Asset Management Plan
2011 Update

June 2011

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Chapter 1 - Introduction and Background

The Asset Management Plan (Plan) provides a summary of the findings and recommendations of the work done to update Zone 7's Asset Management Program (AMP), including the asset management processes that were developed during the 2011 Asset Management Program Update Project (2011 Update), and the recommended asset renewal requirements and their related renewal funding needs.

Background

Zone 7 provides water to approximately 220,000 residents within the Livermore-Amador Valley via the California Water Service Company, the Cities of Livermore and Pleasanton, and the Dublin San Ramon Services District. Zone 7 has an ongoing commitment to plan for existing and future needs, maintain a high quality, reliable water delivery system and provide a quality product and service to the community.

The purpose of the AMP is to proactively plan for and implement asset renewal projects such that Zone 7 can continue to provide high quality, reliable water delivery to the residents of the Livermore-Amador Valley.

Zone 7 initiated its formal AMP in 2004, including the development of an asset registry and proposed methodology for forecasting long term renewals, as described in the 2004 *Asset Management Program Phase II Summary Report*. The work completed in 2004 laid the foundation for Zone 7's AMP and was used as the basis for the 2011 Update.

As part of the 2011 Update, the original program, including definitions and methodologies, was reviewed to determine where opportunities existed for improvement. As a result, a number of recommendations were made. The most significant recommendations included a change in the long term funding forecast methodology and the creation of the asset classes to facilitate future data collection and decision making. These recommendations, among others, are further described later in this Plan.

Objectives

The principal goal of the 2011 Update was to develop an affordable, realistic asset management program that is consistent with good utility practice, while building Retailer support for the program and its recommendations. The corresponding objectives of the 2011 Update were to:

- Develop recommendations regarding the fixed asset inventory, including the asset hierarchy,
- Evaluate asset renewal methodologies and recommend a suitable methodology for Zone 7 based upon data needs and availability, as well as affordability,

- Develop asset renewal decision processes to ensure consistency with policies and Retailer expectations, as well as to maintain consistent practices over time and across varying staff,
- Develop a condition assessment program (CAP) and associated tools such that Zone 7 staff can implement condition inspections and assessments on a regular basis,
- Evaluate the risk associated with Zone 7's transmission pipelines and prioritize pipelines for future condition assessments,
- Identify near term renewal needs and develop a 15-year renewal CIP, and
- Develop a long term renewal forecast and associated recommended annual funding level necessary to implement future renewal needs.

Stakeholder Involvement

During the development of this Plan, two workshops were held with representatives from Zone 7's Retailers, including California Water Service Company, the Cities of Livermore and Pleasanton, and Dublin San Ramon Services District. The purpose of the workshops was to share the results and recommendations of the project and provide opportunities for the Retailers to understand the process and provide input on key aspects.

The first workshop focused on reviewing the findings and recommendations regarding the existing asset registry, presenting various methodologies for forecasting future asset renewal funding needs and presenting the recommended approach, as well as introducing the draft asset renewal decision processes for mechanical equipment and water transmission pipelines.

The second workshop was primarily focused on describing the recommended near term renewal CIP and the recommended annual funding level. An overview of the condition assessment program was also presented.

Report Organization

This Plan is divided into five chapters. The first chapter presents general background information and terminology. The second chapter, Program Framework, discusses Zone 7's asset management program and methodologies, including an overview of the asset registry, the recommended methodology for forecasting future asset renewal needs, processes for implementing consistent renewal decisions, and an overview of the condition assessment program. The third chapter, Near Term Renewal CIP, presents the capital improvement program (CIP) for near term renewal projects. The fourth chapter, Long Term Funding Forecast, presents the recommended long term AMP funding forecast through fiscal year (FY) 2049/2050. Finally, the fifth chapter, Summary and Recommendations, summarizes the findings and recommendations of the 2011 Update.

There are also five appendices to this Plan, which included technical memoranda that were developed during the course of the 2011 Update to document interim analyses, findings and recommendations. These appendices are presented in the order of the progression of work completed, and include:

- *Appendix A - Fixed Asset Inventory Technical Memorandum*. Presents the initial evaluation of Zone 7's existing asset inventory and various recommendations. Many of the recommendations included were implemented during the course of the 2011 Update.

- *Appendix B - Comparison of Asset Renewal Program Planning Methodologies Technical Memorandum.* Presents a comparison of six asset renewal program planning methodologies and recommendations to update Zone 7's existing methodology. This recommendation was implemented, and forms the basis of the long term funding forecast.

- *Appendix C - Risk Analysis of Below Ground Assets Technical Memorandum*. Presents the risk evaluation of Zone 7's transmission pipelines and the respective results and prioritization for future condition assessments.

- *Appendix D - Condition Assessment Program Implementation Plan.* The implementation plan describes how to plan for, the approach to, and scheduling of condition assessments, as well as how to conduct the assessments using condition assessment forms. The conditions assessment forms are also included.

- *Appendix E. Near Term Renewal CIP and Long Term Funding Plan Technical Appendix.* Presents the details and data associated with the near term renewal CIP and long term funding forecast.

- *Appendix F. Board Agenda Item and Acceptance Resolution*. Includes the Zone 7 staff report to the Board of Directors, dated June 15, 2011, regarding the findings and recommendations of the 2011 Update, as well as Board Resolution No. 11-4092, Resolution for Acceptance of Asset Management Plan Update.

Acknowledgements

During the development of this Plan, the project team received invaluable assistance and cooperation from Zone 7 staff and the Retailer representatives on the Technical Review Committee. Members of Zone 7's engineering, operations, and finance divisions contributed significantly to the development of tools, the proposed near term renewal capital improvement plan, and financial analyses.

Terminology and Definitions

Several abbreviations and acronyms are used in this document to improve readability. These are summarized in Table 1.

Table 1. Terminology and Definitions

Abbreviation or Term	Definition or Explanation
ACT	asset condition threshold; former terminology was level of service for a particular asset
AMP	Asset Management Program
AMTools	proprietary asset management software
CAP	Condition Assessment Program
CIP	Capital Improvement Program
CMMS	Computerized maintenance management system
CWS	California Water Service
DVWTP	Del Valle Water Treatment Plant
FY	fiscal year
LOS	Level of Service; refers to Agency-wide level of service goals
M&I	Municipal and Industrial
MCL	Maximum Contaminant Level
MG	million gallons
MGDP	Mocho Groundwater Demineralization Plant
O&M	Operation and Maintenance
OUL	Original Useful Life estimate (at the time the asset is put in service)
renewal	asset repair, rehabilitation, or replacement
Retailers	California Water Service Company, City of Livermore, City of Pleasanton, Dublin San Ramon Services District
SCADA	Supervisory Control and Data Acquisition
SWI	System-Wide Improvements
RO	reverse osmosis
RUL	Remaining Useful Life estimate (at a time after the asset has been in service for some time)
Zone 7	Zone 7 Water Agency
Plan	Asset Management Plan, 2011 Update
PP-UF	Patterson Pass Ultrafiltration Plant
PPWTP	Patterson Pass Water Treatment Plant

Chapter 2 - Program Framework

This chapter presents a summary of Zone 7's level of service goals, describes the status of the asset management database, summarizes the recommended methodology for forecasting asset renewal needs, and presents three processes to support renewal decision making. In addition, this chapter presents a summary of the pipeline risk assessment methodology and results, as well as an overview of the condition assessment program that was developed in collaboration with Zone 7 staff.

Level of Service Goals

Zone 7 has established agency-wide level of service (LOS) goals which are consistent with its mission statement to provide a reliable supply of high quality water to its customers. The LOS goals guide its operations and maintenance (O&M) activities as well as the development and implementation of the CIP. Implementation of the AMP and use of renewal funds should be consistent with the LOS goals, which are summarized below. For a complete description of the LOS goals, refer to Zone 7's Resolutions, or the 2004 AMP Report.

- Meet 100 percent of its treated water customers' water supply demands including existing and projected demands through build out (expected to occur around 2040).

- Provide sufficient treated water production capacity and infrastructure to meet at least 75 percent of the maximum daily municipal and industrial (M&I) contractual demands should any one of Zone 7's major supply, production, or transmission facilities experience an extended unplanned outage.

- Meet all state and federal primary Maximum Contaminant Levels (MCLs) for potable water delivered to the M&I contractors' turnouts.

- Meet all state and federal secondary MCLs in the potable water delivered to its M&I Contractors' turnouts. In addition, Zone 7 shall, within technical and fiscal constraints, proactively mitigate earthy-musty taste and odor events from surface water supplies, reduce hardness levels to "moderately hard" (75 – 150 mg/L as $CaCO_3$), and optimize its treatment processes to minimize chlorinous odors.

- Zone 7 shall endeavor to deliver to its non-potable contractor turnouts, from a variety of sources, water of a quality that meets the irrigation needs of its contractors and does not negatively impact vegetation, crops, or soils.

- Zone 7 shall continue to work to improve the quality of its source water. This may be achieved through Zone 7's Salt Management Plan and Groundwater Management Plan, which will maintain or improve the water quality in the groundwater basin, and also through advocacy of improvements to the State Water Project, its facilities and its operations, which may improve the quality of Zone 7's surface water supplies.

It should be noted that the term "level of service" has historically also been used in the AMP in connection with specific assets. To avoid confusion, new terminology, asset condition threshold (ACT) has been adopted to refer to specific assets.

Fixed Asset Inventory

The fixed asset inventory evaluation included a review of the existing asset registry as well as the asset hierarchy, and specifically the division of asset classes and their respective original useful life estimates.

Asset Management Database

As part of the AMP Update project, Zone 7's existing asset registry was evaluated to determine its functionality and ability to support long term asset management needs. The existing registry had been used as a tool to implement the basic asset management element of "inventorying assets" which includes a basic understanding of what assets are critical and should be managed, the condition of the managed assets including a remaining useful life estimate, and a cost estimate to replace the asset if it were to fail. While the existing registry provided the basics needed for initial implementation of the AMP, a number of limitations were identified that could hinder some aspects of the AMP (for additional information, refer to Appendix A), including:

1. Minimum remaining useful life (RUL) was limited to 50% of the original useful life (OUL) (e.g., cannot be less than 50% of OUL even if the asset has failed),
2. When adding assets to the inventory, asset-specific data, such as criticality, redundancy, installation date, OUL, RUL, could not be documented,
3. Condition assessment survey was too generic and not customizable,
4. Complex methodology for assessing redundancy,
5. Level of service was used in connection with asset-specific data and could be confused with the agency-wide LOS goals.

These issues were subsequently resolved during the 2011 Update. To address items 1 and 2, the existing data contained in the asset registry was migrated to a new asset management database, AMTools, which has greater flexibility than the original software. Items 3 and 4 were addressed as part of the CAP, which included the development of asset class specific condition assessment forms (as described further later in this Plan) including a methodology to assess redundancy at the time of the assessment. Finally, to address item 5, the level of service terminology was replaced with asset condition threshold (ACT).

Once the existing asset registry was migrated to the new asset management database, Zone 7 staff updated the database to include new assets which had been constructed or added to the system since the previous work was done in 2004. This updated database served as the basis for evaluating future funding needs, as described later in this report.

Asset Hierarchy

The original asset hierarchy was based on a location-based hierarchy, such that it is driven by the physical location of the asset as opposed to the function the asset performs. The asset hierarchy contains five levels:

1. Facility / System Name
    a. Process / Basin / Zone
        i. Component / Sub-basin / Subzone
            1. Discipline
                a. Asset

Typical industry standard is to assign assets to an asset class, which is missing from the hierarchy presented above. Asset classes are groupings of assets/equipment that share similar functions and characteristics (e.g., pumps, valves, etc.). One of the early recommendations of the 2011 Update, which was implemented, was to replace the discipline level (shown above), with asset classes. As a result, Zone 7's assets were grouped into asset classes based on three main criteria:

- Perform a similar function,
- Operate in a similar environment, and
- Due to the first two criteria, the assets typically have the same OUL.

By combining similar assets into classes, certain characteristics (e.g., OUL, ACT, failure modes, condition inspection criteria, etc.) can be defined, assigned, or tracked at the asset class level which facilitates more efficient data management and decision making.

Table 2 illustrates how each of the original disciplines (mechanical, structural, electrical, instrumentation, and pipeline) were disaggregated to create the new asset classes and the respective OUL assigned to each asset class.

Table 2. Asset Classes and OUL

2004 AMP Study[a]		2011 Update		
Asset Type (Discipline)	OUL (Years)	Asset Class	OUL (Years)[b]	Useful Life Source
Mechanical	25	Filtration Media - Membranes	5	Owner's Judgment
		Filtration Media - Conventional	25	Engineer's Judgment
		HVAC	15	CIBSE[c]
		Mechanical/Electrical/Instrumentation/Piping	Varies	Owner's Judgment
		Motor	30	Engineer's Judgment
		Pumps	30	Engineer's Judgment
		Pumps - Chemical	15	Engineer's Judgment
		Rotating Equipment	25	Engineer's Judgment
		Specified Equipment	25	Owner's Judgment
		Valves	25	Engineer's Judgment
		Well - Arch Mud Rot Combo	50	Owner's Judgment
		Well - Hollow Stem Auger	50	Owner's Judgment
		Well - Nested	50	Owner's Judgment
		Well - Sonic	50	Owner's Judgment
Structural	50	Civil / Sitework	75	Owner's Judgment
		Electrolysis Test Stations	75	Owner's Judgment
		Structural / Architectural	75	Owner's Judgment
		Tank - Chemical	15	Engineer's Judgment
		Tanks	50	Engineer's Judgment
		Turnout	50	Owner's Judgment
Electrical	30	Power Distribution	30	Engineer's Judgment
		Power Distribution - Generator Systems	30	Engineer's Judgment
		Power Distribution - Variable Frequency Drives	20	Manufacturer's Estimate
Instrumentation	15	Instrumentation - Radios	5	Engineer's Judgment
		Instrumentation - Turbidimeters	10	Engineer's Judgment
		Instrumentation - Analyzers	15	Engineer's Judgment
		Instrumentation - General Instrumentation	30	Engineer's Judgment
Pipeline	75	Piping - Above Ground	40	Owner's Judgment
		Piping - Buried	75	Engineer's Judgment
		Valves w/ Actuator	25	Engineer's Judgment

a. Adapted from the Draft Phase II AMP Summary Report, Oct. 2004.
b. The OUL for some specific assets has been adjusted per Zone 7 staff recommendations.
c. Chartered Institute of Building Services.

Recommended Asset Renewal Methodology

There are many alternative asset renewal program planning methodologies that can be utilized to plan asset renewal budgets and to select specific assets for rehabilitation or replacement.

Some methodologies are best suited for developing long range asset renewal forecasts while others are most applicable to the identification of specific near term renewal projects. The subsections below provide an overview of the alternative methodologies that were considered and the recommended methodology that was ultimately used to develop the renewal CIP and funding forecast described later in this Plan. For additional details and information, refer to Appendix B, *Comparison of Asset Renewal Program Planning Methodologies*.

Evaluation of Asset Renewal Methodology Alternatives

The methodology used in the 2004 Report and five other common methodologies, each listed below, were evaluated as part of the AMP Update project.

- Alternative 1: 2004 Methodology – Renewal Budgets Based on Renewal at 50% of an Asset's OUL
- Alternative 2: Renewal Budgets Based on 100% of an Asset's Estimated OUL
- Alternative 3: Asset Renewal Budget Plans Based on Statistical Models
- Alternative 4: Asset Renewal Budgets Based on Business Risk Analysis or Business Case Analysis
- Alternative 5: Asset Renewal Budgets Based on Condition-Based Renewal Planning
- Alternative 6: Asset Renewal Based on Asset Failures or Obsolescence

A general description and the relative advantages and disadvantages of each of these alternatives are provided in Appendix B.

Based on the evaluation of the six alternatives listed above, an asset renewal methodology was selected. The recommended methodology, summarized in Table 3, includes two components (near or long term) and incorporates aspects of four of the six alternatives listed above.

Table 3. Recommend Asset Renewal Methodology

Methodology	Component	Comments
Alternative 2: Renewal @ 100% of OUL	Long Term Renewal Forecasting and Funding	Used to develop initial long term asset renewal forecast
Alternative 3: Statistical Modeling	Long Term Renewal Forecasting and Funding	Use in the future to refine long term asset renewal forecast after sufficient asset failure data are available
Alternative 4: Business Risk Analysis	Near Term Renewal Project Identification	Use business case analysis to calculate payback period for equipment that is in good condition but inefficient.
Alternative 5: Condition-based Renewal	Near Term Renewal Project Identification and Long Term Renewal Forecasting and Funding	Used to identify near term equipment renewal projects; also use to adjust OULs to refine long term forecast

The first component of the methodology is intended for use in the identification of specific near term renewal projects. The second component of the methodology is intended for use in the development of a long term renewal forecast and funding plan. Each of these components is described in the following subsections.

Near Term Asset Renewal Project Methodology

While comparing asset age to physical useful life may be an appropriate way to develop asset renewal forecasts and funding plans (see next subsection), this methodology will not accurately identify specific near term renewal projects. Therefore, condition assessment-based planning has been selected to identify specific near term asset renewal projects. This recommendation includes the following:

- For most asset types, identify specific asset renewal projects based on the results of a condition-based asset renewal planning process. (Alt. 5).
- For assets that are difficult to accurately inspect, complete a risk analysis and consider inspection and condition assessment of inaccessible assets (e.g., buried pipelines) with elevated risk. (Alt. 5).
- For special cases such as aging mechanical equipment that is reliable and in good operating condition, but that has high run times and may be inefficient, conduct an efficiency test. Prepare a business case evaluation to determine whether replacement of the unit is justified. (Alt. 4).
- Establish straightforward, simplified asset renewal business case guidelines (e.g. minimum payback period requirements for energy efficiency upgrade projects) that will allow replacement of aging assets that are still in good condition. (Alt. 4).

Long Term Asset Renewal Forecasting Methodology

The selected methodology for development of asset renewal forecasts and a long term funding plan is the 100% of OUL methodology (Alternative 2). This methodology can be enhanced over time through implementation of the following recommendations:

- Adjust physical OUL estimates for key assets (or classes of assets) based on existing condition data and available historical failure data. (Alt. 2)
- Begin collection of asset failure/asset life data to support development of statistical failure models so that, in the future, long-term asset renewal forecasts can be improved either through the use of condition based remaining useful life calculations and/or the use of statistical asset failure models. (Alt. 3 and Alt. 5)

Asset Renewal Decision Processes

Asset renewal decision processes were developed to support the execution of the recommended asset renewal methodology, described above. Implementation of these processes will:

- Develop maintenance and renewal recommendations that are objective,

- Ensure that maintenance and renewal practices are consistent internally and aligned with Zone 7 policies,
- Ensure that maintenance and renewal practices are consistent with Retailer expectations,
- Use renewal funds in a focused manner, consistent with the LOS goals and organizational priorities, and
- Provide clear documentation and a basis of comparison against which proposed future improvements to the AMP can be considered.

Decision processes were developed for both equipment and transmission pipelines. In addition, a decision process for efficiency testing of mechanical equipment was developed. The decision processes are based on the factors listed in Table 4.

Table 4. Factors Considered in Asset Renewal Decisions

Decision Factor	Explanation
Red Flag Defects	Condition may require immediate actions to resolve a safety issue or insure continuous service to Retailers.
Major Defects	A defect that is not a red flag defect, but is considered to significantly increase the probability that an asset or system will fail in the near future.
Asset Criticality	Is the asset critical to Zone 7's ability to provide continuous service to its Retailers or maintain safety for employees, the Retailers, and the public?
Asset Redundancy	Does the equipment or pipeline have a redundant asset available that can be put into service promptly the primary equipment or pipeline fails?
Consequence of Failure – Pipeline Location	Is the pipeline located near or under a freeway, railroad, a heavily populated area, or other location where a pipeline failure would have a major impact on a large number of people?

The asset renewal decision processes lead to several possible results or outcomes, as shown in Table 5.

The asset renewal processes, described in greater detail in the following subsections, were developed using simple questions that can be answered either "yes" or "no." As experience is gained in using these processes, they may be refined to better suit the specific needs of Zone 7. Additional processes to enhance the overall AMP may also be developed.

Table 5. Decision Process Outcomes

Asset Renewal Decision	Required Action
Maintain	Continue execution of original or modified preventive maintenance frequency or type.
Repair or Rehabilitate	Perform equipment repair or a localized point repair to a pipeline; re-build mechanical or electrical equipment including replacement of major components; for pipelines, perform internal re-lining or external re-coating or encasement.
Replace	Replace asset with new equipment or pipe, removing old asset in most cases.
Evaluate	Further information and/or analysis is required (e.g., collect condition data, calculate payback) before an asset renewal decision can be made.

Equipment Renewal

The equipment renewal process is illustrated in Figure 1; as shown, the starting point for the decision process is the question, “Is the asset a candidate for repair or replacement?” In general, the asset is a candidate if one or more of the following conditions are met:

- The equipment is non-operational,
- The equipment is experiencing excessive vibration,
- The seals are leaking or the bearings are failing,
- The equipment is operating at higher-than-normal or recommended temperatures,
- Important components of the equipment are significantly eroded, corroded, or otherwise worn,
- The equipment is operating at lower than normal output (e.g., flow) or pressure,
- Replacement parts for the equipment are difficult or impossible to obtain, or
- The equipment is technologically obsolete due to the introduction of new designs and technology.

Data from the condition assessment program, maintenance work order history contained in the CMMS, and O&M staff knowledge should be used to determine if the above conditions are applicable.

Once an asset is determined to be a candidate for renewal, the decision process should be utilized to determine the appropriate action required, based on determination of the asset’s (1) criticality, (2) redundancy, (3) reliability, (4) actual age compared to its adjusted original useful life, and (5) cost of renewal compared to the cost of replacement. The process results in three possible outcomes:

- Continue the (existing or modified) preventive maintenance program,
- Repair or rehabilitate the asset and continue the preventive maintenance program, or
- Replace the asset.

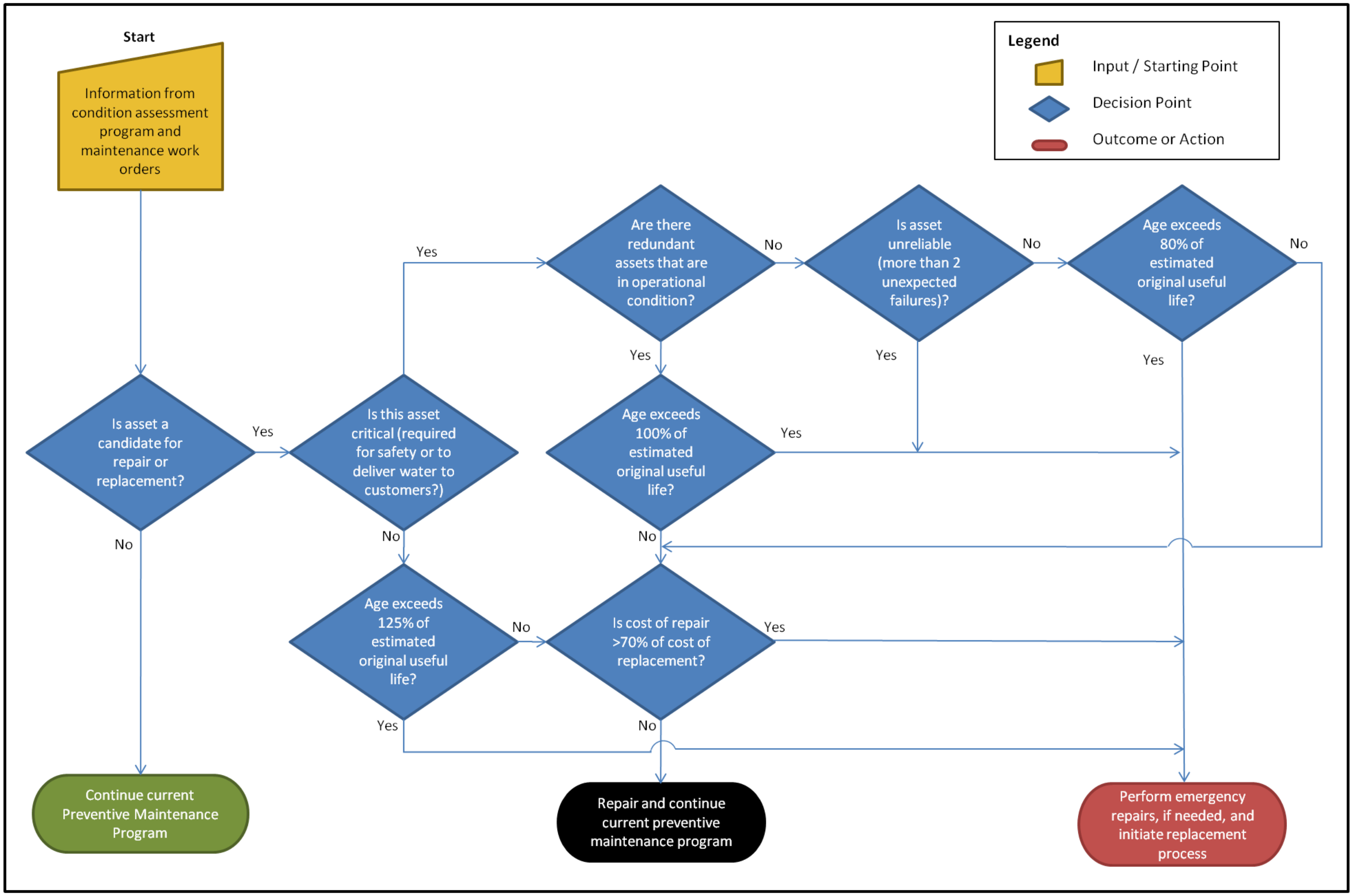

Figure 1. Equipment Renewal Decision Process

Equipment Efficiency Testing

In addition to the equipment renewal decision process described above, a second decision process, shown in Figure 2, was created for efficiency testing for mechanical equipment, which evaluates whether to replace equipment based on its operating efficiency. In virtually all cases, energy usage efficiency will be the determining factor, although, on rare occasions other factors such as chemical usage or automation benefits may be considered as well. The selection criteria for these efficiency evaluations should be a minimum horsepower in combination with a minimum annual run time, in other words, discretion should be used in determining which mechanical assets to evaluate to ensure the process itself is cost effective.

Once an asset is determined to be a candidate for efficiency testing, the process shown in Figure 2 should be used to determine the actions required. The process is based upon (1) the results of an efficiency test and (2) the results of a payback analysis. The process results in a decision to continue maintaining the asset or to consider its replacement on the basis of reduced operating cost and the payback period.

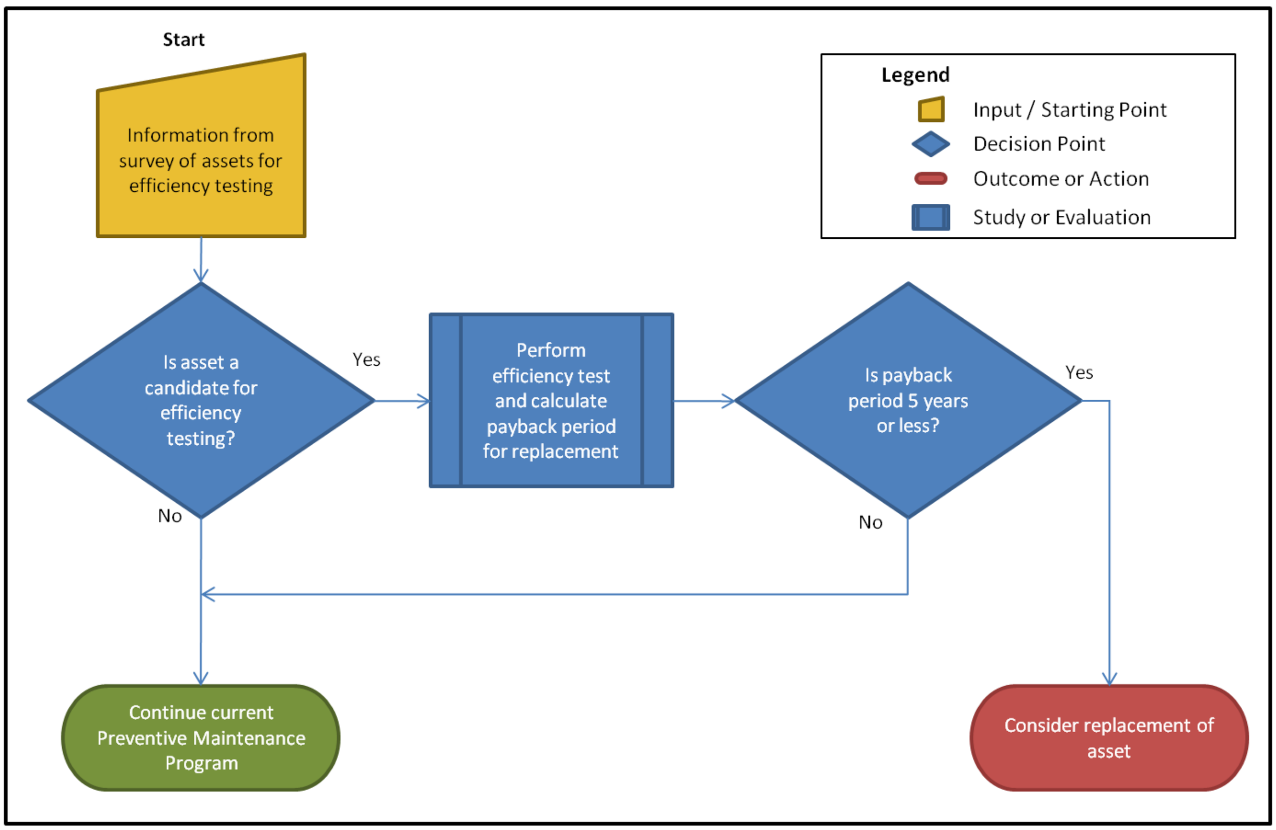

Figure 2. Mechanical Equipment Efficiency Evaluation

Transmission Mains

Currently, Zone 7 has very little data available regarding the condition of the transmission pipelines. Thus, in the near term, the focus of the AMP should be on acquiring condition data.

Therefore, the decision process created for the transmission pipelines, shown in Figure 3 is a process which should be used to prioritize pipelines for future condition assessments.

The starting point for the transmission main inspection prioritization process is the question, "Does the pipeline have a history of failure?" In general, the answer is "yes" if one or more of the following conditions are met:

- The pipeline has failed on more than one occasion. Note that "pipe failure" is usually defined as a condition that results in a significant discharge of water to the surrounding environment such that an immediate corrective action is required. Zone 7 should develop a definition of pipe failure that is specific to its water distribution system.
- There is evidence that the pipe was not installed properly (e.g., improper joints, inappropriate backfill).
- The pipeline is of a type (e.g., prestressed concrete cylinder pipe) or design that has experienced a significant number of failures.
- The actual operating conditions for the pipeline are significantly different than those assumed during design, such that safety factors may be reduced and there may be a higher than average failure risk.
- The pipeline is installed in highly corrosive soils.
- The pipeline is at significant risk (e.g., settlement) due to seismic activity.

To determine if these conditions apply to a particular pipeline, data from the asset management database, maintenance work order or failure history contained in the CMMS, corrosion survey data, future condition assessment data, and O&M staff knowledge should be considered. In addition, as described later in this Plan, the results of the pipeline risk assessment should also be considered in prioritizing the pipelines for condition assessment.

Once a pipeline is determined to have a significant failure risk, a condition assessment is recommended. If the pipeline is not judged to be a failure risk, then (1) redundancy, (2) location, and (3) actual age compared to its adjusted original useful life estimate are considered as shown in Figure 3. The process results in four possible outcomes that are one, or a combination, of the following actions:

- Preparation of a contingency plan,
- Execution of a condition assessment in the near term,
- Execution of a condition assessment in the intermediate term, and/or
- Taking corrective measures.

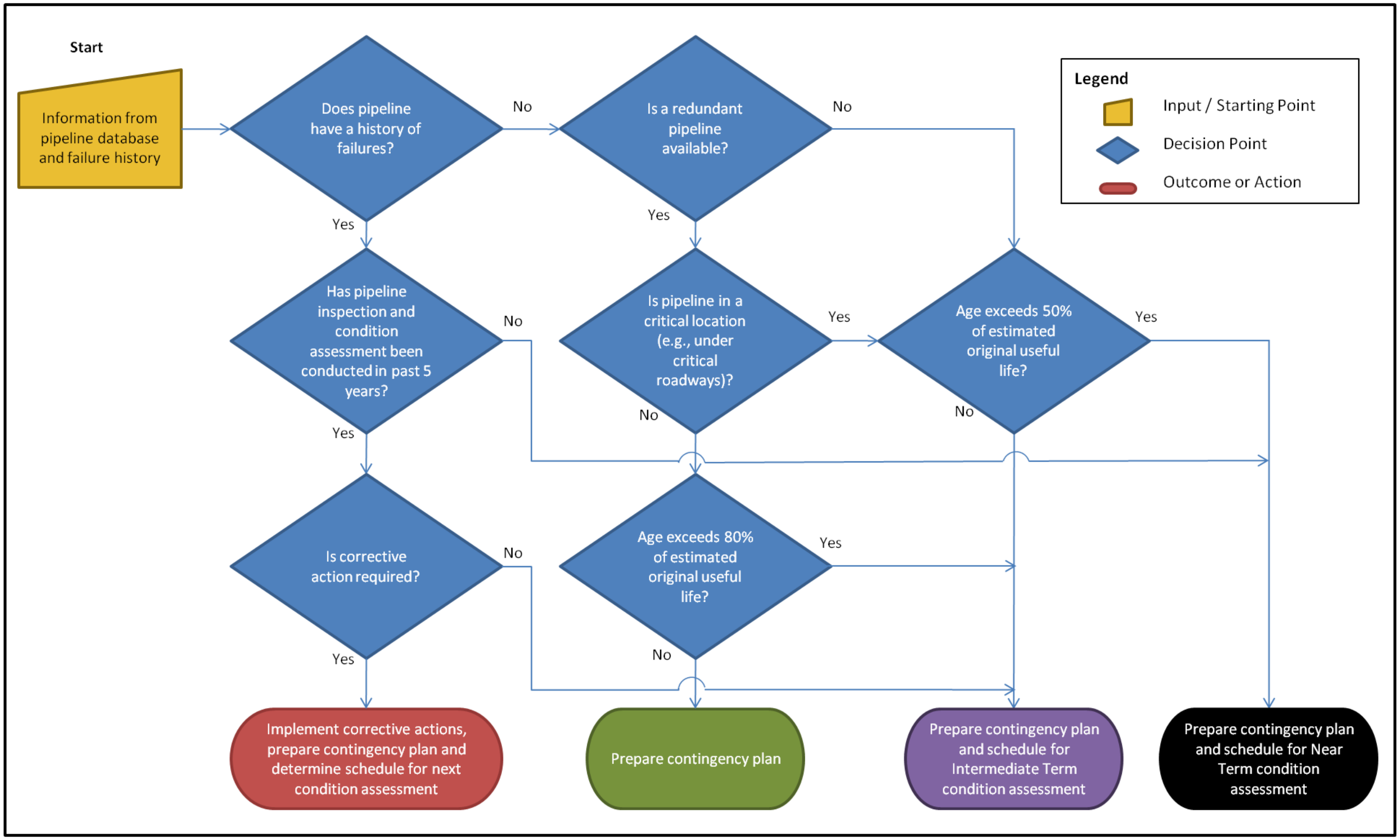

Figure 3. Inspection Prioritization Process for Transmission Pipelines

Pipeline Risk Analysis

Zone 7 operates a system of transmission pipelines ranging in size from 12 to 48 inches in diameter, with materials being primarily concrete cylinder pipe (AWWA C303) and welded steel pipe, and minor amounts of asbestos cement pipe, ductile iron, and PVC. Some pipelines are as old as 57 years, which is more than two-thirds of the OUL, as defined in Table 2. Unfortunately, as described in the previous section, there is limited data regarding the condition of Zone 7's transmission pipelines. As a result, one of the objectives of the 2011 Update was to evaluate the risk associated with these below ground assets.

The risk evaluation included the development of a risk matrix which identifies the risk associated with each of Zone 7's transmission pipelines based on their respective likelihood and consequence of failure. Risk was evaluated as follows:

The criteria, and respective weighting factors, used to evaluate the consequence of failure and likelihood of failure are summarized in Table 6. For additional information and details, refer to Appendix C, *Risk Analysis of Below Ground Assets*.

Table 6. Criteria for Pipeline Risk Assessment

Consequence of Failure		Likelihood of Failure	
Criteria	Weighting Factor	Criteria	Weighting Factor
Diameter	25	Material	15
Length of Pipe	5	Age	20
Freeway Crossing	10	Historical Repairs	25
Ease of Repairs	25	Corrosion Protection	25
Redundant Pipeline	35	Soil Corrosivity	10
-	-	Soil Liquefaction Potential	5

Using the criteria shown in Table 6, each pipeline was evaluated and assigned a score. Each criterion was weighted based on its relative significance and with input from Zone 7 staff. Risk was then calculated, as shown above, by multiplying the consequence and likelihood of failure scores. Tables showing criteria metrics and the calculations are included in Appendix C.

The results of the risk analysis are graphically illustrated in Figure 4 and the four pipelines with the highest risk scores are listed in Table 7. In general, pipelines with a risk score in the upper right side of Figure 4 were considered to be the highest priority for condition assessment. Although, the risk scores varied from approximately 314,000 to as low as 50,000, these scores should be viewed as comparative only, not absolute.

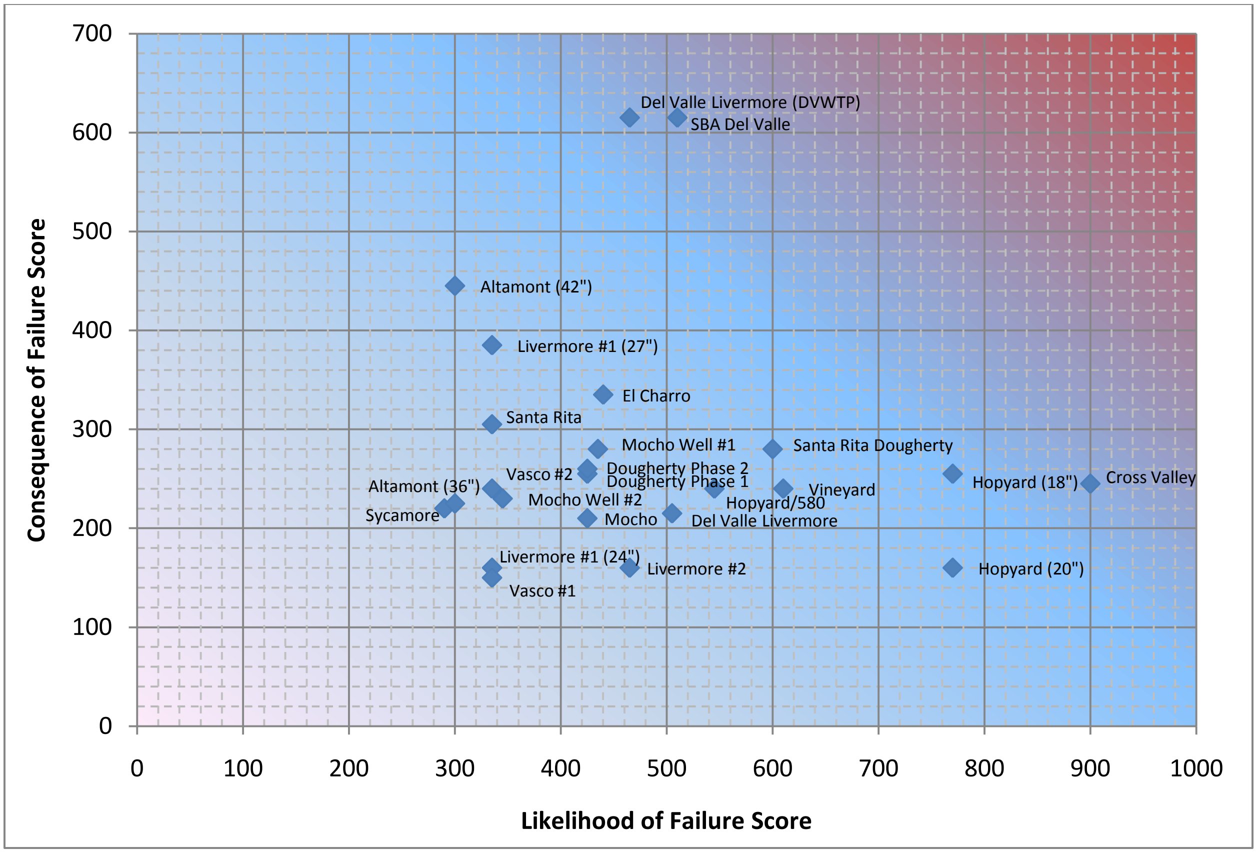

Figure 4. Pipeline Risk Analysis Results

Table 7. Relative Pipeline Prioritization for Condition Assessment

Pipeline[a]	Relative Risk Score	Comment on Ranking
SBA-Del Valle	313,650	Redundancy, diameter and soils
Del Valle-Livermore	285,975	Redundancy, diameter and material
Cross Valley	220,500	Diameter and previous failure at joints
Hopyard (18”)	196,350	Previous repairs, redundancy and age

a. Refer to Appendix C for a complete list of pipelines and their respective relative risk score.

