Aldrich + Elliott
WATER RESOURCE ENGINEERS

CITY OF ST. ALBANS, VERMONT

Lower Weldon
Combined Sewer Overflow

Long Term Control Plan

March 2019

90% SUBMITTAL

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FIGURES

1. PROJECT PLANNING

1.1. Introduction

The City of St. Albans completed a “CSO Planning Study” in August 2013 with Aldrich + Elliott, PC which documented individual and cumulative anticipated impacts of recently completed, on-going and potential future CSO improvement projects. The report intended to provide City staff with an in-house planning tool to make sure potential CSO abatement opportunities are identified.

With the recent issuance of the Lake Champlain Phosphorus TMDL, the State started reissuing the Discharge Permits. Within the Discharge Permit, an updated 1272 Order was issued to the City. A copy of this 1272 Order is available in Appendix B. Under section (1), the 1272 Order requires that the City implement the following minimum controls to maximize pollutant capture and minimize impacts to water quality:

- Proper operation and maintenance programs for collection systems and CSO outfalls;
- Maximum use of the collection system for storage without endangering public health or property, or causing solids deposition problems;
- Review and modification of pretreatment requirements to assure that CSO impacts are minimized;
- Maximization of flow to the treatment plant for treatment consistent with an evaluation of alternative treatment options;
- Prohibition of CSO’s during dry weather;
- Control of solid and floatable materials in CSO’s;
- Establishment of pollution of prevention programs to minimize contaminants in CSO’s;
- Public notification to ensure that the public receives adequate notification of CSO’s and CSO impacts, which shall, at a minimum, comply with the CSO Rule; and
- Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.

Under section (I) (B), submittal of a report on the CSO control projects for the previous calendar is required by January 31st of each year. The latest CSO progress report was submitted by the City in December 2018.

Under section (II), the 1272 Order requires that a Long-Term Control Plan (LTCP) be prepared and submitted within 18 months of the date of the Order which was issued on October 1, 2017. The municipality shall employ a public participation process that actively involves the affected public in the decision-making to develop and select the long-term CSO controls. As a minimum, the LTCP shall include:

- An alternatives analysis that shall evaluate the costs and performance of multiple CSO control alternatives;

- A detailed list of the selected CSO control projects to bring the CSO's into compliance with the VWQS and a timeline for implementing the projects;
- A strategy to ensure that new sources of stormwater and wastewater to the CSS do not increase the volume, frequency, or duration of CSO events through implementation of control measures;
- Measures to address and prevent any documented, recurrent instances of sewage backups or discharges of raw sewage onto the ground surface;
- A financing plan to design and implement the CSO control projects identified;
- Green stormwater infrastructure for stormwater runoff and sewer overflow management to the greatest extent possible; and
- A proposed schedule to bring the municipality's CSO's into compliance with the VWQS.

The City of St. Albans retained Aldrich + Elliott, PC to prepare a Long Term Control Plan to document and evaluate completed, ongoing, and future CSO control projects. This plan will develop and evaluate alternatives to reduce the frequency and volume of overflows to comply with the Vermont Water Quality Standards (VWQS).

1.2. Location

The City of St. Albans is located in Franklin County, Vermont. The city is surrounded by "St. Albans Town" which is incorporated separately from the city. The St. Albans sewer system serves users within the City and Town of St. Albans while the storm system mostly serves users in the City. The sewer and stormwater collection systems are shown in Figures No. 1 and 2 in Appendix A.

1.3. Environmental Resources Present

The City consists of residential, commercial, and industrial users. There are known hazardous waste generators near potential project areas that must be monitored closely if projects are recommended to be completed near these sites. These generators are mostly located near the downtown area of the City.

An initial review of the ANR Natural Resources Atlas indicated potential environmental concerns within several of the project areas. These environmental concerns will need to be evaluated in greater detail as projects are further developed.

This criteria will need to be explored in more detail for each specific project as they move through preliminary and final design.

1.4. Population Trends

The 2000 census population for the City of St. Albans was 7,650, while the 2010 census population estimate is 6,918. This census data shows an approximate 9.6% decrease in the population over the past decade. The median household income from the American Community Survey 5-Year Estimate for Hartford is $37,221.

The 2000 census population for the Town of St. Albans was 5,086, while the 2010 census population estimate is 5,999. This census data shows an approximate 18.0% increase in the population over the past decade. The median household income from the American Community Survey 5-Year Estimate for Hartford is $46,875.

1.5. Community Engagement

Public engagement for the City of St. Albans is accomplished through publicly warned City Council meetings and public votes. The City has not passed a bond vote or held a public meeting for the proposed CSO abatement projects. A public hearing was conducted on March 25, 2019, as required for the Long Term Control Plan to present and receive comments on the alternatives. A copy of this presentation is provided in Appendix L. Comments were provided on the siting of a new off-line storage tank and CSO treatment system, and these concerns are discussed further in the plan.

2. EXISTING CONDITIONS

2.1. Location Map

The sewer and stormwater collection system maps are shown on Figures No. 1 and 2, respectively.

2.2. History

2.2.1 Sewer and Stormwater Systems

The sewer and stormwater systems in many areas of the City were separated in the 1970's and 1980's. This work included construction of new storm sewers and a new parallel interceptor sewerline which runs north to the wastewater treatment facility. The original sewer interceptor was converted to conveyance of stormwater, so this work removed a significant amount of stormwater from the combined sewer system (CSS) and created new stormwater outfalls which discharge to Rugg and Stevens Brooks.

An inventory of the sewer and stormwater systems was completed in 2008. Each catch basin, manhole, and outfall was inspected and located using a GPS unit. Figures No. 1 and 2 in Appendix A show the existing sewer and stormwater systems. Figure No. 3 in Appendix A highlights various catch basins and drainage manholes that are connected to the combined sewer system as well as drainage areas delineated by Northwest Regional Planning Commission. These drainage areas depict surface runoff that goes directly into a stream, into the stormwater system, and into the combined sewer system. These drainage areas were used to prioritize areas of the City in order to disconnect surface runoff which discharges to the combined sewer system.

2.2.2 Lower Welden Street CSO Monitoring

The Lower Welden Street Combined Sewer Overflow (CSO) is located at the intersection of South Elm Street and Lower Welden Street. The CSO is located in an area where the sewer and storm systems are not completely separated. During periods of heavy rain, the combined flow surcharges the interceptor sewerline which extends to Lower Welden Street. In December 2008, the City installed an overflow metering manhole. By installing this metering manhole, the overflow is piped below ground, preventing the overflow from discharging to the ground surface near the intersection. This manhole measures overflow volume through a rectangular weir using an ultrasonic flow meter to accurately record the volume, peak flow, and duration of overflows that are discharged into Stevens Brook. Automatic monitoring of the overflow has been performed from December 2012 until present. By installing this metering structure, the City complies with sections (I)(9)(A) and (II)(4) outlined in the 1272 Order.

2.3. Rainfall Data

In accordance with the State of Vermont Combined Sewer Overflow Control Policy, the overflows in St. Albans shall comply with the 5-year design storm when the 24-hour rainfall total exceeds 2.6 inches or the rainfall intensity exceeds 1.2 inches per hour and shall comply with the Vermont Water Quality Standards. Preliminary design criteria is developed around monitoring data for a 24-hour, 2.6" design storm event. Total daily rainfall data is available in Appendix F.

A rain gauge located outside of the City highway garage is used to measure total daily rainfall and rainfall intensity. Use of this precipitation monitoring system complies with section (I)(9)(A) of the 1272 Order. The City garage is located approximately 0.7 miles north of the Lower Welden CSO location. The rain gauge is used from March through November and is not in use during the winter months of December through February due to freezing conditions.

Rainfall data was used from the rain gauge when it was in service from August 2015 through December 2018. Data prior to August 2015 is unavailable due to problems with the unit. The rain gauge was not operational during the following time periods:

- August 1, 2015 – August 20, 2015
- June 23, 2017 – July 8, 2017

The Weather Underground Station in St. Albans (KVTSTALB3) was used for precipitation and rainfall intensity data when the rain gauge was not in service. Historical rainfall data was not available prior to August 2015.

A summary of the monthly rainfall and number of events greater than 0.5 inches for a three (3) year period from August 20, 2015 through December 10, 2018 is provided in Table 2.1. It was observed that although the number of rain events greater than 0.5 inches varies between 15 and 23 events, the total yearly rainfall stays relatively consistent between 30.5 and 34.5 inches per year.

Table 2.1
Monthly Total Rainfall and Events >0.5 inches

Month	2015		2016		2017		2018	
	Total Monthly Rainfall (inches)	Number of Events >0.5"	Total Monthly Rainfall (inches)	Number of Events >0.5"	Total Monthly Rainfall (inches)	Number of Events >0.5"	Total Monthly Rainfall (inches)	Number of Events >0.5"
January	-	-	0	0	1.09	0	2.45	2
February	-	-	2.38	1	2.53	1	1.6	2
March	-	-	2.27	1	1.79	0	1.45	0
April	-	-	2.25	1	4.5	2	5.04	3
May	-	-	2.59	1	2.42	1	1.82	1
June	-	-	3.05	2	4.19	3	2.2	2
July	-	-	4.05	2	2.16	2	2.99	1
August	1.66	2	6.96	5	2.12	1	2.02	1
September	4.89	4	2.59	3	2.34	2	2.97	3
October	2.69	3	4.09	2	3.93	2	4.2	3
November	1.59	0	2.33	1	2.83	1	4.64	2
December	0	0	1.54	0	0.88	0	3.21	3
Total	**10.83**	**9**	**34.14**	**19**	**30.78**	**15**	**34.54**	**23**

Notes:

1. Data is used from the rain gauge when it was in service from 8/20/2015 through 6/22/2017, and 7/9/2017 through 9/11/2018.
2. The rain gauge was not operational between 6/23/2017 and 7/8/2017.

Below is a yearly summary of the rainfall data:

- **2015:** There were a total of nine (9) storm events from the start of data collection with a 24 hour total rainfall over 0.5 inches. Of these nine (9) events, two (2) occurred in the summer (June, July, August) and seven (7) occurred in the fall (September, October, November).
- **2016:** There were a total of nineteen (19) storm events with a 24 hour total rainfall over 0.5 inches. Of these nineteen (19) events, three (3) occurred in the spring (March, April, May), nine (9) occurred in the summer (June, July, August), six (6) occurred in the fall (September, October, November), and two (2) occurred in the winter (December, January, February).
- **2017:** There were a total of fifteen (15) storm events with a 24 hour total rainfall over 0.5 inches. Of these fifteen (15) events, three (3) occurred in the spring (March, April, May), six (6) occurred in the summer (June, July, August), five (5) occurred in the fall (September, October, November), and one (1) occurred in the winter (December, January, February).
- **2018:** There were a total of twenty three (23) storm events with a 24 hour total rainfall over 0.5 inches. Of these twenty three (23) events, four (4) occurred in the spring

(March, April, May), four (4) occurred in the summer (June, July, August), eight (8) occurred in the fall (September, October, November), and seven (7) occurred in the winter (December, January, February).

2015 Rainfall Data

Nine (9) rainfall events were greater than 0.5 inches in a 24-hour period. The maximum intensity of 0.68 inches per hour was recorded on August 20th. There were no rainfall events greater than the 2.6” per 24-hour period design storm, and there were no events with intensities greater than 1.2 inches per hour.

Table 2.2 provides a summary of the 2015 rainfall events greater than 0.5 inches including the date, daily rainfall total, and maximum intensity in inches/hour.

Table 2.2
2015 Rainfall Data
Rainfall Events >0.5”

Date	Daily Rainfall (inches)	Maximum Intensity (inches/hr)
8/20/2015	0.68	0.68
8/25/2015	0.52	0.52
9/8/2015	1.2	0.55
9/13/2015	0.51	0.17
9/29/2015	0.72	0.08
9/30/2015	1.43	0.14
10/9/2015	0.82	0.21
10/28/2015	0.59	0.13
10/29/2015	0.63	0.34

Notes:
1. Data is used from the rain gauge when it was in service from 8/20/2015.

2016 Rainfall Data

The total yearly rainfall for 2016 was 34.1 inches. Nineteen (19) rainfall events were greater than 0.5 inches in a 24-hour period. The maximum intensity of 2.26 inches per hour was recorded on February 26th. There were no rainfall events greater than the 2.6” per 24-hour period design storm. The rain event on February 26th had a maximum intensity greater than 1.2 inches per hour.

Table 2.3 provides a summary of the 2016 rainfall events greater than 0.5 inches including the date, daily rainfall total, and maximum intensity in inches/hour.

Table 2.3
2016 Rainfall Data
Rainfall Events >0.5"

Date	Daily Rainfall (inches)	Maximum Intensity (inches/hr)
2/26/2016	2.26	0.2
3/28/2016	0.59	0.14
4/7/2016	0.65	0.15
5/29/2016	0.92	0.59
6/5/2016	1.5	0.54
6/22/2016	0.53	0.32
7/22/2016	1	0.23
7/23/2016	0.97	0.66
8/12/2016	0.78	0.25
8/16/2016	0.61	0.23
8/21/2016	1.11	0.76
8/28/2016	2.3	0.98
8/31/2016	1	0.56
9/11/2016	0.51	0.42
9/19/2016	0.53	0.41
9/23/2016	0.84	0.19
10/21/2016	1.06	0.16
10/22/2016	1.11	0.19
11/25/2016	0.51	0.08

Notes:

1. Data is used from the rain gauge when it was in service from 1/1/2016-12/31/2016.

2017 Rainfall Data

The total yearly rainfall for 2017 was 30.8 inches. Fifteen (15) rainfall events were greater than 0.5 inches in a 24-hour period. The maximum intensity of 0.80 inches per hour was recorded on July 17th. There were no rainfall events greater than the 2.6" per 24-hour period design storm, and there were no events with intensities greater than 1.2 inches per hour.

