Water and Wastewater Utility Evaluation Guidance Document: Asset Inventory & Assessment, Capital Cost, and Operating Cost Analyses

North Carolina Department of Environmental Quality: Division of Water Infrastructure

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Acronyms and Abbreviations

Term	Description
AACEI	Association for the Advancement of Cost Estimating International
AIA	Asset Inventory and Assessment
BPS	Booster Pump Station (Water)
CCTV	Closed Circuit Television
CM	Corrective Maintenance
COG	Council of Governments
CR	Condition Rating
DEQ	North Carolina Department of Environmental Quality
Division	North Carolina Division Of Water Infrastructure
DMR	Discharge Monitoring Report
DWR	North Carolina Division of Water Resources
FEMA	Federal Emergency Management Agency
FTE	Full-time Equivalent Employees
GIS	Geographic Information Systems
I/I	Infiltration And Inflow
JHA	Job Safety Hazard Analysis
LWSP	Local Water Supply Plans
NASSCO	National Association of Sewer Service Companies
NCCGIA	North Carolina Center For Geographic Information and Analysis
NCDWI	North Carolina Division of Water Infrastructure
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
OH&P	Overhead and Profit
PACP	Pipeline Assessment Certification Program
PER	Preliminary Engineering Report
PM	Preventative Maintenance
PPE	Personal Protective Equipment
PS	Pump Station
R&R	Rehabilitation And Replacement
SCADA	Supervisory Control And Data Acquisition
SWIA	State Water Infrastructure Authority (also, “Authority”)
UNC EFC	University Of North Carolina Environmental Finance Center
USDA	United States Department Of Agriculture
WTP	Water Treatment Plant
WWPS	Wastewater Pump Station
WWTP	Wastewater Treatment Plant

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1 Introduction

1.1 Background: The Road to Utility Viability

In 2013, the North Carolina General Assembly created the State Water Infrastructure Authority (Authority) to assess and make recommendations about the state's water and wastewater infrastructure needs, and the infrastructure funding programs available to the state's local governments and utilities. Authority membership is comprised of elected officials, state and local government staff, and private citizens. By authorizing the Authority to make funding decisions, the legislature highlighted the important role of North Carolina's water infrastructure in safeguarding public health, protecting the environment, supporting vibrant communities, and encouraging economic development.

In 2017, the Authority and the North Carolina Department of Environmental Quality (DEQ) Division of Water Infrastructure (NCDWI) completed the *Statewide Water and Wastewater Infrastructure Master Plan: The Road to Viability*. The purpose of the *Master Plan* was to provide a road map for water and wastewater utility viability while maximizing the impact of state investments.

The *Master Plan* defines a "viable utility" as *one that functions as a long-term, self-sufficient business enterprise, which establishes organizational excellence and provides appropriate levels of infrastructure maintenance, operation, and reinvestment that allow the utility to provide reliable water services now and in the future*. In addition, a viable utility has the ability to attract and retain qualified management, operations, and financial staff.

The *Master Plan* recognizes that utilities may encounter a range of challenges to their viability. Many of these relate to how infrastructure is managed, such as backlogs of needed repairs and overall condition of the infrastructure. Others are outside the direct control of the utility including but not limited to:

- Loss of industrial customers, leading to revenue impacts due to lower water usage and wastewater flows.
- Declining population, leading to revenue impacts due to lower water usage and wastewater flows.
- Increasingly stringent drinking water regulations and water quality regulations.

The *Master Plan* identifies three utility management best practices that are essential for viable utility systems:

- **Infrastructure Management**. Utilities take proactive approaches to enable the right investments to be made in the right projects at the right time, taking into consideration life-cycle costs and risk management.
- **Organizational Management**. Utility governing boards understand the long-term nature of water/wastewater systems and prioritize the financing and completion of the most critical infrastructure projects.

- **Financial Management**. Utilities generate sufficient revenue to fund infrastructure construction, maintenance, operations, and renewal/replacement without long-term reliance on grant funds.

1.2 Viable Utility Assessment Pilot Program

Between 2017 and 2019, NCDWI conducted a pilot program to evaluate the long-term viability of several interconnected small, rural water and wastewater utilities in North Carolina. The numerous challenges facing these utilities included aging infrastructure, geographic isolation, decreasing population, increasing utility rates, affordability issues, declining revenues, and workforce limitations.

NCDWI partnered with the NC Department of State Treasurer Local Government Commission (LGC), the University of North Carolina Environmental Finance Center (UNC EFC), Compass Services LLC, HDR Engineering, Inc. of the Carolinas (HDR), and representatives from the small utilities. This team collaborated to conduct an overall utility assessment in order to identify a potential road map to future utility viability. The objectives of the pilot program included:

- Identify the infrastructure, organizational, and financial situation of the water and wastewater utilities and evaluate options for the utilities to achieve long-term viability; and
- Develop a systematic process that could serve as a template for other communities across the state that face similar challenges to conduct similar evaluation and planning work.

A central component of this pilot program was the development of an Asset Inventory and Assessment (AIA). The AIA resulted in an understanding of the current asset inventory, asset condition, and existing facility operations and maintenance (O&M) levels across all facility and asset types. The AIA was then used to identify future capital rehabilitation and replacement (R&R) needs, identify improved O&M practices, and estimate the associated funds necessary for the utilities to provide reliable water and wastewater services to their communities for the long-term.

1.3 Next Steps

As part of its *Master Plan* implementation, NCDWI plans to work with consultants to apply the Pilot Program approach to evaluate situations in other small to medium-sized utilities that may lack the resources to accomplish this work with internal staff.

2 Guidance Document Purpose and Scope

2.1 Guidance Document Purpose

The purpose of this guidance document is to outline a repeatable, standardized process to conduct AIA and cost analyses at an appropriate level of detail, to high-quality standards, and in a consistent, thorough manner. The steps include:

1. Develop an inventory of water and/or wastewater system assets the utility owns and operates,
2. Develop asset condition ratings and criticality ratings for utility assets that are sufficient to identify and prioritize R&R projects and identify needed O&M activities,

3. Develop capital and O&M costs for a 10-year planning period using a standard estimating process, and
4. Prepare an estimate of cash flow requirements for the 10-year period.

2.2 Guidance Document Scope

This guidance document provides examples of real asset inventory and condition assessment documents and processes, along with example forms, questionnaires, and references designed to support the site visits, condition assessments, staff interviews, and cost development tasks. Deliverables will include:

- Asset inventory and condition assessment;
- GIS-based depiction of the water system and/or wastewater system vertical and linear infrastructure and facilities;
- Capital cost estimates for asset R&R needs;
- Prioritization of the most critical R&R projects into the first two years of the planning horizon, and additional capital projects needed for years 3-10 of a capital improvement plan;
- O&M practices assessment;
- O&M cost estimates for tasks needed to proactively maintain the assets within and beyond the 10-year CIP horizon; and
- 10-year cash flow analysis.

NCDWI and its consultants should anticipate the possibility of modifying the example forms based on utility-specific information needs.

A recommended workflow chart of the process is provided in Appendix A and a checklist for completion is included at the end of each section of this document.

2.3 Variations from Standardized Approach

NCDWI recognizes that not every element of developing the AIA, estimating capital costs, and estimating O&M costs can be standardized. Specific situations and conditions may be identified by the consultant, utility staff, resource partners, and any other relevant parties as work progresses, and it may be necessary to make case-by-case decisions about how to address such situations.

The parties listed above should use professional judgment to accurately address site-specific or utility-specific conditions and must propose to NCDWI any recommended variations from the standards presented in this guidance document. The recommendations are to include the reason for the variation, justification, and supporting references.

NCDWI will review the recommendations and document approved variations prior to use in the analyses.

3 Building an Asset Inventory

A first step to efficiently manage water and wastewater infrastructure and set a utility on a path to long-term viability is understanding and documenting the utility's assets.

Assets are the pipe networks, equipment, buildings, and land needed to deliver safe and reliable water and/or wastewater services.

For the purposes of assessing utility viability, AIA analyses are concerned with two types of assets:

- Facility/vertical assets which are facilities, process equipment, treatment basins, pump stations, storage tanks, and buildings; and
- Linear assets which are water distribution or wastewater collection pipeline networks.

Developing an asset inventory begins with identifying the components required to provide water and/or wastewater services to utility customers. This is accomplished through record reviews, staff interviews, and direct observation during site visits, as outlined in this section.

3.1 Records and Data Review

Utility asset data, both historical and spatial records, are essential to completing the AIA. However, the consultant should anticipate that subject utilities may not have extensive asset-related records, such as GIS mapping of linear assets; Section 3.6 addresses this in detail. Review of available existing utility records and data are essential to building an asset inventory, including:

Utility asset data should be requested immediately upon beginning an AIA analysis.

UTILITY ASSET & REGULATORY DATA (ALL ASSETS)

- Asset inventory data from the utility's maintenance management systems, spreadsheets, or lists
- As-builts/Record drawings
- Operating permits (National Pollutant Discharge Elimination System (NPDES), collection system, biosolids, etc.)
- Local Water Supply Plans (LWSP) submitted to the NC DEQ Division of Water Resources (DWR)
- Consultant studies and reports prepared for the utility, including those for expansions, upgrades, and condition assessments
- Utility operating data, including water and wastewater treatment facility regulatory compliance reports, maintenance records, repair contracts, and invoices

SPATIAL DATA (LINEAR ASSETS)

- Spatial data from the utility's geographic information system (GIS) for utility linear assets, including water distribution and wastewater collection pipelines, manholes, valves, water tanks, wells, pump stations, etc.
- If GIS is not available, secondary sources of data for linear assets should be explored:

- As-built/Record drawings
- Consultant studies and reports prepared for the utility
- Wastewater collection system CCTV inspection data, including available PACP scores
- Land survey spatial depictions of easement locations
- Assessments or Asset Management Plans completed by the Councils of Government (COGs) or other agencies/groups. Appendix B-1 is a map of North Carolina counties and their associated COGs.
- Applications for infrastructure-related financial assistance submitted to the NCDWI, US Department of Agriculture, North Carolina Department of Commerce Rural Economic Development Division, Rural Community Assistance Partnership, US Economic Development Administration, etc.

UTILITY OPERATING AND FINANCIAL DATA

- Utility staffing information, including staffing plan for employees performing O&M functions and position descriptions
- Lists of on-call contractors
- Lists of utility vehicles, portable equipment, etc.
- Intergovernmental agreements relating to utility services
- Annual utility financial report and audit statements
- Operating budgets, records of expenditures, and financial asset register

Table 3-1 includes a summary of potential data sources.

Table 3-1. Potential Data Sources

Data type	Data	Data source
Spatial Data	Locations of water and wastewater system assets	1. Utility GIS 2. North Carolina Center for Geographic Information and Analysis (NCCGIA) NC OneMap 3. COG Assessments/Asset Mgmt. Plans 4. Prior Asset Inventories
	Road centerlines, parcels, zoning, municipal limits	County GIS Department
	Land contour data	North Carolina Department of Transportation
Existing Asset Inventory data	Maintenance management system	Utility records
	Spreadsheets or lists	Utility records
Record Drawings	As-built drawings for water & wastewater system construction projects	1. Utility records 2. Contractor records 3. Engineering consultant records

Data type	Data	Data source
Consultant Reports	Consultant studies, reports, mapping, or figures	1. Utility records 2. Engineering consultant records
Condition Assessment	Gravity Sewer PACP Scores	1. Utility records 2. Contractor/ consultant reports, data
	Prior contractor condition assessments	1. Utility records 2. Contractor/ consultant records
Facility Operating Permits & Compliance Reports	NPDES, Collection System, Public Water Supply, Biosolids Permits; DMRs; Compliance inspections/ reports	1. Utility records 2. DWR; NCDEQ Regional Offices
WWTP Influent and Effluent	Discharge Monitoring Report (DMR)	1. Utility records 2. DWR
Water System Asset Summary	Local Water Supply Plan (LWSP)	DWR LWSP database
Interlocal Agreements	Intergovernmental agreements relating to utility services	Local government records
Financial	Financial Conditions Report	Local Government Commission (LGC)
	Operating budgets & expenditures	Local government records
	Annual audit statements/ financial report	Local government records
	Fixed asset register	Local government records
	Insurance declarations or appraisal/valuation reports	Local government records
Operations and Staffing	Organization staffing and positions	Utility staff interviews
	Utility vehicles, portable equipment, spares	Utility records and staff interviews
	Utility on-call vendors and contractors	Utility records and staff interviews

The consultant may need to create a spatial asset inventory from secondary source data or through staff interviews. Section 3.6 provides guidance for additional methods for the consultant to generate depictions of the water and wastewater systems if utility GIS data are not available.

It is anticipated that the consultant will use the spatial asset inventory source data listed in Table 3-1, supplemented by the additional methods described in Section 3.6, to prepare a GIS-based depiction of the water system and wastewater system linear and vertical infrastructure and facilities. This depiction will be prepared in draft form in advance of site visits, to guide field investigations, and a final version will be included in the report. The consultant will provide a copy of the GIS shapefile, in digital format, to NCDWI as part of the final report.

3.2 Data Requirements

The consultant will populate draft asset inventory tables for (1) facility/vertical assets and (2) linear assets based on the records obtained from the utility and secondary data sources. Recommended asset inventory fields for each asset type are listed in Table 3-2; bold items are asset attribute data that would be optimal to have populated in an inventory table before any site visit. Inventory fields which are not in bold font are expected to be populated by the consultant following the site visit. Appendix B-2 provides the required asset inventory data template for these analyses.

The consultant will determine the required data that were not obtained from the records review and request it from utility staff prior to or during the site visit.

Table 3-2. Asset Inventory Fields

Facility/Vertical Assets	Linear Assets
SERVICE (WATER/WASTEWATER)	Linear Asset
ASSET NUMBER	**ASSET NUMBER**
FACILITY*	**SERVICE (WATER/WASTEWATER)**
System*	**SUB-AREA** (Basin/Pressure Zone)
Asset Name*	**ASSET TYPE** (Ex. Pipe, Manhole, Valve, Vault)
QUANTITY*	**PIPE MATERIAL** (When Applicable)
INSTALL YEAR*	**DIAMETER**
REBUILD YEAR*	**MANHOLE SIZE**
Overall System Condition Rating*	**LENGTH** (If Applicable)
Asset Condition Rating*	Depth (manhole/vault) (if available)
Asset Criticality Rating	Manufacturer (e.g., valve)
ASSET CLASS*	**INSTALL YEAR**
Asset Subclass	Asset Condition Rating (as necessary)
ASSET DESCRIPTION	Asset Criticality Rating
Manufacturer*	Asset Description
Model*	Notes
Size/Capacity*	
Notes	

Note: Essential asset data in **BOLD** & capitalized; asterisk (*) denotes fields for site visit data collection. See Appendix B-3 for descriptions of fields.

3.3 Site Visits

Visual inspection of utility assets will yield important insights into the operability, performance, and condition of these assets. Multiple site visits may be beneficial, but at a minimum, the consultant must conduct a site visit following completion of the records review.

The objectives of the site visit are to:

- Collect additional asset inventory data for both facility and linear assets

- Fill identified data gaps
- Conduct asset condition assessments for facility and linear assets as necessary. Due to the complexity and expense of conducting condition assessments for linear assets, condition assessments should be completed as needed based on the information gathered during the inventory and site visit processes, e.g., physical assessment activities such as smoke testing and CCTV may not be needed throughout the system.

For facility assets, the assessment of current operability, condition, performance, and safety status should be performed through visual observation; intrusive testing of assets should be conducted as necessary to accurately assess critical or failing assets. It is recommended that field assessments be conducted by a multi-staff team representing at least mechanical and structural disciplines. Prior experience conducting condition assessments of water and wastewater system treatment and pumping systems is required of the consultant.

3.3.1 Prior to the Site Visit

1. The consultant will coordinate with the appropriate utility staff to schedule the site visit and staff interviews several weeks before the intended date.
2. The consultant will become familiar with the available data and records provided by the utility and secondary sources, and will identify additional asset data to be collected during the site visit. This preparation will enhance the efficiency of the site visit, and aid in determining locations on which to focus, access permissions needed, required equipment and tools (e.g., cameras, drones, etc.), and potential safety hazards which may be encountered during the site visit.
3. The consultant will prepare a Site Visit Plan that identifies the sites to be accessed, days/times on site, and needs for in-person meetings to be held in conjunction with the site visit (with meeting topics, duration, and suggested attendees). The Site Visit Plan will be provided to the utility to facilitate their preparations and assure appropriate personnel are available to provide the requested access. The Site Visit Plan will be submitted to NCDWI.
4. The consultant will prepare a Field Safety Plan for its staff conducting the site visits, identifying actions to mitigate potential safety hazards, including appropriate personal protective equipment (PPE). A Job Hazard Analysis (JHA) consistent with OSHA guidance (https://www.osha.gov/Publications/osha3071.pdf) should be completed for each potential hazard type prior to the site visit(s). The Field Safety Plan will be submitted to NCDWI.
5. The consultant will prepare GIS-based depictions of the utility's water system and wastewater system, based on the best available data from the utility and secondary sources, and will note any assets that are located within the 100-year floodplain.
6. The consultant will create and prepopulate asset data sheets based on data review and pre-visit staff contacts, so that field data collection needs are clearly identified. The consultant will use the Microsoft Excel templates provided by NCDWI, and an example of the asset data sheet is provided in Appendix B-2.