Based on the results of the risk prioritization analysis, it was recommended that Zone 7 initiate a condition inspection and assessment program such that the highest ranked pipelines are inspected first (e.g., within the next 1 to 3 years) followed by the lower ranked pipelines (refer to Appendix C for further details). Pipelines less than 10 years old (e.g., El Charro and Altamont pipelines) do not need to be inspected unless, for example, there is a large seismic event or other event that would necessitate an inspection.

Condition Assessment Program

A key objective of the AMP Update project was to develop a formal condition assessment program (CAP) to provide Zone 7 with a process for systematic, consistent, and sustainable determination of an asset's condition in order to make informed maintenance and renewal decisions. In addition, the standardized tools developed for the CAP should allow Zone 7 staff to conduct equipment condition inspections and assessments with limited outside consulting resources.

The following subsections highlight the key components of the CAP; for additional information and detail, refer to Appendix D, *Condition Assessment Program Implementation Plan*.

Role of Condition Assessment in the AMP

A *condition assessment* determines the physical deterioration of an asset, as well as the reliability (potential to fail) of the asset and the performance of the asset in relation to the system in which it is installed. This differs from a *condition inspection,* which only determines an asset's position on a theoretical "physical mortality time line."

The output of the *condition assessment* serves two main purposes:

- It determines if an asset is performing as expected and is being maintained at, or greater than, the predetermined asset condition target, and
- It is used to estimate the RUL of the asset in order to plan for near- and long-term renewal projects and funding thereof.

As the renewal of a particular asset shifts from long term to near term, condition assessment of the asset becomes more important and inspection techniques may be escalated to more comprehensive tests to gain better confidence in the asset's RUL. As a result, the CAP was developed such that condition assessments are scalable, elevating in complexity and thoroughness based on the importance, cost, and apparent defects of a respective asset, as needed. There are 3 levels of condition assessment:

- Level 1 – Visual Observation and Interview
- Level 2 – Evaluation and Decisions
- Level 3 – Nondestructive Testing

Condition assessment forms, developed with the input of Zone 7 staff, help to guide the assessment team through these levels. The forms are included in Appendix D.

Condition Assessment Approach

Condition assessments should be performed with an awareness of the asset's respective role in the system, process, and/or facility in which it functions. The most effective approach to a condition assessment is to conduct assessments of multiple assets within a selected process or facility (e.g., DVWTP raw water pump station, DVWTP superpulsators, etc.) as one coordinated activity, such that all assets within the process are evaluated at the same time.

Grouping condition assessments will depend on the facility characteristics. The CAP identifies the following methods for grouping condition assessments:

- Individual Asset Condition Assessments. Performed on very critical assets that are near the end of RUL.
- Asset Class. There are some cases where a condition assessment would not be performed because an individual asset's replacement cost is relatively small (e.g., instruments and analyzers); therefore, if a number of assets within the same asset class are nearing the end of RUL, a condition assessment can be scheduled for all the assets.
- Equipment Specific. Equipment that is proprietary (e.g., ultrafiltration membranes, reverse osmosis modules, etc.) or that cannot be grouped into a typical asset class should be assigned a unique asset class and an equipment specific condition assessment should be conducted.
- Site or Process Specific. Similar to proprietary equipment, some treatment processes have a unique function or design that could require a special condition assessment form and assessment (e.g., DVWTP superpulsator, etc.).

Scheduling Condition Assessments

The need to understand the condition and performance of Zone 7's assets should be balanced with the amount of effort (and cost) to collect the information. There are two parallel processes used to monitor asset condition on a consistent basis:

- Equipment inspections performed by maintenance staff as part of an annual preventive maintenance work order, and
- Program driven (scheduled) AMP condition assessments.

Annual equipment *inspections* are recommended so that *condition assessments*, which require more time and resources, are not scheduled too frequently. However, the schedule for condition assessments can be accelerated if an inspection reveals that the condition or performance of the asset does not meet its ACT. The frequency of program driven condition assessments is partly driven by the length of the OUL and partly by the resources available. Since equipment condition inspections are to be performed at least annually, the risk of an asset prematurely failing before an assessment occurs is reduced. Therefore, while a program driven condition assessment is scheduled on a regular basis, the time between assessments can be adjusted as appropriate. Additional criteria for scheduling condition assessments are described in Appendix D.

Performing a Condition Assessment

The *CAP Implementation Plan*, included in Appendix D, also identifies roles and responsibilities for a condition assessment, how to prepare for the assessment, how to use the condition assessment forms, and how to escalate to a Level 2 or Level 3 assessment.

Chapter 3 - Near Term Renewal CIP

This chapter presents the recommended near term renewal CIP. The near term renewal plan is based on the results of condition assessments as well as a review of the remaining useful lives of the assets in the asset management database in conjunction with Zone 7's planned CIP projects. These results and the recommended near term renewal plan are described in the following subsections.

Condition Assessment Findings

As previously described in this Plan, a condition assessment program that Zone 7 staff could implement was developed as part of the AMP Update project. During the development of the CAP, a number of assets were also assessed. Of the assets that were evaluated, three assets were flagged for a renewal project, escalation to level 3 condition assessment (i.e., non-destructive testing), or escalation to an equipment renewal decision process. These assets are briefly described below.

PPWTP Above Ground Filter Piping

The PPWTP above ground filter piping was flagged for a level 3 condition assessment due to signs of corrosion on the external surface of the pipe. In addition to the visual inspection findings, staff had reported that several pin-hole leaks had been repaired. Based on the results of the condition assessment, the filter piping is recommended for a level 3 condition assessment. It is expected that the filter piping will be evaluated as part of the PPWTP Filter Improvement Study, which is included in the recommended CIP projects, as discussed later in this Plan.

DVWTP Ferric Tanks

As described in the *Condition Assessment Program Implementation Plan*, included as Appendix D, condition assessments address the physical deterioration of an asset, as well as the reliability (potential to fail) and the capacity of an asset in relation to the system in which it is installed.

Although the condition inspection of the ferric tanks at DVWTP did not identify any significant physical condition defects, the tanks were escalated to an equipment renewal decision process based on capacity issues. It was reported by staff that the capacity of the tanks is limited, resulting in chemical deliveries every two to three days during summer months. Typical industry standard is to provide a storage capacity of 15 days at the maximum chemical dosage and average daily production rate. Per the Equipment Renewal Decision Process, described previously, the storage tanks should be replaced because they are a critical asset, there is no redundant asset during peak demand periods, and while the asset itself is reliable, its age exceeds 80% of OUL. An annotated decision process diagram documenting this conclusion is included in Appendix E1. Therefore, the DVWTP ferric tanks were added to the existing DVWTP Chemical System Improvements CIP project, described in Zone 7's Fiscal Year 2010/11 Capital Improvement Program, and as discussed later in this Plan. While the existing DVWTP Chemical System Improvements CIP project is a system-wide improvement project (see discussion on system-wide improvement projects later in this Plan), rather than a renewal project, this project is included in this analysis as a recommended project to address near term renewal needs. To avoid double-counting in the funding analysis discussed later in this Plan, this project was removed from the system-wide improvement program's total project costs.

DVWTP Superpulsator Plates

During the condition assessment of the DVWTP superpulsators, only the plates could be visually observed from above. A more detailed assessment, including non-destructive testing of the piping and concrete, was performed by V&A Engineers, as reported in the *Superpulsator Basin Concrete Condition Assessment TM*. The V&A assessment confirmed that the superpulsator plates in basins 2 and 4 are cracked or deformed at several locations. Damaged plates can cause hydraulic restrictions, turbulence and flow discontinuities and reduce the solids removal efficiency of the superpulsator unit. These assets were installed at the same time and were operated in the same manner as superpulsators 1 and 3; therefore, it is assumed that the plates in basins 1 and 3 are in similar condition. As a result, these assets were recommended for renewal and are included in the Superpulsator Rehab Program Phase 1 and Phase 2 projects, respectively. These CIP projects are discussed later in this Plan.

Review of Asset Database

As previously described, the asset management database was updated by Zone 7 in late 2010 to reflect the new assets that were added to the system since the previous update in 2004. Prior to the update, the database included 659 assets with a total estimated replacement value of approximately $310 million; the database now includes 1,049 assets, with a total estimated replacement value of approximately $420 million.

The asset database was reviewed to identify those assets which are already past 100% OUL, or which will reach 100% of OUL before 2020. In addition to the assets described above, these assets were considered for the near term renewal plan. Figure 5 illustrates the number of assets that will reach 100% OUL in each decade through 2089.

Of the 1,049 assets recorded in the asset database, there are approximately 74 assets that reached 100% OUL before 2010 and an additional 99 that will reach 100% of OUL before 2020.

These assets were reviewed to determine if they would be addressed by a project in Zone 7's existing CIP. In addition, new CIP projects were developed with input from Zone 7 staff, based on their knowledge of asset condition and current planning efforts. The assets not addressed by an existing or newly created CIP project were identified for future condition assessment. For planning purposes, these assets were grouped into conceptual projects which will serve as placeholders in the CIP. Following the condition assessment of these assets, the conceptual projects, including their respective schedules and budgets, should be refined.

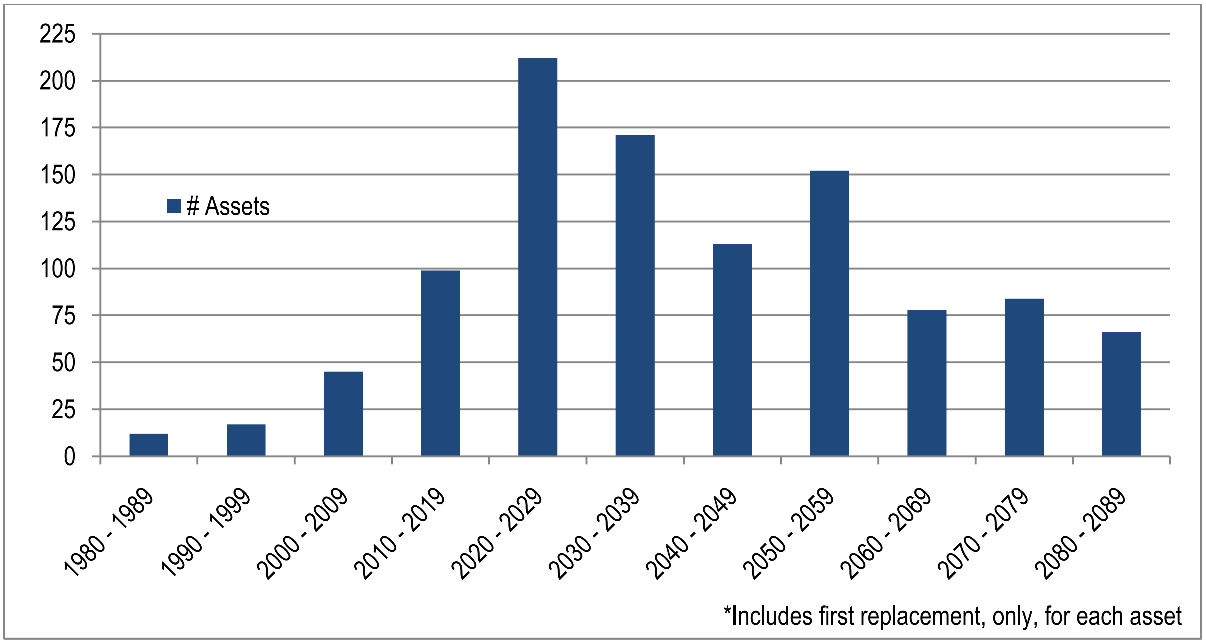

Figure 5. Number of Assets Reaching 100% of OUL per Decade

In addition, there were a number of assets that had already been replaced or rehabilitated, so the database was updated and these assets were not included in the near term analysis. There were also a number of assets removed from the analysis since they had been removed or abandoned, or because they are routinely replaced under the maintenance budget. Table 8 summarizes the number of assets falling into each of these categories.

Table 8. Summary of Near Term Assets by Category

Asset Type	Number of Assets
Addressed in Existing CIP Projects	35 assets
Included in New CIP Projects	21 assets
Recommended for Condition Assessment	85 assets
Removed from Near Term Analysis	32 assets

Recommended Near Term CIP Projects (Existing and New)

As described in the previous section, 56 assets are included in existing or newly identified CIP projects. These projects, and their estimated cost and timing are presented in Table 9. The total estimated CIP cost is approximately $25.4 million. The assets addressed by each CIP project are listed in Appendix E2.

Descriptions of the existing CIP projects can be found in Zone 7's Fiscal Year 2010/11 Capital Improvement Program. The DVWTP Chemical System Improvement project has been increased in scope and budget to include replacement of the ferric tanks, as previously described in this Plan. In addition, based on input from Zone 7 staff, the initiation of the PPWTP Improvement Project 2012 has been delayed two years (to 2014) and the PPWTP Clarifier Rehab / Motor Replacement project has been delayed one year.

Table 9. Recommended Existing and New CIP Projects to Address Near Term Renewal Needs

Project Name	Fiscal Year (Dollars are in Millions, $2011)[a]										Total
Existing CIP Projects[b]	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	
DVWTP Aqueous Ammonia System						2.65					2.65
DVWTP Chemical System Improvements[c]	0.20	0.30	3.30								3.80
DVWTP Instrumentation Upgrades					0.03	0.32					0.35
PPWTP Clarifier Rehab / Motor Replacement	1.15	0.33									1.48
PPWTP Electrical Power System Upgrade Project	0.69										0.69
PPWTP Filter Improvement Study		0.08									0.08
PPWTP Improvement Project 2012			0.25	0.94							1.19
PPWTP Instrumentation Upgrades					0.11	0.31					0.42
PPWTP UF Membrane Replacement[d]	0.39	0.38	0.38	0.36	0.79	0.00	0.39	0.39	0.39	0.39	3.84
SCADA Enhancements	0.25	0.24	0.23	1.02	0.23	0.22	0.21	1.03	0.22	0.21	3.87
Subtotal Existing CIP Projects	2.68	1.33	4.16	2.32	1.16	3.51	0.60	1.41	0.61	0.60	18.37
New CIP Projects											
CWS Turnout 4 Relocation/Replacement[e]				0.3							0.3
DVWTP Filter Media & Underdrain Replacement Phase 1[f]								2.18			2.18
DVWTP Filter Valves Replacement Phase 2[g]						0.50					0.50
DVWTP Superpulsator Rehab Program Phase 1[h]			1.40								1.40
DVWTP Superpulsator Rehab Program Phase 2[i]				1.40							1.40
DVWTP Valve Replacements for 3 MG Clearwell[j]			0.17								0.17
MGDP RO Membrane Replacement Project[k]				0.53					0.53		1.05
Subtotal New CIP Projects			1.57	2.23		0.5		2.18	0.53		7.00
Total CIP Projects ($2011)	**2.68**	**1.33**	**5.72**	**4.55**	**1.16**	**4.01**	**0.60**	**3.59**	**1.13**	**0.60**	**25.37**

a. All costs are presented in 2011 dollars, referenced to the ENR San Francisco CCI Index (10,116.29) for January 2011.
b. Projects are based on Zone 7's FY10/11 Capital Improvement Program; schedule and project cost were adjusted per Zone 7 direction.
c. Project listed in FY10/11 Capital Improvement Program as an SWI project, to avoid double-counting, this project was removed from the SWI total project costs. Project cost has been increased to include the replacement cost of the DVWTP ferric tanks.
d. Includes replacement of 24 modules per year, except in FY14/15, 48 modules are scheduled for replacement and no modules are scheduled for FY15/16.
e. Includes replacement and relocation of CWS turnout 4, including property acquisition.
f. Phase 1 includes replacement of the media and underdrains for Filters 1, 2, 3 and 4.
g. Includes replacement of 32 isolation valves (8 per filter).
h. Includes replacement of plates in basins 2 and 4.
i. Includes replacement of plates in basins 1 and 3.
j. Includes valve replacements for the clearwell.
k. Replacement of reverse osmosis membranes at Mocho Groundwater Demineralization Plant. These assets have a 5 year OUL; replacement is scheduled every 5 years.

The newly identified CIP projects were developed with input from Zone 7 staff. Each is briefly described below:

- **DVWTP Filter Media and Underdrain Replacement – Phase 1.** This project includes replacement of the filter media and underdrains for filters 1 through 4. The Fiscal Year 2010/11 CIP included a project for underdrain replacement for all eight DVWTP filters. This newly identified project replaces the existing project in the CIP. The media in filter 1 was replaced in 2001 and may not need replacement during this project. However, the underdrains in filter 1 and both the media and underdrains in filter 2 reached 100% OUL in 2000; the media and underdrains in filters 3 and 4 reached 100% OUL in 2005. These assets were also identified in the 2006 Condition Assessment for renewal. Filters 5 through 8 have newer media and underdrains, and are not recommended for renewal at this time.
- **DVWTP Filter Valve Replacement – Phase 2.** This project includes the replacement of isolation valves on filters 5, 6, 7, and 8. Eight isolation valves will be replaced on each filter, for a total of 32. These assets will reach the end of their useful life in 2014. The isolation valves on filters 1 through 4 were replaced in 2010.
- **DVWTP Superpulsator Rehabilitation Program.** This project has been included in two phases, Phase 1 and Phase 2. Phase 1 includes work in superpulsators 2 and 4 and Phase 2 includes superpulsators 1 and 3. These two projects will include replacement of the inlet feed pipe, incline plates and bracket supports, as well as concrete protection for each superpulsator, respectively. These assets will reach the end of their useful life in 2014.
- **DVWTP Valve Replacement for 3 MG Clearwell.** This project includes the replacement of valves at the 3 MG clearwell due to valve performance and obsolescence.
- **MGDP RO Membrane Replacement Project.** This project includes the replacement of the reverse osmosis (RO) membranes at the Mocho Groundwater Demineralization Plant (MGDP). These membranes are estimated to have a useful life of approximately five years. Therefore, this should be a recurring project in the CIP.
- **CWS Turnout 4 Relocation / Replacement.** This project consists of the relocation and replacement of a California Water Service turnout. This asset is approaching the end of its useful life. Furthermore, the turnout is located in a heavily trafficked intersection, which presents a safety issue when it needs to be accessed for meter calibration and maintenance.

Project costs for existing CIP projects are based on costs presented in the Fiscal Year 2010/11 CIP. Costs for new CIP projects were developed based on the estimated asset replacement cost included in the asset database and input from Zone 7 staff.

In addition to the existing CIP projects listed in Table 9, there are 12 additional renewal projects included in Zone 7's Fiscal Year 2010/11 CIP. Through FY19/20, these projects total approximately $14.5 million (in 2011 dollars). These projects include annually recurring and renewal costs for assets that are not associated with specific assets in the database, projects identified during previous assessments, one renewal project (PPWTP ammonia facility replacement) which is needed prior to reaching its OUL due to safety, as well as as-needed replacement and destruction of monitoring wells. The 12 additional renewal projects (listed in Appendix E3) were included in developing the recommended funding level, which is described Chapter 4 of this Plan. Of particular note is the recurring Minor Renewal/Replacement Project, which is allotted $250,000 per year. At this time, this annual line item in the CIP has not been adjusted; however, considering that the asset renewal methodology has been adjusted from renewal at 50 to 100 percent of an asset's OUL, it is recommended that Zone 7 monitor the actual expenditures for minor, unplanned replacements and repairs to determine if the budgeted amount is adequate. If the actual expenditures are increasing with time as additional maintenance is required to keep assets in service longer, it is recommended that the annual allocation be adjusted accordingly.

Recommended Near Term Condition Assessments and Conceptual Projects

The near term assets not included in the CIP projects described above are recommended for condition assessment. The projected replacement value of these assets based on replacement at 100% OUL is presented in Figure 6.

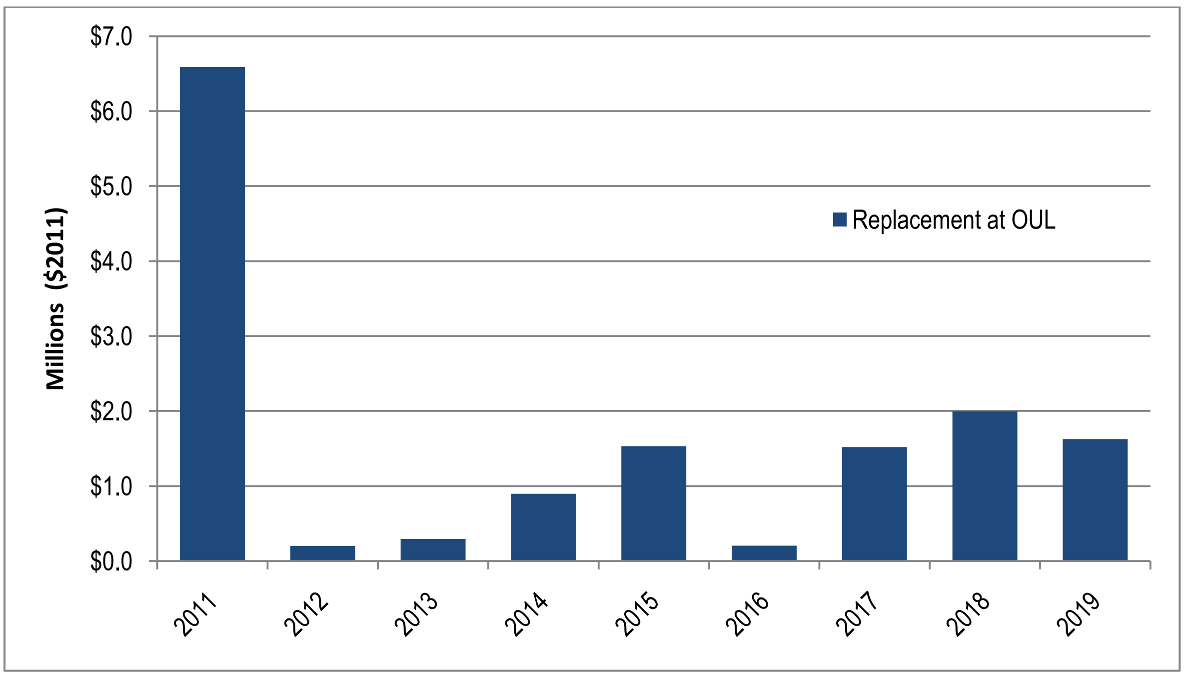

Figure 6. Projected Renewal Costs for Assets Identified for Condition Assessment

The total estimated replacement value for the assets identified for condition assessment as part of the near term renewal program, is approximately $15.7 million. As shown in Figure 6, there is approximately $6.6 million projected for 2011. This "backlog" in replacement cost is due to the assets which are already at or beyond their OUL.

As previously described, the assets recommended for condition assessment were grouped into conceptual projects, including:

- *Distribution System Rate Control Station Replacement Project.* Replace valves and ancillary equipment at the Cross Valley, Dougherty, Livermore (Station 220), and Vineyard Rate Control Stations.
- *DVWTP Electrical Components Replacement Project.* Replace main plant generator and ancillary support for the raw water influent metering station (downstream of the meter maintained by the Department of Water Resources) at DVWTP.
- *DVWTP Chemical Tanks and Pumps Replacement Project*. Replace chemical tanks and chemical feed pumps at DVWTP, including only those that will not be replaced as part of the 2011 DVWTP Chemical System Improvements Project, shown in Table 9.
- *DVWTP Filter Media and Underdrain Replacement Project - Phase 2.* Replace filter media and underdrains for filters 5 through 8 at DVWTP.
- *DVWTP HVAC Replacement Project.* Replace the heating, ventilating, and air conditioning (HVAC) system at DVWTP.
- *DVWTP Rehabilitation Project 2016.* Replace components of the backwash system, washwater recovery system, and compressed air system, and some ancillary support equipment at DVWTP.
- *PPWTP Backwash Supply Tank Rehabilitation Project.* Replace or rehabilitate the backwash supply tank at PPWTP.
- *PPWTP Chemical Tanks and Pumps Replacement Project - Phase 1.* Replace chemical tanks and chemical feed pumps in the PPWTP conventional plant.
- *PPWTP Chemical Tanks and Pumps Replacement Project - Phase 2.* Replace chemical tanks and chemical feed pumps in the PPWTP ultrafiltration (PP-UF) plant and those installed around the same time in the PPWTP conventional plant.
- *PPWTP Filter Rehabilitation Project.* Replace filter media, underdrains, piping, and valving for filters 1 through 3 at PPWTP.
- *PPWTP Instrumentation Replacement Project.* Replace water quality analyzers (e.g., turbidimeters, chlorine residual analyzer, and particle counter) at PP-UF plant.
- *PPWTP Rehabilitation Project 2018.* Replace components of the backwash system and compressed air system, and some ancillary support equipment at PPWTP.
- *Turnout Replacement Program.* Replace or rehabilitate one to two turnouts per year over four years for those turnouts that were installed prior to 1970 (Livermore-1,

Livermore-2, Livermore-3, LLNL, Pleasanton-1, VA-1, and VA-3/Wente/LARPD/ BVYR). Actual schedule will take operational requirements into consideration in order to minimize impact to deliveries.

- *Wellfield Chemical Tanks and Pumps Replacement Project.* Replace chemical tanks and chemical feed pumps at Hopyard Well 6, Mocho Wells 3 and 4, and Stoneridge Well.

- *Wellfield Switchboard Replacement Project.* Replace switchboards at Hopyard Well 6 and Mocho Well 1.

A project cost and schedule, shown in Table 10, was developed for each of the conceptual projects described above. The project costs are based on estimated replacement cost. To allow time for Zone 7 to complete the recommended condition assessments, the conceptual projects, and their associated costs, were scheduled beginning in FY14/15 and extending through FY26/27. The projects were scheduled considering both expected remaining useful life of the assets, as well as the total annual forecasted funding level in order to avoid scheduling a significantly larger funding requirement in a particular year.

The list of assets included in each of the conceptual projects is included in Appendix E4. As previously described, the scope, schedule and cost of the conceptual projects should be refined based on the results of future condition assessments.

The recommended conceptual projects for condition assessment assets, combined with the recommended CIP projects described in the previous subsection, were included in developing the recommended funding level, described in Chapter 4.

It is important to note that the costs presented above are based on asset replacement costs included in the asset database. For assets included in the database prior to 2006, these costs were developed as part of Zone 7’s original AMP efforts, and include an estimating contingency, general conditions and contractor adjustments including overhead and profit, and a contingency for engineering, legal, administrative and construction management costs. For new assets constructed since 2006, replacement costs were provided by Zone 7 staff and reflect the actual cost of construction or installation. All costs were modified using the Engineering News Record Construction Cost Index to escalate the original replacement cost to current 2011 dollars.

Table 10. Conceptual CIP Projects for Assets Recommended for Condition Assessment

Conceptual Project Name[b]	Fiscal Year[a]												
	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Distribution System Rate Control Station Replacement Project							0.71						
DVWTP Electrical Components Replacement Project									0.96				
DVWTP Chemical Tanks and Pumps Replacement Project			1.54										
DVWTP Filter Media and Underdrain Replacement Project - Phase 2											1.61		
DVWTP HVAC Replacement Project								0.51					
DVWTP Rehabilitation Project 2016			2.16										
PPWTP Backwash Supply Tank Rehabilitation Project													0.20
PPWTP Chemical Tanks and Pumps Replacement Project - Phase 1	0.35												
PPWTP Chemical Tanks and Pumps Replacement Project - Phase 2									0.45				
PPWTP Filter Rehabilitation Project[c]	3.26												
PPWTP Instrumentation Replacement Project					0.27								
PPWTP Rehabilitation Project 2018					0.28								
Turnout Replacement Program										0.21	0.41	0.41	0.27
Wellfield Chemical Tanks and Pumps Replacement Project										0.97			
Wellfield Switchboard Replacement Project				1.07									
Total Conceptual CIP Projects ($2011)	**3.61**	**-**	**3.71**	**1.07**	**0.55**	**-**	**0.71**	**0.51**	**1.42**	**1.18**	**2.02**	**0.41**	**0.47**

a. All costs are presented in 2011 dollars, referenced to the ENR San Francisco CCI Index (10,116.29) for January 2011.
b. The specific assets included in each conceptual project are listed in Appendix E4.
c. This project includes assets that will be evaluated as part of the PPWTP Filter Improvement Study, which is scheduled for FY11/12, as shown in Table 9.

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Chapter 4 - Long Term Funding Forecast

This chapter presents the long term funding requirements to support future renewal needs. The long term funding analysis includes both near term and long term renewal needs and presents a recommended annual funding level to address both renewal programs and system wide improvement (SWI) projects through 2050. Each is described in the following sections.

System Wide Improvements

Renewal projects focus on existing facilities that have deteriorated or are in need of rehabilitation or replacement to maintain the established level of service to existing Zone 7 customers. SWI projects address enhancements to existing facilities that will improve water quality, environmental compliance, reliability, efficiency, operational flexibility, and/or decrease costs. Since both renewal and SWI projects in the CIP are funded by water rates via an annual transfer from Zone 7's Fund 52 to Fund 72, SWI costs were included in the long term funding forecast.

At the completion of the SWI projects proposed in the existing CIP, funds collected in the future will be used to fund as-yet unknown projects. For example, it is reasonable to anticipate (based on recent history) that Zone 7 will continue with system-wide improvements related to future regulatory requirements or security improvements. Therefore, to support the long term renewal forecast it was necessary to develop an assumption regarding future SWI funding needs beyond those projects already planned.

Zone 7's existing CIP includes approximately $57 million (see Appendix E5) which will be spent on system-wide improvements in the next ten year period. However, this includes a large taste and odor project for PPWTP and DVWTP. Excluding the taste and odor project, the total SWI funding through 2020 is approximately $23.5 million (or approximately $2.35 million per year). With uncertainty about future project needs and associated funding requirements, a minimum annual funding level of $2.35 million per year is assumed beyond 2020.

Zone 7's existing CIP also includes costs for a third demineralization facility. Zone 7 plans to complete an update of its Groundwater Management Plan in the next few years, which will include an update of its Salt Management Plan. The update will review and update any recommended facilities required to meet both salt management and delivered water quality goals. Even though the project could change, Zone 7's goals will not; consequently, the estimated costs that will be funded by Fund 72 for the third demineralization facility were included in the long term funding analysis. The estimated cost for this project is approximately $32 million (in 2011 dollars), of which 90 percent, or $28.4 million, would be funded by Fund 72.

The total estimated cost for SWI projects included in the funding analysis is approximately $146 million between 2011 and 2050, including projects proposed in the existing CIP in combination with the taste and odor project, the third demineralization facility and the recommended annual average funding level of $2.35 million beyond 2020. These costs are illustrated in Figure 7.

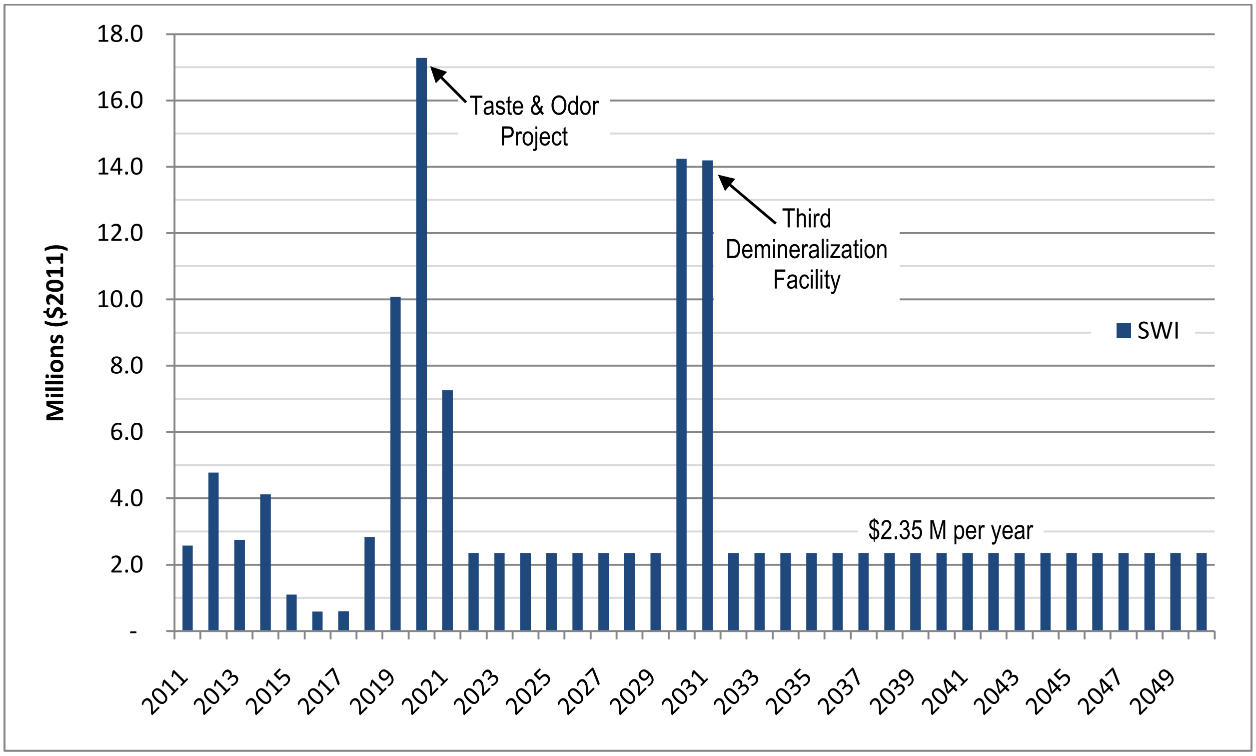


Figure 7. System-Wide Improvement Projects

In addition to the SWI projects described above, and illustrated in Figure 7, Zone 7 is currently evaluating its water supply system, and has identified several additional studies that may be recommended for completion in the near future. For example, Zone 7 has identified the need to study the benefits of a new intertie with another major water agency to improve reliability (e.g., in the event of a major earthquake in the Sacramento-San Joaquin Delta area). The initial planning-level cost estimate for this project is approximately $18 million. Although this particular project was not included in the long term funding analysis, as described later in this Plan, it has been used as an example of how the inclusion or exclusion of various projects can influence the required funding level.

Long Term Renewal Forecast

As previously described, the recommended method to forecast long term renewal budgets is to assume asset replacement at approximately 100% of estimated OUL. The long term renewal forecast includes the first and subsequent replacements of assets that will reach 100% of OUL between 2020 and 2050, as well as subsequent replacements of assets (falling within the planning horizon 2020 – 2050) which were included in the near term analysis. The projected long term renewal needs, and associated timing through 2050, are illustrated in Figure 8.

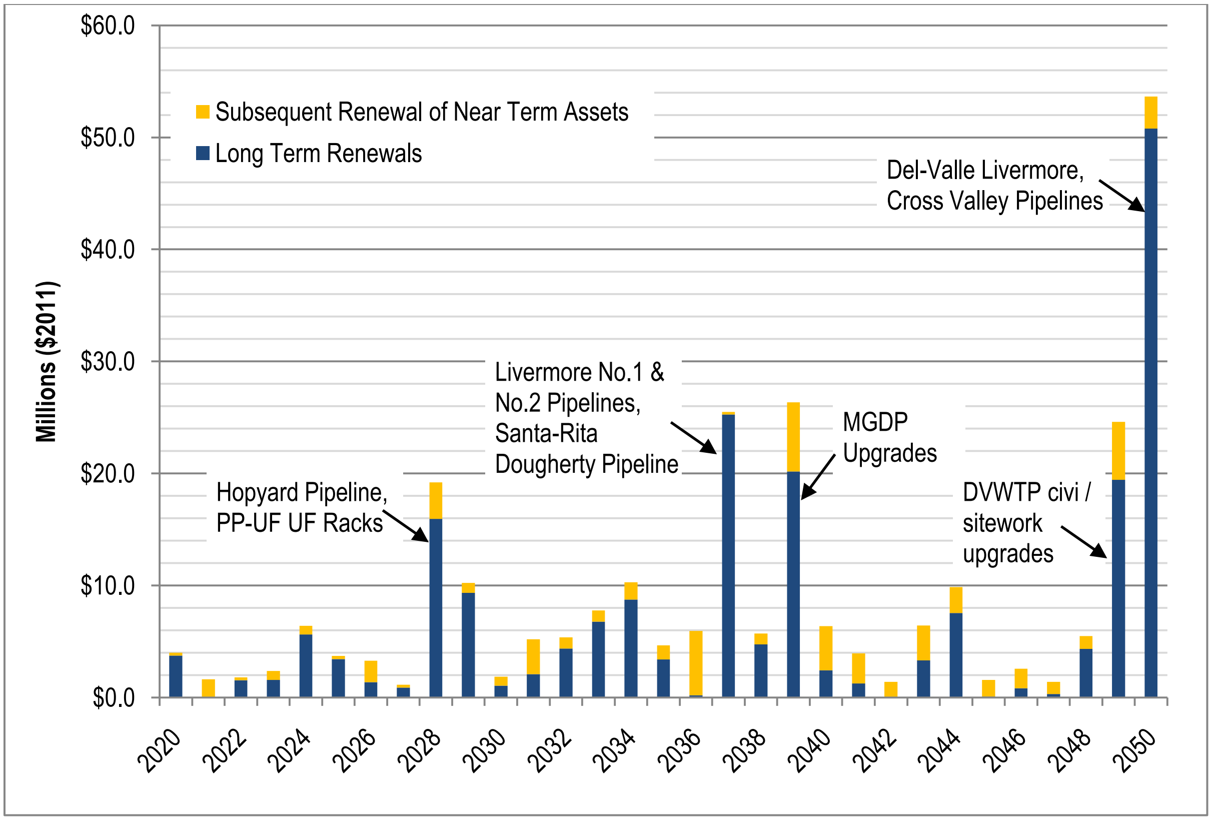


Figure 8. Long Term Renewal Forecast, 2020 through 2050

The total projected long term renewal funding requirement, from 2020 through 2050, is estimated to be approximately $270 million. The annual replacement amounts range from $250,000 in some years to approximately $50 million in 2050. The largest annual funding requirements occur in 2028, 2037, 2039, 2049 and 2050, due in large part to the projects highlighted in Figure 8.

As shown, there is a large forecasted renewal requirement in 2028. In that year, portions of the Hopyard pipeline, which is Zone 7's oldest pipeline, will reach 100% of OUL (75 years). In addition, the ultrafiltration racks at PP-UF will reach 100% of OUL (25 years). The years 2037 and 2039 have approximately $25 million and $20 million, respectively, in projected long term renewal needs. In 2037, a number of pipelines will reach 100 % of OUL (75 years), including the Livermore No. 1 and No.2 pipelines and the Santa Rita – Dougherty pipeline. In 2039, the largest contributing factors to the projected funding need are instrumentation and various pump assets at MGDP, as it reaches 30 years of service. In 2050, there is another large spike in projected funding needs, which is a result of the Cross Valley and the Del-Valle Livermore pipelines reaching 100% OUL.

The years, 2036, 2039 and 2049 also have relatively high projected costs (greater than $5 million) for subsequent replacements of near term assets (shown as gold bars in Figure 8). In 2036, the cost is largely due to the subsequent replacement of the ultrafiltration membranes at

PP-UF, as well as renewal of piping and valves for filters 1, 2 and 3 at the PPWTP conventional plant. In 2039, the cost is largely due to the subsequent replacement of the plates in DVWTP superpulsators 1 through 4, and the piping and valves at DVWTP filters 5 through 8. Finally, in 2049, the ancillary systems associated with the PPWTP electrical system will reach 100% OUL, which is estimated to be 30 years. To provide additional insight into the data presented in Figure 8, the six highest value asset classes are listed in Table 11 and the five most costly replacements are presented in Table 12. The OUL estimates used to forecast the long term renewal requirements were included in Table 2.

