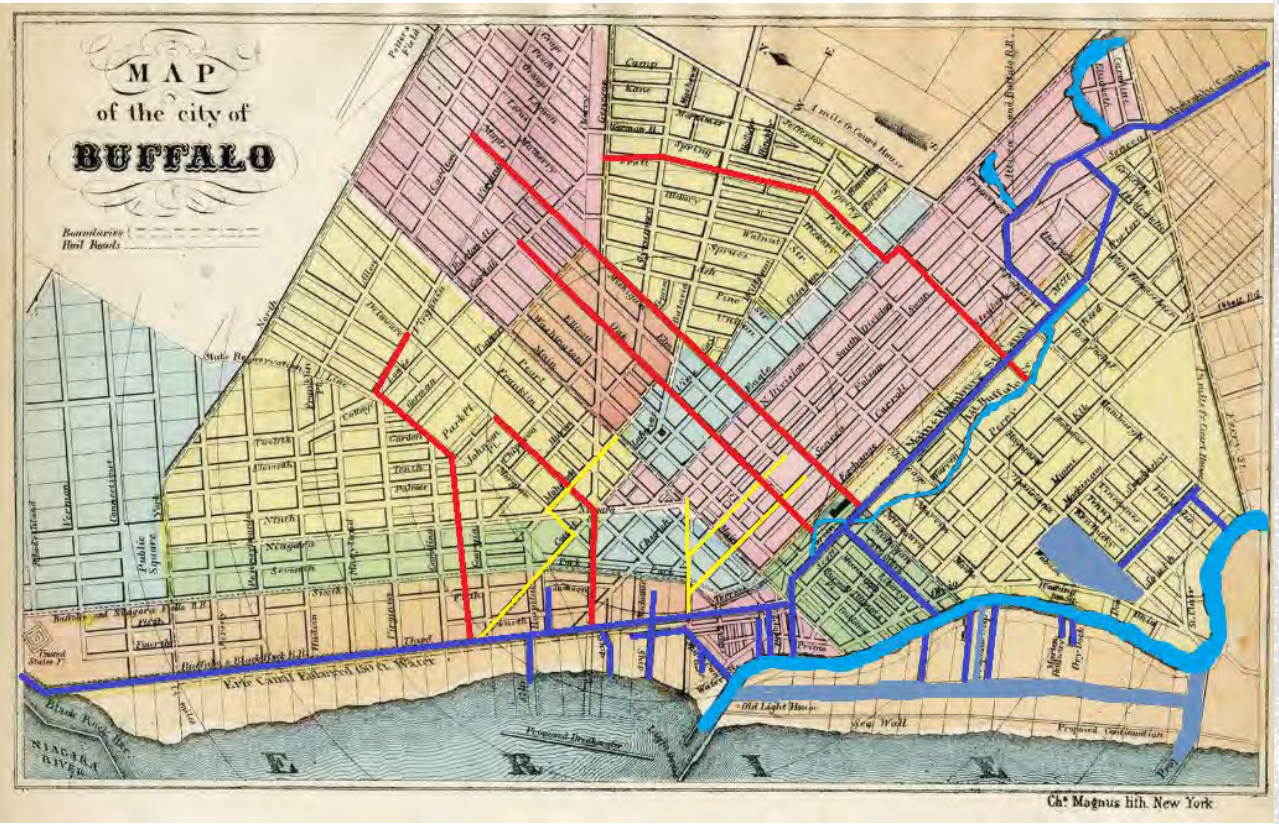

The only dwelling not destroyed at the burning of Buffalo
36

1825-1848: Early Canal Years

- Drain to nearest water way
- Cholera epidemic 1832
- Private construction
- Oak Street 1834-1835
  - Dry brick
  - Board bottom
  - Triangular
- Pennsylvania (???)
  - Flag Stone
  - Arch

1825-1848: Early Canal Years





1848-1861: Later Canal Years

- Report of Committee on Sewers
  - 2/15/1848
  - Basis of design report
  - Property owners and taxes
- Cholera epidemics 1849, 1854
- 1852 Water Works Company
  - Bathing
  - Indoor toilets
- 1860 Albany Street Trunk (Black Rock)

Quiz: Up to 1861

- Why were these early sewers primarily constructed?

  Drainage

- What materials were used to construct these sewers?

  Stone and Brick

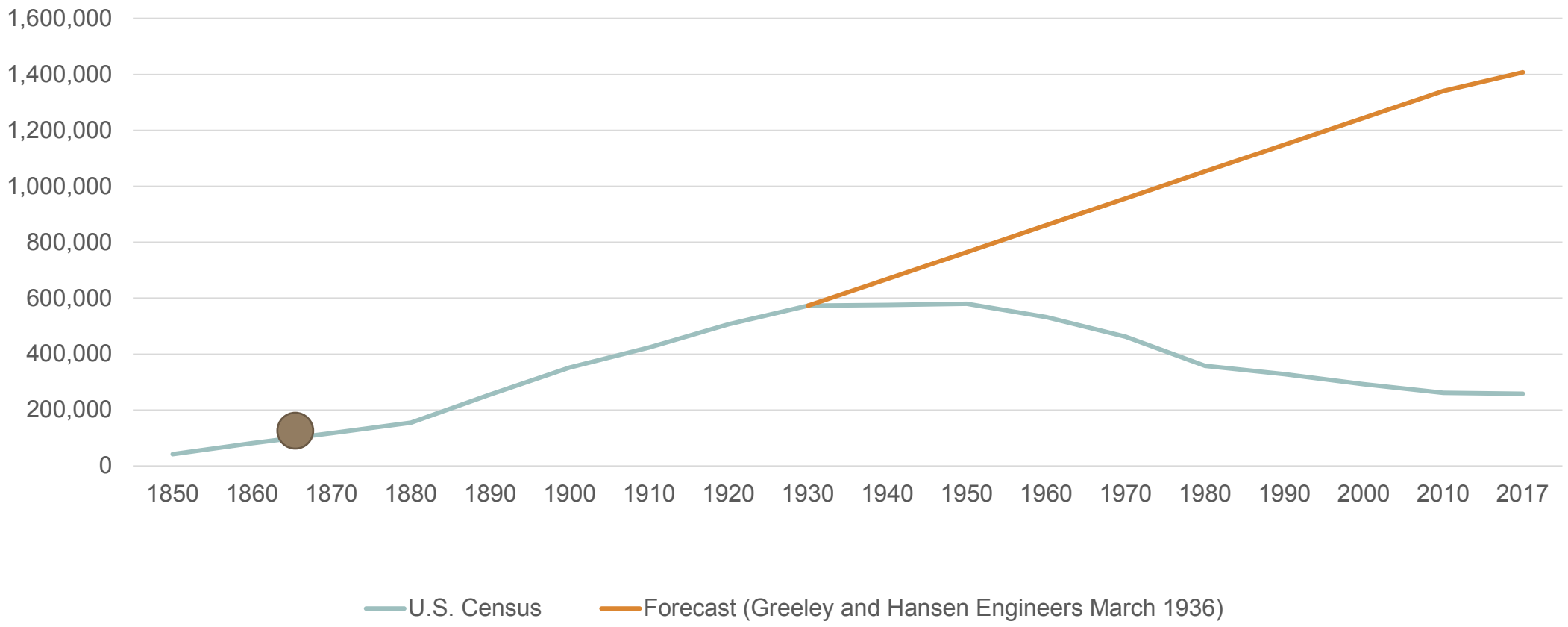
- What events precipitated construction of additional sewers?

  Cholera and Piped Drinking Water

1861-1865: The Civil War

- The Civil War
  - Halt in construction
  - Materials and manpower needed for war
- Presentation to Historical Society Club
  - Oliver G. Steele, Esq. in 1866
  - Leader of 1848 Sewer Committee
  - Warned of need for more work
    - Issue of lack of proper traps
    - Too few catch basins and manholes

1861-1865: Civil War

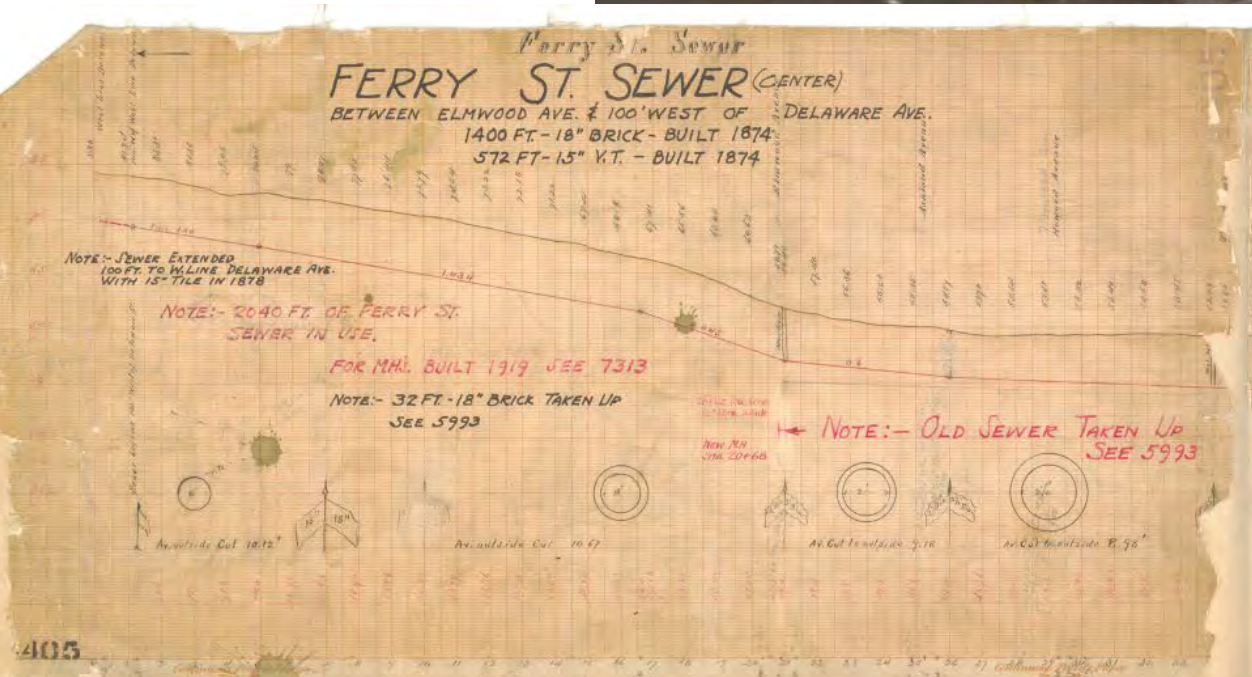


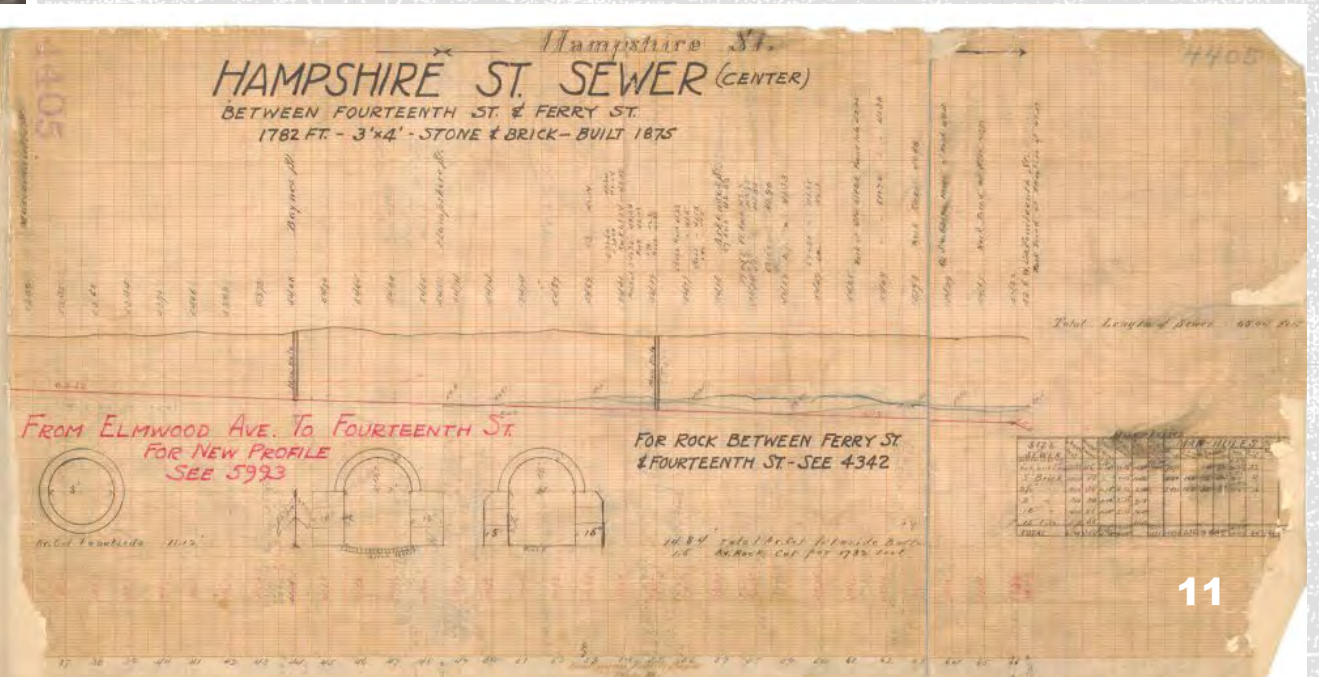
1867-1899: Industrial Revolution

- George E. Waring, Jr. 1884
- Separate sewers and treatment considered, but not pursued
- Trunks
  - Genesee, Bird-Ferry, Hertel, Bailey, Mill Race
  - Swan
    - 3 Flushing gates
    - Main and Hamburg canal and Wilkenson Slip putrid
    - 90 degree turn at Albany Street

