UNDERWOOD engineers

WOODARD &CURRAN

Town of New Castle, New Hampshire

Sewer Infrastructure Evaluation

March 2016

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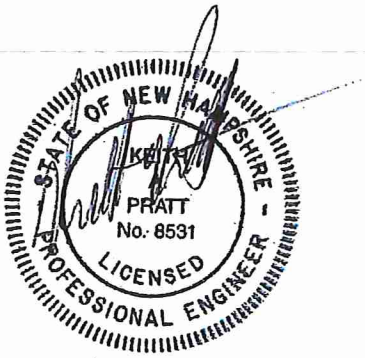

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EXECUTIVE SUMMARY

The Town of New Castle (Town) is working collaboratively with the City of Portsmouth (City) to consider options for the water and wastewater systems, including transferring ownership and/or operating responsibility to the City. The Sewer Infrastructure Evaluation is intended to identify the location of sewer assets as well as their strengths and deficiencies. The team of Woodard & Curran (Woodard & Curran) and Underwood Engineers, Inc. (UEI) performed the sewer infrastructure evaluation in the spring and summer of 2015 consisting of several tasks focused on sewer system elements including pipe, manholes and pump stations.

Based on data in the City's GIS, the New Castle sewer system consists of approximately 22,200 linear feet of gravity sewer, 12,200 linear feet of force main, 131 manholes and 13 pump stations. Portions of the sewer system are owned and operated by the Town of New Castle and portions are operated by non-Town entities. In preparation for the work reported herein, Woodard & Curran, UEI and the City developed a preliminary drainage basin map utilizing the available GIS data for New Castle. From this map, Woodard & Curran established 5 drainage basins with 3 continuous flow metering locations to gather baseline information on extraneous flows that could be entering the sewer system.

Infiltration/Inflow Program

Throughout this report, excess sewer flow from groundwater, stormwater, and river water will be referred to as Infiltration and Inflow (I/I). Infiltration is generally defined as groundwater which enters the collection system through leaking pipes or manholes. Infiltration occurs when existing sewer lines experience material and/or joint degradation and deterioration. Infiltration also can occur when sewer lines are poorly designed and constructed.

Inflow is generally defined as stormwater or river water which enters the collection system directly through open manholes, manhole covers, frame seals or indirect connections with storm sewers. Inflow also includes direct piped connections to the collection system such as sump pumps and roof drains. These sources may exhibit a delayed response to storm events as the rainfall must first infiltrate the ground. Often times these sources are referred to as rainfall-induced infiltration.

The identification of subareas with high levels of I/I is essential to protect the considerable investment the Town has made in its collection system. This report provides identification of priority subareas within the collection system for additional I/I investigation and/or future rehabilitation with the end goal of minimizing wastewater flows and the associated costs for transport and treatment. Extraneous "clean water" flows which enter collection system consume capacity that could be allocated to other areas of the Town and leads to undue operational and maintenance costs.

Based on the GIS map of the New Castle sewer system, flow monitoring (metering) was performed in three locations covering the system's five sewer basins for 10 weeks during April, May and June, 2015. One rain gauge was installed within the New Castle sewer system area and monitored during the metering period. Groundwater level monitoring was accomplished at each flow meter site utilizing a piezometer installed through the manhole wall, with the level recorded on a weekly basis. The rain events and groundwater levels are key elements in contributing extraneous flow to the sewer system.

Flow metering data was evaluated to estimate peak infiltration by examining the total flow at each meter on a dry day, or series of dry days, between the hours of midnight and 6:00 AM, during the peak groundwater season. The inch diameter mile of sewer pipe in the metered sewer basins was determined based on the City's GIS mapping for the purpose of expressing infiltration rates in a manner to determine excessive infiltration. in two locations where metering was not possible, instantaneous night flow measurements were made to estimate infiltration. The meter data was also evaluated to estimate peak inflow by examining the difference in peak hour flows between wet days and corresponding dry days. A correlation between recorded storm events and a theoretical 1-year, 6-hour storm event, the industry acceptable normalized design storm for determining inflow, was established to estimate peak storm inflow for each

metered area. Infiltration and Inflow (I/I) analysis included graphing of total flows with rainfall and groundwater levels over time. Once the data analysis of each meter was complete, the subareas within the basins were ranked according to their potential to contribute I/I to the sewer system. This prioritization is used to determine recommended future phases of I/I work to more accurately locate and quantify specific sources, and schedule corrective work if necessary.