Table 11. Highest Value Asset Classes

Asset Class	Estimated Replacement Cost, 2020 – 2050 ($2011 Millions)	Percent of Total Long Term Funding Renewal Cost[a]
Piping - Buried	$71.9	34%
Piping - Above Ground	$19.7	9%
Instrumentation	$18.1	9%
Pumps	$15.8	8%
Structural / Architectural	$15.1	7%
Civil / Sitework	$12.7	6%

a. Based on assets in long term analysis, total replacement cost is $211 million, between 2020 and 2050, which does not include subsequent replacement of assets in near term analysis (accounts for an additional $59 million in the time period).

Table 12. Highest Cost Renewal Items

Asset	Estimated Replacement Cost ($2011 Millions)	Projected Replacement Year[a]
MGDP Electrical System and Controls	$7.8	2039
Cross Valley Pipeline, Livermore 145 Segment	$7.0	2050
DVWTP Instrumentation and Ancillary Equipment	$5.8	2026 & 2041[b]
Livermore No. 1 Pipeline, Livermore 131 Segment	$4.7	2037
Del Valle – Livermore Pipeline, Livermore 106 Segment	$3.8	2050

a. Replacement year is based on replacement at 100% OUL.
b. OUL is 15 years; thus this asset is forecasted for replacement multiple times.

Funding Analysis

The recommended funding level described in this section is based on the forecasted capital expenditures for total renewal costs, including near and long term renewal costs, as well as SWI costs. The basis and assumptions for near term, long term and SWI costs were previously described in this Plan.

The total renewal and SWI funding needs are illustrated in Figure 9 and included in detail in Appendix E6.

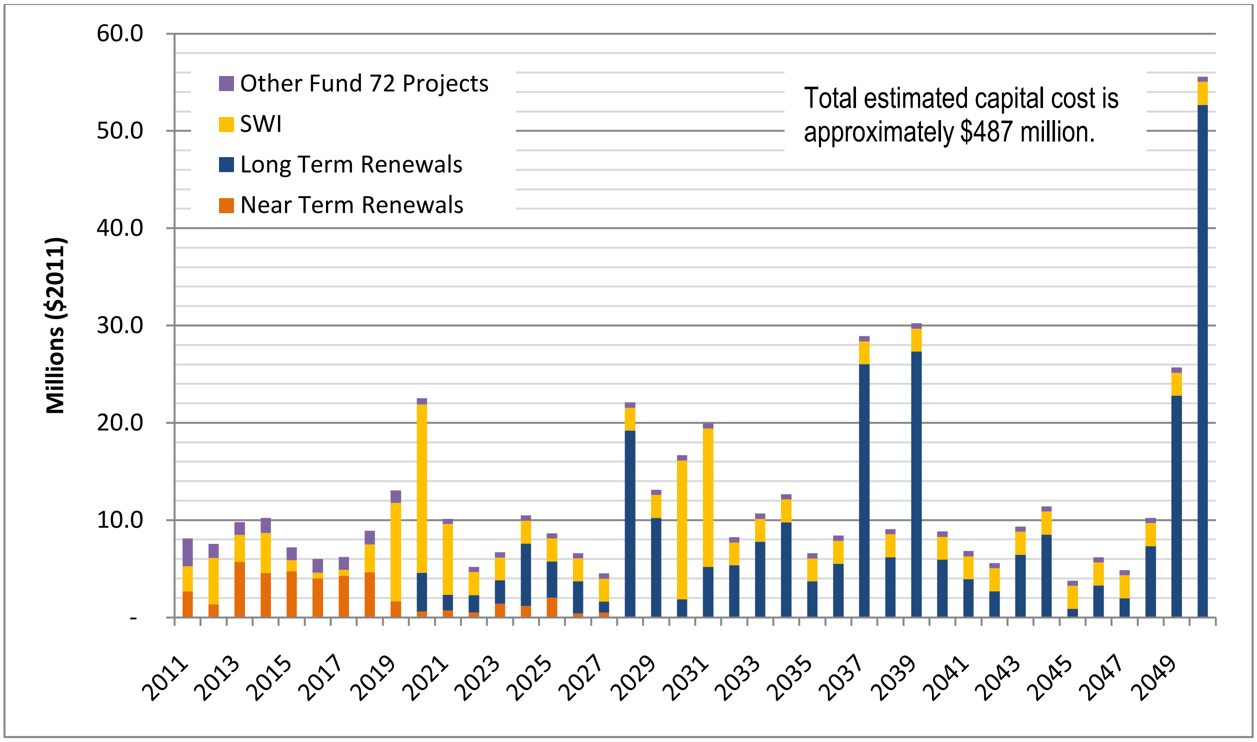


Figure 9. Total Forecasted Renewal and SWI Funding Requirements, 2011 - 2050

As shown in Figure 9, the total estimated capital cost for renewal and SWI projects between 2011 and 2050 is approximately $487 million. The total cost for each component of the funding forecast is presented in Table 13.

Table 13. Total Forecasted Renewal and SWI Funding Requirements, 2011 - 2050

Funding Forecast Component	Total Capital Cost, 2011 – 2050[a] ($2011 Millions)
Near Term Renewal Projects	
Existing CIP Projects[b]	$18.4
New CIP Projects[b]	7.0
Conceptual Projects For Assets Awaiting Condition Assessment[c]	15.7
Long Term Renewal Projects	
Subsequent Replacement of Near Term Assets[d]	58.3
Long Term Renewals[d]	210.7
System Wide Improvement Projects[e]	145.8
Other Fund 72 Projects[f]	30.9
Total Forecasted Capital Cost	**$486.7**

a. Refer to Appendix E6 for a complete listing of annual costs for each component of the funding forecast.
b. Refer to Table 9 and Appendix E2.
c. Refer to Table 10 and Appendix E4.
d. Based on replacement of assets at 100% of OUL.
e. Includes specific projects through 2020, a third demineralization plant in 2030/2031, and $2.35 million per year in years without specific projects identified.
f. Refer to Appendix E3.

To determine the appropriate recommended annual funding level, Zone 7's existing Fund 72 balance, $17.7 million, was considered. It was assumed that approximately 75% of the recommended annual funding level should be remaining at the end of the planning period, per Zone 7's current practice. In addition, the currently planned transfers from Fund 52 to Fund 72 for FY10/11 through FY13/14 were not adjusted. As a result of these adjustments and assumptions, the recommended annual funding level, beginning in FY14/15, is approximately $12.5 million per year, as shown in Table 14.

Table 14. Recommended Annual Funding Level

	($2011 Millions)
Total Forecasted Capital Funding Need	**$486.7**
Less: Current Fund 72 Balance[a]	17.7
Plus: Required Remaining Fund 72 Balance at end of Planning Period[b]	9.4
Less: Planned Transfers from Fund 52 to Fund 72 for FY10/11 through FY13/14[c]	26.6
Net Forecasted Capital Funding Need, FY14/15 through FY49/50	**451.9**
Period (FY14/15 through FY49/50)[c]	36 Years
Recommended Annual Funding Level[d]	**$12.5/year**

a. Fund balance provided by Zone 7. Deducted from total forecasted funding need.
b. Per Zone 7's current policy, it is assumed that approximately 75% of the funding level should be held in reserve. Added to forecasted funding need.
c. It is assumed that currently planned transfers from FY10/11 through FY13/14 (4 years) will not be adjusted; therefore, the remaining net forecasted capital funding need is allocated over the remaining 36 years in the 40 year planning period.
d. Recommended annual funding level is rounded up to avoid underfunding forecasted needs. Annual funding level should be escalated periodically to account for inflation.

Based on the recommended annual funding level and forecasted renewal and SWI funding needs, Figure 10 shows the end of year Fund 72 balance through 2050. The figure indicates that the recommended annual funding level and current available Fund 72 balance provides sufficient revenue to fund the forecasted capital requirements through 2050 while maintaining a positive balance in Fund 72.

It is important to note that the costs presented in this Plan, including the recommended funding level of $12.5 million per year, have been presented in 2011 dollars. The annual funding level should be escalated annually to reflect inflation.

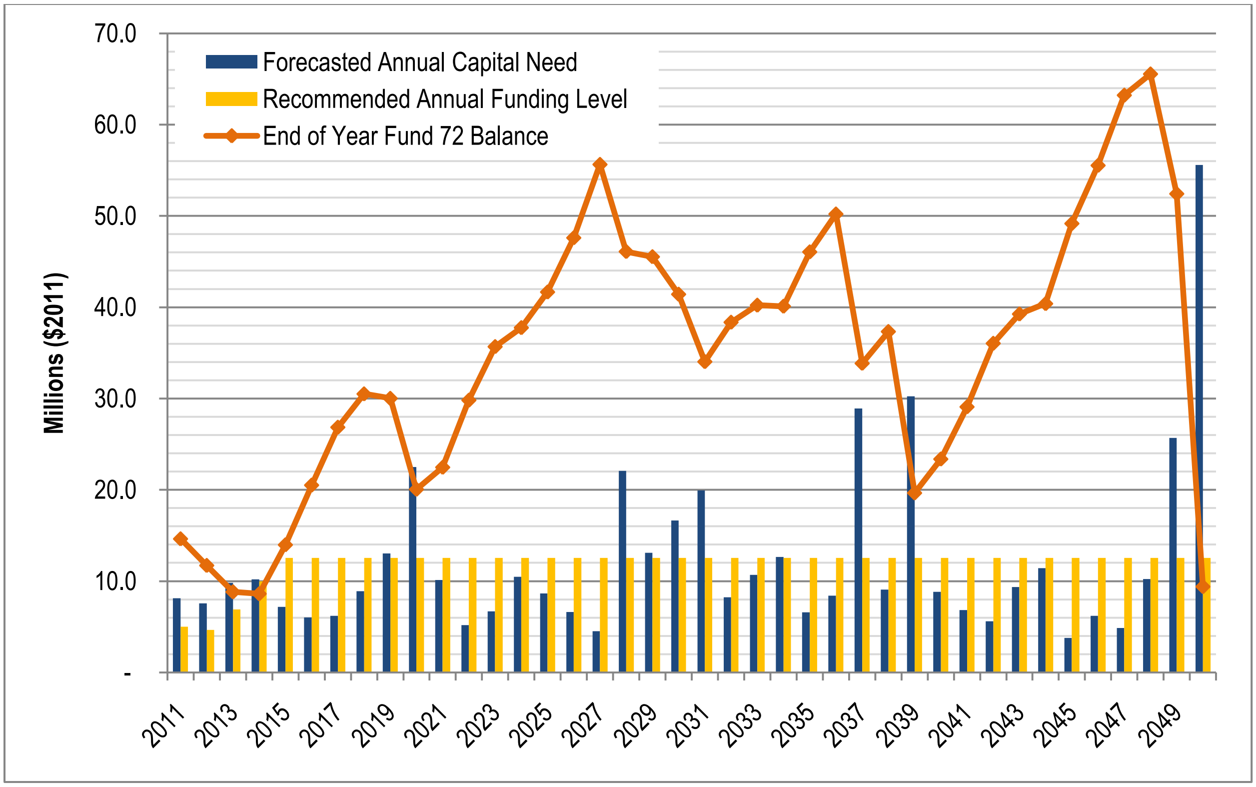


Figure 10. Forecasted Funding Needs and Recommended Annual Funding Level

The sensitivity of the annual funding level to addition or deletion of selected projects was also evaluated. As previously described, the recommended annual funding level includes the taste and odor project, with an estimated cost of approximately $35.5 million, and the third demineralization facility, with an estimated cost of approximately $28.4 million in 2030 and 2031. Table 15 indicates the annual funding level if these projects were eliminated or funded through some other means.

Table 15. Annual Funding Level Sensitivity Analysis

Sensitivity Scenario	Annual Funding Level[a] ($2011 Millions)
Recommended Annual Funding Level	**$12.5**
Funding Level without Third Demineralization Plant	$11.8
Funding Level without Third Demineralization Plant and Taste & Odor Project	$10.7
Funding Level with Reliability Intertie Project	$13.0

a. Based on planned transfers from Fund 52 to Fund 72 for FY10/11 through FY13/14 (see Table 14); annual funding level is for the period FY14/15 tough FY49/50.

In addition, as part of the water system evaluation, Zone 7 has identified the potential need for an intertie with another major water supply agency in order to increase reliability. Based on input from Zone 7 staff, the reliability intertie has an initial planning-level cost estimate of approximately $18 million. Table 15 also indicates the increase to the annual funding level if this project were included.

Recommended Annual Funding Level

Based on an analysis of Zone 7's asset management database, select condition assessments, review of Zone 7's Fiscal Year 2010/11 CIP, and input from Zone 7 staff, the total forecasted funding need through 2050 for renewal and SWI projects is approximately $486.7 million. The corresponding annual funding level is $12.5 million (in 2011 dollars), which should be adjusted in the future to reflect inflation.

As described in Appendix F, in response to comments from Zone 7's Retailers and the Finance Committee, Zone 7 staff developed and evaluated other funding alternatives. As a result, the recommended annual funding level accepted by Zone 7's Board of Directors is $11.4 million and includes a six year ramp-up period in order to reduce rate impacts. This final recommended funding level does not include the Third Demineralization Facility or water conservation programs.

It is recommended that Zone 7 view funding of its renewal and SWI needs as a process that is essentially continuous. Studies such as this lead to identification of both immediate renewal needs and needed condition assessments. The results of those efforts should be used to reexamine and adjust projected costs and actual renewal needs. Remaining useful lives should also be adjusted to more accurately reflect the condition of Zone 7's assets. These adjustments will enable Zone 7 to better define, schedule, and prioritize both its renewal and SWI projects.

In addition, ongoing maintenance programs will provide further input regarding the needed renewals and condition assessments. Zone 7 should monitor its annual expenditures for minor, unplanned replacements and increase the Minor Renewal/Replacement Project CIP line item to appropriately fund the additional maintenance associated with keeping its assets in service longer. Furthermore, as future regulations and system improvement needs are better understood, Zone 7 should update its SWI projects. After several such cycles, Zone 7 will have a more accurate, data-based forecast upon which it can base its future financial plans.

Chapter 5 - Summary and Recommendations

As described in Chapter 1, the primary goal of the 2011 Update was to develop an affordable, realistic asset management program that is consistent with good utility practice, while building Retailer support for the program and its recommendations. The following summarizes the key elements of the 2011 Update.

- **Fixed Asset Inventory.** The fixed asset inventory has been migrated to a new software platform, AMTools, which provides greater flexibility for data management. The fixed asset inventory has also been updated to include new assets that were constructed or added to the system since the previous update in 2006 as well as the results of the condition assessments completed in 2010. Finally, asset classes were created to facilitate more efficient data management and decision making.

- **Asset Renewal Methodology.** A new asset renewal methodology was developed which includes both near and long term components. Near term asset renewal projects are primarily based on condition, while the long term renewal forecast is based on asset replacement at 100% of OUL. This new methodology was subsequently used in developing the recommended annual funding level.

- **Decision Processes.** To support near term asset renewal decisions, formal decision processes were developed. These processes will ensure objective and consistent implementation of renewal practices, as well as clear documentation for renewal projects.

- **Pipeline Risk Assessment.** Zone 7's transmission pipelines were evaluated to determine the relative risk associated with each and prioritize them for future condition assessments. The risk analysis was based on an evaluation of both the consequence of failure and the likelihood of failure.

- **Condition Assessment Program.** A condition assessment program was developed to provide Zone 7 with a process for systematic, consistent, and sustainable determination of an asset's condition in order to make informed maintenance and renewal decisions. In addition, standardized tools were developed which will allow Zone 7 staff to conduct equipment condition assessments with limited outside consulting resources.

- **Near Term Renewal CIP.** A number of CIP projects were identified totaling approximately $41.1 million, based on the results of condition assessments as well as a review of the remaining useful lives of the assets in the asset management database. Ten projects are included in Zone 7's existing CIP, while another seven projects were identified and developed with staff input. Finally, 15 conceptual projects were identified to address assets which will reach the end of their estimate OUL by 2020. These assets will require condition assessments to better define the scope and cost of actual renewal needs.

- **Long Term Funding Forecast.** The long term funding analysis included both near term and long term renewal needs, projected through FY 49/50, which is consistent with the new asset renewal methodology described above. The recommended annual funding level is approximately $12.5 million per year, which includes both renewal needs and system wide improvement projects through 2050.

  As previously described, in response to comments from Zone 7's Retailers and the Finance Committee, the annual funding level accepted by Zone 7's Board of Directors is $11.4 million and includes a six year ramp-up period in order to reduce rate impacts (refer to Appendix F). This final recommended funding level does not include the Third Demineralization Facility or water conservation programs.

Next Steps

As summarized above, the 2011 Update had a number of objectives that were achieved. Nonetheless, the following next steps are recommended to continue to implement and improve Zone 7's AMP.

- **Implementation Work Plan.**

  Develop an AMP implementation work plan describing the tasks that should be completed, the department or appropriate staff responsible for each task, and the schedule for each task. It is expected that the work plan would contain:

  - Tasks to address the remaining recommendations contained in the Fixed Asset Inventory Technical Memorandum (see Attachment A).
  - Tasks to incorporate equipment inspection criteria in annual preventive maintenance work orders within the CMMS.
  - Tasks to develop a system to continuously update the asset registry, including addition of new assets, removal of assets that no longer exist, and update of asset condition, RUL, and other attributes as necessary based on the results of condition assessments.
  - Condition assessment tasks necessary to define the scope and budget for the conceptual projects included in the near term renewal CIP.
  - A schedule for implementation of the various tasks.
  - Budgets and staffing requirements for implementation of the various tasks.
- **Pipeline Condition Assessment.**

  As previously described, this AMP Update included a risk analysis of Zone 7's buried pipelines. Among other things, these assets are important because they enable Zone 7 to deliver treated water to its customers (the Retailers). Based on the likelihood and consequences of failure, the risk analysis identified a number of pipelines that should be assessed within the next three years. However, over the longer term, virtually all of Zone 7's large diameter buried pipelines should be assessed and the assessments should become a regular, ongoing asset management process for Zone 7, similar to the preventive maintenance program for mechanical equipment.

Because of the ongoing need for inspection of buried pipelines, it is recommended that Zone 7 develop a standard procedure for conducting these assessments. The standard procedure should address:

- The background, objectives, approach, and limitations of the procedure
- The contents of a pipeline condition assessment work plan (e.g., pipeline design and data review, corrosion risks, field reconnaissance, inspection plan and schedule, safety plan, required permits and approvals, and contracting plan)
- The selection of inspection methods (surface, external, and internal)
- The contents and preparation of a condition assessment report (implementation/ modification of work plan, preliminary risk assessment, assessment methods and results, findings, and recommended action plan)

Once the standard procedure is developed and approved, it should be applied during a pilot assessment project. This project would likely involve the assessment of one higher risk pipeline to achieve two objectives. The first objective would be to identify any corrective actions necessary to significantly reduce the risk of failure of the pipeline, and second objective would be to train Zone 7 staff in the use of the buried pipeline assessment procedure such that they would be able to carry out future assessments independently. It is also likely that the pilot project would produce some "lessons learned" that would be used to update and improve the standard procedure documents.

- **Biennial Renewal CIP Update.**

Consistent with Zone 7's current practice of updating the CIP every two years, it is recommended that the list of renewal projects be reviewed and updated on a biennial basis. Condition assessments should be used to identify specific near term projects and refine the scope, cost estimate and schedule for renewal of assets reaching the end of their useful lives. This is particularly applicable for the list of conceptual projects that were presented in Chapter 3; once condition assessments of those assets has been completed, the scope, schedule and budget for those projects should be refined and incorporated in the CIP.

- **Updates to AMP.**

The AMP should be reviewed and updated, as appropriate, approximately every five years to reflect changing strategic priorities, new data on useful lives, condition and costs, as well as the progress Zone 7 has made in further improving the AMP. Future updates may include the analysis of historical failure data and development of statistical models to improve the forecasting of long term renewal needs. AMP updates should also reflect any efforts undertaken to improve integration of the new CMMS software with the AMP and the asset management database. Additionally, AMP updates should reflect Zone 7's experience in collecting asset data and using the new asset classes recommended herein; further refinement of asset classes and associated data collection techniques may be appropriate. Finally, it may be appropriate to modify the decision processes or develop new processes to further define Zone 7's asset management framework and policies.

Appendix A

Fixed Asset Inventory Technical Memorandum

FIXED ASSET INVENTORY

Asset Management Program Update *August 4, 2010*

Introduction

This technical memorandum (TM) presents the evaluation of Zone 7's existing asset inventory and provides recommendations that will support Zone 7 in more effectively managing its assets.

Background

Zone 7's primary fixed asset inventory is the *Water/Wastewater Asset Manager* (WAM) database. This database contains the asset hierarchy and the attributes, condition, useful life, risk, and financial information for each asset contained in the database. The WAM database is supplemented by a Datastream MP2 computerized maintenance management system (CMMS) which is used to create, track, and schedule maintenance work. Zone 7 is currently in the process of implementing Tabware, an internet-based CMMS, to replace MP2. Zone 7 also maintains a geographic information system (GIS) database. The GIS is primarily focused on distribution pipe and appurtenances but also contains the location of significant facilities. Zone 7 also uses a Wonderware SCADA system which is based upon "tag names."

Fixed Asset Inventory Evaluation

The fixed asset inventory evaluation included a review of the existing asset hierarchy used in WAM, the level of detail provided for various types of assets, and the completeness of the data in WAM. Each of these is described in the following subsections.

Asset Hierarchy

The existing asset hierarchy in WAM is a location-based hierarchy. That is, the hierarchy is driven by the physical location of the asset as opposed to the function the asset performs. The asset hierarchy contains the five levels shown below:

1. Facility / Systems Name
    a. Process / Basin / Zone
        i. Component / Sub-basin / Subzone
            1. Discipline
                a. Asset

An example of the asset hierarchy provided in WAM is illustrated in Figure 1. In this example, the Del Valle Water Treatment Plant is the Facility (hierarch level 1), Clarification is the

Process (level 2), Superpulsator #1 is the Component (level 3), Mechanical / Electrical / Instrumentation / Piping is the Discipline (level 4), and the asset list (level 5) should follow. It should be noted however, that the asset lists are not currently populated within the WAM database for most above ground infrastructure (the red text in Figure 1 indicates that the assets are not listed for that discipline).

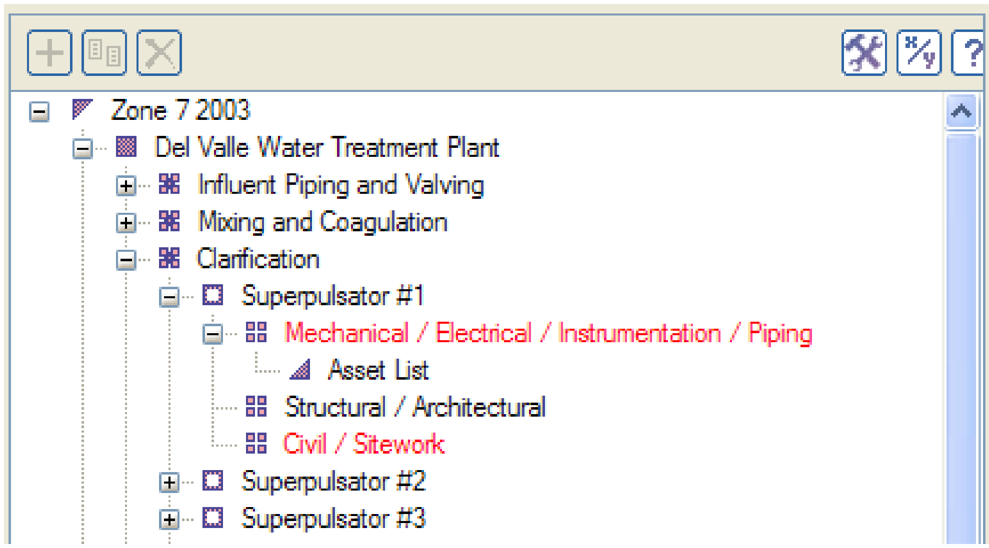


Figure 1. Asset Hierarchy Example

In the balance of this TM, the term "assets" is used to define the lowest level of detail (level 5) in the WAM database.

Data Collection Standards

Data collection standards vary by the data point being collected. For example, pipe condition assessment data is collected at the "Asset" level, treatment plant asset condition assessment data is collected at the "Discipline" level, and instrumentation condition assessment data at Hopyard Well #6 is collected at both the "Discipline" and "Asset" level. The variation in data collection approach can make analysis challenging, lead to end user confusion, and potentially result in inaccurate data. Generally, this variation is dependent on the type of asset the data is being collected for. Although not explicitly identified, there appear to be three primary groups of facilities where data collection standards are relatively consistent:

- Distribution Pipe and Appurtenances;
- Water Treatment Plants, Pump Stations, Reservoirs and Wells;
- Some Electrical and Instrumentation.

Table 1 identifies key pieces of data collected about each asset and at what level in the asset hierarchy they are documented.

Another key finding is that not all related data are captured at the same level of detail in the asset hierarchy. For example, condition and cost data for the switchboard at Hopyard #6 is tracked at the "Asset" level, while risk is documented at the "Component" level (i.e., electrical/instrumentation). Therefore, in order to make decisions that account for condition, cost, and risk, the decision could not be made for the switchboard alone. Instead, the decision would need to use rolled-up condition and cost values that would include all "Assets" (i.e., Pump Breaker, Programmable Logic Controller, Transformer, Telemetry Cabinet, and three Chlorine Analyzers) that make up the "Component" for which risk is documented.

Table 1. Data Collection within the Asset Hierarchy

Facility Type	Attribute	Component (WAM Level 3)	Discipline (WAM Level 4)	Asset (WAM Level 5)
Distribution Pipe and Appurtenances	Install Date			X
	Useful Life			X
	Condition Assessment			X
	Date of Inspection		X	
	Risk			X
	Cost Data			X
	Other Attributes			X
Treatment Plants, Pump Stations, Reservoirs, and Wells	Install Date		X	
	Useful Life		X	
	Condition Assessment		X	
	Date of Inspection		X	
	Risk	X		
	Cost Data		X	
	Other Attributes		None	
Some Electrical and Instrumentation	Install Date		X	
	Useful Life		X	
	Condition Assessment		X	X
	Date of Inspection		X	
	Risk	X		
	Cost Data			X
	Other Attributes		None	

Another example of the challenges that may be faced when collecting related data at various levels of detail is pipe condition assessment. The date of the pipe condition assessment is documented at the "Discipline" level while the results of the condition assessment are documented at the "Asset" level. If Zone 7 performed a condition assessment on some but not all of the pipes that make up a particular "Discipline", it would not be possible to accurately document the date of the condition assessment for each pipe.

Assets at the component and process level can also be grouped into three disciplines including:

- Mechanical / Electrical / Instrumentation / Piping,
- Structural / Architectural, and
- Civil / Sitework.

Individual assets are listed in the Distribution Pipe and Appurtenances Facility types but are not listed for the remaining facilities.

Level of Detail

The following subsections summarize our findings regarding the level of detail contained in the WAM database. Where appropriate, recommendations or suggestions for improvements are included.

Pipes and Appurtenances

Four pipe and appurtenance asset types are included in WAM, including Pipes, Valves, Turnouts, and Electrolysis Test Stations. The number of assets associated with each asset type is provided below.

- Pipes – 130
- Valves – 8
- Turnouts - 64
- Electrolysis test stations – 18

Each of the asset types is further described below.

Pipes

When the export feature in WAM is run for pipes, each pipe appears to be duplicated. The only difference appears to be that the copy does not have a pipe acquisition cost and duplicate pipes have a "0" placed in the "COPYpipe_vulnerability" field. For the purposes of this analysis, the duplicate pipes have been removed. WAM indicates that the system includes 40.8 miles of pipe while GIS identifies 35.8 miles of pipe. This discrepancy should be resolved and the appropriate database(s) should be updated.

The level of detail for pipes appears to be driven by the pipe material, install date, diameter, and vulnerability. If one of these attributes changes along the length of a pipe, it triggers the creation of a new asset to document this change. This level of detail is useful for long term planning. In addition to these criteria, it is a best practice to identify pressurized water pipe assets based on significant valved intersections (e.g., tees and crosses). This supports more effective failure tracking, condition assessment, consequence of failure assessment, and eventually rehabilitation and replacement decision-making.

Valves

WAM identifies eight distribution valves in the system, whereas GIS identifies 122 valves. In general, distribution valves should be identified as assets if maintenance is performed on them or if their operation results in the ability to serve additional customers during a pipeline outage. Therefore, Zone 7 should confirm that the eight valves in the distribution system are appropriately included in WAM and whether others should be added.

Turnouts

WAM identifies 64 turnouts, whereas GIS identifies 40. This discrepancy should be resolved and the appropriate database(s) should be updated.

Electrolysis Test Stations

WAM identifies 18 test stations and GIS identifies 80. This discrepancy should be resolved and the appropriate database(s) should be updated.

Treatment Plants, Pump Stations, Wells, and Reservoirs

Treatment plant asset information is populated down to the component level. Individual equipment is not listed, but rather grouped into disciplines. Economic and condition assessment data is stored in the Main tab under discipline, but assessment of criticality, redundancy, and vulnerability are entered in the component level. Grouped component information contains economic data for the discipline, but not the asset. Individual equipment asset identification is not populated. Because the assets are grouped into disciplines and quantities are not defined it is impossible to determine redundancy. However, the data structure will support individual asset/component attributes and should be populated in the near future.

Treatment Plants

Table 2 identifies the number of treatment plant records by discipline.

Table 2. Treatment Plant Records by Discipline

Discipline	Count of Records
Civil / Sitework	62
Site Work	37
Yard Piping	25
Mechanical / Electrical / Instrumentation / Piping	213
Backwash Supply	7
Buildings	2
Chemical System	28
Clarification	22
Electrical	21
Filtration	54
Influent Piping and Valving	15
Instrumentation	19
Mixing and Coagulation	6
Prefiltration	5
Support System	14
Waste Stream	12
Water Storage	8
Structural / Architectural	105
Backwash Supply	4
Buildings	17
Chemical System	24
Clarification	11
Electrical	1
Filtration	15
Influent Piping and Valving	9
Mixing and Coagulation	2
Support System	5
Waste Stream	9
Water Storage	8
Grand Total	380

Pump Stations

Table 3 identifies the number of pump station records by discipline.

Table 3. Pump Station Records by Discipline

Discipline	Count of Records
Civil / Sitework	4
Ancillary Support System	2
Sitework	2
Mechanical / Electrical / Instrumentation / Piping	6
Ancillary Support System	2
Electrical	2
Pump and Piping	2
Structural / Architectural	2
Ancillary Support System	2
Grand Total	12

Wells

Table 4 identifies the number of records by discipline.

Table 4. Well Records by Discipline

Discipline	Count of Records
Civil / Sitework	19
Ancillary Support	2
Ancillary Support System	7
Site Work	8
Sitework	2
Mechanical / Electrical / Instrumentation / Piping	42
Ammonia Electrical	3
Ammonia Feed Pump #1	3
Ammonia Feed Pump #2	3
Ammonia Feed Pump #3	1
Ammonia Tank	3
Ancillary Support	3
Ancillary Support System	7
Chemical System	5
Electrical	1
Electrical/Instrumentation	6
Pump and Piping	7
Structural / Architectural	20
Ammonia Building	3
Ancillary Support	3
Ancillary Support System	7
Building	7
Grand Total	81

Reservoirs

Table 5 identifies the number of records by discipline.

Table 5. Reservoir Records by Discipline

Discipline	Count of Records
Structural / Architectural	**1**
Dougherty Reservoir	1
Grand Total	**1**

Data Completeness

As previously noted, in this TM the term “asset” is used to define the lowest level of detail in the WAM database. 843 assets are currently identified in WAM. Below is a summary of the critical fields in the database and the current state of completeness:

- **Install Year**. Installation dates are populated for all assets or components.

- **Original Useful Life**. Original useful life estimates are populated for all assets or components.

- **Replacement Cost**. Estimated replacement costs are populated for all assets or components. However, replacement costs are difficult to verify for treatment plant, pump stations and wells since all assets are grouped into disciplines where quantities and attributes are not described.

- **Condition Assessment**. Populated for all components. Condition assessment data is documented on a 0-5 scale. This data is used to calculate remaining useful life (see the condition based remaining useful life section of this TM for more details). Although not directly dependent on each other, their condition assessments are also recorded in a simple yes/no questionnaire at the discipline level under the tab “Component Information.” The questionnaires are discipline specific and are used to prompt the condition inspector in quantifying the component’s condition ranking. However, filling out the questionnaire does not quantify the component’s condition and is still dependent on the inspector’s subjective opinion. For example, the Mechanical/Electrical/Instrumentation/ Piping discipline questionnaire is shown in Figure 2.

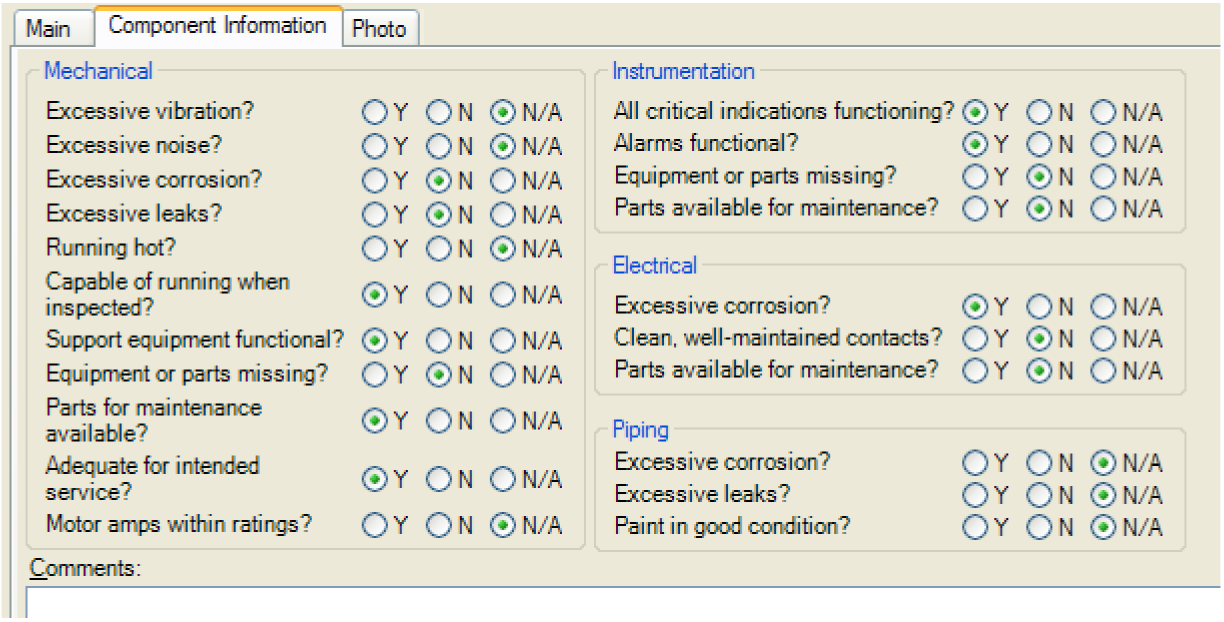


Figure 2. Example WAM Condition Assessment Questionnaire

A random selection of components revealed that all had the component evaluation questionnaires completed; narrative comments can be entered in the component information tab under discipline and also in the comments window at the component level. The purpose of providing narrative comment fields in two different levels in the hierarchy was not apparent.

- **Criticality, Vulnerability, Redundancy, and Risk.** Criticality, Vulnerability, and Risk are populated for all assets. Redundancy does not appear to be populated as all redundancy values are set equal to 1. As a result, this skews the overall risk score of assets.

- **Level of Service Goals.** Populated for all assets. Level of service in the software is defined as the asset condition threshold which should be maintained for the asset or component. Targeted asset condition thresholds are shown in Table 6.

Table 6. Level of Service Codes

Code	Level of Service Description
0	Non-existent
1	Very good
2	Minor defects
3	Requires significant maintenance
4	Requires rehabilitation
5	Requires replacement

All assets at the component level have a target level of service code of "2, Minor Defects." Per the definition, if an asset's condition drops to a "3, Requires Significant Maintenance," then the LOS goal is not being met.

The level of service goals used by WAM should not be confused with Level of Service Goals defined for the Agency. The first two goals listed are currently under review and may be revised as part of the updated to the Water Supply Master Plan. Zone 7's Level of Service Goals were summarized in the 2004 Asset Management Summary Report, and include:

- Meet 100 percent of its treated water customers' water supply demands including existing and projected demands through build out (expected to occur around 2030).
- Provide sufficient treated water production capacity and infrastructure to meet at least 75 percent of the maximum daily M&I contractual demands should any one of Zone 7's major supply, production, or transmission facilities experience an extended unplanned outage.
- Meet all state and federal primary Maximum Contaminant Levels (MCLs) for potable water delivered to the M&I contractors' turnouts.
- Meet all state and federal secondary MCLs in the potable water delivered to its M&I Contractors' turnouts. In addition, Zone 7 shall, within technical and fiscal constraints, proactively mitigate earthy-musty taste and odor events from surface water supplies, reduce hardness levels to "moderately hard" (75 – 150 mg/L as CaCO3), and optimize its treatment processes to minimize chlorinous odors.
- Zone 7 shall endeavor to deliver to its non-potable contractor turnouts, from a variety of sources, water of a quality that meets the irrigation needs of its contractors and does not negatively impact vegetation, crops, or soils.
- Zone 7 shall continue to work to improve the quality of its source water. This may be achieved through Zone 7's Salt Management Plan, which will maintain or improve the water quality in the groundwater basin, and also through advocacy of improvements to the State Water Project, its' facilities and its operations, which may improve the quality of Zone 7's surface water supplies

HDR recommends that the WAM Level of Service Goals be renamed as "Asset Condition Threshold" to avoid confusion. The purpose of WAM LOS is to pre-define an asset's targeted condition. Based upon a condition inspection or actual asset failure, if the condition ranking fails to meet the Asset Condition Threshold then this should trigger either a maintenance adjustment, or a repair, rehabilitate, or replace decision. In addition, the Asset Condition Threshold should reflect the asset/discipline/component/process criticality. Setting the Asset Condition Threshold globally in the software at a level 2 effectively treats all assets the same when performing a condition inspection. For example, if a restroom ventilation fan asset condition threshold is "2 – Minor Defects Only" then its maintenance frequency, and repair/rehab/replace decision is managed at the same level as a turbidimeter on the effluent side of a treatment plant filter. Because of their importance in assuring that Zone 7 is able to meet its Agency-wide water quality goals, significantly more effort should be expended in managing filter turbidimeters than restroom fans.

Other findings

In addition to the analysis of asset hierarchy, level of detail, and data completeness, other significant findings regarding the asset database are described below.

Asset Identification

The unique asset identification numbers in WAM, GIS, and MP2 do not appear to be related. It is an industry best practice to maintain a single asset identification number across all database systems because it increases the ability to use and cross-reference data from multiple sources when making asset management decisions. Asset identification numbers for Treatment Plant, Pump Stations, Reservoirs and Wells do not exist in WAM. However, based on conversations with Zone 7 staff, individual asset identifiers do exist for a significant percentage of assets in the CMMS and SCADA databases.

Redundancy Logic

Risk is calculated as the product of vulnerability, criticality, and the redundancy factor. The redundancy factor is a percentage between 50 and 100 that reduces the risk of asset failure based on the ability to leverage other asset(s) to deliver a similar level of service. WAM requires the identification of the number of redundant assets. Based on the data regarding number of redundant assets, a redundancy factor is assigned as shown in Table 7.

Table 7. Calculation of Redundancy Factors

Number of Redundant Assets	Redundancy Factor
2	95%
3	92%
4	88%
5	85%
6-10	80%
11-15	70%
16-20	60%
>20	50%

Following the logic in Table 7, if there are three pumps in a pump station, the pump station would have a 92 percent redundancy. This logic does not incorporate the pumping capacity needed to meet the required level of service (LOS). So, if all three pumps are needed to meet the LOS required, the redundancy factor should be 100 percent. If only one pump is necessary to meet the required LOS, the redundancy factor should be substantially less than 92%.

Equipment Life Cycle

Original useful life and condition based remaining useful life were reviewed as described in the following sections.

Original Useful Life

Original useful life estimates are documented in WAM. In general, useful life estimates were assigned based in Table 8.

Table 8. Estimated Useful Life Based on Asset Type [(a)]

Asset Type	Original Useful Life
Mechanical	25 years
Structural	50 years
Electrical	30 years
Instrumentation	15 years
Pipeline	75 years

(a) Adapted from Draft Phase II Summary Report, Oct. 2004.