3.3.2 During the Site Visit

1. The consultant will coordinate with appropriate utility staff during the site visit and follow utility staff direction concerning communication, site access, and safety protocols.
2. The consultant will confirm expected safety hazards and adjust the Field Safety Plan as required for hazards existing on the date of the site visit.
3. The site visit is expected to include at least two (2) staff of the consultant.
4. Consultants will NOT operate utility assets; these will be operated by utility staff only.
5. Facility inspections will be conducted for the following facility-related system/asset class groups. An example field assessment form is provided in Appendix B-3.
   - Site/Civil assets: Roads, drainage, parking, exterior lighting, landscaping, fencing, and stormwater management. The facility's proximity to floodplains will be noted.
   - Architectural/structural: Building and process basin structures, concrete and steel condition, pipe supports, roofs, doors, windows, floors, and paint systems.
   - Power distribution and standby generators: Main feed, transformers, switchgear, generators, and transfer switches.
   - Electrical: Equipment motors, motor control centers, variable frequency drives, conduit, wiring, and disconnects.
   - Pumping systems: Pumps, motors, tanks, and related valves.
   - Piping and valves: Above-ground piping not supplied as part of pumping systems.
   - Instrumentation and control: Control panels, instrumentation, field devices, primary elements, supervisory control and data acquisition (SCADA) systems, and network communications.
   - Process and storage tanks as well as submerged and below-ground assets, including mechanical and process equipment in them.
   - Heating, ventilation, and air conditioning: Air handling equipment, make-up air units, heating equipment, ductwork, controls, and support equipment.
   - Odor control equipment.
6. The consultant will take representative photographs of utility assets. A log will be created identifying the asset associated with each photograph.
7. The consultant will validate prepopulated fields on asset inventory datasheets, and complete additional data fields, based on visual observations and input from utility staff.
8. When additional assets are identified during the site visit, an asset inventory datasheet will be completed for that asset, and the information entered into the asset inventory.
9. Asset condition assessments for facility/vertical assets are anticipated to be performed during the site visits alongside the asset inventory tasks. Condition assessments for linear assets may be completed during the site visits or may be scheduled separately. Guidance on conducting asset condition assessments is provided in Section 4.

3.4 Utility Staff Interviews

Interviews with utility staff can yield important insights into the system layout as well as asset performance, reliability, and maintenance/repair history.

Staff interviews can also serve as a means for establishing rankings for each asset's criticality to operating the water and/or wastewater systems.

Appendix B-4 provides sample questions for staff interviews.

3.5 Organization of the Asset Inventory

Organizing the asset inventory is important in order to summarize R&R projects and costs at multiple levels of detail. It is advised that a simple asset hierarchy be used for both facility assets and linear assets, as follows:

Facility / Vertical Assets:

- Level 1 – Location (Town or Utility)
- Level 2 – Facility (Name of WWTP, Pump station, Water supply well)
- Level 3 – Process (Headworks, Influent Pumping System, Primary Clarifiers)
- Level 4 – Asset Class (Submersible pump, bar screen, chemical system)

Linear Assets:

- Level 1 – Location (Town or Utility)
- Level 2 – System (Water distribution, Wastewater collection)
- Level 3 – Basin/Pressure Zone (if available)
- Level 4 – Asset Class (Water main, water valve, water meter, manhole, gravity sewer, force main)

The asset hierarchy levels are reflected in the asset inventory data fields presented in Table 3-2.

3.6 Addressing Data Gaps for Linear Assets

Estimating utility infrastructure R&R costs will depend on reasonably complete and accurate asset information. Consultants should make every reasonable effort to develop an inventory that captures the utility's facility and linear assets. As noted above, NCDWI anticipates that many utilities may have gaps in their knowledge base related to their water and wastewater infrastructure, particularly buried linear assets.

If utility GIS data are not available, the following procedure is recommended to create consultant-generated depictions of the utility water and wastewater systems:

- Scan and digitize water and sewer infrastructure from as-built drawings (PDF or hard-copy) obtained from the utility or secondary data sources. Extract asset attribute data from as-builts, including pipe material, size, and install year.

- Review available property surveys for locations of existing pipeline infrastructure and/or easements. Incorporate scanned/digitized spatial data as appropriate.
- Contact county GIS department, COG serving the project area, North Carolina Rural Water Association, and state/federal agencies that have provided financial assistance for the utility's infrastructure improvements and request available spatial data for incorporation into the consultant-generated depictions of the water and wastewater systems described in Section 3.1.
- Conduct site visits with utility staff to identify the general routes of primary water distribution and/or wastewater collection system infrastructure, based on utility staff knowledge and visible infrastructure, such as manholes or hydrants (e.g., which streets infrastructure is located on; whether pipelines are located in an easement or under roads; locations of vaults).
  - Mark locations on available sketches, drawings, or maps. While precise location information is not critical for the assessment, the number, types, and general location of infrastructure assets are critical.
  - Estimate pipe material, size, and age based on field observations, readily available maintenance records, and utility staff institutional knowledge.
  - Estimate year of installation based on staff institutional knowledge or financial records of the year of construction, year of debt-funded or grant-funded improvements, or similar secondary information sources.
  - When a utility's asset inventory is based on secondary or estimated information, document ALL assumptions that support the estimates. The most important is information about age, material, and estimated size and length.
- Create GIS shapefiles of water and/or wastewater systems based on data and field observations. Review draft depictions of the system with utility staff and make adjustments as necessary.

Asset Inventory Checklist

At this point, the consultant should have completed the following activities:

- ☐ Define appropriate staff needed for asset inventory, asset condition assessment, R&R forecast development, and O&M assessment tasks.
- ☐ Compile and review existing documentation obtained from utility records, GIS, as-built drawings, and secondary data sources.
- ☐ Create GIS-based depiction of the water/wastewater system(s).
- ☐ Create draft asset inventory tables following the NCDWI format requirements, based on data obtained from utility and secondary data sources.
- ☐ Prepare a Field Safety Plan prior to the site visit based on anticipated hazards; review and update the plan as needed based on utility staff input.
- ☐ Schedule site visit to access utility facilities and interview relevant staff. Prepare a Site Visit Plan and provide to the utility.
- ☐ Compile pre-populated asset inventory data sheets (using templates provided by NCDWI), noting data that were not obtained from the records review, to be completed from site visit field observations, staff interviews, or correspondence with the utility staff.
- ☐ Conduct site visits to complete the asset inventory and facility/vertical asset condition assessment, based on field observations and staff interviews.
- ☐ Assign facility/vertical asset condition ratings during the same site visit as the asset inventory. Assign linear asset condition ratings at the time of assessment. Guidance on condition ratings and other assessments is provided in Section 4.
- ☐ Photograph assets which are evaluated, including nameplate data and observed condition issues.
- ☐ Organize asset inventory data into an asset hierarchy.
- ☐ Address data gaps for linear assets.

4 Physical Asset Assessment

Physical asset assessment includes asset condition, criticality, and rehabilitation or replacement needs, including estimated rehabilitation and replacement costs. This section provides step-by-step guidance for performing physical asset assessments using the utility asset inventory developed according to the process prescribed in Section 3. This section also includes examples designed to illustrate the recommended process and provide guidance in completing this portion of the AIA.

4.1 Process and Tools to Complete an Assessment

The AIA workflow diagram in Appendix A details the recommended assessment process, which is summarized in Figure 4-1.

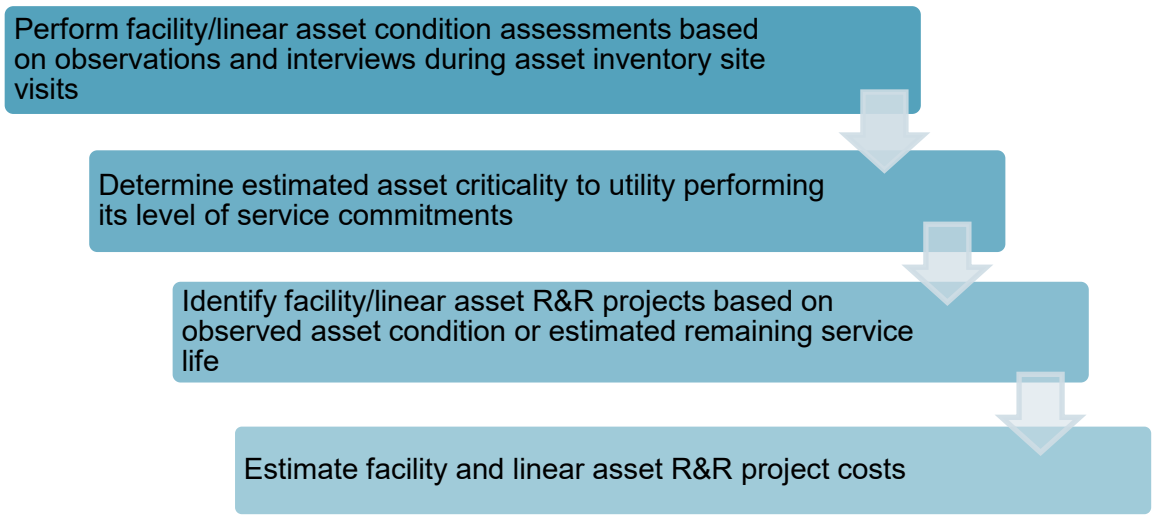


Figure 4-1. AIA Workflow Summary

4.2 Assessment Data, Interviews, and Observations

The objective of performing assessments is to collect sufficient detail on the utility's assets to develop capital projects and forecast R&R costs to address identified deficiencies, as well as to identify potential changes that may be needed to the existing O&M program. All the data, staff interviews, and direct observations obtained prior to and during site visits are valuable for completing these tasks.

4.2.1 Prior to Asset Assessments

Prior to beginning asset assessments, the asset inventory tasks described in Section 3 should be completed. If an asset characteristic needs to be estimated due to lack of direct data, document the assumptions or data supporting the assumption, and review assumptions with utility staff and NCDWI staff.

4.2.2 Facility/Linear Asset Assessments

Based on the records review, staff interviews, and direct visual observations, four elements of each asset will be evaluated: condition, performance, safety status, and O&M status. A field assessment form example is provided in Appendix B-3; assessment guidelines are as follows:

- **Condition** will be based on available records, staff interviews, and visual observations; no intrusive testing will be conducted. Powered equipment will be observed while in operation, but ONLY utility operations staff will operate utility equipment.
- **Performance** will be assessed as an asset's ability to support the required level of service for current operations. Assessment will be based on interviews with utility staff and records review, including peak flow rates, equipment run times, station cycle times, power use,

NPDES compliance submittals, Sanitary Sewer Overflows (SSOs), repeated clogging/breaks, and similar performance criteria.

- **Safety status** will be assessed based on the condition of protective measures, determined by utility staff interviews and visual observations. Safety assessments evaluate a device's ability to function as designed, not whether the device is appropriate or if newer practices and technologies should be implemented.
- **O&M status** of current operations and maintenance practices for major equipment systems (e.g., pump station or WWTP unit process) will be assessed through staff interviews. O&M status will be used to determine if changes to the utility's current O&M program are recommended.

Refer to Section 4.3 for guidance on the application of the condition rating scale, including how to reflect performance deficiencies in asset ratings. Safety and O&M assessments are addressed further in Section 6.

If a field assessment is not completed for a particular asset, surrogate information (e.g., asset year of installation, material) should be used to estimate R&R requirements and schedule.

Figures 4-2 and 4-3 provide examples of facility asset assessment summaries, illustrating the types of descriptive information, condition observations, and types or number of asset photographs needed.

4.2.3 Structural Rehabilitation and Flood Resiliency Projects

The consultant will assess structural deficiencies and the potential for flooding during the field assessments. For assets located within the 100-year floodplain, the consultant will recommend improvements that would help reduce flooding and improve resiliency. Table 4-1 presents examples of potential structural rehabilitation and flood resiliency improvements.

Table 4-1. Example Structural Rehabilitation and Flood Resiliency Projects

Structural Rehabilitation Description	Flood Resiliency Improvements
Rehab pump station structure or wet well	Raise electrical panels
Rehab valve vault (incl. new hatches)	Install flood-proof hatches
Replace fence	Raise vents
Replace above-ground piping	Raise emergency generator
Replace structure (roof, building, basin)	Raise chemical system
Rehab/line manholes	Seal manhole penetrations and cover

Name of Town

In **location (county)**

Name of Asset with Address and GPS coordinates

- Above ground duplex pump station
- It has two pumps though only one pump is functional
- Pump-1-Corwn P03LB-7; Motor 1-3 phase, 3hp, 230/460V
- Pump 2: 200B-007B-001; Motor 2-3 phase, 5hp, 230/460V
- Pump station and controls have not been flooded
- This pump station is in very poor condition and should be replaced
- Recommend replacement with submersible duplex pump station
- NC agency inspection report from 2014 stated that the top of a buried fuel tank was seen, the tank needed to be investigated to find out if any fuel remained and ideally the tank should be removed from the site.
- The path of the force main leaving this site is not mapped nor is its easement maintained.

Figure 4-2. Asset Condition Assessment Example 1 (Wastewater Pump Station)

Facility/Asset/Issue	Photo
Facility: Wastewater Pump Station Asset: all Issue(s): This PS was initially installed in 1990 for approximately 5 homes. The physical condition of all assets is very poor. Only has 1 pump, which does not meet the State requirement for wastewater PSs.	
Facility: Wastewater Treatment Plant Asset: Sludge loading station pump, motor, and valves Issue(s): Per WWTP Operator, the sludge loading station has not worked in many years. Pump, motor, and valves have not been operated in over a decade and need to be replaced. The failure of these assets has contributed to the O&M issues related to solids build-up in the WWTP.	

Figure 4-3. Asset Condition Assessment Example 2
(Submersible Pump Station and WWTP Sludge Loading Station)

4.3 Condition Rating Guidance

4.3.1 Facility / Vertical / Linear Assets

A common condition rating scale for facility/vertical/linear assets will be used in order to maintain consistency. Condition assessments reflect a “snapshot in time” of an asset’s current condition to aid in the estimation of remaining useful life of an asset to forecast future R&R needs.

The consultant will assign a condition rating of 1 to 5 to every facility/vertical/linear asset in the asset inventory, based on visual observations, staff interviews, direct physical assessment (such as CCTV, smoke testing, etc.), and asset records reviewed, following the definitions in Table 4-2. Photographs illustrating the application of the condition ratings described in Table 4-2 are provided in Appendix C. A condition rating (CR) of 1 indicates that the asset is nearly new, having no observed significant deficiencies. A condition rating of 5 indicates an asset is in very poor condition or has already failed, needing complete rehabilitation or replacement. Asset condition ratings will be entered into the asset inventory.

The condition rating definitions in Table 4-2 should be applied according to the professional judgment of the consultant, keeping in mind that consistent application of the rating scale is essential to the proper development of the R&R program.

Table 4-2. Facility Asset Condition Rating Scale Definitions

Condition Rating (CR)	Condition Description	Estimated % Remaining Useful Life	Notes
1	Very good. New or nearly new.	>95%	Receiving normal preventative maintenance (PM)
2	Good. Minor wear.	75%	Normal PM; minor corrective maintenance (CM) needed
3	Fair. Major wear impacting the level of service.	<50%	Normal PM; Major CM needed
4	Poor. Unable to meet the level of service performance requirements.	<15%	Major R&R needed in the next 1-5 years
5	Very poor. Requires complete rehabilitation or replacement. Failed.	<5%	Complete rehab or replacement needed immediately or within the next year

Assets rated as CR5 (Very Poor), which should be addressed in less than one year, should be immediately reported to both the utility and NCDWI, and specifically identified in the report.

The following additional condition rating guidance is provided to aid the consultant.

1. Appendix D provides the expected useful life for a range of select utility asset classes. In cases where a utility asset's classification is not included in Appendix D, an asset's expected useful life will be estimated by the consultant using professional judgment, documenting the supporting assumptions.

2. An asset's estimated remaining useful life (in years) is calculated using the formula below in which expected useful life is based on Appendix D or estimated by the consultant, as described in Step 1. The percent remaining useful life is estimated by the consultant applying professional judgment.

$$Estimated\ Remaining\ Useful\ Life = [Asset\ \%\ Remaining\ Useful\ Life\ (based\ on\ condition\ rating)\ x\ Asset\ Expected\ Useful\ Life]$$

3. If asset age exceeds its expected useful life, then:
    a. Default condition rating is CR4 (Poor).
    b. Assets with observed severe deterioration should maintain the CR4 rating.

c. Assets observed in good condition, performing its intended function, and without immediate repair or replacement needs in order to meet industry standards could be upgraded to CR3 (Fair).

d. Assets observed in good condition could be considered for an upgrade to CR2 (Good) rating only if the consultant and utility staff concur that the asset is performing well, and repair or replacement may be delayed beyond the 10-year horizon.

4. If asset age is within its estimated useful life, then:

    a. Equipment which is newly installed or has 95% or more estimated remaining useful life has default condition rating CR1 (Very Good)

    b. Equipment which has 50% or more remaining useful life, with no indication of frequent repairs or evident physical deterioration has default condition rating CR2 (Good)

    c. Equipment which has less than 50% remaining useful life, with reports of frequent repairs or evident physical deterioration has default condition rating CR3 (Fair)

    d. Equipment which has less than 15% remaining useful life, significant observed physical or performance deterioration, or utility staff/contractor reports indicating a need for replacement or rehabilitation, has default condition rating CR4 (Poor)

5. Performance Guidance: Regardless of asset age, if the asset fails to perform its intended function and/or is observed in very poor condition and is assessed to require rehabilitation or replacement immediately or within the next year, it will be assigned condition rating CR5 (Very Poor). This rating may also be applied when an asset does not have sufficient capacity to meet its service requirements (e.g., hydraulic capacity, electrical capacity).

Table 4-3 and Table 4-4 present several examples of CR5 and CR4 assets, respectively, that were identified in the Viable Utility Assessment Pilot Program in very poor or poor condition, that did not meet performance requirements, or had failed entirely.