The following tables summarize the results of the Infiltration/Inflow Analysis.

Infiltration:

Estimated Infiltration Rates from Flow Metering

Drainage Basin	Meter No.	Estimated Infiltration Rate,*	
		gpd	gpdim
NC-1	NC-1	6,485	1,062
NC-2	NC-2	2,116	1,196
NC-3	NC-3	5,001	318

*gpd=gallons per day, gpdim=gallons per day per inch mile of pipe

Estimated Infiltration Rates from Night Flow Gaging

Drainage Basin	Meter Area	Manhole No.	Street	Estimated Infiltration Rate, gpdim
NC-2	Not Metered	5643	Piscataqua Street	2,681
NC-1	Not Metered	5608	River Road	240

Recommended Plan - Infiltration

Estimated infiltration rates exceeding 4,000 gpdim are considered excessive**.** Infiltration rates in the New Castle sewer system are not considered excessive and no further action is recommended.

Inflow:

Estimated Metered Area Total Design Storm* Inflow

Drainage Basin	Meter No.	Estimated Total Design Storm Inflow, gal	Rank
NC-1	NC-1	22,067	1
NC-2	NC-2	10,504	2
NC-3	NC-3	0	NA
Total		32,571	

***Design storm is a one year six-hour rain storm producing 1.72 in. of rain

Inflow was found in two of the three areas. Direct Inflow is that from sources such as downspouts, area drains and drainage system cross-connections. Indirect inflow is primarily from sump pumps.

Metered Areas Recommended for Further Inflow Study – Design Storm Direct Inflow

Drainage Basin	Meter No.	Estimated Direct Design Storm Inflow, gal	Cumulative Direct Design Storm Inflow, gal	Percent of Total Cumulative Direct Design Storm Inflow
NC-1	NC-1	6,323	6,323	55
NC-2	NC-2	5,119	11,442	100

Metered Areas Recommended for Further Inflow Study – Design Storm Indirect Inflow

Drainage Basin	Meter No.	Estimated Indirect Design Storm Inflow, gal	Cumulative Indirect Design Storm Inflow, gal	Percent of Total Cumulative Indirect Design Storm Inflow
NC-1	NC-1	15,740	15,744	75
NC-2	NC-2	5,384	21,128	100

Recommended Plan

As a result of the metering program, further action is recommended to locate the sources of direct inflow (downspouts, area drains and cross-connections) in Areas 1 and 2, and indirect inflow (sump pumps) in Area 1.

Recommended SSES Phases I and II Inflow Program

Type of Investigation	Meter	Area	Estimated Quantity, LF	Unit Cost, $	$Total Estimated Cost
Inflow - Direct					
Smoke Testing					
	NC-1	NC-1	4,066		
	NC-2	NC-2	1,214		
Total			5,280	$0.40/LF	$2,112
Dye Water Tracing					
Budget No. of Locations			2	$200.00 EA	$400
Dye Water Flooding					
Budget No. of Locations			2	$500.00 EA	$1,000
Sub-Total Field Work					$3,512
Engineering (Project Management, Data Analysis and Report)					$25,000
Sub-Total Direct Inflow Program Cost					**$28,512**
Inflow - Indirect					
Building Inspections – Area NC-1					
Estimated No. of Buildings			100	$100.00 EA	$10,000
Sub-Total Field Work					$10,000
Engineering (Project Management, Data Analysis and Report)					$15,000
Sub-Total Indirect Inflow Program Cost					**$25,000**
Total Estimated Phase I & II Inflow Program Cost					**$53,512**

Smoke testing, dye water tracing and dye water flooding is recommended in subareas where direct inflow sources are suspected. Smoke testing will identify direct drain connections, roof leaders and leaking manhole covers in low wet areas, providing manholes are not submerged. Smoke testing should be conducted during low groundwater season.

Contracting of this work is recommended. Building inspections are recommended in areas where high rates of indirect inflow were found. Specifically, sump pumps are a concern, but roof drains, driveway drains, etc. may also be identified during building inspections. This work may be conducted by Town crews or contracted.