Table 2.4 provides a summary of the 2017 rainfall events greater than 0.5 inches including the date, daily rainfall total, and maximum intensity in inches/hour.

Table 2.4
2017 Rainfall Data
Rainfall Events >0.5"

Date	Daily Rainfall (inches)	Maximum Intensity (inches/hr)
2/25/2017	1.09	0.33
4/1/2017	0.63	0.21
4/6/2017	1.07	0.25
5/1/2017	1.15	0.35
6/23/2017	1.53	0.35
6/24/2017	0.74	0.47
6/29/2017	1.14	0.38
7/17/2017	0.8	0.80
7/24/2017	0.57	0.11
8/18/2017	0.62	0.26
9/3/2017	0.92	0.13
9/5/2017	0.64	0.28
10/9/2017	1.58	0.32
10/26/2017	0.91	0.17
11/3/2017	0.68	0.51

Notes:

1. Data is used from the rain gauge when it was in service from 1/1/2017 through 6/22/2017, and 7/9/2017 through 9/11/2018.
2. Rainfall Data from 6/23/2017-7/8/2017 was taken from Weather Underground.

2018 Rainfall Data

The total yearly rainfall for 2018 was 33.9 inches. Twenty three (23) rainfall events were greater than 0.5 inches in a 24-hour period. The maximum intensity of 1.41 inches per hour was recorded on July 25th. There were no rainfall events greater than the 2.6" per 24-hour period design storm. The rain event on July 25th had a maximum intensity greater than 1.2 inches per hour.

Table 2.5 provides a summary of the 2018 rainfall events greater than 0.5 inches including the date, daily rainfall total, and maximum intensity in inches/hour.

Table 2.5
2018 Rainfall Data
Rainfall Events >0.5”

Date	Daily Rainfall (inches)	Maximum Intensity (inches/hr)
1/12/2018	0.87	0.28
1/23/2018	0.73	0.14
2/11/2018	0.6	0.23
2/20/2018	0.57	0.13
4/16/2018	0.6	0.13
4/25/2018	0.68	0.15
4/29/2018	1.03	0.11
5/3/2018	0.65	0.22
6/4/2018	0.51	0.08
6/18/2018	0.7	0.27
7/25/2018	1.77	1.41
8/8/2018	0.8	0.27
9/11/2018	0.62	0.39
9/21/2018	0.8	0.27
9/26/2018	0.71	0.37
10/2/2018	1.14	0.24
10/11/2018	0.82	0.19
10/27/2018	0.55	0.19
11/2/2018	0.55	0.08
11/3/2018	1.01	0.17
12/2/2018	0.58	0.1
12/21/2018	0.66	0.1
12/22/2018	0.67	0.16

Notes:

1. Data is used from the rain gauge when it was in service from 1/1/2018-12/31/2018.

2.4. Lower Welden Street Overflow Data

The 1272 Order requires the City to monitor the Lower Welden CSO discharges to characterize the CSO impacts, so the overflow discharges are measured inside the overflow metering manhole. A rectangular weir is used as the primary measurement device, and an ultrasonic level sensor and flow meter located inside the flow metering manhole are used to calculate the frequency, duration, and magnitude of the overflows. The software records the time, level, and flow rate every ten (10) minutes, and this data is transmitted via cellular through the Mission telemetry unit for web based access by the City and engineer.

Tables 2.6 and 2.7 provide a summary of the overflow events from May 24th, 2012 until the last time the meter data was downloaded on December 25, 2018. Of these thirty-seven (37) events, 3 events occurred during a storm event greater than the 2.6” 24-hour or 1.2 inch per hour design storm in which an overflow occurred and they are highlighted in the table. For overflows that have occurred during rainfall and snow melt events, the water equivalency of the snow melt was estimated using the National Oceanic and Atmospheric Administration (NOAA) daily snow/water equivalency mapping.

Table 2.6
Lower Welden Street CSO
Overflow Event Log (2012-2016)

Date	Overflow Start Time	Overflow End Time	Total Duration (Hours)	Total Volume (Gallons)	Maximum Overflow Rate (MGD)	Total 24 Hour Rainfall (in.)	Max Rainfall Intensity (in./hour)
5/24/2012-5/26/2012	22:30	8:55	34.08	1,786,644	3.5	2.81	0.26
7/24/2012	0:15	1:00	0:45	37,613	1.2	1.22	0.94
10/19/2012	19:30	20:40	1.16	20,000	0.7	1.03	0.58
3/12/2013	14:40	22:20	7.67	565,562	3.3	0.91 Snow/Water Eq. 1[3] 1.91	0.22
6/25/2013	13:35	15:05	1.5	98,305	1.5	0.92	0.81
7/5/2013	17:05	17:50	0.75	21,076	1.0	0.60	0.60
7/7/2013	16:30	17:25	0.92	25,063	1.2	0.56	0.44
4/15/2014-4/16/2014	12:45	3:20	14.58	607,674	3.321	1.38	0.59
5/17/2014	1:55	5:25	3.5	184,735	1.804	0.75	0.75
5/22/2015	12:22	4:30	4.17	33,684		1.06	0.64
6/9/2015			6.42	504,563			
6/12/2015			5.9	276,076		1.26	0.41
7/1/2015				419,796		0.84	0.36
8/22/2015	14:00	15:00	1	100	0.024	0.4	0.25
8/25/2015	14:00	14:45	0.75	7,700	0.246	0.52	0.52
2/26/2016	0:00	13:00	13	1,436,000	1.06	2.26 Snow/Water Eq. 1[3] 3.26	0.2
6/5/2016	17:45	19:45	2	266,900	4.109	1.46	0.67
8/21/2016	18:15	19:15	1	128,100	4.032	0.98	0.84
8/28/2016	16:30	21:00	4.5	671,100	4.09	2.3	1.4
8/31/2016	17:15	18:30	1.25	141,600	4.022	1	0.57

Notes:

1. Total 24 hour rainfall was obtained from the St. Albans highway garage rain gauge.
2. Shaded areas indicate events where the storm event was greater than a 2.6” 24-hour or 1.2”/hr design storm.
3. Snow melt water equivalency was obtained from the National Oceanic and Atmospheric Administration (NOAA).
4. The last time the overflow meter data was downloaded was on December 25, 2018.
5. The rain gauge did not record data on 5/17/2014, 6/9/2015.

Table 2.7
Lower Welden Street CSO
Overflow Event Log (2017-2018)

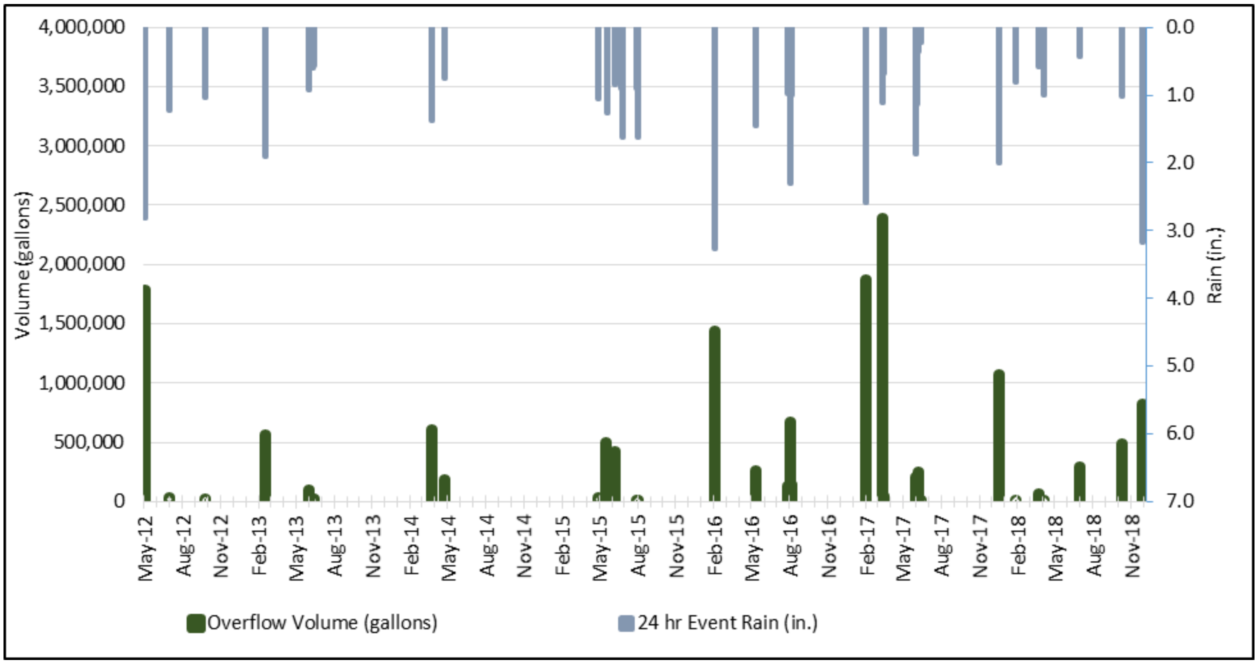
Date	Overflow Start Time	Overflow End Time	Total Duration (Hours)	Total Volume (Gallons)	Maximum Overflow Rate (MGD)	Total 24 Hour Rainfall (in.)	Max Rainfall Intensity (in./hour)
2/25/2017-2/26/2017	17:45	5:30	11.75	1,877,800	4.109	1.18 Snow/Water Eq. 0(3) 1.18	0.39
4/6/2017-4/7/2017	14:15	5:00	14.75	2,395,900	4.118	1.12	0.28
4/7/2017	16:45	18:30	1.75	42,800	1.45	0.66	0.19
4/7/2017	20:00	20:15	0.25	900	0.086	0.68	0.19
6/23/2017	13:00	14:30	1.5	103,600	4.042	1.23	0.45
6/24/2017	1:30	3:15	1.75	203,400	4.08	1.87	0.48
6/29/2017	21:00	21:45	0.75	20,800	1.037	0.98	0.4
6/29/2017	22:00	23:15	1.25	133,400	4.08	1.14	0.4
6/30/2017	22:00	23:45	1.75	247,000	4.061	0.36	0.28
7/8/2017	8:00	8:45	0.75	4,800	0.365	0.22	0.19
1/12/2018	9:00	16:00	7	1,073,500	4.08	1.00 Snow/Water Eq. 1(3) 2.00	0.35
2/20/2018	11:45	12:15	0.5	1,600	0.1056	0.52 Snow/Water Eq. 0.3(3) 0.82	0.16
4/16/2018	19:30	20:45	1.25	65,500	2.189	0.59	0.22
4/29/2018	21:15	21:45	0.50	300	0.0192	1	0.1
7/25/2018	21:15	23:30	2.25	293,300	4.07	0.43	0.43
11/3/2018	14:00	17:45	3.75	493,200	4.09	1.01	0.17
12/22/2018	6:00	11:15	5.25	829,700	4.04	0.97 Snow/Water Eq. 2.2(3) 3.17	0.35

Notes:

1. Total 24 hour rainfall was obtained from the St. Albans highway garage rain gauge.
2. Shaded areas indicate events where the storm event was greater than a 2.6” 24-hour or 1.2”/hr design storm.
3. Snow melt water equivalency was obtained from the National Oceanic and Atmospheric Administration (NOAA).
4. The last time the overflow meter data was downloaded was on December 25, 2018.

Figure 2.1 provides a summary of the overflow events described in Tables 2.6 and 2.7. The majority of the overflow events were observed to occur between January and July. Typically, the total rainfall and/or snowmelt totals about 1” before an overflow occurs. These overflows are largely caused by snow melt on frozen ground and high groundwater levels contributing to the surface runoff reaching the combined sewer system. Once the groundwater level drops in late summer, overflows rarely occur. This indicates that the existing sewer collection system can generally provide adequate storage for the large rainfall events which occur late summer and fall.

Figure 2.1
Overflow Event Summary (2012-2018)



The number of overflow events typically range from 3 to 7 per year. The average overflow volume has stayed relatively the same, however the majority of the largest overflows occurred in 2017 which had very wet weather conditions from about May through July. Overall, the individual rainfall events weren't excessive, so it isn't clear what caused these significant overflow events.

Table 2.8 provides a summary of the overflow events with a storm event similar to the 2.6" 24-hour design storm. There were three (3) overflow events where storm conditions were similar to the design storm.

- The first event occurred on February 26, 2016. The total 24-hour rainfall was 2.26 inches plus 1 inch of snow melt and the maximum intensity was 0.2 inches/hour.
- The second event occurred on August 28, 2016. The total 24-hour rainfall was 2.3 inches and the maximum intensity was 1.4 inches/hour.
- The most recent event occurred on December 22, 2018. The total 24-hour rainfall was 0.97 inches plus 2.2 inches of snow melt and the maximum intensity was 0.16 inches/hour.

