Storm Water System
Asset Management Program
Wolfeboro, New Hampshire

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Prepared by:

UNDERWOOD engineers

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1. Introduction

The purpose of this report is to document the progress the Town of Wolfeboro has made with respect to its storm water asset management program (AMP).

The Town is continuing its systematic evaluation of the assets for which it is responsible; and is pursuing a fully functional asset management program. The Town uses Utility Cloud asset management software to create, distribute and track work orders. Utility Cloud also has the ability to generate reports, which can be used to share information with staff, the Select Board and the public.

To date the Town has completed asset management programs for its potable water system and its wastewater collection system; and also plans to pursue an asset management program for its wastewater treatment facility.

The framework of this AMP includes the following core components.

- Asset Inventory and Condition Assessment
  - What storm water assets is the Town responsible for maintaining?
  - Which are able to serve their purpose? Which are not?
  - What is their condition?
- Level of Service (LOS)
  - What are the Town's goals in operating and maintaining the system?
  - Goals should be specific, measurable, attainable, realistic, timely (SMART)
- Criticality
  - Prioritize assets by their probability of failure versus their impact of failure.
- Minimum Life Cycle Cost (Practices)
  - Estimate costs needed to properly inspect and repair assets in order to maintain the desired LOS.
- Long-Term Funding Strategy (Budget)
  - Schedule estimated replace costs out over the life of the assets.
- Implementation and Communication Plan
  - Data collection
  - Planning tools
  - Management reporting
- Recommendations and next Steps

2. Asset Inventory and Condition Assessment

The Storm Water AMP included a significant data collection effort. A Town employee along with an Underwood Engineering staff member spent several weeks from June 2018 through August 2018 field verifying the existing GIS-based map of the Town's storm water system. Information on pipe invert depths and sump depths were collected. Pipe diameters, clock position and material were collected as well. Unmapped structures were added to the map. In total 655 structures of 1,026 were evaluated.

Storm pipes were drawn based on catch basin field data collection. Information collected from the structure inspections were transferred to the pipes. Based on the current effort, there are an estimated 1,138 storm water pipes totaling 62,341 linear feet.

Storm water facilities within the Town belong to various owners besides the Town, including the State, School District and private property owners. Break down by ownership is provided in Tables 1 and 2 below.

Table 1. Storm Water Structures by Ownership

STRUCTURES BY OWNER AND INSPECTION STATUS			
	Inspected		
Owner	**Yes**	**No**	**Grand Total**
Town	493	181	674
State	147	97	244
School District	0	2	2
Private	15	91	106
Grand Total	**655**	**371**	**1026**

Table 2. Storm Water Pipe by Ownership

STORM PIPE BY OWNER	
Owner	**Total**
Town	35,982
State	21,393
School District	244
Private	4,722
Grand Total	62,341

2.1. Maintenance and Capital Cost Responsibility

The Town is responsible for maintenance costs related to all Town-owned and State-owned facilities. Capital cost responsibility for State-owned facilities is less clear. The operating assumption for the purposes of this report is that the State is responsible for 100% of capital costs if the facilities are included in the NHDOT's Ten-Year Plan. For municipal projects, the Town is responsible for one-third of the capital cost and the State is responsible for two-thirds.

Private property owners and the school district are responsible for maintenance and replacement costs associated with their own facilities.

2.2. Data History and Information Sources

The Town's storm water structures were first mapped in GIS format by drawing them over an aerial. The locations and lengths of storm water pipes were drawn based on what seemed logical and appropriate based on the location and arrangement of visible structures.

Those files were loaded into Utility Cloud.

As mentioned above, that initial map was expanded and verified by a two-person crew as part of this current storm water AMP effort. A work order was created based on the form provided in **Appendix A**. When unmapped structures were encountered, they were added to the map. Information pertaining to storm water pipe was collected, and condition scores were assigned as follows.

