APPENDIX I

ASSET MANAGEMENT PLAN GAP ANALYSIS TECHNICAL MEMORANDUM

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City of Flint, MI

ASSET MANAGEMENT PLAN (AMP) GAP ANALYSIS TECHNICAL MEMORANDUM

Flint Drinking Water Distribution System Optimization

FINAL

September 14, 2017

AMP GAP ANALYSIS TECHNICAL MEMORANDUM

Flint Drinking Water Distribution System Optimization

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1.0 INTRODUCTION

The City of Flint (City) has retained the services of Arcadis of Michigan, LLC (Arcadis) to perform a Drinking Water Distribution System Optimization Study. Task 8 of this project focuses on helping the City continue further development and implementation of an Asset Management Plan (AMP) which meets the following criteria:

- Meets the minimum criteria established within the Michigan Department of Environmental Quality (MDEQ) Asset Management Program Checklist and Asset Management Guidance for Water Systems
- Addresses all assets related to potable water distribution, pumping, and storage assets maintained by the City's Department of Public Works - Water Service Center and Water Treatment Plant divisions
- Contains a schedule for the development and implementation of an Asset Management (AM) Program that can be achieved in 3-5 years
- Is submitted to the MDEQ on or before January 1, 2018

"Asset management is an integrated set of processes to minimize life cycle costs of assets, at an acceptable level of risk, while continuously delivering established levels of service."
- National Association of Clean Water Agencies (NACWA)

All decisions related to the update of the new AMP will be made in collaboration with City of Flint Department of Public Works (Water Service Center and Water Treatment Plant divisions) and newly formed Asset Management Steering Team[1] representatives.

1.1 Brief History of Asset Management Planning at the City of Flint

Incorporated in 1855, it is estimated that the City of Flint's first water distribution pipelines were installed as early as 1900. The first Flint Water Treatment Plant was constructed in 1917. Many studies and master plans have been performed on the system, as early as the 1965[2]. In 2008, the City of Flint Water System Review (MDEQ 2008) cited many key improvements being necessary to the water supply, including the recommendation to develop an Asset Management System.

Historically, the City's water horizontal assets (distribution pipelines, fire hydrants, valves, and appurtenances) have been owned and maintained by the City's Department of Public Works (DPW) - Water Service Center division. Vertical assets (water storage, pumping, and treatment facilities) have been operated and maintained by the DPW - Water Treatment Plant (WTP) division. Evidence of separate asset management activities have been found for both horizontal and vertical assets in the Water Reliability Study (Rowe Engineering 2013) and Water Supply Assessment (Tucker Young Jackson & Tull 2013), respectively. This included the field verification of hydrants and valves, development of a GIS-based model, and the development of a replacement program for assets in excess of fifty years old. Pumping and treatment facilities were also assessed in 2013 (at varying levels of detail). However, like many water utilities across the country, the City lacked the resources to implement the proposed Asset

[1] Members of the Asset Management Steering Team to include attendees of the 4/20/17 kickoff meeting.
[2] Per the 2015-2020 Capital Improvement Plan, "…the first Master Plan was developed over 50 years ago…" (DLZ Michigan 2015)

Replacement Program and other recommendations documented within the reports. City resources often were shifted away from this preventive work to respond to corrective issues, such as emergency breaks or construction activities.

In 2014, the City experienced a highly-publicized drinking water crisis. In response to the state of emergency declaration and United States Environmental Protection Agency (USEPA) emergency administrative order, multiple projects were initiated between 2015 and 2017. Efforts related to asset management included:

- Resume purchasing water from the Great Lakes Water Authority (GLWA, formerly Detroit Water and Sewerage Department)
- Provide an inventory of lead service lines, water interruptions, and unoccupied homes
- Develop and implement a distribution system water quality optimization plan (Arcadis 2017)
- Valve Assessment and Exercising (Wachs Water Services 2015)
- Development of a Capital Improvement Plan (DLZ Michigan 2015)[3]
- Deliver a Fiscal Year 2016 Year-End Report (Water Service Center 2016)

In 2016, the City published their first Draft Asset Management Report (Rowe Engineering 2016). The purpose of the report was to "…develop an inventory and define the needs of the City's utilities and roadways." It was a good first step in the process of asset management and begins to provide information for the City to make decisions and establish priorities for maintenance and replacement of the City's infrastructure. The Asset Management Plan was reviewed by the MDEQ and feedback was provided for areas of improvement. This feedback will be used to update/revise the City's Asset Management Report and submit to the MDEQ on or before January 1, 2018.