Table 2.8
Lower Welden Street CSO
Summary of Overflow Events Similar to Design Storm

Date	Overflow Start Time	Overflow End Time	Total Duration (Hours)	Total Volume (Gallons)	Maximum Overflow Rate (MGD)	Total 24 Hour Rainfall + Snowmelt Equiv. (in.)	Max Rainfall Intensity (in./hour)
2/26/2016	0:00	13:00	13	1,436,000	1.06	3.26	0.2
8/28/2016	16:30	21:00	4.5	671,100	4.09	2.3	1.4
12/22/2018	6:00	11:15	5.25	829,700	4.04	3.17	0.35

The largest total volume of overflow recorded for an event similar to the design storm was 1,436,000 gallons, which occurred in 2016. Since 2016, completed CSO abatement projects have disconnected approximately 15.2 acres of surface area contributing to the combined sewer system, which during a 2.6” design storm equates to around 695,000 gallons entering the sewer system. This aligns closely with the observed volume of 830,000 gallons seen during the 12/22/2018 overflow event. It is estimated that more than 1,000,000 gallons of stormwater runoff still needs to be removed from the combined sewer system and/or temporary off-line storage needs to be provided for this design storm to control the CSO’s.

2.5. Wastewater Treatment Facility Bypass Data

Tables 2.9 through 2.13 provide a summary of the wastewater treatment facility (WWTF) influent flows for the time periods of 2012 to present when overflows have occurred at the Lower Welden CSO. The dates of when an overflow was recorded are shaded. Typically, a bypass at the WWTF occurs when the flow rate exceeds 8 MGD. All of the influent flow receives preliminary and primary treatment, and the bypass flow is disinfected and blended with the effluent. When the WWTF influent flow rate is in excess of 8 MGD, the interceptor sewerline can surcharge, and if the flow backs up all of the way to Lower Weldon Street, then a CSO can occur. This bypass process at the WWTF meets the minimum control measure (I)((4) specified in the 1272 Order which requires maximization of flow to the treatment plant.

The other reason for summarizing this data is that it can be used in evaluating the CSO control alternatives. Further separation will be needed to reduce the flows entering the combined system, however, off-line storage may be applicable in combination with the separation projects. If the CSO is stored temporarily, then there needs to be adequate capacity in the interceptor sewerline and WWTF to receive this flow after the storm event recedes.

Table 2.9
Wastewater Treatment Facility
2012-2013 Influent Flow Conditions During Lower Welden CSO Events

Date	Rainfall/ Snowmelt Equivalency (in.)	Overflow Duration (Hours)	Overflow Volume (Gallons)	Max Flow Rate (MGD)	Treated Flow (MG)	Bypass Flow (MG)	Bypass Duration (Hours)	Total Flow (MG)
5/23/2012				4.00	2.704	0	0	2.70
5/24/2012	0.94	1.50	112,771	4.00	2.876	0	0	2.88
5/25/2012	1.48	24.00	1,293,472	4.10	2.518	0	0	2.52
5/26/2012	0.39	8.92	380,401	3.90	2.554	0	0	2.55
5/27/2012				3.40	6.642	0	0	6.64
5/28/2012				8.00	3.112	0.242	3	3.35
7/23/2012				8.00	2.846	0.915	4.5	3.76
7/24/2012	1.22	0.75	37,613	5.20	2.52	0	0	2.52
7/25/2012				4.00	2.389	0	0	2.39
7/26/2012				3.40	2.2	0	0	2.20
10/18/2012				3.40	2.908	0	0	2.91
10/19/2012	1.03	1.17	20,000	8.20	6.015	0.688	3.5	6.70
10/20/2012				8.20	5.795	0.034	1	5.83
10/21/2012				6.00	5.201	0	0	5.20
3/10/2013				7.30	5.026	0	0	5.03
3/11/2013				8.60	5.824	0.003	0.25	5.83
3/12/2013	1.91	7.67	565,562	8.40	7.543	2.948	20	10.49
3/13/2013				8.00	6.519	0.018	1	6.54
3/14/2013				6.20	5.042	0	0	5.04
6/22/2013				6.50	3.846	0	0	3.85
6/23/2013				4.60	3.788	0	0	3.79
6/24/2013				6.50	3.813	0	0	3.81
6/25/2013	0.92	1.50	98,305	8.10	3.817	0	0	3.82
6/26/2013				8.10	4.485	0.08	1.5	4.57
6/27/2013				8.10	5.355	0.107	2.5	5.46
7/4/2013				8.00	4.1	0	0	4.10
7/5/2013	0.60	0.75	21,076	8.20	5.229	0.441	3	5.67
7/6/2013				8.00	4.871	0	0	4.87
7/7/2013	0.56	0.92	25,063	8.20	6.385	0.523	5.7	6.91
7/8/2013				7.90	5.512	0	0	5.51
7/9/2013				6.00	4.347	0	0	4.35

Table 2.10
Wastewater Treatment Facility
2014-2015 Influent Flow Conditions During Lower Welden CSO Events

Date	Rainfall/ Snowmelt Equivalency (in.)	Overflow Duration (Hours)	Overflow Volume (Gallons)	Max Flow Rate (MGD)	Treated Flow (MG)	Bypass Flow (MG)	Bypass Duration (Hours)	Total Flow (MG)
4/13/2014				9.10	5.77	0.052	2	5.82
4/14/2014				9.10	7.59	0.133	4	7.72
4/15/2014	1.38	11.25	597,308	8.80	7.953	4.566	18	12.52
4/16/2014		3.33	10,366	8.50	8.035	2.298	24	10.33
4/17/2014				8.00	7.869	0.441	18	8.31
4/18/2014				9.10	7.804	0.004	1	7.81
5/16/2014				9.60	5.453	1.195	8	6.65
5/17/2014	0.75	3.50	184,735	9.00	6.21	0.057	2.5	6.27
5/18/2014				8.50	4.904	0	0	4.90
5/19/2014				6.90	4.686	0	0	4.69
5/20/2014				5.80	4.22	0	0	4.22
5/21/2014				5.40	3.892	0	0	3.89
5/22/2014	1.06	4.17	33,684	8.50	4.484	0.008	1	4.49
5/23/2014				8.80	5.847	0.37	5	6.22
5/24/2014				8.50	5.149	0	0	5.15
6/8/2015				8.50	4.385	0	0	4.39
6/9/2015		0.27	504,563	8.70	7.118	2.167	14	9.29
6/10/2015				8.90	7.569	0.358	10	7.93
6/11/2015				8.80	6.251	0.006	0.75	6.26
6/12/2015	1.26	5.90	276,076	9.00	7.459	2.146	13.5	9.61
6/13/2015				8.90	7.216	0.332	11	7.55
6/14/2015				8.70	5.517	0	0	5.52
6/30/2015				5.30	2.9	0	0	2.90
7/1/2015	0.84		419,796	8.90	6.226	0.61	8	6.84
7/2/2015				6.10	4.967	0	0	4.97
7/3/2015				5.20	4.113	0	0	4.11
8/21/2015				8.40	3.326	0	0	3.33
8/22/2015	0.4	1	100	4.00	2.818	0	0	2.82
8/23/2015				3.50	2.387	0	0	2.39
8/24/2015				5.40	2.768	0	0	2.77
8/25/2015	0.52	0.75	7,700	4.10	2.822	0	0	2.82
8/26/2015				5.20	2.923	0	0	2.92
8/27/2015				3.90	2.832	0	0	2.83

Table 2.11
Wastewater Treatment Facility
2016 Influent Flow Conditions During Lower Welden CSO Events

Date	Rainfall/ Snowmelt Equivalency (in.)	Overflow Duration (Hours)	Overflow Volume (Gallons)	Max Flow Rate (MGD)	Treated Flow (MG)	Bypass Flow (MG)	Bypass Duration (Hours)	Total Flow (MG)
2/24/2016				8.80	7.037	3.701	19	10.74
2/25/2016				8.70	6.423	0.428	6	6.85
2/26/2016	3.26	13	1,436,000	6.60	5.029	0	0	5.03
2/27/2016				5.20	4.091	0	0	4.09
2/28/2016				5.30	3.515	0	0	3.52
6/4/2016				3.60	2.574	0	0	2.57
6/5/2016	1.46	2	266,900	9.00	4.724	0.485	5	5.21
6/6/2016				4.60	3.131	0	0	3.13
6/7/2016				5.50	3.267	0	0	3.27
8/20/2016				3.50	2.297	0	0	2.30
8/21/2016	0.98	1	128,100	8.80	3.54	0.31	2	3.85
8/22/2016				4.70	2.808	0	0	2.81
8/23/2016				4.50	2.628	0.31	2	2.94
8/27/2016				3.50	2.431	0	0	2.43
8/28/2016	2.3	4.5	671,100	8.80	5.087	1.131	5	6.22
8/29/2016				8.80	4.125	0	0	4.13
8/30/2016				8.80	3.478	0	0	3.48
8/31/2016	1	1.25	141,600	8.80	5.178	0.308	3	5.49
9/1/2016				5.90	4.078	0	0	4.08
9/2/2016				5.80	3.381	0	0	3.38

Table 2.12
Wastewater Treatment Facility
2017 Influent Flow Conditions During Lower Welden CSO Events

Date	Rainfall/ Snowmelt Equivalency (in.)	Overflow Duration (Hours)	Overflow Volume (Gallons)	Max Flow Rate (MGD)	Treated Flow (MG)	Bypass Flow (MG)	Bypass Duration (Hours)	Total Flow (MG)
2/24/2017				8.90	6.341	0	0	6.34
2/25/2017	1.18	6.25	1,877,800	8.80	7.636	3.46	14	11.10
2/26/2017		5.50		10.20	7.625	0.814	10	8.44
2/27/2017				9.10	6.304	0	0	6.30
2/28/2017				6.30	5.526	0	0	5.53
4/1/2017				9.00	5.036	0	0	5.04
4/2/2017				9.10	7.637	0.229	3	7.87
4/3/2017				9.50	6.998	0.004	0.25	7.00
4/4/2017				8.20	8.1	1.197	24	9.30
4/5/2017				9.20	7.466	0.085	5	7.55
4/6/2017	1.12	9.75	2,395,900	9.10	7.832	3.888	18	11.72
4/7/2017		5.00		8.80	8.889	3.128	24	12.02
4/8/2017				9.00	6.872	0.085	4	6.96
4/9/2017				9.20	5.973	0	0	5.97
6/19/2017				9.10	3.144	0.067	1	3.21
6/20/2017				9.00	3.34	0.027	1	3.37
6/21/2017				4.30	2.945	0	0	2.95
6/22/2017				6.70	3.18	0	0	3.18
6/23/2017	1.23	1.5	103,600	9.10	6.54	0.799	4	7.34
6/24/2017	1.87	1.75	203,400	9.10	5.568	0.028	1	5.60
6/25/2017				5.60	4.342	0	0	4.34
6/26/2017				6.10	3.748	0	0	3.75
6/27/2017				8.70	3.7	0	0	3.70
6/28/2017				4.90	3.434	0	0	3.43
6/29/2017	1.14	0.75 / 1.25	154,200	9.00	5.483	0	0	5.48
6/30/2017	0.36	1.75	247,000	9.00	6.764	0	0	6.76
7/1/2017				8.90	5.555	0.022	0.5	5.58
7/2/2017				6.30	4.945	0	0	4.95
7/7/2017				4.20	3.084	0	0	3.08
7/8/2017	0.22	0.75	4,800	9.10	4.505	0.154	2.5	4.66
7/9/2017				5.70	3.687	0	0	3.69
7/10/2017				8.80	4.075	0.025	1	4.10

Table 2.13
Wastewater Treatment Facility
2018 Influent Flow Conditions During Lower Welden CSO Events

Date	Rainfall/ Snowmelt Equivalency (in.)	Overflow Duration (Hours)	Overflow Volume (Gallons)	Max Flow Rate (MGD)	Treated Flow (MG)	Bypass Flow (MG)	Bypass Duration (Hours)	Total Flow (MG)
1/11/2018				10	5.543	0.091	4	5.634
1/12/2018	1	7	1,073,500	8.9	7.557	2.703	21	10.26
1/13/2018				8.80	6.209	0	0	6.209
1/14/2018				8.80	4.794	0	0	4.794
2/19/2018				6.5	4.401	0	0	4.401
2/20/2018	0.52	0.5	1,600	8.7	8.029	2.006	22	10.035
2/21/2018				8.80	7.408	0.638	8	8.046
2/22/2018				8.80	5.808	0	0	5.808
4/15/2018				6.2	4.42	0	0	4.42
4/16/2018	0.59	1.25	65,500	8.6	7.296	0.454	6	7.75
4/17/2018				8.70	6.899	0.042	3	6.941
4/18/2018				8.80	5.59	0	0	5.59
4/27/2018				8.4	5.15	0	0	5.15
4/28/2018				6.2	4.52	0	0	4.52
4/29/2018	1	0.50	300	8.3	7.538	1.974	22	9.512
4/30/2018				8.70	7.297	0.589	7	7.886
5/1/2018				8.70	6.006	0.002	0.75	6.008
7/24/2018				6.60	2.651	0	0	2.65
7/25/2018	0.43	2.25	293,300	9.30	4.023	0.435	4	4.46
7/26/2018				5.10	3.157	0	0	3.16
7/27/2018				6.40	2.899	0	0	2.90
11/2/2018				9.60	5.035	0	0	5.04
11/3/2018	1.01	3.75	493,200	9.10	6.638	1.124	10	7.76
11/4/2018				6.50	4.769	0	0	4.77
11/5/2018				5.50	4.12	0	0	4.12
12/21/2018				9.40	6.93	0.741	9	7.67
12/22/2018	3.17	5.28	829,700	8.90	6.864	0.992	17	7.86
12/23/2018				8.70	5.171	0	0	5.17
12/24/2018				6.00	4.547	0	0	4.55

2.6. Condition of Existing Facilities

Approximately 18 percent of the City's catch basins are still connected to the sewer system. During heavy rain events, the stormwater discharge into the combined sewer system can cause high flows at the wastewater treatment facility. This causes flows greater than 8.0 mgd to receive only primary treatment and disinfection. These high flows surcharge the interceptor sewerline and can also cause combined sewer overflows (CSOs) at the Lower Welden Street CSO that discharges untreated sewage and stormwater into Stevens Brook.