1. Very Low Risk-Asset is extremely reliable
2. Low Risk-Sporadic Failures possible
3. Moderate Risk-Possibility of Failure
4. High Risk-Asset sometimes fails to meet performance requirements.
5. Very High Risk-Asset is likely to fail or has failed to meet performance requirements.

The data was then exported to ArcGIS shapefiles and Excel spreadsheets for further processing. These updated files are being provided to the Town for inclusion into Utility Cloud. Originally, the evaluation areas were to be limited to two work areas spanning the congested downtown area – approximately 400 structures. However, the crew worked efficiently enough to collect data on 655 structures within the allotted budget.

Maps of the structures evaluated and the initial work areas are provided in **Appendix C**.

Unlike the Town's sanitary sewer system, the flow direction of storm water is not always readily apparent. The original ArcGIS file included partial elevation information and the source was unknown. Therefore, depth to invert information was collected as part of the storm water AMP. Rim elevations were assigned to structures from Connecticut River Watershed (2015) data available from the UNH LiDAR Distribution site (http://lidar.unh.edu/map/). Invert elevations were calculated by deducting depth to invert from the rim elevation. Sump elevations were calculated in a similar fashion.

Detailed storm water system information is provided in the following Appendices.

- **Appendix C** – Map of Storm Water Structures by Condition Score.
- **Appendix D** – Storm Water Structure Attribute Tables and Summary Sheets.
- **Appendix D** – Storm Water Pipe Attribute Tables and Summary Sheets.

3. Level of Service

The Level of Service (LOS) provides specific goals for the operation, maintenance and performance of storm water assets. The first step in formulating the LOS was to review problems identified during the Asset Inventory and Condition Assessment process.

3.1. Problems Identified

As mentioned in section 2, condition scores were assigned to each storm water structure evaluated. Overall, storm water structures are in serviceable condition. However, eleven (11) catch basins received a condition score of 4 or 5. That is they are in poor condition and/or have failed to meet performance requirements.

Table 3 provides a summary of the condition of each structure in the system, and Table 4 provides a list of specific structures in need of repair or replacement.

Table 3. Summary of Structures by Condition

STRUCTURES BY CONDITION					
Condition	**Town**	**State**	**School District**	**Private**	**Grand Total**
1	437	73		11	521
2	40	33		2	75
3	10	37		1	48
4	3	4			7
5	3			1	4
Not Evaluated	181	97	2	91	371
Grand Total	**674**	**244**	**2**	**106**	**1026**

Table 4. Structures Requiring Repair or Replacement

STRUCTURES WITH CONDITION SCORE OF 4 OR 5					
Condition Score	**Asset ID**	**Town**	**State**	**Private**	**Grand Total**
4	CB-138-2	1			1
	CB-190-7		1		1
	CB-203-1		1		1
	CB-217-28		1		1
	CB-217-59		1		1
	CB-217-82	1			1
	CB-217-98	1			1
4 Total		**3**	**4**		**7**
5	CB-138-1	1			1
	CB-218-2	1			1
	CB-218-84	1			1
	CB-231-52			1	1
5 Total		**3**		**1**	**4**
Grand Total		**6**	**4**	**1**	**11**

The Town's goal is to repair or replace structures with a condition score of 4 within two years; and to repair or replace structures with a condition score of 5 within six months.

3.2. Inspection and Routine Maintenance Goals

The main function of the storm water facilities is to mitigate water quality impacts. The first line of defense are catch basin sumps, which collect silt and debris and prevent it from reaching nearby waterbodies, including Lake Winnipesaukee. The Town's goal is to clean each sump annually. However, the Town lacks the equipment to perform this task in-house and the work must be hired out to a contractor who is accompanied by a Town staff member to supervise the work and monitor progress. The number of sumps cleaned often depends on the contractor's availability. Typically, about 75% of sumps are cleaned each year.

The Town is responsible for maintaining both Town-owned and State-owned facilities, which amounts to 918 structures and 57,375 linear feet of storm water pipe. The annual cost of cleaning the structures is figured into the Town's budget.