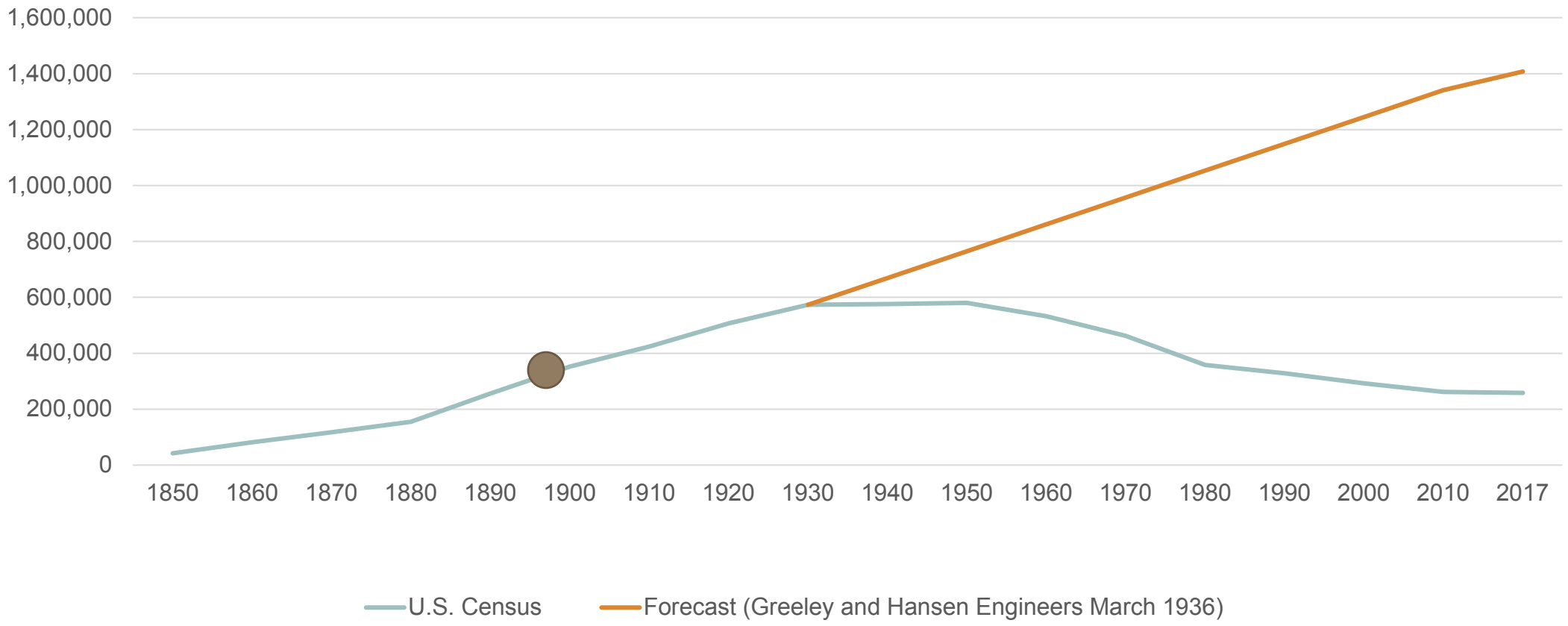
1867-1899: Industrial Revolution

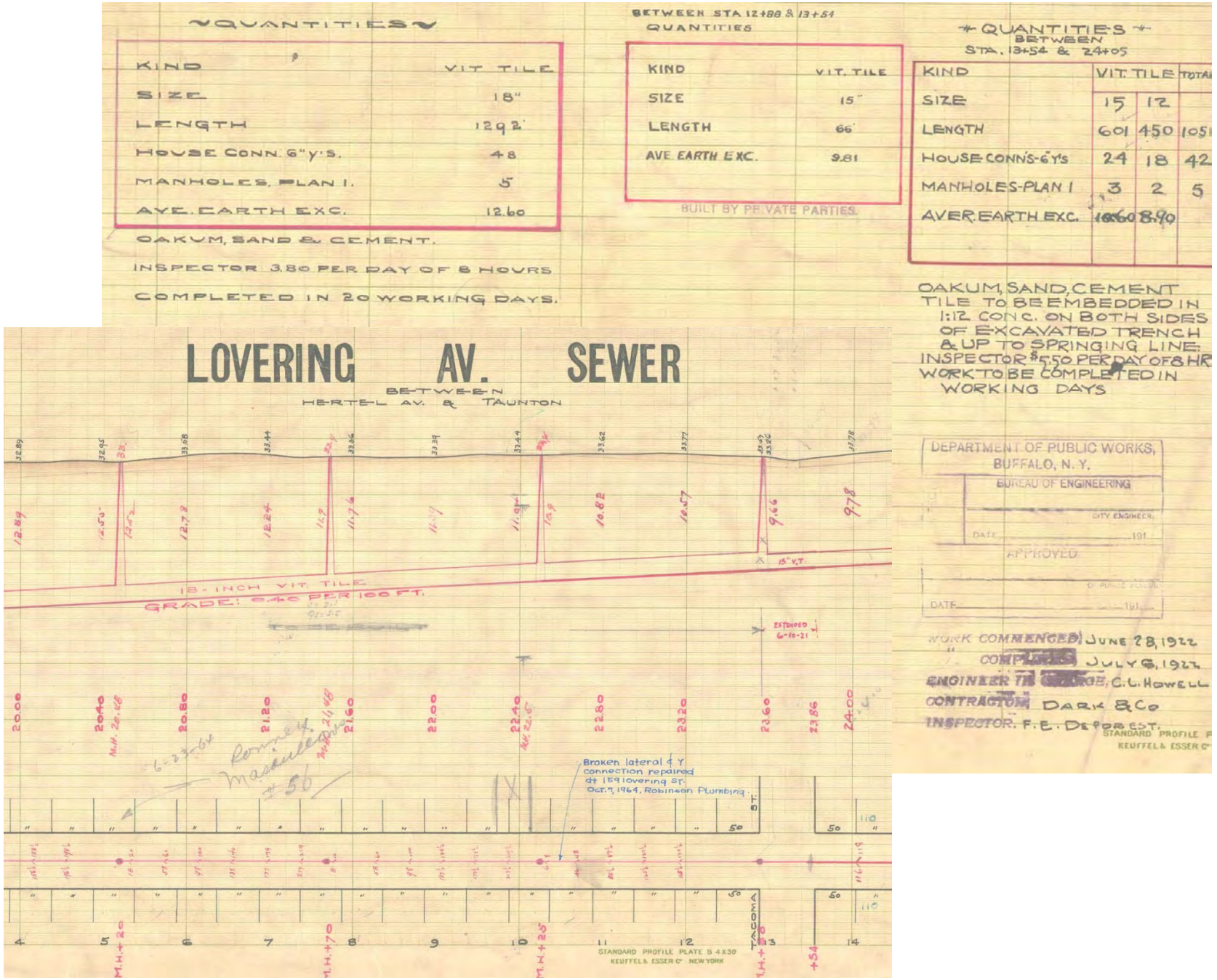
- Majority of existing system
- Hundreds of miles of pipe
- Brick 24”+
- Vitrified Tile Pipe (VTP) 8”-21”





1867-1899: Industrial Revolution





1900-1929: N. Buffalo & Burying of Waters

Sewers installed in North Buffalo for intra-city suburban developments

- Sandy soils
- Need to tie into former Cornelius Creek
- Into rock
- Laterals plunge suddenly into main

1900-1929: N. Buffalo & Burying of Waters

- Waterways → Sewers
  - Main Hamburg Canal to Hamburg Drain 1901-1903
  - Ohio Basin to Ohio Drain 1902-1904
  - Cornelius Creek to Hertel Avenue Overflow Drain 1914
  - Scajaquada Creek to Scajaquada Drain 1925

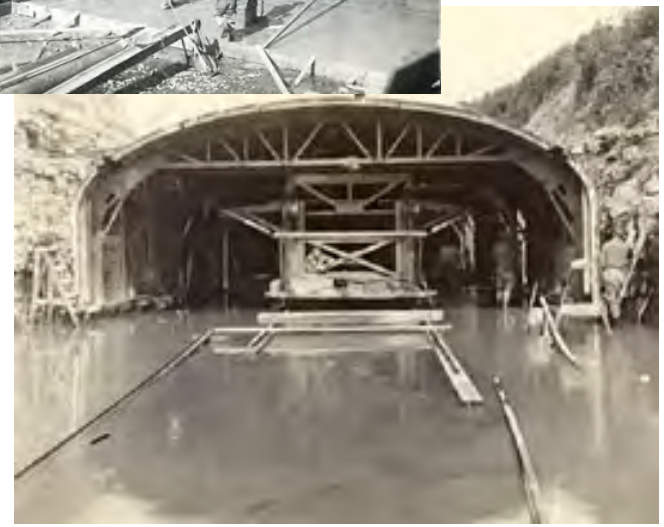
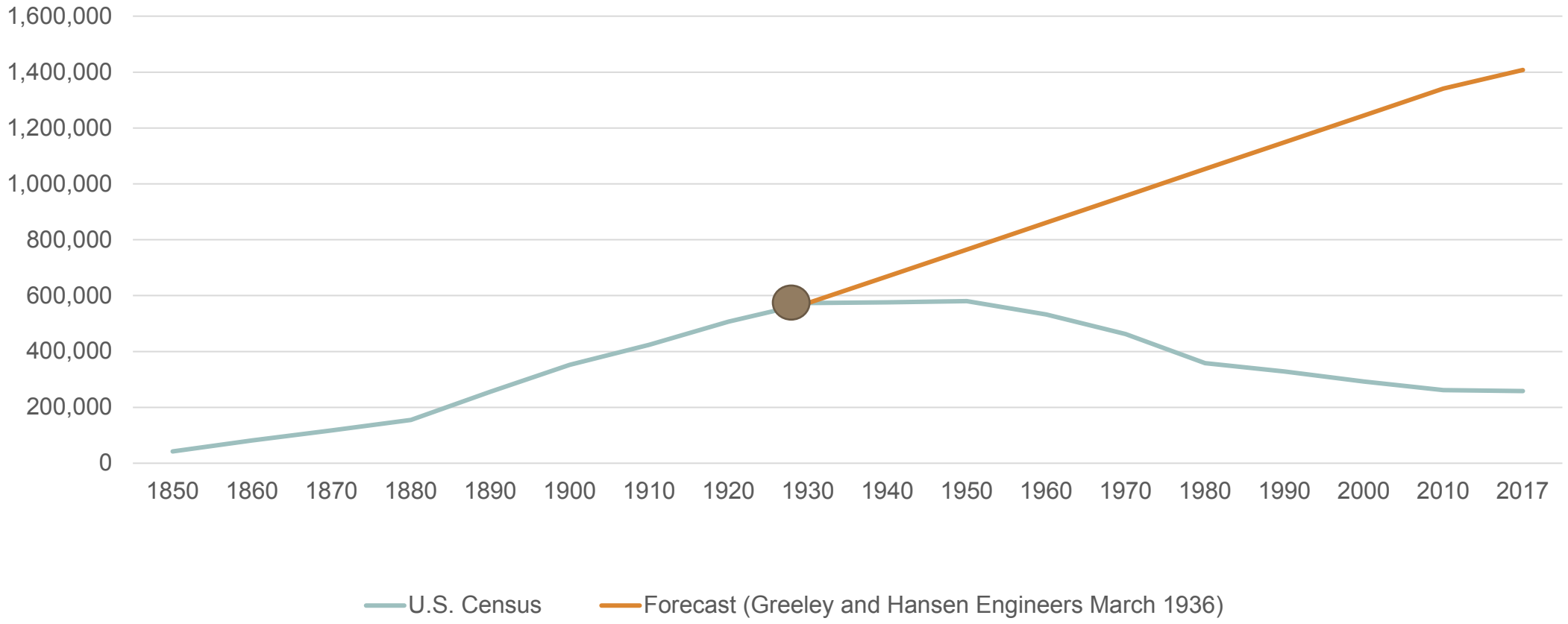


Photo Credit: https://www.wnyheritage.org/content/scajaquada_drian_project_-_1920s/index.html

Quiz: 1861-1929

- What was the primary reason for the construction of the Swan Trunk?
  Flushing of canals
- Why were canals and other waterways buried/ covered?
  Heavily polluted and source of disease
- When were most of the sewers constructed in Buffalo?
  1880s-1890s

History: 1929-1941 Creation of the Buffalo Sewer Authority



1929-1941: The Buffalo Sewer Authority

- 1907 Canadian Public Health Report
  - Niagara Falls, NY typhoid death rate
  - 222.4 deaths/100,000 persons/ year
- Establishment of International Joint Commission
  - January 11, 1909
  - "…boundary waters …shall not be polluted on either side to the injury of health or property on the other."

BUFFALO EVENING NEWS: MONDAY, DECEMBER 5, 1927

NEW BUFFALO PASTOR

Keitzel Assails Buffalo for 'Bathing in Own Filth'

on League Hits Dumping of Sewage

BUFFALO EVENING NEWS: TUESDAY, SEPTEMBER 24, 1929

HERTEL SEWER TO BE THRESHED OUT OCT. 7

Date for Hearing on Flood Relief Set by City Council.

50,000,000 Gallons of Waste Dumped Daily in Buffalo River

Report to Council by Fisk Stirs Perkins to Demand Check on Plants

1929-1941: The Buffalo Sewer Authority

1918 Report

- "In the Detroit and Niagara Rivers conditions exist which imperil the health and welfare of the citizens of both countries in direct contravention of the treaty."
- 80% of pollution of Niagara River originates in Buffalo
- "the sewage of Buffalo is polluting to a serious extent the available water supplies of the two Tonawandas and the city of Niagara Falls, NY"

1929-1941: The Buffalo Sewer Authority

- *Comprehensive Plan of Sewerage for Buffalo, NY*
  - George B. Gasciogne, Consulting Engineer
  - May 1930
- 10-12 year plan
- Sewage treatment through construction of 2 WWTFs
  - South-East by Tifft-Hopkins WWTF
  - North by Unity Island WWTF
- Construction of sewers
  - Interceptors
  - Swan Trunk extension
  - Storm relief sewers
- $23,000,000.00 ($362 M in 2021 dollars)

1929-1941: The Buffalo Sewer Authority

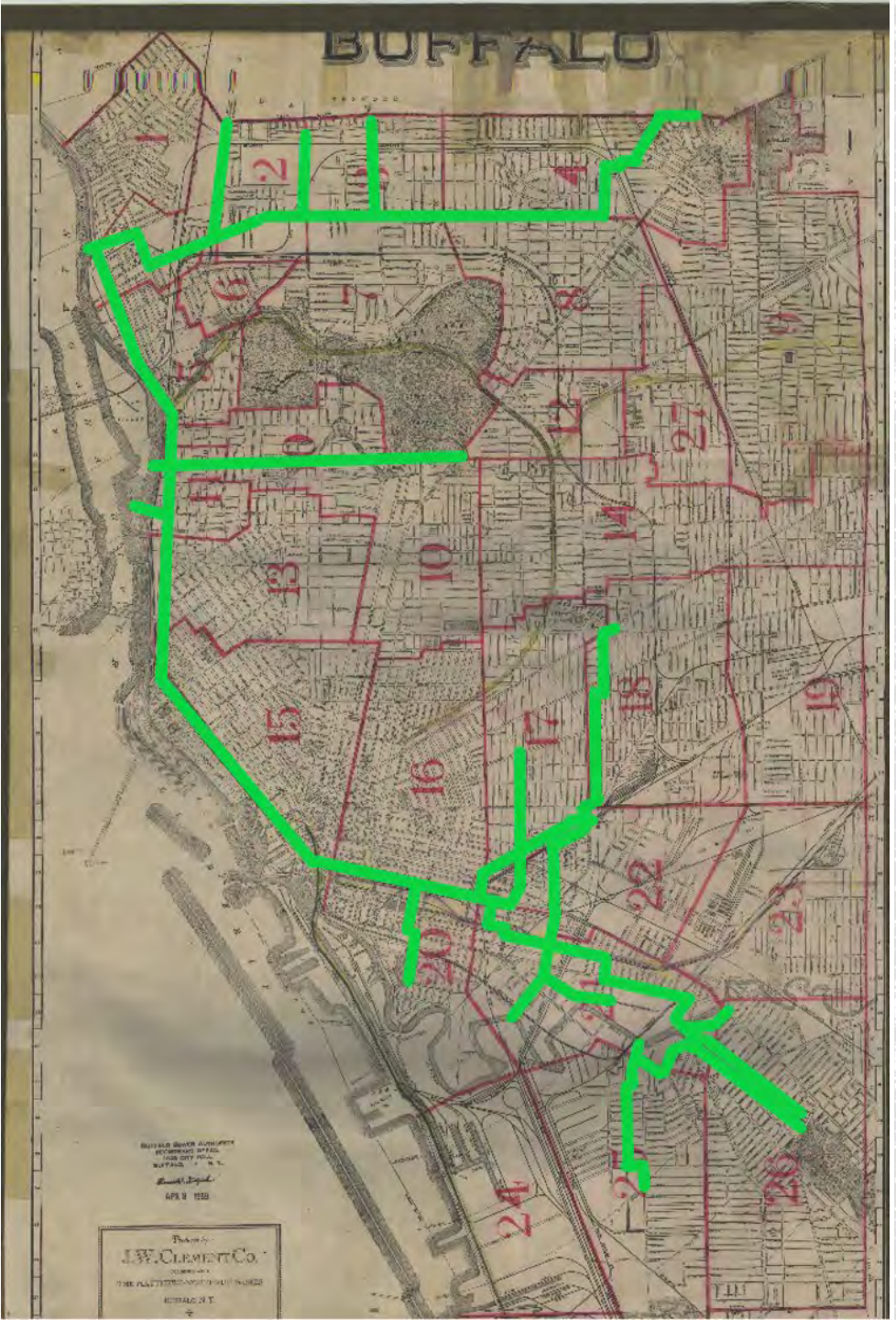
- NYS Dept. of Health mandate
  - March 1935
  - Primary Sewage Treatment Plant
  - Interceptor sewers
- Establishment of BSA
  - April 8, 1935
  - $15 million bonding capacity ($287 M in 2021 dollars)
  - After 5 years or after all bonds are paid off, system will revert to city and Buffalo Sewer will dissolve
  - Structures of any public service corporation must be removed at expense of corporation for Buffalo Sewer to construct project