A sanitary sewer and storm sewer system inventory was performed in 2008. Each catch basin, sewer and storm manhole, and outfall was physically located using a global positioning (GPS) unit. Each catch basin and manhole was physically inspected to observe condition, pipe size, material, and flow direction. Table 2.14 provides a summary of interconnected storm and sewer infrastructure. The information has been updated to include recent storm and sewer separation projects.

Table 2.14
Summary of Storm Sewer Infrastructure

Item	Quantity
Catch Basins connected to Combined Sewer	149
Catch Basins connected to Storm Sewers	659
Drainage Manholes Connected to Combined Sewer	10
Drainage Manholes connected to Storm Sewer	236
Stormwater Outfalls	34

A combined sewer storm map was produced as part of the inventory and is provided in Figure No. 3 in Appendix A. Catch basins and drainage manholes connected to the combined sanitary sewer system are colored in red, while those connected to storm sewers are colored in blue. Sanitary sewer manholes and pipelines are colored in brown. The Northwest Regional Planning Commission commissioned the delineation of the different drainage subareas throughout the city. These drainage areas are also depicted on Figure No. 3 in Appendix A. The areas shaded in green are areas of overland flow where run-off flows directly to surface water. Areas in blue are areas in which run-off flows to a catch basin connected to a storm sewer, and areas in red are areas where run-off flows to a catch basin that is connected to the combined sanitary sewer. Table 2.15 summarizes the overall acres contributing run-off to overland flow, storm sewers and combined sewers. About 10.5% of the drainage area or 160 acres in the City directs surface runoff to the combined sewer system.

Table 2.15
Summary of Drainage Areas

Drainage Area Type	Area (Acres)
Overland Flow to Surface Water	443
Flow to Catch Basins Connected to Storm Sewers	925
Flow to Catch Basins Connected to Combined Sewer	160

Table 2.16 summarizes the major drainage areas identified on Figure No. 3 in Appendix A in which surface run-off flows to catch basins connected to the combined sewers. The largest drainage areas which flow into the sanitary sewer system include the area surrounding Messenger and Congress Street, Upper Welden Street, Federal Street, Cedar Street, and Lake Street (between South Main and Maple Street). There are other smaller areas connected to the combined sewers that are not included in this table.

Table 2.16
Summary of Drainage Areas for Combined Sewers

Drainage Area Name	Impervious Area (SF)	Pervious Area (SF)	Total Area (SF)
Main Street Streetscape Project	39,000	0	39,000
Federal Street	532,000	97,000	629,000
Lower Welden Street (includes Edward Street, Russell Street, and Murray Drive)	121,000	362,000	483,000
Lake Street (between South Main and Maple including portions of Houghton and Federal)	607,000	21,000	628,000
Stebbins Street (includes Post Office Roof)	42,000	6,000	48,000
Cedar Street	106,000	436,000	542,000
Pearl Street (between Walnut and Adams)	35,000	131,000	166,000
Lake Street (between Russell and Huntington)	67,000	35,000	102,000
Stowell Street	99,000	66,000	165,000
Messenger/ Congress/ High/ Prospect Streets	326,000	1,593,000	1,919,000
Messenger/ Borley/ Farrar Streets	184,000	599,000	783,000
Bishop Street (between Church and Lincoln)	36,000	15,000	51,000
Upper Welden (between Lincoln Ave and Thorpe Ave)	220,000	544,000	764,000
Total			
SF	2,414,000	3,905,000	6,319,000
Acres	55	90	145

Areas that are a part of or near the downtown area have been prioritized and are the focus of this long term control plan. This is due to the downtown area having a high groundwater table and large impervious areas which results in poor infiltration and high surface runoff. These flows are not attenuated and currently reach the interceptor sewer quickly with high peak flows which can cause the surcharging of this sewerline.

2.6.1 Completed CSO Related Improvements

Since 2012, CSO related improvements have been completed by the City and are listed below:

- Lower Welden Street CSO Monitoring
- Main Street Streetscape Project (Phase I)
- Lake Street Reconstruction (Phase I)
- Fairfield Street Reconstruction

A total of 15.2 acres of drainage area have been disconnected from the combined sewer system since 2012. This equates to approximately 695,000 gallons of runoff during a 2.6, 24-hour design storm. Stormwater runoff calculations are available in Appendix E.

Lower Welden Street CSO Monitoring

In 2012, the City purchased and installed an overflow metering manhole which consists of a manhole with a baffle wall, rectangular weir, and a data logging ultrasonic flow meter. A new overflow pipe was installed from the overflow manhole to the existing storm sewer that outlets to Stevens Brook. The overflow runs below ground in the pipes, minimizing the discharge of raw sewerage onto the ground surface. The overflow metering manhole was installed along the overflow pipe in order to monitor the overflow frequency, duration, and volume. The rectangular weir was installed at an elevation just below the manhole rim elevation so that all of the overflow would be metered; but not too low to allow more frequent overflows. A sensor measures the volume of and duration of overflows when they occur and a mission unit records the data which can be used for remote monitoring of the site. The discharge from the overflow metering manhole is released into the Stevens Brook. Automatic monitoring of the overflow has been performed from 2012 until present and meets complies with section (I)(9) of the 1272 Order.

Main Street Streetscape Project (Phase I)

In 2011, Aldrich + Elliott performed a basement inspection of all the buildings along Main Street within the streetscape project area. The basement inspection included identifying the water service, sewer service and buildings that have roof drains connected to the sewer system. There is a total of 39,156 square feet of roof area connected to the combined sewer from the buildings on the west side of North Main Street. In the spring of 2013 as part of the streetscape project (phase I), the City decided to provide a separate storm pipe for several of these buildings. A new pipe was extended through the building foundations for those buildings that connect to the existing sewerline that exits to the Main Street side (east) only. This separate storm system was constructed from Lake Street north to the City Hall, and included connections for approximately 12 of these buildings. This was done due to the difficulty of bringing the roof drain lines from the rear of the buildings to the front. A total of up to 26,293 square feet of roof area could be diverted to the stormwater system in the future. If this work wasn't performed under Phase I, then there wouldn't be a separate outlet provided for a separate roof drain.

Connection is anticipated to be voluntary as property owners may need to perform extensive renovations which could include interior replumbing. It should also be noted that there is a cost/benefit to disconnecting individual roofs. The priority should be the larger roofs as the smaller roofs that are less than 1,500 sf won't have a significant impact on reduction of the flows even if they are disconnected.

Drawings from the Main Street Streetscape Project are available in Appendix J. Information gathered from the basement inspection and current status of the roof drain connections are summarized in Table 2.17.

Table 2.17
Main Street Basement Inspection Summary

Location	Prop. #	Sewer Connection	Roof Drain Connected to Sewer	Storm Pipe Provided as Part of Streetscape Project	Area of Roof Connected to Combined Sewer (S.F.)
South Main Street - West Side	20-24	4" CI to back	N	N	0
	24-28	4" CI to Main Street	N	N	0
	30-36	4" CI to Main Street	N	N	0
	38	6" CI to Main Street	N	N	0
	42-46	6" CI to Main Street	Y	N	4,128
	52-54	6" PVC to Stebbins Street	Y	N	7,626
	2-8	4" CI to back	Y	N	3,816
	10	4" CI to back	Y	N	1,197
	12	4" CI to back	N	N	0
	16-18	4" PVC to back	N	N	0
	20-24	4" CI to back	N	N	0
North Main Street - West Side	46	4" CI to back	N	N	0
	40-44	4" CI to Main Street	N	Y	2,100
	36-38	4" CI to Main Street	N	Y	1,562
	32-34	4" CI to Main Street	N	Y	1,386
	30	4" CI to Main Street	N	Y	6,944
	22-28	4" CI to Main Street	N	Y	2,700
	18-20	4" CI to Main Street	N	Y	2,775
	6-16	4" CI to Main Street	N	Y	0
	2	4" CI to back	N	N	0
	104-108	4" CI to Hudson	N	N	0
	100	4" CI to Main Street	N	N	0
	92-94	4" CI to Main Street	N	Y	1,080
	86	4" CI to Main Street	N	Y	4,048
	80	4" CI to Main Street	N	Y	3,698
	76-78	4" CI to back	Y	N	1,420
	72-74	4" CI to back	Y	N	1,360
	68-70	4" CI to back	Y	N	2,250
	64-66	4" CI to back	Y	N	3,003
	60-62	4" CI to back	Y	N	1,680
	56-58	4" CI to back	Y	N	1,680
	54	4" CI to back	Y	N	1,470
	50-52	4" CI to back	N	N	0
	46	4" CI to back	N	N	0
North Main Street - East Side	89	4" CI to Main Street	N	N	0
	83-87	4" CI to Main Street	N	N	0
	81	4" CI to Main Street	N	N	0
	77	4" CI to Main Street	N	N	0
	71-75	4" CI to Main Street	N	N	0
	65	4" CI to Main Street	N	N	0

Lake Street Reconstruction (Phase I)

In 2013, water, sewer, and stormwater improvements were completed on Lake Street between Main Street and Federal Street during reconstruction of the roadway. Approximately five (5) catch basins were disconnected from the sanitary sewer system and redirected into the stormwater system. Approximately 109,771 square feet (2.5 acres) of surface runoff was redirected into a separate stormwater system in this project. However, the stormwater system in this section of the city ultimately discharges into the combined sewer system downstream on Lake Street. This system will need to be fully disconnected further west on Lake Street in order to divert the stormwater out of this new sewer collection system as phase II of this project. When this system is fully disconnected approximately 158,800 gallons of stormwater runoff during the 2.6" 24-hour design storm will be removed from the sewer system.

Fairfield Street Reconstruction

In 2016, water, sewer, and stormwater improvements were completed on Fairfield Street between High Street and Smith Street during the roadway reconstruction project. Nine (9) catch basins and a stormwater manhole were disconnected from the combined sanitary sewer system. New catch basins and stormwater piping were constructed to covey this flow into existing the stormwater system. Approximately 661,000 square feet (15.2 acres) of drainage area was redirected from the combined sewer system in this project. This disconnected approximately 695,000 gallons of stormwater runoff during the 2.6" 24-hour design storm from the sewer system.

2.7. Financial Status of Existing Facilities

The City of St. Albans has continued to invest in their sewer and storm infrastructure and has been constructing and planning projects that focus on CSO control. Some of these projects remove flow from the combined sewer system and other projects can achieve this goal under future phases. Over the past 5 years, the City has invested approximately $1,500,000 in CSO related control work for the projects previously discussed.

2.8. Water/Energy/Waste Audits

This section is not applicable to the overall Long Term Control Plan but may be applicable to specific CSO control projects as they are developed.

3. NEED FOR PROJECT

3.1. Health, Sanitation, and Security

The State adopted the Combined Sewer Overflow Rule on August 25, 2016 which is included in the Environmental Protection Rule, Chapter 34. The purpose of this Rule is protect public health and the environment by ensuring that all remaining CSO's are brought into compliance with the requirements of state and federal law, including the Vermont Water Quality Standards (VWQS). The Combined Sewer Overflow Rule has requirements necessitating the identification of CSO outfalls for municipalities with combined sewer-storm systems during the National Pollutant Discharge Elimination System (NPDES) discharge permit application and renewal process. These NPDES Discharge Permits issued to municipalities with CSO outfalls contain conditions required by the CSO Rule requiring compliance with the technology-based and water quality-based requirements of state and federal law, including VWQS.

Under Phase I of the General Requirements in the CSO Rule, the municipality is required to:

- Implement the technology-based minimum controls and document that these requirements have been met.
- Comply with the water quality-based requirements of state law, including the VWQS. If a municipality is not in compliance with water quality-based requirements of state law, the Agency will issue a 1272 Order with the NPDES discharge permit which is a legally enforceable mechanism requiring the municipality to update a Long Term Control Plan (LTCP).

During Phase II of the General Requirements in the CSO Rule, the following is required.

- As a condition of the NPDES Discharge Permit, a municipality shall continue implementing the minimum controls.
- Once the Agency has approved a municipality's LTCP, the Agency shall issue an order containing a compliance schedule by which the municipality shall implement the CSO controls identified in its Agency approved LTCP.

3.2. Reasonable Growth

Reasonable growth will be considered and incorporated into the proposed CSO control projects to minimize the addition of new stormwater flow to the combined sewer system. As land is developed and more impervious surfaces are created, the increased surface runoff will need to be diverted to the storm infrastructure.

3.3. Preliminary Design Criteria

Table 3.1 provides a summary of overflow events with a storm event similar to the 2.6 inch 24-hour design storm. There were three (3) similar storm events where the rainfall totals range from 2.26 to 2.81 inches. The total overflow volumes ranged from 671,100 gallons to 1,436,000 gallons and the maximum overflow rate ranged from 1.06 to 4.09 MGD. These three (3) events occurred on February 26, 2016, August 28, 2016, and December 22, 2018.