Table 4-3. Examples of Facility Assets with CR5 (Very Poor)

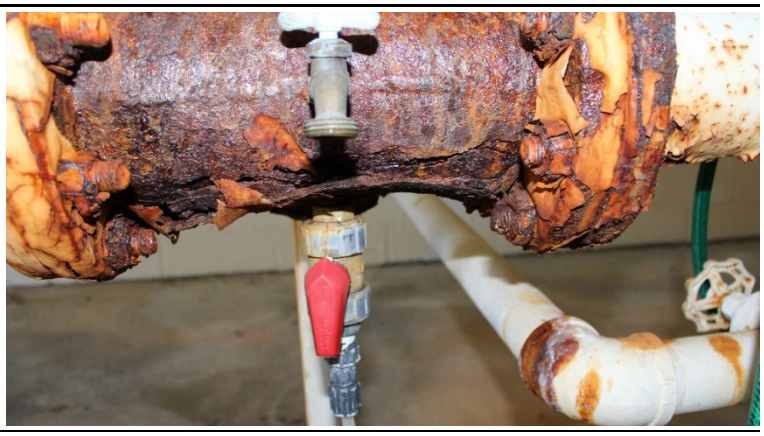
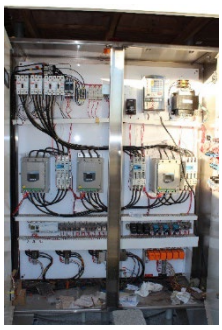
Facility/Condition Rating/Asset/Issue	Photo
Facility: Drinking Water Well Condition Rating: 5 Asset: Piping and valves Issue(s): Severe corrosion resulting in significant delamination of piping. This asset was reported to utility staff as an item that needed immediate attention during the assessment.	
Facility: Drinking Water Well Condition Rating: 5 Asset: Well Pump Issue(s): The pump was installed in 1960. Pump leaking with metal-on-metal grinding heard inside the pump.	
Facility: Wastewater Pump Station Condition Rating: 5 Asset: Pump station pump support and rails Issue(s): Severe corrosion. This asset was reported to utility staff as an item that needed immediate attention, during the assessment. Asset actually failed a few months after reporting its condition to the utility.	
Facility: Wastewater Pump Station Condition Rating: 5 Asset: 3-phase transformers & other electrical equipment Issue(s): Electrical equipment not suited for outdoor environment; 3-phase transformers showing corrosion.	

Table 4-4. Examples of Facility Assets with CR 4 (Poor)

Facility/Condition Rating/Asset/Issue	Photo
Facility: Wastewater Pump Station Valve Vault Condition Rating: 4 Asset: Check valves Issue(s): Corrosion; check valves have failed to operate as intended	
Facility: Wastewater Pump Station Condition Rating: 4 Asset: Control Panel Issue(s): Overheating issues in panel	
Facility: Wastewater Treatment Plant Condition Rating: 4 Asset: Aeration Basin Blowers Issue(s): Not properly mounted, leaks in air piping, some of the suction valves have failed, blowers exhibiting wear	
Facility: Wastewater Pump Station Condition Rating: 4 Asset: Wastewater Pump Station electrical equipment Issue(s): Pump station flooded above all panels and only received minor rehab work, which primarily included cleaning.	

4.3.2 Linear Assets

NCDWI requires that condition ratings for linear assets be based on the best-available data, as follows:

- Condition rating scale will be 1 to 5, as shown in Table 4-5.
- Condition ratings will be used to estimate an asset's remaining useful life. Appendix D provides the expected useful life for a range of linear asset classes.
- Prior direct observations of gravity sewers (e.g., CCTV inspections yielding NASSCO PACP scores for individual gravity sewer segments) or water distribution system assets should be used where available. Numerical condition ratings from previous evaluations should be aligned to the 1 to 5 condition rating scale shown below.
- New direct observations including CCTV, smoke testing, and other evaluation methods should be obtained and used as necessary.
- Where directly observed condition information is not available for buried water distribution system and wastewater collection system assets, data used to assign condition ratings may include:
  - Pipe material
  - Pipe diameter
  - Pipe year of installation
  - Gravity service vs pressure service
  - Pipe location (e.g., in easement vs under roadway)

The consultant will assign a condition rating of 1 to 5 to every linear asset in the asset inventory, using existing or new direct observation information as the primary source when available. If observation information is not available, the estimated percent of useful life remaining will be utilized. Table 4-5 summarizes condition rating scale definitions for linear assets. Problem assets identified by the utility should be specifically documented as exceptions to the guidance provided in Table 4-5.

Problem assets identified by the utility should be specifically documented as exceptions to the guidance provided in Table 4-5.

Table 4-5. Linear Asset Condition Rating Scale Definitions

Condition Rating	Condition Description	Estimated % Remaining Useful Life
1	Very good. New or nearly new.	>95%
2	Good.	75%
3	Fair.	<50%
4	Poor. Unable to meet the level of service performance requirements.	<15%
5	Very poor. Requires complete rehabilitation or replacement. Failed.	<5%

4.4 Asset Criticality Guidance

Criticality ratings represent an asset's relative importance to achieving a utility's appropriate level of service, including permit requirements, and may be evaluated at a facility or asset group level, as appropriate. The consultant will assign a criticality rating of 1 to 5 to every facility and linear asset in the asset inventory based on records reviewed, staff interviews, visual observations, and professional judgment. The criticality rating is intended to support assigning prioritization for the 10-year capital improvement plan. The rationale for the criticality ratings will be documented in the report. Factors to be considered include, but are not limited to:

- Location (e.g., is the facility near sensitive environmental areas, roadways, etc.?)
- Equipment Capacity (e.g., pumping capacity, amps) or area served
- Critical customers (e.g., hospitals, schools, etc.)
- System dependency
- Redundancy
- Operability or maintainability

A criticality rating of 1 indicates the asset is not critical to the utility meeting its level of service commitments; for example, the facility may have sufficient excess capacity or redundancy such that the loss of use of this asset would not impair system performance. A criticality rating of 5 indicates the loss of the asset is expected to result in serious impacts to the utility's level of service, such as causing a hospital or school to be closed due to lack of water or wastewater service. Asset criticality ratings will be entered into the asset inventory. Table 4-6 summarizes criticality rating scale definitions.

Table 4-6. Asset Criticality Rating Scale Definitions

Criticality Rating	Criticality Descriptions
1	Very low potential for harm if asset fails; parts on-hand and easy access for repair; redundant unit
2	Low potential for harm if asset fails; parts available and easy access for repair; failure does not impact permit compliance; redundant unit
3	Some potential for harm if asset fails; parts available but some access issues for repair, with brief shutdown required; failure is nuisance, but alternatives are available to meet the appropriate level of service, including permit requirements; limited redundancy
4	High potential for harm if asset fails; spare parts hard to obtain, some access issues for repair, and shutdown required; failure may impact the appropriate level of service, including permit compliance; no redundancy
5	Failure will cause harm; spare parts hard to obtain, difficult access, long lead times for repair with extended shutdown; direct impact on the appropriate level of service, including permit compliance; no redundancy

4.5 Summarizing Asset Assessment Data

The completed assessment summary will include the following elements:

- Completed asset inventory, in spreadsheet form, including condition ratings and criticality ratings for each facility and linear asset, following the structure of Appendix B-2.
- Completed summary table of linear assets, organized by material, diameter, and year of installation, following the structure of Appendix B-2.
- Completed asset field assessment datasheets, interview summaries, and asset photographs.
- Summary graphics depicting the number and percent of assets for each condition rating, following the example shown in Figure 4-4.
- Summary graphics depicting the number and percent of assets for each criticality rating, following the example shown in Figure 4-5.

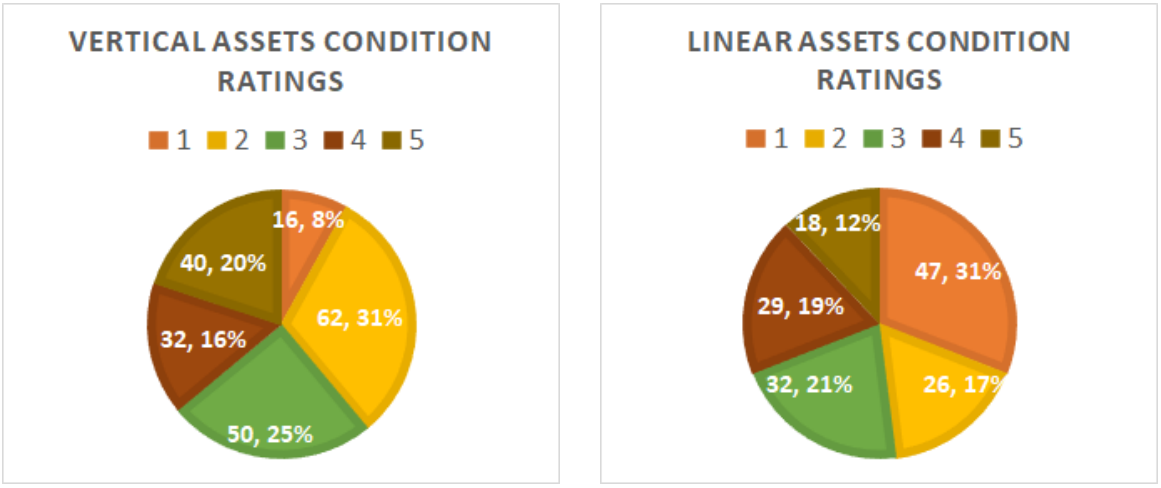


Figure 4-4. Example Asset Condition Rating Summary, All Facilities and Linear Assets

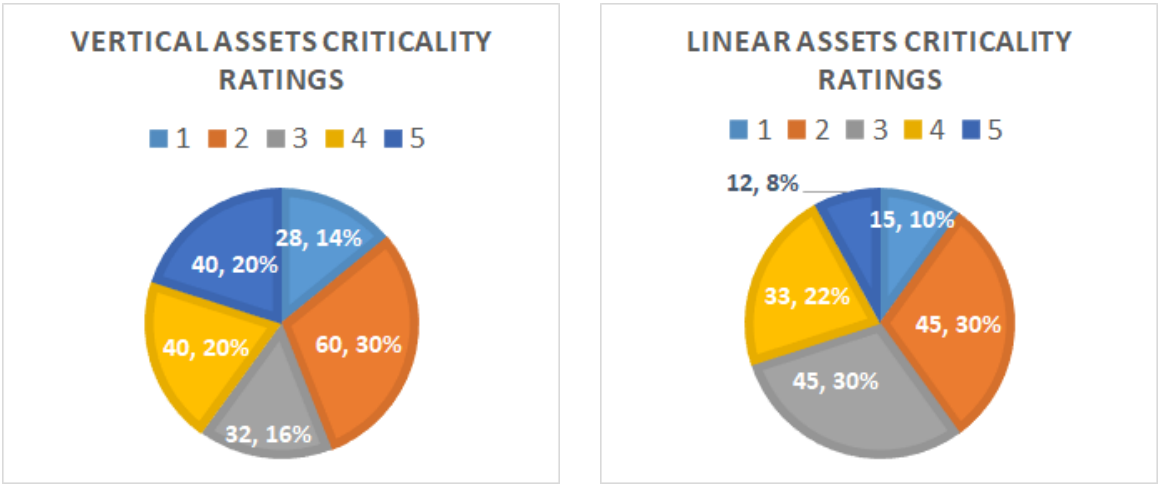


Figure 4-5. Example Asset Criticality Rating Summary, All Facilities and Linear Assets

Asset Assessment Checklist

At this point, the consultant should have completed the following activities:

- ☐ Prior to asset assessment, review the asset inventory and compare it with observed assets in the field, defining any data gaps that were encountered. Review any assumptions made with utility staff and NCDWI staff.
- ☐ Document asset condition and performance status based on records reviewed, staff interviews and direct field observations. An example field assessment form can be found in Appendix B-3.
- ☐ Update GIS-based depiction of the water/wastewater system assets.
- ☐ Assess structural deficiencies and the potential for flooding. See Table 4-1 for example structural rehabilitation and flood resiliency projects.
- ☐ Assess the current condition and performance of facility/vertical assets and estimate the remaining useful life following the condition rating scale in Table 4-2. Assign condition rating to each asset.
- ☐ Create a table that groups all the facility assets by condition rating with pictures displayed and issues stated. See Table 4-3 and Table 4-4 for examples.
- ☐ Assess linear assets based on best-available data from existing and new direct observation of water distribution system assets, sewer system CCTV inspections, and information based on professional judgment. Assign condition rating to each asset, following the condition rating scale in Table 4-5.
- ☐ Assess the criticality of every facility and linear asset in the asset inventory based on records reviewed, staff interviews, visual observations, and professional judgment, following the criticality rating scale in Table 4-6. Assign criticality rating to each asset.
- ☐ Summarize all asset assessment data following the example template provided.

5 Rehabilitation and Replacement Identification and Cost Estimating

A central component of long-term utility planning is adequate and timely R&R planning to preserve the utility system's functionality and reliability. Based on the work described in the preceding sections, the consultant will identify asset R&R projects which should be completed in the next 10 years, and their associated costs. This R&R plan will be completed for both facility/vertical assets and linear assets. The overarching goal for the R&R plan is to provide planning-level budgetary cost estimates for the capital improvements that are necessary for the subject utility, as follows:

- Rehabilitation needs should be based on the standard asset class assumptions provided in Appendix D.
- Replacement needs should be based on the values in Appendix D, which are considered Class 5 – Planning Level estimates as defined by the Estimate Classification Systems from the Association for the Advancement of Cost Engineering International (AACEI). The sources of these replacement values include industry knowledge, recent construction project costs (provided by NCDWI), vendor information, and the R.S. Means manual.

- Capital or R&R cost estimates developed by the consultant should be Class 5 – Planning Level estimates as defined by AACEI.

5.1 Asset Level R&R Identification

The consultant will complete a planning level assessment and identification of asset-level R&R needs over the next 10 years for both the facility/vertical and linear assets. The following will be used to facilitate the identification of the timing of R&R needs for all assets:

- Asset inventory:
  - Asset install year
- Asset assessment:
  - Condition rating and % of remaining useful life
- Asset class assumptions (provided in Appendix D, or as supplemented for project-specific needs):
  - Expected useful life
  - Rehabilitation frequency

The calculation for estimating the timing of the next R&R event will be as follows:

$$Estimated\ Replacement\ Year = Current\ Year + [Asset\ \%\ Remaining\ Useful\ Life\ (based\ on\ condition\ rating) \times Asset\ Expected\ Useful\ Life]$$

Asset R&R timing should be reviewed to determine if there are overriding considerations that would adjust the timing, such as asset performance or operational limitations. Professional judgment should be applied for the final recommendations for R&R timing.

It is likely that a 10-year forecast of R&R needs will focus on mechanical and electrical equipment, which have shorter expected useful lives; these assets require periodic rehabilitation and replacement and utilize technology that may more quickly become obsolete. Structural asset needs may also require R&R, depending on the condition. Professional judgment will be required to determine the timing of structural R&R projects. Similarly, flood resiliency projects will require professional judgment on when they should be implemented over the 10-year period.

5.2 Asset Replacement Values

Facility/Vertical assets: Asset replacement values are provided for typical facility asset classifications in Appendix D-1, in 2020 dollars. A low, base, and high replacement value was estimated for each facility asset class, where the base value indicates the central tendency for the replacement value of assets within each class. The high and low values indicate the range in replacement value due to either variability in cost or in some cases uncertainty related to the specific assets within an asset class.

The consultant will use professional judgment in selecting the appropriate asset replacement value. See Section 2.3 for procedures for variations from this guidance document.

Linear assets: The linear asset replacement values are based on pipe diameter for each asset grouping and presented by pipe size in Appendix D-2, in 2020 dollars. Similar to the facility assets, low, base, and high replacement values were estimated. For the purposes of this report, only full replacement should be considered for identifying future R&R costs for linear assets.

5.3 Facility/Vertical Asset Rehabilitation Costs

Standard assumptions related to rehabilitation frequency and cost for specific assets are provided in Appendix D. Rehabilitation costs are based on the percent of total asset replacement value and defined at a specified frequency between each full asset replacement. Rehabilitation costs for facility/vertical assets must be part of the asset R&R cost development.

5.4 Project Development

The asset level R&R identification will then be used to group assets into capital improvement projects that could be completed in a logical and efficient manner, based on the following general approach:

- Asset-level R&R should be aggregated to R&R projects.
- Projects should be prioritized based on asset condition and criticality ratings.
- Assets with severe condition deficiencies and non-functioning assets should be classified as immediate needs.
- R&R projects should be paired with an upgrade to address known performance/capacity issues at the same facility.
- Project costs should include mark-ups and escalation (see Section 5.5).

5.4.1 Facility/Vertical Assets

- Vertical assets with required R&R over the 10-year planning period should be grouped into capital improvement projects that could be completed in a logical and efficient manner.
- Project groups should be based on asset location (for example at a WWTP or pump station), asset class/type (for example, emergency generators, pumps, or valves), or technical discipline. For example, using the same contractor for emergency generator and

transfer switch replacements at more than one location offers the opportunity for better pricing, consistent equipment manufacturer, and simplified construction coordination.

- Projects should be bundled to minimize the frequency of work at each location and maximize project value to encourage competitive contractor pricing. To achieve this, in some cases projects may need to be moved to an earlier year than originally identified.
- Structural R&R or improvements for flood resiliency should be included as elements in larger projects at a facility, for efficiency and competitive pricing. If no other work is required at a facility, then structural R&R or flood resiliency improvements may be standalone work.

5.4.2 Linear Assets

- Projects for linear asset R&R over the 10-year planning period should be determined based on the asset identification and the asset hierarchy (Location, System, Basin/Pressure Zone, Asset Class).

5.4.3 Project Timeline

- Projects should be separated into three phases: planning; design/permitting; and construction/equipment installation. Completion of each project phase may occur in different years.
- Projects scheduled in the first two years of the 10-year planning horizon should include those to address immediate R&R needs based on condition assessment findings and criticality determination.
- Facility/vertical assets: Years 3-10 capital improvements should be based on the condition assessment, criticality, and age-based determination of timing for R&R.
- Linear assets: R&R in Years 3-10 is recommended to be performed through annual projects with uniform costs.