Information regarding the condition of storm water pipe was not collected during this phase of the asset management program. However, it is known that corrugated metal pipe (CMP) is generally in poor condition and that vitreous clay pipe, installed in the 1920's and 1930's is nearing the end of its useful life.

The Town's goal is to include pipe inspections, using a mirror and light, in its annual maintenance budget. An initial target is to inspect 10% of the storm water pipe per year, or approximately 5,700 feet. Pipe inspections will be prioritized based on material, age or location within a road project.

The material and age of Town-owned and State-owned storm water pipe is provided in Table 5 below.

Table 5. Age and Material of Town-owned and State-owned Storm Water Pipe

State and Town-owned Storm Water Pipe by Estimated Age and Material							
	Year Installed (Estimated)						
Material	**1930**	**1950**	**1970**	**1980**	**1985**	**Unknown**	**Total**
CMP		9,428					9,428
Aluminum		45					45
Cast Iron		205					205
Iron		79					79
Metal		403					403
Clay	5,998						5,998
Clay Tile	313						313
Plastic				6,266	288		6,554
PVC				1,516	1,360		2,875
CPE				2,902	6,095		8,996
Cement			37				37
Concrete			941				941

State and Town-owned Storm Water Pipe by Estimated Age and Material							
	Year Installed (Estimated)						
Material	**1930**	**1950**	**1970**	**1980**	**1985**	**Unknown**	**Total**
RCP			2,925				2,925
NC		16					16
Unknown						18,558	18,558
Total	**6,311**	**10,177**	**3,903**	**10,683**	**7,742**	**18,558**	**57,375**

3.3. Data Collection and Follow-up

As the Town's infrastructure ages, maintenance and upkeep continues to consume more staff time. An automated, streamlined system of data collection and follow-up would enable easier access to information for decision-making. Therefore, the Town has established a goal of documenting complaints and incident reports 100% of the time.

Customer complaints fielded by office staff are relayed to field staff who then close out the complaint using a paper-based system. As the Town's asset management program progresses, a computerized system will be developed within Utility Cloud where all appropriate personnel will be able to input information and attach documents to each complaint. This system can be expanded to include incidents, such as system surcharging or local flooding, reported or observed by staff. The goal is to assess incidents within 24 hours and implement a response plan within three days. The goal for emergencies is to respond within thirty minutes.

The form currently used by the Town is provided in **Appendix A.** This can be adapted for use in a computerized system.

Storm water assets are being added regularly. Between 20 and 100 structures are added each year, as are 2 to 3 BMP's. The goal is to update inventory annually. In addition, the data collected will be used to generate management reports as needed and update the LOS once per year.

A LOS is provided in **Appendix B**.

4. Critical Assets and Priority Projects

In order to allocate scarce financial and physical resources in the most efficient possible way, it is necessary to systematically prioritize projects. For the purposes of this AMP, assets will be ranked by their criticality. Criticality is defined as probability of failure versus impact of failure.

As mentioned in sections 2 and 3, a condition score was assigned to each structure evaluated. Condition is analogous to probability of failure. The scoring system is provided below.

1. Very Low Risk-Asset is extremely reliable
2. Low Risk-Sporadic Failures possible
3. Moderate Risk-Possibility of Failure
4. High Risk-Asset sometimes fails to meet performance requirements.
5. Very High Risk-Asset is likely to fail or has failed to meet performance requirements.

Storm water pipes were not assigned a condition score. However, probability of failure can be surmised based on age and material.

Impact of failure was assigned with the following points in mind.

- Catch basins with sumps are considered the first line of defense when it comes to water quality mitigation. Catch basins without sumps should be flagged and prioritized for replacement. See Table 6 for a summary of catch basin sumps.
- BMP's are second in importance to catch basins.
- Outfalls to surface waters are considered the most important storm water pipes.

Impact of failure scoring is detailed below.