1.2 Purpose of This Document

The purpose of this Technical Memorandum is to document the proposed plan to update the City's AMP for water-related City assets and obtain approval/consensus before proceeding. To ensure delivery of an approvable AMP to the MDEQ on or before January 1, 2018, an approach and schedule must be developed to close the identified gaps as part of the AMP. With many on-going water-related projects being performed in parallel at the City and multiple stakeholders, it is important to identify a detailed plan for conducting on-site workshops with City staff, allow for ample time for the understanding of key AM concepts, and gain consensus on decision points. This will ensure the resulting AMP is efficient, complete, and provides long-term value to the City.

Once feedback from this Gap Analysis TM is obtained from the City, Arcadis will proceed with drafting the AMP.

[3] Per the 2015-2020 Capital Improvement Plan, "…this was the first formal Capital Improvement Plan in in many years…" (DLZ Michigan 2015). Water-related assets addressed in this plan include both vertical assets (Water Treatment Plant 2, water testing laboratory, pumping stations, water storage facilities, and a number of smaller facilities) as well as linear assets (conveyance systems and appurtenances).

1.3 Assets to be Included

The proposed 2017 Water Asset Management Plan Update (report) will be focused on potable water distribution system assets which are owned, maintained, and operated by the City. Chapter 1 will identify a plan for the development and implementation of a full Water Asset Management Program within the next 3-5 years. Additional chapters will be focused on the five (5) core elements of asset management, which includes: (1) Asset Inventory, (2) Level of Service, (3) Criticality, (4) Capital Improvement Project (CIP) Plan. The assets proposed to be included in the report are detailed in Table 1 below.

Table 1. Assets to be Included in the 2017 AMP

Asset Category	Asset Class/Type	Asset-Maintaining Department
Fixed Assets (Capitalized)	Water – Horizontal Assets • Mains (distribution pipelines) • Fire hydrants • Control Valves (in-line gate/butterfly valves, pressure reducing valves, hydrant valve, side connect valve, etc) • System Valves (air release, blowoff, etc) • Meters • Service Lateral Lines (entire line – from main to the meter[4])	Department of Public Works - Water Service Center Division
	Water – Vertical Assets[5] • Storage Facilities[6] • Pumping Stations	Department of Public Works - Water Treatment Plant (WTP) Division

Fixed assets proposed to be excluded from the 2017 AMP Water Update include: transmission pipelines, water treatment plant, dams, water fittings (plug, adapter, tee, etc), other minor water-related appurtenances/facilities, water administration buildings, facilities, and yards, land/real estate, and other asset types (wastewater, stormwater, streets, traffic, etc.). Non-Fixed Assets (also known as expendable/portable assets) which are not included are: fleet, equipment/major tools, spare parts inventory, office equipment and computers, etc. Since the scope of this project is to address water linear/vertical infrastructure, these assets will not be included in the 2017 Water AMP. It is the intention that the Water AMP will serve as a template and other City asset types would be added as separate documents.

[4] Historically, the City legally owns the water service lateral from the main to the property line/meter. The remainder of the line (from the property line to the meter) was the homeowner portion and was not a City asset. However, the City now needs to take ownership/responsibility of the entire line in order to meet the USEPA objective of replacement of the entire service line.

[5] For vertical assets, improvement recommendations will be at the project level.

[6] This includes the City's underground storage reservoirs, elevated storage tank, and the Dort Reservoir, and any other system storage (actively in-service or temporarily off-line).

1.4 Framework to be Adopted

In the Unites States, municipalities and utilities have begun to recognize the need to develop a more structured approach to ensure accurate/defendable budget forecasting and project prioritization. A wide variety of organizations have published their own unique approach to asset management, as there is no "one size fits all" standard. For the City of Flint's 2017 AMP, Arcadis proposes to align the report with the following publications:

- Asset Management Guidance for Water Systems (MDEQ 2013)
- Asset Management Program Checklist (MDEQ 2013)

In addition to meeting these minimum requirements, Arcadis proposes to also consider opportunities to align the program with other newly-published best practices, such as:

- Asset Management Guidance and Best Practices (USEPA 2008)
- Asset Management Systems Requirements and Guidelines for the Application of ISO 55000-2 (International Organization for Standardization 2014)
- International Infrastructure Management Manual (IIMM 2015)
- IAM Anatomy of Asset Management (Institute of Asset Management 2015)

The previous draft Asset Management Report (Rowe Engineering 2016) organized the report by asset type. For the 2017 AMP, Arcadis proposes to re-organize the content to more align with the MDEQ's "five (5) core components in an Asset Management Plan". This includes chapters for:

- Asset Inventory
- Level of Service
- Criticality
- Revenue Structure
- Capital Improvement Project Plan

Additional details on the proposed report outline are discussed below.