1929-1941: The Buffalo Sewer Authority

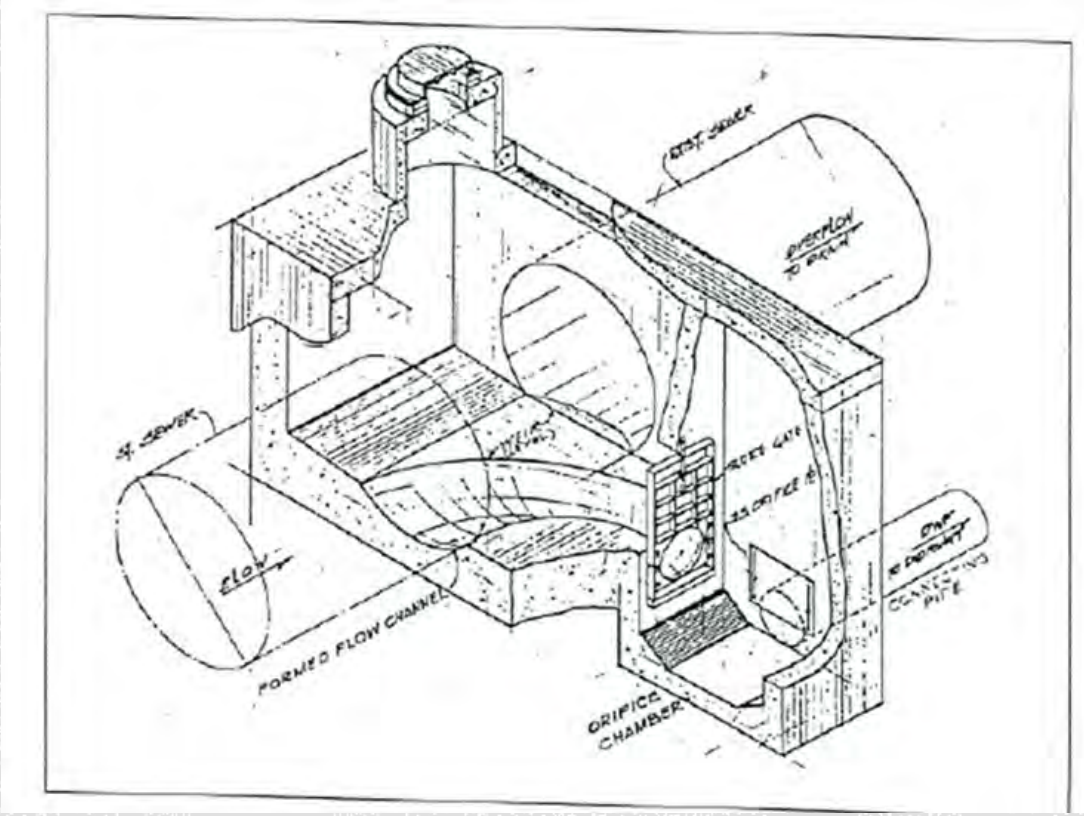
- *Buffalo Sewer Authority General Plan for Collecting and Treating the Sewage of Buffalo*
- Greeley and Hansen Engineers
  - Redid Gasciogne's calculations
  - March 1936
- Treatment and conveyance for treatment
  - Single WWTF on Bird Island
  - CSO diversion structures
  - Interceptors
- $15 million cost

1929-1941: The Buffalo Sewer Authority

From: https://www.wnyheritage.org/content/scajaquada_drian_project_-_1920s/index.html



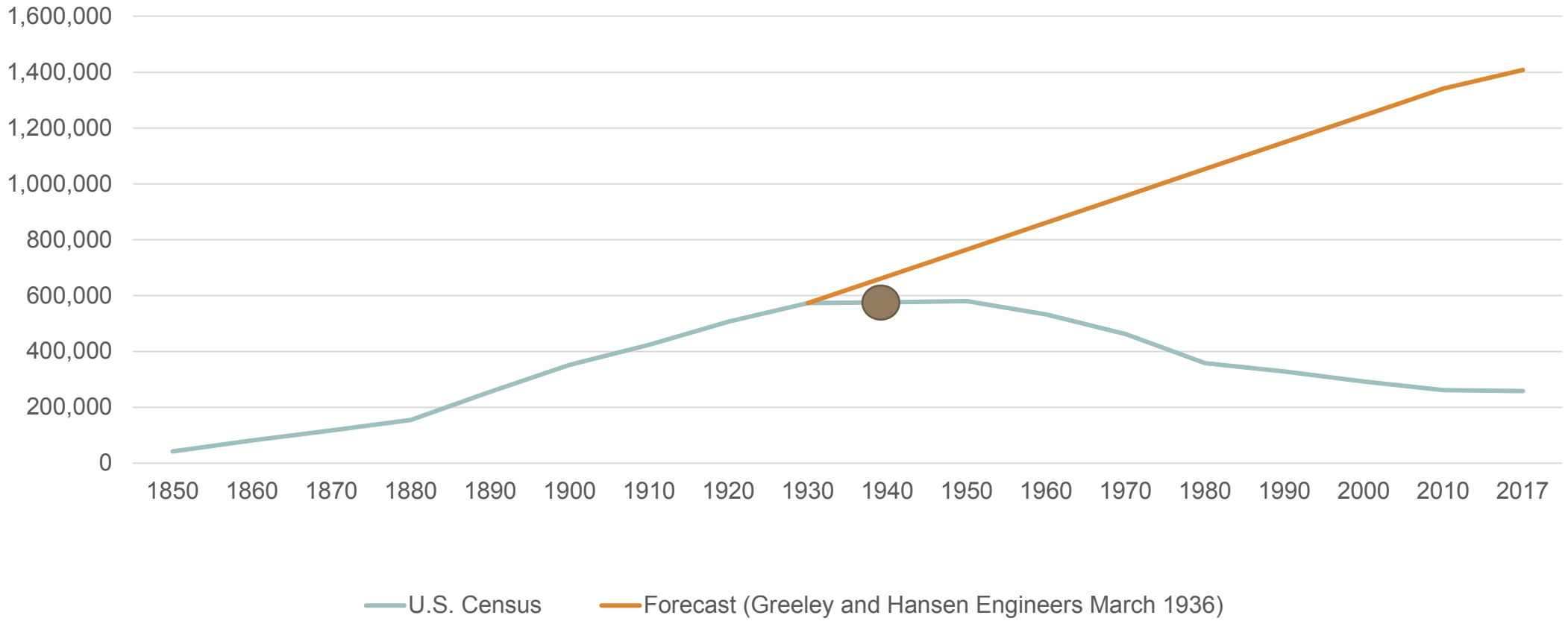
1929-1941: The Buffalo Sewer Authority



Quiz: 1929-1941

- What was the estimated cost for the Gasciogne plan (1930 dollars)?
  - **$23,000,000.00**
- When was the Buffalo Sewer Authority founded?
  - **April 8, 1935**
- What was the revised cost under Greeley-Hansen's redesign (1935 dollars)?
  - **$15,000,000.00**

1941-1970 : Storm Relief and Sprawl



1941-1970: Storm Relief and Sprawl

- *Comprehensive Plan for Relief Sewers*
  - February 1941
  - Greeley and Hansen
  - WWTF online as of 1938
- Attack on Pearl Harbor December 7, 1941
- Post-1945 suburban development
- Floods of 1963
  - July 29: 3.8”: $1.5 M ($12.7 M in 2021 dollars) in damage
  - August 7: 3.88” in 5 hours: $35 M
    ($295.9 M in 2021 dollars) in damage

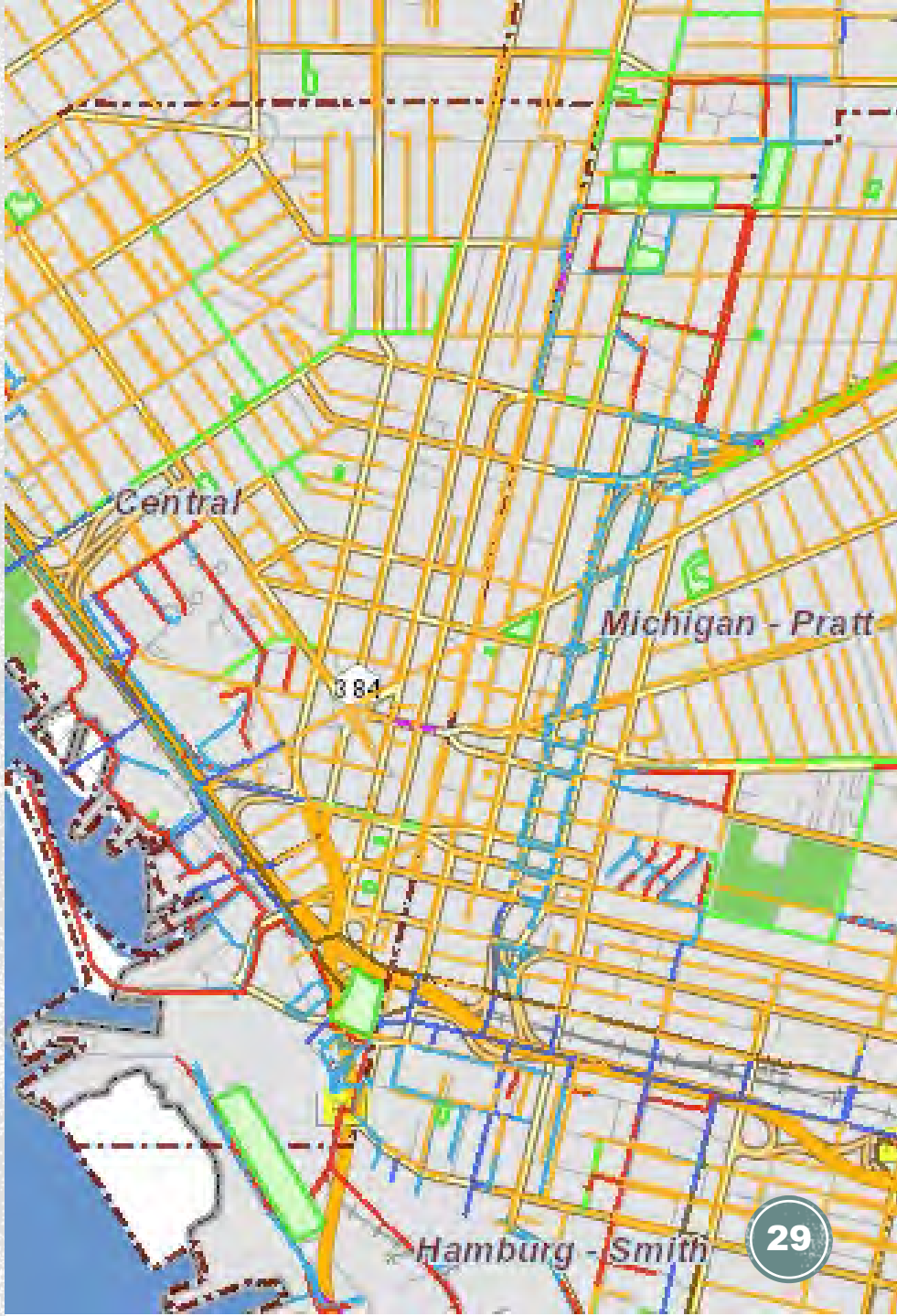
1941-1970: Storm Relief and Sprawl

- NYS Route 33
  - Severed Bird-Ferry Trunk
  - Stormwater added to system
  - New pump station for stormwater and groundwater
  - New trunk sewers constructed
- I-198
  - New storm sewers
  - Direct discharge to Scajaquada Creek
- I-190
  - Old Erie Canal bed
  - On top of
    - Swan Trunk
    - Interceptors
    - Hamburg Drain