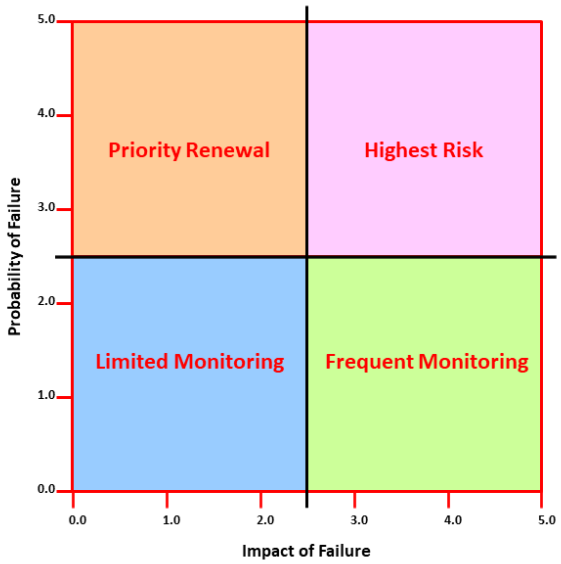
1. Very low impact of failure: unlikely to affect a surface water or a major roadway. Would impact a small number of customers.
2. Low impact of failure: unlikely to affect a surface water or a major roadway. Has the potential to impact a moderate number of customers.
3. Moderate impact: unlikely to affect a surface water. May affect a major roadway. Has the potential to impact a moderate to large number of customers.
4. Significant impact: could affect a surface water based on proximity to a BMP or surface water. Located in a congested area or on a major roadway. Has the potential to impact a moderate to large number of customers.
5. Major impact: directly connected to a surface water and could have significant impact. May affect a major roadway. Has the potential to impact a large number of customers.

Table 6. Summary of Catch Basin Sumps

TOWN-OWNED AND STATE-OWNED STRUCTURE SUMPS		
Sump Description	**Condition**	**Quantity**
Sump < 0; RECHECK Measured depth to sump was less than measured depth to invert.	1 2 3 4 5	13 6 7 1 2
Sump 0-1 ft Difference between depth to sump and depth to deepest pipe invert is less than 1 foot.	1 2 3 4 5	166 24 19 2 1
Sump > 1 ft	1 2 3 4	313 41 21 3
No pipe inverts	1	7
Depth to sump not measured	1 2 4	11 2 1
Not Evaluated	Not Evaluated	278
Grand Total		**918**

The criticality of an asset can be categorized as listed below. See Figure 1 for a visual representation.

Figure 1. Criticality Matrix



Highest Risk

- High Probability of Failure (poor condition)
- High Impact of Failure

Priority Renewal

- High Probability of Failure (poor condition)
- Low Impact of Failure

Frequent Monitoring

- Low Probability of Failure (good condition)
- High Impact of Failure

Limited Monitoring

- Low Probability of Failure (good condition)
- Low Impact of Failure

Storm water assets are mapped by probability of failure (ie. condition), impact of failure and criticality in **Appendix C**.

5. Minimum Life Cycle Cost (Practices)

At a minimum the Town will need to inspect and repair structures on an ongoing basis. To perform the detailed inspections that were done for this AMP, it took a two-person crew and approximately fifteen minutes per structure. At $35 per hour, it would cost approximately $18,000 in staff time to inspect all 1,026 structures or approximately $18 per structure. A contractor would typically charge approximately $50-$60 per structure.

The less in-depth annual cleaning requires one staff person and a contractor. This cost is already included in the Town's annual budget. The Town endeavors to clean all Town-owned and State-owned catch basins each year. However, more detailed data collection could be used to fine tune cleaning frequencies. For instance, catch basins that don't accumulate much silt or debris could be cleaned less frequently. It may be found that others need to be cleaned more frequently than once per year.

Data collected could also be used to determine whether it is more cost-efficient to perform tasks in-house or contract them out.