5.5 Project Cost Mark-ups & Escalation

5.5.1 Facility/Vertical Assets

The basic unit rates for facility asset replacements provided in Appendix D-1 **do not** include mark-ups for contractor overhead and profit (OH&P), mobilization, site civil work, contingency, or engineering costs. Project cost markups must be added to the base capital project cost estimates. For the purpose of this report, the consultant will apply the following values for mark-ups:

- Facility/vertical asset mark-ups to base project cost estimate:
  - Mobilization/demobilization – 5%
  - Site civil – 5%
  - General contractor OH&P – 20%
  - Contingency – 5-10% (per DWI eligibility)
  - Engineering and permitting – 10%

5.5.2 Linear Assets

Linear project unit rates provided in Appendix D-2 **include** contractor overhead and profit (OH&P) and mobilization/demobilization, but **do not** include markups to represent costs for demolition of existing pipelines, project contingency, and engineering. These should be added as appropriate to the system and the individual R&R project estimates; and may utilize estimated percentages based on the guidance provided below:

- Linear asset mark-ups to base project cost estimate:
  - Existing pipe/manhole demolition – 25%
  - Contingency – 5-10% (per DWI eligibility)
  - Engineering and permitting – 10%
  - Contractor OH&P, mobilization/demobilization are included in pipe replacement unit prices presented in Appendix D-2

5.5.3 Escalation

The replacement values presented in Appendix D are in 2020 dollars. R&R project capital cost estimates for both facility and linear assets should be escalated to future years using an annual escalation rate of 2.3% per year, which is based on analysis and guidance provided to NCDWI by the UNC EFC.

NCDWI notes that the information in Appendix D will be updated periodically. The consultant must confirm the information to be used with NCDWI.

Based on utility-specific data, the consultant may recommend using a different escalation rate. See Section 2.3 for procedures for variations from this guidance document.

5.6 R&R Cost Forecast and Cash Flow Development

The cost information to be presented in the report for each R&R project will include the base project cost estimate, mark-up amount, engineering and permitting cost, and total estimated project cost. The report will present the utility R&R program costs in a table listing each project and associated cost, as shown in Appendix D-3.

The consultant will also prepare an estimate of cash flow requirements for the R&R program, which may differ from the year that individual project funding is authorized. For example, a treatment plant rehabilitation project may be designed in year 1 and constructed in years 2 and 3. Cash flow analyses should be completed for each project over the 10-year period and presented in the report as shown in Figure 5-1 and Appendix D-3.

The overall cash flow analysis should include both R&R and O&M (see Section 6.5) program costs. Section 7 details the reporting requirements for these estimates.

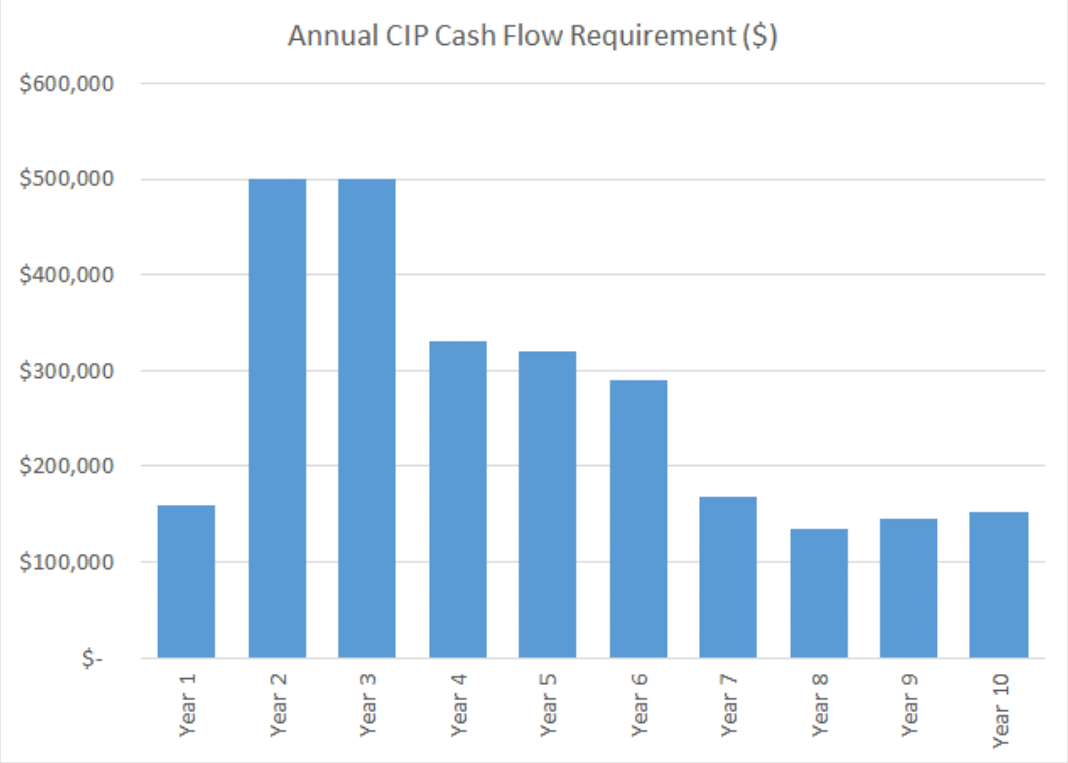


Figure 5-1. Example Graph of Annual Capital Cash Flow

Rehabilitation and Replacement Identification and Cost Estimating Checklist

At this point, the consultant should have completed the following activities:

- ☐ Identify asset R&R projects which should be completed in the next 10 years for both facility/vertical and linear assets.
- ☐ Vertical assets with required R&R over the 10-year planning period should be grouped into capital improvement projects that could be completed together to maximize efficiency and cost savings.
- ☐ Follow the guidance provided in the reference information (Appendix D-1 and Appendix D-2) to estimate the cost of the recommended R&R projects.
- ☐ Develop estimate for the total annual costs for the 10-year R&R plan.
- ☐ Depict the cash flow following the example shown in Figure 5-1 and in tabular form as shown in Appendix D-3.

6 O&M Program Assessment and Cost Estimating

Assessment of the utility's O&M program, including identifying specific program gaps or areas for improvement, is an essential complement to the asset inventory and condition assessments. The consultant will review the operation, maintenance, and safety of the facilities visited during the site visit to gain insights into utility O&M practices, how asset function and performance are sustained, and identify gaps or opportunities for O&M program or safety improvements.

6.1 Documenting O&M Program Observations

The consultant should clearly identify O&M program related observations in the asset assessment data sheets in the 'Notes' field and in staff interview summaries, and collect these observations into the report's O&M Program Assessment section. Identified deficiencies should include both:

- Asset-related R&R projects necessary to restore proper asset function, which may have been negatively impacted by existing O&M practices, and
- O&M program improvement recommendations.

An example of an O&M observation is provided in Figure 6-1, which is an excerpt from the field assessment of a WWTP chemical storage and feed facility. In the course of the site visit, it was observed that sodium hypochlorite facilities were in a degraded condition due to weather and UV exposure. Opportunities were identified for (1) installation of a cover for the facility and (2) infrastructure modifications and O&M program changes to prevent the issue from recurring in the future.

Sodium Hypochlorite

a. Tanks and equipment are exposed to UV which shortens useful life and increases the rate of degrading sodium hypochlorite concentration.
b. There is no high-point off-gassing of sodium hypochlorite piping.
c. The required emergency shower is not operational and not located within the containment area.
d. Tank 1 is in very poor to failing condition. Lower sight glass fitting is severely delaminated. Once rehabilitated, a schedule for ongoing inspection and preventive maintenance should be developed.

Figure 6-1. Example of Asset Assessment Leading to O&M Program Assessment (Sodium Hypochlorite Facility)

6.2 Safety Review

Safety-related deficiencies are an important subset of O&M program deficiencies. This review is not intended to serve as a comprehensive safety audit, but since worker and public safety are essential elements of utility operations, the presence, condition, and function of safety-related equipment must be included in the report.

Critical safety-related deficiencies should be immediately reported to both the utility and NCDWI, and specifically identified in the report.

The consultant should clearly identify safety-related observations in the asset assessment forms and collect these observations into the Safety-Related Observations section of the report. Identified deficiencies in the utility safety program should include both asset-related R&R projects to restore safe conditions (for example, an access ladder with observed structural deterioration), as well as safety improvement recommendations. Figure 6-2 is an excerpt from a field assessment detailing observed safety deficiencies at a wastewater pump station, water well sites, and a WWTP.

GENERAL FINDINGS

1. Wet well safety nets are missing from all wastewater pump stations (PS).
2. No chlorine gas leak detector present for any water supply wells. Wind sock or alternative device to indicate wind direction not present.
3. There are no eyewashes or emergency showers at water supply well sites. These should be present at any site that contains chlorine gas or sodium hypochlorite.
4. ArcFlash signage is missing from all PSs.
5. Confined space signage is missing or broken at most PSs, and there is an apparent need for a formal confined space program. The confined space program should identify all confined spaces, mounting of appropriate signs, equipment to test for hazardous atmosphere, portable forced ventilation equipment, procedures for entering a confined space, and appropriate confined space training.
6. Hydrogen sulfide monitors, fans, etc. are missing at wastewater treatment plant (WWTP).
7. Chemicals in tanks or totes are not labeled with a chemical safety data sheet.
8. There is no indication that backflow prevention devices located at some PS's have been inspected for proper operation.
9. None of the water well sites/buildings have intrusion alarms.
10. Cranes should be inspected according to the following OSHA standards:
    a. A crane which has been idle for a period of over 6 months shall be given a complete inspection conforming with requirements of paragraphs (j)(2) and (3) and paragraph (m)(2) of OSHA 1910.179.

SITE-SPECIFIC FINDINGS

1. WWTP – in order to access valve operators and pole lights, staff must go beyond the safety railing in an area directly above open basins.
2. Well A – chlorine room fan does not work. There is not a no-trespassing sign. Used chlorine barrels outside of the fence, spare chlorine barrels next to generator.
3. Well B – Generator fuel tank, well pump and electrical panels are too close to each other.
4. PS AA – PS is close to the road, adding bollards is recommended.

Figure 6-2. Safety Review Example

6.3 O&M Program Development

Based on the O&M program assessment and safety review, the consultant will recommend and provide supporting rationale for the minimum O&M tasks required to support a **viable level of service**, particularly preventative and corrective maintenance program for the utility, with task frequency and estimated staff-hours to complete each task.

An example list of the minimum tasks and frequency estimates is provided in Appendix E-1.

As part of the development of the O&M task list, a determination will be needed on tasks that can be accomplished by the utility's staff and tasks that will need to be contracted. Contracted services often include WWTP solids removal and sewer line cleaning. Cost estimates for contracted services will be developed based on prior work completed for the utility, vendor quotes, or industry-standard unit cost assumptions.

The consultant can base the costs for consumables including power, chemicals, etc., on the utility's current budgets.

Budget increases needed for the recommended additional O&M tasks will be listed separately from currently budgeted costs. All budget items will be shown separately for the water system and for the wastewater system.

6.4 Estimating O&M Staffing Requirements

The consultant will include a detailed breakdown of the recommended additional total full-time equivalent (FTE) staff needed for the recommended O&M program. FTE needs should be based on an 80% utilization rate to account for vacation time, holidays, sick time, and administrative job elements. A utility's cost per FTE will be based on its current staffing, though the consultant may propose another basis, per Section 2.3.

A utility's cost per FTE will be based on its current staffing, though the consultant may propose another basis. See Section 2.3 for procedures for variations from this guidance document.

Budget increases needed for the recommended additional O&M staff will be listed separately from the currently budgeted staff and shall be shown separately for the water system and the wastewater system.

6.5 Summarize O&M Program Costs

Based on the typical O&M tasks in Appendix E-1 or others identified by the utility or consultant, the consultant will develop estimates of the existing and additional recommended annual O&M program costs. An example of the cost estimating approach is presented in Appendix E-2.

The estimates will be developed for both the (1) current (study year) year costs and (2) escalated future year costs using the annual cost escalation guidance from Section 5.5.

Costs will be presented in tables itemized by element for each year in the 10-year planning period as shown in Appendix E-3, and graphically as shown in Figure 6-3.

The overall cash flow analysis should include both R&R (see Section 5.6) and O&M program costs. Section 7 details the reporting requirements for these estimates.

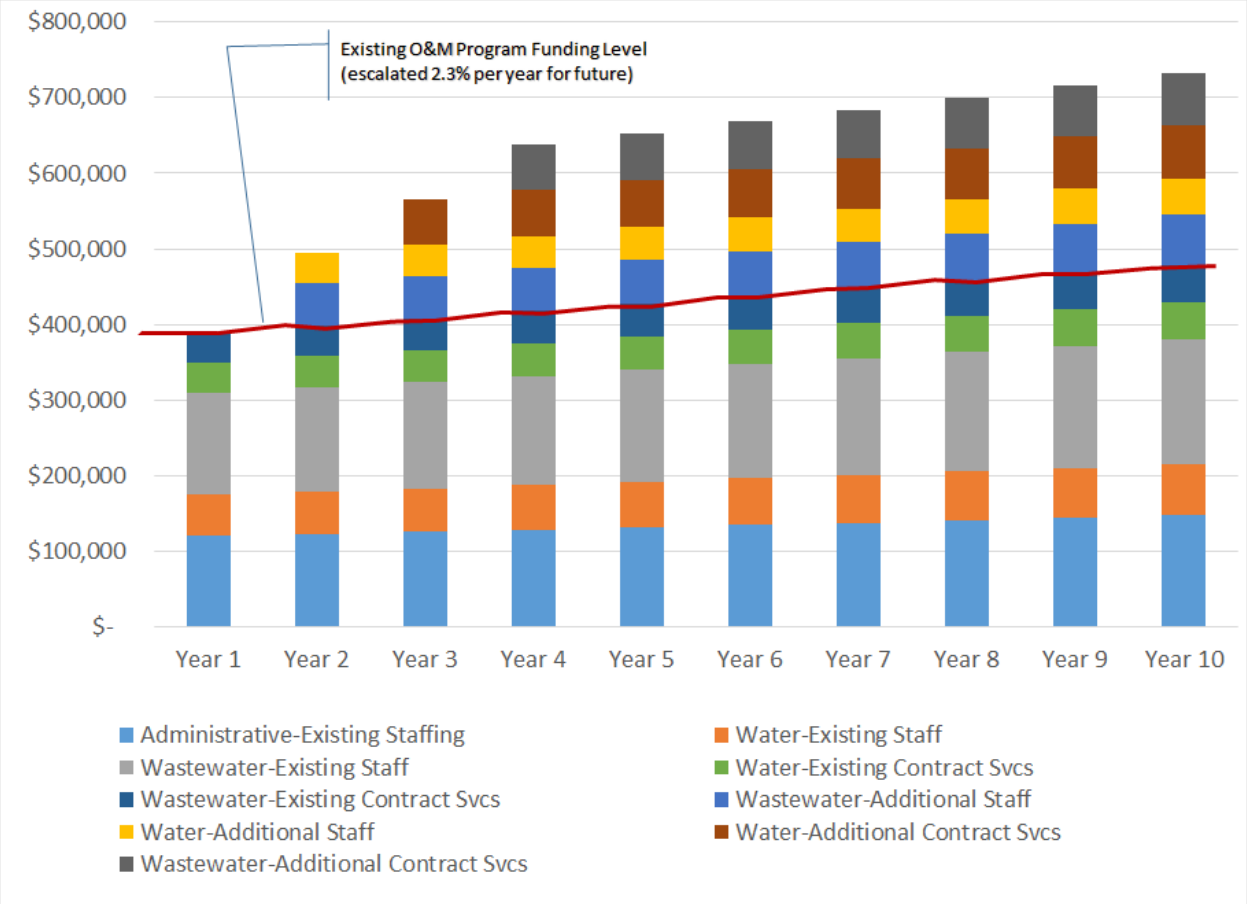


Figure 6-3. Example Graph of Existing and Recommended Future O&M Program Costs

O&M Program Assessment and Cost Estimating Checklist

At this point, the consultant should have completed the following activities:

- ☐ Document O&M and safety status based on records reviewed, staff interviews and direct field observations.
- ☐ Based on the O&M information acquired from utility staff interviews, document O&M program observations, supplementing the interview data with observations made on existing asset issues related to O&M practices.
- ☐ Document the safety review of the facility. Identify safety related deficiencies that may put the worker and/or public at risk, including safety improvement recommendations.
- ☐ Recommend the minimum tasks required to operate and maintain the utility.
- ☐ Identify O&M cost estimates for both facility (vertical) and linear assets.
- ☐ Identify additional O&M staff needs and associated cost estimates.
- ☐ Develop estimate for the total annual O&M costs for the 10-year plan.
- ☐ Depict the O&M costs following the example shown in Figure 6-3 and in tabular form as shown in Appendix E-3.

7 Preparing the Report

The report will follow the standard outline shown in Table 7-1.