Table 9 identifies the number of assets in each discipline for each respective useful life category. A comparison of the information in Table 9 with Table 8 indicates that the useful life value for some assets was adjusted. For example, there are 85 assets in the Civil / Sitework discipline, of which 81 assets have a useful life of 50 years, which is consistent with the information in Table 8. However, the remaining four assets have a useful life of 20 years. No documentation was found to explain why the data was adjusted or if it is justified.

There are also some instances where the original useful life for an asset is different than other similar assets. Taking the same Civil /Sitework example, there are 12 components that are identified as “sitework”. Of those, 9 components have a useful life of 50 years and 3 components have a useful life of 20 years. There is no documentation to explain the reasoning behind this difference or if it is justified.

Table 9. Summary of Original Useful Life Data

Discipline / Useful Life	Count of Facility / System
Civil / Sitework	85
20 Years	4
50 Years	81
Mechanical / Electrical / Instrumentation / Piping	261
6 Years	1
15 Years	19
20 Years	9
25 Years	199
30 Years	33
Nodes / Appurtenances (Total and Average Values)	17
50 Years	13
53 Years	1
54 Years	1
57 Years	1
62 Years	1
Pipes (Total and Average Values)	27
75 Years	27
Structural / Architectural	129
25 Years	1
50 Years	128
Grand Total	519

Condition Based Remaining Useful Life

Condition assessments were performed in 2004 and 2006. The condition scores identified were used to define the percentage of remaining useful life based on the methodology shown in Table 10.

Table 10. Condition Based Remaining Useful Life Methodology

Condition Score	% Remaining Useful Life
5	50%
4	70%
3	85%
2	95%
1	100%
0	100%

Based on this methodology, it appears that assets are, in general, lasting longer than the Original Useful Life estimate. Figure 3 shows the number of assets and how long their anticipated replacement was extended based on the condition assessment performed. For example, while approximately 210 assets had a remaining useful life similar to that expected based on original useful life (i.e., within -5 to +4 years), 120 assets had their anticipated remaining useful life extended between 5 and 14 years; in total, the replacement period was extended on over 300 assets.

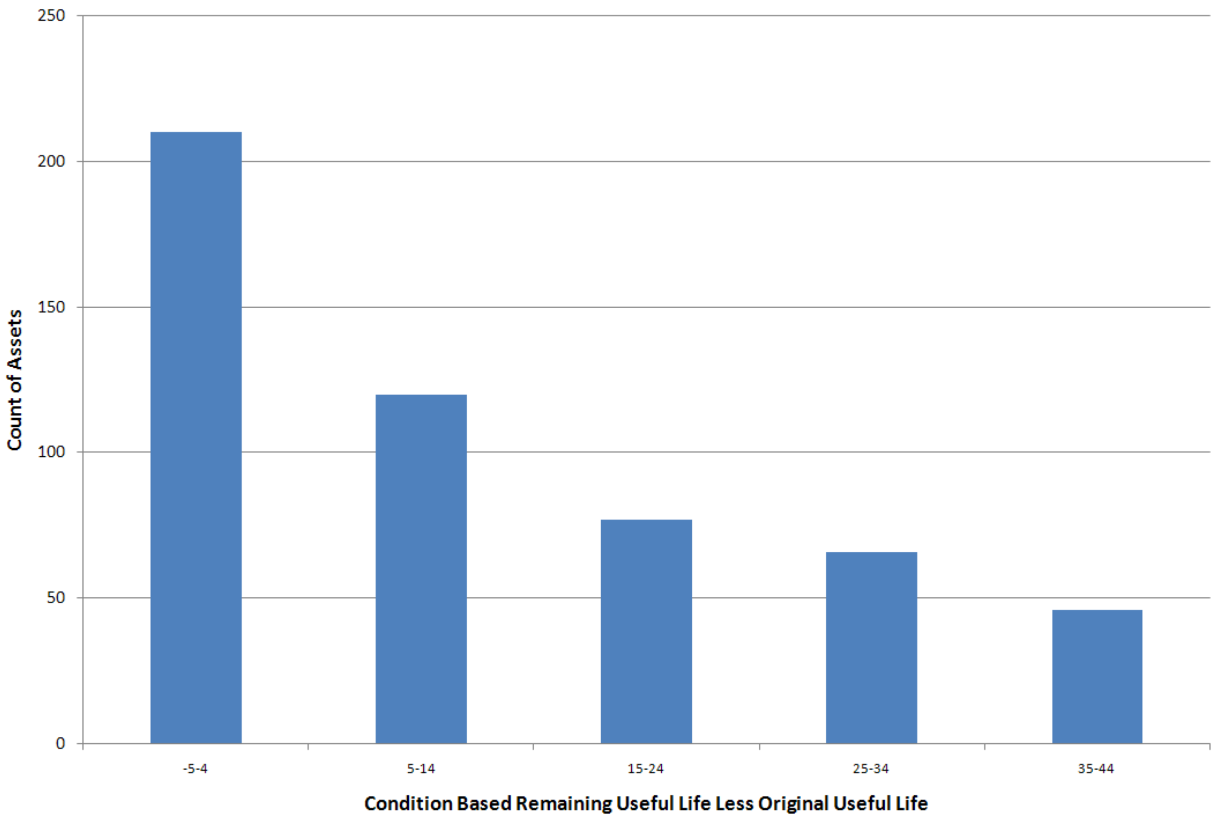


Figure 3. Condition Based Remaining Useful Life less Original Useful Life

Maintenance Management

Zone 7's current maintenance management tools and strategies were reviewed to determine how they interact with the Agency's other asset management tools and policies. As described by Zone 7 staff, the Agency uses an informal maintenance system that is focused on the major maintenance items that the staff expects will be required during the succeeding year. The maintenance program is largely driven by the knowledge of Zone 7 staff members regarding the history and condition of assets. Formal written policies regarding reactive, preventive, and predictive maintenance have not been established. For the water treatment plants, a significant effort is spent planning the annual maintenance work that will be accomplished when the plants are shut down during the low production periods in the winter.

Zone 7 currently uses Datastream's MP2 CMMS for maintenance management. Use is primarily limited to work order requests, preventive maintenance management, and minimal reporting. Equipment identification numbers are predicated on the SCADA system tags or equipment identification. The MP2 CMMS is not being used for equipment repair cost accounting, inventory control, or maintenance reporting. As noted previously, Zone 7 is in the process of replacing MP2 with Tabware.

Work requests are generated by operators and mechanics in MP2. If multiple work requests are generated on a piece of equipment or common asset type, an Engineering Service Request (ESR) is generated. The ESR may initiate a capital improvement project. There are two types of projects funded by capital money. The first type, paid from Fund 72, include Replacement/Renewal and System-Wide Improvements projects funded by ratepayers. The second, paid from Fund 73, include expansion projects that are funded by developer charges. At this time all Capital Improvement Program (CIP) support documentation is manually gathered from Zone 7's financial accounting program (i.e., Intuit FundWare). The CMMS does not support or provide maintenance history and/or ongoing repair costs, failure rates, or results of condition inspection information to assist in repair, rehabilitation, or replacement decisions. Rather, the CMMS is used to schedule some preventive maintenance, such as ensuring all regulatory required calibration checks are performed on water quality instrumentation. The resulting documents are used for reporting compliance with regulatory requirements.

An effective predictive maintenance program is in place to monitor electrical and power distribution asset condition by using infrared testing (thermography) every 3 years. In addition, annual cathodic protection evaluations are performed. Predictive maintenance test reports are stand alone and not stored in the CMMS or WAM. Condition inspections of system components or assets are not being performed on a regular basis. The condition inspections conducted in 2004 through 2006 during the WAM development have not been repeated.

There are no formal data mechanisms or policy directives to collect asset condition information and share this data among the management software platforms. Repair and project cost data is stored in the financial accounting software system and is not integrated with WAM or the CMMS systems. Predictive maintenance reports do not tie in with any other condition assessment programs. Inventory systems are informal and there is no clear consensus on the value of equipment kept in storerooms. Decisions to adjust maintenance, implement repair, replacement, or rehabilitation is accomplished by direct communication between Operations, Maintenance, Engineering, and Management personnel.

Zone 7 is in the process of integrating a new CMMS software program called Tabware. Based on discussions with key staff, the conceptual approach to this new program will incorporate features such as repair maintenance cost accounting, improved replacement and project cost assignments to the process and component levels, better maintenance report generation to support Engineering Service Requests, and enhanced project management.

Recommendations

Based on the evaluation described in the previous sections, a series of recommendations were developed. The recommendations are summarized in the following subsections, and are grouped according to the section of this TM to which they pertain.

Fixed Asset Inventory

Recommendations were developed regarding data collection standards, the level of detail, data completeness, and data quality, as presented below.

- Document data at the lowest level of detail and at a consistent level of detail in the asset hierarchy.
- Currently, assets are named differently in each major information system (e.g., WAM, GIS, and MP2 or the new Tabware). Define a consistent asset naming convention and apply that naming convention to all assets in all information systems.
- Develop new methodology for determining the redundancy factor used to calculate risk.
- The term "Level of Service" is used in WAM to describe an "Asset Condition Threshold". Consider revising this terminology to reduce confusion and better represent the intent of the metric.
- There is insufficient data to accurately define LOS (more appropriately referred to Asset Condition Threshold) at the asset level. Therefore, develop the asset condition thresholds in the context of the Asset Renewal Decision Processes. (Asset Renewal Decision Processes will be developed as part of Task A5 of the AMP Update Project.)
- Currently, condition assessment scores have a corresponding Percent Useful Life that ranges from 100% to 50%. Modify this scoring system to use a Percent Useful Life that ranges from 100% to 0%.
- When collecting condition assessment data, identify the methodology and/or accuracy of data. Develop and implement a quality control procedure and program to validate condition assessment data.
- Determine the appropriate database (i.e., WAM, GIS, or MP2) to document asset attributes.
- Confirm replacement costs are valid and up to date.
- Data gaps and inconsistencies exist between WAM and GIS.
    - Determine the difference in facilities included in GIS versus WAM (i.e., pipe mileage, valves, turnouts, ET Stations),
    - Rectify inconsistencies only after revising the hierarchy level at which data shall be managed under the AMP,

- Add additional valves to registry,
- Tie pipes to GIS and determine if additional pipes should be added to registry.

- Update the asset registry with assets built after last condition assessment/inventory.
- Currently, above ground assets are grouped into disciplines and quantities are not defined. Assets within each discipline should be identified and documented to support redundancy evaluation and asset decision making.

Equipment Life Cycle

- Consider breaking the disciplines into subgroups that better reflect the useful life of the assets associated with each discipline.
- Define an effective way to evaluate and adjust original useful life estimates as more data about actual useful lives becomes available.
- Document the methodology or reasoning for useful life estimates.

Maintenance Management

- Develop Tabware reports to better support repair and replacement cost accounting to the asset level. Identify aspects of the AMP that should be supported by Tabware.
- Develop a basic inventory system within the new CMMS that supports Asset Condition Thresholds for critical assets as defined in a formal Maintenance Strategy. Ensure the inventory system provides a summed valuation of stock.
- Develop a formal Maintenance Strategy that describes what information is collected to support Zone 7 Agency Level of Service targets, better CIP planning, and Maintenance / Repair / Rehabilitate and Replace decisions.

Asset Registry Suitability

In addition to the recommendations presented above, Zone 7 has also requested that HDR consider the suitability of WAM as the Agency's asset registry based on the findings presented in this TM.

WAM does provide the basics needed for Zone 7 to begin implementation of its AMP. However, it should be viewed as a tool in implementing the basic asset management element of "inventorying assets" which includes a basic understanding of what assets are critical and should be managed, the condition of the managed assets including a remaining useful life estimate, and a cost estimate to replace the asset if it were to fail.

During the review of the WAM software, several limitations were identified that could hinder some aspects of the AMP, including:

- The complex methodology for assessing redundancy (as previously described in this TM).

- The minimum condition rating and level of service rating is 50% of the original useful life (e.g., cannot be less than 50% of original useful life even if the asset has failed).

- When adding assets to the inventory, the only attributes that can be collected are condition and replacement costs. Additional asset-specific data cannot be documented (e.g., criticality, redundancy, installation date, useful life, remaining useful life, date of inspection, etc.). Moreover, the asset condition and replacement costs do not "roll up" to the next level in the hierarchy. This information would need to be exported and manually tabulated.

- The condition assessment survey is too generic and is not customizable.

- The original and remaining useful lives cannot be managed consistently.

In the context of developing an inventory, WAM is sufficient. However, to fully support Zone 7's AMP, the software should do more than just serve as an inventory. Therefore, the following elements may need to be revisited:

- Method to estimate remaining useful life,

- Approach to evaluating risk, and particularly redundancy,

- Definition of failure.

Based on the above, HDR recommends Zone 7 continue to use WAM for basic asset inventorying, but the Agency should plan on enhancing WAM to better reflect its future AMP needs or migrate the WAM database to a more robust program.

Appendix B

Comparison of Asset Renewal Program Planning Methodologies

Technical Memorandum

COMPARISON OF ASSET RENEWAL PROGRAM PLANNING METHODOLOGIES

Asset Management Program Update *August 4, 2010*

Introduction

This technical memorandum (TM) presents a comparison of six asset renewal (i.e., repair, rehabilitation and replacement) program planning methodologies and recommendations to update the methodology Zone 7 uses for its Asset Management Program.

Background

Based on the current version of Zone 7's asset register (WAM), the total acquisition cost (escalated to 2006) of Zone 7's assets is approximately $265 million as shown in Table 1. The total "Current Value" of assets in the Zone 7 system in 2006 is also shown in Table 1. Per the WAM documentation, the current value is the replacement cost multiplied by the percent of remaining original useful life, as shown below.

$$Current\ Value = \frac{OUL - Age}{OUL} * Replacement\ Cost$$

Table 1. Acquisition Cost and Current Value (2006) of Zone 7 Fixed Assets

FACILITY	ESCALATED ACQUISITION COST ($millions)	CURRENT VALUE ($millions)
Administration	1.8	1.4
Del Valle Water Treatment Plant	88.9	43.5
Distribution System	101.1	62.3
Groundwater Wells	20.3	13.5
Patterson Pass Conventional Water Treatment Plant	28.1	10.5
Patterson Pass Ultrafiltration Water Treatment Plant	22.3	19.8
Pump Stations	1.4	0.7
Reservoirs (Dougherty Reservoir)	1.4	0.8
TOTAL	$265.3	$152.5

Another commonly utilized method to determine current asset value is to determine the current replacement value of assets less accumulated depreciation.

Zone 7's current asset management strategy includes an assumption that asset replacement budgets should be based on replacement of assets at the end of an asset's economic useful life.

Based on the definitions in the Zone 7 Water Agency Asset Management Program document dated Draft - October 2004, the definition for Economic Remaining Useful Life is:

> **"Economic Remaining Useful Life**: The remaining period in which the asset value is greater than the cost of repair. When the asset value reaches *approximately half of its original value, the cost for maintenance or repair of the asset increases considerably, resulting in an exponentially decreasing investment rate of return. This is the optimal economic point in which to replace the asset"* (emphasis added).

In the remainder of this TM, half of an asset's original value will be considered to be synonymous with 50% of the asset's original useful life (OUL).

The current Asset Management Program document (2004 AMP) does not provide data, calculations or referenced documents to support the conclusion that the optimal economic point for replacement of an asset is when the asset value reaches approximately half of its original value. This strategy resulted in a recommended asset renewal /replacement (R/R) budget of $8.8 million per year and a system-wide improvement (SWI) budget of $1.2 million per year (Zone 7, Fiscal Year 2009/10 Capital Improvement Program, page 2-27.)

This asset renewal strategy may underestimate the actual economic remaining useful life of many assets (e.g. structures, pipelines, etc.) and over estimate the annual asset renewal budgets required to support Zone 7's level of service goals.

Since the 2004 AMP did not provide a justification for the conservative assumption that assets should be replaced after 50% of original useful life and due to concern over increasing water rates, Zone 7's retailers asked for a reduced annual RR/SWI budget allocation. Through a series of discussions between Zone 7 and its retailers, the RR/SWI budgets were reduced from the recommended $10 million/year to $4.6 million/year for fiscal years 2005/06, 2006/07, and 2007/08 as shown in Table 2. A gradual ramp-up of the RR/SWI budgets through 2015 was also discussed but specific RR/SWI budget targets were not established. The actual amounts allocated for each of the last five years for asset renewal/replacement and system-wide improvement is also shown in Table 2.

Table 2. Asset Renewal/Replacement and System-wide Improvement Budgets, 2006 through 2010.

FISCAL YEAR	"CONSENSUS" ZONE 7/RETAILER RR/SWI TARGET ($ million)	ZONE 7 ASSET RR/SWI BUDGET ALLOCATION ($ million)
2005-2006	$4.6	$4.5
2006-2007	$4.6	$2.5
2007-2008	$4.6	$5.5
2008-2009	Not specified	$6.6
2009-2010	Not specified	$5.3

In Zone 7's 2004 AMP, the economic useful life based upon 50% of the asset's original useful life was only utilized to set annual renewal program budgets; specific near-term asset renewal projects are identified based on asset condition and obsolescence.

To address these issues and to evaluate other alternative asset renewal program planning strategies, Zone 7's Asset Management Program Update for 2010 requires a comparison of several alternative asset renewal planning methodologies. This TM discusses several alternatives and provides a preliminary recommendation for Zone 7's consideration as the Asset Management Program Update process proceeds.

Asset Renewal Methodologies

There are many alternative asset renewal program planning methodologies that can be utilized to plan asset renewal budgets and to select specific assets for rehabilitation or replacement. This section presents five of the most common methodologies utilized by water and wastewater utilities in the United States, as well as the current methodology used by Zone 7.

Alternative 1: Current Methodology – Renewal Budgets Based on Renewal at 50% of an Asset's Original Useful Life

As described in the Background section above, the 2004 AMP states an assumption that assets have an economic useful life that is approximately 50% of the asset's original useful life. This method is suitable for preparing highly conservative long-term renewal forecasts. Zone 7 does not currently have an analysis process to analyze or confirm the validity of this assumption.

As presented in the 2004 AMP, this assumption was used to develop an annual renewal allowance for the Zone 7 system that is approximately $8.8M/year in 2004 dollars. The report also recommended a $1.2M/year (2004 dollars) allowance for system-wide improvements to improve water quality and for projects required to meet Zone 7's level of service goals. This resulted in a recommendation of $10M/year, in 2004 dollars, as a total annual budget for asset renewal and system-wide improvements.

Figure 1 illustrates how asset renewal budgets would be estimated for a hypothetical utility for a group of assets with a 50-year original useful life (OUL), that are scheduled for replacement after 50% of asset OUL. In this example, assets are scheduled for replacement approximately 25 years after installation. Figure 1 shows only the first replacement cycle; additional replacement cycles would also need to be budgeted approximately every 25 years in the future.

Thus, for this utility that began installing assets in the 1920s, asset replacements are required beginning in approximately 1950. Peak asset installation periods were the three decades from 1950 to 1980. During the 1980s and 1990s, the installation of new assets tapered off significantly. As a result of this pattern of asset installation, peak asset replacement occurs during the 1980s and 1990s and the entire system has been replaced by the 2020 decade.

However, as noted previously, Zone 7 has not allocated sufficient finds and therefore has not been implementing actual asset rehabilitation and replacement projects based on this methodology (per agreement with its retailers). It appears that most of the recently completed asset rehabilitation and replacement projects were based on physical inspection and identification of assets that were in poor condition and/or were obsolete. Sources of this information include the AMP condition assessments, annual corrosion assessment studies, and investigations following an Engineering Services Request.

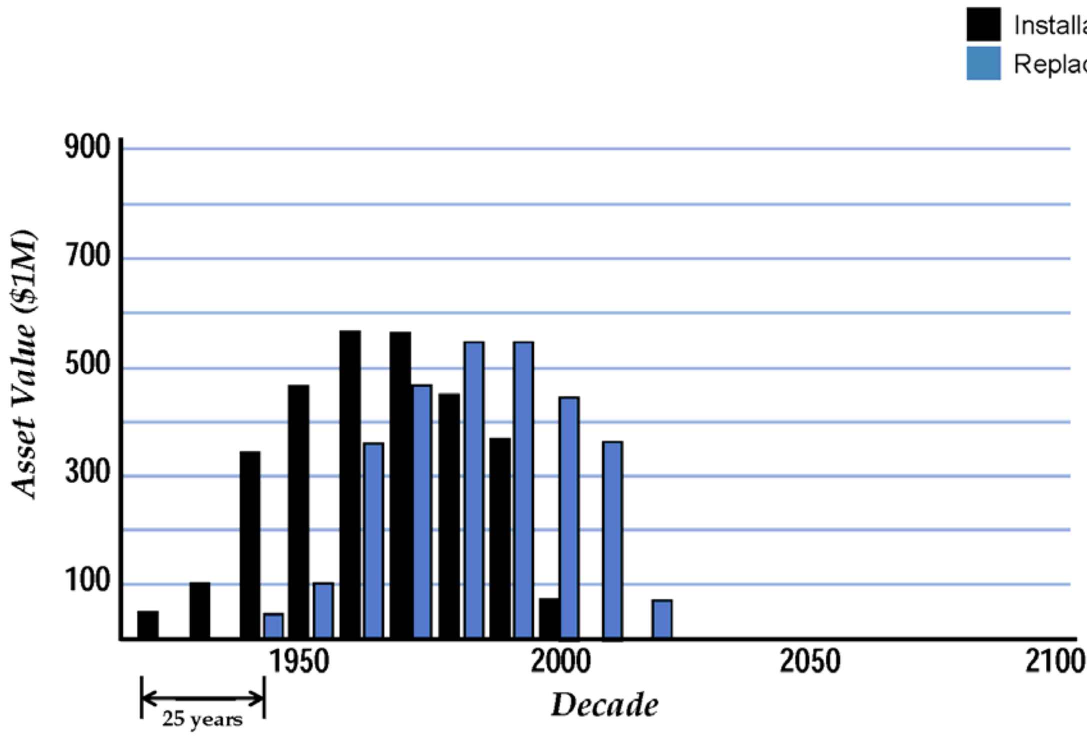


Figure 1: Example Asset Renewal Forecast – Assuming a 50-year original useful life and Asset Renewal at 50% of original useful life

Alternative 2: Renewal Budgets Based on 100% of an Asset's Estimated Original Useful Life

While a formal survey has not been completed as part of this project, based on experience of the team members developing this TM, this approach is commonly used in public utilities in California and throughout the United States, particularly for financial reporting purposes. This method is suitable for preparing long-term renewal forecasts.

Finance officers often assume asset renewal at 100% of the original useful life to calculate asset depreciation, often using the straight-line depreciation method. They use the depreciation value (annual and accumulated) for preparing annual financial statements.

With respect to renewal, they often plan their capital renewal budgets based upon the replacement value of the assets that are at a point close to 100% of original useful life (e.g. 90% or greater). Then, the total replacement value of assets in this category is leveled over a number of years to create an asset renewal budget forecast. Leveling the renewal budget forecasts over several years prevents spikes in renewal budgets and minimizes impacts to cash flow and rates.

Figure 2 illustrates asset renewal budgets for the same hypothetical utility illustrated in Figure 1. As before, the utility installs assets with a 50-year original useful life. However, under this alternative, the assets are scheduled for replacement after 100% of original useful life. In this example, assets are scheduled for replacement beginning in the 1970s and ending in the 2050 decade. The peak asset replacement period is 2010 to 2030.

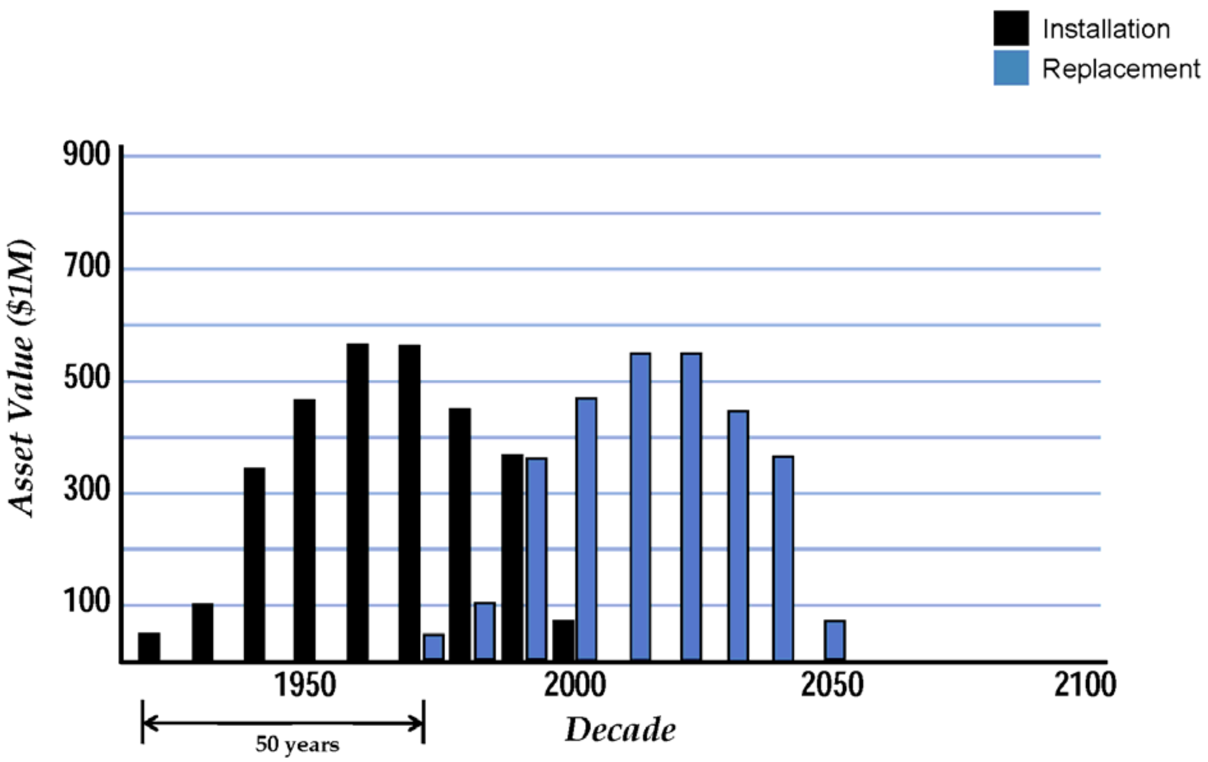


Figure 2: **Example Asset Renewal Forecast – Assuming a 50-year original useful life and Asset Renewal at 100% of original useful life**

Alternative 3: Asset Renewal Budget Plans Based on Statistical Models

In reality, some assets last much longer than their estimated original useful life and some assets do not last as long as their estimated original useful life (e.g. all pipelines with a 50-year estimated original useful life do not suddenly fail and require replacement after 50 years).

To address these issues and to more accurately forecast future (i.e., long-term) asset renewal requirements in a specific system, historical asset failure data can be utilized to prepare statistical asset failure models. These models (e.g., Weibull failure analysis, Iowa Curve method) can then be utilized to more accurately forecast asset renewal allocation budgets.

Development of failure models for a specific type of asset in a specific system requires a well documented history of asset failures within that system. In other words, in a system where a significant percentage of the assets are beyond their estimated physical lives and there is a well documented asset failure history, there will typically be adequate data to develop an asset failure model to forecast future asset failures. If a system is relatively new without a significant history of asset failures, it is more difficult to develop accurate asset failure models.

Figure 3 illustrates how asset failures can be predicted depending on the definition of an asset failure. The curves in this figure are the result of a Weibull analysis. In this case, the curve represents the cumulative percentage of pipeline assets that can be expected to fail based on age. There are multiple curves shown so that multiple definitions of an asset failure can be considered prior to planning an asset renewal budget.

For example, in the example asset failure model for water mains shown in Figure 3, if an asset failure is defined as one main break, then after 50 years, approximately 20% of assets will have failed and 100 years after installation, approximately 85% of water main assets will have failed. If an asset failure is defined as 3 breaks on the same water main, after 50 years approximately 5% of mains will have failed and after 100 years just over 20% of mains will have failed. Development asset failure models require a reliable record of historical asset failure data and clear definitions of asset failures. In newer systems, there may not be sufficient historical failure data to develop accurate asset failure models.

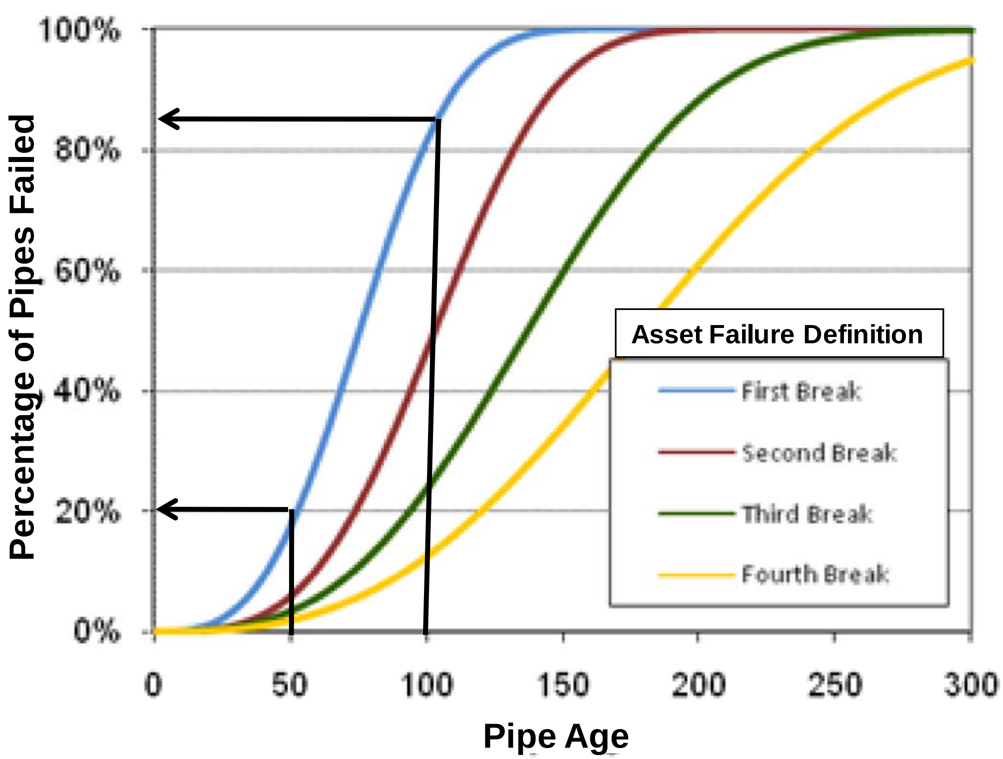


Figure 3: Example Asset Failure Models

Alternative 4: Asset Renewal Budgets Based on Business Risk Analysis or Business Case Analysis

Another approach for the development of asset renewal budgets is to perform a business risk analysis that looks at the projected cost of asset ownership in the future, including costs associated with potential failures versus the projected cost of asset replacement and operation of a new asset. If the cost of ownership exceeds the cost of replacement and operation of the new equipment, then an asset replacement project can be planned and budgeted.

Development of a business risk model often requires the development of a complex risk cost formula and a set of assumptions about the estimated future risk costs associated with aging assets based on a set of asset attributes (e.g., criticality, condition, age, life expectancy, etc.) It is often a challenge to develop a future risk cost model that can accurately reflect the cost of ownership for aging assets. It can also be expensive to accurately collect the data that are required to calculate the future business risk associated with each asset.

A related approach is to perform a business case analysis for the replacement of specific assets that may still be in good, reliable operating condition, but which may be inefficient due to reduced energy efficiency or due to the development of new energy efficient technologies that make the cost of continued ownership of the original asset higher than the capital cost of the replacement asset plus the cost of its operation.

Alternative 5: Asset Renewal Budgets Based on Condition-Based Renewal Planning

To try to improve the accuracy of asset renewal forecasts, it is possible to perform a condition assessment of assets and to estimate remaining useful life based on the condition assessment data. For example, condition assessment ratings that are collected for individual assets can be translated into an updated estimate for physical remaining useful life as a percentage of original useful life for each asset. These updated useful lives can be then be used to update renewal budgets.

This approach can allow utilities to extend the life of an asset beyond the asset's estimated original useful life if the asset is found to be in good condition. This approach can also support elimination of assets that are in poor condition regardless of asset age versus the asset's estimated original useful life.

Another potential benefit of this alternative is that Zone 7 could consider the implementation of Condition Based Depreciation for financial statements to increase the book value of existing assets that will last longer than the physical original useful life. This also could have the benefit of reducing the level of risk for the finance community if Zone 7 were to consider the use of bond financing in the future.

Alternative 6: Asset Renewal Based on Asset Failures or Obsolescence

Whether by design or by default, many water utilities manage the vast majority of their assets by performing preventive maintenance and continually repairing asset failures until an asset reaches the point where it cannot be repaired anymore due to poor condition or obsolescence and a lack of spare parts availability.

For assets that are required to provide service to customers, and for assets that are required for public health and safety, this may not be an appropriate methodology. However, there are times when this approach may be appropriate for non-critical assets that do not have an impact on customer level of service or safety.

This approach can be utilized for renewal budget forecasting by implementing an asset replacement cost schedule based on 110% to 120% of original useful life.

Evaluation of Asset Renewal Planning Alternatives

This section evaluates the status of Zone 7's current asset renewal planning methodology and presents the relative advantages and disadvantages of the alternatives described in the previous section.

Alternative 1: Current Methodology – Renewal Budgets Based on Renewal at 50% of an Asset's Original Useful Life

The concept of replacing assets at the end of their economic useful life, instead of at the end of each asset's physical life, is a sound concept. However, Zone 7's current asset renewal methodology makes a very broad assumption that the end of every asset's economic useful life is at approximately 50% of an asset's original useful life.

Planning renewal of assets at 50% of an asset's original useful life is a very conservative and risk-averse approach which is not commonly practiced in water or wastewater utilities in the United States. By assuming that most assets will require renewal after 50% of the assets' physical life, most assets will be budgeted for renewal much sooner than under other asset management approaches.

As a result, the projected cost of asset replacement is significantly higher under this alternative.

If fully implemented, this approach will result in a significant increase in water rates without a noticeable improvement to level of service or reliability.

Alternative 2: Renewal Budgets Based on Renewal at 100% of an Asset's Original Useful Life

This methodology is typically the preferred alternative for finance officers to calculate asset depreciation and is often utilized for financial planning purposes to forecast future asset rehabilitation and replacement budget requirements and for the development of rehabilitation and replacement reserves. Furthermore, the original useful life can be adjusted, if necessary, to account for specific assets or classes of assets whose original useful lives are known to be inaccurate (e.g. to account for condition assessment data or for preventive maintenance programs that have extended/shortened the useful life).

For a relatively new system like Zone 7's system, this approach is typically more than sufficient for development of asset renewal budget allocations and for financial reporting purposes. For older systems where many of the assets are already at or beyond their original useful life and where an adequate capital replacement fund is not already in place, this approach may not be adequate to develop adequate capital replacement budgets and reserves.

Also, this methodology is not an accurate way to identify specific near-term asset renewal projects. Typically, an alternate methodology for identifying specific, near-term asset renewal projects should also be included in a successful asset management program.

Alternative 3: Asset Renewal Plans Based on Statistical Failure Models

When sufficient failure data is available for a particular system, the development of asset renewal plans and budgets based on statistical models can be a good way to extract useful life from assets while limiting the risk of failures, particularly for assets where condition-based decisions are not feasible.

Another advantage of this methodology is that it is relatively inexpensive to develop asset failure models to forecast future asset renewal budgets.

A disadvantage to this methodology is that the accuracy of failure model is dependent on the quality and quantity of asset failure history utilized to develop the failure models. Also, this methodology may not extract all of the useful life from an asset that could otherwise be extracted if assets are utilized until they fail.

In general, this methodology will extend many assets beyond 100% of the assets' expected physical lives with less risk of asset failures than a run-to-fail methodology.

The key concern about implementation of this methodology for the Zone 7 system is that the system is relatively new and there is a limited amount of historical asset failure data currently available. Due to this lack of historical asset failure data, it may not be currently feasible to develop accurate statistical failure models for key asset classes in the Zone 7 system unless Zone 7 utilizes depreciation studies from other agencies or from investor owned utilities.

Alternative 4: Asset Renewal Budgets and Project Lists Based on Business Risk Analysis or Business Case Analysis

To implement a business risk analysis-based asset management program, Zone 7 would need to develop a complex formula to estimate the costs associated with different types of risk related to asset ownership. Then, Zone 7 would need to collect a large quantity of asset attributes and data to support use of the formula. Once the attributes were collected, Zone 7 could calculate the "risk cost" associated with each asset, and could compare this risk cost to the cost of replacing the asset and operating the new asset. If the risk cost exceeds the cost of installing and operating the new asset, Zone 7 could justify a renewal project.

There are several challenges associated with this approach. First, development of the risk analysis formula and collection of the attributes for all assets to support the analysis is expensive and would slow down the renewal decision processes for Zone 7. Also, since there are inherent errors in the assumptions used to develop the business risk analysis formula, when these errors are combined for several assumptions, the results can often not make sense (e.g., assets that are clearly inefficient or are clearly in poor condition will not necessarily be at the top of the list). In this case, the assumptions often have to be adjusted until the project list makes sense to the utility managers.

Instead of developing a business risk analysis for every asset, business case analysis as a renewal planning methodology for specific, selected assets can be also appropriate under certain circumstances. For example, for assets that are energy intensive and with high run times (e.g., pumps that run close to 24 hours per day, 7 days per week) utilizing this alternative could be a best practice since decreasing energy efficiency can drive up operating costs to a point where it is less expensive to replace a pump than to continue operation even if it is still in reliable operating condition.

Before utilizing this methodology, there would normally be some level of data collection and analysis to identify when an asset has reached the end of its economic useful life. For example, Zone 7 could implement a standard practice to calculate wire-to-water pump efficiency tests immediately after installation of new mechanical equipment, periodically re-calculate efficiency during the life of the asset, and to again re-calculate efficiency prior to a planned replacement of these assets to confirm that there has been a significant efficiency reduction that justifies rehabilitation or replacement of an asset. However, these practices have not currently been implemented by Zone 7.

If Zone 7 is going to consider development of business cases for renewal of specific, targeted assets, Zone 7 should develop guidelines for how the assets will be selected (e.g. assets with a high energy consumption that are at risk for reduced energy efficiency) and guidelines should be developed for selection of an asset for renewal (e.g., if the cost to install and operate a new pump has a payback period of less than 5 years the asset will be considered for replacement).

Alternative 5: Asset Renewal Budgets and Project Lists Based on Condition-Based Renewal Planning

Renewal projects can be identified through an inspection and condition assessment process and future renewal budgets can be estimated based on condition-based renewal planning. In the near term, assets that have deteriorated to the point where they require rehabilitation or replacement can be identified and scheduled for renewal in the near future. In the long term, the inspection and condition assessment process can be utilized to estimate the remaining useful life for assets. Based on the estimated remaining useful life of each asset, renewal budgets can be forecasted to plan for renewal at the end of each asset’s estimated remaining life.

In the near term, this methodology provides a relatively accurate list of asset renewal projects and relatively accurate near-term renewal budgets. In the long term, one advantage is that each asset can have an estimated remaining life that is independent of the initial estimated life assigned to an entire class of assets. This can lead to a more accurate forecast of asset renewal budgets *if* remaining useful life can be accurately estimated.

The disadvantage to this approach is that it can be costly to inspect and perform condition assessment on every asset in the system on a periodic basis, particularly for below ground assets. It is also difficult to accurately estimate the remaining useful life of assets that are not in an advanced state of deterioration. To address this concern, condition assessment costs can be controlled by focusing on assessment of critical assets rather than trying to inspect every asset periodically.

Alternative 6: Run to Fail Strategy - Asset Renewal Based on Asset Failures

Another possible methodology for asset renewal project planning is to replace assets as the assets fail. Many utilities utilize this approach as a default approach for planning asset renewal, and this strategy can work in the near term because many water systems have 100% redundancy in most if not all of their process and pumping equipment.

The advantage of this approach is that all useful life is extracted from each asset and it is inexpensive to plan a failure-based program. For non-critical assets that are not needed to provide service to customers, are not required for health and safety issues, and do not consume a significant amount of energy, this can actually be a feasible renewal strategy.