The Town will also need to budget for replacements or repairs of facilities found to be in poor condition. The estimated installation cost for a new storm water structure is $6,000 assuming the Town is responsible for the entire cost. There is some uncertainty as to how much capital cost responsibility the Town has for state-owned structures. For the purposes of this report, it will be assumed that the Town is responsible for one-third. If that is the case, the Town's contribution is estimated to be $2,000 per structure. The Town has no financial responsibility to replace privately-owned structures, but may need a mechanism to ensure that property owners maintain their facilities so as not to impact water quality or interfere with the Town-owned system.

The detailed inspection performed as part of this storm water AMP effort found that eleven (11) catch basins were in poor condition. See Table 7 for a detailed list of catch basins found to be in poor condition and their associated replacement costs.

The storm water pipe associated with these structures will also require repair or replacement. The estimated installation cost of storm water pipe is assumed to be $90 per foot for the purposes of this analysis. However, the unit cost can vary greatly depending on the size and material of the pipe; and on the restoration work required. Estimated replacement costs are shown in Table 8.

Table 7. Estimated Replacement Cost of Structures in Poor Condition

Condition Score	Asset ID	Town	State	Private	Grand Total
4 – to be replaced within two years	CB-138-2	$6,000			$6,000
	CB-190-7		$2,000		$2,000
	CB-203-1		$2,000		$2,000
	CB-217-28		$2,000		$2,000
	CB-217-59		$2,000		$2,000
	CB-217-82	$6,000			$6,000
	CB-217-98	$6,000			$6,000
4 Total		$18,000	$8,000		$26,000
5 – to be replaced within six months	CB-138-1	$6,000			$6,000
	CB-218-2	$6,000			$6,000
	CB-218-84	$6,000			$6,000
	CB-231-52			$0	$0
5 Total		$18,000		$0	$18,000
Grand Total		$36,000	$8,000	$0	$44,000

Table 8. Cost of Pipe Related to Catch Basins in Poor Condition

Condition Score	Catch Basin ID	Town	State	Grand Total
4 – to be replaced within two years	CB-190-7		$609	$609
	CB-203-1		$957	$957
	CB-217-28		$5,681	$5,681
	CB-217-59		$4,106	$4,106
	CB-217-82	$5,020		$5,020
	CB-217-98	$6,170		$6,170
4 Total		$11,190	$11,353	$22,543
5 – to be replaced within six months	CB-138-1	$3,068		$3,068
	CB-218-2	$7,796		$7,796
	CB-218-84	$7,243		$7,243
5 Total		$18,108		$18,108
Grand Total		$29,298	$11,353	$40,650

6. Long Term Funding Plan (Budget)

Total storm water replacement costs have been scheduled out each year for the next ten years in Table 9. Because pipes and structures are such long-lived assets, replacement costs have also been scheduled out each decade for the next one-hundred years in Table 10.

Best Management Practice (BMP) areas are included in this cost analysis. However, it should be noted that no detailed analysis or inspections were performed. Costs related to BMP areas were divided into short-lived assets (swales, plantings) and long-lived assets (pipes, structures).

Estimated replacement costs are based on installation costs only. Engineering and design costs were excluded.

Table 9. Estimated Replacement Costs - Ten Years

Year	Catch Basin	Storm Water Pipe	BMP Area	Grand Total
2019	$104,000	$669,188	$0	$773,188
2020	$0	$0	$0	$0
2021	$0	$0	$0	$0
2022	$0	$0	$0	$0
2023	$0	$0	$0	$0
2024	$0	$0	$0	$0
2025	$52,000	$0	$0	$52,000
2026	$0	$0	$0	$0
2027	$0	$0	$0	$0
2028	$0	$0	$0	$0
2019-2028	**$156,000**	**$669,188**	**$0**	**$825,188**