Pumping Station and Manhole Investigation

Evaluation of eight (8) pumping stations and 150 manholes was requested for this evaluation. The wastewater pumping stations and manholes evaluated as part of this investigation were owned either by the Town of New Castle or by one of the eight (8) Wentworth-By-The-Sea private homeowner associations. The private sewers and pumping stations located in the vicinity of the US Coast Guard Station and those owned and operated by the Wentworth-By-The-Sea Hotel were not included in this evaluation as requested by the City. Throughout this evaluation we have differentiated between 'public sewers' which are those that are owned and operated by the Town of New Castle and 'private sewers' which are those that are owned and operated by one of the homeowner associations based on described ownership delineations indicated by New Castle DPW personnel and Wentworth-By-The-Sea (WBTS) Master Association personnel. The following Table summarizes the public and private sewer infrastructure that was evaluated.

Evaluated Sewer Infrastructure

	Public	Private
Pumping Stations	River Street P.S. Steamboat P.S. Boson's Hill P.S.	North Gate #1 P.S. North Gate #2 P.S. Great Island Condo P.S. Campbell's Island P.S. Little Harbor P.S.
Inspected Sewer Manholes	79	50
Suspected Sewer Manholes not Inspected[1]	9	12

[1] These manholes were identified on the base maps provided by the City of Portsmouth, but could either not be located or accessed in the field.

Pumping station evaluations included a visual and electrical assessment of eight (8) wastewater pumping stations to identify visible deficiencies and provide opinions of probable cost for improvements needed to bring the infrastructure to City and State standards. Infrastructure was evaluated based on the requirements of *NH Code of Administrative Rules, Part Env-Wq 705 Sewage Pumping Stations,* City of Portsmouth City Ordinances, and City of Portsmouth Department of Public Works (DPW) standard practices. Electrical evaluations of the pumping stations included review of the existing electrical services, identification of observed code issues, and estimates of backup power requirements at each station. Conceptual level pumping station improvements recommendations with opinions of probable costs were developed, including evaluating the feasibility of eliminating the North Gate #1 pumping station and replacing it with gravity sewers.

Manhole inspections included observations of visible structural deficiencies, infiltration, depth to and size of pipes entering/exiting the manhole. Manhole inspections were completed from the surface without manhole entry. The pipe size and pipe orientation information from the manhole inspection reports was also used to develop a presentation map of New Castle sewers based on City GIS information. A total of 150 manholes were identified for inspection. Internal inspections were performed on 129 manholes. Twenty-one (21) manholes could not be entered because they were either paved over, could not be located, or the cover could not be opened, and where possible observations about the manhole cover were made. The following is a summary of the condition codes that were used for the evaluation of the different features of the manholes (cover, corbel, walls, shelf, invert, etc.):

Code 1: Good Condition – No further action needed

Code 2: Minor Defects Observed – No immediate action needed, no I/I observed

Code 3: Minor Defects or I/I Potential - Needs attention or rehabilitation

Code 4: Significant Defects and or I/I Potential – Corrective action should be scheduled in the near future

Code 5: Manhole or Connecting Pipes in Extremely Poor Condition – Failure eminent, needs immediate attention

Pumping Station and Manhole Findings and Recommendations
The following summarize the major findings and recommendations of the Pumping Station and Manhole Investigations:

- Public pumping stations (3) were approximately 40 years old and much of the pump equipment appeared to be original. The underground enclosures that contained the pumps and controls exhibited deterioration and leakage. The sites are located within 100-year flood zones and limited flood protection provisions were observed. Multiple Env-Wq 705 compliance deficiencies were observed at each station. Generally, upgrade of the public pumping stations was recommended to remove the pumps from the leaking underground pump chamber and re-habilitate and re-use the existing wetwells. The River St. and Boson's Hill pumping stations were recommended to be upgraded to self-priming centrifugal pumps within new buildings constructed to protect infrastructure from flood damage. The Steamboat pumping station was recommended to be upgraded to submerged submersible station with cabinet enclosed pump controls due to site space constraints. The addition of Supervisory Control and Data Acquisition (SCADA) interface panels was recommended for all pumping stations to allow for remote monitoring and control of the stations.

- The private pumping stations (5) were approximately 15-30 years old, much of the pump equipment appeared to be original, and most were not intrinsically-safe, municipal-grade systems. Wetwell access for safe operation and maintenance was severely limited by landscaping plantings. Multiple Env-Wq 705 compliance deficiencies were observed at each station. Generally, upgrade of the private pumping stations included electrical improvements with installation of municipal-grade pumps and appurtenances and rehabilitation and re-use of the existing wetwells. The Great Island and Campbells Island pumping stations were recommended to be consolidated into a single new pumping station at a location that is more accessible for maintenance. The North Gate #1 pumping station was recommended to be abandoned and the internal plumbing of the one house connected to the pumping station be re-routed to a gravity sewer extension to the North Gate #2 pumping station. Landscape plantings that were used for visual screening around many of the stations was recommended to be removed and replaced with fencing or other low-maintenance hardscape features to improve safety and access for maintenance. The addition of SCADA interface panels was recommended for all pumping stations to allow for remote monitoring and control of the stations.