There are many significant disadvantages associated with this approach, particularly for assets that are important to the operation of the utility. The key disadvantage is that unplanned failures of critical assets are costly and will result in disruptions to customer deliveries. This can have a negative impact on reliability, level of service, and regulatory compliance. Unplanned failures of critical assets can also lead to property damage and create unsafe conditions for the public and for employees.

Another key disadvantage of this approach is that it is very difficult to develop accurate budgets for near-term and long-term asset renewal. This can often lead to unexpected failures, unexpected expenditures, and the use of emergency reserve funds.

Summary of Findings

Table 3 summarizes the six asset renewal methodologies discussed in the previous section, including the relative advantages and disadvantages of each, as well as their suitability for long and near-term renewal planning.

There are many possible renewal planning methodologies that Zone 7 can adopt. Since no one asset renewal strategy is ideal for development of both near-term lists of specific asset renewal projects and an accurate forecast of long-term asset renewal budget requirements, it may be appropriate for Zone 7 to implement a combination of these alternatives to address the need for accurate identification of near-term renewal projects and the need for accurate long-term renewal budget forecasts.

Recommendations

Based on the evaluation described in the previous sections, a series of recommendations have been developed. These recommendations include aspects of four of the six alternatives discussed above (the alternative is indicated in parentheses following each recommendation).

The first subsection below addresses recommendations regarding the future methodology for forecasting development of a renewal budget forecast and ultimately a Capital Replacement Fund (i.e., long-term renewal forecasts). The second subsection identifies recommendations regarding the identification of specific annual asset renewal projects (i.e., short-term renewal projects).

These recommendations are for the asset management database only and are intended for use in the development of future capital replacement budget estimates and for identification of specific assets renewal projects. These recommendations are not intended as recommended changes for Zone 7's fixed asset ledger nor for inclusion in financial statements.

Update Asset Renewal Forecasting Methodology to Serve as the Basis for Development of a Capital Replacement Fund

Zone 7 needs an updated methodology to develop asset renewal budget forecasts that can be utilized for development of a realistic Capital Replacement Fund. The updated methodology should reflect the realistic costs associated with its asset renewal program. The following preliminary recommendations are intended to give Zone 7 a starting point for discussions in future workshops.

- Consider adjusting physical original useful life estimates for key asset classes based on existing condition data and based on available historical failure data. (Alt. 2)
- Develop initial long-term renewal budget forecasts and a Capital Replacement Fund based on asset replacement at approximately 100% of these adjusted physical original useful life estimates. (Alt. 2)
- Begin collection of asset failure/asset life data to support development of statistical failure models so that, in the future, long-term asset renewal forecasts can be improved either through the use of condition based remaining useful life calculations and/or the use of statistical asset failure models. (Alt. 3)
- Continue the practice of annually budgeting an RR/SWI contingency amount (currently $750,000) until an adequate contingency fund balance is accumulated such that, if RR/SWI needs occur during a specific budget period that exceed the annual asset renewal budget, the renewal needs can be met without delay. (General)

Table 3: Summary of Advantages and Disadvantages for Alternative Asset Renewal Methodologies

Alternative	Advantages	Disadvantages	Suitability for Long / Near Term Planning
1. Current Methodology – Renewal Budgets based on Renewal at 50% of an Asset's Original Useful Life	▲ Conservative approach that minimizes risk of failures	▲ Does not identify specific near-term projects accurately ▲ Many assets replaced before the end of actual remaining useful life without the use of additional methodologies for project identification ▲ High cost with significant rate impacts and without significant improvement to level of service ▲ Newer assets in poor condition may be overlooked ▲ Not an industry standard approach	▲ Suitable for long-term planning
2. Renewal budgets based on Renewal at 100% of an Asset's Original Useful Life	▲ When combined with an emergency repair fund, this provides adequate funding for asset renewal ▲ Consistent with typical utility finance practice ▲ Lower cost than Alternative 1 without a significant impact to level of service	▲ Does not identify specific near-term projects accurately ▲ Some assets could be replaced before the end of actual remaining useful life without the use of additional methodologies for project identification ▲ Newer assets in poor condition may be overlooked	▲ Suitable for long-term planning
3. Asset Renewal based on Statistical Models	▲ Inexpensive methodology to develop if accurate data is available ▲ Can extend assets beyond 100% of Original Useful Life	▲ Does not identify specific near-term projects accurately ▲ Requires asset failure history	▲ Suitable for long-term planning
4. Asset Renewal Based on Business Risk Analysis or Business Case Analysis	▲ If utilized properly, business case analysis can reduce cost of ownership by replacing assets that are inefficient or very high maintenance but are still in relatively good condition	▲ Business Risk Analysis for all assets to identify future asset renewal budgets is a very cumbersome and expensive process ▲ Business Risk Analysis for all asset renewal slows decision processes and hinders operations if applied improperly ▲ Renewal projects resulting from Business Risk Analysis may be questionable due to error in cost assumptions ▲ Expensive to collect accurate data needed to perform business case evaluation unless focused on assets with a high probability of a positive business case	▲ Suitable for long-term planning, but can be difficult to implement ▲ Suitable for near-term planning
5. Asset Renewal based upon Condition Assessment	▲ Not just budget forecast based on age vs. life expectancy; can be utilized to identify specific asset renewal projects ▲ More accurate forecast of renewal budgets than most other methods if condition data can be collected accurately	▲ Difficult and expensive to collect condition data for some assets (e.g. pipelines) ▲ Requires the estimate or calculation of remaining useful life based on condition data; it can be difficult to accurately estimate remaining life for assets in relatively good condition ▲ Does not consider economics when identifying renewal projects; does not consider payback period for renewal of inefficient assets in good condition	▲ Suitable for near-term planning
6. 'Run to Fail' Methodology or Asset Renewal at Failure	▲ Can extend assets beyond 100% of Original Useful Life ▲ Maximum value extracted from each asset, thereby keeping costs lower ▲ Inexpensive to plan for non-critical assets	▲ Does not identify specific near-term projects for inclusion in annual renewal project lists ▲ Difficult to forecast future renewal budgets accurately ▲ High risk because assets may fail at unfortunate times ▲ High potential for disruption to service for customers if critical assets are managed with this methodology	▲ This is a reactive methodology and is not well suited for planning

Identification of Specific Annual Asset Renewal Projects

While comparing asset age to physical useful life may be an appropriate way to develop asset renewal budgets and for development of a Capital Replacement fund, these forecasts will not accurately identify specific renewal projects. A separate process needs to be implemented to identify specific assets that will be planned for renewal over the next 1 to 5 fiscal years. The following preliminary recommendations are related to the identification of specific asset renewal projects.

- For most asset types, identify specific asset renewal projects based on the results of a condition-based asset renewal planning process. (Alt. 5)
- For assets that are difficult to accurately inspect, complete a risk analysis and consider inspection and condition assessment of inaccessible assets with elevated risk. (Alt. 5)
- For special cases such as aging equipment that is reliable and in good operating condition, but that has high run times and may be inefficient, conduct an efficiency test and prepare a business case evaluation to determine whether replacement of the equipment can be justified. Where applicable, Zone 7's "Guidelines for Energy-Related Activities" should be incorporated in the business case evaluation. (Alt. 4)
- Establish straightforward, simplified asset renewal business case guidelines (e.g. minimum payback period requirements for energy efficiency upgrade projects) that will allow replacement of aging assets that are still in good condition. (Alt. 4)

Appendix C

Risk Analysis of Below Ground Assets Technical Memorandum

RISK ANALYSIS OF BELOW GROUND ASSETS

Asset Management Program Update ***June 30, 2011***

Introduction

This technical memorandum (TM) presents an evaluation of Zone 7's transmission pipelines to identify the risk associated with these below ground assets. The evaluation included the development of a risk matrix which identifies the risk associated with each of Zone 7's transmission pipelines based on their respective likelihood and consequence of failure. Based on the results of the risk analysis, the pipelines were then prioritized for condition inspection and assessment.

Background

Zone 7 supplies wholesale potable water to several retailers serving the cities of Pleasanton, Livermore, Dublin, and the Dougherty Valley area of the East Bay Area in Northern California. Zone 7 operates a system of transmission pipelines ranging in size from 12 to 48 inches in diameter. Some pipelines are as old as 57 years. Pipeline materials are primarily concrete cylinder pipe (AWWA C303) and welded steel pipe, with minor amounts of asbestos cement pipe, ductile iron, and PVC.

Risk Assessment

The risk associated with pipelines can be defined in terms of the consequence of failure and the likelihood of that failure occurring. For the purposes of this study, consequence of failure includes impacts to the public and the environment that may occur should a pipeline fail. The likelihood of failure for a given pipeline is based on a number of criteria that may contribute to failure. The two factors are multiplied together to determine the pipeline risk score.

$$Risk = Likelihood\ of\ Failure\ \times Consequence\ of\ Failure$$

The criteria used to determine the consequence of failure and likelihood of failure, are described in the following subsections.

Consequence of Failure

Five criteria were considered in evaluating the consequence of failure, including the following:

- **Pipe Diameter.** The pipeline size is a general indicator of the amount of flow that it is designed to carry; therefore, the larger the pipe, the more flow it would handle. Failure in large diameter pipelines would typically affect a large service area and population. Large diameter lines are also more difficult to repair, and thus can be expected to take more time for service to be restored.

- **Pipeline Length.** The length of a pipeline is related to its replacement or rehabilitation cost and its consequence of failure. The longer the pipeline, the more important it is to maintain its condition and maximize its reliability.

- **Location – Freeway Crossings.** Transmission pipelines that cross freeways or major transportation corridors are considered to have a higher consequence of failure due to potential public impacts of making repairs within a Caltrans right of way or damage or other impacts to freeway facilities.

- **Ease of Repair.** Factors other than pipe size that can impact the cost of emergency repairs include depth of pipe, pipe making an underwater crossing, pipe alignment through a congested urban corridor, pipe located in steep slopes, and pipe located in high groundwater areas. Since the cost of making emergency repairs is typically considered in decisions to replace facilities, the cost of making emergency repairs should be considered a consequence of pipeline failures. The higher the cost, the more critical the potential failure is considered. This factor was evaluated in the original AMP and documented in the WAM database. The data was used as it was provided.

- **Redundancy.** The severity of an outage on a major transmission pipeline can be reduced by requirements for reliance on local storage in the distribution system, or alternate sources of supply. Requirements for retailers to have 10 days, for example, of emergency storage or emergency interconnections with alternate water sources can reduce the critical nature of transmission pipeline failures while repairs are made. Transmission systems that do not have emergency storage or redundancy in their system should be rated as more critical than systems that can withstand a short-term outage while emergency repairs are made. Zone 7's customers have multiple connections to the transmission system, and no customer is dependent on a single pipeline.

In addition to criteria described above, there are additional criteria that could be considered if additional analysis was conducted or desired. For example, typical (average) flow could also be considered if the data were available. The amount of flow carried by a pipeline, similarly related to the pipe size, corresponds to the size of the facility's service area and population that would be impacted by a pipeline failure. The situation could be compounded during peak flow months where flow rates can be expected to be even higher. Average flow was not considered in this analysis. Pipe diameter was considered to be proportional to flow. Additional criteria that could be considered are impacts to sensitive areas, such as critical wildlife habitats or highly populated areas.

Likelihood of Failure Criteria

There are many factors that affect pipeline performance, such as design criteria, construction methods, modes of operation, maintenance procedures, the external environment, and the product conveyed in the pipeline. Six criteria were considered in evaluating the likelihood of failure. These criteria include:

- **Pipeline Material.** Typically, the major cause of pipe breaks for water utilities can be attributed to pipeline corrosion. Zone 7's pipe materials most susceptible to corrosion include concrete cylinder pipe (CCP), steel and ductile iron pipe (DIP). Asbestos cement pipe (ACP) and thermoplastic pipe materials, including polyvinyl chloride (PVC), are also installed and have shown excellent resistance to corrosion.

  While CCP and steel are both made of the same materials, CCP received the highest rating in terms of likelihood of failure because it is a composite design (thin steel cylinder with pre-tensioned steel rods wrapped around the cylinder, manufactured in accordance with AWWA C303). Ferrous materials (DIP), while more susceptible to corrosion than steel, received a lower rating because they are typically cement mortar lined and polyethylene wrapped with cathodic protection system and bonded joints. ACP, concrete pipe with asbestos fibers for reinforcement, received the next lowest rating because there are no steel components to corrode, although cement is susceptible to acid corrosion from soil. Thermoplastic pipes (PVC) received the lowest rating as they are least susceptible to corrosion.

- **Age.** There is no strong evidence of direct correlation between pipeline age and frequency of pipeline failure. However, age should be considered as a factor in recommending action on a given pipeline. Older pipes were installed using older construction techniques and materials and should be reviewed more frequently to assess the pipelines performance and operation.

- **Documented Repairs.** The strongest evidence indicating a reduction in reliability is the number and frequency of repairs on a given pipeline. In general, the greater the number of repairs, the higher the likelihood of future failure.

- **Corrosion Protection and Monitoring Systems.** HDR reviewed the 2010 Corrosion Control Survey performed by V&A. The report indicates that the Santa Rita-Dougherty Pipeline, Livermore #1 pipeline, a realigned portion of Livermore #2 pipeline, the Vasco #1 and #2 pipelines, and the Altamont pipeline are protected with active cathodic protection facilities. The report concludes that these pipelines, except for the southern en of the Santa Rita-Dougherty pipeline, are being adequately protected by the cathodic protection systems.

  The report also discusses corrosion monitoring system surveys on a number of pipelines. Some of the pipelines exhibited higher potentials than previous surveys which may be an indication of active corrosion. Other pipelines exhibited potentials which indicated that the cement mortar coating was adequately protecting the steel.

  For this criterion, pipelines which indicated active corrosion were rated with a high likelihood of failure, pipelines which were not tested or where the testing was inconclusive were rated moderate, and pipelines which were adequately protected were rated with a low likelihood of failure.

- **Geology – Soil Corrosivity.** Ferrous pipelines are susceptible to corrosion from the surrounding soil. In general, soil corrosivity can be predicted from general soil characteristics and soil resistivity measurements. Soil corrosivity was interpreted from USGS Soil Surveys (1966) and geotechnical information from the Altamont Pipeline Project. Sandy, silty soils in low lying alluvial formations were considered to have lower resistivity, and therefore higher corrosion potential, than soils in upland areas.

- **Geology – Liquefaction Potential/Fault Crossing.** Alluvial soils in areas of high groundwater may have a high potential for seismically induced liquefaction. Pipeline alignments in alluvial fans and flood plains were rated higher for liquefaction induced settlement. Settlement can result in joint failures, longitudinal stress in the pipe shell leading to pipe failure, and coating and lining failures which make the pipe susceptible to corrosion. Pipelines that cross known faults also received a high rating in this criterion.

In addition to the criteria described above, there are additional factors that could be considered if additional analysis was conducted or desired. These additional criteria include:

- Pipe Design Criteria. Current design practices for flexible pipe materials recommend minimum wall thickness for handling. These practices limit deflection of the pipe prior to backfill to protect linings and coating from damage. For steel pipe, the handling criteria is often referred to as “D/t ratio”, or the ratio of diameter to wall thickness. Pipe designs with ratios less than 240 would be considered to have a lower likelihood of failure than designs with ratios higher than 240.

  For concrete cylinder pipe manufactured prior to 1970, there was no minimum specified ratio for bar reinforcement to cylinder thickness. In the 1970’s, AWWA started to specify that a minimum of 40% of the steel needed to be in the cylinder. HDR recommends that at least 50% of the steel be in the cylinder. Concrete cylinder pipes with less than 50% of the steel in the cylinder should be considered to have a higher likelihood of failure. They are more susceptible to cracked mortar lining and coating due to handling and external loads. Thin cylinders are also subjected to higher longitudinal stress due to bending and hydraulic thrust.

  Thermoplastic pipes have a minimum recommended dimension ratio (DR). This is the ratio of outside diameter to wall thickness. A higher DR is considered to have a higher likelihood of failure.

- Horizontal and Vertical Bends. Thrust forces and longitudinal stress in pipe are typically restrained by thrust blocks or welded joints. Pipelines with inadequate thrust restraint should be considered to have a higher likelihood of failure.

- Right of Way. Pipeline alignments that have significant changes in surface conditions should be considered to have a higher likelihood of failure. Changes include additional fills or reductions in cover which result in additional external loads. Improvements such as retaining walls and the construction of adjacent structures can impose external loads on pipelines that were not accounted for in the design. The construction of new utilities under existing pipelines can lead to settlement and potential damage. Cathodic protection systems on adjacent utilities can lead to stray currents and corrosion on existing ferrous pipelines. The presence of any of these conditions can cause a higher likelihood of failure.

- High Operating or Transient Pressures. Pipelines operating with high system pressures or transient pressures would be subject to pipeline fatigue and are more likely to experience failure.

Risk Assessment Results

Using the criteria described in the previous section, each pipeline was evaluated and assigned a score. The scores are included in tables in Appendix A. The criteria were then weighted based on their relative significance and with input from Zone 7 staff. The criteria weightings are summarized in Table 1 and Table 2.

Table 1. Consequence of Failure, Criteria Weighting Factors

Consequence of Failure	Weighting Factor (W)
Diameter	25
Length of Pipe	5
Freeway Crossing	10
Repair Costs	25
Redundant Pipeline	35

Table 2. Likelihood of Failure, Criteria Weighting Factors

Likelihood of Failure	Weighting Factor (W)
Material	15
Age	20
Repairs	25
Corrosion Protection & Monitoring	25
Soil Corrosivity	10
Soil Liquefaction Potential	5

The total consequence of failure score is calculated by multiplying a particular pipeline's score for each criterion by the weighting factor (W) for that criterion and then summing the weighted scores for all six criteria. As an example, the consequence of failure score for the Hopyard pipeline (20") was calculated as shown in Table 3.

Table 3. Hopyard (20") Pipeline Consequence of Failure (CoF) Calculation

Criteria	Consequence of Failure Score	Weighting Factor	Weighted Score
Diameter	4	25	100
Length of Pipe	3	5	15
Freeway Crossing	1	10	10
Ease of Repair	0	25	0
Redundant Pipeline	1	35	35
Total Consequence of Failure Score			160

The results of the analysis for all pipelines are provided in Table 4 and illustrated in Figure 1. The detailed calculations for all Zone 7 pipelines and additional information have been included in Appendix A.

Table 4. Risk Assessment Results

Pipeline	Consequence of Failure Score	Likelihood of Failure Score	CoF x LoF = Risk
Hopyard (20")	160	770	123,200
Hopyard (18")	255	770	196,350
Hopyard (under 580)	240	545	130,800
Livermore #1 (27")	385	335	128,975
Livermore #1 (24")	160	335	53,600
Livermore #2	160	465	74,400
Mocho	210	425	89,250
Mocho Well #1 Discharge	280	435	121,800
Mocho Well #2 Discharge	230	345	79,350
Santa Rita-Dougherty	280	600	168,000
Vasco #1	150	335	50,250
Vasco #2	240	335	80,400
Cross Valley	245	900	220,500
Del Valle-Livermore	215	505	108,575
SBA-Del Valle	615	510	313,650
Del Valle-Livermore	615	465	285,975
Dougherty-Phase I	255	425	108,375
Dougherty-Phase II	260	425	110,500
Santa Rita	305	335	102,175
Sycamore	220	290	63,800
Vineyard	240	610	146,400
Altamont - Livermore Reach (42")	445	300	133,500
Altamont - Livermore Reach (36")	225	300	67,500
El Charro - Phase 1	335	440	147,400

Prioritization for Condition Assessment

Based on the criteria scores and the weight of the criteria, the pipeline inventory was ranked by risk. Table 5 summarizes the pipeline ranking and indicates which criteria resulted in the high risk scores for the highest priority pipelines. In general, pipelines with a risk score in the upper right side of Figure 1 (and as indicated in Table 5) were considered to be the highest priority for condition inspection and assessment.

Based on the results of the risk prioritization analysis, Zone 7 should initiate a condition inspection and assessment program such that the highest ranked pipelines are inspected first (e.g., within the next 1 to 3 years) followed by the lower ranked pipelines. Pipelines less than 10 years old (e.g., El Charro and Altamont pipelines) do not need to be inspected unless, for example, there is a large seismic event or other event that would necessitate an inspection.

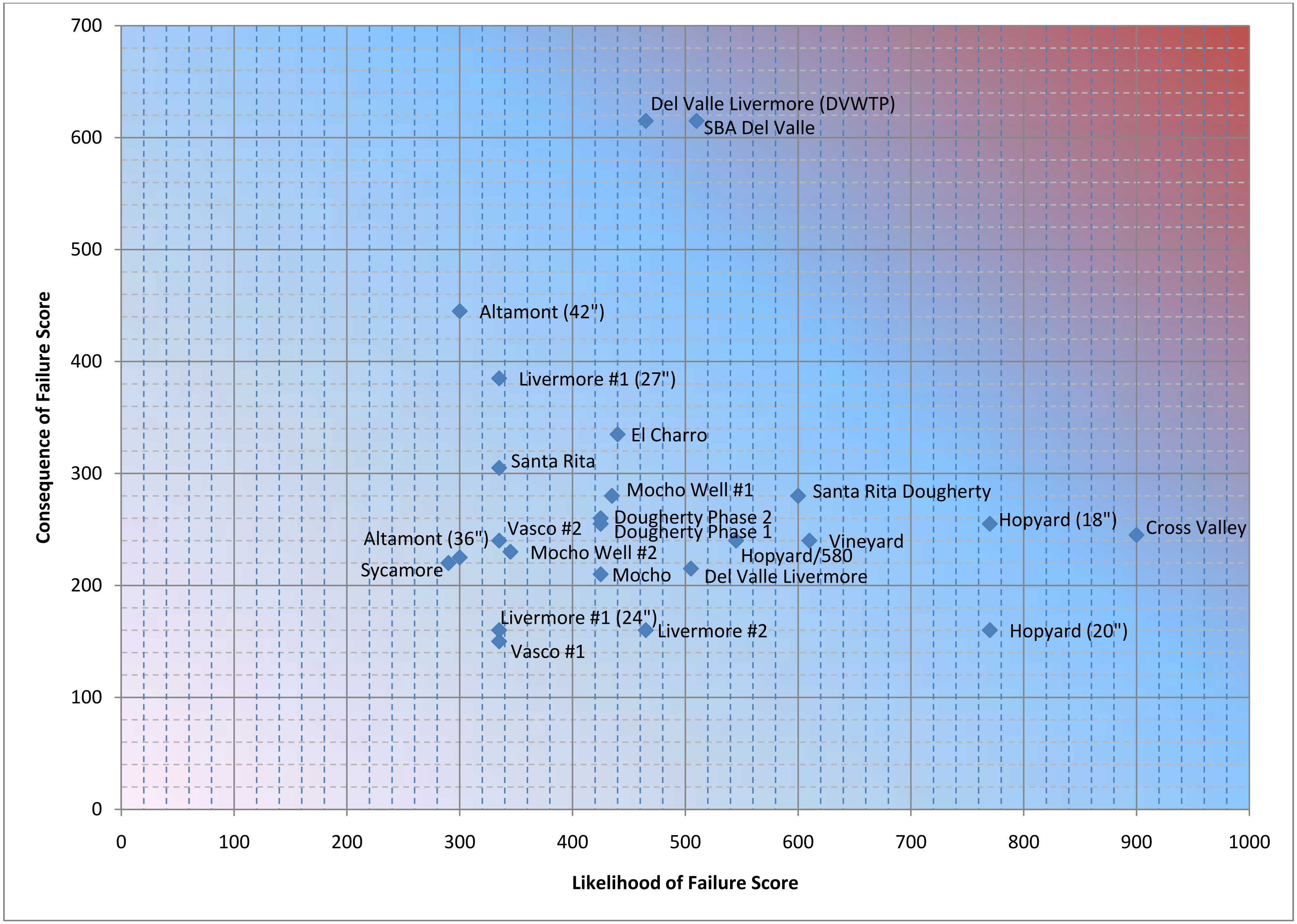


Figure 1. Risk Assessment Results

Table 5. Pipeline Prioritization for Condition Assessment and Inspection

Pipeline	Relative Risk Score	Comment on Ranking
SBA-Del Valle	313,650	Redundancy, diameter and soils
Del Valle-Livermore	285,975	Redundancy, diameter and material
Cross Valley	220,500	Diameter and previous failure at joints
Hopyard (18”)	196,350	Previous repairs, redundancy and age
Santa Rita-Dougherty	168,000	
El Charro - Phase 1	147,400	
Vineyard	146,400	
Altamont - Livermore Reach (42”)	133,500	
Hopyard (under 580)	130,800	
Livermore #1 (27”)	128,975	
Hopyard (20”)	123,200	
Mocho Well #1 Discharge	121,800	
Dougherty-Phase II	110,500	
Del Valle-Livermore	108,575	
Dougherty-Phase I	108,375	
Santa Rita	102,175	
Mocho	89,250	
Vasco #2	80,400	
Mocho Well #2 Discharge	79,350	
Livermore #2	74,400	
Altamont - Livermore Reach (36”)	67,500	
Sycamore	63,800	
Livermore #1 (24”)	53,600	
Vasco #1	50,250	

Condition assessment on underground assets should be a continuing effort for Zone 7. Zone 7 should update this risk evaluation annually to reflect any new data collected and any changes in criteria or weighting assumptions when doing risk evaluation and condition assessment. For example, Zone 7 may decide to add additional Likelihood of Failure criteria to its methodology for determining relative risk after completing condition assessments of one or more pipelines.

It is important to note that the proposed method is a prioritization method for ranking the pipelines based on information known to the evaluators. The pipelines are only ranked relative to each other in an effort to establish an initial priority for conducting condition assessments. Scores will change over time as data is collected and criteria weighting may change based on opinions at Zone 7. These changes will result in changes to the risk scores of each pipeline.

Appendix A

Pipeline Inventory

Appendix A - Table 1
Zone 7 Pipeline Inventory

Pipeline	Year Installed	Minimum Diameter (in)	Maximum Diameter (in)	Length (ft)	Material	Cylinder	Cylinder	Joint	Lining	Coating	Redundancy	Comments
Hopyard	1953	20	20-23.7	8,980	Concrete Cylinder	14 Gage	0.0747	R. Gasket	Cement 3/4"	Cement 1"	Yes	Originally built during WW2 for Parks AFB. Pipe replaced w/CCP w/unmortared joints in 1951.
Hopyard	1953	18	18-21.6	2,240	Concrete Cylinder	14 Gage	0.0747	R. Gasket	Cement 3/4"	Cement 1"	No	Originally built during WW2 for Parks AFB. Pipe replaced w/CCP w/unmortared joints in 1951.
Hopyard (under 580)	1953	20		458	Concrete Cylinder						Yes	30" steel casing under 580
Livermore #1	1962	27	27-28.9	10,920	Steel	3/16"	0.188	Welded	Cement 5/8"	Coal Tar	Yes	
Livermore #1	1962	24	24-25.6	10,450	Steel	8 Gage	0.1644	Welded	Cement 1/2"	Coal Tar	Yes	
Livermore #2	1962	24	24-27.3	9,580	Concrete Cylinder	10 Gage	0.1345	Welded	Cement 1/2"	Cement 1"	Yes	
Mocho	1991	24	24-27.875	8,004	Concrete Cylinder	3/16"	0.188	Welded	Cement 3/4"	Cement 1"	Yes	
Mocho Well #1 Discharge	1967	24	24-25.6	330	Steel	8 Gage	0.1644	Welded	Cement 1/2"	Coal Tar	No	
Mocho Well #2 Discharge	1969	12	12-14.08	600	Asbestos Cement	Class 200		R. Gasket			No	
Santa Rita-Dougherty	1962	24	24-25.6	12,870	Steel	8 Gage	0.1644	Welded	Cement 1/2"	Coal Tar	Yes	No casing under 580
Vasco #1	1964	18	18-19.8	2,800	Steel (42 KSI)	12 Gage	0.1046	R. Gasket w/bonding	Cement 3/8"	Coal Tar	Yes	
Vasco #2	1969	18	18-19.8	3,750	Steel	10 Gage	0.1345	R. Gasket w/bonding	Cement 1/2"	Coal Tar	Yes	welded inside 24"casing under 580
Cross Valley	1975	36	36-40.75	40,794	Concrete Cylinder	10 Gage	0.1345	R. Gasket w/bonding	Cement 1/2"	Cement 1"	Yes	Bell & Spigot joints. Full welded near bends, joints not welded on straights
Del Valle-Livermore	1975	36	36-40.75	14,156	Concrete Cylinder	10 Gage	0.1345	R. Gasket w/bonding	Cement 1/2"	Cement 1"	Yes	Bell & Spigot joints. Full welded near bends, joints not welded on straights
SBA-Del Valle	1975	48	48-51	914	Concrete Cylinder	10 Gage	0.1345	R. Gasket	Cement 3/4"	Cement	No	Bell & Spigot joints. Full welded near bends, joints not welded on straights
Del Valle-Livermore	1975	48	48-51	3,873	Concrete Cylinder	10 Gage	0.1345	R. Gasket w/bonding	Cement 3/4"	Cement	No	Bell & Spigot joints. Full welded near bends, joints not welded on straights
Dougherty-Phase I	1982	24	24.27.75	640	Concrete Cylinder	10 Gage	0.1345	Welded	Cement 3/4"	Cement 1"	No	
Dougherty-Phase II	1982	24	24.27.7	4,552	Concrete Cylinder	10 Gage	0.1345	Welded w/bonding	Cement 3/4"	Cement 1"	No	
Santa Rita	1984	16	16.53-17.4	2,731	Ductile Iron	0.34"	0.34	R. Gasket	Cement 3/32"	Poly Wrap(4)	No	
Sycamore	1991	12	12-13.2	12,319	PVC	0.733	0.733	R. Gasket			No	
Vineyard	1994	36	36-39.875	34,530	Concrete Cylinder	3/16"	0.188	Welded	Cement 3/4"	Cement 1"	Yes	
Altamont - Livermore Reach	2009	42	42	27,413	Steel	0.25"	0.25"	Welded	Cement	Cement	Yes	casing under 580
Altamont - Livermore Reach	2009	36	36	668	Steel	0.25"	0.25"	Welded	Cement	Cement	Yes	
El Charro - Phase 1	2009	36	36	4,652	Steel	0.188"	0.188"	Welded	Cement 3/8"	Cement 3/4"	No	305' of 48" diameter welded steel casing under Arroyo Mocho (0.625" wall)

Appendix A - Table 2
Criteria Metrics

Liklihood of Failure Criteria

Age	Score
0 - 10 Years	2
10 - 30 Years	4
30 - 50 Years	6
50+ Years	10

Material	Score
Polyvinyl chloride (PVC)	1
Asbestos cement pipe (ACP)	2
Ductile iron pipe (DIP)	4
Steel	8
Concrete cylinder pipe (CCP)	10

Soil Corrosivity	Score
Very low	1
Low	2
Medium	4
high	8
Very high	10

Soil Liquefaction	Score
Not liquefiable	1
Liquefiable	10

CP Survey	Score
No active corrosion	1
No CP system	5
Active corrosion	10

Consequence of Failure Criteria

Diameter	Score
< 12"	1
12" - 24"	4
24" - 36"	6
<36"	10

Length	Score
<4000 ft	1
4000-8000 ft	2
8000-12000 ft	3
12000-16000 ft	4
16000-20000 ft	5
20k-24k ft	6
24k-28k ft	7
28k-32k ft	8
32k-36k ft	9
>36k ft	10

Freeway Crossing	Score
No	1
Yes	10

Redundant Supply	Score
Yes	1
No; wells or turnouts	4
No; PP Supply	6
No: DV Supply	10

Ease of Repair	Score
Less Difficult / Costly	0
Difficult / Costly	1
More Difficult / Costly	2

Appendix A - Table 3

Likelihood of Failure Score

Pipeline	Age		Material		Repairs	Corrosivity	Liquefaction	Corrosion Survey
	Age	Score	Material	Score	Score	Score	Score	Score
Hopyard	57	10	Concrete Cylinder	10	10	4	1	5
Hopyard	57	10	Concrete Cylinder	10	10	4	1	5
Hopyard (under 580)	57	10	Concrete Cylinder	10	1	4	1	5
Livermore #1	48	6	Steel	8	1	4	1	1
Livermore #1	48	6	Steel	8	1	4	1	1
Livermore #2	48	6	Concrete Cylinder	10	1	4	1	5
Mocho	19	4	Concrete Cylinder	10	1	4	1	5
Mocho Well #1 Discharge	43	6	Steel	8	1	4	1	5
Mocho Well #2 Discharge	41	6	Asbestos Cement	2	1	4	1	5
Santa Rita-Dougherty	48	6	Steel	8	1	8	1	10
Vasco #1	46	6	Steel (42 KSI)	8	1	4	1	1
Vasco #2	41	6	Steel	8	1	4	1	1
Cross Valley	35	6	Concrete Cylinder	10	10	8	10	10
Del Valle-Livermore	35	6	Concrete Cylinder	10	1	8	1	5
SBA-Del Valle	35	6	Concrete Cylinder	10	1	4	10	5
Del Valle-Livermore	35	6	Concrete Cylinder	10	1	4	1	5
Dougherty-Phase I	28	4	Concrete Cylinder	10	1	4	1	5
Dougherty-Phase II	28	4	Concrete Cylinder	10	1	4	1	5
Santa Rita	26	4	Ductile Iron	4	1	4	1	5
Sycamore	19	4	PVC	1	1	4	1	5
Vineyard	16	4	Concrete Cylinder	10	5	8	10	5
Altamont - Livermore Reach	1	2	Steel	8	1	4	10	1
Altamont - Livermore Reach	1	2	Steel	8	1	4	10	1
El Charro - Phase 1	1	2	Steel	8	1	8	10	5

Appendix A - Table 4

Consequence of Failure Score

Pipeline	Diameter		Length		Freeway Crossing		Ease of Repair[1]	Redundant
	Diam (in)	Score	Length (ft)	Score	(y/n)	Score	Score	Score
Hopyard	20	4	8,980	3	n	1	0	1
Hopyard	18	4	2,240	1	n	1	0	4
Hopyard (under 580)	20	4	458	1	y	10	0	1
Livermore #1	27	6	10,920	3	n	1	0	6
Livermore #1	24	4	10,450	3	n	1	0	1
Livermore #2	24	4	9,580	3	n	1	0	1
Mocho	24	4	8,004	3	n	1	2	1
Mocho Well #1 Discharge	24	4	330	1	n	1	1	4
Mocho Well #2 Discharge	12	1	600	1	n	1	2	4
Santa Rita-Dougherty	24	4	12,870	4	y	10	1	1
Vasco #1	18	4	2,800	1	n	1	0	1
Vasco #2	18	4	3,750	1	y	10	0	1
Cross Valley	36	6	40,794	10	n	1	0	1
Del Valle-Livermore	36	6	14,156	4	n	1	0	1
SBA-Del Valle	48	10	914	1	n	1	0	10
Del Valle-Livermore	48	10	3,873	1	n	1	0	10
Dougherty-Phase I	24	4	640	1	n	1	0	4
Dougherty-Phase II	24	4	4,552	2	n	1	0	4
Santa Rita	16	4	2,731	1	n	1	2	4
Sycamore	12	1	12,319	4	n	1	1	4
Vineyard	36	6	34,530	9	n	1	0	1
Altamont - Livermore Reach[2]	42	10	27,413	7	y	10	1	1
Altamont - Livermore Reach[2]	36	6	668	1	n	1	1	1
El Charro - Phase 1[2]	36	6	4,652	2	n	1	1	4

Notes:

1 - Criterion was evaluated in the original AMP. The data were used as provided.

2 - Pipelines were not included in the original AMP analysis for Ease of Repair since they had not yet been installed. A value of 1 has been assigned for each pipeline.

Appendix A - Table 5
Risk Summary

Pipeline	Consequence of Failure Score	Likelihood of Failure Score	Risk = CoF x LoF	Rank
Hopyard (20”)	160	770	123,200	11
Hopyard (18”)	255	770	196,350	4
Hopyard (under 580)	240	545	130,800	9
Livermore #1 (27”)	385	335	128,975	10
Livermore #1 (24”)	160	335	53,600	23
Livermore #2	160	465	74,400	20
Mocho	210	425	89,250	17
Mocho Well #1 Discharge	280	435	121,800	12
Mocho Well #2 Discharge	230	345	79,350	19
Santa Rita-Dougherty	280	600	168,000	5
Vasco #1	150	335	50,250	24
Vasco #2	240	335	80,400	18
Cross Valley	245	900	220,500	3
Del Valle-Livermore	215	505	108,575	14
SBA-Del Valle	615	510	313,650	1
Del Valle-Livermore	615	465	285,975	2
Dougherty-Phase I	255	425	108,375	15
Dougherty-Phase II	260	425	110,500	13
Santa Rita	305	335	102,175	16
Sycamore	220	290	63,800	22
Vineyard	240	610	146,400	7
Altamont - Livermore Reach (42”)	445	300	133,500	8
Altamont - Livermore Reach (36”)	225	300	67,500	21
El Charro - Phase 1	335	440	147,400	6

Appendix D

Condition Assessment Program Implementation Plan

CONDITION ASSESSMENT PROGRAM

Asset Management Program Update ***May 2, 2011***

Introduction

This implementation plan describes planning for, approach to, and scheduling of condition assessments, as well as how to conduct the assessments using condition assessment forms. This document is intended to be dynamic in nature, such that it will be updated as Zone 7 continues to develop and augment its Condition Assessment Program (CAP). This document should be revisited and revised to include improvements to the CAP and reflect future lessons as they are learned and incorporated into the program.

The main purpose of developing a formal CAP is to provide Zone 7 with a process for systematic, consistent, and sustainable determination of an asset's condition in order to make informed maintenance, repair, and renewal decisions. Implementation of this program should elevate Zone 7's confidence in the condition of its assets when making investment decisions.

Background

Zone 7 conducted condition assessments in 2004, and again in 2006, the results of which were documented in Zone 7's asset registry. The condition rating method used in 2006 is similar to the condition rating method described in this plan with the exception that in 2006, it was assumed that at 50% of Remaining Useful Life (RUL) an asset would be scheduled for renewal. For long term project planning, assets are not scheduled for renewal until they reach the end of their Original Useful Life (OUL) or as they near 0% of their RUL. As a project shifts from long term to near term, the condition assessment of the affected assets becomes more important and inspection techniques may be escalated to more comprehensive tests to gain better confidence in the asset's RUL.

Role of Condition Assessment in the Asset Management Program

A *condition assessment* determines the physical deterioration of an asset, as well as the reliability (potential to fail) of the asset and the performance (capacity) of the asset in relation to the system in which it is installed. This differs from a *condition inspection,* which only determines an asset's position on a theoretical "physical mortality time line."

The following example is provided to illustrate the difference between condition inspection and condition assessment.

> A pump station installed in 1985 has four pumps, each with a capacity of 250 gpm, a pump station design capacity of 750 gpm, and a pump OUL of 30 years. Based on age alone, the equipment renewal of all the pumps would be scheduled for replacement in 2015. However, based on a condition inspection performed in 2010, it is determined that the pumps are in good condition and RUL is 50 percent. Thus, the pumps would have approximately 15 years of service life

remaining, and replacement of the pumps could be postponed from 2015 to 2025. This result is based on the *condition inspection*. To gain more confidence in the decision, a condition assessment is conducted. The *assessment* indicates that in 1985 the pump station design capacity was 750 gpm; however, in 2010, the peak operating requirement is 1200 gpm. Since the pump station is not meeting capacity requirements, the pump renewal project may need to accelerated to before 2015, rather than the delay indicated by the condition alone.

The output of the *condition assessment* serves two main purposes:

1. It determines if an asset is performing as expected and is being maintained at, or greater than, the predetermined asset condition targets, and

2. It is used to estimate the RUL of the asset in order to plan for near- and long-term renewal projects and funding thereof.

Levels of Assessment

Condition assessments should be scalable, elevating in complexity based on the importance, cost, and apparent defects of a respective asset, as needed. There are 3 levels of condition assessment:

- Level 1 – Visual Observation and Interview
- Level 2 – Evaluation and Decisions
- Level 3 – Nondestructive Testing

A more detailed explanation of each inspection level is provided in the *Performing a Condition Assessment* section of this document.

Condition Assessment Planning

The CAP must reflect and support Zone 7's work practices in order to be sustainable. In addition, key elements of the Asset Management Program (AMP) must be in place and updated. For example, as new equipment, processes, and/or facilities are constructed, it is important to incorporate new assets into the asset registry.

To support the development of the CAP, Zone 7's existing assets were grouped into asset classes, as described further below.