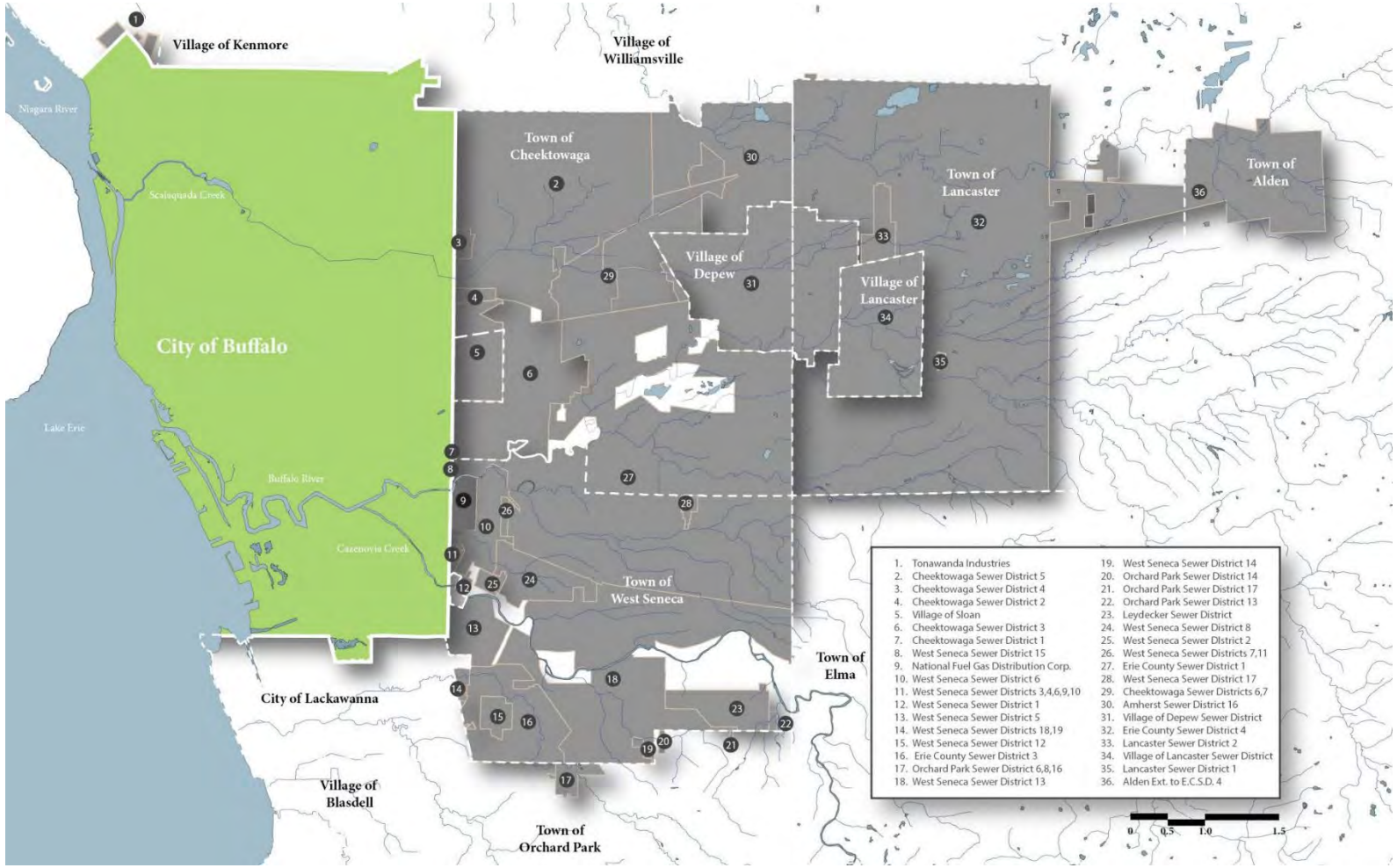
1941-1970: Storm Relief and Sprawl

1941-1970: Storm Relief and Sprawl

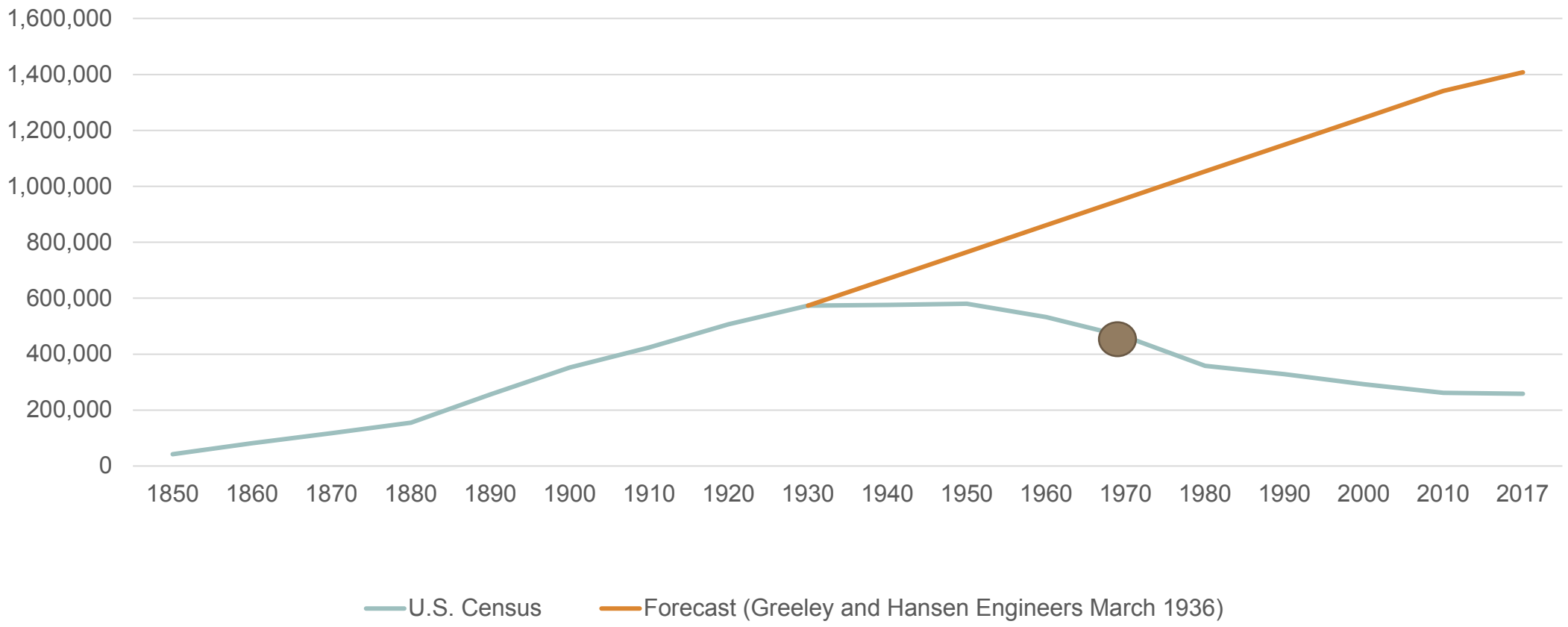
- Urban Renewal 1960-1970
- Demolition of tenement areas
  - Urban core
  - Oldest parts (and oldest sewers) of city
- New municipal housing projects
  - New separated sewers
  - Concrete storm sewers
  - Asbestos concrete pipe sanitary sewers

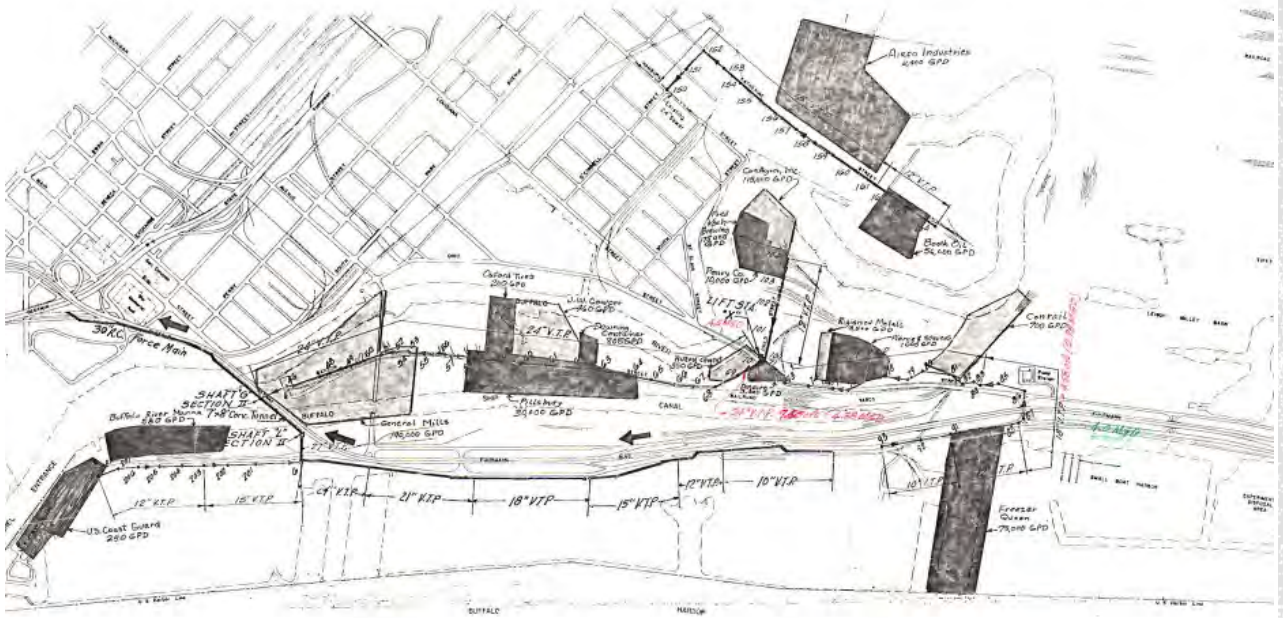


1941-1970: Storm Relief and Sprawl



1970-1982: Clean Water Act





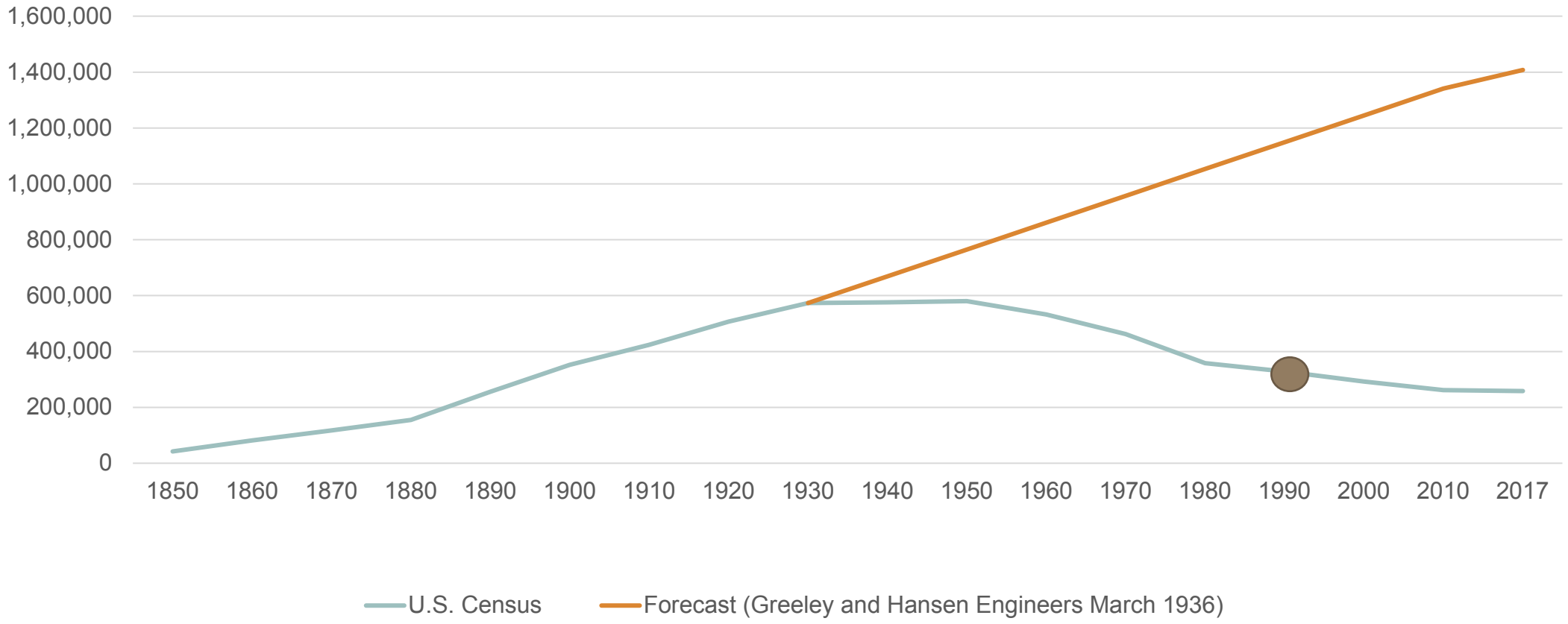
1970- 1982: Clean Water Act

- Kelly Island
  - “Outer Harbor”
  - Heavily industrialized
  - Never sewered
    - Direct discharge to waterways
    - Failing septic systems
- August 1966 Visit from LBJ
- Buffalo River Fire: 1968
- 1976 Project

1970-1982: Clean Water Act

- Scajaquada Tunnel 1977
- Weir Modifications 1980-1982
  - Diversion from Scajaquada Drain to Tunnel
  - Raising of weirs
- Backwater Gates
- Secondary Treatment Process
  - Completed 1980
  - Constructed on municipal landfill in Niagara River on piles
  - Liquid handling
  - Solids handling

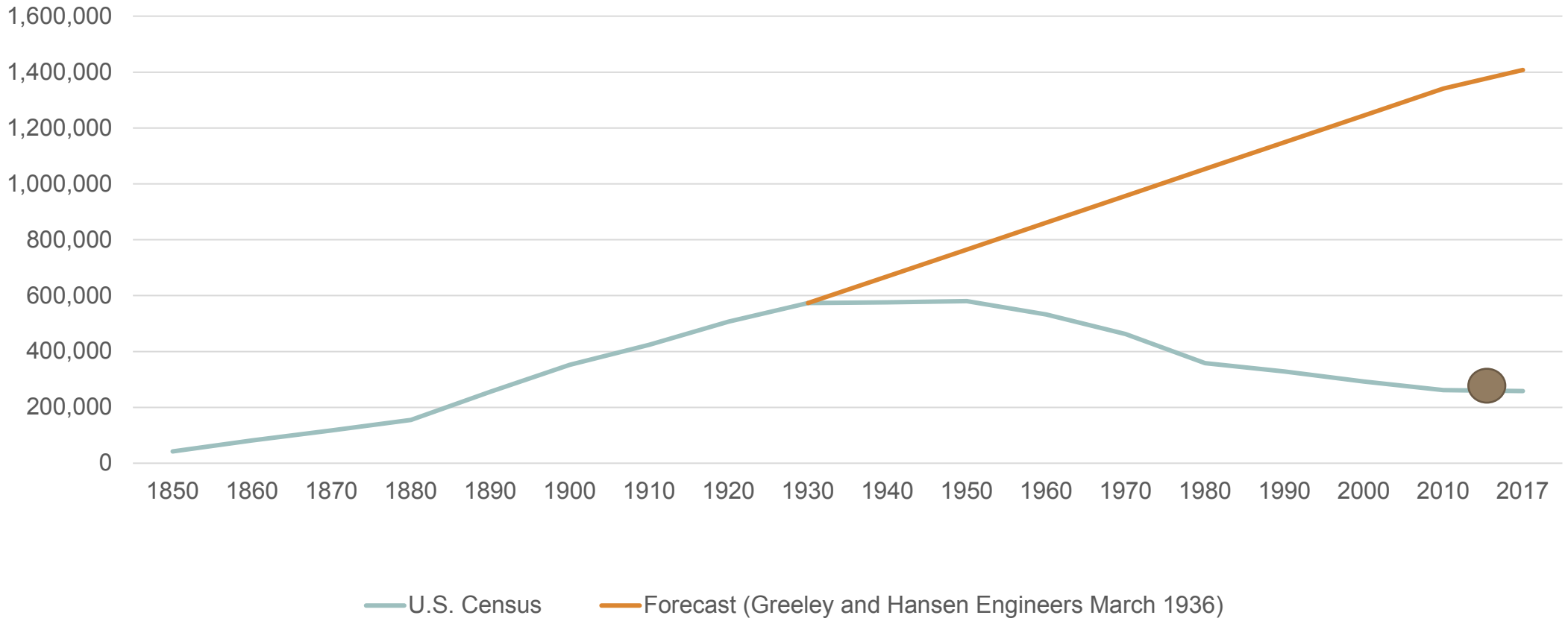
1983-2010: CSO Abatement Phase I

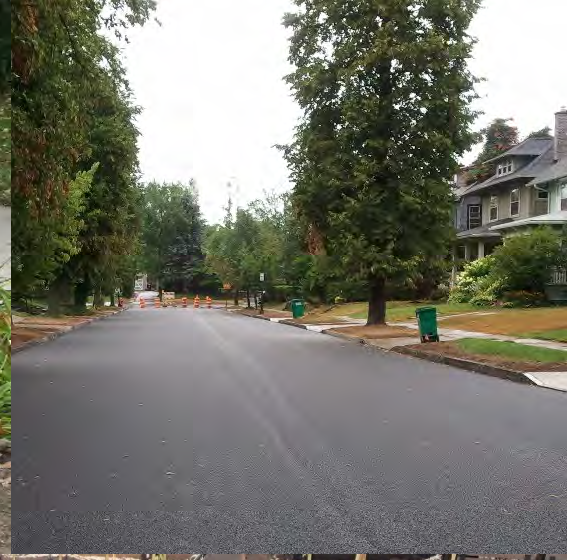


1983-2010: Combined Sewer Overflow (CSO) Abatement Phase I

- Sewer Separation
- Weir modifications
- Emphasis on eliminating number of CSO locations