Table 7-1. Report Outline

Section No.	Section Title	Required Elements
1	Project Background and Objectives	▪ Service area description ▪ Utility services provided ▪ Population served ▪ Location map (at minimum, must include north arrow, scale, municipal boundary, location of utility facilities, roads/railroads, and hydrologic features) ▪ Historical background ▪ List of significant facilities ▪ Relevant utility issues ▪ Project objectives
2	Asset Inventory	▪ Utility assets overview ▪ Site visit description ▪ Table: Utility assets, organized by service type, location, etc. (reference Appendix B)
3	Condition and Criticality Assessment	▪ Condition assessment overview ▪ Facility/vertical asset condition findings summary, by facility ▪ Linear asset condition findings summary ▪ Tables: Condition rating definitions; facility assets with condition ratings of CR 4 and CR 5 ▪ Photographs of important condition assessment findings ▪ Summary graphics depicting the number and percent of assets for each condition rating ▪ Criticality assessment overview ▪ Facility/vertical criticality findings summary, by facility ▪ Linear asset criticality findings summary ▪ Table of criticality rating definitions ▪ Summary graphics depicting the number and percent of assets for each criticality rating
4	Rehabilitation and Replacement Program	▪ Recommended R&R projects organized by facility, with priority ranking ▪ Structural and flood resiliency deficiency observations
5	O&M Program Assessment	▪ O&M-related deficiency observations ▪ Safety-related deficiency observations ▪ Recommended O&M program improvements ▪ Safety improvement recommendations

Section No.	Section Title	Required Elements
6	R&R/O&M Cost Estimates	▪ R&R costs for 10-year forecast, by year, costs escalated to a future year with facility/vertical R&R grouped into capital projects that can be completed together to maximize efficiency and cost savings ▪ O&M costs for 10-year forecast, by year, organized by facility and linear asset group, costs escalated to a future year ▪ O&M cost graphic ▪ Cash flow analysis with graphic, including both R&R and O&M costs
	Appendices	A. GIS-based depictions of utility systems B. Site Visit Reports C. Completed Facility/Vertical Asset Inventory, in tabular format, including condition ratings, estimated remaining service life for each asset, and criticality ratings D. Linear Asset Inventory Summary, in tabular form, organized by total feet for material/diameter/year of installation, including condition ratings for each asset grouping, and criticality ratings E. Facility/Vertical Asset Condition Assessment Summary – completed datasheets, interview summaries, and photographs F. Linear Asset Condition Assessment Summary – completed datasheets, interview summaries, and photographs G. R&R Cost Estimate Detail and Cash Flow Detail H. O&M Program Cost Estimate Detail

8 References

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A

Appendix A – Asset Inventory and Assessment Process

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Asset Inventory & Assessment Process

START

Collect and Review Records (Sec. 3.1)

Develop/update water & wastewater systems GIS-based depiction

Populate draft asset inventory tables (Appendix B-2)

Conduct site visits (Appendix B-3)
1. Collect additional asset inventory data
2. Conduct asset condition assessment for vertical assets

Conduct O&M staff interviews (Appendix B-4)

ASSET INVENTORY

Vertical (Facility) Assets (Appendix B-3)
- Conduct a field condition assessment:
  1. Condition
  2. Performance
  3. Safety
  4. O&M
  5. Structural
  6. Flood potential
- Complete Field Assessment Forms
- Assign condition rating of 1 to 5 to every facility asset

Linear Assets (Appendix B-2)
- Assign condition ratings of 1 to 5 for linear assets based on pipe material, pipe diameter, pipe year of installation, etc.
- Use data obtained from prior direct observations of gravity sewers if available.

Estimate percent of remaining useful life (Appendix D, Table 4-2)

Determine asset criticality (Sec. 4.4)

Assess utility's O&M program (Sec. 6)

ASSET ASSESSMENT

- Identify facility asset R&R projects based on asset condition rating & estimated remaining service life
- R&R Project Funding Demands:
  1. Estimate asset replacement value
  2. Estimate R&R project cost (Sec. 5)
  3. Forecast R&R funding demands over next 10 years for both vertical (facility) and linear assets
- Estimate annual cash-flow requirements for the R&R funding program (Appendix D)

CAPITAL COST ESTIMATES FOR R&R

- Estimate required effort to operate and maintain the utility
- Forecast 10-year staffing and other O&M costs in addition to currently-budgeted costs (Appendix E)

O&M PROGRAM COST REQUIREMENTS

Prepare Report (Section 7)

B

Appendix B – Asset Inventory Templates and References

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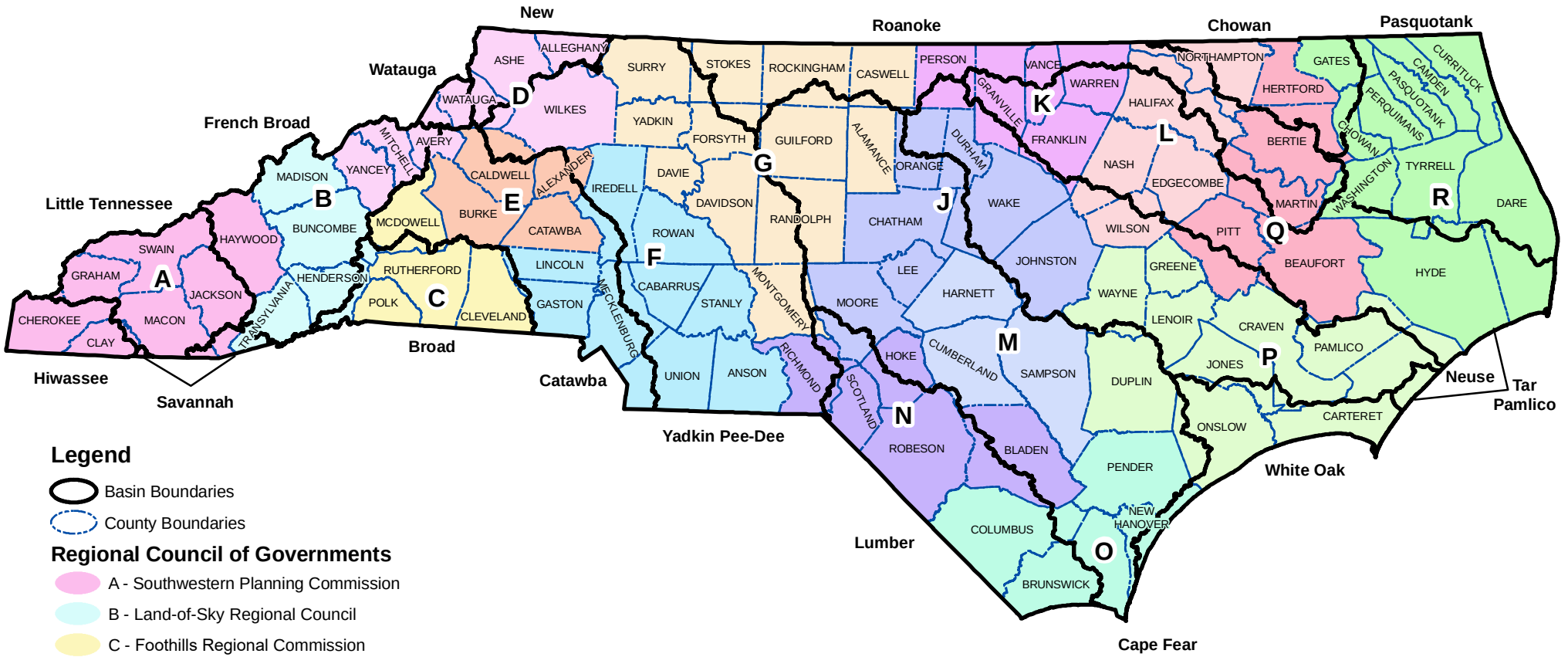
B-1: North Carolina Regional Council of Governments & River Basins Map

Regional Council of Governments & River Basins



Legend

- Basin Boundaries
- County Boundaries

Regional Council of Governments

- A - Southwestern Planning Commission
- B - Land-of-Sky Regional Council
- C - Foothills Regional Commission
- D - High Country Council of Governments
- E - Western Piedmont Council of Governments
- F - Centralina Council of Governments
- G - Piedmont Triad Regional Council of Governments
- J - Triangle J Council of Governments
- K - Kerr-Tar Regional Council of Governments
- L - Upper Coastal Plain Council of Governments
- M - Mid-Carolina Council of Governments
- N - Lumber River Council of Governments
- O - Cape Fear Council of Governments
- P - Eastern Carolina Council
- Q - Mid-East Commission
- R - Albemarle Commission

0 20 40 80 120 160 Miles

Basinwide Planning Unit
Planning Section
Div. of Water Resources, NCDEQ
Original: September 2011
Updated by DWI: February 2022

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B-2: Asset Inventory Format Template

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FACILITY/VERTICAL ASSET INVENTORY DATAFIELDS
Date:
Facility:
Utility:

Service (Water/ Wastewater)	Asset Number	Facility	System	Asset Name	Quantity	Install Year	Rebuild Year	Overall System Condition Rating	Asset Condition Rating	Asset Criticality Rating	Asset Class	Asset Subclass	Asset Description	Manufacturer	Model	Size/ Capacity	Notes

LINEAR ASSET INVENTORY
Facility:
Utility:

Linear Asset	Asset Number	Service (Water/ Wastewater)	Sub-Area	Asset Type	Pipe Material (if applicable)	Diameter	Manhole size	Length (if applicable)	Depth (manhole/ vault)	Manufacturer (valve)	Install Year	Asset Condition Rating	Asset Criticality Rating	Asset Description	Notes

B-3: Example Field Assessment Approach

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Appendix B-3
Example Field Condition Assessment Form

Assessment Approach

Objective: Provide DEQ with a planning level forecast of required capital projects to address identified deficiencies and long-term R&R (10-year planning period)

Notes:

1. This assessment will focus on the WWTP utility (also pump stations and well sites if applicable).
2. No assessment of pipelines or other linear assets (system valves, meters, etc.).
3. The field portion of the assessment will all be visual observation, no intrusive testing will be conducted.
4. If no field assessment is completed, surrogate information will be used to determine R&R requirements (asset age, material, etc.).

Approach:
The consulting engineer will assess the condition, performance, safety and O&M status of each facility to determine the current status of each of the following four (4) elements, assumptions as follows:

- **Condition** will be based on visual observation and limited to equipment in its current operating status.
- **Performance** will be based on interviews with the O&M staff. Where possible, consulting engineer will assess equipment run times, station cycle times, power use, effluent quality and others as available.
    - Performance will be assessed as ability to achieve required performance for current operations.
- **Safety** equipment will be assessed based on the status of typical facilities' protective measures.
    - Safety equipment will assessed as meeting safety requirements or not.
- **O&M status** will be based on interviews with the O&M staff and will seek to understand current equipment O&M practices for each major system (i.e. pump station or WWTP unit process).

System / Asset Class Groupings for Inspections:
For all facilities to have a field assessment conducted, the following assets, assigned to each major system, will be inspected and assigned a condition rating;

- Civil and Site - roads, drainage, parking, exterior lighting, landscaping, fencing, flooding potential
- Architectural - roofs, doors, window, floors, paint system, finishes
- Structural – building structures, process structures, concrete condition, structural steel condition, supports, miscellaneous metals
- Power distribution & standby generation – main feed, transformers, switchgear, transfer switches
- Electrical – MCC's, VFD's, major motors, conduit, wiring, disconnects
- Pumping systems – pumps, motors, tanks and associated valves
- I/C systems - field devices, control panels, instrumentation, outdated primary elements, SCADA systems, network communications.
- Piping and valves – above ground not supplied as part of pumping systems
- Tanks – pressure and vacuum
- HVAC – air handlers, make-up air units, heating equipment, ductwork, controls, support equipment
- Odor control
- For Treatment Facilities: Treatment unit processes, solids handling and disposal

Condition Rating Scale:
Condition Rating is a subjective measure of the state of deterioration based on visual observation and interview with O&M staff; the rating will be based on "Best Professional Judgment" and as follows:

Condition Rating (CR)	Description	Percent of Estimated Useful Life (EUL)	Maintenance Requirement Note
1	Very good. New or nearly new.	>95%	Normal PM
2	Good. Minor wear.	75%	Normal PM; Minor CM
3	Fair. Major wear impacting level of service.	<50%	Normal PM; Major CM
4	Poor. Unable to meet level of service life.	15%	Major rehab or repair
5	Very poor. Requires complete rehabilitation	<5%	Complete rehab or replacement
0	Unknown		

Condition Rating Approach:
1. If the age of the asset exceeds its estimated useful life, then:
    a. By default it is rated a CR4
    b. If it shows severe deterioration then maintain the CR4 (Poor) rating
    c. Consider upgrading to a CR3 (Fair) if it appears to be in good condition, performs its intended function, and does not have an immediate need to repair or replace to meet industry standards.
    d. Consider upgrading to a CR2 (Good) only if we have a report or an assessment that the asset is performing well and repair or replacement may be delayed beyond the 10 year horizon.
2. If the age of the asset is within its estimated useful life, then follow this logic;
    a. If equipment is a recent install or has 90% or more estimated remaining useful life then by default it is a CR1 (New)
    b. If equipment has 50% or more remaining useful life and there is no indications of frequent repairs or physical deterioration the rating should be a CR2 (Good)
    c. If equipment has less than 50% remaining useful life and there are reports of frequent repairs or physical deterioration then rating should be CR3 (Fair)
    d. If equipment has less than 50% remaining useful life, findings of significant deterioration and reports indicating a need for rehabilitation then the rating should be CR4 (Poor)

Condition and Performance Assessment Criteria:
Note:
(V): visual; an auditor would be able to evaluate the assessment criteria directly (visually),
(O): opinion based; the auditor would be able to evaluate the assessment criteria indirectly (by interview),
(M): measurable; the assessment criteria could be directly measured (inspected/monitored) or assessed through analysis of available operations/maintenance data.

The table below provides some asset observations that relate to the **condition** of various categories of asset using information from the *Condition Assessment Strategies and Protocols for Water and Wastewater Utility Assets Report (*Water Environment Research Foundation, 2007).

Asset Type	Assessment criteria
Buildings	Security (V/O) Weatherproof/leaks (V/O) Damp/rising damp (V/O) Level and urgency of maintenance required (O) Rust staining (V) Cracking of brick work or masonry (V) Broken slipped roof tiles (V) State of woodwork; sound to rotten (V) Structural integrity (V/M) Serviceability; useable or not? (V/O/M) Safety of building; considered unsafe? (V/O)
Civil assets	Soundness of structure (V/O) Level of wear and tear (V) Corrosion (V/M) Level and urgency of maintenance required (O) Presence of cracking/spalling (V) Presence of staining (V) Leakage (V/O) Deformation of structure (V/M) Safety of structure; considered unsafe? (V/O) Contamination of potable water (O/M)
Electrical assets	Electrically safe (O/M) Level and urgency of maintenance required (O) Visible wear and tear (V) Condition of insulation (V/M) Break downs and failure history (M) Maintenance costs (M) Health and safety issues (V/O) Serviceability (V/O/M)
Mechanical assets	Soundness of unit; as new? (V) Level and urgency of maintenance required (O) Level of wear and tear (V) Condition of protective coatings (V/M) Corrosion (V/M) Break down and failure history (M) Maintenance costs (M) Serviceability (V/O/M) Health and safety issues (V/O)
Sewers	Cracking (V) Fractures (V) Deformation (V/M) Loss of fabric; including mortar loss, brick displacement, etc. (V) Joint/connection defects (V) Loss of level (V/M)

Asset Type	Assessment criteria
Water mains	Smoothness of bore/tuberculation (V) Level of corrosion (V/M) Soundness of lining (V/M) Operational history; bursts, etc. (M) Levels of service (V/O/M) Operating costs (M) Presence of deposits (M) Design regarding current standards (O)

The table below provides asset observations that relate to the **performance** of various asset categories.