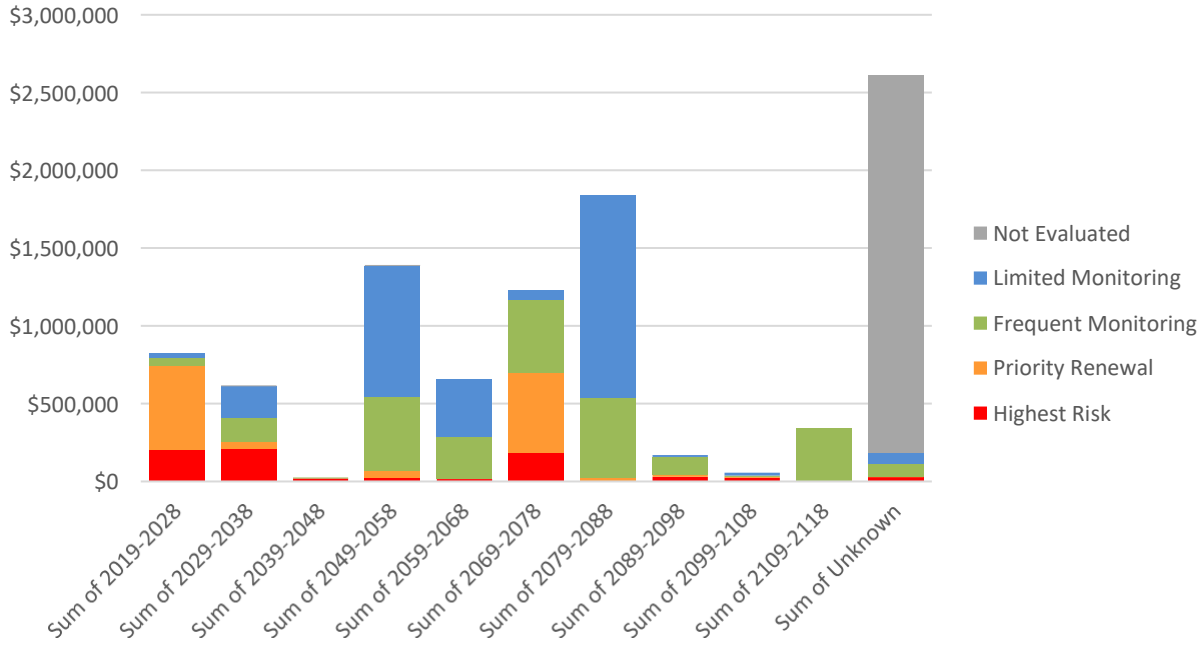
In some cases, the age of the asset is unknown. Costs related to these assets were included in the hundred-year summary in Table 10.

Table 10. Estimated Replacement Costs Next 100 Years

Year	Catch Basin	Storm Water Pipe	BMP Area	Grand Total
Unknown	$1,332,000	$1,255,961	$24,000	$2,611,961
2019-2028	$156,000	$669,188	$0	$825,188
2029-2038	$312,000	$235,353	$70,000	$617,353
2039-2048	$26,000	$0	$0	$26,000
2049-2058	$386,000	$935,445	$70,000	$1,391,445
2059-2068	$106,000	$551,615	$0	$657,615
2069-2078	$262,000	$901,760	$70,000	$1,233,760
2079-2088	$1,844,000	$0	$0	$1,844,000
2089-2098	$100,000	$0	$70,000	$170,000
2099-2108	$56,000	$0	$0	$56,000
2109-2118	$0	$0	$345,000	$345,000
2019-2118	**$4,580,000**	**$4,549,322**	**$649,000**	**$9,778,322**

Replacement costs for existing assets are estimated to be approximately $98,000 per year. In order to enable to the Town to allocate resources appropriately, storm water assets have been categorized based on their Probability of Failure (Condition) and Impact of Failure. Costs by criticality and estimated decade of replacement are shown in Figure 2 below.