2.0 2016 ASSET MANAGEMENT REPORT REVIEW

Arcadis performed an objective third-party review of the Draft Asset Management Report (Rowe Engineering 2016). The contents of the existing report were reviewed, along with the data gaps outlined by the MDEQ. The following text summarizes the strength and improvement opportunities (gaps) which have been identified.

2.1 Strengths

A cursory review of the 2016 Asset Management Report indicates it does include basic asset inventory, condition, criticality, and revenue information for the majority of the water asset classes. Content which has been confirmed to be valid and is proposed to be used in the 2017 update is listed in Table 2 below.

Table 2. Information from the 2016 AMP to be Leveraged

Asset-Owning Department	Asset	Asset Inventory	Condition	Prioritized CIP (R&R) Plan
Water Service Center	wMain (Distribution)	X		X[7]
	wMeter			
	wLateralLine	X		X
	wValve	X		
	wHydrant			
Water Treatment Plant	wStructure (Storage Reservoir/Tank)			
	wStructure (Pump Station)	X		
	wPump	X		

2.2 Improvement Opportunities

A cumulative list of gaps, which have been identified to-date, have been summarized in Table 3 below. The 2017 AMP will address each of these items.

Table 3. List of identified gaps to be addressed in the 2017 AMP

Source	ID	Potential Gap
MDEQ Memo	1	Asset Inventory (asset definition, location, condition score, remaining useful life (RUL), replacement value). The inventory must be "comprehensive, accessible, and protected" Note: The most complete GIS layers have been identified. It is being reconciled with the hydraulic model. Hydrant survey is being completed to provide approximate installation date of pipes based on hydrant fabrication.

[7] Note a methodology description was included in the 2016 AMP, however the approach will be revised.

Source	ID	Potential Gap
	2	Level of Service Goals/Statement (regulatory & complaints vs cost = low/medium/high, etc) Note: Risk analysis will provide RUL in terms of break rate which will be used to develop LOS goals. Hydraulic model will provide performance scores and goals per pipe.
	3	Estimating the overall high-risk assets using likelihood of failure (LOF) and consequence of failure (COF) criteria
	4	Revenue Structure (actual budget line items required by State of MI Chart of Accounts related to Water, estimation of cost to replace assets with <20yrs RUL)
	5	Capital Improvement Project Plan (short-term 5-year, long-term 20 years) Should include future regulations, major asset replacement, expansion, consolidation/regionalization, and technology. CIP Project form setup. Note: The proposed Rehabilitation and Replacement Planning System (RRPS) model will be used to create 5 and 20-year plans.
	6	Schedule for development/implementation of AM Program
	7	Impact of O&M Costs and effect on user rates/City budget currently in progress (Raftelis)
	8	Capacity/Obsolesce/Cost-Benefit Analysis Note: This analysis is being performed as part of the hydraulic model and RRPS models
	9	Current and Proposed future LOS (with cost impact) Note: This is the results of the RRPS
	10	Stakeholder engagement
	11	Revise CIP Prioritization methodology (sociological, economical, environmental) Note: This is triple bottom line terminology used to define COF factors for risk prioritization. This is part of the RRPS model.
	12	Add missing asset inventory (elevated storage tanks/reservoirs, pumping facilities)
	13	Valves - Add asset summary table, revise methodology (criticality, cause of break, water age) Note: This will be coordinated with the proposed Valve Exercising Program and other on-going recommendations
	14	Service Lines – are currently missing from the GIS inventory but will be added. Also approach for prioritizing R&R will be identified.
MDEQ's AM Program Checklist	15	Summarize AM activities planned for past and upcoming year
	16	Staffing levels (how staffing levels/full-time equivalents (FTEs) are determined, focus on plant/collection/lab staff)
	17	Description and detailed expenditures of Inspection/Maintenance Activities and Corrective Actions (collection, treatment, capital improvements)
	18	Plan to update asset inventory, details about progress made on the water distribution system map: -from as-builts or GPS -electronic or paper -include all water lines, pump stations, storage units -legible labels for pipe diameter/install date/material/