Table 3.1
Lower Welden Street CSO
Summary of Overflow Events Similar to Design Storm

Date	Overflow Start Time	Overflow End Time	Total Duration (Hours)	Total Volume (Gallons)	Maximum Overflow Rate (MGD)	Total 24 Hour Rainfall + Snowmelt Equiv. (in.)	Max Rainfall Intensity (in./hour)
2/26/2016	0:00	13:00	13	1,436,000	1.06	3.26	0.2
8/28/2016	16:30	21:00	4.5	671,100	4.09	2.3	1.4
12/22/2018	6:00	11:15	5.25	829,700	4.04	3.17	0.35

The largest total volume of overflow recorded for a similar design storm event was 1,436,000 gallons which occurred in 2016. These recent projects have disconnected approximately 15.2 acres of surface area contributing to the combined sewer system, which during a 2.6” design storm equates to around 695,000 gallons entering the sewer system. This aligns closely with the observed volume of 830,000 gallons seen during the 12/22/2018 overflow event. It is estimated that a minimum of 1,000,000 gallons of stormwater runoff would either need to be removed from the sanitary sewer system and/or have temporary off-line storage available for this design storm.

The permitted capacity of the St Albans Wastewater Treatment Facility (WWTF) is 4.0 MGD. Over the past seven (7) years, the actual average annual flows at the WWTF have been between 58% and 73% of the design capacity or between 2.3 to 2.9 MGD. Table 3.2 provides a summary of the CSO elimination design criteria.

Table 3.2
Lower Welden Street CSO
CSO Elimination Design Criteria

Parameter	Current Flow Conditions
Flow (MGD)	2.3-2.9
Min. Volume of Off-line Storage or Stormwater f Removal Required to Control an Overflow at Lower Welden Street CSO (Gallons)	1,000,000 to 1,200,000

4. ALTERNATIVES CONSIDERED – CURRENT PROJECTS

4.1. In Progress CSO Related Improvements

The sewer and stormwater systems in many areas of the City were separated in the 1970's and 1980's. This work included construction of new storm sewers and a new interceptor sewerline which runs to the wastewater treatment facility. This work removed a significant amount of stormwater from the sewer system and created new stormwater outfalls which discharge to the Rugg and Stevens Brook.

Several storm-sewer separation projects are in various stages and are intended to reduce flows entering the combined sewer system. It is estimated that these improvements have the potential to disconnect approximately 1,152,700 gallons of stormwater from the combined sewer system. Stormwater runoff calculations for these projects are available in Appendix E. Some projects are in the study phase or have progressed to a design, but haven't proceeded to construction. A list and summary of these in progress projects are provided below.

- North Elm Street Catch Basin Separation
- Federal Street CSO Separation
- Main Street Roof Drain Separation (Phase II)
- Kingman Street Road Reconstruction
- Stebbins Street Road Reconstruction
- Hungerford Stormwater Project

4.1.1 North Elm Street Catch Basin Separation

There have been ongoing efforts by City staff to locate and disconnect stormwater infrastructure which is connected into the sanitary sewer system. While conducting field investigations on North Elm Street, a catch basin tied into a sewer manhole was discovered near 67 North Elm Street. There is a limited drainage area associated with this infrastructure so it is a relatively low priority. Infrastructure such as this will continue to be cataloged and disconnected in conjunction with other street upgrades.

4.1.2 Federal Street CSO Separation

In 1973, The City installed a separate storm drainage and sanitary sewer systems along Federal Street from Lake Street to Hoyt Street. The storm drainage system consisted of new 12"-21" storm sewers, catch basins, and storm manholes. There are a total of twenty two (22) catch basins connected to this system. The collection portion of this system is separated from the sanitary sewer, however it discharges to the combined sewer system on the west side of Federal Street between Kingman and Center Street and runs underneath the railroad tracks to the sanitary sewer on Pine Street.

Since the collection portion of this system is separate from the sanitary sewer, CSO separation would involve disconnecting the discharge point from the combined sewer and constructing additional infrastructure to connect into the stormwater system. Dye testing was conducted on December 20, 2018 in order to locate this discharge point. The interconnection between the stormwater system and the sewer system was unable to be located and additional investigation is needed in order to locate this interconnection. Further work with the City on television inspection of these existing pipelines is planned once the weather is suitable.

Two alternative layouts are currently being considered which are dependent on the existing interconnection between the sewer and stormwater systems. Further field investigation needs to be completed before an alternative layout can be selected. The first alternative involves disconnecting the storm infrastructure at the intersection of Pearl and Pine Street. New stormwater piping will run along Pearl Street and discharge the stormwater into the existing stormwater trunk line at the intersection of Pearl and Maple Street. The second alternative will involve the construction of new stormwater piping from Federal Street, crossing the railroad via directional boring, and crossing onto Pine Street just north of Food City. New stormwater piping will run along Pine Street, turn onto Pearl Street and ultimately discharge the Federal Street stormwater into the existing stormwater trunk line at the intersection of Pearl and Maple Street.

Depending on the exact location of this discharge point and the selected alternative, a second phase of this project could utilize unused space just north of Food City by constructing a stormwater pond to provide storage and treatment. The drainage area that contributes to the stormwater runoff to this system is approximately 628,369 square feet (14.4 acres), 85% of it being impervious surface. An estimated 869,700 gallons of stormwater runoff during the 2.6" 24-hour design storm could be abated by separating this infrastructure. The location of the catch basins and drainage areas are shown on Figure No. 4 in Appendix A and additional drawings with the proposed alternatives are provided in Appendix G.

Advantages and disadvantages are listed below.

Advantages

- Separation provides a lower future operation and maintenance cost.
- Separation will reduce the flows to the wastewater treatment facility, reducing O&M costs and increasing reserve capacity.
- The second alternative has the benefit of providing stormwater storage and treatment in a future phase so as not to negatively impact the high flow targets for Stevens Branch specified in the Flow Restoration Plan.

Disadvantages

- Easements will be needed for work on private property if public funding will be used.
- Land acquisition will be required if the City were to include a stormwater detention and treatment pond as part of this project.
- Crossing the existing railroad tracks under the second alternative will be very costly.

- By removing these flows from the combined system, they will be diverted to the existing stormwater outfalls which can negatively impact the high flow targets set for Stevens Brook.
- Treatment may be required for the discharge.

4.1.3 Main Street Roof Drain Separation (Phase II)

In the spring of 2013 as part of the streetscape project (phase I), the City constructed storm pipe for approximately twelve (12) building roof drains that connect to the sewer that exit to the Main Street side only. A total of 26,293 square feet of roof area could be diverted to the stormwater system as part of this project.

These existing buildings have the potential to separate their roof drains and connect to these new storm pipes, but will require extensive interior plumbing modifications. These connections are voluntary at this point, but as a building requires extensive renovations, this would be time to encourage these disconnections. The focus here should also be in the larger roof areas as eliminating smaller roofs less than 1,500 s.f. won't have a significant impact on reducing the flows.

Advantages and disadvantages are listed below.

<u>Advantages</u>

- The Main Street roof drains connected to the sewer system exiting the backside could be disconnected from the sewer system as a part of the Federal Street CSO Separation Project.
- If renovation of a building is planned, disconnection of the roof drain can be done cost effectively.
- Separation provides a lower future operation and maintenance cost.
- Separation will reduce flows to the wastewater treatment facility, reducing O&M costs and increasing reserve capacity.

<u>Disadvantages</u>

- Easements will be needed for work on private property.
- This separation work would likely be the responsibility of the property owner and the interior modifications can be very costly.
- Removal of smaller roofs from the combined sewer system has a very minor impact on reducing the flows.
- Separation without storage or treatment can increase the peak flows to Stevens Brook, negatively impacting the high flow targets.

4.1.4 Kingman Street Road Reconstruction

There is currently no stormwater infrastructure on Kingman Street. The surface runoff currently flows west onto Federal Street where it enters the existing stormwater infrastructure. A full road reconstruction and utility design is currently in progress which is proposing to add additional catch basins on Kingman Street and connect into the stormwater collection system on Federal Street. Also, the building basements will be inspected to confirm which roofs are still connected to the sewer system. The estimated construction cost for this project is $964,000 (ENR 11390 = May 2019), with approximately $150,000 allocated towards stormwater improvements.

The drainage area that contributes to the stormwater runoff to this system is approximately 74,500 square feet, 99% of it being impervious surface. An estimated 65,200 gallons of stormwater runoff during the 2.6” 24-hour design storm is estimated to come from this drainage area. This runoff however is already accounted for in the Federal Street CSO separation evaluation. The location of the catch basins and drainage areas are shown on Figure No. 4 in Appendix A.

Advantages and disadvantages are provided below.

Advantages

- New stormwater infrastructure will be done concurrently with a full road reconstruction.
- Separation provides a lower future operation and maintenance cost.
- Separation will reduce flows to the wastewater treatment facility, reducing O&M costs and increasing reserve capacity.

Disadvantages

- Separation without storage or treatment can increase the peak flows to Stevens Brook, negatively impacting the high flow targets.

4.1.5 Stebbins Street Utility Upgrades

There are two (2) catch basins connected to the combined sewer on Stebbins Street. The back half of the post office also has a flat roof with roof drains connected to the combined sewer on Stebbins Street. The post office drains are separated from the sewer inside the building and outlet from the building through a separate pipe. The roof drain outlet pipe connects separately into a sewer manhole which makes separation easy. An existing separate storm drain system is located at the bottom of the hill at the intersection of Stebbins and Allen Street. Approximately 50 linear feet of new storm drainage piping will be required to separate the two (2) catch basins and roof drains from the sewer system. This separation is part of a larger utility upgrade project on Stebbins Street which is currently in the final design phase. Refer to Appendix H for these design drawings. The estimated construction cost for this project is $504,000 (ENR 11390 = May 2019), with approximately $133,400 going towards stormwater improvements.

The drainage area that contributes to the stormwater runoff to this system is approximately 47,300 square feet, 88% of it being impervious surface. An estimated 66,400 gallons of stormwater runoff during the 2.6” 24-hour design storm could be abated by separating this infrastructure. The layout of the catch basins and drainage areas are shown on Figure No. 5 in Appendix A and additional drawings are available in Appendix H.

Advantages and disadvantages are provided below.

Advantages

- New stormwater infrastructure will be done concurrently with a full road reconstruction.
- Separation provides a lower future operation and maintenance cost.
- Separation improvements will reduce flows to the wastewater treatment facility, reducing O&M costs and increasing reserve capacity.

Disadvantages

- Separation without storage or treatment can increase the peak flows to Stevens Brook, negatively impacting the high flow targets.

4.1.6 Hungerford Stormwater Project

In 2012 Watershed Consulting Associates, LCC through the Vermont Ecosystem Restoration Program conducted a stormwater feasibility study for the Hungerford Property. The purpose of the study was to evaluate the feasibility of conveying stormwater runoff to a proposed stormwater management system on the Hungerford Property via surface runoff and the main trunk line of the stormwater system. The study also evaluated low impact development (LID) opportunities in order to enhance groundwater recharge and mitigate stormwater runoff. A copy of the report body and relevant appendices are available in Appendix K.

The recommended stormwater management system consists of a lower and upper system. The lower system involves a water quality channel with natural vegetation and rocks to mitigate peak flows and treat stormwater from the trunk line. The upper system consists of a conventional flow control basin that would accept runoff from lateral surface inputs from the surrounding land.

A total of 38 subwatersheds with an approximate drainage area of 262.2 acres could potentially connect to the proposed Hungerford Stormwater System. Approximately 28% of this drainage area is impervious cover. Some of these subwatersheds connect to the stormater trunk line while others discharge into Stevens Book or the sewer collection system and intend to be redirected to the Hungerford Stormwater System.

This proposed project makes some assumptions on the feasibility of connecting some of the subwatersheds that run into Stevens Brook or the combined sewer system into the stormwater trunk line. The proposed subwatershed connections will need to be evaluated further in order to determine the feasibility of this recommendation.

Advantages and disadvantages are provided below.

<u>Advantages</u>

- Provides treatment and attenuation of stormwater flows.
- Can be constructed in phases.
- Separation will reduce flows to the wastewater treatment facility, reducing O&M costs and increasing reserve capacity.

<u>Disadvantages</u>

- Property would need to be purchased from Hungerford Family Trust Property to utilize for stormwater management system.
- Further investigation must be done to determine feasibility of connecting some of the upstream subwatersheds.

5. ALTERNATIVES CONSIDERED – FUTURE PROJECTS

5.1. Screening of CSO Control Alternatives

The objective of the Long-Term Control Plan (LTCP) is to determine the wet weather conditions that cause an overflow and estimate a volume of flow that needs to be controlled. Based on this preliminary design criteria, alternatives are evaluated for control of the Lower Welden Street CSO with a focus on green stormwater infrastructure opportunities. Alternatives could include the following:

- Sewer/Storm separation
- Green stormwater infrastructure
- Off-line storage
- CSO treatment
- Other

5.1.1 Storm / Sewer Separation

Storm/Sewer separation involves disconnecting interconnected storm and sewer infrastructure into two (2) separated systems. This approach removes the stormwater runoff from the combined sewer system to reduce the frequency and volume of overflows. However, by disconnecting the stormwater infrastructure from the combined sewer system, untreated stormwater discharges will increase in frequency and volume to the receiving waters.