CSO Abatement Phase II LTCP 2010-Today



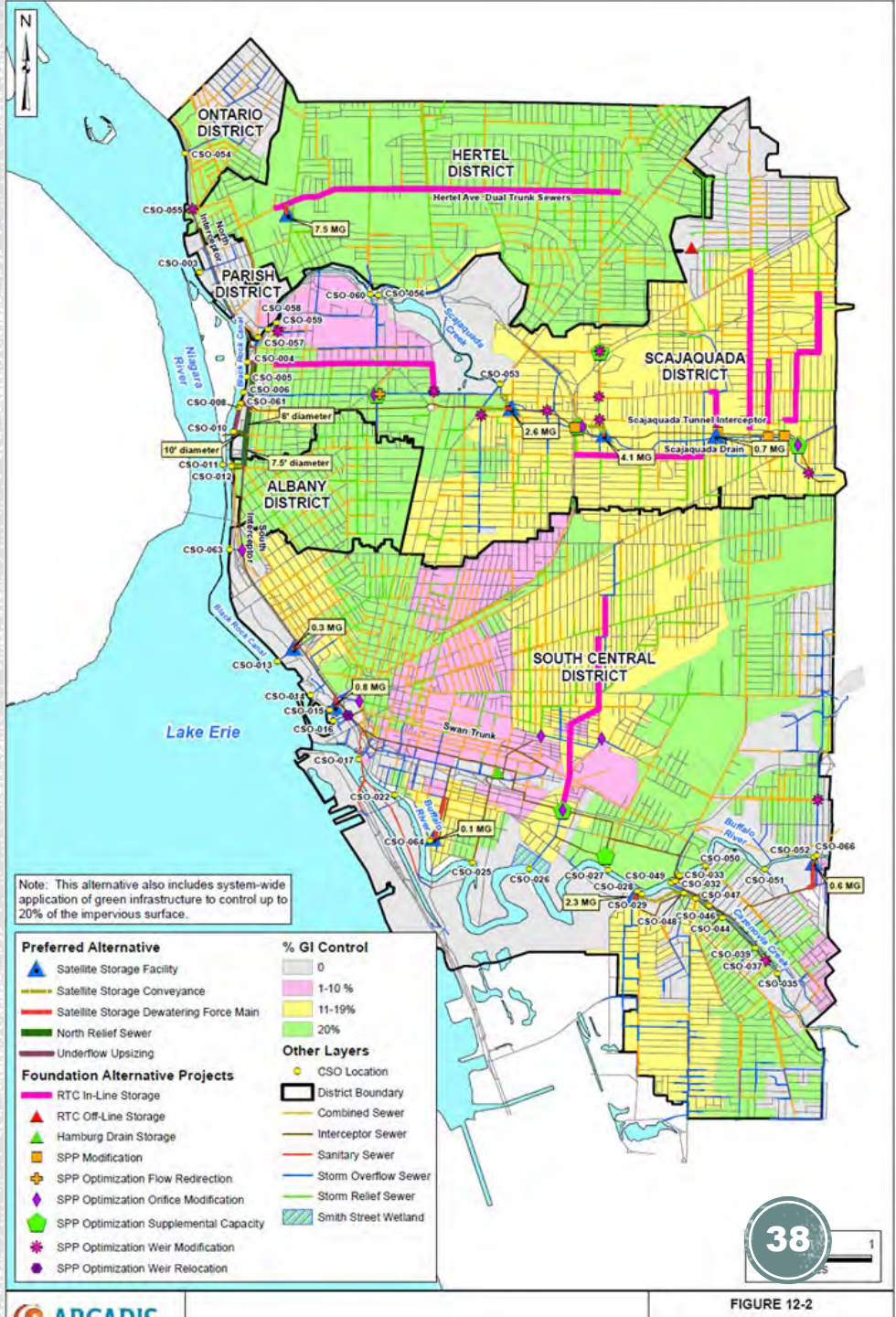


2010-Today: CSO Abatement Phase II

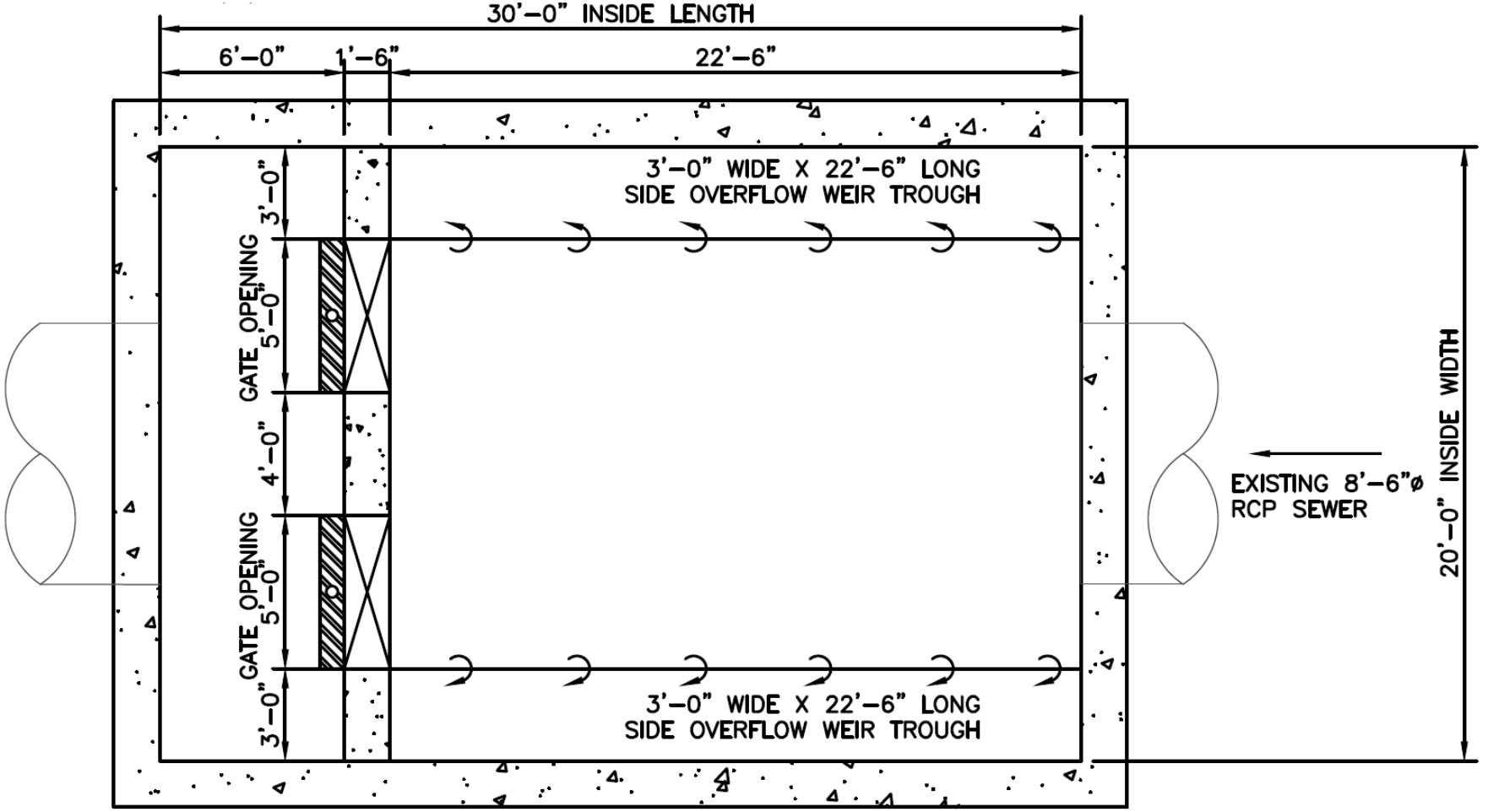
- Final Long-Term Control Plan (LTCP) approved March 18, 2014
- Decrease CSO activations
- $380 Million
- Mix of gray
  - Waste Water Treatment Facility upgrades
  - Real Time Control “Smart Sewers”
  - Localized Sewer Separation
  - Underground detention tanks
- And green
  - Bioretention
  - Permeable pavement
  - Demolitions

2010-Today: Real Time Control (RTC) Smart Sewer Concept Viability

- Vacancy on East Side
  - Vacant lots absorbing water that would have gone into combined system
  - Sanitary and industrial discharges reduced
- Kensington Expressway cutting off half of the flows
- Hertel sewers are deep to capture Cornelius Creek



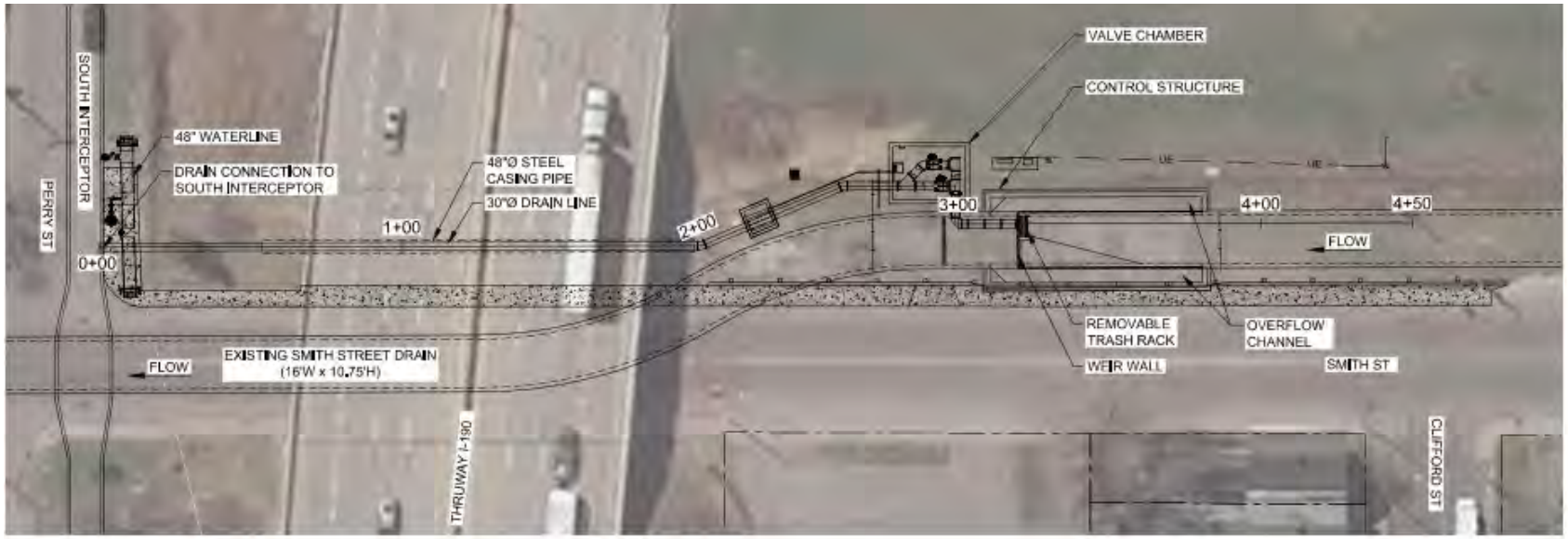
2010-Today: Real Time Control (RTC) Smart Sewer Inline Storage Concept



2010-Today: Real Time Control (RTC) Smart Sewer Concept

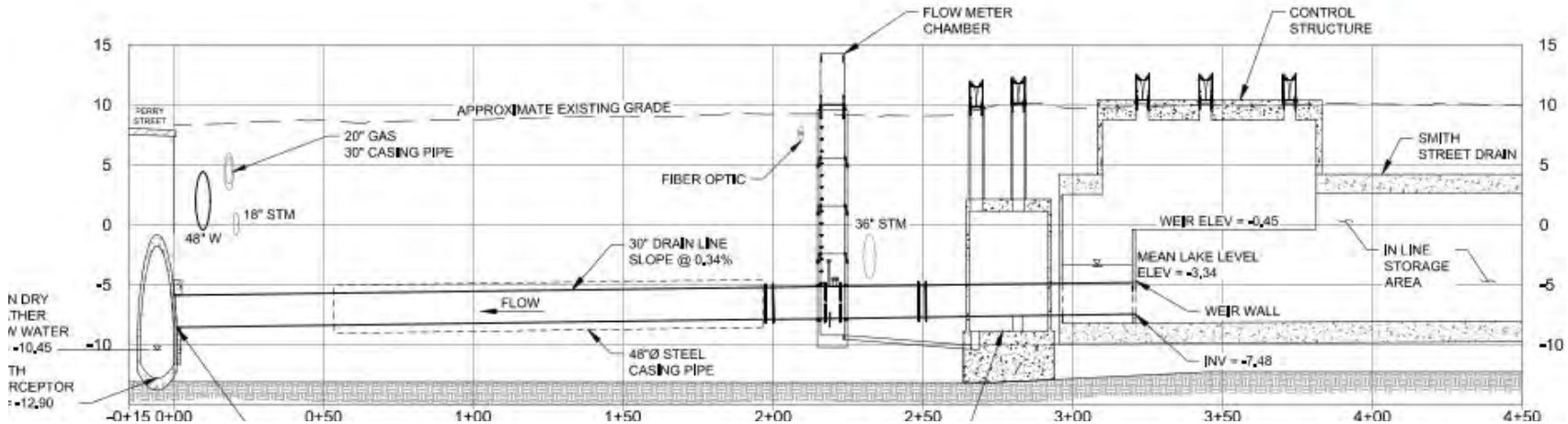
- Two sluice gates per site
- Non-rising stem configuration
- Design each gate for 100% of sewer capacity when fully open
- Side overflow weirs in event both gates fail closed
- Weir elevations based on elevation of upstream collector sewer connections
- Gate opening based on level
- PLC controls with radio telemetry to Bird Island
- Swap “Lead” and “Lag” gates after each event

Long Term Control Plan: CSO 026 Smith Street RTC



PLAN

SCALE: 1" = 40'