Treatment Facility Asset Type	Assessment criteria
Buildings	Adequacy for current and foreseeable use; size, location, facilities; current/anticipated shortcomings (O)
Operational security	On-site standby capacity (V/O) Mobile standby capacity and availability (V/O) Number of grid supplies (V/O) Level of manning (V/O) Level of monitoring and control (V/O) Level of telemetry (V/O) Fail-safe systems (V/O) Operational response capacity (V/O) Risk (or history) of consent/quality failure (M) Risk (or history) of service failure (M)
Control and monitoring equipment	Capacity to meet current and future requirements; current/ anticipated shortcomings; hardware & software considerations (O)
General performance grades	Hydraulic adequacy at all flows (O/M) Process capacity at all flows (O/M) Process stability; ability to control (O) Headroom with respect to inefficiencies in upstream/downstream processes (O/M) Distribution between and within assets (V/O) Level of mixing (V/O) Process retention times (O/M) Adequacy for current and foreseeable use (O)
Raw water storage	Flexibility of draw-off arrangements (O) Susceptibility to eutrophication (O/M) Effectiveness of circulation/de-stratification (O) Effectiveness of scour valves (O) Control of compensation volumes? (O)
Raw water intakes	Hydraulic adequacy at all flows (O/M) Pump capacity (V/O) Pump standby capacity (V/O) Siltation (O/M) Exclusion of surface films/slicks (O) Gross solid/screenings removal (O) Ease of well isolation and impact on capacity (O)

Treatment Facility Asset Type	Assessment criteria
Ground water source	Hydraulic adequacy at all flows (O/M) Draw down at maximum pumping capacity (O/M) Pump capacity with respect to license (O) Turbidity issues (O/M) Cavitation issues (O) Air entrainment issues (O) Protection from surface contamination (O/M) Ease of well isolation and impact on capacity/quality (O/M)
Pre-treatment	Hydraulic adequacy at all flows (O/M) Process capacity with respect to loads and required standards (O/M) Distribution of flows over weirs (V/O)
Chemical dosing plant	Ability to dose at all flow rates (O/M) Quality of control; automatic/manual (V/O) Level of storage (O) Frequency of blockages of dosing lines (O/M) Effectiveness of delivery area drainage (O) Ability to handle changes in raw water quality (O/M)
Dissolved air flotation	Hydraulic adequacy at all flows (O/M) Process capacity with respect to loads and required standards (O/M) Efficiency and distribution of air saturated water (V/O) Effectiveness of surface skimmer (O) Degree of solids depositions (O)
Sludge blanket clarifiers	Hydraulic adequacy at all flows (O/M) Process capacity with respect to loads and required standards (O/M) Degree of mixing and flocculation retention prior to tank (O/M) Ability to maintain a stable sludge blanket (O) Efficiency of sludge remove facilities (O) Degree of turbidity and pH measurement (V/O) Solids carry over (O)
Water filtration	Ability to 'buffer' poor clarification (O) Capacity of process with respect to loads and required standards, including with units off-line (O/M) Ability to achieve filter run-times (O/M) Presence/absence of turbidimeter (V/O) Quality of control (O) Quality of backwash (O) Signs of media growth (O/M)
Chlorination/dechlorination	Specification of installation; telemetry, triple validation chlorine residual monitors, chlorine-time values and mixers, etc. (O) Control of residuals at all flow rates (M)
Wash Water and Sludge Disposal	Effectiveness of wash water settlement facilities (O) Quality of supernatant water produced with respect to standard (M) Effectiveness of sludge withdrawal and consolidation facilities (O) Facility to divert returned supernatant (O) Effectiveness of sludge dewatering (M) Degree of automation (V/O)
Distribution pumping/boosting	Hydraulic output capacity (M) History or risk of service impacts; pressure or interruptions (M)

Treatment Facility Asset Type	Assessment criteria
Secondary disinfection	Specification of installation; telemetry, triple validation chlorine residual monitors, chlorine-time values and mixers, etc. (O) Control of residuals at all flow rates (M)
Sewage force mains	Hydraulic adequacy at all flows, including storm (O/M) Appropriate velocity maintained (O/M) Ease of access for maintenance (O) Septicity problems (O)
Sewage Pump Stations (including in let works pumping station)	Hydraulic adequacy at all flows (O/M) Capacity of pumps with respect to loads (O/M) Standby capacity (V/O) Capacity of sump and storm tanks (O/M) Ease of access for maintenance and emergency tinkering (O) Capacity to handle solids/rags (O) Blockage history (M) Service history: upstream flooding or premature overflow (M) Overflow history: events, loads and environmental impact (M) Service history with respect to odor and noise (M) Telemetry/alarms
Inlet works	Hydraulic adequacy at all flows (O/M) Overtopping of screens and grit channel (O) Efficiency of screenings washing/dewatering/handling equipment (O) Return of organics to flow; from grit removal (O) Efficiency of grit removal (O/M) History of blockages (M) Suitability of screen size (O) Spillage inside and outside of structure (O/M)
Storm tanks	History of discharge to overflow with respect to events, loads, consents and environmental impact (M) History of complaints (M) Return arrangements (automatic?) and impact on downstream processes (O/M) Requirement for tank cleaning after use (O) Overtopping of structure (O)
Primary settlement	Hydraulic adequacy at all flows (O/M) Carry over of solids (O) Efficiency of scum trapping and removal (O) Efficiency of sludge removal (O) Adequacy of sludge thickness (M) Presence of rising sludge, septicity or rising gases (O) Impact on inlet or outlet channels (O) Flow distribution over weirs and between units (V/O)
Biological filters	Condition of media; blockages, etc. (O/M) Distribution and ventilation (O) Occurrence of ponding (O) Ability to 'buffer' inefficient primary settlement stage (O) Condition of film (/M) Impact on downstream processes (O/M) Odor problems (O/M)

Treatment Facility Asset Type	Assessment criteria
Activated sludge plant	Hydraulic adequacy at all flows (O/M) Mixing efficiency: settled sewage and (RAS) (O) Distribution of air/oxygen (O/M) Efficiency of aeration control (O/M) Ability to 'buffer' inefficient or over-loaded primary settlement stage (O/M) Ease of maintenance of mixed liquor suspended solids (O/M) Impact on works performance and downstream processes (O/M)
Final tanks and RAS pumps	Hydraulic adequacy at all flows (O/M) Carry over of solids (O) Ability to 'buffer' inefficient or over-loaded upstream processes (O) Efficiency of scum trapping and removal (O) Presence of rising sludges, gases or septicity (O) Control of RAS and surplus sludges (O) Backing up of inlet/outlet channels (O) Flow distribution over weirs V/O) Clarity of effluent (O/M)
Tertiary treatment	Ability to buffer inefficient or over-loaded upstream processes (O) Clarity/quality of effluent (O/M) Adequacy of run times for solids filters (O/M) Efficiency of backwash/solids removal (O) Signs of media growth (O/M)
Sludge holding and consolidation tanks	Sufficiency of buffer holding capacity regarding economic tank sizing, considering normal demands and operational problems (O) Consolidation regarding percent dry solids target (M) Ease of control/operation (O) Occurrence of blockages (M) Environmental impacts (M) Complaints (M)
Sludge presses and mechanical thickening	Consolidation regarding percent dry solids target (M) Effectiveness of sludge feed and output equipment (O) Consistency of sludge production (O/M) Ease of control/operation (O) Occurrence of blockages (O/M)
Sludge digestion	Consistency of sludge production (O) Stability of sludge (O/M) Adequacy of retention times (O) Efficiency of circulation, mixing, gas collection and holding, heating and heat exchange (O) Ease of control/operation (O) Occurrence of blockages (O/M) Environmental impacts (M) Complaints (M)

A GENERIC CONDITION ASSESSMENT FORM
FOR MECHANICAL AND ELECTRICAL EQUIPMENT

ASSET DETAILS

Asset Name: _____
Asset Type: (Pump, Blower, Motor, etc) _____
System: (Pumping, controls, electrical, etc) _____
Location: _____
Asset Age: _____
Facility: _____
Asset No.: _____
Quantity: _____
Installation Year: _____
Rehabilitation Year: _____
Overall System Condition Modifier: _____
Condition Modifier: _____

Lookup Code: _____
General Asset Class: (PMP, STR, VLV, etc) _____
Asset Class: (PMP SUB, VLV PG, etc) _____
Asset Description: (PUMP – Submersible, Transfer Switch Manual, etc) _____
Manufacturer: _____
Make/Model: _____
Size/Capacity: _____
Date of Inspection: _____
Inspector: _____
Output Requirements: (flow, temperature, etc) _____
Reference Work Orders: (as a result of a PM, CM)

CONDITION CODE (check one which best describes the asset's current condition)

___ Excellent (no noticeable defects, no reason to expect failure, PMs being done, new asset)
___ Satisfactory (minor defects/wear, low possibility of failure, Some PMs being skipped)
___ Poor (significant defects/wear, high probability of failure, health/safety issue, not being PM'd)
___ Failed (excessive defects/wear, unit is in a failed state/inoperable)

FAILURE MODES (check all that apply)

___ Coating Failure/Rust/Corrosion
___ Vibration/Excessive Noise
___ Excessive Heat/Hot to touch
___ Fluid Leaks/Drips
___ Unit Failed
___ Reduced Output/Capacity
___ Lack of Lubricant/Zirk Fittings Dirty
___ Design Issue
___ Instrument/Control Failure
___ Other: _____

CORRECTIVE ACTION (Check one)

___ Corrective Maintenance Work Order (Minor Repairs)
___ By Elect. ___ By Mech. ___By Intr.
___ Engineering/ Construction Project
___ Candidate for PdM Program (oil analysis, vibration, IR)

Comments: _____
_____
_____
_____

CORRECTIVE ACTION PRIORITY (Check one)

___ Low (PM program adequately covers asset, high level of redundancy, consequence/cost of failure is low)
___ Med (Can be covered in upcoming upgrade/project, minimal level of redundancy, consequence/cost of failure > $10k)
___ High (Health/Safety issue, failure < 1 year, secondary damage possible, immediate CM needed, beyond useful life)

CORRECTIVE ACTION BENEFITS (Check all that apply)

___ Continue to maintain output/service levels ___ Process/ operational improvements

___ O&M Cost Savings due to energy savings ___ Extend Asset Life

___ Other: _____

MAINTENANCE RECORDS (Check all that apply)

___ PM History Available ___ PM Being Done ___ PMs Being Skipped ___ CM Count High

___ List PM Job Plans (this might be something we'd like to review on the first Condition Assessment as part of a PM Optimization process)

PM Job Plans (Tasks and Frequency here)

CONDITION ASSESSMENT WORK ORDER DETAILS (Complete ALL Prior to Closing IPM – Required Fields)

Time to complete inspection - ____ minutes/hours Name of inspector: _____ Date: _____

Re-inspection required (Y / N) (CA Priority 1 only) within _____ days/months

Inspection PM data entered into system on _____ (date) by _____

Comments/ Notes:

_____

_____

_____

_____

B-4: Staff Interview Example Questionnaire

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APPENDIX B.4 – Staff Interview Example Questionnaire

Date: _____ Interviewer:

_____ 1 – General Information

a. Utility Name / Location _____

b. Name _____ Position Title _____

c. List the utility assets do you work with the most. _____

_____

d. How long have you worked here? _____

e. Full-Time/Part-Time? _____ Operator's license or other certifications? _____

2 – Utility Information

a. How many O&M Employees work here & what are their work areas? _____

_____

b. Describe a typical work-day _____

_____

_____

c. How often do you visit utility facilities assigned to you? What activities do you perform there?

_____

_____

d. What comprises your typical preventative maintenance program? _____

_____

_____

e. What are the normal O&M activities that are currently being performed for (list on a separate sheet):

- Wells or Water Supply
- Water Treatment Plant
- Water Distribution System
- Wastewater Gravity Sewers
- Wastewater Manholes
- Wastewater Pump Stations
- Wastewater Force Mains
- Wastewater Treatment Facilities

f. What written O&M procedures does the Utility have? _____

_____

_____

g. What vehicles and equipment do you have available to perform your work? _____

_____

h. Do you typically conduct corrective maintenance in-house, or use on-call contractors? _____

_____

i. How do you keep your maintenance records? _____

3 – Asset Information

a. Which utility assets are in the best condition overall? Which utility assets, if any, would you consider to be in poor condition? Which assets are not currently functioning? _____

_____

_____

b. Which portions of the water distribution and wastewater collection systems are the newest? When were they installed? _____

_____

_____

c. What are the typical maintenance activities that you know are not getting done? _____

_____

_____

d. Which portions of the water distribution and wastewater collection systems are the oldest?

When were they installed? _____

_____

_____

e. Does the utility have water system valves which cannot be operated? _____ Show the locations on a map.

f. What water line breaks have occurred in the past 2 years? Show the locations on a map. Identify the line size, pipe material and estimated pipe age for each. _____

_____

_____

g. What sanitary sewer overflows have occurred in the past 2 years? Show the locations on a map. Identify the line size and cause (e.g., roots, grease, structural, etc.) for each.

_____

_____

h. Has the utility performed CCTV inspections of portions of its wastewater collection system? Where? _____

_____

i. Has the utility performed cleaning or root control in portions of its wastewater collection system? Where? _____

_____

j. Are any utility facilities (wells, treatment plants, pump stations, etc.) prone to flooding? During normal rain events or extreme weather events? _____

_____

_____

k. Describe well, water supply or treatment facility assets which require extensive maintenance to keep in service. _____

_____

l. Is there anything else the field assessment crew should know about utility facilities or O&M to conduct an accurate and complete assessment? _____

_____

_____

_____

C

Appendix C – Photograph Examples of Asset Condition Ratings

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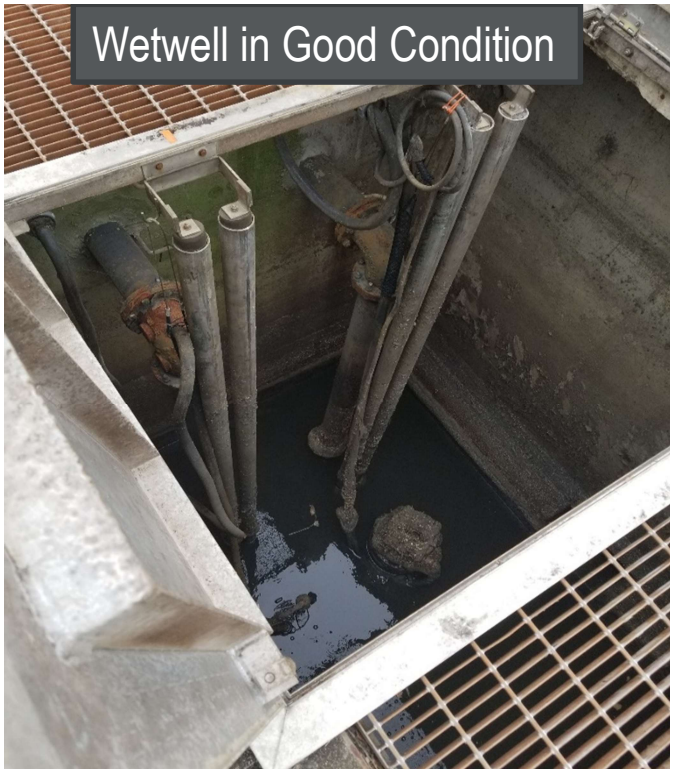
New Equipment

Fiberglass-Lined Wetwell

CR1

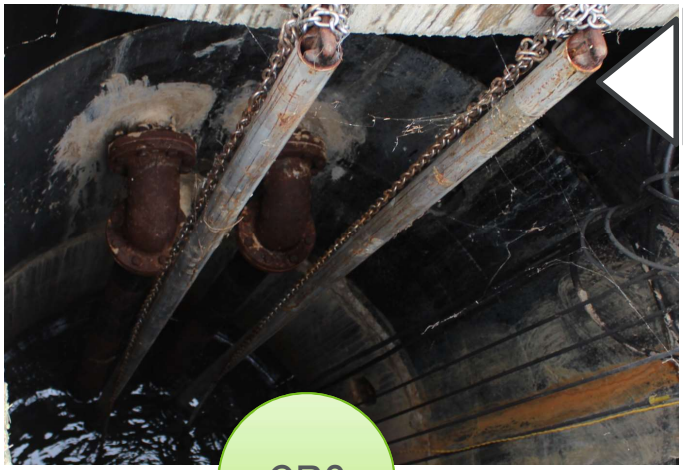
Condition Rating 1

New and Very Well Maintained Assets



Wetwell in Good Condition

Condition
Rating 2

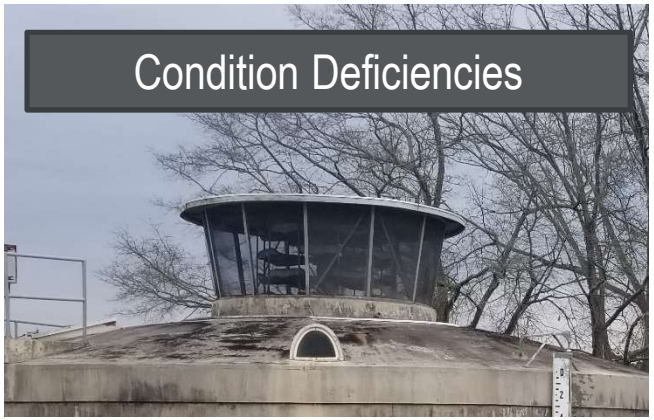


CR2

Good Housekeeping,
Good Condition

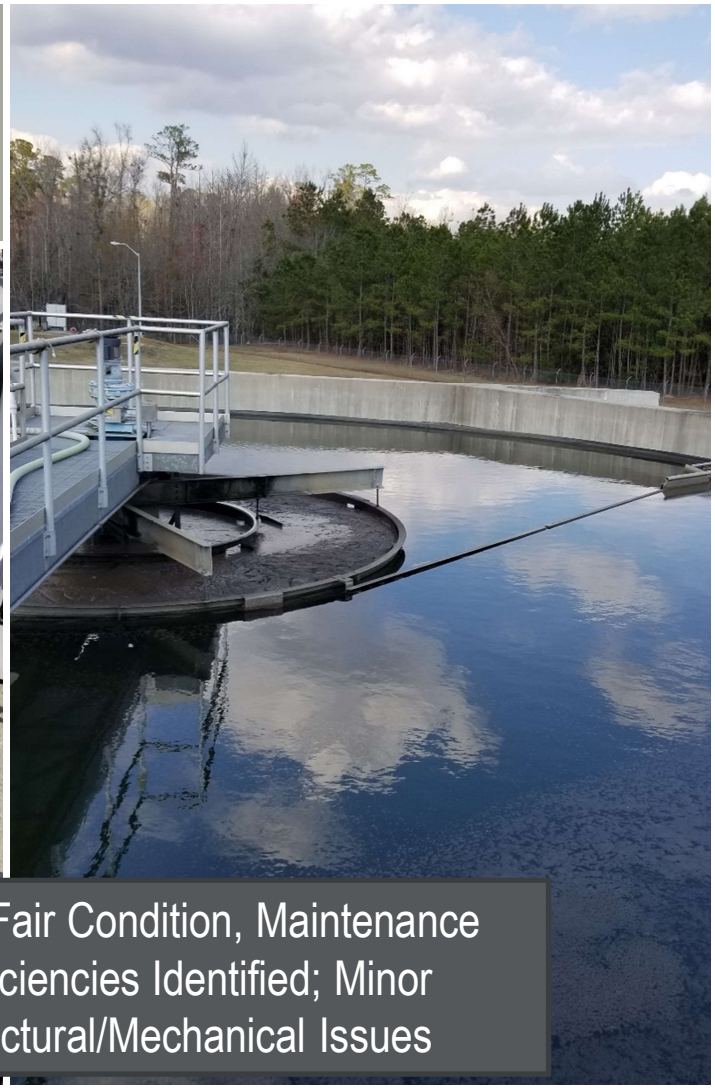
Wetwell in Good Condition,
No Corrosion, Coating Intact