Figure 2. Estimated Replacement Costs by Criticality and Decade



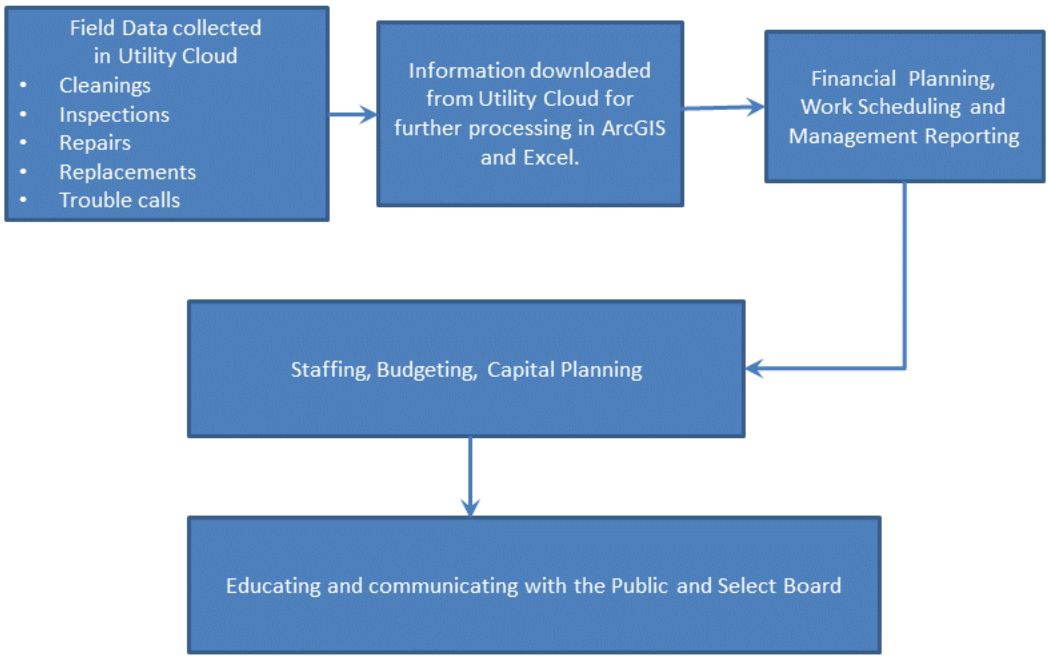
7. Implementation and Communication

The Town has assembled a great deal of data regarding its water distribution system, wastewater collection system, and now its storm water system. Because of ongoing inspections and evaluations, there is a significant amount of information available regarding the condition of the assets. However, accessing the data and keeping it up-to-date remains a challenge.

For the storm water AMP, data was field collected using the Town's asset management software, Utility Cloud. The information collected was downloaded into shapefiles for further processing in ArcMap and Excel.

See Figure 3 for an information flow chart.

Figure 3. Information Flow Chart



The information assembled can be used as the basis for a staffing plan, operating budget and capital budget. It can also be used to generate reports, which can be used to educate and inform the Select Board and the public. See **Appendix A** for a sample management report.

8. Conclusions and Recommendations

Ongoing data collection and verification will be required. Of the 1,026 catch basin structures mapped, 655 were inspected as part of the storm water AMP with 371 remaining. Facilities are being installed and upgraded each year.

Storm water pipe invert information was collected during the catch basin inspection process. However, storm water pipe layout and quantities were not verified. This will require an ongoing data collection effort.

The Town intends to continue to develop and refine its field data collection process. To assist in that effort the following recommendations are offered.

1. Develop drop-down menus to ensure data integrity and simplify data input for the field crew.
2. Develop defaults and auto-fill fields where appropriate to reduce repetitive data entry in the field.
3. Set up masks and error messages to reduce data entry errors.
4. Make certain fields required.
5. Develop an Incident Report form to track and follow-up on customer complaints, equipment failures, etc.
6. Develop a simplified inspection form for annual cleanings and inspections.

Going forward the data collected can be used to do the following.

1. Refine and update criticality.
2. Refine and update replacement costs.
3. Refine and update Level of Service Statement