Rugg Brook and Stevens Brook are listed as stormwater impaired waters by the State of Vermont due to urban stormwater runoff. A Total Maximum Daily Load (TMDL) is developed for these impaired waters. A TMDL attempts to limit discharge loads to impaired waters to attain water quality standards. The Department has issued EPA-approved hydrologic TMDLs for Stevens Brook, available in Appendix C, and Rugg Brook, available in Appendix D, in October of 2008. The City has Flow Restoration Plans developed to address the impairments, so proposed CSO control projects also need to align with the goals of this plan.

It is unclear on how the State would treat separation projects in stormwater impaired drainage areas. If the State treats the separation projects as new discharges, then a stormwater permit may be needed that requires treatment and detention. If the State treats the separation as existing discharges, then a permit may not be needed. A good case can be made that these are existing discharges because they serve existing impervious areas, but this will need to be confirmed with the State as these individual projects move forward.

5.1.2 Green Stormwater Infrastructure

Green Infrastructure involves any stormwater management technique or practice employed with the primary goal of preserving, restoring, mimicking, or enhancing natural hydrology. Green infrastructure includes, but is not limited to, methods of using soil and vegetation to promote soil percolation, evapotranspiration, and filtering or the harvesting and reuse of precipitation. Green stormwater infrastructure has the capability of treating what would otherwise be untreated stormwater which flows into the impaired Stevens Brook, and can also reduce the peak flows. These practices can also have the added benefit of reducing phosphorus loads on the stream. These practices can be beneficial when implemented with other CSO control projects, but can't significantly reduce the flows on their own. Also, these practices can have limited effectiveness when the overflows occur during snowmelt and/or frozen ground conditions. The following are types of green infrastructure that can be considered:

- Rain Gardens
- Rain Barrels or Cisterns
- Green Roofs and Rooftop Detention
- Pervious Pavement and Pavers
- Swales
- Constructed Wetlands
- Subsurface Detention or Infiltration

5.1.3 Off-line Storage

The objective of off-line storage is to reduce overflows by capturing combined sewage in excess of the overflow volume during wet weather for controlled release into the wastewater collection system after a storm event. Off-line storage can provide a relatively constant flow into the sewer system thereby reducing the hydraulic impact into the downstream WWTF. This infrastructure is typically located close to the overflow points. A major factor in determining the feasibility of off-line storage is land availability and siting. Operation and maintenance costs are generally low, typically requiring only collection and disposal cost for residual sludge solids, unless inlet or outlet pumping is required.

5.1.4 CSO Treatment

CSO treatment includes technologies designed to separate solids and/or floatables from the combined sewage flow and to disinfect for pathogens prior to discharge. This infrastructure is typically located at the overflow location. The following are types of treatment technologies to achieve these goals:

- Screening
- Vortex Separation
- Disinfection

5.2. CSO Separation Alternatives

Since the CSO Planning Study completed in 2013, the City has continued to prioritize CSO related projects. Projects that are currently in progress are summarized in Section 4.1. Potential future separation projects are listed below and are shown on Figures No. 6 through 11 in Appendix A.

- Lake Street (Phase II)
- Lower Welden Street (Murray Drive, Edward, & Russel Street)
- Congress, High, Messenger, & Prospect Street
- Messenger, Borley, and Farrar Street
- Upper Welden Street
- Cedar Street

5.2.1. Lake Street CSO Separation (Phase II)

In 2013, water, sewer, and stormwater improvements were completed on Lake Street between Main Street and Federal Street. Approximately five (5) catch basins were disconnected from the combined sewer system and redirected into the new stormwater collection system. However, the stormwater system in this section of the city ultimately discharges into the combined sewer system downstream. This system will need to be fully disconnected in order to divert the stormwater out of the combined sewer system as phase II of this project. When this system is fully disconnected, approximately 158,800 gallons of stormwater runoff during the 2.6" 24-hour design storm could be removed from the sewer system.

There are an additional twenty-one (21) catch basins connected to the combined sewer system along Lake Street between Main Street and Maple Street. Additional storm drainage infrastructure will need to be constructed in order to tie the existing catch basins into the stormwater system. A jack and bore will be required to extend existing stormwater infrastructure west on Lake Street underneath the existing railroad tracks, and will be very costly. Approximately 1,000 linear feet of new storm drain pipe will be required to reconnect to the existing stormwater interceptor on Maple Street.

The contributing drainage area to these catch basins is approximately 11.9 acres, 98% of it being impervious surface. It is estimated that an additional 760,000 gallons of stormwater runoff for the design storm could be removed from the sewer system by disconnecting this drainage area. Providing treatment and flow attenuation for this separation project will be difficult because of the location, so any negative impacts to the receiving stream need to be taken into account. The location of the catch basins and drainage areas are shown on Figure No. 6 in Appendix A, and stormwater runoff calculations are available in Appendix E.

5.2.2. Lower Welden Street (Murray Drive, Edward, & Russel Street)

There have been known drainage and flooding problems in the Murray Drive area. There are currently approximately 10 catch basins located on Huntington Street, Russell Street, and Edward Street connected to the sanitary sewer system. Additional storm drainage infrastructure will need to be constructed in order to tie the existing catch basins into the stormwater system. Approximately 2,000 linear feet of new storm drain pipe will be required. Preliminary site drawings of the proposed drainage improvements on Murray Drive are available in Appendix I.

The contributing drainage area to these catch basins is approximately 11 acres, 25% of it being impervious surface. It is estimated that 490,000 gallons of stormwater runoff for the design storm could be removed from the sewer system by disconnecting this drainage area. Any negative impacts to the receiving stream need to be taken into account for this separation project. The location of the catch basins and drainage areas are shown on Figure No. 7 in Appendix A, and stormwater runoff calculations are available in Appendix E.

5.2.3. Congress, High, Messenger, & Prospect Street

The largest drainage area connected to the combined sewer system is the area surrounding Congress, High, Messenger, and Prospect Street. There are currently approximately 12 catch basins located in this drainage area connected to the sanitary sewer system. Additional storm drainage infrastructure will need to be constructed in order to tie the existing catch basins into the stormwater system. Stormwater infrastructure will divert flow south along High, Prospect, and Messenger Street onto Congress Street, where it will continue west connecting onto existing infrastructure on either Church Street or Lincoln Avenue. Approximately 3,900 linear feet of new storm drain pipe will be required and the impacts to the downstream stormwater infrastructure will need to be further evaluated. Existing infrastructure and topography will need to be evaluated further in order to determine the feasibility of this project.

The contributing drainage area to these catch basins is approximately 44.1 acres, 17% of it being impervious surface. It is estimated that approximately 1,867,000 gallons of stormwater runoff for the design storm could be removed from the sewer system by disconnecting this drainage area. The location of the catch basins and drainage areas are shown on Figure No. 8 in Appendix A, and stormwater runoff calculations are available in Appendix E.

5.2.4. Messenger, Borley, & Farrar Street

One of the larger drainage areas connected to the combined sewer system is the area surrounding Messenger, Borley, and Farrar Street. There are currently approximately 8 catch basins located in this drainage area connected to the sanitary sewer system. Additional storm drainage infrastructure will need to be constructed in order to tie the existing catch basins into the stormwater system. New stormwater infrastructure will divert flow along Messenger Street into existing infrastructure on either Upper Newton Street or Lakeview Terrace. The topography of Messenger Street is nearly flat and there may be some difficulty maintaining the required slope (without pumping) and connecting to the existing stormwater infrastructure. Part of the flow from Messenger may need to be diverted north towards Lakeview Terrace while another portion may need to be diverted south to Upper Newton Street. Existing infrastructure and topography will need to be evaluated further in order to determine the feasibility of this separation project. Approximately 1,300 linear feet of new storm drain pipe will be required.

The contributing drainage area to these catch basins is approximately 18 acres, 23% of it being impervious surface. It is estimated that approximately 792,000 gallons of stormwater runoff for the design storm could be removed from the sewer system by disconnecting this drainage area. The location of the catch basins and drainage areas are shown on Figure No. 9 in Appendix A, and stormwater runoff calculations are available in Appendix E.

5.2.5. Upper Welden Street

One of the larger drainage areas connected to the combined sewer system is the area surrounding Upper Welden Street. There are currently approximately 9 catch basins located in this drainage area connected to the sanitary sewer system. Additional storm drainage infrastructure will need to be constructed in order to tie the existing catch basins into the stormwater system. Stormwater infrastructure will divert flow south along Lincoln Ave, Barlow Street, and Burnell Terrace onto Diamond Street, where it will continue west connecting onto existing infrastructure on Diamond Street. The topography of the drainage area is relatively flat and there may be some difficulty maintaining the required slope (without pumping) and connecting to the existing infrastructure. Approximately 1,700 linear feet of new storm drain pipe will be required. Existing infrastructure and topography will need to be evaluated further in order to determine the feasibility of this project.

The contributing drainage area to these catch basins is approximately 17.5 acres, 29% of it being impervious surface. It is estimated that approximately 799,000 gallons of stormwater runoff for the design storm could be removed from the sewer system by disconnecting this drainage area. The location of the catch basins and drainage areas are shown on Figure No. 10 in Appendix A, and stormwater runoff calculations are available in Appendix E.

5.2.6. Cedar Street

One of the larger drainage areas connected to the combined sewer system is the area along Cedar Street. There are currently approximately 13 catch basins located in this drainage area connected to the sanitary sewer system. Additional storm drainage infrastructure will need to be constructed in order to tie the existing catch basins into the stormwater system. New stormwater infrastructure will divert flow along Cedar Street connecting onto existing infrastructure on either Pearl Street or Lake Street. Approximately 1,500 linear feet of new storm drain pipe will be required. Existing infrastructure and topography will need to be evaluated further in order to determine the feasibility of this project.

The contributing drainage area to these catch basins is approximately 12.4 acres, 20% of it being impervious surface. It is estimated that approximately 536,000 gallons of stormwater runoff for the design storm could be removed from the sewer system by disconnecting this drainage area. The location of the catch basins and drainage areas are shown on Figure No. 11 in Appendix A, and stormwater runoff calculations are available in Appendix E.

5.3. Green Stormwater Infrastructure Alternatives

Watershed Consulting Associates, LCC reviewed existing information for the City including mapped CSO areas and existing stormwater infrastructure to assess the feasibility of constructing green stormwater infrastructure. Areas with green street potential were noted which consist of streets with adequate ROW width, low to moderate slopes and soil infiltration potential. A field assessment was then conducted to collect further data. The results of this field investigation are available in Appendix M.

Based on Watershed Consulting's field assessment, 34 locations were assessed which resulted in 27 potential green stormwater practices. These recommended practices include:

- Curb bump-outs
- Bioretention / Bioswales
- Removal of impervious cover
- Rooftop disconnection
- Stormwater planters
- Filer vaults
- Sand filters
- Gravel wetlands
- Subsurface filtration and detention

These sites were assigned scores based on numerous criteria some of which include drainage area, impervious surface, runoff volume, landowner, cost, and complexity. The top five (5) ranked green stormwater practices are summarized below in Table 5.1, and indicate the location, proposed practice, and drainage area. A full summary of all 27 sites considered is available in Appendix M.

Table 5.1
Green Stormwater Infrastructure
Top 5 Alternatives Summary

BMP ID	Location	Proposed Practice	Drainage Area (acres)
9	Federal Street & Hoyt Street	Gravel Wetland, Underground Storage, Sand Filter	4.49
2	Catherine Greenspace	Gravel Wetland, Underground Storage, Sand Filter	1.15
23	Pine Street & Lake Street	Gravel Wetland, Underground Storage, Sand Filter	1.86
11	Fiddlehead Dentist	Gravel Wetland, Underground Storage, Sand Filter	6.76
24	Railroad Parking	Underground Storage, Sand Filter	0.73

5.4. CSO Storage Alternatives

5.4.1. GMP Cooling Ponds for Off-Line Storage

This alternative considers utilizing the existing Green Mountain Power (GMP) cooling ponds on Lower Welden Street for temporary off-line storage of combined sewer between the elevation of the top of the sewer pipe and the overflow point. This off-line storage layout at this location has been evaluated in detail previously, but was eliminated from further consideration for several reasons. The City is evaluating using these existing ponds for stormwater management which could be a better use, and temporarily storing sewage in these open ponds creates some aesthetic and potential odor concerns.

5.4.2. New Above Ground Off-Line CSO Storage Tank

This alternative includes constructing a new glass-lined, above ground, covered storage tank along the interceptor line and in the vicinity of the overflow location. Feedback was received from the City that Houghton Park is not a suitable site for this use. The conceptual layout for this approach is presented, so other downstream locations along the interceptor sewer need to be explored further. One tank could initially be constructed with approximately 500,000 gallons of storage capacity. This would not abate all of the estimated overflow volume during design storm conditions without the completion of sewer separation projects. However, as in-progress CSO separation projects are completed the overflow volume that needs to be abated will be decreased. It is recommended the overflow volume be reevaluated as these projects are completed in order to assess what the required size of the off-line storage tank needs to be. Refer to Figure No. 12 in Appendix A for a conceptual layout of this alternative.