Valves/Vault in
Good Condition



Condition
Rating 3

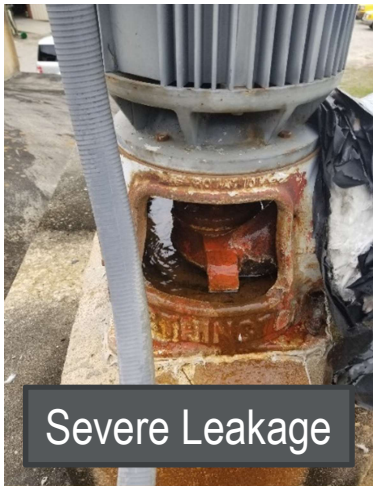
CR3

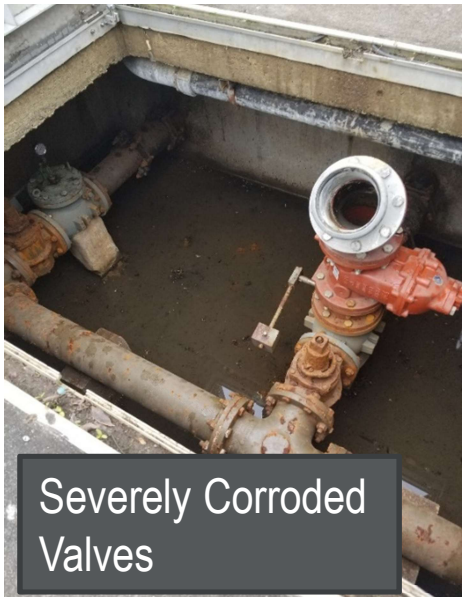


Good/Fair Condition, Maintenance Deficiencies Identified; Minor Structural/Mechanical Issues

Condition Rating 4

CR4





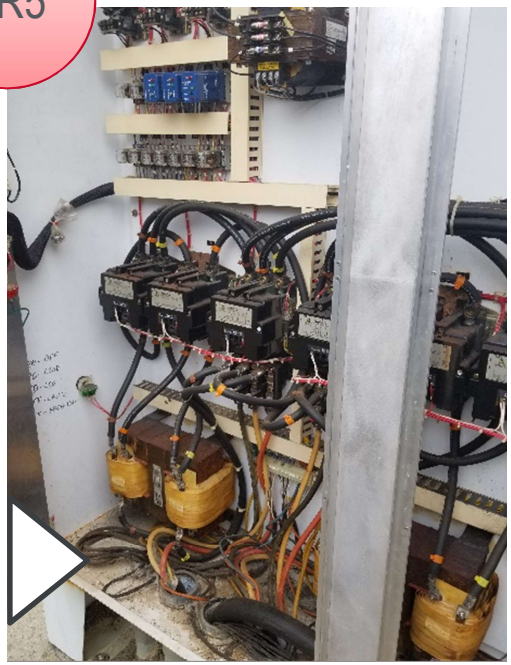
Mechanical/Structural Failures, Significant Corrosion

CR5

Non-Operational Equipment/Systems

Pump near Failure

- Electrical Equipment Failures
- Improper Protection From Environment
- Operator Safety Concerns



Condition Rating 5

D

Appendix D – Renewal & Replacement Forecasting Expected Useful Life & Cost References

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D-1: Facility/Vertical Asset R&R Forecasting References

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Appendix D-1 Vertical Asset R&R References

Generalized Asset Class	Asset Description	Asset Size	Life Cycle (yrs) - Low	Life Cycle (yrs) - Base	Life Cycle (yrs) - High	Replacement Value ($) - Low	Replacement Value ($) - Base	Replacement Value ($) - High	Rebuild Frequency (yrs)	Rebuild % of Repl. Value
Control	CONTROLS - GENERAL		5	10	15	$2,000	$4,000	$6,000	0	0%
	CONTROL PANEL	LARGE	10	15	20	$45,000	$60,000	$75,000	0	0%
		MEDIUM	10	15	20	$25,000	$35,000	$45,000	0	0%
		SMALL	10	15	20	$5,000	$10,000	$15,000	0	0%
Data	AUTO DIALER		3	10	12	$3,000	$5,000	$7,500	0	0%
	SCADA SYSTEM		5	7	10	$16,000	$20,000	$24,000	0	0%
Electrical	GENERATOR		10	20	30	$160,000	$200,000	$240,000	0	0%
		≤ 100 KW	10	20	30	$40,000	$65,000	$90,000	0	0%
		≥ 300 KW	10	20	30	$600,000	$750,000	$900,000	0	0%
		100 - 300 KW	10	20	30	$160,000	$200,000	$240,000	0	0%
	MOTOR STARTER		10	20	30	$800	$5,000	$10,000	0	0%
			2	5	7	$800	$5,000	$10,000	3	26%
	POWER PACK		15	20	25	$10,000	$20,000	$30,000	0	0%
	TRANSFORMER		10	20	30	$2,000	$5,000	$10,000	0	0%
	TRANSFER SWITCH AUTOMATIC	LARGE	15	20	25	$60,000	$75,000	$80,000	0	0%
		MEDIUM	15	20	25	$20,000	$50,000	$60,000	0	0%
		SMALL	5	15	30	$7,500	$20,000	$40,000	0	0%
	TRANSFER SWITCH MANUAL	SMALL	20	30	45	$2,500	$20,000	$40,000	0	0%
	ELECTRICAL - GENERAL	LARGE	15	20	30	$7,000	$12,000	$20,000	0	0%
		MEDIUM	15	20	30	$3,000	$7,000	$12,000	0	0%
		SMALL	15	20	30	$1,000	$3,000	$5,000	0	0%
Gate	SLIDE GATE		7	20	30	$10,000	$12,000	$15,000	0	0%
HVAC	HVAC	MEDIUM	10	15	20	$7,000	$8,000	$10,000	0	0%
	HVAC	SMALL	10	15	20	$2,000	$5,000	$25,000	0	0%
Instrumentation	FLOW METER		5	10	20	$2,000	$5,000	$7,500	0	0%
	LEVEL SENSOR		5	10	20	$900	$1,500	$2,100	0	0%
	INSTRUMENTAITON - MAG METER		5	10	20	$10,000	$15,000	$25,000	0	0%
	GENERAL	LARGE	5	10	15	$10,000	$15,000	$20,000	0	0%
		SMALL	2	3	5	$3,000	$5,000	$7,000	0	0%
Mechanical	MECHANICAL - GENERAL		5	10	15	$1,000	$2,000	$3,000	0	0%
	AERATOR		10	20	30	$5,000	$15,000	$25,000	0	0%
	BAFFLE CURTAIN		30	40	50	$35,000	$50,000	$75,000	0	0%
	BLOWERS - WWTP	125 HP	15	20	30	$45,000	$55,000	$65,000	5	10%
		30 HP	15	20	30	$15,000	$20,000	$25,000	5	10%
	CHEMICAL SYSTEMS		5	12.5	15	$10,000	$20,000	$30,000	0	0%
	CIRCULAR CLARIFIER		15	20	30	$100,000	$150,000	$250,000	0	0%
	CRANE		30	50	60	$15,000	$20,000	$25,000	0	0%
	MECHANICAL DIFFUSERS		5	7.5	15	$45	$60	$75	0	0%
	FLOW METER-PARCHALL FLUME	LARGE	35	40	50	$10,000	$15,000	$21,000	0	0%
		SMALL	35	40	50	$5,000	$7,500	$9,000	0	0%
	GRIT SEPARATOR		30	40	50	$120,000	$150,000	$200,000	2	5%
	HOIST		30	50	60	$2,000	$3,500	$5,000	0	0%
	BARSCREEN		15	20	25	$100,000	$125,000	$150,000	0	0%
	SLUDGE COLLECTOR		15	20	30	$100,000	$150,000	$250,000	0	0%
	SCREENING COMPACTOR		15	20	25	$10,000	$20,000	$30,000	0	0%
	WASH PRESS		20	25	35	$50,000	$75,000	$100,000	10	5%

Appendix D-1 Vertical Asset R&R References

Generalized Asset Class	Asset Description	Asset Size	Life Cycle (yrs) - Low	Life Cycle (yrs) - Base	Life Cycle (yrs) - High	Replacement Value ($) - Low	Replacement Value ($) - Base	Replacement Value ($) - High	Rebuild Frequency (yrs)	Rebuild % of Repl. Value
Motor	MOTOR	<20 HP	4	10	20	$1,000	$5,000	$9,000	0	0%
			10	17	25	$5,000	$15,000	$25,000	0	0%
Pump	CENTRIFUGAL PUMP	15 hp	10	20	30	$10,000	$25,000	$45,000	10	35%
	CHEMICAL FEED PUMP - PS	≤ 50 gpm	3	5	7	$1,000	$2,000	$4,000	0	0%
			3	5	7	$1,000	$2,000	$4,000	0	0%
			3	5	7	$1,000	$2,000	$4,000	0	0%
	PUMP RAILS		15	25	35	$1,000	$3,000	$5,000	5	23%
	SUMP PUMP		5	7	10	$1,000	$2,000	$4,000	0	0%
	SUBMERSIBLE PUMP	<30 hp	15	25	35	$5,000	$9,000	$15,000	5	25%
		>80 hp	15	25	35	$65,000	$85,000	$120,000	5	23%
		30-80 hp	15	25	35	$10,000	$20,000	$30,000	5	25%
	WELL PUMP	<30 hp	20	25	35	$20,000	$25,000	$30,000	5	0%
		>30 hp	20	25	35	$40,000	$50,000	$60,000	5	0%
		UNK	20	25	35	$40,000	$50,000	$60,000	0	3%
Reservoir	FW STORAGE RESERVOIR	100,000 gal	20	50	70				0	0%
Structures	GENERAL BLDG		20	50	70				0	0%
	FENCE		30	50	70				0	0%
	VALVE VAULT		30	50	70				0	0%
	WELL HOUSE BLDG		20	50	70				0	0%
	PS WETWELL		30	50	70				0	0%
Tank	BULK TANK - WELL	Well	10	15	20	$1,500	$2,000	$3,000	0	0%
		WWTP	10	15	20	$50,000	$75,000	$100,000	0	0%
	ELEVATED TANK	200,000 gal	30	50	70				0	0%
		300,000 gal	30	50	70				0	0%
		500,000 gal	30	50	70				0	0%
	FUEL TANK	150 gal	15	20	25	$2,000	$3,000	$8,000	0	0%
	HYDROPNEUMATIC TANK	7,000 gal	20	35	50	$15,000	$20,000	$60,000	0	0%
Valve	AIR RELEASE VALVE		10	20	30	$4,000	$5,000	$7,000	0	0%
	BUTTERFLY VALVE	>24"	10	20	30	$5,000	$15,000	$25,000	0	0%
		12-24"	10	20	30	$2,500	$3,000	$5,000	0	0%
		6-12"	10	20	30	$1,000	$1,500	$2,000	0	0%
	BACK FLOW PREVENTER		10	20	30	$500	$1,500	$2,000	0	0%
	GATE VALVE	<6"	10	20	30	$1,000	$1,500	$2,000	0	0%
		12-24"	10	20	30	$7,000	$10,000	$15,000	0	0%
		6-12"	10	20	30	$2,000	$4,000	$7,000	0	0%
	PRESSURE REGULATING VALVE	8-12"	10	20	30	$2,000	$2,500	$5,000	0	0%
	VALVE - UNK	6-12"	10	20	30	$2,000	$4,000	$6,000	0	0%
	CHECK VALVE	<6"	10	20	30	$1,200	$2,000	$2,800	0	0%
		6-12"	10	20	30	$2,800	$3,000	$3,500	0	0%
	PLUG VALVE	<6"	10	20	30	$600	$1,000	$1,400	0	0%
		>18"	10	20	30	$4,200	$6,000	$8,000	0	0%
		6-18"	10	20	30	$1,400	$3,000	$4,200	0	0%

*Costs are in 2020 dollars, not escalated.

D-2: Linear Asset R&R Forecasting References

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Appendix D-2 Linear Asset R&R References

Construction Costs for PVC/HDPE Replacement — **Cost Per Linear Foot**

Asset Type	Size	Description	Cost - Low	Cost - Base	Cost - High
Force main	**10-in**		$80.00	$100.00	$110.00
	12-in		$90.00	$110.00	$120.00
	4-in		$50.00	$70.00	$80.00
	6-in		$60.00	$80.00	$90.00
	8-in		$70.00	$90.00	$100.00
Gravity sewer	**10-in**	**Depth <12 feet**	$100.00	$120.00	$130.00
	12-in	**Depth <12 feet**	$110.00	$130.00	$140.00
	16-in	**Depth <12 feet**	$120.00	$140.00	$150.00
	4-in	**Depth <12 feet**	$70.00	$90.00	$100.00
	6-in	**Depth <12 feet**	$80.00	$100.00	$110.00
	8-in	**Depth <12 feet**	$90.00	$110.00	$120.00
	Manhole	**Depth <12 feet**	$2,500.00	$5,000.00	$6,500.00
Water Main	**10-in**		$80.00	$100.00	$110.00
	12-in		$90.00	$110.00	$120.00
	14-in		$100.00	$120.00	$130.00
	16-in		$110.00	$130.00	$140.00
	2-in		$25.00	$50.00	$70.00
	4-in		$50.00	$70.00	$80.00
	6-in		$60.00	$80.00	$90.00
	8-in		$70.00	$90.00	$100.00
Water meter	**Small**		$300.00	$500.00	$750.00
	large		$1,500.00	$2,000.00	$2,500.00

*Costs are in 2020 dollars, not excalated. Costs considered representative of rural, coastal plain communities with light to moderately traveled roadways

Life Cycle, by Existing Pipe Material Type

Asset Type	Material Type	Life Cycle- Low	Life Cycle- Base	Life Cycle- High
Force Main	**CIP (Cast Iron Pipe)**	30	50	100
	DIP (Ductile Iron Pipe)	30	50	100
	HDPE (High Density Polyethyler	50	80	120
	PVC (Polyvinyl Chloride)	50	80	120
	VCP (Vitrified Clay)	30	50	100
Gravity Sewer	**AC (Asbestos Cement)**	40	60	100
	CIP (Cast Iron Pipe)	40	60	100
	CIPP (Cured In-place Liners)	30	50	70
	DIP (Ductile Iron Pipe)	40	60	100
	HDPE (High Density Polyethyler	60	80	120
	PVC (Polyvinyl Chloride)	60	80	120
	RPM (Reinforced Plastic Mortar	40	60	80
	RPP (Reinforce Plastic Pipe)	40	60	80
	VCP (Vitrified Clay)	35	60	100
	UNK(Unknown)	40	60	100
	Brick Manhole	40	50	70
	Concrete Manhole	40	50	70
	Precast Concrete Manhole	40	50	70
	Unknown Manhole	40	50	70
Water Main	**ACP (Asbestos Cement Pipe)**	40		100
	CIP (Cast Iron Pipe)	40	90	110
	CONC (Concrete)	50	90	110
	DIP (Ductile Iron Pipe)	60	90	120
	PVC (Polyvinyl Chloride)	60	80	120
	UNK(Unknown)	40	70	100
Water Meter	**Meter**	7	10	15

D-3: R&R Program Cost Estimating

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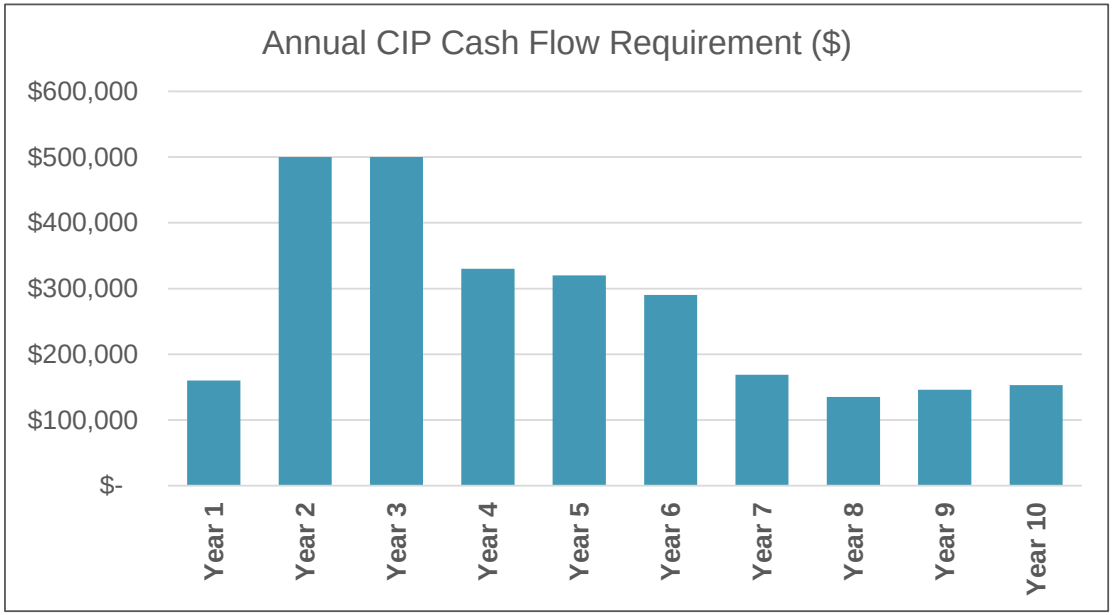
Appendix D-3 R&R Program Funding Needs

Project No.	Project Name	Recommended Completion Year	Base Cost, $	Mark-ups, $ (except Engineering & Permitting)	Engineering & Permitting, $	Total Project Cost, $

10-Year Capital Funding Cash Flow Requirements Example

	Annual CIP Cash Flow Requirement ($)
Year 1	$ 160,000
Year 2	$ 500,000
Year 3	$ 500,000
Year 4	$ 330,000
Year 5	$ 320,000
Year 6	$ 290,000
Year 7	$ 169,000
Year 8	$ 135,000
Year 9	$ 146,000
Year 10	$ 153,000



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Appendix E – O&M Program References

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E-1: O&M Task List Example

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Appendix E-1 O&M Task List Example