Source	ID	Potential Gap
	19	Inventory and Assessment of Fixed Assets (stationary pumps, blowers, buildings) -Description of the fixed asset, tag#, location -Required capacity -Level of redundancy -Install Date -Present Condition (excellent, good, fair, poor) and description of how assessed -Current replacement cost estimated -Confirmation that the Fixed Asset Assessment will be based on a Business Risk Evaluation (BRE) -Plan on how to rate the probability of failure/consequence of failure (POF/COF) and overall Risk Score
	20	Currently in progress – Cost of Service Study completed; currently performing rate design Operation, Maintenance & Replacement (OM&R) Budget and Rate Sufficiency for the Water System and Treatment Works -Confirm an Assessment of user rates and replacement funds will be performed and details on the plan -Amount in the replacement fund for next year (and all assets with useful life of 20 years or less) -Rate calculation demonstrating sufficient revenues to cover OM&R expenses -Details about identified revenue shortfalls and details about addressing -or does Plan state that there is at least one rate adjustment planned within 3 fiscal years that would reduce the revenue gap by at least 10%
	21	Schedule (timeframe for development and implementation of AM Program to be within 3-5 years)
	22	Reporting
MDEQ's AM Guidance for Water Systems	23	Glossary of Terms / City-approved definitions / Referenced MDEQ Standards
	24	Mission Statement
	25	Software Inventory (accounting, financial reporting, purchasing, payroll, etc.)
	26	List of AM Team Members and Stakeholders
	27	Documented commitment to update the AM Plan regularly and detailed plan
	28	Documented Goals and Action Plan
Other Arcadis Recommendations	29	Condition Information missing for wMain, wLateralLine, wValve, wHydrant, wStorageReservoir, wDam
	30	Missing R&R Plan for wValves, wHydrants, wStorage, wPumpStation
Gaps Identified from kick-off meeting 4/20/17	31	Manage daily and peak hour flow to not exceed GLWA agreement of 12.6 mgd average day and 15.0 mgd peak hour flow. One exceedance can increase cost for entire year.
	32	Right-sizing the pipes and adjusting flow for best water quality
	33	Echologics data not yet received/incorporated into GIS (additional 200 miles found)
	34	Reacquired 9 miles of 72" PCCP mains + new Genesee County alternate feed planned (2018)
	35	GIS missing installation date, material
	36	Remaining hydrants should be GPS'd (50% complete)
	37	Break records need to be geolocated and assigned to pipes

3.0 APPROACH TO 2017 WATER AMP

The Water System AMP is a living document that is updated periodically. The MDEQ requires an annual update to the AMP. It will serve as a roadmap for the City to develop and implement a full AM Program within the Water Department within the next 3-5 years. Since these efforts will be ongoing continuously, the report will identify which decisions have been made-to-date and approach to be used consistently over time. A process for proposing and accepting changes will also be addressed. Finally, the report will conclude with a Year-End status report summarizing actual work completed for the previous year and documented commitment for proposed activities to be completed over the following year.

3.1 Proposed AMP Outline

The previous draft Asset Management Report (Rowe Engineering 2016) organized the report by asset type. Within each chapter (e.g., Water Mains), detailed information was found on the asset inventory and documented other decisions made-to-date on condition assessment, level of service, operation and maintenance (O&M) costs, and effect on user rates and City-wide budget. Separate chapters for other asset types (e.g., Services, Dams, Water Supply, Storage) discussed varying approaches at different levels of detail.

For the 2017 Water AMP, Arcadis proposes to re-organize the content to more align with the MDEQ's "five (5) core components in an Asset Management Plan". This includes chapters for:

- Asset Inventory
- Level of Service
- Criticality
- Revenue Structure
- Capital Improvement Project Plan

Within each of these chapters, the water system will be discussed using a "top-down approach". This means decisions (related to each of the components above) that are made holistically for the entire water system will be documented. Any unique variances or additional details/breakdown for each asset type will also be summarized. This methodical approach will help the City get out of the "asset inventory" rut and create momentum. Tracking decisions at an enterprise-level will also make it easier for the AM Program to be implemented and success monitored over time.