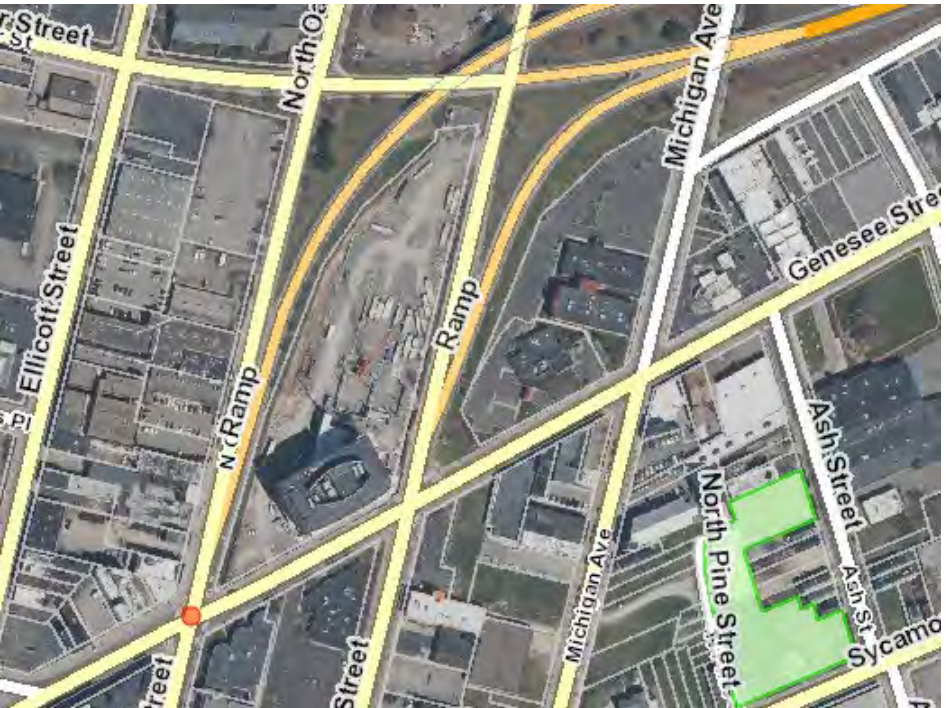


Long Term Control Plan Projects: Bioretention and VTP

Quiz: 1941 - Today

- What impact did the construction of the NY-33 Kensington Expressway have on the sewer system?
  - **Cut off the Eastern part of the city (severed the Bird-Ferry Trunk)**
  - **Required additional storm sewers be constructed**
- What was the main criteria for CSO abatement in the 1980s, 1990s, and 2000s?
  - **Elimination of CSO outfalls**
- What is the main criteria for CSO abatement today?
  - **Elimination of CSO activations**

Maintenance and Repairs: Pratt Street



Maintenance and Repairs: North Oak Street

- Call from contractor
  - Cut for DOT project for electrical line
  - Street gave way
- Hole in 1851 sewer
- Once repair started kept running into issues
  - 150 feet of sewer replacement
  - Washed out bottom area further up Oak

Maintenance and Repairs: Reactive to Preventative

- Observations
  - Part of Pratt Street sewer collapsed (pre-Civil War) in 2016
  - Part of North Oak Street sewer collapsed (pre-Civil War) in 2016
  - Parts of two other large diameter pre-Civil War sewers collapsed in 2017
  - Pre-Civil War sewers represent a very small portion of sewer system
- Conclusion: pre-Civil War sewers should be prioritized for inspection
- Problem: Buffalo Sewer's records for many pre-Civil War sewers are missing dates
- Solution: look at historical mapping for areas where older sewers would have been built and then cross-reference with sewers without dates

Maintenance and Repairs: Lost Waterways

Maintenance and Repairs: Lost Waterways

Modern Location

River is ~450 feet away

1870 Map

Buffalo Creek runs under location

Maintenance and Repairs: 10 States Non-Compliance

- Most sewers had manholes installed in 1930s
- Still some sewers without manholes or 1000+ feet between manholes
- Tempting to just order manholes to be installed
- But….

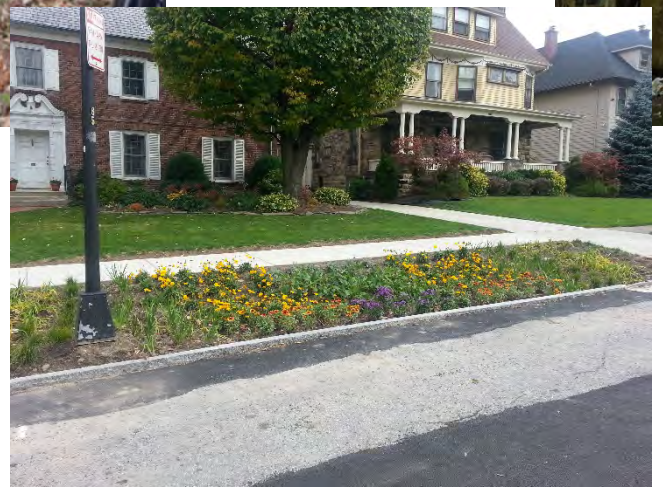
Quiz: Maintenance and Repairs

- What criteria can be searched for within GIS data to identify Pre-Civil War Sewers?
  - **Stone or brick material**
  - **24”+ diameter round, rectangular, or egg-shaped cross-section**
  - **Located along waterways as they existed prior to 1865**
- What issues may be encountered with buried waterways?
  - **Subsidence and excessive drainage**

Bibliography

- Gasciogne, George B. “A Comprehensive Plan of Sewerage for Buffalo, New York Summary Report.” May 1930.
- Greeley and Hansen. “Comprehensive Plan for Relief Sewers Summary Report.” February 1941.
- Greeley and Hansen. “General Plan for Collecting and Treating the Sewage of Buffalo.” March 1936.
- Kane, Patrick, Jr. “Buffalo, N.Y. is Doing Away with Public Nuisance Through the Construction of an Underground Drain.” *The American City.* February 1923. https://www.wnyheritage.org/content/scajaquada_drian_project_-_1920s/index.html
- Robison, F. Luman. “Floods of August 7 in Buffalo, NY.” *Floods of 1963 in the United States*. 1963.
- Rossi, Mary C. “The History of Sewage Treatment in the City of Buffalo, New York.” 1995.
- Rotated 1894 City of Buffalo Atlas. http://www2.erie.gov/atlases/index.php?q=rotated-index-map.
- Steele, Oliver G. Esq. “Buffalo City Sewerage and Sanitary Science.” Jan. 3, 1866.
- Waring, George E. “The Buffalo Trunk Sewer in Course of Construction.” June 1884.

Questions?



Women's Leadership Initiative of ULI WNY

Engaging the Private Sector in Green Infrastructure Development & Financing

June 17th, 2021

ULI New York

wendel

BUFFALO SEWER AUTHORITY

JOY KUEBLER LANDSCAPE ARCHITECT, PC

THANK YOU TO ULI WESTERN NEW YORK SPONSORS

ANNUAL LEADER SPONSOR

SINATRA & COMPANY REAL ESTATE

ANNUAL DONOR SPONSORS

Phillips Lytle LLP

Uniland DEVELOPMENT COMPANY

wendel

ANNUAL CONTRIBUTOR SPONSOR

Lippes Mathias Wexler Friedman LLP

savarino companies

TM Montante DEVELOPMENT

ANNUAL PARTICIPANT SPONSOR

ULI New York

wendel

ELLICOTT DEVELOPMENT

LaBella Powered by partnership.

Women's Leadership Initiative

Urban Land Institute of WNY

OUR MISSION

1. Promote the advancement of women, throughout their careers, as leaders in the real estate industry.
2. Increase the number of women who serve in leadership positions in the real estate industry and in ULI.
3. Increase the visibility of women leaders in the real estate industry and in ULI.
4. Increase the number of women who are active ULI Full members and support the development of young women members as leaders in ULI and in their professions.

ULI New York wendel

Please turn off your camera and microphone until the Q&A portion of the event.

MODERATOR:

Elizabeth Colvin

Senior Project Manager

WENDEL

SPEAKERS:

Scott Rybarczyk, PE, LEED AP

Senior Environmental Engineer

WENDEL

Aliesa Adelman, CSDP, CRM, LEED AP
BD+C, Fitwell Ambassador

Director of Sustainability

WENDEL

Joy Kuebler, RLA, ASLA

President & CEO

JOY KUEBLER LANDSCAPE ARCHITECT, PC

Taylor Brown, EIT

Junior Sanitary Engineer

BUFFALO SEWER AUTHORITY

ULI New York wendel

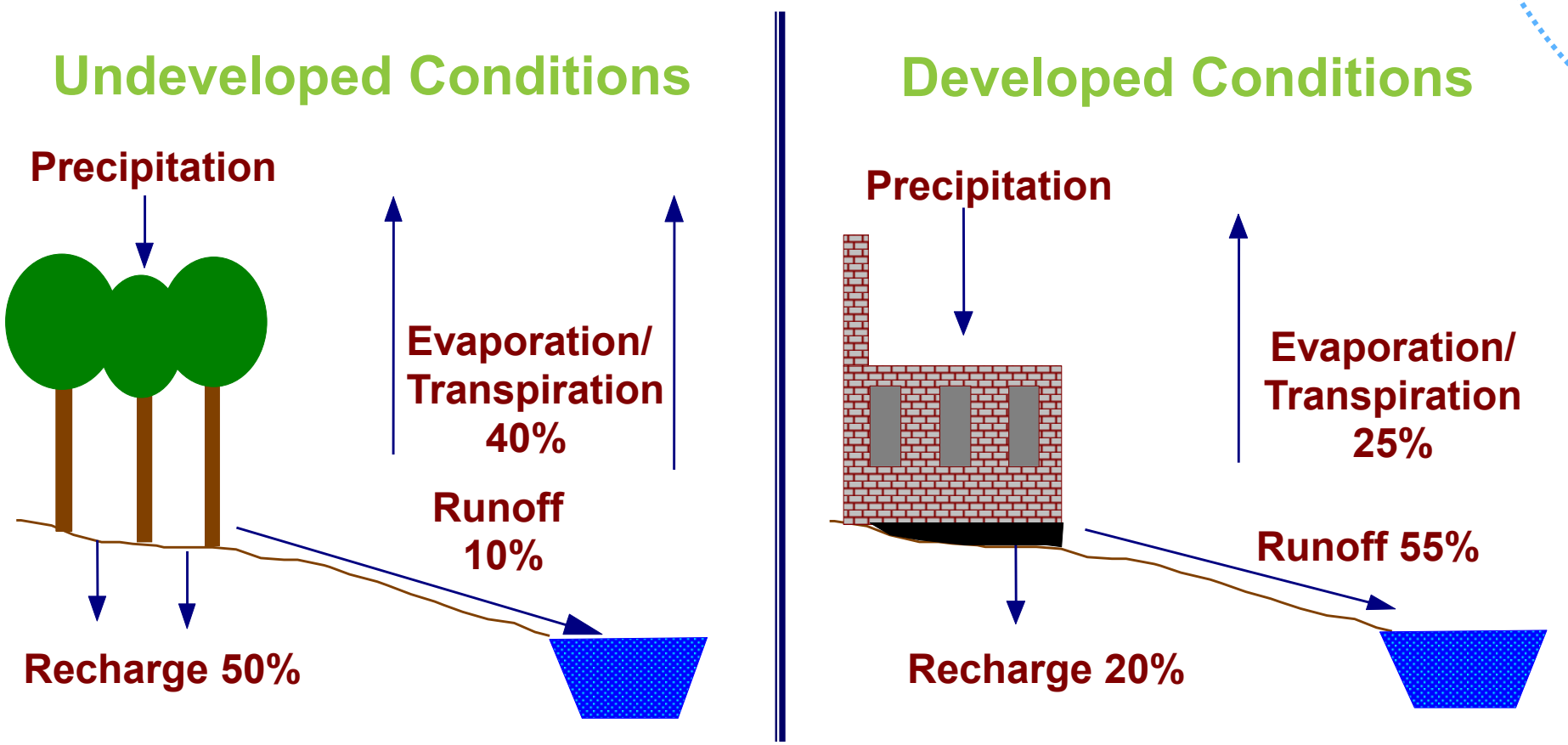
Agenda

What is Stormwater?

- Stormwater runoff occurs when precipitation from rain or snowmelt flows over the ground
- In natural systems, soil absorbs much of the stormwater
- In developed environments, surfaces shed stormwater
  - Larger runoff
  - Stormwater Picks up Pollutants
    - Trash
    - Sediment
    - Nutrients
    - Oils
    - Pesticides
- Many local stream and rivers are impaired
  - Storm sewer systems are untreated

ULI New York wendel

Stormwater Impact on Flooding



As land uses have changed, stormwater runoff has increased by as much as 45%

ULI New York wendel

What is Green Infrastructure (GI)?

A Shift in Thinking

- Old Way
  - Get Rid of Runoff Quickly
  - No Concern for Downstream Impacts
- New Way
  - Slow it down
  - Match Pre-Developed Conditions
  - Minimize Downstream Impacts

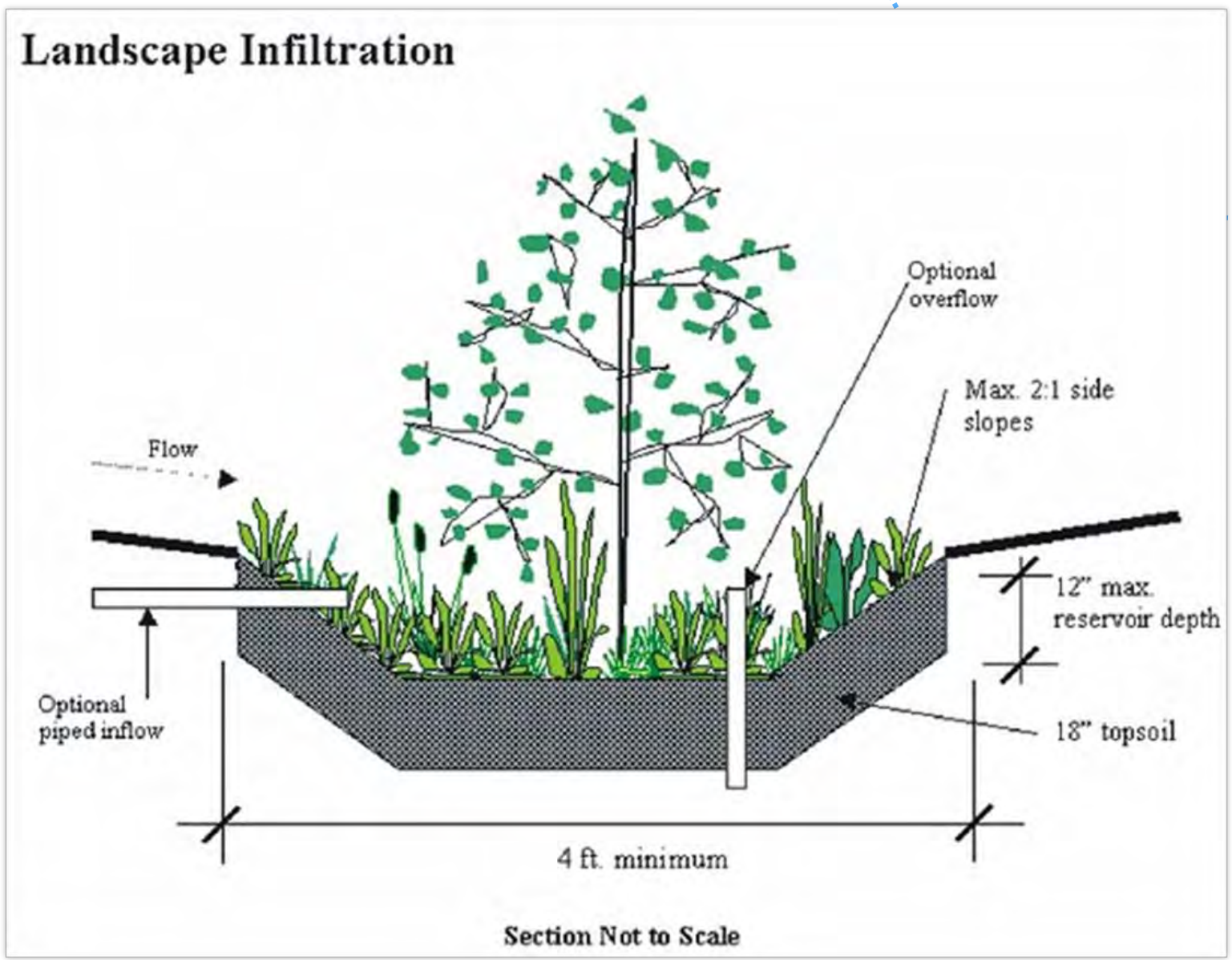
Objectives of GI

- Keep Stormwater Out of Sewers
- Treat Stormwater
- Infiltrate for Groundwater Recharge