Asset Class Definition

Asset classes are groupings of assets/equipment that share similar functions and characteristics (e.g., pumps, valves, etc.). Zone 7's assets were grouped into asset classes based on three main criteria:

1. Perform a similar function, and
2. Operate in a similar environment, and
3. Due to the first two criteria, the assets typically have the same OUL.

By combining similar assets into classes, certain characteristics can be defined, assigned, or tracked at the asset class level which facilitates more efficient data management and decision making. These characteristics include:

- Asset Condition Targets (ACT). ACTs are predetermined condition levels (defined in Zone 7's Maintenance Strategy) that the equipment must meet or exceed. If the condition of the equipment drops below the ACT during a maintenance inspection or condition assessment, then the maintenance plan for the equipment is adjusted or the level of inspection is escalated respectively.

- Original Useful Life (OUL). OUL is defined at the asset class level by default, but can be adjusted for individual assets. Adjustments at the asset level are usually due to the operating environment or maintenance applied. As a rule, to enhance project planning and maintenance strategies, the OUL of an asset should only be revised at the time of installation or purchase date. After this revision, only the RUL should be adjusted and planning activities should be based on the revised RUL.

- Failure Modes. As Zone 7 collects additional data on its assets as they age and fail, that data can be analyzed at the asset class level to identify typical failure modes.

- Condition Inspection Criteria. These criteria include the asset class specific inspection checks that should be incorporated on a maintenance inspection preventive maintenance (PM) work order, as well as the more detailed checks found on the Asset Class Condition Assessment Form (refer to Appendix B for example forms). The checks guide the inspector or Condition Assessment Team (CAT) in determining the condition of an asset in a manner that is consistent between asset inspections within the asset class.

Initial Asset Classes

Approximately two dozen asset classes were initially developed for the CAP, which are summarized in Appendix A. Table 1 describes the information documented with each asset class for several example asset classes.

The asset class characteristics included in Table 1 are described below:

1. **Asset Class** – a grouping of equipment that share similar functions and characteristics.

2. **Useful Life Years** – The default OUL assigned to the asset class.

3. **Useful Life Source** – For the purpose of developing references and standards it is recommended that Zone 7 cite the source of the OUL. In addition to those shown in Table 1, references include IRS Publication 946 Table B and the Chartered Institute of Building Services (CIBSE). Other sources can be used in the future as they become available.

Table 1. Example of Asset Classes and Characteristics

Asset Class	Useful Life (Years)	Useful Life Source	Description	Applicable Level 3 Testing
Pump	30	Engineers Judgment	Includes vertical turbine, centrifugal, piston, rotary lobe, diaphragm, and progressive cavity.	1. Vibration Analysis 2. Performance Testing of Rotating Machinery 3. Motor Circuit Analysis
Motor – Electrical	30	Manufacturer's Estimate	AC only	1. Current Monitoring 2. Insulation Testing 3. Motor Circuit Analysis
Valve	25	Engineers Judgment	Includes all common valves found in water treatment with exception of stop logs.	1. Valve Exercising 2. Acoustic Emission
Valve with Actuator	25	Engineers Judgment		1. Valve Exercising 2. Acoustic Emission 3. Current Monitoring
Tank	50	Engineers Judgment	Treatment plant tanks only. Does not include storage reservoirs. Concrete basins and tanks can be grouped with the structural asset class.	1. Magnetic Flux Leakage
Pump – Chemical	20	Engineers Judgment		1. Performance Testing of Rotating Machinery 2. Pull-off Adhesion Testing
Tank – Chemical	15	Engineers Judgment		1. Pull-off Adhesion Testing 2. Penetrating Dye Testing
Chemical System	15	Owner Judgment		1. System Specific / Generate per Manufacturer's Specification
Piping – Above Ground	20	Failure Analysis		

4. **Description** – short description of typical equipment found in the asset class.

5. **Applicable Level 3 Testing** – If a condition assessment is to be escalated to a Level 3 nondestructive test (NDT), then the test should have a reference and be applicable to the asset class. The Water Research Foundation's *Condition Assessment Strategies – Appendix F, Review of Condition Assessment Tools and Techniques* has been used in identifying the NDTs presented in Table 1.

Additional Asset Classes

The asset classes described above, and further listed in Appendix A, represent an initial breakout of Zone 7's assets. As Zone 7 completes more condition assessments and further develops both the AMP and CAP, asset classes may be added or modified to better categorize assets, such as the following:

- **Pumps –** Typically, all pumps serve the same purpose but may not operate in similar environments. For example, to adjust for differences due to environment, chemical pumps have already been assigned a specific asset class. Since pump types inherently have different useful lives, it is recommended that the pump asset class be divided into more pump types such as vertical turbine, centrifugal, piston, diaphragm, progressive cavity, peristaltic and others per Zone 7's experience and as relevant to Zone 7's assets.

- **Instruments/Analyzers/Meter -** The OUL for this asset class is 15 years; however, this OUL may or may not reflect each asset's actual expected service life. Since condition inspections and assessments are performed at the asset level, and typically there are numerous instrumentation assets installed in each facility, the labor effort and planning coordination involved can be significant. In order to address instruments in the CAP, it is recommended that the instrument asset class be further divided by application such as: level indicators, pressure indicators, flow metering, flow meters – small diameter, flow meters – large diameter, flow meters - venturi, analyzer – chlorine, analyzer – turbidity and others per Zone 7's needs. Assessing a group of instrument types by application will decrease the labor effort, while providing a better defined renewal project.

- **Structural –** It is recommended that the existing structural asset class be divided by functional purpose such as buildings, roofs, process basin and others per Zone 7's needs.

- **SCADA –** SCADA (supervisory control and data acquisition) is a general term used to describe assets related to the automation and control of equipment, and includes communications, networks and archiving of data. These assets generally have a short OUL and generally have obsolescence failure modes. SCADA is listed in Zone 7's asset registry as an asset at each treatment plant. However, in order to properly plan near term renewal projects, it is recommended that 'SCADA' be broken down further into a finer level of detail and entered into the asset registry, including an estimate of their RUL. The asset classes listed below should be developed; their respective components are also identified.

  - SCADA
    - Software
    - Galaxy server
    - Workstations (PC and local view nodes)
  - Control Cabinets
    - RTUs
    - Racks
    - Conduit / Wire
    - Local Displays
    - PLC software
    - UPS
    - Ventilation and Cooling
  - Communication
    - Radio
    - Microwave
    - T1
    - Routers and Switches
    - Converters
    - Poles / Masts / Antennas
    - Ventilation and Cooling

Condition Assessment Approach

Condition assessments must be performed with an awareness of the individual asset's role in the system, process, and/or facility in which it functions. The most effective approach to a condition assessment is to conduct multiple assessments within a certain process or facility as one coordinated activity. Since program driven condition assessments should be scheduled by asset class, there may be several asset classes represented in a process or facility.

A process / facility level assessment can be planned or triggered based on the following factors:

- The highest rated critical asset in the process / facility.
- The asset (or group of assets) with the most expensive replacement cost.
- A performance issue (e.g., capacity, functional deficiency, obsolescence).
- As part of the decision making process to replace the parent process / facility.

Grouping the condition assessments will depend on the facility characteristics. Some treatment processes are proprietary requiring tailored assessments. Other treatment processes may have one core technology with supporting equipment. If the core technology is replaced, then supporting equipment no longer serves any function and it may also require replacement. The following subsections describe methods for grouping condition assessments.

Individual Asset Condition Assessments

Individual condition assessments are performed on very critical assets that are near the end of their useful life. As a rule of thumb, individual asset condition assessments should only be performed on equipment with replacement costs of $25,000 or more. Typically if the replacement cost of the asset is less than $25,000, then the cost to conduct a full assessment may not provide a payback. However, the CAT leader should consider feasible groupings of equipment or systems, such as a process or facility, to better reflect condition and performance of treatment units. For example, Raw Water Pump #1 may be scheduled for a condition assessment. The CAT leader should consider performing a condition assessment on both Raw Water Pump #1 and #2, as well as the pump motors and variable frequency drives. This facilitates a more comprehensive understanding of the overall condition and performance of the raw water pump station, and can provide better project planning.

Asset Class

Since the condition assessment is typically conducted at the asset or equipment level, there are some cases where a condition assessment would not be performed because an individual asset’s replacement cost does not exceed the $25,000 threshold (e.g., instruments and analyzers). Replacing, for example, one or two flow meters may not trigger a condition assessment due to the low replacement cost. However, if 10 or more of the same type of flow meter are installed throughout the plant, and the RUL is close to 0%, or there is an obsolescence failure issue, then a condition assessment is warranted for all 10 flow meters. In addition, to perform 10 or more individual condition assessments on a recurring cycle is a significant labor effort. By grouping the 10 flow meters into asset classes, the effort is significantly decreased, but near- and long-term planning is enhanced.

Equipment Specific

Equipment that is proprietary or that cannot be grouped into a typical asset class should be assigned a unique asset class. This may be due to unique features of the asset like OUL, failure modes, replacement procedures and/or inspection techniques. In this case, a new asset class should be defined and a new asset class condition assessment form should be developed specific to the equipment. Candidates for an equipment specific condition assessment may include the following:

- Membranes at the Patterson Pass Ultrafiltration Facility
- R/O modules at the Mocho Demineralization Facility
- Well casings
- On-Site Sodium Hypochlorite Generation Facilities
- Ozonation Processes
- Other skid or package type chemical feed systems

Site or Process Specific

Some treatment processes are difficult to assess using the asset class based condition assessment forms due to a unique function or design. In this case, a new asset class and condition assessment form should be developed specific to the process. Examples include:

- Del Valle WTP Superpulsator
- Del Valle WTP Filters
- Patterson Pass WTP Filters
- Turnouts

Condition Assessment Scheduling

The need to clearly understand the condition and performance of Zone 7's assets must be balanced with the amount of effort (and cost) to collect the information. To perform a condition assessment on all the assets would be a large effort. A more practical approach is needed to apply the right amount of effort to the right assets. The following should be considered when determining if a condition assessment should be performed:

- Condition assessments should only be performed on critical assets. Critical assets are defined as "an asset critical to Zone 7's ability to provide continuous service to its retailers or maintain safety for employees, the retailers, and the public."

- The replacement cost of the asset. Typically if the replacement cost of the asset is less than $25,000, then the cost to conduct a full assessment may not provide a payback.

- The level (degree of complexity) of the assessment should be phased or escalated based on criticality, redundancy and/or observed defects. Assets that are "single points of failure" or which have limited redundancy should warrant more attention. For example, power distribution assets have a higher consequence of failure, are generally more expensive to repair or replace, and have significant safety aspects. These assets may not benefit from visual observations or a Level 1 condition assessment, and thus, may warrant a Level 3 condition assessment (i.e., non-destructive testing) performed by a third party who has the necessary skills and equipment.

There are two parallel processes used to ensure that an asset's condition is being monitored on a consistent basis:

1. Equipment inspections performed by maintenance staff as part of an annual preventive maintenance work order, and
2. Program driven (scheduled) AMP condition assessments.

Equipment inspections are recommended such that condition assessments are not scheduled too frequently, but can be initiated if the condition or performance of the asset does not meet its ACT. Figure 1 illustrates the progression of each of these processes.

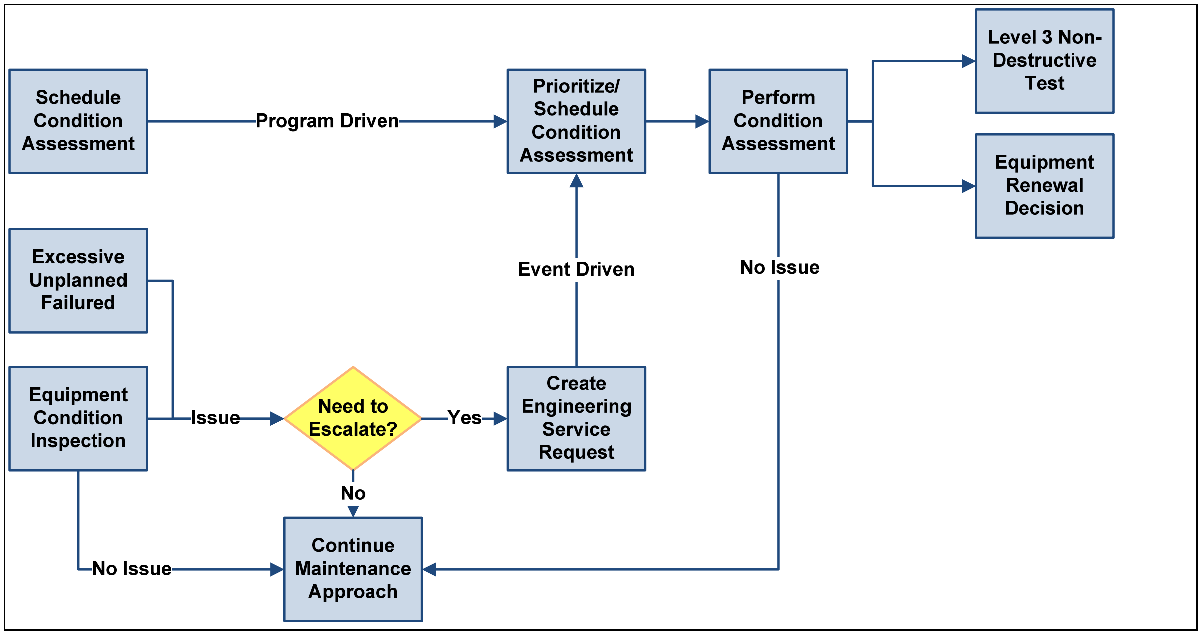


Figure 1. Program and Event Driven Condition Assessments

Equipment Condition Inspections

Zone 7 maintenance staff should schedule an abbreviated inspection process on critical assets as part of a regularly scheduled annual preventive maintenance work order[1]. Suggested inspection survey questions include the following:

- Is the equipment non-operational due to an existing failure?
- Is the equipment experiencing excessive vibration?
- Are the seals leaking or are the bearings failing?
- Is the equipment operating at higher-than-normal or recommended temperatures?
- Are important components of the equipment significantly eroded, corroded, or otherwise worn?

[1] Recommend that the inspection is nested into a typical PM task for that asset class. For example, if pump oil is replaced annually, then the inspection could be scheduled at the same time. The goal is to avoid extra work and documentation.

- Is the equipment operating at lower than normal output (e.g., flow) or pressure?
- Are replacement parts for the equipment difficult or impossible to obtain?
- Is the equipment technologically obsolete due to the introduction of new designs and technology?

In general, if a piece of equipment fails an inspection (i.e., several of the questions are answered "yes") then either a maintenance adjustment should be initiated or an Engineering Service Request (ESR) would be initiated to perform a condition assessment. To make this determination, the technician performing the inspection will discuss the event with the Operations Manager, Maintenance Manager, and the O&M Support Engineer before initiating an ESR for a condition assessment.

Program Driven Condition Assessments

The frequency of condition assessments is partly driven by the length of the OUL and partly by the resources available. Since equipment condition inspections are to be performed at least annually, as described above, the risk of an asset prematurely failing before an assessment occurs is reduced. Therefore, while a program driven condition assessment is scheduled on a regularly occurring basis, the time between assessments can be adjusted as appropriate. The following two scheduling strategies are recommended:

1. Short OUL Assets – For assets that have an OUL of less than 15 years, and a replacement cost of less than $25,000, a condition assessment should be scheduled at 20% to 25% of the asset's RUL. For example, if a group of turbidity analyzers installed in 2000 have a 15 year OUL, then a condition assessment should be scheduled for 2011 or 2012.

2. Long OUL Assets – For assets that have an OUL of 15 years or greater, a rule of thumb is to divide the OUL by 5 to determine the minimum frequency of performing a condition assessment. For example, if a pump has a 30 year OUL, then a condition assessment should be scheduled at least every 6 years.

As assets age and have less RUL, condition assessments can be scheduled more frequently, as determined by staff.

Event Driven Condition Assessments

In addition to discovering failures during annual equipment inspections or during scheduled condition assessments, it is also possible that an asset could fail (as indicated in Figure 1). If an asset has more than two unplanned failures, over a two year period, then the Maintenance Manager and the O&M Support Engineer should determine if an ESR should be initiated for a condition assessment.

Criteria that should be discussed before initiating an ESR include the following:

- What is the consequence of failure?
- What is the replacement cost of the equipment and does the cost require a capital expenditure?
- Can the condition of the equipment be improved by adjusting maintenance practices?
- Is the wear or failure common to similar assets?
- Can the equipment be replaced by “like kind”?
- If the equipment is replaced, does the replacement trigger replacement of other assets in the system, process, and/or facility?
- Is there more efficient equipment that can accelerate the payback period?

Performing a Condition Assessment

The following subsections describe the roles and responsibilities for a condition assessment, how to prepare for the assessment, how to use the condition assessment forms, and how to escalate to a Level 2 or Level 3 assessment.

Roles and Responsibilities

Condition assessments should be performed by a condition assessment team (CAT). Depending on the type of asset(s) being assessed, team members may include:

- Structural Engineer
- Facility Engineer
- Facility Operations Supervisor
- Operator
- Maintenance Supervisor
- Mechanic
- Electrician
- Instrument Technician

The Facility Engineer is responsible for determining and/or adjusting the frequency of condition assessments, scheduling condition assessments, and forming the CAT, as well as the following tasks:

- Leading the condition assessment.
- Following through on an escalated condition inspection (nondestructive test) or equipment renewal decision process.
- Documenting the condition assessment in the appropriate database.
- Coordinating with project planners and financial staff to ensure capital projects are created, adjusted, or revised, as necessary.

The Maintenance Supervisor is also responsible for determining and/or adjusting the frequency of condition inspections, in collaboration with the Facility Engineer, as well as:

- Following through on failed condition inspections.
- Assisting with the development of the ESR, if required.

- Providing repair or failure history, if available.
- Providing maintenance, electrical or instrumentation staff, as necessary, to support the CAT.

The Operations Supervisor is responsible for:

- Working with the Facility Engineer to ensure SCADA data for identified assets is available.
- Providing capacity requirements and performance history of assets, if available.
- Assisting with the development of the ESR, if required.
- Identifying and assigning an operator who is knowledgeable of the system /process being assessed to support the CAT.

Preparation

Based on the facility, process or system which will be assessed, the CAT leader should determine which asset classes will be included in the condition assessment and gather the respective condition assessment forms. In addition, the leader should determine if the assessment needs to be coordinated with a particular operating condition; for example:

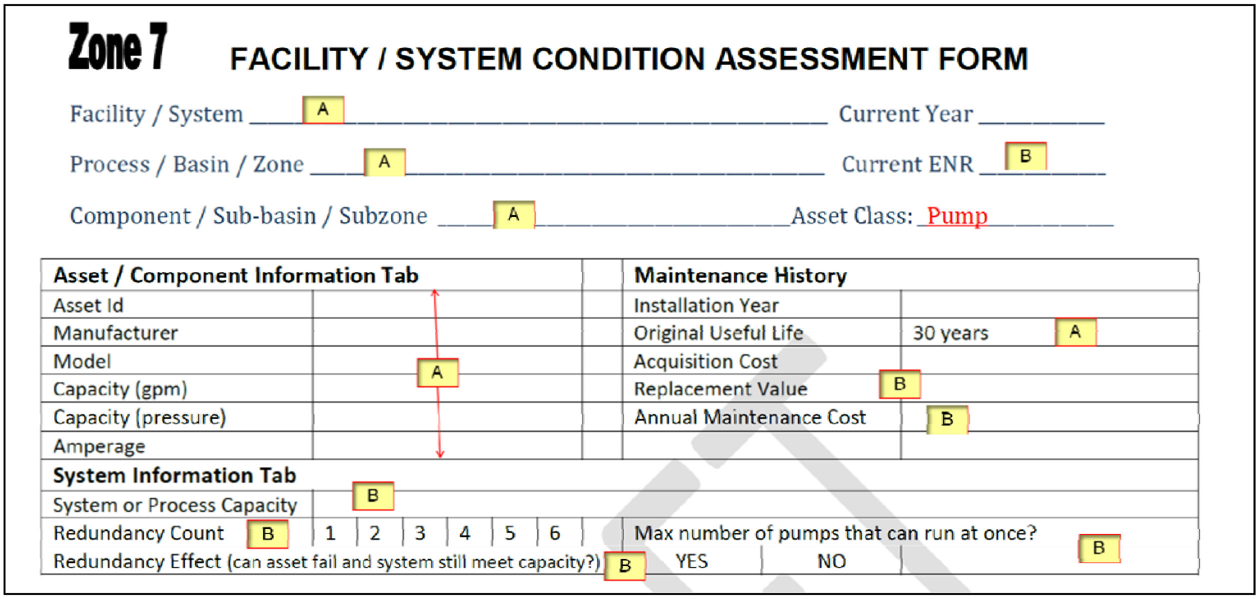
- Ability to run equipment (i.e., in cases where equipment operation may be intermittent)
- Filter cells removed from service for inspection
- Tank, basin, or structure drained
- Plant flow requirement
- Pump station flow requirement
- Well Station flow requirement

Condition Assessment Forms

Condition assessment forms were developed to guide the CAT in performing condition assessments. The following subsections describe how to use the forms to collect the required information.

Asset Physical Attributes

Figure 2 illustrates the physical attribute data to be collected for a pump asset. Each of the labeled items is described below.



Zone 7 FACILITY / SYSTEM CONDITION ASSESSMENT FORM

Facility / System ____A____________________ Current Year __________

Process / Basin / Zone ____A____________________ Current ENR ___B___

Component / Sub-basin / Subzone ____A____________ Asset Class: Pump__________

Asset / Component Information Tab			Maintenance History	
Asset Id	A		Installation Year	
Manufacturer			Original Useful Life	30 years A
Model			Acquisition Cost	
Capacity (gpm)			Replacement Value B	
Capacity (pressure)			Annual Maintenance Cost	B
Amperage				
System Information Tab				
System or Process Capacity	B			
Redundancy Count B	1 | 2 | 3 | 4 | 5 | 6		Max number of pumps that can run at once?	B
Redundancy Effect (can asset fail and system still meet capacity?) B			YES	NO

Figure 2. Condition Assessment Form Header

A This information should be obtained from the asset registry, prior to the condition assessment. Note that the OUL should only be adjusted at the asset level during initial installation; thereafter, only the RUL should be adjusted.

B This information should be completed at the start of the Level 1 condition assessment:

- Replacement values developed during previous assessment need to be updated.
- Annual maintenance cost is obtained from the CMMS.
- System or process capacity is based on design capacity.
- Redundancy count is established based on whether there is sufficient redundancy to meet the capacity requirements.

Level 1 Inspection Criteria

Figure 3 illustrates the Level 1 inspection criteria. The red arrows pointing to the “M” and “E” in the response boxes indicate that if that response is selected, an action is required. If an “M” is selected, a maintenance adjustment may be needed. If an “E” is selected, the assessment may need to be escalated to a Level 2.

Figure 4 illustrates the rating scales and rating descriptions for condition, reliability, and capacity.

If your answer is in this box with an "E" it may trigger an escalating inspection,
If your answer is in this box with an "M" it may trigger a maintenance adjustment

B

	Level 1 - Inspection Criteria	YES	NO	N/A
1	Equipment tag & nameplate permanently affixed?			
2	Pumps is in place and properly grouted			
3	Pump environment is clean?			
4	Field alignment is correct? (Cold and Hot alignment performed?)			
5	Power disconnects are in place and labeled?			
6	Adequate access for maintenance?			
7	Vibration isolation devices are installed and functional?			
8	Temperature, pressure, flow gages and sensors properly installed?			
9	Required valves installed & in right direction?			
10	Pump is lubricated?			
11	Visible leaks at fittings?			
12	Capable of running when inspected? *(If no, stop inspection and determine if asset can run)*			
13	Any indication of over greasing?	*M*		
14	Pipe fittings complete and pipes properly supported?		*M*	
15	Required critical spares available?		*M*	
16	If belt or chain drive, is belt deflection per manufacturer specification?		*M*	
17	Mechanical seal or packing is leaking?		*M*	
24	If close coupled, any indication of misalignment?	*M*		
18	Start and stop pump, any indication of loose drive shafts, belts, guards?		*M*	
19	Is equipment still supported by the manufacturer?		*E or M*	
20	Excessive vibration?	*E*		
21	Excessive noise?	*E*		
22	Excessive corrosion?	*E*		
23	Running hot?	*E*		
25	Motor amps within rating? (Follow site Flash-Arc Program)		*E*	

Figure 3. Level 1 Inspections

C Based on the results of inspection shown in Figure 3, the CAT should subjectively rate the condition of the asset. The following guidelines are recommended:

- If more than one question is answered with an "E" designation, then the asset should not be rated higher than a 2.
- If one question is answered with an "E" designation, then the asset should be rated no higher than a 3, unless there is a maintenance solution.

D Based on the condition rating defined in C, the estimated RUL is assigned to the asset, and the AMP database should be updated accordingly.

If a condition rating of 2 or less is assigned. Escalate to Level 2 or initiate decision process for equipment renewal

Condition Rating C	Description	D Percentage of Remaining Useful Life	Maintenance Benchmark
5	New or Excellent Condition	100%	Normal Preventive Maintenance
4	Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
2	Significant Deterioration	25%	Rehabilitation, if possible
1	Virtually Unserviceable	1%	replace
0	Unknown		

Discuss with a knowledgeable field technician or end user about the reliability of the asset and the system it operates in. If reliability rating is 2 or less consider escalating inspection. Use the rating scale below.

Reliability Rating E	Description	Failure Timing F	Probability of Failure Estimate
5	As specified by the manufacturer	No known failures	0%
4	Random Breakdown	Every 15 years	10%
3	Occasional Breakdown	Every 10 years	50%
2	Periodic Breakdown	Every 5 years	75%
1	Continuous Breakdown	At least once / year	100%

Discuss with a knowledgeable field technician and end user about the performance / capacity of the asset within the system it operates in. If capacity rating is 3 or less consider escalating to Level 2 and/or Level 3 testing.
Use the rating scale to the right.

Capacity Rating G	Description
5	Exceeds required capacity
4	Meets required capacity
3	Minor capacity and/or performance issues
2	Significant capacity deficient
1	Out of service

Figure 4. Condition, Reliability, and Capacity Rating Scales

E The reliability rating should be based on maintenance history provided by knowledgeable CAT members. The resulting reliability rating should be entered into the AMP database as an estimated probability of failure. The reliability rating can be considered as a quality assurance check. For example, the CAT can work through the inspection criteria for a pump and determine the condition rating is a 4. However, input provided by Operators and/or Mechanics could reveal that the pump was just rebuilt (major repairs) and painted, and it has a history of breaking down annually. This information would lead the team to adjust the condition rating score lower to either a 2 or 3.

F Failure timing is an informed estimate based on the experience of knowledgeable team members. The history may be anecdotal for several years until failure history is collected in the CMMS. Once a sufficient amount of failure history is collected, the reliability rating section of the condition assessment should be replaced with a failure analysis process. As described in the *AMP Charter - Equipment Renewal Decision Process*, two or more unplanned failures make the equipment a candidate for replacement. If the CAT assigns a reliability rating of 2 or less, then the condition assessment should be escalated to a Level 2.

G The capacity rating is a measure of performance of the asset within its parent system. A rating of 4 or 5 requires no action, whereas a rating of 3 may require an escalation to a Level 2 assessment depending on the situation. The asset may not meet design capacity, but is meeting or exceeding actual peak operating demand.

Based on the results of the condition, capacity and reliability ratings, an appropriate output or action must be determined. The following guidelines are recommended:

- If the condition rating is above the ACT (shown as condition rating of 3), the reliability rating is above 3, and the capacity rating is 4 or above, then the assessment is complete. The condition assessment summary section (see Figure 6 and discussion in the following subsections) should be completed and data should be uploaded into the AMP database.
- If the condition rating is below the ACT, then the CAT escalates the condition assessment to Level 2.
- If a reliability rating of 2 or less is assigned, then the CAT escalates the condition assessment to Level 2.
- If a capacity rating of 3 or less is assigned, then the CAT escalates the condition assessment to Level 2.

Escalating to a Higher Level Inspection or Equipment Renewal Decision

Figure 5 illustrates the Level 2 questions, H, that should be answered to determine what the next step in the process should be. Each question is described below.

If a result of the condition inspection or a reliability rating indicates escalating to a higher level of inspection then consider the following

Level 2 Tasks Questions H		YES	NO
1	If reliability rating is 2 or less can breakdown history be verified?		
2	Is a common failure noted for the inspected asset?		
3	Describe this common failure		
4	Does the severity of repairs indicate a replacement or overhaul decision is necessary?		
5	Does the visual inspection of the asset indicate a potential failure?		
6	Is a Level 3 Condition Inspection test recommended?		

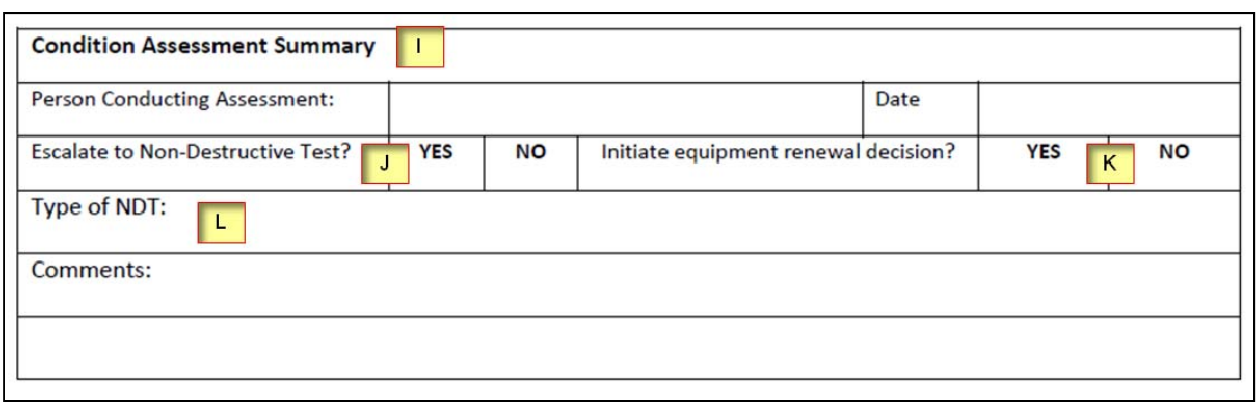
Figure 5. Level 2 Questions

1. **If reliability rating is 2 or less, can the breakdown history be verified?** The purpose of this question is to make sure the CAT is being provided accurate information. A decision to initiate an equipment renewal or justifying the cost for nondestructive testing should be based on accurate maintenance history.
2. **Is a common failure noted for the inspected asset?** The purpose of this question is to collect failure data and to understand equipment failures and, as appropriate, collect data to support development of asset class failure modes. This will be useful in future AMP updates and support the development of statistical failure models.

3. **Describe this common failure?** Same purpose as #2.
4. **Does the severity of repairs indicate a replacement or overhaul decision is necessary?** The purpose of this question is to determine if:
   - An emergency repair is required, or
   - An equipment renewal decision should be initiated, or
   - To obtain better information, a Level 3 nondestructive test should be initiated.
5. **Does the visual inspection of the asset indicate a potential failure?** The purpose of this question is to determine the urgency of returning the asset to meet or exceed its ACT. This question is similar to question 4, but assumes the asset is still in service.
6. **Is a Level 3 condition inspection test recommended?** The purpose of this question is to determine if the expense and effort of a Level 3 nondestructive test is justified. The following guidelines are recommended:
   - If the asset is still in service, if the asset is not in a failure mode, and the urgency of the repair is not immediate then time is available to conduct a Level 3 Test. If time is not available then initiate either an emergency repair or an equipment renewal decision.
   - With time available, the CAT must decide if the information obtained from a Level 3 test will increase confidence in the equipment renewal decision or the information will not bring any more value to the decision. If no value is gained from a Level 3 Test, then an equipment renewal decision should be initiated.
   - If the information obtained from the Level 3 test is of value, the CAT must decide if the cost is justified in relation to the asset's replacement cost. If the cost of the inspection is not justified then an equipment renewal decision should be initiated.

Condition Assessment Summary

Figure 6 illustrates the condition assessment summary section of the form.



Condition Assessment Summary I					
Person Conducting Assessment:			Date		
Escalate to Non-Destructive Test? J	**YES**	**NO**	Initiate equipment renewal decision?	**YES** K	**NO**
Type of NDT: L					
Comments:					

Figure 6. Condition Assessment Summary

I The condition assessment summary section should be used to ensure the assessment is properly closed out. The CAT leader should enter their name and the date of the inspection.

J If the assessment is completed at Level 1, then NO is entered on the form for the nondestructive test. If a nondestructive test is scheduled, then mark YES.

K If the assessment is completed at Level 1, then enter NO. If the result of the Level 2 assessment was to initiate an equipment renewal, indicate YES.

L If the assessment is completed at Level 1, then N/A is entered. If a nondestructive test was scheduled, indicate the type of test per the asset class definition.

Once the form is complete, the results of the condition assessment should be documented in the AMP database.

Appendix A

Asset Classes

Asset Class	Useful Life (Years)	Useful Life Source	Assessment Frequency	Description	Applicable Level 3 Testing
Pump	30	Engineers Judgment	6	Includes vertical turbine, centrifugal, piston, rotary lobe, diaphragm, and progressive cavity.	1. Vibration Analysis, 2. Performance Testing of Rotating Machinery 3. Motor Circuit Analysis
Motor - Electrical	30	Engineers Judgment	6	AC only.	1. Current Monitoring, 2. Insulation Testing 3. Motor Circuit Analysis
Valve	25	Engineers Judgment	5	Includes all common valves found in water treatment with exception of stop logs	1. Valve Exercising 2. Acoustic Emission
Valve w/ Actuator	25	Engineers Judgment	5		1. Valve Exercising 2. Acoustic Emissions 3. Current Monitoring
Tank	50	Engineers Judgment	10	Treatment plant tanks only. Concrete basins and tanks can be grouped into structural asset class	1. Magnetic Flux Leakage
Pump - Chemical	15	Engineers Judgment	3		1. Performance Testing of Rotating Machinery 2. Pull-off Adhesion Testing
Tank - Chemical	15	Engineers Judgment	3		1. Pull-off Adhesion Testing
Chemical Systems	15	Engineers Judgment	3		1. System Specific. Generate per Manufacturer's Specification
Piping - Buried	75	Engineers Judgment	25		
Piping - Above Ground	40	Owners Judgment	8		1. Acoustic Emissions / Active Acoustic Emissions 2. Ultrasonic Measurements, Discrete 3. Visual Inspection of Pipe 4. CCTV
Structural / Architectural	75	Owners Judgment	10	Major concrete structures Buildings	1. Crack Measurement Tools
Civil / Sitework	75	Owners Judgment	10		
Rotating Equipment	25	Engineers Judgment	5	Rotating equipment other than pumps and motors (e.g., blowers, air compressors, fans (except HVAC), and conveyors)	1. Performance Testing of Rotating Machinery 2. Oil Testing
Power Distribution	30	Engineers Judgment	3	Including power transformers, busses, switchgear, MCC panels, lighting panels	1. Thermographic / Infra-red 2. Ductor (Micro Ohm) testing 3. Oil Testing 4. Transformer Circuit Protection Coordination and Protection Relays 5. NETA

Power Generation	30	Engineers Judgment	3	Includes permanent and portable diesel and gas backup generators	1. Performance Testing of Rotating Machinery 2. Oil Testing 3. NETA
Power Distribution - Variable Frequency Drives	20	Manufacturer Estimate	4		1. Process Control Systems (On-line Monitoring) 2. NETA
Filtration - Media	25	Engineers Judgment	5		1. Process Control Systems (On-line Monitoring) 2. AWWA Filter Evaluation Procedures
Filtration – UF Membranes	5	Owners Judgment	Yearly		1. Process Control Systems (On-line Monitoring) 2. System Specific. Generate per Manufacturer's Specification
Filtration – RO Membranes	5	Owners Judgment			1. Process Control Systems (On-line Monitoring) 2. System Specific. Generate per Manufacturer's Specification
Well - Sonic	50	Owners Judgment	TBD		TBD
Well - Nested	50	Owners Judgment	TBD		TBD
Well – Hollow Stem Auger	50	Owners Judgment	TBD		TBD
Boiler	25	Manufacturer Estimate	5		1. Thermographic / Infra-red
HVAC	15	CIBSE (Chartered Institute of Building Services)	Year 12		1. Thermographic / Infra-red
SCADA	5		Year 4		N/A
Control Cabinets	15				N/A
Communication	10				N/A
Instrumentation, Radios	5	Engineers Judgment			
Instrumentation, Turbidimeters	10	Engineers Judgment			
Instrumentation, Analyzers	15	Engineers Judgment			
Instrumentation, General	30	Engineers Judgment			

Appendix B

Condition Assessment Forms

Contents

Zone 7

ASSET CLASS CONDITION ASSESSMENT FORM

Facility / System ______________________________ Current Year __________

Process / Basin / Zone ______________________________ Current ENR __________

Component / Sub-basin / Subzone ____________________Asset Class: Above Ground Pipe

Asset / Component Information Tab							**Maintenance History**		
Asset Id							Installation Year		
Manufacturer							Original Useful Life	40 years	
Material							Acquisition Cost		
Diameter							Replacement Value		
Joint Type							Annual Maintenance Cost		
Application									
System Information Tab									
System or Process Capacity									
Redundancy Count	1	2	3	4	5	6	Max number of units that can run at once?		
Redundancy Effect (can asset fail and system still meet capacity?)							YES	NO	

If your answer is in this box with an "E" it may trigger an escalating inspection,
If your answer is in this box with an "M" it may trigger a maintenance adjustment

	Level 1 - Inspection Criteria	**YES**	**NO**	**N/A**
1	Process identified with flow arrow permanently affixed?			
2	Pipe is in place and properly secured?			
3	Seismic restraints in place?			
4	Does paint shows signs of peeling or bubbling?			
5	Is PVC pipe protected from UV if installed outside?			
6	Is there adequate access for replacement?			
7	Inspect pipes external surface for any defects, delamination, bubbling, cracking, or spalling?			
8	Inspect pipes internal surface for any defects, delamination, bubbling, cracking, or spalling?			
9	Any visible leaks at fittings or joints?	*M*		
10	Does the pipe support foundation show signs of cracking or rebar protruding?	*M*		
11	Does the pipe support foundation show signs of cracking or rebar protruding?	*M*		
12	Are there signs of excessive corrosion on steel pipes?	*E*		
13	Note any discoloration or surface defects. Does the defect give or feel spongy?	*E*		
	Optional: Determine pipe thickness using an Ultrasonic Discrete Measurement if at 0% RUL			

If a condition rating of 2 or less is assigned. Escalate to Level 2 or initiate decision process for equipment renewal

Condition Rating	Description	Percentage of Remaining Useful Life	Maintenance Benchmark
5	New or Excellent Condition	100%	Normal Preventive Maintenance
4	Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
2	Significant Deterioration	25%	Rehabilitation, if possible
1	Virtually Unserviceable	1%	replace
0	Unknown		

Discuss with a knowledgeable field technician or end user about the reliability of the asset and the system it operates in. If reliability rating is 2 or less consider escalating inspection. Use the rating scale below.

Reliability Rating	Description	Failure Timing	Probability of Failure Estimate
5	Failure not anticipated	No known failures	0%
4	Minor leaks	Every 30 years	10%
3	Minor leaks	Every 15 years	50%
2	Major leak in the last	2 years	75%
1	Continuous patching	At least once / year	100%

Discuss with a knowledgeable field technician and end user about the performance / capacity of the asset within the system it operates in. If performance rating is 3 or less consider escalating to Level 2 and/or Level 3 testing.
Use the rating scale to the right.

Capacity Rating	Description
5	Exceeds required capacity
4	Meets required capacity
3	Minor capacity and/or performance issues
2	Significant capacity deficient
1	Out of service

If a result of the condition inspection or a reliability rating indicates escalating to a higher level of inspection then consider the following

	Level 2 Tasks Questions	YES	NO
1	If reliability rating is 2 or less can breakdown history be verified?		
2	Is a common failure noted for the inspected asset?		
3	Describe this common failure		
4	Does the severity of repairs indicate a replacement or overhaul decision is necessary?		
5	Does the visual inspection of the asset indicate a potential failure?		
6	Is a Level 3 Condition Inspection test recommended?		