	1		2		3		4		5	
ASSET	ASSET INVENTORY		LEVEL OF SERVICE		CRITICALITY		LIFE-CYCLE COSTING		CIP PLANNING	
	GRADE	NOTES	GRADE	NOTES	GRADE	NOTES	GRADE	NOTES	GRADE	NOTES
wMain	B	Information to be merged into a single source of record, compliant with the ESRI LGIM								
wValve	B									
wHydrant	C									
wDam	B									
wLateralLine	F									
wServiceConnection	F									
wStorageReservoir	F									
wPumpStation	F									
wTreatment Plant/Facility	F									

Figure 1. Sample Table Showing How AMP Status can be Summarized At-A-Glance

In addition, an entire chapter of the report will be dedicated to the "Water AM Program". This will include a summary of decisions related to the establishment of a Water AM Policy/Mission Statement, Short and Long-Term Goals, City-approved Glossary of Terms and Acronyms, and a Plan/Schedule for development/implementation of full Water AM Program (3-5 years). The proposed title of the report will be "**2017 Water System Asset Management Plan**". The document will be marked "draft" until it is reviewed and approved by the MDEQ. A proposed outline for the plan is provided in Table 4 below.

Table 4. Proposed Report Outline

Proposed Content	Topics to be Addressed
Acronyms and Abbreviation	
Glossary of Terms	
Executive Summary	
1. ASSET MANAGEMENT PROGRAM OVERVIEW	• City/Water Department Overview • Purpose of this Document • Adopted Framework • Water AMP Policy/Mission Statement/ Vision • Goals and Objectives • Plan/Schedule for development/implementation of full AM Program (3-5 years) • AM Roles and Responsibilities • List of Water AM Steering Team Members and Stakeholders • AM Tools and Systems • Continuous Improvement / Change Management
2. ASSET INVENTORY	• Asset Definition / Registry / Hierarchy / ID System • Field Location (spatial coordinates) • Asset Inventory (Detailed Information/Attributes) • Work Management • Asset Inspection and Condition Scores • Remaining Useful Life • Replacement Value • Other Decisions made to-date
3. LEVEL OF SERVICE	• Service Level Statement • Current and Proposed LOS Targets • KPIs and Performance Management • Other Decisions made to-date
4. RISK/CRITICALITY	• Likelihood of Failure (LOF) • Consequence of Failure (COF) • Resulting Risk Rating (BRE) • Introduction of the RRPS Tool • Other Decisions made to-date

Proposed Content	Topics to be Addressed

5. REVENUE STRUCTURE	• Planning
	  o Master Planning / Capacity Analysis - right-sizing the pipes and adjusting flow for best water quality)
	• Operating Expenditures (OpEx)
	  o State of MI Chart of Accounts
	  o Repair vs Replacement
	  o Planned/Preventive Maintenance Budget
	  o Unplanned/Corrective Maintenance Budget
	  o Future Regulation Changes or City expansion /consolidation/ regionalization
	  o Technology Changes
	• Capital Expenditures (CapEx) [8]
	  o RRPS Tool Results
	  o Major Asset Replacement (<20yrs RUL)
	  o Capital Project Identification
	  o Project Bundling
	  o Revise CIP Prioritization methodology (sociological, economic, environmental)
	• City-wide Budget Process Overview
	• Water Rate Methodology
	• Impact of O&M Costs and effect on user rates/City budget
	• Other Decisions made to-date

6. CAPITAL IMPROVEMENT PROJECT PLAN	• CIP Plan o Proposed plan to close gaps • Updating RRPS Tool with financial modeling • Other Decisions made to-date
7. FY2017 YEAR-END REPORT (WORK PERFORMED/COMPLETED THIS YEAR)	• Table showing list of assets owned, and % complete (Asset field-located, attributes inventoried, condition score assigned, etc) • Detailed expenditures of Inspection/Maint Activities and Corrective Actions (collection, treatment, capital improvements)
8. FY2018 PROPOSED AM ACTIVITIES (PLANNED FOR UPCOMING YEAR)	• AM Activities Planned for Upcoming Year (FY2018)

[8] Per the City of Flint Capital Improvement Plan, "A Capital Improvement Plan (CIP) is a multi-year program for expenditures by the City of Flint for rehabilitation, replacement, and balancing of the City's municipal infrastructure systems. Projects considered through the CIP process involve proposed investments in the City's infrastructure and facilities, such as police and fire stations, parks and recreation facilities, community centers, offices, roads and sidewalks, and utilities." (DLZ Michigan, Inc. 2015)

3.2 Proposed Schedule

In order to meet the submittal deadline of the draft 2017 AMP to the MDEQ on or before January 1, 2018, the following milestones have been identified:

- Week of 10/2/17 - Workshop 1 Methodology Overview (Task 8.3.1 Condition Assessment Workshop + Task 8.3.2 Service Level Workshop)
- Week of 10/16/17 – Workshop 2 Results of Desktop Analysis (Task 8.3.3) and Staff Interviews / Survey (Task 8.3.4)
- 12/1/17 – draft 2017 AMP delivered to City for review (1-week turnaround time)
- 12/8/17 - City comments to be delivered back to Arcadis
- 12/15/17 - Final 2017 AMP sent to City
- 12/22/17 – City Acceptance due

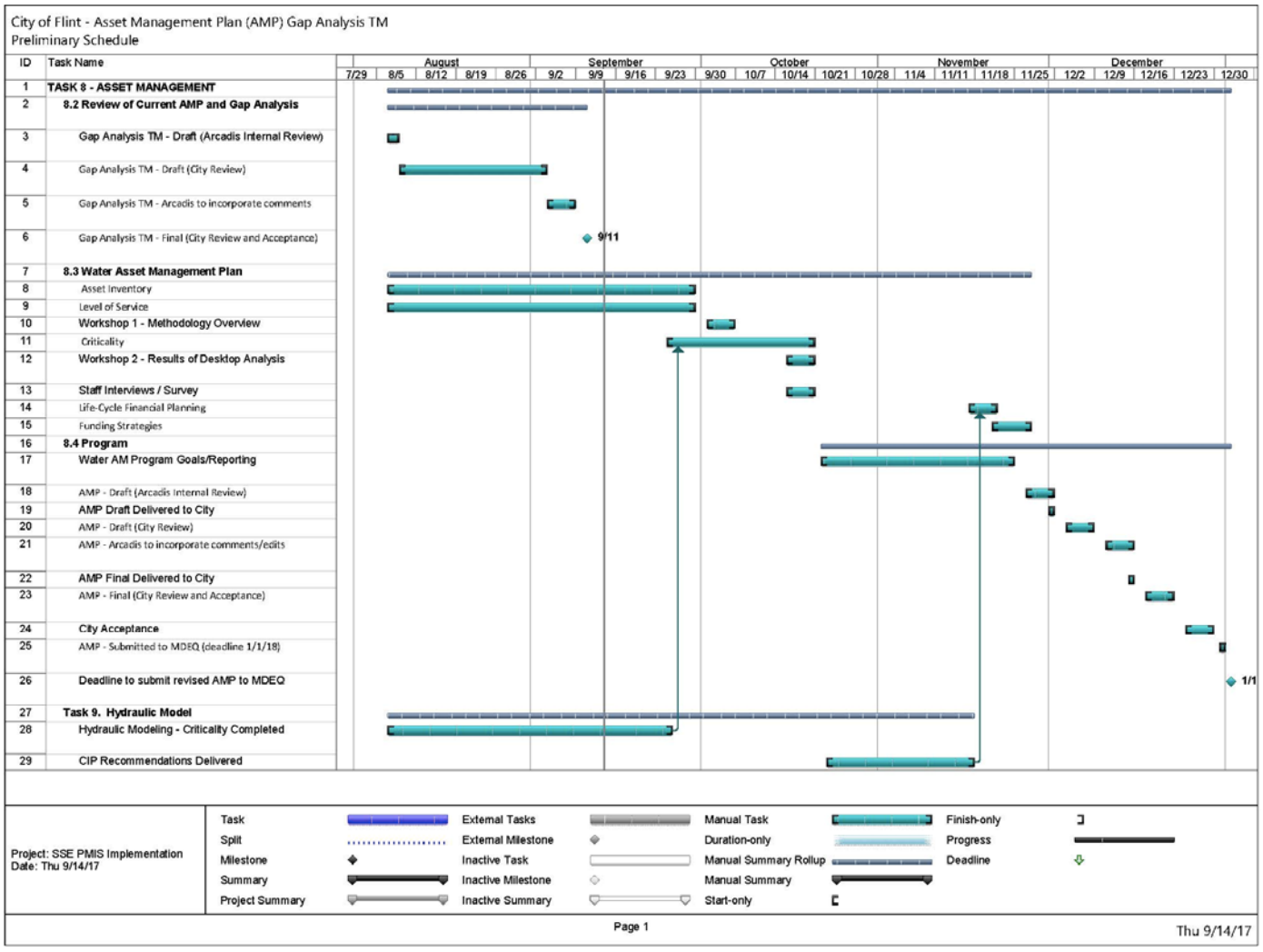

Figure 2. Proposed Schedule

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