- A summary of the Engineers Opinion of Probable Cost for recommended pumping station improvements are provided (Attachment 4) and are summarized in the following table.

Summary of Recommended Pumping Station Improvements

Pump Station	Ownership	Opinion of Probable Cost
River Street	Public	$870,000
Boson's Hill	Public	$700,000
Steamboat	Public	$470,000
Subtotal		***$2,040,000***
North Gate #1 Elimination	Private	$140,000
North Gate #2	Private	$310,000
Great Island & Campbell's Consolidation	Private	$770,000
Little Harbor	Private	$340,000
Subtotal		***$1,560,000***
Total		**$3,600,000**

- With few exceptions, manholes were constructed of precast concrete, equipped with 30" covers with brick corbels and brick shelves/inverts. Generally, the precast structures appeared to be in good condition and the majority of observed defects were limited to the upper cover/frame/corbel portion of the manhole. No leaking manhole defects were observed, but signs of previous leakage such as staining and/or mineral deposits were noted. Due to contract scheduling issues, manhole inspections were performed in the summer months and during dry weather when I/I conditions were presumed to be low. Recommended manhole improvements and associated opinions of probable costs included manholes with defect codes 2, 3, 4, and 5 are summarized in *Table 2-Recommended Manhole Rehab. Summary (Page 9 of UE's Technical Memorandum and Attachment 4)* assuming transition toward City operation/ownership. The following table summarizes the Engineer's Opinion of Probable Costs for manhole improvements:

Summary of Recommended Manhole Improvements

	Locate, Inspect, and Raise Frame and Cover	Repair Allowance for Uninspected Manholes	Raise Frame and Cover	Replace Frame and Cover	Rebuild Corbel	Grout Leaks and Line Manhole	Rebuild Shelf and Invert
Private Manholes	12	12	2	31	12	3	1
Public Manholes	9	9	2	6	56	9	0
Totals	**21**	**21**	**4**	**37**	**68**	**12**	**1**

Opinion of Probable Cost for Recommended Public and Private Manhole Improvements is $310,000 ($190,000 public, $120,000 private).

- Manholes with defects having condition code ratings of 3, 4 or 5 are the most critical to address in the near term and the total number of observed code 3, 4, and 5 defects are summarized as requested by the Town. However, it should be noted that opinions of probable cost also include rehabilitation of Code 2 defects.

  Code 3: Twelve (12) manholes

  Code 4: One (1) manhole

  Code 5: Zero (0) manholes

- The following repairs were recommended (see *Table 2-Recommended Manhole Rehab. Summary)* for manholes located along NH Route 1B which we understand is planned to be paved this summer:

  Locate and raise manhole frame and cover: 5620

  Rebuild Corbel: 5624, 5627, 5614, 5623, 5630, 5632, 5633, 5634, 5642, 5636, 5637

  Remove and Reset Cover: 5635

- CCTV of sewers was recommended to evaluate for structural defects if an operation/ownership transition to the City is being considered. The Engineers Opinion of Probable Cost for this additional evaluation is $88,000 ($54,000 public, $34,000 private).

- The following is a summary of recommended sewer evaluation and improvement opinion of probable costs based on the findings of this evaluation. The costs for required structural improvements that may be identified by CCTV or during the Phase I&II Inflow Program are listed as TBD pending the finding of those evaluations.

Summary of Recommended Infrastructure Improvements

Description	Opinion of Probable Cost		
	Public	Private	Total
Pump Stations	$2,040,000	$1,560,000	$3,600,000
Manhole Rehabilitation	$190,000	$120,000	$310,000
Gravity Sewer Evaluation	$54,000	$34,000	$88,000
Sewer Rehabilitation	TBD	TBD	TBD
Total	***$2,284,000 +TBD***	***$1,714,000 +TBD***	**$3,998,000 + TBD**

Summary of Total Estimated Costs

I/I Program	$ 53,512
Infrastructure	$3,998,000
I/I and Sewer Rehabilitation	TBD
Total	$4,051,512