An overflow pipe would be installed off the existing interceptor sewerline at an elevation above the top of the sewerline, but below the overflow elevation. This overflow pipe will direct surcharged flow from the sewer to a new precast submersible grinder pump station. The grinder pump station will pump the overflow into the CSO storage tank. There will be an emergency off level switch to shut the pump off if the tank is full. A back-up overflow pipe toward the top of the tank would pipe any overflows from the tank back into the sewer. A radio telemetry system with communication back to the WWTF will inform the operators of an overflow and the liquid level in the tank. After the high flows recede and there is capacity in the combined sewer system, an outlet pipe from the tank would be manually opened and the tank will be drained back into the sewer system at a controlled discharge rate.

This alternative also includes the continued use of the existing overflow pipe and metering structure in case of rainfall which produces overflow volumes above the design capacity of the storage tank.

Advantages and disadvantages are provided below.

<u>Advantages</u>

- Closed tankage helps reduce odor issues in nearby neighborhoods.
- Cost would be similar to CSO separation projects required to eliminate an overflow at the design storm event.
- Storage would not add any additional untreated stormwater to Stevens Brook as all of this flow will be discharged to the WWTF.

<u>Disadvantages</u>

- Aesthetics are a major issue for the surrounding residential neighborhoods and commercial area.
- The City has raised concerns about the use of Houghton Park for this use, so other potential locations need to be investigated.
- Construction of a below grade tank here could be an option at the park, but would be significantly more costly.
- The cost is similar to a CSO separation project, however this project carries a significantly higher operation and maintenance cost to run the pump station as well as cleaning of the tank.

The opinion of probable cost is approximately $2,000,000 and is summarized in Table 5.3. This cost is subject to change depending on the location found for this new infrastructure.

Table 5.3
New Above Ground Off-Line CSO Storage Tank
Opinion of Probable Cost

Category	**Opinion of Probable Construction Cost**
General Requirements	$ 124,000
Bonds	$ 33,000
Sitework	$ 120,000
Yard Piping	$ 80,000
Concrete	$ 200,000
Equipment	$ 1,250,000
Electrical / Controls	$ 100,000
Subtotal	$ 1,707,000
15% Contingency	$ 256,000
Total	$ 1,963,000
Use	**$ 2,000,000**

Notes:
1. ENR 11390 = May 2019

5.5. CSO Treatment and Disinfection Alternatives

5.5.1. CSO Treatment and Disinfection

Under this alternative, the overflow would receive screening, primary treatment, and disinfection prior to discharge to Stevens Brook. A conceptual layout for this alternative is shown on Figure No. 13 in Appendix A. The overflow will flow through the existing overflow metering manhole and continue through a new 6’ diameter dynamic separator for primary treatment. The floatables and waste material will be transferred from the unit into a new precast concrete storage tank located next to the unit. The collected material in the storage tank can be removed by the City’s vactor truck after each CSO event and taken to the wastewater treatment facility for disposal. Effluent from the dynamic separator will then flow into a new chlorine contact tank for disinfection. The chlorine contact tank would need to be able to provide 30 minutes of contact time for the peak overflow rate of approximately 4 MGD. It is estimated that the chlorine contact tank would need to have a volume of approximately 83,000 gallons. Effluent from the chlorine contact tank will then flow into a new manhole where dechlorination will occur. Effluent from the dechlorination manhole will then flow in the existing overflow pipe and discharged into Stevens Brook. Chlorine for disinfection and sodium bisulfite for dechlorination will be stored and fed from a new 12’x24’ heated chemical feed building. A change in the classification of the stream may be required, and would need to be discussed further with the State.

Advantages and disadvantages are provided below.

<u>Advantages</u>

- Provides primary treatment and disinfection of CSO overflows prior to discharge to the stream.
- Doesn't add more flow to the receiving waters of Stevens Brook.

<u>Disadvantages</u>

- The primary treatment system will require pumps due to elevation and headloss through the system.
- The City does not want the Houghton Park area to be used for construction of this new infrastructure.
- Permitting of this discharge will need to be explored further with the State.
- This approach has a high operation and maintenance cost for treatment equipment that is only used 3 to 8 times per year.
- Maintenance and cleaning will be necessary after the treatment system is used to minimize odors.
- Makes significant portions of the City park unusable for recreation purposes.

The opinion of probable cost is approximately $3,000,000 and is summarized in Table 5.4. Due to the higher construction costs and O&M challenges, this isn't a viable alternative for control of the CSO's.

Table 5.4
CSO Treatment and Disinfection
Opinion of Probable Cost

Category	**Opinion of Probable Construction Cost**
General Requirements	$ 188,000
Bonds	$ 51,000
Sitework	$ 300,000
Yard Piping	$ 100,000
Concrete	$ 600,000
Equipment	$ 1,000,000
Misc. Metals	$ 80,000
Building	$ 100,000
Mechanical	$ 70,000
Electrical / Controls	$ 80,000
Subtotal	$ 2,566,000
15% Contingency	$ 385,000
Total	$ 2,951,000
Use	**$ 3,000,000**

Notes:

1. ENR 11390 = May 2019

6. SELECTION OF ALTERNATIVES

6.1. Description

Life cycle costs were evaluated qualitatively for the proposed alternatives. CSO separation alternatives involving new stormwater piping will usually have a useful lifespan of 70+ years. Alternatives involving additional equipment such as pumps or treatment equipment are typically designed with an expected useful life of 20 years. This indicates that the equipment will need to be replaced or upgraded nearly four (4) times in the same lifespan of the stormwater systems.

The storage/conveyance and treatment alternatives considered have similar construction costs compared to separation alternatives with comparable flow removal during the design storm. The alternatives involving additional equipment incur higher operation and maintenance cost compared to separation alternatives. For these reasons it is recommended that separation projects be prioritized in the short term.

Non-monetary factors were also evaluated while selecting and prioritizing alternatives. Although CSO separation projects could result in discharging additional untreated stormwater into receiving waters, it will ultimately reduce the amount of untreated, combined sewage that is discharged during high flow events.

The storage/conveyance and treatment alternatives evaluated are presented, but the specific sites still need to be evaluated further. The City has requested that the space in the Houghton Park on Lower Welden Street not be used for this purpose. This use not only takes away the public use of portions of the park but also creates potential aesthetic and odor problems for residents in the surrounding area. Additional manpower is also necessary to clean the storage tanks after each CSO storage event and to maintain proposed treatment equipment. Storage/conveyance alternatives may mitigate peak flows, however this flow is ultimately directed into the combined sewer system and is treated by the wastewater treatment facility, therefore it does not reduce total flow volumes seen at the treatment facility.

Using the costs, constructability, life cycle costs, and non-monetary factors, alternatives were organized into either short or long term CSO control improvements. Separation projects in progress were prioritized and new cost effective separation improvements were prioritized over CSO storage and treatment. Areas that are a part of or near the downtown area have been prioritized for CSO separation. This is due to the downtown area having a high groundwater table and large impervious areas which results in poor infiltration and high surface runoff. Areas outside of the downtown center such as Congress Street, Messenger Street, Upper Welden Street, and Cedar Street were not selected for the recommended plan due to potential constructability concerns which can be reevaluated as higher priority projects are completed and further investigation is done on the constructability of the projects. Project’s life cycle costs and other non-monetary factors selected for short term improvements are described in further detail in this section. The recommended plan for the short-term CSO control is detailed further in Section 7.

6.2. Federal Street CSO Separation

The Federal Street CSO Separation has been part of an ongoing effort to disconnect this drainage area from the combined sewer system beginning when the area had its own stormwater collection system constructed in 1973. Although the collection portion of this system is separated from the sanitary sewer, it discharges to the combined sewers on the west side of Federal Street between Kingman and Center Street and runs underneath the railroad tracks to the sanitary sewer on Pine Street. The proposed project will disconnect the existing stormwater infrastructure from the sanitary sewer downstream and connect it to the stormwater trunk line.

This alternative involves a limited increase in operation and maintenance costs to the system. This drainage area is a part of the downtown portion of the City and is mostly impervious surface. Disconnecting this drainage area will greatly reduce peak flows seen during wet weather events, and is one of the more cost effective alternatives due to the presence of existing stormwater infrastructure.

There is also the possibility of constructing a stormwater pond by the unused parcel of land by Food City and the railroad tracks. If constructed in a later phase, this pond would be able to help treat the stormwater and control the flows before discharge into Stevens Brook. Further investigation on the exact connection point between the stormwater system on Federal Street and the sanitary sewer needs to be done before this second phase of the separation is evaluated further.

6.3. Kingman Street Road Reconstruction

The Kingman Street road reconstruction project involves constructing new stormwater infrastructure on Kingman Street as a part of the full road reconstruction project. The proposed project will connect this new stormwater infrastructure to the existing stormwater system on Federal Street.

This project is currently in progress and will not significantly increase operation and maintenance costs for the system. This drainage area is a part of the downtown portion of the City and is mostly impervious surface. Although the project does not remove significant flow from the sewer system, this separation of the runoff on Kingman Street from the sanitary sewer is cost effective as it is being done in conjunction with the full road reconstruction.

6.4. Stebbins Street Utility Upgrades

The Stebbins Street work involves disconnecting stormwater infrastructure from the sanitary sewer system on Stebbins Street. This work is a part of a completed final design for a full road reconstruction project slated to start in 2020. The proposed project will connect this new stormwater collection system to the existing stormwater system on Catherine Street.

This project is currently in progress and will not significantly increase the operation and maintenance costs for the system. This drainage area is a part of the downtown portion of the City and is mostly impervious surface. Although the project does not remove significant flow from the sewer system, this separation of the runoff on Stebbins Street from the sanitary sewer is cost effective as it is being done in conjunction with the full road reconstruction.

6.5. Main Street Roof Drain Separation (Phase II)

In the spring of 2013 as part of the streetscape project (phase I), the City decided to provide storm pipe for those roof drains that connect to the sewer that exit to the Main Street side only. A total of 26,293 square feet of roof area could be diverted to the stormwater system as part of this project. This is planned to be completed on a case by case basis as opportunities arise with property owners to disconnect their roof drains.

This project is currently in progress and will not add any additional operation and maintenance costs for the system. This drainage area is a part of the downtown portion of the City and is mostly impervious surface. Roof drains are inherently difficult to disconnect and coordination efforts with property owners will need to be done in conjunction with other work on these properties. This will make the separation more cost effective if it is completed with other renovation work. The size of the roof and relative costs should be also considered as it may not be cost effective to disconnect roofs smaller than 1,500 s.f. as this disconnection won't reduce the flows significantly.

7. RECOMMENDED PLAN – SHORT TERM CSO CONTROLS

7.1. Description

The purpose of this long term control plan is to ultimately reduce the frequency and volume of overflows through the proposed CSO control projects. An informational meeting presenting a summary of the alternatives documented in the LTCP to the City was completed on March 25, 2019, and a copy of this presentation is available in Appendix L. During this meeting, concerns were raised the location of an off-line storage tank, so alternative sites for this tank will need to be evaluated.

The following priority projects were categorized into short term projects (0-5 years) as listed below:

- Interceptor Sewerline Level Monitoring
- Federal Street Separation
- Kingman Street
- Stebbins Street
- Main Street Roof Drain Separation (Phase II)
- Green Stormwater Infrastructure

The Agency recognizes that CSO abatement and control is a costly and iterative process, so the recommended plan is presented in a phased approach with short and long term CSO controls so that:

- Monitoring of the surcharged water levels in the sewer interceptor sewerline will be performed for modeling purposes.
- The City can continue to monitor the overflows and document the reduction in the frequency and volume of the CSO’s as these improvements are completed.
- The long-term effects of climate change can be accounted for in the future improvements.
- As the CSO frequency and volumes are reduced, a cost/benefit analysis of future CSO controls can be performed to factor in the affordability criteria for the City sewer customers.
- The City can continue to evaluate future separation projects presented in the long-term plan in conjunction with off-line storage to cost effectively address the CSO’s.
- The volume required for an off-line storage tank can be better defined and potential sites for the tank can be evaluated.

Long term CSO control projects are presented in Section 8, and additional separation project(s) in combination with the off-line storage will need to be completed to comply with the CSO Rule.

7.2. Short Term Projects

The short term CSO control projects listed above are described in detail in Section 4 of the plan. The following Table 7.1 summarizes the estimated drainage areas and abated surface runoff that can be eliminated from the combined sewer system for these priority projects.

Table 7.1
Short Term CSO Control Projects Summary

Project	Drainage Area (Acres)	Estimated Flow Removed from Sewer System - 2.6" 24-hr Design Storm (gallons)
Federal Street	14.4	869,700
Kingman Street[(1)]	0	0
Stebbins Street	1.1	66,400
Main Street Roof Drain Separation (Phase II)	0.6	42,612
Total	**16.1**	**978,712**

Notes:
1. The Kingman Street drainage area is already accounted for in the Federal Street drainage area.

7.2.1. Interceptor Sewerline Monitoring

The interceptor sewerline surcharges during wet weather events, and if the capacity is exceeded, an overflow can occur at Lower Weldon Street. Monitoring of the water levels in this sewerline during these conditions will provide valuable information on the capacity of this pipeline and better document what happens when an overflow occurs. This data will be very useful in assessing potential locations for off-line storage and also documenting the success of various CSO control projects as they are completed. Automatic level monitoring with remote access is proposed to be installed at approximately four (4) locations along the interceptor sewerline.

7.2.2. Federal Street Separation

The stormwater collection portion of this system is separated from the sanitary sewer as it serves a mostly impervious drainage area of approximately 14.4 acres, however it discharges to the combined sewer on the west side of Federal Street between Kingman and Center Street and runs underneath the railroad tracks to the sanitary sewer on Pine Street. Since the collection and conveyance portion of this system is separate from the sanitary sewer, CSO separation would involve disconnecting the discharge point into the combined sewer and constructing additional infrastructure to connect it into the stormwater system.