ULI New York wendel

Typical Green Infrastructure Types

- Rain Gardens / Bioretention
- Green Roofs
- Pervious Pavement
- Rainwater Storage
- Conservation of Open Space
- Stream Restoration



ULI New York wendel

Status of Green Infrastructure in Development

Green Infrastructure isn't new

- Design with Nature (1969)
- Low Impact Development (1981)
- NYS Design Regulations (2010)

However, it is evolving

- NGICP
- Precast Pervious Concrete
- Better Plant Selection
- Better Soil Mixes

Sustainability and Climate Resilience

Sustainability – No Regrets Design

- Rain Gardens
- Pervious & High Albedo Surfaces
- Retention Ponds & Bioswales
- Native Species Landscaping

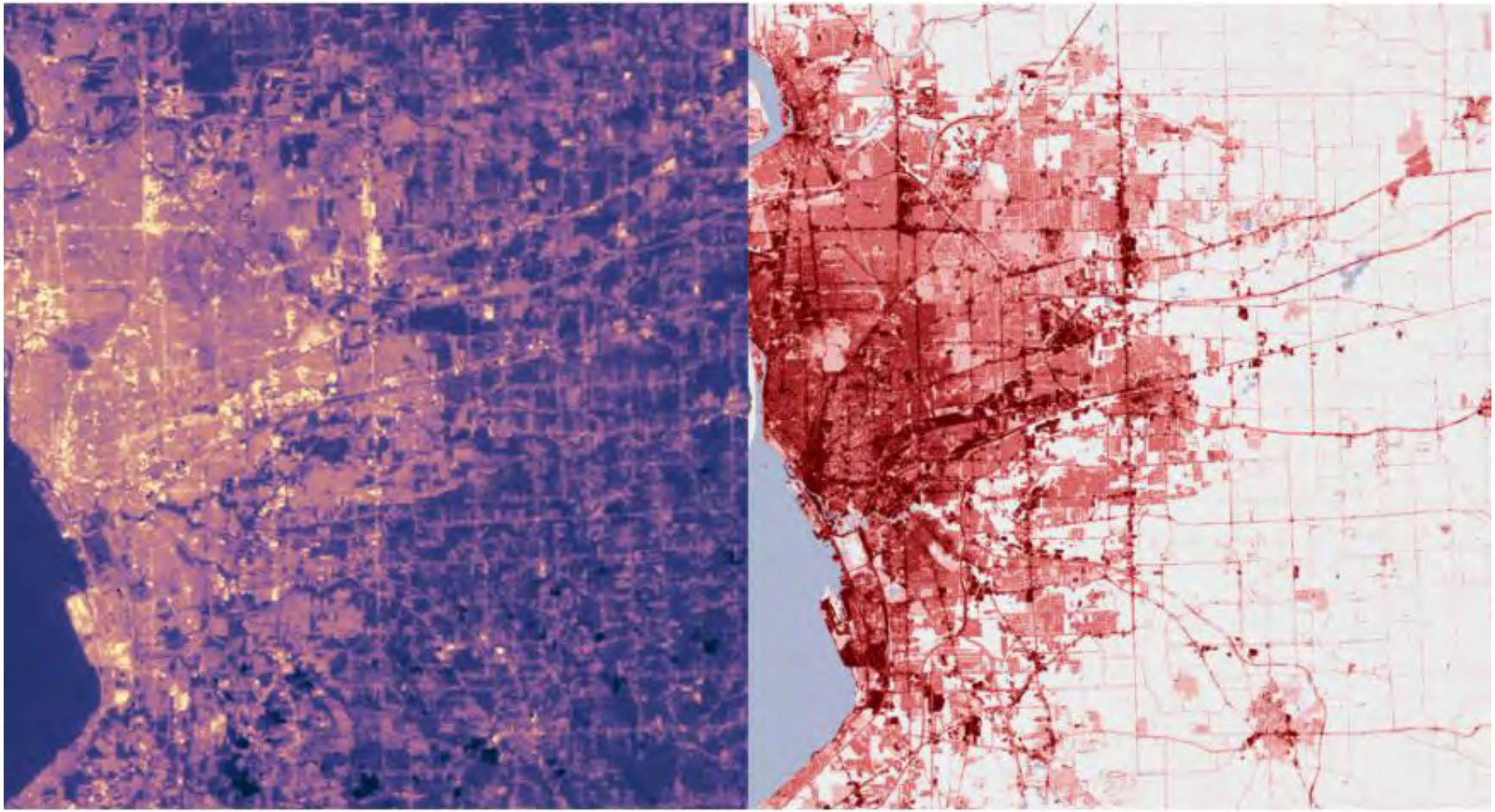
Climate Resilience – Absorptive/Restorative/Adaptive Capacity

- Climate Appropriate Landscaping
- Reclaimed Water/Cistern
- Avoidance Flood Plains
- Elevated First Floor

ULI New York wendel

Sustainability and Climate Resilience Impacts:

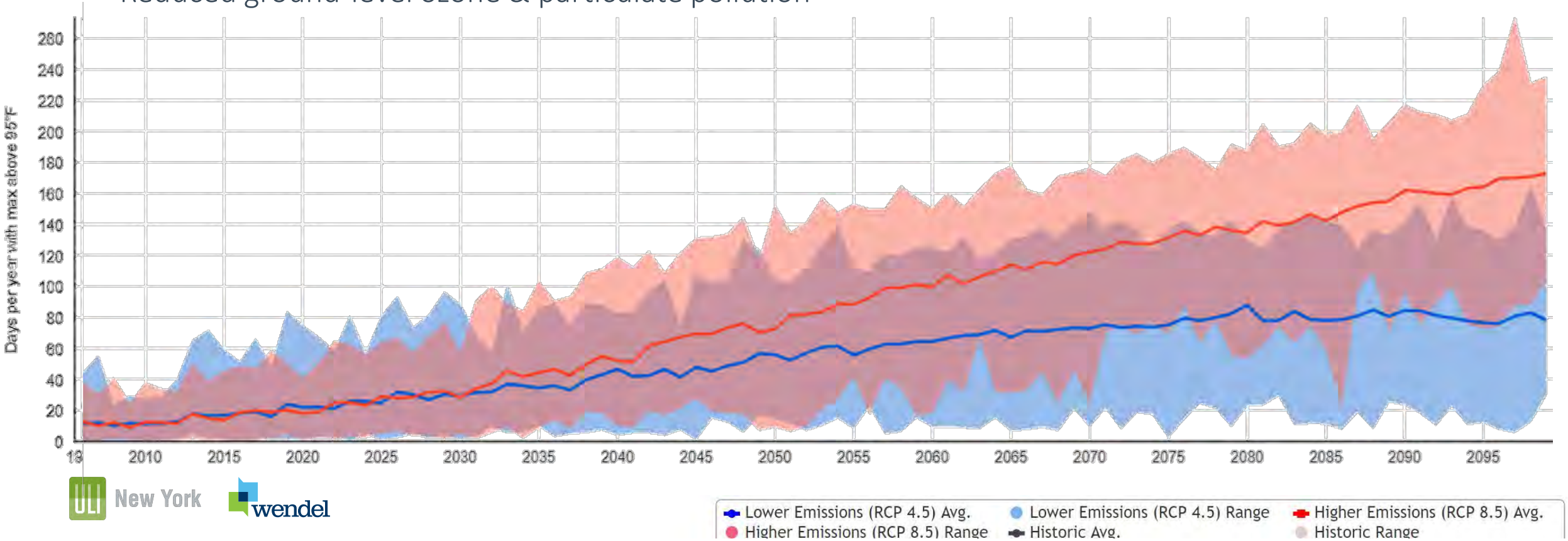
Future Build Out Projections



Sustainability and Climate Resilience Impacts:

Temperature Increases

- Heat Island Reduction Impact
- Areas of Respite
- Reduced Operational Costs
- Reduced ground-level ozone & particulate pollution



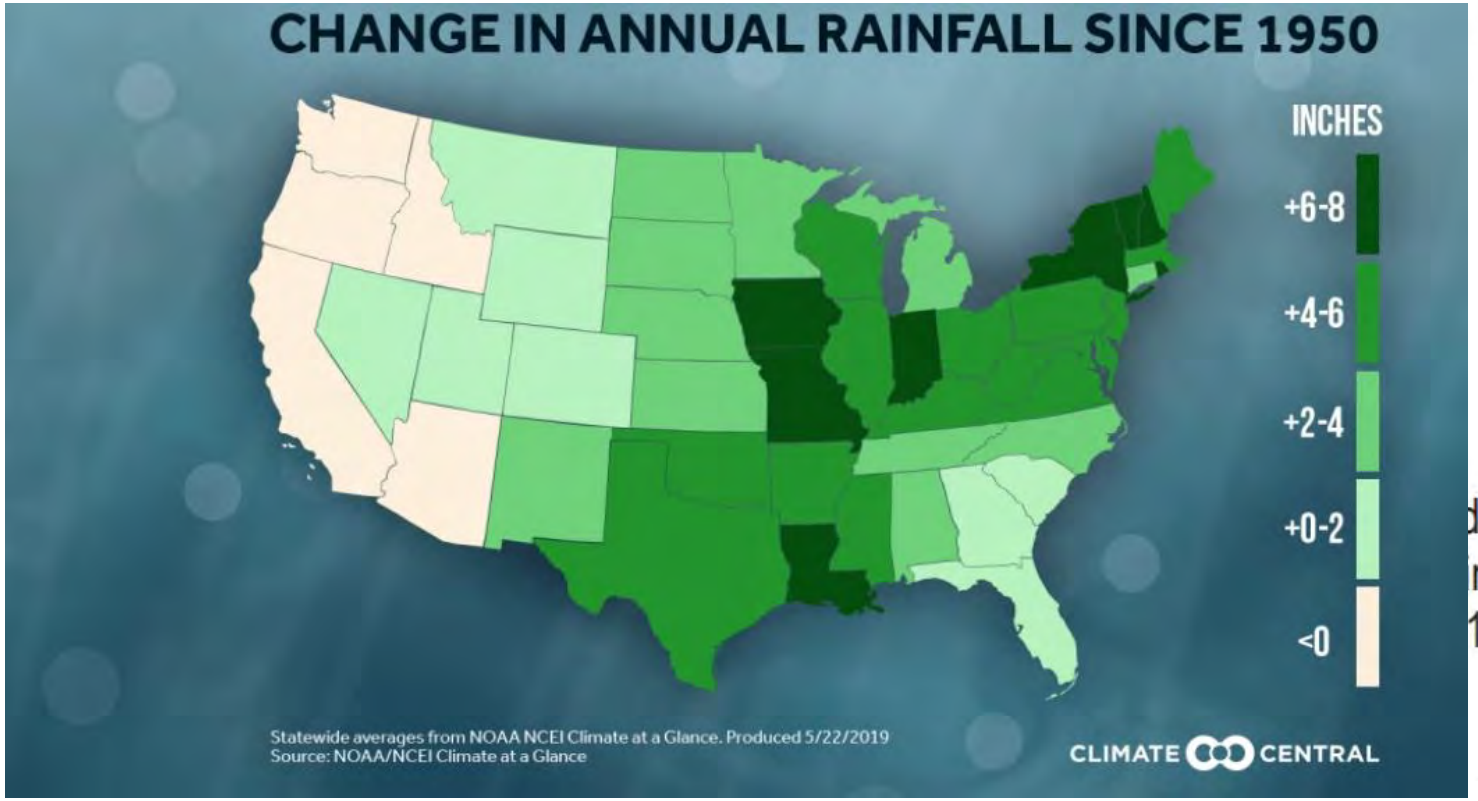
ULI New York

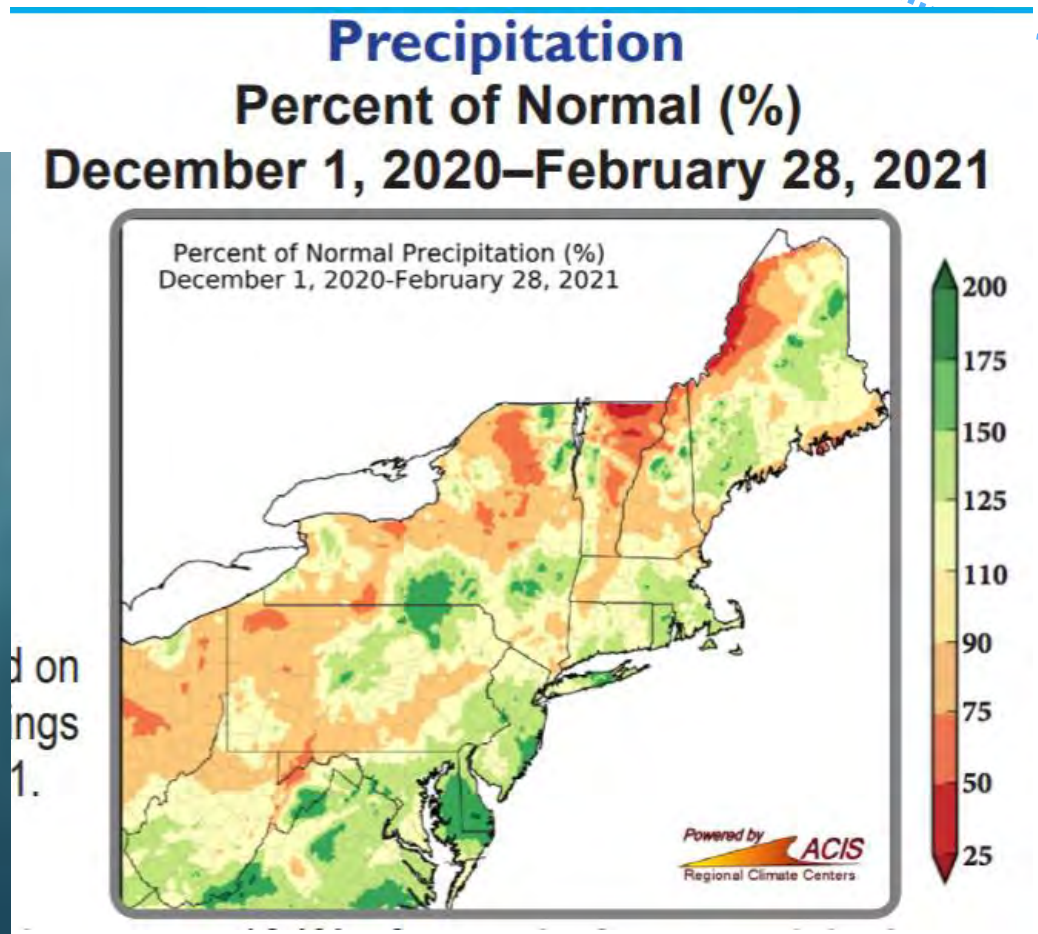
wendel

Sustainability and Climate Resilience Impacts:

Storm Frequency and Changes in Precipitation

- Mitigation of Impacts on Building Materials
- Flood Risk mitigation
- Species Migration
- Regulatory Impacts





Green Infrastructure:

Quantifiable Economic Benefits

- Increased developable land
- Increased market value, sometimes described as a “sustainability premium”
- Enhanced marketing opportunities
- Placemaking opportunities, amenity value, and improved building user experience
- A smooth permitting process
- Avoided losses in peak weather events
- Reduced operating and maintenance costs
- Decreased potable water use

A 57,000-square-foot commercial development with an 800,000-gallon rainwater catchment system, including placement of a visible cistern.