Condition Assessment Summary						
Person Conducting Assessment:				Date		
Escalate to Non-Destructive Test?	**YES**	**NO**	Initiate equipment renewal decision?		**YES**	**NO**
Type of NDT:						
Comments:						

Zone 7

ASSET CLASS CONDITION ASSESSMENT FORM

Facility / System ______________________________ Current Year __________

Process / Basin / Zone ______________________________ Current ENR __________

Component / Sub-basin / Subzone ______________________ Asset Class: Pump-Chemical

Asset / Component Information Tab			**Maintenance History**	
Asset Id			Installation Year	
Manufacturer			Original Useful Life	20 Years
Model			Acquisition Cost	
Capacity (gph)			Replacement Value	
Capacity (pressure)			Annual Maintenance Cost	
Amperage				

System Information Tab									
System or Process Capacity									
Redundancy Count	1	2	3	4	5	6		Max number of pumps that can run at once?	
Redundancy Effect (can asset fail and system still meet capacity?)							YES	NO	

If your answer is in this box with an "E" it may trigger an escalating inspection,
If your answer is in this box with an "M" it may trigger a maintenance adjustment

Inspection Criteria		**YES**	**NO**	**N/A**
1	Equipment tag & nameplate permanently affixed?			
2	Pump is in place and properly secured?			
3	Pump environment is clean?			
5	Power disconnects are in place and labeled?			
6	Adequate access for maintenance?			
7	Splash guards are installed and functional?			
8	Leak detection, pressure, flow gages and sensors properly installed?			
9	Visible leaks at fittings?			
10	Required valves installed & in right direction?			
11	Capable of running when inspected? *(If not, stop inspection and determine if asset can run?)*			
12	Start and stop pump, any indication of loose drive shafts, belts, guards?	*M*		
13	Pump is lubricated?		*M*	
14	Any indication of over greasing?	*M*		
15	Air/vacuum reliefs or off gas vent valves properly installed and functional?		*M*	
16	If close coupled, any indication of misalignment?	*M*		
17	Pipe fittings complete and pipes properly supported?		*M*	
18	Equipment is entered into CMMS?		*M*	
19	Mechanical seal or packing is leaking?		*M*	
20	Parts for maintenance available and still supported by vendor?		*E or M*	
21	Material appropriate for chemical application?		*E*	
22	Excessive vibration?	*E*		
23	Excessive noise?	*E*		
24	Excessive corrosion?	*E*		
25	Running hot?	*E*		
26	Motor amps within rating? (Follow site Flash-Arc Program)		*E*	

If a condition rating of 2 or less is assigned. Escalate to Level 2 or initiate decision process for equipment renewal

Condition Rating	Description	Percentage of Remaining Useful Life	Maintenance Benchmark
5	New or Excellent Condition	100%	Normal Preventive Maintenance
4	Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
2	Significant Deterioration	25%	Rehabilitation, if possible
1	Virtually Unserviceable	1%	replace
0	Unknown		

Discuss with a knowledgeable field technician or end user about the reliability of the asset and the system it operates in. If reliability rating is 2 or less consider escalating inspection. Use the rating scale below.

Reliability Rating	Description	Failure Timing	Probability of Failure Estimate
5	Failure Not Anticipated	No known failures	0%
4	Random Breakdown	Every 20 years	10%
3	Occasional Breakdown	Every 10 years	50%
2	Periodic Breakdown	Every 2 years	75%
1	Continuous Breakdown	At least once / year	100%

Discuss with a knowledgeable field technician and end user about the performance / capacity of the asset within the system it operates in. If capacity rating is 3 or less consider escalating to Level 2 and/or Level 3 testing.
Use the rating scale to the right.

Capacity Rating	Description
5	Exceeds required capacity
4	Meets required capacity
3	Minor capacity and/or performance issues
2	Significant capacity deficient
1	Out of service

If a result of the condition inspection or a reliability rating indicates escalating to a higher level of inspection then consider the following

Level 2 Tasks Questions		YES	NO
1	If reliability rating is 2 or less can breakdown history be verified?		
2	Is a common failure noted for the inspected asset?		
3	Describe this common failure		
4	Does the severity of repairs indicate a replacement or overhaul decision is necessary?		
5	Does the visual inspection of the asset indicate a potential failure?		
6	Is a Level 3 Condition Inspection test recommended?		

Condition Assessment Summary					
Person Conducting Assessment:			Date		
Escalate to Non-Destructive Test?	**YES**	**NO**	Initiate equipment renewal decision?	**YES**	**NO**
Type of NDT:					
Comments:					

Zone 7

ASSET CLASS CONDITION ASSESSMENT FORM

Facility / System ______________________________ Current Year __________

Process / Basin / Zone ______________________________ Current ENR __________

Component / Sub-basin / Subzone ____________________ Asset Class: Tank - Chemical

Asset / Component Information Tab			**Maintenance History**	
Asset Id			Installation Year	
Manufacturer			Original Useful Life	15 years
Model			Acquisition Cost	
Size / Volume			Replacement Value	
Material			Annual Maintenance Cost	
Application				
System Information Tab				
System or Process Capacity				
Redundancy Count	1 2 3 4 5 6		Max number of pumps that can run at once?	
Redundancy Effect (can asset fail and system still meet capacity?)			YES	NO

If your answer is in this box with an "E" it may trigger an escalating inspection,
If your answer is in this box with an "M" it may trigger a maintenance adjustment

	Level 1 - Inspection Criteria	**YES**	**NO**	**N/A**
	Record volume or level of tank during inspection			
1	Equipment tag & nameplate permanently affixed?			
2	Tank is in place and properly secured? Seismic restraints in place?			
3	Pipe fittings and/or nozzles complete and pipes properly supported?			
4	If the tanks has strainer on the outlet side, inspect and note type of debris			
5	Is overflow pipe secured to tank and routed to drain or sump?			
6	Is there adequate access for maintenance?			
7	Hazard and chemical notification signs are installed, visible and applicable to the chemical?			
8	Leak detection alarm tested? Notification or annunciation properly triggered?			
9	Leak detection installed properly and operational?		*M*	
10	Any visible leaks at fittings and/or nozzles?	*M*		
11	Level sensors properly installed?		*M*	
12	Level indication provided and accurate?		*M*	
13	If secondary containment is provided does sealant shows signs of peeling or bubbling?	*E / M*		
14	Tank support and foundation material appropriate for the chemical application?		*E*	
15	Inspect tanks external surface for any defects, delamination, bubbling, cracking, or spalling?	*E*		
16	Inspect tanks internal surface for any defects, delamination, bubbling, cracking, or spalling?	*E*		
17	Are there signs of excessive corrosion on steel tanks?	*E*		
18	Note any discoloration or surface defects. Does the defect give or feel spongy?	*E*		
19	Are there any cracks? (if crack is more than 1/3 of shell thickness, remove from service)	*E*		
20	Does the foundation show signs of cracking or rebar protruding from supports or floor?	*E*		

If a condition rating of 2 or less is assigned. Escalate to Level 2 or initiate decision process for equipment renewal

Condition Rating	Description	Percentage of Remaining Useful Life	Maintenance Benchmark
5	New or Excellent Condition	100%	Normal Preventive Maintenance
4	Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
2	Significant Deterioration	25%	Rehabilitation, if possible
1	Virtually Unserviceable	1%	replace
0	Unknown		

Discuss with a knowledgeable field technician or end user about the reliability of the asset and the system it operates in. If reliability rating is 2 or less consider escalating inspection. Use the rating scale below.

Reliability Rating	Description	Failure Timing	Probability of Failure Estimate
5	Failure Not Anticipated	> 15 years	0%
4	NA	NA	NA
3	Patch or major rehab	Every 10 years	50%
2	Patch or excessive leaks, deformation	Within past 2 years	75%
1	Patch or excessive leaks, deformation	Within past year	100%

Discuss with a knowledgeable field technician and end user about the performance / capacity of the asset within the system it operates in. If capacity rating is 3 or less consider escalating to Level 2 and/or Level 3 testing.
Use the rating scale to the right.

Capacity Rating	Description
5	Exceeds required capacity
4	Meets required capacity
3	Minor capacity and/or performance issues
2	Significant capacity deficient
1	Out of service

If a result of the condition inspection or a reliability rating indicates escalating to a higher level of inspection then consider implementing the following

	Level 2 Tasks Questions	YES	NO
1	If reliability rating is 2 or less can breakdown history be verified?		
2	Is a common failure noted for the inspected asset?		
3	Describe this common failure		
4	Does the severity of repairs indicate a replacement or overhaul decision is necessary?		
5	Does the visual inspection of the asset indicate a potential failure?		
6	Is a Level 3 Condition Inspection test recommended?		

Condition Assessment Summary					
Person Conducting Assessment:			Date		
Escalate to Non-Destructive Test?	**YES**	**NO**	Initiate equipment renewal decision?	**YES**	**NO**
Type of NDT:					
Comments:					

Zone 7

ASSET CLASS CONDITION ASSESSMENT FORM

Facility / System ______________________________ Current Year __________

Process / Basin / Zone ______________________________ Current ENR __________

Component / Sub-basin / Subzone ____________________Asset Class: Filtration - Media

Note: Coordinate with Plant Operations Supervisor. Filter may be inspected by external contractors

Asset / Component Information Tab			**Maintenance History**	
Asset Id			Installation Year	
Under drain Manufacturer			Original Useful Life	25 years
Size / Volume			Acquisition Cost	
Depth			Replacement Value	
Media Material			Annual Maintenance Cost	
Under drain Type				
System Information Tab				
System or Process Capacity	Average Hydraulic Load (gal/ft^2)		Peak Hydraulic Load (gal/ft^2)	
Redundancy Count	1 2 3 4 5 6		Max number of units that can run at once?	
Redundancy Effect (can asset fail and system still meet capacity?)		YES	NO	

If your answer is in this box with an "E" it may trigger an escalating inspection,
If your answer is in this box with an "M" it may trigger a maintenance adjustment

Level 1 - Inspection Criteria		**YES**	**NO**	**N/A**
	This form assumes the filter cell is offline but ready for operation with filter media in place.			
	Drain filter and record level of media in a grid pattern.			
1	Is a mandatory individual filter assessment being conducted due to a turbidity level greater than 1.0 NTU in two consecutive measurements taken 15 minutes apart in each of three consecutive months?	*E*		
2	Is the filter experiencing short filter runs?			
3	Is the filter experiencing abnormal post-backwash turbidity spikes?			
4	Is there any indication of cratering or mounding of the media?			
5	Are there any visible mudballs on the surface?			
6	With the filter drained below the surface of the media, are there any cracks on the surface?			
7	With the filter drained below the surface of the media, is media separating from the walls?			
8	Pipe fittings complete and pipes properly supported?			
9	Inspect the washwater troughs, any signs of cracking, delaminating, or any other defects?			
10	Inspect filter cell concreter coating. Any signs of peeling, bubbling, or excessive wear	*M*		
11	Level sensors properly installed?		*M*	
12	Level indication provided and accurate?		*M*	
13	Inspect the surface wash, any signs of excessive corrosion?		*M*	
14	Any visible leaks at fittings and/or protrusions into the filter cell?	*E*		
15	Inspect filter's external surface for any defects, delamination, bubbling, cracking, or spalling?	*E*		
16	Does the filter walls or foundation show signs of cracking or protruding rebar?	*E*		
17	Inspect filter's visible internal surface, any protruding rebar?	*E*		
18	Any indication or reports of media accumulating in the clearwell?	*E*		
19	Any indication of vortexing when draining filter?	*E*		
20	Measure the gravel footprint; is a severe disruption of 3" or greater present?	*E*		
21	Does a core sample show a satisfactory media interface?		*E*	
22	Optional: Conduct a sieve test. Does the media uniformity coefficient meet AWWA B100?		*E*	

If a condition rating of 2 or less is assigned. Escalate to Level 2 or initiate decision process for equipment renewal

Condition Rating	Description	Percentage of Remaining Useful Life	Maintenance Benchmark
5	New or Excellent Condition	100%	Normal Preventive Maintenance
4	Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
2	Significant Deterioration	25%	Rehabilitation, if possible
1	Virtually Unserviceable	1%	replace
0	Unknown		

Discuss with a knowledgeable field technician or end user about the reliability of the asset and the system it operates in. If reliability rating is 2 or less consider escalating inspection. Use the rating scale below.

Reliability Rating	Description	Failure Timing	Probability of Failure Estimate
5	Failure Not Anticipated	No known failures	0%
4	Random Breakdown	Every 15 years	10%
3	Occasional Breakdown	Every 10 years	50%
2	Periodic Breakdown	Every 5 years	75%
1	Continuous Breakdown	At least once / year	100%

Discuss with a knowledgeable field technician and end user about the performance / capacity of the asset within the system it operates in. If capacity is **3** or less consider escalating to Level 2 and/or Level 3 testing. Use the rating scale to the right.

Capacity Rating	Description
5	Exceeds required capacity
4	Meets required capacity
3	Minor capacity and/or performance issues
2	Significant capacity deficient
1	Out of service

If a result of the condition inspection or a reliability rating indicates escalating to a higher level of inspection then consider implementing the following

Level 2 Tasks Questions		YES	NO
1	If reliability rating is 2 or less can breakdown history be verified?		
2	Is a common failure noted for the inspected asset?		
3	Describe this common failure		
4	Does the severity of repairs indicate a replacement or overhaul decision is necessary?		
5	Does the visual inspection of the asset indicate a potential failure?		
6	Is a Level 3 Condition Inspection test recommended?		

Condition Assessment Summary					
Person Conducting Assessment:			Date		
Escalate to Non-Destructive Test?	**YES**	**NO**	Initiate equipment renewal decision?	**YES**	**NO**
Type of NDT:					
Comments:					

Zone 7

ASSET CLASS CONDITION ASSESSMENT FORM

Facility / System ____ Current Year __________

Unit or Train ____ Current ENR __________

Module / Rack ____________________________________ Asset Class: __Ultrafiltration-Membranes

Asset / Component Information Tab							Maintenance History	
Asset Id							Installation Year	
Manufacturer							Module Install Year	
Size / Volume							Original Useful Life	7 years
							Acquisition Cost	
							Replacement Value	
							Annual Maintenance Cost	
System Information Tab								
System or Process Capacity								
Redundancy Count	1	2	3	4	5	6	Max number of units that can run at once?	
Redundancy Effect (can asset fail and system still meet capacity?)							YES	NO

If your answer is in this box with an "E" it may trigger an escalating inspection,
If your answer is in this box with an "M" it may trigger a maintenance adjustment

	Level 1 Inspection Criteria	YES	NO	N/A
	Retrieve data from North Canyons SCADA data historian			
	Assessment to be performed annually			
1	Permeability of module has decrease below _____(4.5 gfd/psi)_____________ ?			
2	Frequency of Pressure Decay Test failure is more than __________per xxxx operating hours?			
3	Fiber break count (in operator Excel log) exceeds ________________ breaks?			
4				
5				

If a condition rating of 2 or less is assigned. Escalate to Level 2 or initiate decision process for equipment renewal

Condition Rating	Description	Percentage of Remaining Useful Life	Maintenance Benchmark
5	New or Excellent Condition	100%	No gluing of fibers
4	Minor Defects Only	75%	Some gluing of fibers, less than 2 AIT failures
3	Moderate Deterioration	50%	Several gluing events, more than 2 AIT failures
2	Significant Deterioration	25%	Multiple AIT failures, maximum fibers glued
1	Virtually Unserviceable	1%	Removed from service
0	Unknown		

Discuss with a knowledgeable field technician or end user about the reliability of the asset and the system it operates in. If reliability rating is 2 or less consider escalating inspection. Use the rating scale below.

Reliability Rating	Description	Failure Timing	Probability of Failure Estimate
5	Failure Not Anticipated	No known failures	0%
4	Random Breakdown	Every hours	10%
3	Occasional Breakdown	Every hours	50%
2	Periodic Breakdown	Every hours	75%
1	Continuous Breakdown	Every hours	100%

Discuss with a knowledgeable field technician and end user about the performance / capacity of the asset within the system it operates in. If capacity rating is 3 or less consider escalating to Level 2 and/or Level 3 testing. Use the rating scale to the right.

Capacity Rating	Description
5	Exceeds required capacity
4	Meets required capacity
3	Minor capacity and/or performance issues
2	Significant capacity deficient
1	Out of service

If a result of the condition inspection or a reliability rating indicates escalating to a higher level of inspection then consider implementing the following

Level 2 Tasks Questions		YES	NO
1	If reliability rating is 2 or less can breakdown history be verified?		
2	Is a common failure noted for the inspected asset?		
3	Describe this common failure		
4	Does the severity of repairs indicate a replacement or overhaul decision is necessary?		
5	Does the visual inspection of the asset indicate a potential failure?		
6	Is a Level 3 Condition Inspection test recommended?		

Condition Assessment Summary					
Person Conducting Assessment:			Date		
Escalate to Non-Destructive Test?	**YES**	**NO**	Initiate equipment renewal decision?	**YES**	**NO**
Type of NDT:					
Comments:					

Zone 7

ASSET CLASS CONDITION ASSESSMENT FORM

Facility / System ____ Current Year __________

Process / Basin / Zone ____ Current ENR __________

Component / Sub-basin / Subzone _________________________Asset Class: _Instrumentation / Analyzers_

Asset / Component Information Tab							**Maintenance History**		
Asset Id							Installation Year		
Manufacturer							Original Useful Life	15 years	
Model							Acquisition Cost		
Type or Application							Total Replacement Value		
Measurement Range							Annual Maintenance Cost		
Probe shelf life							Probe / Element Cost		
Probe life in process									
System Information Tab									
System or Process Installed									
Redundancy Count	1	2	3	4	5	6	Max number of same units in service at once?		
Redundancy Effect (can asset fail and system still meet capacity?)							YES	NO	

If your answer is in this box with an "E" it may trigger an escalating inspection,
If your answer is in this box with an "M" it may trigger a maintenance adjustment

	Level 1 - Inspection Criteria	**YES**	**NO**	**N/A**
1	Equipment tag & nameplate permanently affixed?			
2	Are wiring diagrams and/or P&ID's up to date?			
3	Adequate access for maintenance?			
4	Material appropriate for application?			
5	For flowmeters, is the element installed with recommended upstream & downstream straight pipe lengths?			
6	Capable of running when inspected? (Stop inspection and reschedule when in operation)			
7	UV or splash guards are installed, appropriate and functional?		*M*	
8	Visible leaks at fittings, sampling ports and/or connection to pipes?	*M*		
9	Fittings complete and pipes/ conduit properly supported?		*M*	
10	Are electrical conduit connections complete and intact?		*M*	
11	Wiring terminations loose or showing signs of corrosion?	*M*		
12	Parts for maintenance available and stocked on-site?		*M*	
13	Are there spare parts available from the manufacturer for the next 5 years?		*M*	
14	Transmitter, instrument housing, probes, and/or element casings show signs of damage?	*E*		
15	Analyzers probe body cracked or rusted through?	*E*		
16	Does the instrument drift or have as history of calibration errors?	*E*		
17	Is the software and/or hardware more than 2 versions old? Check with manufacturer.	*E/M*		
18	Are there technical support issues? Explain in comments.	*E*		
19	Is local display readable?		*E*	

If a condition rating of 2 or less is assigned. Escalate to Level 2 or initiate decision process for equipment renewal

Condition Rating	**Description**	**Percentage of Remaining Useful Life**	**Maintenance Benchmark**
5	New or Excellent Condition	100%	Normal Preventive Maintenance
4	Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
2	Significant Deterioration	25%	Rehabilitation, if possible
1	Virtually Unserviceable	1%	replace
0	Unknown		

Discuss with a knowledgeable field technician or end user about the reliability of the asset and the system it operates in. If reliability rating is 2 or less consider escalating inspection. Use the rating scale below.

Reliability Rating	**Description**	**Failure Timing**	**Probability of Failure Estimate**
5	Failure Not Anticipated	No known failures	0%
4	Random Breakdown	Every 10 years	10%
3	Occasional Breakdown	Every 5 years	50%
2	Periodic Breakdown	Every 2 years	75%
1	Continuous Breakdown	At least once / year	100%

Discuss with a knowledgeable field technician and end user about the performance / capacity of the asset within the system it operates in. If capacity rating is 2 or less consider escalating to Level 2 and/or Level 3 testing. Use the rating scale to the right.

Capacity Rating	**Description**
5	Exceeds required capacity
4	Meets required capacity
3	Minor capacity and/or performance issues
2	Significant capacity deficient
1	Out of service

If a result of the condition inspection or a reliability rating indicates escalating to a higher level of inspection then consider the following

	Level 2 Tasks Questions	YES	NO
1	If reliability rating is 2 or less can breakdown history be verified?		
2	Is a common failure noted for the inspected asset?		
3	Describe this common failure		
4	Does the severity of repairs indicate a replacement or overhaul decision is necessary?		
5	Does the visual inspection of the asset indicate a potential failure?		
6	Is a Level 3 Condition Inspection test recommended?		

Condition Assessment Summary					
Person Conducting Assessment:			Date		
Escalate to Non-Destructive Test?	**YES**	**NO**	Initiate equipment renewal decision?	**YES**	**NO**
Type of NDT:					
Comments:					

Zone 7

ASSET CLASS CONDITION ASSESSMENT FORM

Facility / System ______________________________ Current Year __________

Process / Basin / Zone ______________________________ Current ENR __________

Component / Sub-basin / Subzone ____________________ Asset Class: Electric Motor

Asset / Component Information Tab			**Maintenance History**	
Asset Id			Installation Year	
Manufacturer			Original Useful Life	30 years
Model			Acquisition Cost	
HP			Replacement Value	
Voltage / Amperage			Annual Maintenance Cost	
Frame				
RPM				
System Information Tab				
System or Process Capacity				
Redundancy Count	1 2 3 4 5 6		Max number of units that can run at once?	
Redundancy Effect (can asset fail and system still meet capacity?)			YES	NO

If your answer is in this box with an "E" it may trigger an escalating inspection,
If your answer is in this box with an "M" it may trigger a maintenance adjustment

	Level 1 - Inspection Criteria	**YES**	**NO**	**N/A**
	Perform on motors 25 HP and above or on critical equipment.			
	Follow all electrical safety policies including the site specific Flash-Arc program			
1	Equipment tag & nameplate permanently affixed?			
2	Power disconnects are in place and labeled?			
3	Adequate access for maintenance?			
4	Environment is ventilated and at proper ambient temperature?			
5	Parts for maintenance available?			
6	Motor mounted properly to frame?		*M*	
7	Field alignment is correct? (Cold and Hot alignment performed?)		*M*	
8	If belt drive, is belt deflection per manufacturer specification?		*M*	
9	If close coupled, any indication of misalignment? (look for coupling damage or debris)	*M*		
10	Vibration isolation devices are installed and functional?		*M*	
11	Any indication of over greasing?	*M*		
12	Start and stop pump, any indication of loose drive shafts, belts, guards?	*M*		
13	Is motor technical and parts support available from manufacturer?		*E*	
14	Excessive vibration?	*E*	*M*	
15	Excessive noise?	*E*		
16	Excessive corrosion?	*E*		
17	Frame running hot?	*E*		
18	Bearings running hot?	*E*		
19	Any discoloration on the motor leads or J-box that would indicate excessive heat?	*E*		
20	If submersible pump, does insulation testing of power leads indicate deterioration?	*E*		
21	Measure the full load amps after 30 minutes of run time. Is reading per nameplate data?	*E*		

If a condition rating of 2 or less is assigned. Escalate to Level 2 or initiate decision process for equipment renewal

Condition Rating	Description	Percentage of Remaining Useful Life	Maintenance Benchmark
5	New or Excellent Condition	100%	Normal Preventive Maintenance
4	Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
2	Significant Deterioration	25%	Rehabilitation, if possible
1	Virtually Unserviceable	1%	replace
0	Unknown		

Discuss with a knowledgeable field technician or end user about the reliability of the asset and the system it operates in. If reliability rating is 2 or less consider escalating inspection. Use the rating scale below.

Reliability Rating	Description	Failure Timing	Probability of Failure Estimate
5	Failure Not Anticipated	No known failures	0%
4	Random Breakdown	Every 30 years	10%
3	Occasional Breakdown	Every 10 years	50%
2	Periodic Breakdown	Every 5 years	75%
1	Continuous Breakdown	At least once / year	100%

Discuss with a knowledgeable field technician and end user about the performance / capacity of the asset within the system it operates in. If capacity rating is 3 or less consider escalating to Level 2 and/or Level 3 testing.
Use the rating scale to the right.

Capacity Rating	Description
5	Exceeds required capacity
4	Meets required capacity
3	Minor capacity and/or performance issues
2	Significant capacity deficient
1	Out of service

If a result of the condition inspection or a reliability rating indicates escalating to a higher level of inspection then consider implementing the following

Level 2 Tasks Questions		YES	NO
1	If reliability rating is 2 or less can breakdown history be verified?		
2	Is a common failure noted for the inspected asset?		
3	Describe this common failure		
4	Does the severity of repairs indicate a replacement or overhaul decision is necessary?		
5	Does the visual inspection of the asset indicate a potential failure?		
6	Is a Level 3 Condition Inspection test recommended		

Condition Assessment Summary					
Person Conducting Assessment:			Date		
Escalate to Non-Destructive Test?	YES	NO	Initiate equipment renewal decision?	YES	NO
Type of NDT:					
Comments:					

Zone 7 ASSET CLASS CONDITION ASSESSMENT FORM

Facility / System ______________________________ Current Year __________

Process / Basin / Zone ______________________________ Current ENR __________

Component / Sub-basin / Subzone ______________________Asset Class: Pump__________

Asset / Component Information Tab			Maintenance History	
Asset Id			Installation Year	
Manufacturer			Original Useful Life	30 years
Model			Acquisition Cost	
Capacity (gpm)			Replacement Value	
Capacity (pressure)			Annual Maintenance Cost	
Amperage				

System Information Tab										
System or Process Capacity										
Redundancy Count	1	2	3	4	5	6		Max number of pumps that can run at once?		
Redundancy Effect (can asset fail and system still meet capacity?)								YES	NO	

If your answer is in this box with an "E" it may trigger an escalating inspection,
If your answer is in this box with an "M" it may trigger a maintenance adjustment

Level 1 - Inspection Criteria		YES	NO	N/A
1	Equipment tag & nameplate permanently affixed?			
2	Pumps is in place and properly grouted			
3	Pump environment is clean?			
4	Field alignment is correct? (Cold and Hot alignment performed?)			
5	Power disconnects are in place and labeled?			
6	Adequate access for maintenance?			
7	Vibration isolation devices are installed and functional?			
8	Temperature, pressure, flow gages and sensors properly installed?			
9	Required valves installed & in right direction?			
10	Pump is lubricated?			
11	Visible leaks at fittings?			
12	Capable of running when inspected? *(If no, stop inspection and determine if asset can run)*			
13	Any indication of over greasing?	*M*		
14	Pipe fittings complete and pipes properly supported?		*M*	
15	Required critical spares available?		*M*	
16	If belt or chain drive, is belt deflection per manufacturer specification?		*M*	
17	Mechanical seal or packing is leaking?	*M*		
24	If close coupled, any indication of misalignment?	*M*		
18	Start and stop pump, any indication of loose drive shafts, belts, guards?		*M*	
19	Is equipment still supported by the manufacturer?		*E or M*	
20	Excessive vibration?	*E*		
21	Excessive noise?	*E*		
22	Excessive corrosion?	*E*		
23	Running hot?	*E*		
25	Motor amps within rating? (Follow site Flash-Arc Program)		*E*	

If a condition rating of 2 or less is assigned. Escalate to Level 2 or initiate decision process for equipment renewal

Condition Rating	Description	Percentage of Remaining Useful Life	Maintenance Benchmark
5	New or Excellent Condition	100%	Normal Preventive Maintenance
4	Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
2	Significant Deterioration	25%	Rehabilitation, if possible
1	Virtually Unserviceable	1%	replace
0	Unknown		

Discuss with a knowledgeable field technician or end user about the reliability of the asset and the system it operates in. If reliability rating is 2 or less consider escalating inspection. Use the rating scale below.

Reliability Rating	Description	Failure Timing	Probability of Failure Estimate
5	Failure Not Anticipated	No known failures	0%
4	Random Breakdown	Every 20 years	10%
3	Occasional Breakdown	Every 10 years	50%
2	Periodic Breakdown	Every 2 years	75%
1	Continuous Breakdown	At least once / year	100%

Discuss with a knowledgeable field technician and end user about the performance / capacity of the asset within the system it operates in. If the capacity rating is 3 or less consider escalating to Level 2 and/or Level 3 testing. Use the rating scale to the right.

Capacity Rating	Description
5	Exceeds required capacity
4	Meets required capacity
3	Minor capacity and/or performance issues
2	Significant capacity deficient
1	Out of service

If a result of the condition inspection or a reliability rating indicates escalating to a higher level of inspection then consider the following

Level 2 Tasks Questions		YES	NO
1	If reliability rating is 2 or less can breakdown history be verified?		
2	Is a common failure noted for the inspected asset?		
3	Describe this common failure		
4	Does the severity of repairs indicate a replacement or overhaul decision is necessary?		
5	Does the visual inspection of the asset indicate a potential failure?		
6	Is a Level 3 Condition Inspection test recommended		

Condition Assessment Summary					
Person Conducting Assessment:			Date		
Escalate to Non-Destructive Test?	YES	NO	Initiate equipment renewal decision?	YES	NO
Type of NDT:					
Comments:					

Zone 7

ASSET CLASS CONDITION ASSESSMENT FORM

Facility / System ____ Current Year __________

Process / Basin / Zone ____ Current ENR __________

Component / Sub-basin / Subzone ___________________________Asset Class: Rotating Machinery

Asset / Component Information Tab								Maintenance History		
Asset Id								Installation Year		
Manufacturer								Original Useful Life		
Model								Acquisition Cost		
Capacity								Replacement Value		
Capacity								Annual Maintenance Cost		
Amperage										
System Information Tab										
System or Process Capacity										
Redundancy Count	1	2	3	4	5	6		Max number of pumps that can run at once?		
Redundancy Effect (can asset fail and system still meet capacity?)								YES	NO	

If your answer is in this box with an "E" it may trigger an escalating inspection,
If your answer is in this box with an "M" it may trigger a maintenance adjustment

	Level 1 - Inspection Criteria	YES	NO	N/A
1	Equipment tag & nameplate permanently affixed?			
2	Equipment is in place and properly grouted			
3	Power disconnects are in place and labeled?			
4	Adequate access for maintenance?			
5	Vibration isolation devices are installed and functional?			
6	Temperature, pressure, flow gages, torque indicators & sensors properly installed / functional?			
7	Required valves installed & in right direction?			
8	Visible leaks at fittings?			
9	Environment is clean and appropriate for equipment?			
10	Capable of running when inspected? *(Stop inspection and determine when to run)*			
11	Field alignment is correct? (Cold and Hot alignment performed I appropriate?)		*M*	
12	Equipment is properly lubricated?		*M*	
13	Any indication of over greasing?	*M*		
14	Pipe fittings complete and pipes properly supported?		*M*	
15	Equipment is accounted for in the CMMS?		*M*	
16	If belt drive, is belt deflection per manufacturer specification?		*M*	
17	If close coupled, any indication of misalignment?	*M*		
18	Start and stop equipment, any indication of loose drive shafts, belts, guards?	*M*		
19	Spare parts available and supported by vendor ?		*E or M*	
20	Excessive vibration?	*E*		
21	Excessive noise?	*E*		
22	Excessive corrosion?	*E*		
23	Running hot?	*E*		
24	Motor amps within rating? (Follow site Flash-Arc Program)		*E*	

If a condition rating of 2 or less is assigned. Escalate to Level 2 or initiate decision process for equipment renewal

Condition Rating	Description	Percentage of Remaining Useful Life	Maintenance Benchmark
5	New or Excellent Condition	100%	Normal Preventive Maintenance
4	Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
2	Significant Deterioration	25%	Rehabilitation, if possible
1	Virtually Unserviceable	1%	replace
0	Unknown		

Discuss with a knowledgeable field technician or end user about the reliability of the asset and the system it operates in. If reliability rating is 2 or less consider escalating inspection. Use the rating scale below.

Reliability Rating	Description	Failure Timing	Probability of Failure Estimate
5	Failure Not Anticipated	No known failures	0%
4	Random Breakdown	Every 10 years	10%
3	Occasional Breakdown	Every 5 years	50%
2	Periodic Breakdown	Every 2 years	75%
1	Continuous Breakdown	At least once / year	100%

Discuss with a knowledgeable field technician and end user about the performance / capacity of the asset within the system it operates in. If capacity rating is 3 or less consider escalating to Level 2 and/or Level 3 testing. Use the rating scale to the right.

Capacity Rating	Description
5	Exceeds required capacity
4	Meets required capacity
3	Minor capacity and/or performance issues
2	Significant capacity deficient
1	Out of service

If a result of the condition inspection or a reliability rating indicates escalating to a higher level of inspection then consider the following

Level 2 Tasks Questions		YES	NO
1	If reliability rating is 2 or less can breakdown history be verified?		
2	Is a common failure noted for the inspected asset?		
3	Describe this common failure		
4	Does the severity of repairs indicate a replacement or overhaul decision is necessary?		
5	Does the visual inspection of the asset indicate a potential failure?		
6	Is a Level 3 Condition Inspection test recommended		

Condition Assessment Summary					
Person Conducting Assessment:			Date		
Escalate to Non-Destructive Test?	YES	NO	Initiate equipment renewal decision?	YES	NO
Type of NDT:					
Comments:					

Zone 7

ASSET CLASS CONDITION ASSESSMENT FORM

Facility / System ______________________________ Current Year __________

Process / Basin / Zone ______________________________ Current ENR __________

Component / Sub-basin / Subzone ____________________ Asset Class: Structure

Asset / Component Information Tab			Maintenance History	
Asset Id			Installation Year	
Manufacturer			Original Useful Life	50 years
Size / Volume			Acquisition Cost	
Material 1			Replacement Value	
Material 2			Annual Maintenance Cost	

System Information Tab									
System or Process Capacity									
Redundancy Count	1	2	3	4	5	6		Max number of units that can run at once?	
Redundancy Effect (can asset fail and system still meet capacity?)							YES	NO	

If your answer is in this box with an "E" it may trigger an escalating inspection,
If your answer is in this box with an "M" it may trigger a maintenance adjustment

	Level 1-Inspection Criteria	YES	NO	N/A
	Inspection team should note below if internal surfaces can be inspected or the % not visible.			
	Seismic restraints in place?			
	If a metal building, any signs of corrosion?			
	If grating is installed, any signs of corrosion, cracking, or other deformities?	*M*		
	Are steps not level or show signs of surface cracking?	*M*		
	Piping or conduit protruding through the structure is properly sealed?		*M*	
	Handrails properly secured?		*M*	
	If slide gates are installed into structure, does gate move freely without binding?		*M*	
	Inspect external surface for any defects, delamination, bubbling, cracking, or spalling?	*M*		
	Any leaks or seepage through the walls?	*M*		
	Paint or coating is peeling, worn, bubbling, and or flaking off?	*E / M*		
	Is the structure level?		*E*	
	Any signs of the structure settling?	*E*		
	Are there any visual structural deformities?	*E*		
	Are there any depressions or sink holes directly adjacent to the structure	*E*		
	Is access compromised by settling or other deformities?	*E*		
	Note any discoloration or surface defects. Does the defect give or feel spongy?	*E*		
	Is roof or covering in good condition		*E*	
	Inspect visible internal surface, any protruding rebar, defects, delamination, bubbling, cracking, or spalling?	*E*		
	Is there any exposed rebar in the foundation?	*E*		
	Material is appropriate for operating environment?		*E*	

If a condition rating of 2 or less is assigned. Escalate to Level 2 or initiate decision process for equipment renewal

Condition Rating	Description	Percentage of Remaining Useful Life	Maintenance Benchmark
5	New or Excellent Condition	100%	Normal Preventive Maintenance
4	Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
2	Significant Deterioration	25%	Rehabilitation, if possible
1	Virtually Unserviceable	1%	replace
0	Unknown		

Discuss with a knowledgeable field technician or end user about the reliability of the asset and the system it operates in. If reliability rating is 2 or less consider escalating inspection. Use the rating scale below.

Reliability Rating	Description	Failure Timing	Probability of Failure Estimate
5	Failure Not Anticipated	No known failures	0%
4	Random Breakdown	Every 50 years	10%
3	Occasional Breakdown	Every 20 years	50%
2	Periodic Breakdown	Every 10 years	75%
1	Continuous Breakdown	At least once / year	100%

Discuss with a knowledgeable field technician and end user about the performance / capacity of the asset within the system it operates in. If capacity rating is 3 or less consider escalating to Level 2 and/or Level 3 testing. Use the rating scale to the right.

Capacity Rating	Description
5	Exceeds required capacity
4	Meets required capacity
3	Minor capacity and/or performance issues
2	Significant capacity deficient
1	Out of service

If a result of the condition inspection or a reliability rating indicates escalating to a higher level of inspection then consider implementing the following

Level 2 Tasks Questions		YES	NO
1	If reliability rating is 2 or less can breakdown history be verified?		
2	Is a common failure noted for the inspected asset?		
3	Describe this common failure		
4	Does the severity of repairs indicate a replacement or overhaul decision is necessary?		
5	Does the visual inspection of the asset indicate a potential failure?		
6	Is a Level 3 Condition Inspection test recommended?		

Condition Assessment Summary					
Person Conducting Assessment:			Date		
Escalate to Non-Destructive Test?	**YES**	**NO**	Initiate equipment renewal decision?	**YES**	**NO**
Type of NDT:					
Comments:					

Zone 7

ASSET CLASS CONDITION ASSESSMENT FORM

Facility / System ____________________ Current Year ________

Process / Basin / Zone ____________________ Current ENR ________

Component / Sub-basin / Subzone ____________________ Asset Class: Tank

Asset / Component Information Tab							**Maintenance History**	
Asset Id							Installation Year	
Manufacturer							Original Useful Life	50 years
Model							Acquisition Cost	
Size / Volume							Replacement Value	
Material							Annual Maintenance Cost	
Application								
System Information Tab								
System or Process Capacity								
Redundancy Count	1	2	3	4	5	6	Max number of units that can run at once?	
Redundancy Effect (can asset fail and system still meet capacity?)							YES	NO

If your answer is in this box with an "E" it may trigger an escalating inspection,
If your answer is in this box with an "M" it may trigger a maintenance adjustment

	Level 1 Inspection Criteria	**YES**	**NO**	**N/A**
	Record volume or level of tank during inspection			
1	Equipment tag & nameplate permanently affixed?			
2	Tank is in place and properly secured? Seismic restraints in place?			
3	Is there adequate access for maintenance?			
4	Any visible leaks at fittings and/or nozzles?			
5	Pipe fittings and/or nozzles complete and pipes properly supported?			
6	Is overflow pipe secured to tank and routed to drain or sump?			
7	Level indication provided and accurate?			
8	If the tank has strainer on the outlet side, inspect and note type of debris			
9	Leak detection alarm tested? Notification or annunciation properly triggered?			
10	Leak detection installed properly and operational?		*M*	
11	If secondary containment is provided does sealant shows signs of peeling or bubbling?	*M*		
12	Level sensor / element properly installed?		*M*	
13	Inspect tanks external surface for any defects, delamination, bubbling, cracking, or spalling?	*E*		
14	Inspect tanks internal surface for any defects, delamination, bubbling, cracking, or spalling?	*E*		
15	Are there signs of excessive corrosion on steel tanks?	*E*		
16	Note any discoloration or surface defects. Does the defect give or feel spongy?	*E*		
17	Are there any cracks? (if crack is more than 1/3 of shell thickness, remove from service)	*E*		
18	Does the foundation show signs of cracking or rebar protruding from supports or floor?	*E*		
Reference – *API 653, Tank Inspection*				

If a condition rating of 2 or less is assigned. Escalate to Level 2 or initiate decision process for equipment renewal

Condition Rating	Description	Percentage of Remaining Useful Life	Maintenance Benchmark
5	New or Excellent Condition	100%	Normal Preventive Maintenance
4	Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
2	Significant Deterioration	25%	Rehabilitation, if possible
1	Virtually Unserviceable	1%	replace
0	Unknown		

Discuss with a knowledgeable field technician or end user about the reliability of the asset and the system it operates in. If reliability rating is 2 or less consider escalating inspection. Use the rating scale below.

Reliability Rating	Description	Failure Timing	Probability of Failure Estimate
5	Failure Not Anticipated	No known failures	0%
4	Random Breakdown	Every 10 years	10%
3	Occasional Breakdown	Every 5 years	50%
2	Periodic Breakdown	Every 2 years	75%
1	Continuous Breakdown	At least once / year	100%

Discuss with a knowledgeable field technician and end user about the performance / capacity of the asset within the system it operates in. If capacity rating is 3 or less consider escalating to Level 2 and/or Level 3 testing.
Use the rating scale to the right.