	Frequency	Grouping
Wastewater		
Treatment		
Test and certify operation of Backflow Prevention Devices	Annually	Routine Operations
Exercise Generator	Monthly	Generator Maintenance
Inspect Generator fluid and fuel levels, battery, belts, hoses and filters	Monthly	Generator Maintenance
Perform annual PM on Generator including load testing.	Annually	Generator Maintenance
Conduct annual inspections of hoists and monorail system (per OSHA requirements)	Annually	Equipment Maintenance
Test alarms for proper function	Monthly	Routine Operations
Test autodialer for proper function	Monthly	Routine Operations
Inspect all security devices (fences, locks, motion sensors, cameras, etc.)	Weekly	Routine Operations
Grounds maintenance (as required)	Weekly	Routine Operations
Building maintenance (paint, caulk, weatherstrip, clean gutters, etc.)	Monthly	Routine Operations
Drain, Clean and inspect all treatment basins	Annually	Equipment Maintenance
Calibrate or verify accuracy of flow meters	Annually	Equipment Maintenance
Inspect operation of chemical feeders	Daily	Routine Operations
Calibrate chemical feeders, change diaphragms/tubing as recommended by manufacturer	Monthly	Routine Operations
Exercise Valves	Semiannually	Routine Operations
Perform equipment PM, including instrument calibration, as recommended by the manufacturer	Weekly	Equipment Maintenance
Perform process control testing as required	Weekly	Laboratory Duties
Calculate solids inventory and adjust wasting rate as needed	Weekly	Solids Management
Dispose of digested solids as needed to maintain desired solids inventory	Weekly	Solids Management
Inspect all safety equipment and insure it is in place and operational	Monthly	Inspect Safety Equipment
Inspect all safety labeling and placement of MSDS sheets and insure they are in place and legible	Monthly	Inspect Safety Equipment
Test emergency eye wash/shower	Monthly	Inspect Safety Equipment
Perform FOG management program duties	Annually	Administration
In-house lab QA/QC and recordkeeping	Daily	Laboratory Duties
Perform regulatory testing as required using in-house lab.	Daily	Laboratory Duties
Collect samples for permit analysis by contracted lab. Complete chain of custody paperwork	Daily	Laboratory Duties
Prepare regulatory reports	Monthly	Administration
Perform corrective maintenance as required	Daily	Equipment Maintenance
Order, receive and manage chemicals and maintenance supplies	Daily	Laboratory Duties
Respond to after normal working hour call-outs	Daily	Routine Operations
Remove equipment for repairs by outside contractor	Daily	Equipment Maintenance
Prepare annual operations and maintenance budget	Annually	Administration
Meet, provide access, escort and observe outside contracted work	Daily	Administration

NOTE: Provided task list and task frequencies are for reference purposes, utility specific practices should be used to inform the final O&M task list for an AIA.

Appendix E-1 O&M Task List Example

	Frequency	Grouping
Wastewater (Continued)		
Collection		
Pump Station		
Test and certify operation of Backflow Prevention Devices	Annually	Routine Operations
Perform drawdown test to verify pumping capacity - record and compare to previous results	Semiannually	Routine Operations
Exercise Generator	Monthly	Generator Maintenance
Inspect Generator fluid and fuel levels, battery, belts, hoses and filters	Monthly	Generator Maintenance
Perform annual PM on Generator including load testing	Annually	Generator Maintenance
Conduct annual inspections of hoists and monorail system (per OSHA requirements)	Annually	Equipment Maintenance
Test alarms for proper function	Monthly	Routine Operations
Test autodialer for proper function	Monthly	Routine Operations
Inspect all security devices (fences, locks, motion sensors, cameras, etc.)	Weekly	Routine Operations
Grounds maintenance (as required)	Weekly	Routine Operations
Calibrate or verify accuracy of flow meters	Annually	Equipment Maintenance
Perform general inspection and record findings (daily for PS w/o telemetry, weekly for PS with telemetry)	Daily	Routine Operations
Building maintenance (paint, caulk, weatherstrip, clean gutters, etc.)	Monthly	Routine Operations
Exercise Valves	Annually	Routine Operations
Perform equipment PM as recommended by the manufacturer	Weekly	Routine Operations
Pump down, clean & inspect wet wells, remove & inspect submersible pumps, remove grease buildup	Semiannually	Equipment Maintenance
Record electrical consumption, pump run hours, flow meter readings. Compare to historical data	Monthly	Routine Operations
Record pump operating data - volts/amps for each phase, flow rate, pressure	Weekly	Routine Operations
Check motors and electrical switchgear for excess noise, vibration heat and odors	Weekly	Routine Operations
Check equipment for adequate lubrication	Weekly	Routine Operations
Check bearing temperatures (monthly if accessible)	Monthly	Routine Operations
Check packing for leakage and tighten/replace as required	Weekly	Routine Operations
Perform corrective maintenance as required	Daily	Equipment Maintenance
Remove equipment for repairs by outside contractor	Weekly	Equipment Maintenance
Respond to after normal working hour call-outs	Daily	Routine Operations
Prepare annual operations and maintenance budget	Annually	Administration
Meet, provide access, escort and observe outside contracted work	Weekly	Administration
Order, receive and manage maintenance supplies	Weekly	Administration
Gravity Sewer Mains		
Clean/Jet sewers (every two years, more often for problem sewers)	Biannually	Pipe Maintenance
Inspect manholes, document condition (every two years in conjunction with Clean/Jet)	Biannually	Pipe Maintenance
Clean and inspect High Priority sewers and document findings	Semiannually	Pipe Maintenance
Perform Grease Control Program duties as required.	Monthly	Pipe Maintenance
For lines with root problems, cut roots and apply root control chemical	Annually	Pipe Maintenance
Respond to after normal working hour call-outs	Daily	Routine Operations
Contract and observe pipeline repairs	Weekly	Administration
Force Mains		
Inspect Air Relief Valves	Annually	Equipment Maintenance
Inspect R/Ws - Ability to access for maintenance and integrity of markers	Annually	Pipe Maintenance
Pressure test (annually) How would this be done? Not sure if this is typical activity	Annually	Pipe Maintenance
Contract and observe pipeline repairs	Weekly	Administration

NOTE: Provided task list and task frequencies are for reference purposes, utility specific practices should be used to inform the final O&M task list for an AIA.

Appendix E-1 O&M Task List Example

	Frequency	Grouping
Water		
Water Supply Wells		
Exercise Valves	Annually	Routine Operations
Exercise Generator	Monthly	Generator Maintenance
Inspect Generator fluid and fuel levels, battery, belts, hoses and filters	Monthly	Generator Maintenance
Perform annual PM on Generator including load testing.	Annually	Generator Maintenance
Test and certify operation of Backflow Prevention Devices	Annually	Routine Operations
Test alarms for proper function	Monthly	Routine Operations
Test autodialer for proper function	Monthly	Routine Operations
Inspect all security devices (fences, locks, motion sensors, cameras, etc.)	Weekly	Routine Operations
Inspect for vandalism or any sign of unauthorized activity (weekly if intrusion detection exists, otherwise daily)	Weekly	Routine Operations
Calibrate or verify accuracy of flow meters	Annually	Equipment Maintenance
Grounds maintenance (as required)	Weekly	Routine Operations
Inspect hydropneumatic tanks, add air as needed	Monthly	Routine Operations
Inspect operation of chemical feeders	Weekly	Routine Operations
Calibrate chemical feeders, change diaphragms/tubing as recommended by manufacturer	Monthly	Routine Operations
Building maintenance (paint, caulk, weatherstrip, clean gutters, etc.)	Monthly	Routine Operations
Record electrical consumption, pump run hours, flow meter readings, and chemical consumption. Compare to historical data	Monthly	Routine Operations
Record pump operating data - volts/amps for each phase, flow rate, pressure	Weekly	Routine Operations
Perform equipment PM as recommended by the manufacturer	Weekly	Equipment Maintenance
Check motors and electrical switchgear for excess noise, vibration heat and odors	Weekly	Equipment Maintenance
Check equipment for adequate lubrication	Weekly	Equipment Maintenance
Check bearing temperatures (monthly if accessible)	Monthly	Equipment Maintenance
Check packing for leakage and tighten/replace as required (weekly)	Weekly	Equipment Maintenance
Perform regulatory testing as required	Weekly	Laboratory Duties
Prepare regulatory reports (monthly)	Monthly	Administration
Order, receive and manage chemicals and maintenance supplies	Weekly	Laboratory Duties
Collect samples for permit analysis by contracted lab. Complete chain of custody paperwork	Monthly	Laboratory Duties
Prepare regulatory reports / consumer confidence report	Annually	Administration
Respond to after normal working hour call-outs	Daily	Routine Operations
Perform corrective maintenance as required	Daily	Equipment Maintenance
Remove equipment for repairs by outside contractor	Weekly	Equipment Maintenance
Prepare annual operations and maintenance budget	Annually	Administration
Meet, provide access, escort and observe outside contracted work	Weekly	Administration
Storage (Elevated tank & GSTs)		
Test alarms for proper function	Monthly	Routine Operations
Test autodialer for proper function	Monthly	Routine Operations
Inspect all security devices (fences, locks, motion sensors, cameras, etc.)	Weekly	Routine Operations
Inspect for vandalism or any sign of unauthorized activity (weekly if intrusion detection exists, otherwise daily)	Daily	Routine Operations
Grounds maintenance (as required)	Weekly	Routine Operations
Inspect tank for sanitary defects	Annually	Equipment Maintenance
Exercise Valves	Annually	Equipment Maintenance
Contract and observe tank inspections and repairs (5-years)	Annually	Routine Operations

NOTE: Provided task list and task frequencies are for reference purposes, utility specific practices should be used to inform the final O&M task list for an AIA.

Appendix E-1 O&M Task List Example

	Frequency	Grouping
Distribution Mains		
Inspect Air Relief Valves	Annually	Equipment Maintenance
Inspect fire hydrants visually and check operation	Semiannually	Equipment Maintenance
Flow test fire hydrants and record results (every 5 years)	Every 5 years	Equipment Maintenance
Paint fire hydrants (every 5 years or as needed)	Every 5 years	Equipment Maintenance
Inspect and exercise valves, clean valve box, check for leakage and note number of turns to operate (critical valves, semiannually; others, annually)	Varies	Equipment Maintenance
Implement meter inspection/testing/replacement program (small meters tested every 5 - 10 years, large meters every 1 - 4 years)	Varies	Equipment Maintenance
Inspect R/Ws for maintenance access and integrity of markers	Annually	Pipe Maintenance
Check curb/meter boxes for damage or leaking services	Annually	
Perform regulatory testing as required	Weekly	Laboratory Duties
Perform process control testing as needed (chlorine, daily; fluoride, weekly)	Daily	Laboratory Duties
Perform comparison of water production and consumption to determine water loss from leaks or theft	Monthly	Administration
Flush water mains as required to maintain water quality	Monthly	Pipe Maintenance
Respond to after normal working hour call-outs	Daily	Routine Operations
Contract and observe pipeline repairs	Weekly	Administration
Order, receive and manage maintenance supplies	Weekly	Administration
Prepare annual operations and maintenance budget	Annually	Administration
Read customer meters	Monthly	Administration
Respond to customer complaints/concerns	Daily	Administration

NOTE: Provided task list and task frequencies are for reference purposes, utility specific practices should be used to inform the final O&M task list for an AIA.

General O&M Task List (Assumed Contracted Services for Small Utilities)	Facility Type	Frequency	Grouping	Notes for future estimate
Test and certify operation of Backflow Prevention Devices	Wastewater Treatment Plant	Annually		contracted
Perform annual PM on Generator including load testing.	Wastewater Treatment Plant	Annually	Generator Maintenance	contracted but supervised
Drain, Clean and inspect all treatment basins	Wastewater Treatment Plant	Annually	Equipment Maintenance	contract actual cleaning, but supervised
Calibrate or verify accuracy of flow meters	Wastewater Treatment Plant	Annually	Equipment Maintenance	contracted
Dispose of digested solids as needed to maintain desired solids inventory	Wastewater Treatment Plant	Weekly	Solids Management	contracted, but supervised
Test and certify operation of Backflow Prevention Devices	Pump Station	Annually		contracted
Perform annual PM on Generator including load testing	Pump Station	Annually	Generator Maintenance	contracted
Calibrate or verify accuracy of flow meters	Pump Station	Annually	Equipment Maintenance	contracted
Clean/Jet sewers (every two years, more often for problem sewers)	Gravity Sewer	Biannually	Pipe Maintenance	contracted, but supervised
Inspect manholes, document condition (every two years in conjunction with Clean/Jet)	Gravity Sewer	Biannually	Pipe Maintenance	contracted, but supervised
For lines with root problems, cut roots and apply root control chemical	Gravity Sewer	Annually	Pipe Maintenance	contracted
Test and certify operation of Backflow Prevention Devices	Wells	Annually		contracted
Calibrate or verify accuracy of flow meters	Wells	Annually	Equipment Maintenance	contracted
Inspect elevated storage tanks	Tank	Annually	Equipment Maintenance	contracted

E-2: Example O&M Program Requirements and Estimated Costs

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Appendix E-2 EXAMPLE O&M Program Requirements and Estimated Costs

(Example shows Wastewater Pump Stations Only; Similar Estimates would be developed for all utility systems)			Man-Hour estimate		FTE Estimate (1 FTE = 1664 Man-Hours (80% Utilized))		
General O&M Task List	**Frequency**	**Grouping**	**Month**	**Annual**	**WWTP**	**Wastewater Collection**	**Water System**
Wastewater							
Collection							
Pump Station *(man-hour estimate for 1 pump station)*			***per each station***				
Test and certify operation of Backflow Prevention Devices	Annually			0.5		0.0003	
Perform drawdown test to verify pumping capacity - record and compare to previous results	Semiannually	Routine Operations		2		0.001	
Exercise Generator	Monthly	Generator Maintenance	0.25	3		0.002	
Inspect Generator fluid and fuel levels, battery, belts, hoses and filters	Monthly	Generator Maintenance	0.25	3		0.002	
Perform annual PM on Generator including load testing	Annually	Generator Maintenance	1	12		0.007	
Conduct annual inspections of hoists and monorail system (per OSHA requirements)	Annually	Equipment Maintenance		1		0.001	
Test alarms for proper function	Monthly	Routine Operations	0.1	1.2		0.001	
Test autodialer for proper function	Monthly	Routine Operations	0.1	1.2		0.001	
Inspect all security devices (fences, locks, motion sensors, cameras, etc.)	Weekly	Routine Operations	0.1	1.2		0.001	
Grounds maintenance (as required)	Weekly	Routine Operations	1	12		0.007	
Calibrate or verify accuracy of flow meters	Annually	Equipment Maintenance		1		0.001	
Perform general inspection and record findings	Daily	Routine Operations	1.5	18		0.011	
Building maintenance (paint, caulk, weatherstrip, clean gutters, etc.)	Monthly	Routine Operations	1	12		0.007	
Exercise Valves	Annually	Routine Operations		1.5		0.001	
Perform equipment PM as recommended by the manufacturer	Weekly	Routine Operations	4	48		0.029	
Pump down, clean and inspect wet wells, remove and inspect submersible pumps	Semiannually	Equipment Maintenance		16		0.010	
Record electrical consumption, pump run hours, flow meter readings. Compare to historical data	Monthly	Routine Operations	0.5	6		0.004	
Record pump operating data - volts/amps for each phase, flow rate, pressure	Weekly	Routine Operations	1	12		0.007	
Check motors and electrical switchgear for excess noise, vibration heat and odors	Weekly	Routine Operations	1	12		0.007	
Check equipment for adequate lubrication	Weekly	Routine Operations	0.5	6		0.004	
Check bearing temperatures	Monthly	Routine Operations		1		0.001	
Check packing for leakage and tighten/replace as required	Weekly	Routine Operations	0.5	6		0.004	
Perform corrective maintenance as required	Daily	Equipment Maintenance	2	24		0.014	
Remove equipment for repairs by outside contractor	Weekly	Equipment Maintenance	1	12		0.007	
Respond to after normal working hour call-outs	Daily	Routine Operations	2	24		0.014	
Prepare annual operations and maintenance budget	Annually	Administration		2		0.001	
Meet, provide access, escort and observe outside contracted work	Weekly	Administration	1	12		0.007	
Order, receive and manage maintenance supplies	Weekly	Administration	1	12		0.007	
Gravity Sewer Mains			***per 10 miles of pipe/100 MHs***				
TBD						0.000	
Force Mains			***per lift station***				
TBD						0.000	
Water							
FTE Estimate for all utility items					**0.00**	**0.16**	**0.00**

FTE Expenses			
FTE Wastewater	-	0.16	
FTE Water			-
Labor $/hr	$ 45.00	$ 20.00	$ 20.00
Benefit mulitplier	1.35	1.35	1.35
Wastewater Total cost	**$ -**	**$ 8,863**	
Water Total Cost			**$ -**
TOTAL O&M COST	**$ 8,863**		

E-3: Annual O&M Program Costs Template

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Appendix E-3 Annual O&M Program Costs Template

Table 1. Existing annual O&M Program costs

Funding Year	Administrative Existing Staffing		Water				Wastewater			
			Existing Staffing		Existing Contracted Services		Existing Staffing		Existing Contracted Services	
	FTEs	$	FTEs	$	FTEs	$	FTEs	$	FTEs	$
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

Note: Escalate future year costs using the annual cost escalation guidance from Section 5.5

Table 2. Additional proposed annual O&M Program Costs

Funding Year	O&M Program Element		Water				Wastewater			
			Additional Staffing		Additional Contracted Services		Additional Staffing		Additional Contracted Services	
	Element A, etc.		FTEs	$	FTEs	$	FTEs	$	FTEs	$
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

Note: Escalate future year costs using the annual cost escalation guidance from Section 5.5

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