- Harvesting the Value of Water, Stormwater, Green Infrastructure, and Real Estate, ULI Report

ULI New York wendel

Green Infrastructure:

Quantifiable Economic Benefits

RETAIL CENTER

The figures below present the key assumptions, proposed green infrastructure property improvements, and the resulting benefits for a midsize retail center.

GREEN INFRASTRUCTURE IMPROVEMENTS

40,000-sq.-ft. **green roof**, installed at the end of the life of the existing conventional roof, with green covering 90 percent of surface, or 36,000 sq. ft.

50 strategically planted **medium-size trees**, 25 opposite west-facing walls and 25 opposite south-facing walls

Bioswales and **rain gardens** that manage 1 inch of runoff from 2,000 sq. ft. of adjacent impervious area

72,000-sq.-ft. **permeable-pavement** parking lot

Cisterns to capture runoff from 5,000 sq. ft. of roof area and use for irrigation

BUILDING ASSUMPTIONS
(BEFORE IMPROVEMENTS)

SIZE	40,000 sq. ft.
STORIES	1
ROOF SIZE	40,000 sq. ft.
LOT AREA	128,000 sq. ft.
PERMEABLE AREA (COVERED IN TURF)	4,000 sq. ft.
NUMBER OF STORES	15
ANNUAL RENT	$17 per sq. ft.
ANNUAL RETAIL SALES	$2,182,000 per store

POTENTIAL BENEFITS

Energy savings due to reduced demand for heating and cooling	**$3,560** Annually
Avoided costs for conventional roof replacement	**$607,750** net present value over 40-year analysis period
Tax credit	**$100,000** one-time credit in year of installation
Increased **retail sales**	**$1.2 MILLION** per year
Stormwater **fee reduction**	**$14,020** Annually (projected to increase 6% per year)
Total present value benefits (over 40-year analysis period)	**$24,202,000 +** (including $22,963,800 in increased retail sales, which accrue to the tenants)

NON-QUANTIFIED BENEFITS

Water **conservation**	+
Increased **property value**	++
Reduced infrastructure costs due to use of permeable pavement system	+/U
Reduced crime	+/U
Improved **health and employee satisfaction**	+ (for tenants and employees)
Reduced costs associated with flooding	U

ULI New York wendel

Green Infrastructure:

Quantifiable Economic Benefits

MEDIUM-SIZE OFFICE BUILDING

The figures below present the key office building assumptions, the proposed green infrastructure property improvements, and the resulting benefits.

GREEN INFRASTRUCTURE IMPROVEMENTS

- 17,900-sq.-ft. **green roof**, installed at the end of life of the existing conventional roof, with green covering 80 percent of the surface, or 14,300 sq. ft. (Remainder of roof is impervious area.)
- 20 strategically **planted trees**, 10 opposite a west-facing wall and 10 opposite an east-facing wall
- 10,000-sq.-ft. **permeable pavement** parking lot, installed at the end of life of the existing parking lot
- **Bioswales** and **rain gardens** that manage 1 inch of runoff from 4,700 sq. ft. of adjacent impervious area

BUILDING ASSUMPTIONS (BEFORE IMPROVEMENTS)

SIZE	53,600 sq. ft.
STORIES	3
ROOF SIZE	17,900 sq. ft.
LOT AREA	32,000 sq. ft.
PERMEABLE AREA (COVERED IN TURF)	1,000
ANNUAL RENT	$19.23 per sq. ft.

POTENTIAL BENEFITS

Energy savings due to reduced demand for heating and cooling	**$1,630** Annually
Avoided costs for conventional roof replacement	**$271,970** present value over 40-year analysis period
Tax credit	**$67,130** one-time credit in year of installation
Increased **rental income**	**$72,150** annually (assuming no vacancies)
Stormwater **fee reduction**	**$3,490** Annually (projected to increase 6% per year)
Total present value benefits (over 40-year analysis period)	**$1,863,000 +**

NON-QUANTIFIED BENEFITS

Increased **property values**	++
Reduced infrastructure costs due to use of permeable pavement system	+
Reduced crime	+/U
Improved **health and employee satisfaction**	+ (for tenants and employees)
Reduced costs associated with flooding	U

ULI New York wendel

GI and Landscape Architecture

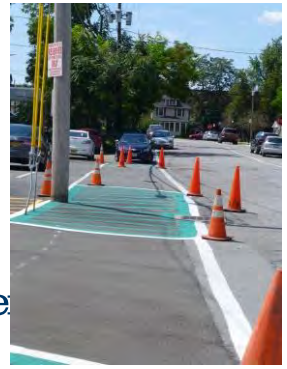
- GI can be a win/win proposition. Meet the requirements while also providing a beautiful project.
- Trees and vegetation are often removed for budget expectations, in GI they are the feature
- Create a Stewardship plan for ongoing function and community benefit

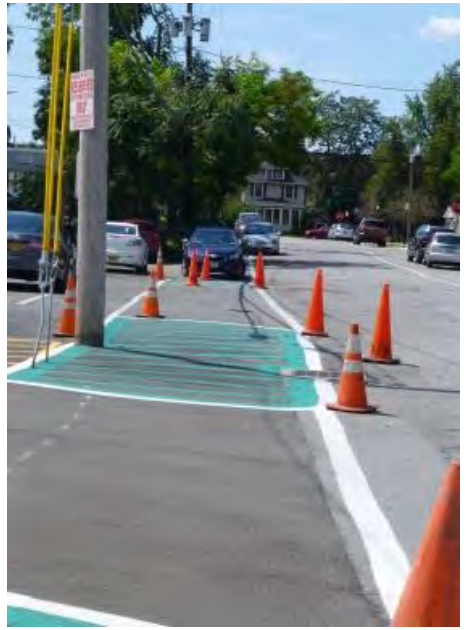
ULI New York wendel

ULI New York wendel

Involving the Public with GI

- Tactical Urbanism to “Try Design on”
- Test the design spatially as well as gauge community support
- Have fun!





ULI New York

wendel

Understanding the Regulatory Requirements

NYS DEC

- All developments with over 1.0 acre of disturbance need runoff reduction for water quality requirements, typically using standard stormwater management practices

City of Buffalo – Green Code

- All development greater than 0.25 acres of disturbance shall provide GI
  - Hierarchy of preference

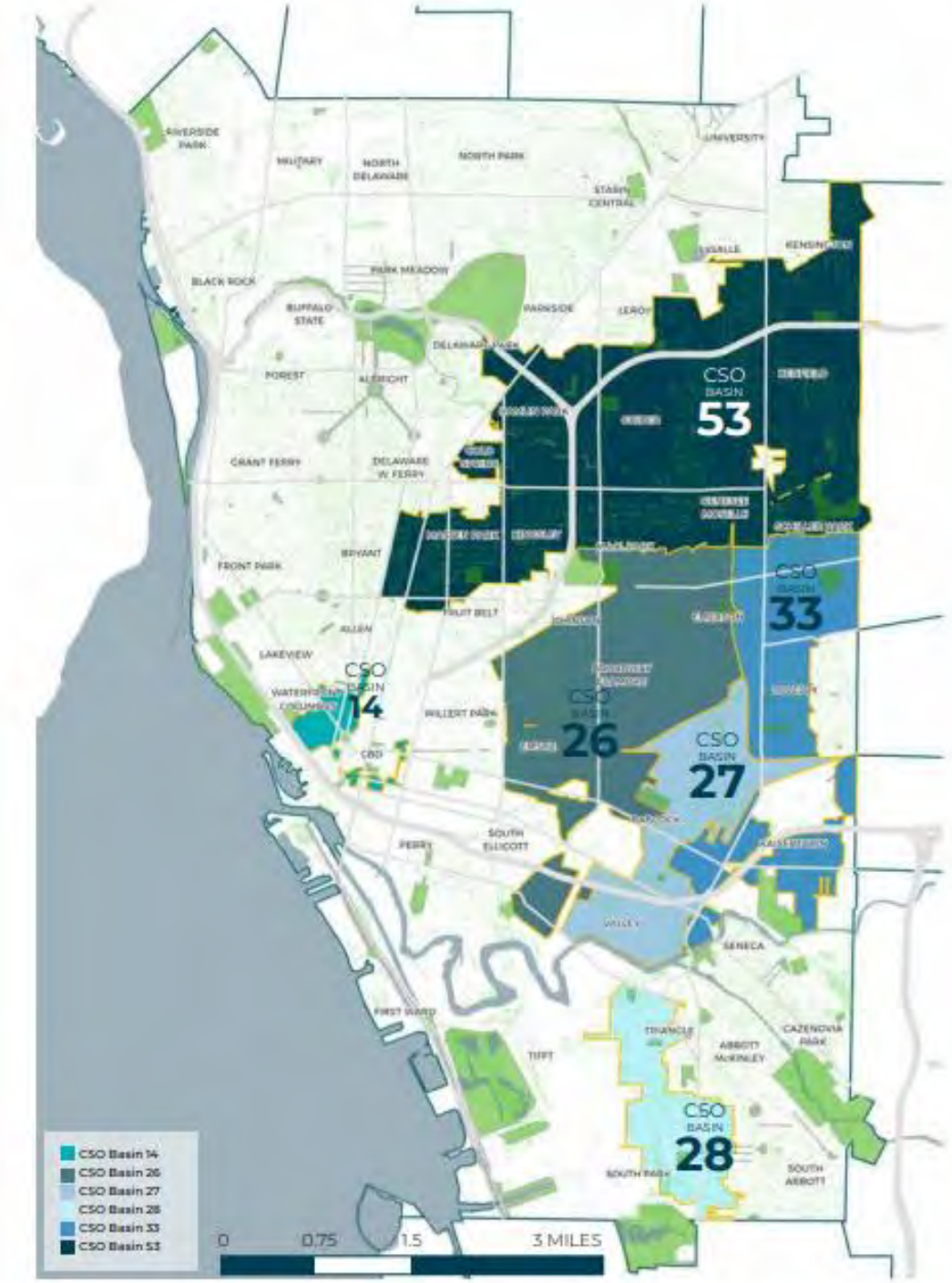
Potential Funding Sources

BSA Rain Check 2.0

- CSO Priority Basins

Rain Check 2.0 Grant Program

https://raincheckbuffalo.org/grants/



ULI New York wendel

Project Examples

Niagara Street

ULI New York wendel

Ohio Street Pervious Pavement

- Travel Lanes are Standard Asphalt
- Parking Lanes are Pervious Asphalt

ULI New York wendel

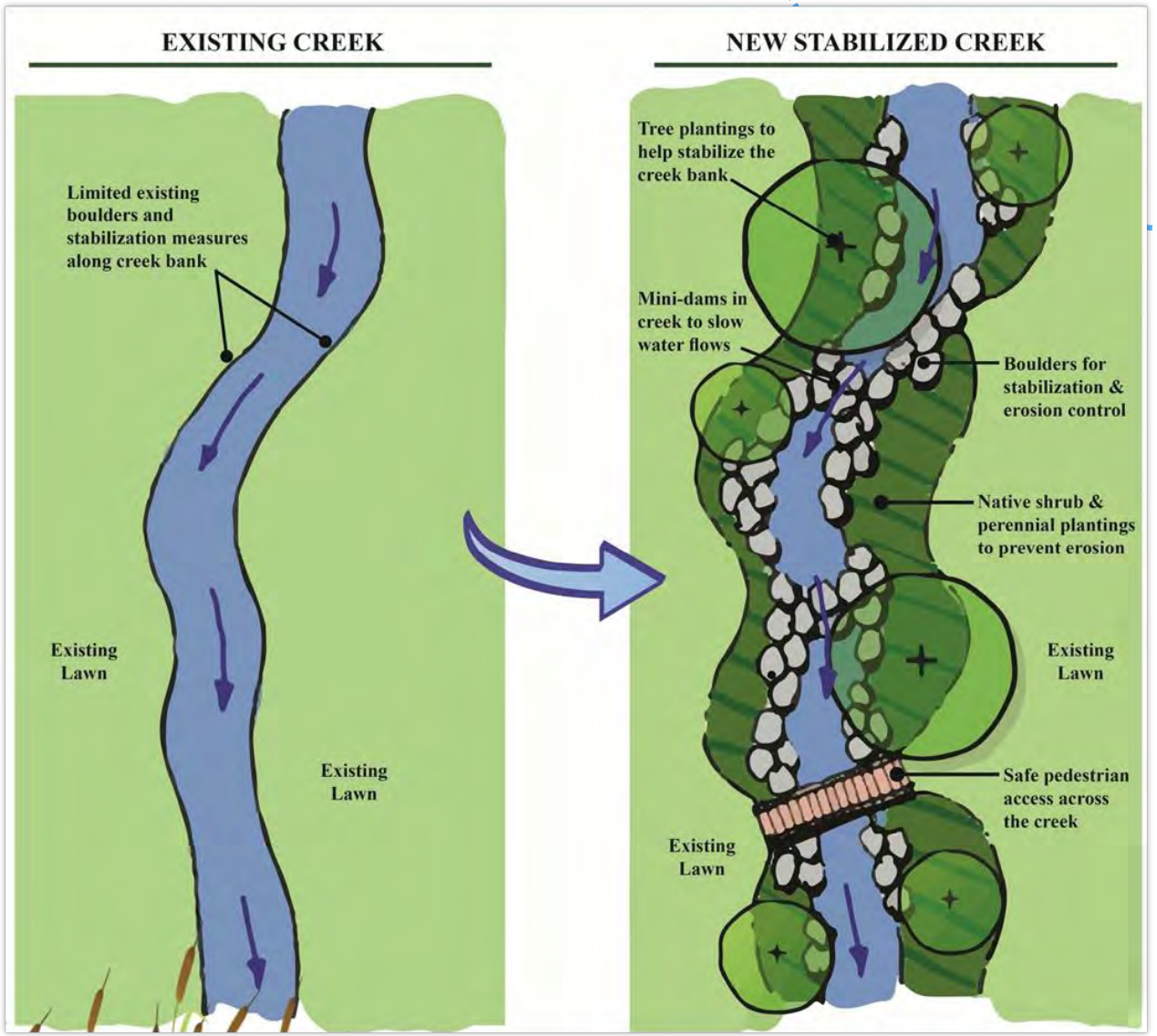
William Street: Pervious Pavement & Bioretention

ULI New York

wendel

Pratt Willert Community Center: Bioretention

Chautauqua Institution: Streambank Restoration



Q & A

Thank you!

Whether by increasing potential development yield, introducing tangible amenities for residents, reducing operating costs, or building on a broader placemaking strategy, innovative stormwater management strategies can create value and contribute to the quality of life and resilience in cities.

– Harvesting the Value of Water, ULI