Two alternatives are currently being considered which are dependent on the existing interconnection between the sewer and stormwater systems. Further field investigation needs to be completed before a preferred alternative can be chosen. Dye testing has been performed but was unsuccessful, so television inspection of the existing pipelines is planned to confirm the point of disconnection.

Depending on the exact location of this discharge point and the selected alternative, a second phase of this project could utilize unused space just north of Food City by constructing a stormwater pond to help attenuate peak flows and provide treatment of the stormwater discharge. This improvement has the added benefit of not negatively impacting the high flow target required for the impaired portion of Stevens Brook.

Once the additional field investigation is completed, the alternative routes can be further evaluated and updated costs developed for the selected alternative route.

The location of the catch basins and drainage areas are shown on Figure No. 4 in Appendix A and additional drawings are provided in Appendix G.

7.2.3. Kingman Street

There is currently no stormwater infrastructure on Kingman Street. The surface runoff currently flows west onto Federal Street where it enters the existing stormwater infrastructure. A full road reconstruction design is currently planned which is proposing to add additional stormwater collection on Kingman Street for connection into the existing stormwater collection system on Federal Street. Elimination of this drainage area from the combined sewer system is included in the 14.4 acre drainage area shown for Federal Street. Inspection of basements for the existing buildings is also planned and may identify opportunities for additional roof disconnections from the sewer system.

This project is currently in the design development phase with construction tentatively planned for 2020.

7.2.4. Stebbins Street

There are two (2) catch basins connected to the combined sewer on Stebbins Street. The back half of the post office also has a flat roof with roof drains connected to the combined sewer on Stebbins Street. The post office drains are separated from the sewer inside the building and outlet from the building through a separate pipe. The roof drain outlet pipe connects separately into a sewer manhole which makes separation easy. An existing storm drainage system is located at the bottom of the hill at the intersection of Stebbins and Allen Street.

The drawings for this project are provided in Appendix H. This separation is part of a larger utility upgrade project on Stebbins Street which is currently at the 90% final design phase, and is scheduled for construction in 2020.

7.2.5. Main Street Roof Drain Separation (Phase II)

In the spring of 2013 as part of the streetscape project (phase I), the City provided storm pipes for those roof drains that connect to the sewer on the west side of Main Street side north. Under Phase II, up to 26,293 square feet of roof area could be diverted to the stormwater system as part of this project. This is planned to be voluntary and completed on a case by case basis as opportunities arise with property owners to disconnect their roof drains. Interior replumbing in these older buildings can be very difficult and costly, but can be done if major renovations are planned. The focus should be on the larger roofs (>1,500 s.f.) as they provide a greater cost benefit in reducing the flows to the combined sewer system.

Costs can't be developed for this improvement as most of the work is on private property and will vary with the site constraints.

7.2.6. Green Stormwater Infrastructure

Green Infrastructure (GSI) involves stormwater management technique or practice employed with the primary goal of preserving, restoring, mimicking, or enhancing natural hydrology. Green stormwater infrastructure has the capability of treating untreated stormwater and reducing peak flows into the combined sewer system or receiving waters in the separated areas. These practices can also have the added benefit of reducing phosphorus loads. Watershed Consulting Associates, LCC reviewed existing information on the City including mapped CSO areas and existing stormwater infrastructure to assess the feasibility of constructing green stormwater infrastructure. Areas with green street potential were noted which consist of streets with adequate ROW width, low to moderate slopes and soil infiltration potential. A field assessment was then conducted to collect further data. Results of this field investigation are available in Appendix M.

Many of the sites evaluated were near the proposed Federal, Kingman, and Stebbins Street project areas. The feasibility of these green stormwater practices should be evaluated in conjunction with these short term CSO control projects and be incorporated when possible. This GSI can help reduce the peak flows that would flow into the combined sewer system, but won't have a significant impact on reducing the overall flows.

7.3. Project Schedule

For the proposed CSO controls, a general project schedule was developed to implement each of the projects. A project schedule showing the anticipated construction date is presented in Table 7.2. As more detail becomes available on some of these projects, the schedule for each project can be refined. More detail on the status of each of these projects is provided in the previous sections.

Table 7.2
Project Schedule

Construction Date	Project
2019	Interceptor Sewerline Level Monitoring
2020	Kingman Street
2020	Stebbins Street
2021	Federal Street Separation – Phase I
tbd	Green Stormwater Infrastructure(1)
2019 -	Main Street Roof Separation – Phase II(2)

Notes:

1. The GSI improvements will be included in the separation projects as appropriate.
2. These individual projects will be voluntary and performed on a case by case basis.

7.4. Permit Requirements

Permit requirements will need to be evaluated for each individual CSO control project and to also meet the applicable requirements for the specific funding agency. The following permits could be required for these priority projects to move them towards construction:

- **Environmental Report –** For CWSRF funded projects, an Environmental Report will be prepared and will need to be approved by VT CWSRF.
- **Archeological Assessment –** An Archeological Resource Assessment (ARA) for these projects at the beginning of final design.
- **Stormwater Construction General Permit –** A Notice of Intent (NOI) will need to be prepared for these projects and submitted to the Vermont Department of Environmental Conservation for determination on the need for coverage under the general permit. This permit will be submitted at the 90% stage of final design.
- **Wetlands Permit** – Any work in or impacting the buffer zone will require a State wetlands permit and possibly Army Corp of Engineers approvals.
- **Railroad Crossing Permit –** A Railroad Crossing Permit will likely be required for the Federal Street separation project. This permit will be prepared and submitted to VTrans at the 90% stage of final design.

7.5. Sustainability Considerations

Sustainability considerations were taken into account when developing these short and long term improvements. Only constructing off-line storage for these events does not solve the capacity limitations of the combined sewer system. This approach in combination with disconnecting stormwater infrastructure from the combined sewer system provides a more sustainable solution to mitigating CSO events as long as negative impacts aren't created on the receiving waters. Permanently separating connected storm infrastructure will relieve strain on the combined sewer as well as free up additional treatment capacity at the plant for these wet weather events.

The off-line storage approach discussed in the long-term CSO controls involves additional equipment that will incur higher operation and maintenance cost compared to separation alternatives. Additional manpower will be necessary to clean the storage tanks after each CSO storage event. Storage alternatives may temporarily mitigate peak flows, however this flow is ultimately directed into the combined system for treatment at the wastewater treatment facility, therefore it does not reduce total flow volumes seen at the treatment facility.

For these reasons, CSO separation improvements were initially prioritized in this long term control plan in order to permanently remove these flows during wet weather events which surcharge the combined sewer system and ultimately cause combined sewer overflows at Lower Welden Street.

7.6. Opinion of Probable Costs

An opinion of probable costs for these short term CSO control projects are summarized in Table 7.3, and the assumptions are as follows:

- The Federal Street separation construction costs can't be finalized until the field investigation is completed and the route is selected.
- The Main Street Roof Drain Separation (Phase II) was not included because the disconnections will be site specific on private property and will need to be completed on a case by case basis.
- The green stormwater infrastructure components are not included as they will likely be incorporated into the other larger separation projects.

Table 7.3
Short Term CSO Abatement Projects
Opinion of Probable Costs

Project Description	Estimated Construction Cost[1]	Potential Funding Source
Interceptor Sewerline Level Monitoring	$50,000	Capital funds or CWSRF
Federal Street Separation – Phase I	tbd	CWSRF
Kingman Street[2]	$964,000	Vtrans
Stebbins Street Utility Upgrades[3]	$504,000	Capital funds and/or CWSRF
Main Street Roof Disconnections	tbd	Private or local funds

Notes:

1. ENR 11390 = May 2019
2. The Kingman Street road reconstruction includes the entire cost of the utilities and roadway reconstruction.
3. The Stebbins Street utility upgrade cost includes all of the utilities.

Depending on the type of project, several different types of funding sources could be used.

8. LONG TERM CSO CONTROLS

8.1. Description

Depending on the measured success of the short-term CSO controls, and other factors, a significant portion of the overflow volume anticipated for a 2.6" 24-hour design storm should be controlled. As short term CSO abatement projects listed in Section 7.2 are completed, long term CSO control projects will be reevaluated and prioritized to optimize CSO reduction and balance the cost/benefit to the sewer customers. The potential long term CSO control projects are listed below.

- Green Stormwater Infrastructure
- Lake Street (Phase II)
- Lower Welden Street (Murray Drive, Edward, & Russel Street)
- Off-Line CSO Storage Tank on Lower Welden Street or other Site
- Hungerford Stormwater Project

Table 8.1 below summarizes estimated drainage areas and surface runoff from the potential long term projects.

Table 8.1
Long Term CSO Control Projects Summary

Project	Drainage Area (Acres)	Estimated Flow Removed from Sewer System - 2.6" 24-hr Design Storm (gallons)
Lake Street (Phase II)	14.4	918,700
Lower Welden Street (Murray Drive, Edward, & Russel Street)	11.0	489,500
Above Ground Off-Line CSO Storage Tank	0	0
Hungerford Stormwater Project	N/A	N/A
Total	**25.4**	**1,408,200**

Notes:

1. The Lake Street CSO Separation includes both areas defined in phase II of the project and work completed from phase I that reconnects to the combined system downstream.
2. The Hungerford Stormwater Project drainage area and flow removal from the sewer system is dependent on the drainage areas that will ultimately be flowing through the system.

8.2. Long Term Projects

8.2.1. Green Stormwater Infrastructure

Watershed Consulting Associates, LCC reviewed existing information on the City including mapped CSO areas and existing stormwater infrastructure to assess the feasibility of constructing green stormwater infrastructure. Results of the field investigation conducted by WCA are available in Appendix M. The feasibility of these green stormwater projects should continue to be evaluated and be incorporated into the larger separation projects when possible. This can help reduce the flows and treat some of the additional untreated stormwater that would flow into Stevens Brook due to these CSO separation projects.

8.2.2. Lake Street (Phase II)

There are approximately twenty one (21) catch basins connected to the sewer system along Lake Street between Main Street and Maple Street. Additional storm drainage infrastructure will need to be constructed in order to connect to the existing catch basins into the stormwater system. Approximately five (5) catch basins were disconnected from the sanitary sewer system and redirected into the stormwater system as a part of phase I of this project. However, the stormwater system in this section of the city ultimately discharges into the sewer system downstream. This system will need to be fully disconnected in order to divert the stormwater out of the sewer system as phase II of this project.

The contributing drainage area to these catch basins is approximately 14.4 acres, 98% of it being impervious surface. It is estimated that 918,700 gallons of stormwater runoff could be removed from the sewer system for the design storm by disconnecting this drainage area, including the drainage area from phase I. The location of the catch basins and drainage areas are shown on Figure No. 6 in Appendix A.

8.2.3. Lower Welden Street (Murray Drive, Edward, & Russel Street)

There are currently approximately 10 catch basins located on Huntington Street, Russell Street, and Edward Street connected to the sanitary sewer system. Additional storm drainage infrastructure will need to be constructed in order to tie the existing catch basins into the stormwater system. Approximately 2,000 linear feet of new storm drain pipe will be required. Site drawings of the proposed drainage improvements on Murray Drive are available in Appendix I.

The contributing drainage area to these catch basins is approximately 11 acres, 25% of it being impervious surface. It is estimated that 490,000 gallons of stormwater runoff could be removed from the sewer system by disconnecting this drainage area. The location of the catch basins and drainage areas are shown on Figure No. 7 in Appendix A.

8.2.4. Above Ground Off-Line CSO Storage Tank

This alternative includes constructing a new glass-lined, above ground, off-line CSO storage near the interceptor sewerline. Alternative downstream sites will need to be investigated in the proximity of this existing sewer interceptor line.

One tank could initially be constructed with approximately 500,000 gallons of storage capacity, but this volume is subject to change depending on the success of the short-term controls and other long-term separation projects. An overflow pipe will direct surcharged flow from the sewer to a new precast submersible CSO grinder pump station. The grinder pump station will pump the overflow into the 500,000 gallon CSO storage tank. After the high flows recede and there is capacity in the sewer system, an outlet pipe from the tank would be manually opened and the tank will be drained back into the sewer system at a controlled rate. Additional detail is provided in Section 5 and a conceptual layout is shown on Figure No. 14 in Appendix A.

8.2.5. Hungerford Stormwater Project

This alternative consists of a two-tiered system to treat stormwater prior to discharging into Stevens Brook. The lower system consists of a water quality channel with natural vegetation and rocks to mitigate peak flows and treat stormwater from the trunk line. The upper system consists of a conventional flow control basin that would accept runoff from lateral surface inputs from the surrounding land. A total of 38 subwatersheds with a total drainage area of 262.2 acres was selected to connect to the proposed Hungerford Stormwater System. Approximately 28% of this drainage area is impervious cover. Some of these subwatersheds connect to the trunk line while others discharge into Stevens Book or the sewer collection system and intend to be redirected to the Hungerford Stormwater System. Additional detail is provided in Section 4 and Appendix J of this report.

This proposed project makes some assumptions on the feasibility of connecting some of the subwatersheds that run into Stevens Brook or the combined sewer system into the stormwater trunk line. The proposed subwatershed connections will need to be evaluated further in order to determine the feasibility of this recommendation.