Capacity Rating	Description
5	Exceeds required capacity
4	Meets required capacity
3	Minor capacity and/or performance issues
2	Significant capacity deficient
1	Out of service

If a result of the condition inspection or a reliability rating indicates escalating to a higher level of inspection then consider implementing the following

	Level 2 Tasks Questions	YES	NO
1	If reliability rating is 2 or less can breakdown history be verified?		
2	Is a common failure noted for the inspected asset?		
3	Describe this common failure		
4	Does the severity of repairs indicate a replacement or overhaul decision is necessary?		
5	Does the visual inspection of the asset indicate a potential failure?		
6	Is a Level 3 Condition Inspection test recommended?		

Condition Assessment Summary					
Person Conducting Assessment:			Date		
Escalate to Non-Destructive Test?	**YES**	**NO**	Initiate equipment renewal decision?	**YES**	**NO**
Type of NDT:					
Comments:					

Zone 7

ASSET CLASS CONDITION ASSESSMENT FORM

Facility / System ______________________________ Current Year __________

Process / Basin / Zone ______________________________ Current ENR __________

Component / Sub-basin / Subzone ____________________Asset Class: _Valve ____

Asset / Component Information Tab								Maintenance History		
Asset Id								Installation Year		
Manufacturer								Original Useful Life	25 years	
Model								Acquisition Cost		
Size								Replacement Value		
Type								Annual Maintenance Cost		
Pressure Rating										
System Information Tab										
System or Process Capacity										
Redundancy Count	1	2	3	4	5	6		Max number of same valves in service at once?		
Redundancy Effect (can asset fail and system still meet capacity?)								YES	NO	

If your answer is in this box with an "E" it may trigger an escalating inspection,
If your answer is in this box with an "M" it may trigger a maintenance adjustment

Level 1 - Inspection Criteria		YES	NO	N/A
1	Equipment tag & nameplate permanently affixed?			
2	Valve is in place and properly secured?			
3	Valve environment is clean?			
4	Adequate access for maintenance?			
5	Stem guards are installed and functional?			
6	Required position indicators installed & in right direction?			
7	Capable of operating when inspected? *(Stop inspection and determine when to operate)*			
8	Pipe fittings complete and pipes properly supported?		*M*	
9	Valve is lubricated?		*M*	
10	Any indication of over greasing?	*M*		
11	Visible leaks at fittings and/or connection to pipes?	*M*		
12	Packing is leaking?	*M*		
13	Parts for maintenance and support form vendor available?		*M*	
14	Open and close valve, any indication incorrect setting of limit stops?	*M*		
15	Material appropriate for application?		*E*	
16	Valve binds when opening or closing?	*E*		
17	Excessive corrosion?	*E*		
18	Valve body cracked or rusted through?	*E*		
19	If rising stem, any indication of warping or stripped threads?	*E*		
20				

If a condition rating of 2 or less is assigned. Escalate to Level 2 or initiate decision process for equipment renewal

Condition Rating	Description	Percentage of Remaining Useful Life	Maintenance Benchmark
5	New or Excellent Condition	100%	Normal Preventive Maintenance
4	Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
2	Significant Deterioration	25%	Rehabilitation, if possible
1	Virtually Unserviceable	1%	replace
0	Unknown		

Discuss with a knowledgeable field technician or end user about the reliability of the asset and the system it operates in. If reliability rating is 2 or less consider escalating inspection. Use the rating scale below.

Reliability Rating	Description	Failure Timing	Probability of Failure Estimate
5	Failure Not Anticipated	No known failures	0%
4	Random Breakdown	Every 20 years	10%
3	Occasional Breakdown	Every 10 years	50%
2	Periodic Breakdown	Every 2 years	75%
1	Continuous Breakdown	At least once / year	100%

Discuss with a knowledgeable field technician and end user about the performance / capacity of the asset within the system it operates in. If capacity rating is 3 or less consider escalating to Level 2 and/or Level 3 testing.
Use the rating scale to the right.

Capacity Rating	Description
5	Exceeds required capacity
4	Meets required capacity
3	Minor capacity and/or performance issues
2	Significant capacity deficient
1	Out of service

If a result of the condition inspection or a reliability rating indicates escalating to a higher level of inspection then consider implementing the following

Level 2 Tasks Questions		YES	NO
1	If reliability rating is 2 or less can breakdown history be verified?		
2	Is a common failure noted for the inspected asset?		
3	Describe this common failure		
4	Does the severity of repairs indicate a replacement or overhaul decision is necessary?		
5	Does the visual inspection of the asset indicate a potential failure?		
6	Is a Level 3 Condition Inspection test recommended?		

Condition Assessment Summary					
Person Conducting Assessment:			Date		
Escalate to Non-Destructive Test?	**YES**	**NO**	Initiate equipment renewal decision?	**YES**	**NO**
Type of NDT:					
Comments:					

Zone 7

ASSET CLASS CONDITION ASSESSMENT FORM

Facility / System ____ Current Year ________

Process / Basin / Zone ____________________________________ Current ENR ________

Component / Sub-basin / Subzone _______________________Asset Class: _Valve w Actuator___

Asset / Component Information Tab			**Maintenance History**	
Asset Id			Installation Year	
Manufacturer			Original Useful Life	25 years
Model			Acquisition Cost	
Size			Replacement Value	
Type			Annual Maintenance Cost	
Pressure Rating				
System Information Tab				
System or Process Capacity				

Redundancy Count	1	2	3	4	5	6		Max number of same valves in service at once?	
Redundancy Effect (can asset fail and system still meet capacity?)							YES	NO	

If your answer is in this box with an "E" it may trigger an escalating inspection,
If your answer is in this box with an "M" it may trigger a maintenance adjustment

Level 1 Inspection Criteria		**YES**	**NO**	**N/A**
1	Equipment tag & nameplate permanently affixed?			
2	Valve is in place and properly secured?			
3	Power disconnects are in place and labeled?			
4	Valve environment is clean?			
5	Required position indicators installed & in right direction?			
6	Adequate access for maintenance?			
7	Stem guards are installed and functional?			
8	Capable of running when inspected? *(Stop inspection and determine when possible)*			
9	Valve is lubricated?		*M*	
10	Any indication of over greasing?	*M*		
11	Visible leaks at fittings and/or connection to pipes?	*M*		
12	Pipe fittings complete and pipes properly supported?		*M*	
13	Packing is leaking?	*M*		
14	Parts for maintenance available and supported by vendor?		*M*	
15	Open & close valve, any indication incorrect setting of limit stops or loose actuator coupling?	*M*		
16	Material appropriate for application?		*E*	
17	Valve binds when opening or closing?	*E*		
18	Actuator runs hot when in operation	*E*		
19	Excessive corrosion?	*E*		
20	Valve body cracked or rusted through?	*E*		
21	If rising stem, any indication of warping or stripped threads?	*E*		

If a condition rating of 2 or less is assigned. Escalate to Level 2 or initiate decision process for equipment renewal

Condition Rating	Description	Percentage of Remaining Useful Life	Maintenance Benchmark
5	New or Excellent Condition	100%	Normal Preventive Maintenance
4	Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
2	Significant Deterioration	25%	Rehabilitation, if possible
1	Virtually Unserviceable	1%	replace
0	Unknown		

Discuss with a knowledgeable field technician or end user about the reliability of the asset and the system it operates in. If reliability rating is 2 or less consider escalating inspection. Use the rating scale below.

Reliability Rating	Description	Failure Timing	Probability of Failure Estimate
5	Failure Not Anticipated	No known failures	0%
4	Random Breakdown	Every 20 years	10%
3	Occasional Breakdown	Every 10 years	50%
2	Periodic Breakdown	Every 2 years	75%
1	Continuous Breakdown	At least once / year	100%

Discuss with a knowledgeable field technician and end user about the performance / capacity of the asset within the system it operates in. If capacity rating is 3 or less consider escalating to Level 2 and/or Level 3 testing.
Use the rating scale to the right.

Capacity Rating	Description
5	Exceeds required capacity
4	Meets required capacity
3	Minor capacity and/or performance issues
2	Significant capacity deficient
1	Out of service

If a result of the condition inspection or a reliability rating indicates escalating to a higher level of inspection then consider implementing the following

Level 2 Tasks Questions		YES	NO
1	If reliability rating is 2 or less can breakdown history be verified?		
2	Is a common failure noted for the inspected asset?		
3	Describe this common failure		
4	Does the severity of repairs indicate a replacement or overhaul decision is necessary?		
5	Does the visual inspection of the asset indicate a potential failure?		
6	Is a Level 3 Condition Inspection test recommended?		

Condition Assessment Summary					
Person Conducting Assessment:			Date		
Escalate to Non-Destructive Test?	**YES**	**NO**	Initiate equipment renewal decision?	**YES**	**NO**
Type of NDT:					
Comments:					

Zone 7

ASSET CLASS CONDITION ASSESSMENT FORM

Facility / System ______________________ Current Year __________

Process / Basin / Zone ______________________ Current ENR __________

Component / Sub-basin / Subzone ______________________ Asset Class: __________ ____

Asset / Component Information Tab							**Maintenance History**	
Asset Id							Installation Year	
Manufacturer							Original Useful Life	
Size / Volume							Acquisition Cost	
							Replacement Value	
							Annual Maintenance Cost	
System Information Tab								
System or Process Capacity								
Redundancy Count	1	2	3	4	5	6	Max number of units that can run at once?	
Redundancy Effect (can asset fail and system still meet capacity?)							YES	NO

If your answer is in this box with an "E" it may trigger an escalating inspection,
If your answer is in this box with an "M" it may trigger a maintenance adjustment

Level 1 Inspection Criteria		**YES**	**NO**	**N/A**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				

If a condition rating of 2 or less is assigned. Escalate to Level 2 or initiate decision process for equipment renewal

Condition Rating	Description	Percentage of Remaining Useful Life	Maintenance Benchmark
5	New or Excellent Condition	100%	Normal Preventive Maintenance
4	Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
2	Significant Deterioration	25%	Rehabilitation, if possible
1	Virtually Unserviceable	1%	replace
0	Unknown		

Discuss with a knowledgeable field technician or end user about the reliability of the asset and the system it operates in. If reliability rating is 2 or less consider escalating inspection. Use the rating scale below.

Reliability Rating	Description	Failure Timing	Probability of Failure Estimate
5	Failure Not Anticipated	No known failures	0%
4	Random Breakdown	Every years	10%
3	Occasional Breakdown	Every years	50%
2	Periodic Breakdown	Every 2 years	75%
1	Continuous Breakdown	At least once / year	100%

Discuss with a knowledgeable field technician and end user about the performance / capacity of the asset within the system it operates in. If capacity rating is 3 or less consider escalating to Level 2 and/or Level 3 testing. Use the rating scale to the right.

Capacity Rating	Description
5	Exceeds required capacity
4	Meets required capacity
3	Minor capacity and/or performance issues
2	Significant capacity deficient
1	Out of service

If a result of the condition inspection or a reliability rating indicates escalating to a higher level of inspection then consider implementing the following

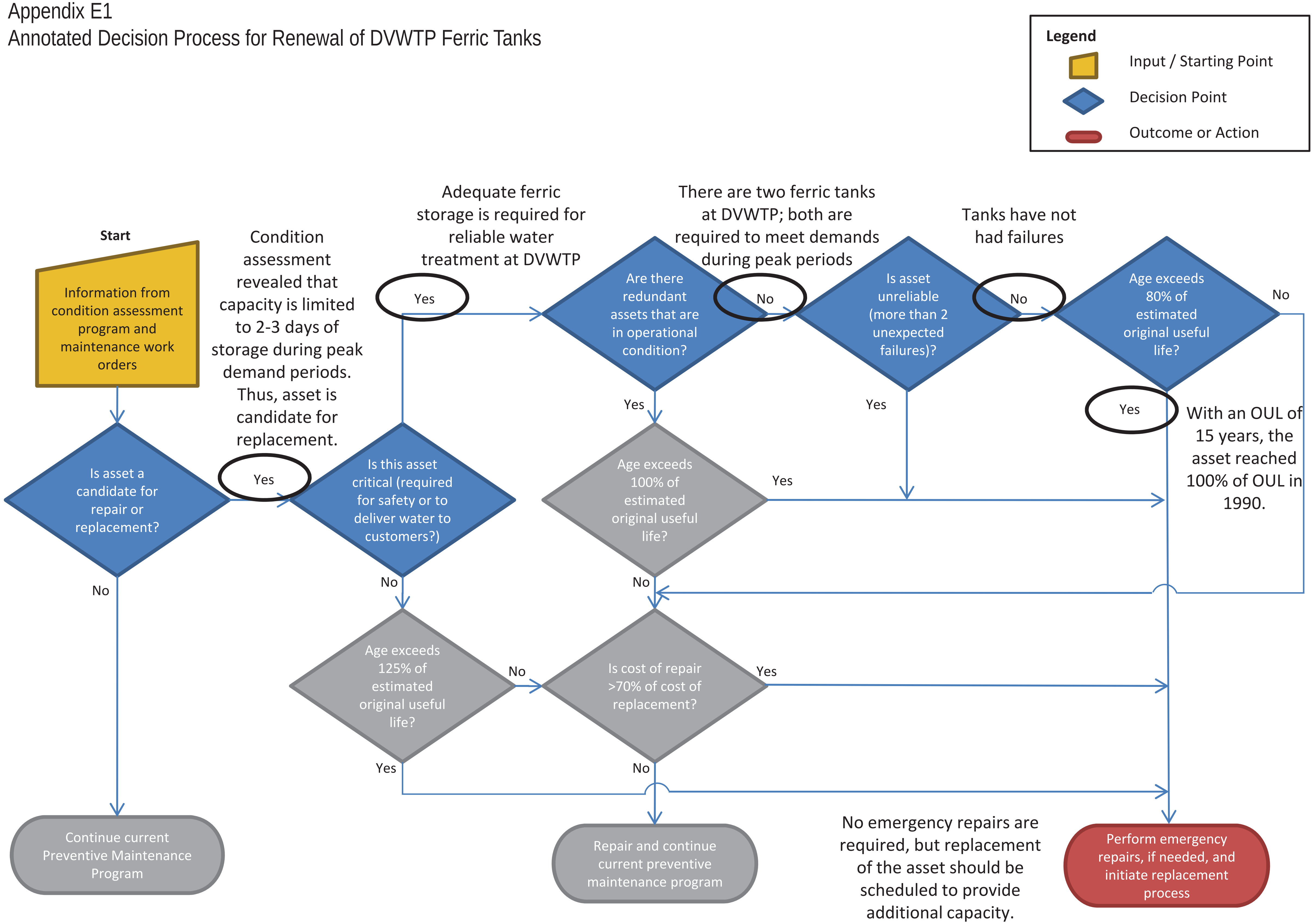
Level 2 Tasks Questions		YES	NO
1	If reliability rating is 2 or less can breakdown history be verified?		
2	Is a common failure noted for the inspected asset?		
3	Describe this common failure		
4	Does the severity of repairs indicate a replacement or overhaul decision is necessary?		
5	Does the visual inspection of the asset indicate a potential failure?		
6	Is a Level 3 Condition Inspection test recommended?		

Condition Assessment Summary						
Person Conducting Assessment:				Date		
Escalate to Non-Destructive Test?	**YES**	**NO**	Initiate equipment renewal decision?		**YES**	**NO**
Type of NDT:						
Comments:						

Appendix E

Near Term Renewal CIP and Long Term Funding Plan, Technical Appendix

Near Term Renewal CIP and Long Term Funding Plan
Appendix E1
Annotated Decision Process for Renewal of DVWTP Ferric Tanks



System	Asset Name	Asset Class	OUL	Install Year	Age Based Replacment Year	Related CIP Project	CIP Project Year
Del Valle Water Treatment Plant\Chemical System\	Ammoniator	Pumps - Chemical	15	2010	2025	DVWTP Aqueous Ammonia System	2016
Del Valle Water Treatment Plant\Chemical System\	Ferric Tanks	Tank - Chemical	15	1975	1990	DVWTP Chemical System Improvements	2013
Del Valle Water Treatment Plant\Clarification - Superpulsators\	Superpulsator #1 Plates	Structural / Architectural	25	1989	2014	Superpulsator Rehab Program Phase 2	2014
Del Valle Water Treatment Plant\Clarification - Superpulsators\	Superpulsator #2 Plates	Structural / Architectural	25	1989	2014	Superpulsator Rehab Program Phase 1	2013
Del Valle Water Treatment Plant\Clarification - Superpulsators\	Superpulsator #3 Plates	Structural / Architectural	25	1989	2014	Superpulsator Rehab Program Phase 2	2014
Del Valle Water Treatment Plant\Clarification - Superpulsators\	Superpulsator #4 Plates	Structural / Architectural	25	1989	2014	Superpulsator Rehab Program Phase 1	2013
Del Valle Water Treatment Plant\Filtration\	Ancillary Support System	Mechanical/Electrical/Instrumentation/Piping	20	1985	2005	DVWTP Filter Media and Underdrain Replacement - Phase 0	2018
Del Valle Water Treatment Plant\Filtration\	Filter #1 Media	Filtration Media	25	1979	2004	DVWTP Filter Media and Underdrain Replacement - Phase 1	2018
Del Valle Water Treatment Plant\Filtration\	Filter #1 Underdrain	Filtration Media	25	1975	2000	DVWTP Filter Media and Underdrain Replacement - Phase 1	2018
Del Valle Water Treatment Plant\Filtration\	Filter #2 Media	Filtration Media	25	1975	2000	DVWTP Filter Media and Underdrain Replacement - Phase 1	2018
Del Valle Water Treatment Plant\Filtration\	Filter #2 Underdrain	Filtration Media	25	1975	2000	DVWTP Filter Media and Underdrain Replacement - Phase 1	2018
Del Valle Water Treatment Plant\Filtration\	Filter #3 Media	Filtration Media	25	1979	2004	DVWTP Filter Media and Underdrain Replacement - Phase 1	2018
Del Valle Water Treatment Plant\Filtration\	Filter #3 Underdrain	Filtration Media	25	1979	2004	DVWTP Filter Media and Underdrain Replacement - Phase 1	2018
Del Valle Water Treatment Plant\Filtration\	Filter #4 Media	Filtration Media	25	1979	2004	DVWTP Filter Media and Underdrain Replacement - Phase 1	2018
Del Valle Water Treatment Plant\Filtration\	Filter #4 Underdrain	Filtration Media	25	1979	2004	DVWTP Filter Media and Underdrain Replacement - Phase 1	2018
Del Valle Water Treatment Plant\Filtration\	Filter #5 Piping and Valving	Valves	25	1989	2014	DVWTP Filter Valves Replacement-Phase 2	2015
Del Valle Water Treatment Plant\Filtration\	Filter #6 Piping and Valving	Valves	25	1989	2014	DVWTP Filter Valves Replacement-Phase 2	2015
Del Valle Water Treatment Plant\Filtration\	Filter #7 Piping and Valving	Valves	25	1989	2014	DVWTP Filter Valves Replacement-Phase 2	2015
Del Valle Water Treatment Plant\Filtration\	Filter #8 Piping and Valving	Valves	25	1989	2014	DVWTP Filter Valves Replacement-Phase 2	2015
Del Valle Water Treatment Plant\Instrumentation\	Clearwell Chlorine Analyzers	Instrumentation	15	2003	2018	DVWTP Instrumentation Upgrades	2016
Del Valle Water Treatment Plant\Instrumentation\	Filter Effluent Particle Counter	Instrumentation	15	2000	2015	DVWTP Instrumentation Upgrades	2016
Del Valle Water Treatment Plant\Instrumentation\	Turbidimeters - Clarification	Instrumentation	10	2008	2018	DVWTP Instrumentation Upgrades	2016
Del Valle Water Treatment Plant\Instrumentation\	Turbidimeters - Clearwell	Instrumentation	10	2008	2018	DVWTP Instrumentation Upgrades	2016
Del Valle Water Treatment Plant\Instrumentation\	Turbidimeters - Filter Effluent	Instrumentation	10	2008	2018	DVWTP Instrumentation Upgrades	2016
Del Valle Water Treatment Plant\Water Storage\	Clearwell #1 (3 MG Concrete Reservoir) - piping, valves	Piping - Above Ground	40	1998	2038	DVWTP Valve Replacements for 3 MG Clearwell	2013
Distribution System\Livermore Pipeline\Livermore No. 2 Pipeline\	CWS-4 Turnout	Turnout	50	1969	2019	CWS Turnout 4 Relocation / Replacement	2014
Mocho Groundwater Demineralization Plant\Filtration\	RO Membranes	Filtration Media	5	2009	2014	MGDP R.O. Membranes Replacement Project	2014
Patterson Pass Conventional Water Treatment Plant\Backwash Supply\	Backwash Rate Control Valve	Valves w/Actuator	25	1984	2009	PPWTP Improvement Project 2012	2014
Patterson Pass Conventional Water Treatment Plant\Clarification\	Ancillary Support System	Mechanical/Electrical/Instrumentation/Piping	20	1973	1993	PPWTP Clarifier Rehab / Motor Replacement	2011
Patterson Pass Conventional Water Treatment Plant\Clarification\	Clarifier Mechanism	Rotating Equipment	25	1962	1987	PPWTP Clarifier Rehab / Motor Replacement	2011
Patterson Pass Conventional Water Treatment Plant\Electrical\	MCC for Service Water Pumps	Power Distribution	30	1984	2014	PPWTP Electrical Power System Upgrade Project	2011
Patterson Pass Conventional Water Treatment Plant\Electrical\	Ancillary Support Systems	Mechanical/Electrical/Instrumentation/Piping	30	1989	2019	PPWTP Electrical Power System Upgrade Project	2011
Patterson Pass Conventional Water Treatment Plant\Filtration\	Ancillary Support System	Mechanical/Electrical/Instrumentation/Piping	25	1974	1999	PPWTP Filter Improvement Study	2012
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #1 Surface Wash Piping and Troughs	Piping - Above Ground	40	1962	2002	PPWTP Filter Improvement Study	2012
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #1 Underdrain	Filtration Media	25	1984	2009	PPWTP Filter Improvement Study	2012
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #2 Media	Filtration Media	25	1984	2009	PPWTP Filter Improvement Study	2012
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #2 Surface Wash Piping and Troughs	Piping - Above Ground	40	1962	2002	PPWTP Filter Improvement Study	2012
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #2 Underdrain	Filtration Media	25	1984	2009	PPWTP Filter Improvement Study	2012
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #3 Media	Filtration Media	25	1984	2009	PPWTP Filter Improvement Study	2012
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #3 Surface Wash Piping and Troughs	Piping - Above Ground	40	1962	2002	PPWTP Filter Improvement Study	2012
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #3 Underdrain	Filtration Media	25	1984	2009	PPWTP Filter Improvement Study	2012
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter Effluent Piping and Valving	Valves	25	1962	1987	PPWTP Filter Improvement Study	2012
Patterson Pass Conventional Water Treatment Plant\Influent Piping and Valving\	Influent Flow Control Valve	Valves w/ Actuator	25	1984	2009	PPWTP Improvement Project 2012	2014

System	Asset Name	Asset Class	OUL	Install Year	Age Based Replacment Year	Related CIP Project	CIP Project Year
Patterson Pass Conventional Water Treatment Plant\Instrumentation\	Ancillary Support System	Mechanical/Electrical/Instrumentation/Piping	15	1998	2013	PPWTP Instrumentation Upgrades	2016
Patterson Pass Conventional Water Treatment Plant\Instrumentation\	Clearwell Chlorine Residual Analyzer	Instrumentation	15	1995	2010	PPWTP Instrumentation Upgrades	2016
Patterson Pass Conventional Water Treatment Plant\Instrumentation\	Filter Effluent Particle Counter	Instrumentation	15	2001	2016	PPWTP Instrumentation Upgrades	2016
Patterson Pass Conventional Water Treatment Plant\Instrumentation\	Turbidimeter - Filter Effluent	Instrumentation	10	2008	2018	PPWTP Instrumentation Upgrades	2016
Patterson Pass Conventional Water Treatment Plant\Instrumentation\	Turbidimeter - Raw Water	Instrumentation	10	2008	2018	PPWTP Instrumentation Upgrades	2016
Patterson Pass Conventional Water Treatment Plant\Instrumentation\	Turbidimeter - Washwater Return	Instrumentation	10	2008	2018	PPWTP Instrumentation Upgrades	2016
Patterson Pass Conventional Water Treatment Plant\Instrumentation\	Turbidimeters - Clearwell	Instrumentation	10	2008	2018	PPWTP Instrumentation Upgrades	2016
Patterson Pass Conventional Water Treatment Plant\Water Storage\	Ancillary Support System	Mechanical/Electrical/Instrumentation/Piping	25	1973	1998	PPWTP Improvement Project 2012	2014
Patterson Pass Conventional Water Treatment Plant\Water Storage\	Clearwell	Mechanical/Electrical/Instrumentation/Piping	20	1962	1982	PPWTP Improvement Project 2012	2014
Patterson Pass Ultrafiltration Water Treatment Plant\Filtration\	Ultrafiltration Membranes	Filtration Media	5	2003	2008	PPWTP UF membrane Replacement	Ongoing
SCADA\	Control Cabinets, Communication	Instrumentation	15	2004	2019	SCADA Enhancements	Ongoing
SCADA\	Servers, Radios	Instrumentation	5	2008	2013	SCADA Enhancements	Ongoing

Project Name	Project Costs ($2011 Millions)[a]										
	FY10/11	FY11/12	FY12/13	FY13/14	FY14/15	FY15/16	FY16/17	FY17/18	FY18/19	FY19/20	Total
Administrative & Engineering Building Lease (Water System)	$0.50	$0.49	$0.48	$0.47	$0.46	$0.45	$0.44	$0.43	$0.43		$4.15
Administrative & Engineering Building Sinking Fund (Fund 72)	0.37	0.36	0.36	0.35	0.35	0.34	0.34	0.33	0.33		3.12
Capital Improvement Program Management[b]	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.50
System-Wide Improvement, Renewal/Replacement Program Management[b]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.49
Laboratory Equipment Replacement[b]	0.11	0.12	0.11	0.12	0.11	0.12	0.11	0.11	0.11	0.11	1.12
Dougherty Reservoir Access Road Rehabilitation[c]	0.26										0.26
DVWTP Interior Coating Improvements to the 4.5 MG Steel Clearwell[c]	1.25										1.25
DVWTP Roof Panel Replacement and Roof System Repair for 3 MG Clearwell[c]		0.01									0.01
Monitoring Well Replacements & Abandonments[d]		0.09		0.10		0.10		0.10		0.10	0.48
PPWTP Ammonia Facility Replacement[e]				0.12							0.12
Well Pump, Motor and Casing Inspections[b,f]	0.03	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.08	0.08	0.53
Minor Renewal/Replacement Projects[b,g]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	2.50
Total Other Fund 72 Renewal CIP Projects ($2011)	$2.87	$1.45	$1.32	$1.55	$1.32	$1.41	$1.31	$1.39	$1.28	$0.63	$14.53
Total Annually Recurring Cost Beyond FY19/20 ($2011)	$0.54										

Notes:
a. All project costs are presented in 2011 dollars.
b. Project costs are recurring annually through FY49/50.
c. These projects have been identified based on previous assessments, and address components of structural assets that have not reach their OUL.
d. Project provides for as-needed replacement and destruction of monitoring wells.
e. Project needed prior to reaching OUL due to safety.
f. Project involves annual inspection of one production well and related repairs and minor rehabiliation for preventive maintenance. The annually recurring cost has been increased from $30,000 (current CIP) to $75,000 based on staff input and recommendations. Increases begin in FY13/14.
g. It is recommended that the annually recurring CIP line item be maintained at $250,000, but be revisited to ensure annual budget is appropriate to meet actual expenditures.

Near Term Renewal CIP and Long Term Funding Plan
Attachment E4
Conceptual Projects for Assets Recommended for Condition Assessment

System	Asset	Asset Class	OUL	Install Year	Age Based Replacement Year (1)	Estimated Replacment Cost ($2011) (2)
Distribution System Rate Control Station Replacement Project						
Distribution System\Livermore Pipeline\Livermore No. 2 Pipeline\	Livermore Rate Control Valve	Valves	25	1962	1987	$177,455
Distribution System\Cross Valley Pipeline\Cross Valley Pipeline\	Cross Valley Ball Valve	Valves	25	1975	2000	177,455
Distribution System\Dougherty Pipeline\Dougherty Pipeline\	Dougherty Rate Control Valve	Valves	25	1982	2007	177,455
Distribution System\Vineyard Pipeline\Vineyard Pipeline\	Vineyard Rate Control Valve	Valves	25	1993	2018	177,455
DVWTP Electrical Components Replacement Project						
Del Valle Water Treatment Plant\Influent Piping and Valving\	Ancillary Support System	Mechanical/Electrical/Instrumentation/Piping	25	1985	2010	665,456
Del Valle Water Treatment Plant\Influent Piping and Valving\	Raw Water Influent Metering Station	Mechanical/Electrical/Instrumentation/Piping	25	1989	2014	106,473
Del Valle Water Treatment Plant\Electrical\	Main Plant Generator	Power Distribution - Generator Systems	30	1988	2018	190,130
DVWTP Chemical Tanks and Pumps Replacement Project						
Del Valle Water Treatment Plant\Chemical System\	Caustic Tank	Tank - Chemical	15	1975	1990	25,351
Del Valle Water Treatment Plant\Chemical System\	Ferric Metering Pumps	Pumps - Chemical	15	1989	2004	35,000
Del Valle Water Treatment Plant\Chemical System\	DAF-Ferric Metering Pumps	Pumps - Chemical	15	1989	2004	35,000
Del Valle Water Treatment Plant\Chemical System\	Caustic Metering Pumps	Pumps - Chemical	15	1993	2008	60,000
Del Valle Water Treatment Plant\Chemical System\	Ancillary Support System	Mechanical/Electrical/Instrumentation/Piping	25	1985	2010	982,340
Del Valle Water Treatment Plant\Chemical System\	Sodium Hypochlorite Metering	Pumps - Chemical	15	1999	2014	405,612
DVWTP Filter Media and Underdrain Replacement Project - Phase 2						
Del Valle Water Treatment Plant\Filtration\	Filter #6 Media	Filtration Media	25	1990	2015	70,073
Del Valle Water Treatment Plant\Filtration\	Filter #7 Media	Filtration Media	25	1990	2015	70,073
Del Valle Water Treatment Plant\Filtration\	Filter #5 Underdrain	Filtration Media	25	1990	2015	332,552
Del Valle Water Treatment Plant\Filtration\	Filter #6 Underdrain	Filtration Media	25	1990	2015	332,552
Del Valle Water Treatment Plant\Filtration\	Filter #7 Underdrain	Filtration Media	25	1990	2015	332,552
Del Valle Water Treatment Plant\Filtration\	Filter #8 Underdrain	Filtration Media	25	1990	2015	332,552
Del Valle Water Treatment Plant\Filtration\	Filter #5 Media	Filtration Media	25	2001	2026	70,073
Del Valle Water Treatment Plant\Filtration\	Filter #8 Media	Filtration Media	25	2006	2031	70,073
DVWTP HVAC Replacement Project						
Del Valle Water Treatment Plant\Support System\	HVAC	HVAC	15	2003	2018	507,014
DVWTP Rehabilitation Project 2016						
Del Valle Water Treatment Plant\Mixing and Coagulation\	Rapid Mix Chamber #3	Mechanical/Electrical/Instrumentation/Piping	25	1974	1999	44,364
Del Valle Water Treatment Plant\Support System\	Air Compressors and Tank	Rotating Equipment	25	1974	1999	38,026
Del Valle Water Treatment Plant\Support System\	Air Compressors and Tank	Rotating Equipment	25	1974	1999	38,026
Del Valle Water Treatment Plant\Backwash Supply\	Backwash Pump #2	Pumps	30	1975	2005	354,910
Del Valle Water Treatment Plant\Backwash Supply\	Ancillary Support System	Mechanical/Electrical/Instrumentation/Piping	25	1985	2010	85,559
Del Valle Water Treatment Plant\Mixing and Coagulation\	Ancillary Support	Mechanical/Electrical/Instrumentation/Piping	25	1985	2010	976,003
Del Valle Water Treatment Plant\Support System\	Ancillary Support System	Mechanical/Electrical/Instrumentation/Piping	25	1985	2010	221,819
Del Valle Water Treatment Plant\Backwash Supply\	Backwash Rate Control Valve	Valves w/ Actuator	25	1989	2014	50,701
Del Valle Water Treatment Plant\Backwash Supply\	Backwash Pump #1	Pumps	30	1989	2019	354,910
PPWTP Backwash Supply Tank Rehabilitation Project						
Patterson Pass Conventional Water Treatment Plant\Backwash Supply\	Backwash Supply Tank	Tanks	50	1962	2012	202,806

System	Asset	Asset Class	OUL	Install Year	Age Based Replacement Year (1)	Estimated Replacment Cost ($2011) (2)
PPWTP Chemical Tanks and Pumps Replacement Project - Phase 1						
Patterson Pass Conventional Water Treatment Plant\Chemical System\	Anionic Tank	Tank - Chemical	15	1984	1999	12,675
Patterson Pass Conventional Water Treatment Plant\Chemical System\	Ferric Pumps	Pumps - Chemical	15	1984	1999	35,000
Patterson Pass Conventional Water Treatment Plant\Chemical System\	Ferric Tank	Tank - Chemical	15	1984	1999	76,052
Patterson Pass Conventional Water Treatment Plant\Chemical System\	Caustic Tanks	Tank - Chemical	15	1984	1999	126,754
Patterson Pass Conventional Water Treatment Plant\Chemical System\	Spare Tank	Tank - Chemical	15	1990	2005	38,026
Patterson Pass Conventional Water Treatment Plant\Chemical System\	Cationic Tank	Tank - Chemical	15	1992	2007	25,351
Patterson Pass Conventional Water Treatment Plant\Chemical System\	Cationic Metering Pumps	Pumps - Chemical	15	1995	2010	35,000
PPWTP Chemical Tanks and Pumps Replacement Project - Phase 2						
Patterson Pass Conventional Water Treatment Plant\Chemical System\	Sodium Hypochlorite Metering	Pumps - Chemical	15	2002	2017	140,000
Patterson Pass Ultrafiltration Water Treatment Plant\Chemical System\	Clean-in-Place Cleaning Solution	Pumps - Chemical	15	2003	2018	25,351
Patterson Pass Ultrafiltration Water Treatment Plant\Chemical System\	Caustic (Detergent) Tank	Tank - Chemical	15	2003	2018	12,675
Patterson Pass Ultrafiltration Water Treatment Plant\Chemical System\	Citric Acid Tank	Tank - Chemical	15	2003	2018	12,675
Patterson Pass Ultrafiltration Water Treatment Plant\Chemical System\	Caustic Metering Pumps	Pumps - Chemical	15	2003	2018	60,000
Patterson Pass Ultrafiltration Water Treatment Plant\Chemical System\	Neutralization Tank	Tank - Chemical	15	2003	2018	38,026
Patterson Pass Ultrafiltration Water Treatment Plant\Chemical System\	Sodium Hypochlorite Metering	Pumps - Chemical	15	2003	2018	105,000
Patterson Pass Conventional Water Treatment Plant\Chemical System\	Caustic Pumps	Pumps - Chemical	15	2004	2019	60,000
PPWTP Filter Rehabilitation Project						
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #1 Piping and Valving	Valves	25	1962	1987	583,067
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #2 Piping and Valving	Valves	25	1962	1987	583,067
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #3 Piping and Valving	Valves	25	1962	1987	583,067
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #1 Media	Filtration Media	25	1980	2005	70,073
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #2 Media	Filtration Media	25	1980	2005	70,073
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #3 Media	Filtration Media	25	1980	2005	70,073
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #1 Underdrain	Filtration Media	25	1984	2009	344,429
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #2 Underdrain	Filtration Media	25	1984	2009	344,429
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #3 Underdrain	Filtration Media	25	1984	2009	344,429
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #1 Surface Wash Piping and	Piping - Above Ground	40	1962	2002	63,377
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #1 Surface Wash Piping and	Piping - Above Ground	40	1962	2002	63,377
Patterson Pass Conventional Water Treatment Plant\Filtration\	Filter #3 Surface Wash Piping and	Piping - Above Ground	40	1962	2002	63,377
Patterson Pass Conventional Water Treatment Plant\Clarification\	Clarifier Bypass	Valves	25	1984	2009	76,052
PPWTP Instrumentation Replacement Project						
Patterson Pass Ultrafiltration Water Treatment Plant\Instrumentation\	Turbidimeter - Influent	Instrumentation	10	2003	2013	13,305
Patterson Pass Ultrafiltration Water Treatment Plant\Instrumentation\	Turbidimeter - Settled Water	Instrumentation	10	2003	2013	13,305
Patterson Pass Ultrafiltration Water Treatment Plant\Instrumentation\	Turbidimeter - Filter Effluent	Instrumentation	10	2003	2013	63,377
Patterson Pass Ultrafiltration Water Treatment Plant\Instrumentation\	Chlorine Residual Analyzer	Instrumentation	15	2003	2018	12,675
Patterson Pass Ultrafiltration Water Treatment Plant\Instrumentation\	Combined Filter Effluent Particle	Instrumentation	15	2003	2018	76,052
Patterson Pass Ultrafiltration Water Treatment Plant\Instrumentation\	Ancillary Support System	Mechanical/Electrical/Instrumentation/Piping	15	2003	2018	88,728

System	Asset	Asset Class	OUL	Install Year	Age Based Replacement Year (1)	Estimated Replacment Cost ($2011) (2)
PPWTP Rehabilitation Project 2018						
Patterson Pass Conventional Water Treatment Plant\Backwash Supply\	Ancillary Support System	Mechanical/Electrical/Instrumentation/Piping	25	1977	2002	84,925
Patterson Pass Conventional Water Treatment Plant\Backwash Supply\	Backwash System Pumps	Pumps	30	1984	2014	130,000
Patterson Pass Conventional Water Treatment Plant\Support System\	Plant Air Compressor #1	Rotating Equipment	25	1990	2015	31,688
Patterson Pass Conventional Water Treatment Plant\Support System\	Plant Air Compressor #2	Rotating Equipment	25	1990	2015	31,688
Turnout Replacement Program						
Distribution System\Livermore Pipeline\Livermore No. 1 Pipeline\	Livermore-2 Turnout	Turnout	50	1963	2013	207,000
Distribution System\Livermore Pipeline\Livermore No. 1 Pipeline\	Livermore-1 Turnout	Turnout	50	1968	2018	207,000
Distribution System\Livermore Pipeline\Livermore No. 1 Pipeline\	LLNL Turnout	Turnout	50	1969	2019	207,000
Distribution System\Vasco Pipeline\Vasco Pipeline\	Livermore-3 Turnout	Turnout	50	1966	2016	207,000
Distribution System\DVWTP Transmission Pipeline\	VA-2 Turnout	Turnout	50	1968	2018	207,000
Distribution System\Mocho Pipeline\Mocho Pipeline\	Pleasanton-1 Turnout	Turnout	50	1968	2018	207,000
Distribution System\Sycamore Pipeline\Sycamore Pipeline\	Va-3, Wente, LARPD, and BVYR	Turnout	50	1969	2019	59,384
Wellfield Chemical Tanks and Pumps Replacement Project						
Groundwater Wells\Production Wells\Mocho #3\	Chemical System	Pumps - Chemical	15	2002	2017	367,585
Groundwater Wells\Production Wells\Mocho #4\	Chemical System	Pumps - Chemical	15	2002	2017	367,585
Groundwater Wells\Production Wells\Hopyard #6\	Chemical System	Pumps - Chemical	15	2003	2018	35,000
Groundwater Wells\Production Wells\Stoneridge\	Chemical System	Pumps - Chemical	15	2003	2018	35,000
Groundwater Wells\Production Wells\Hopyard #6 Ammoniation System\	Ammonia Feed Pump #1	Pumps - Chemical	15	2004	2019	24,083
Groundwater Wells\Production Wells\Hopyard #6 Ammoniation System\	Ammonia Feed Pump #2	Pumps - Chemical	15	2004	2019	24,083
Groundwater Wells\Production Wells\Hopyard #6 Ammoniation System\	Ammonia Tank	Tank - Chemical	15	2004	2019	35,491
Groundwater Wells\Production Wells\Stoneridge Ammoniation System\	Ammonia Feed Pump #1	Pumps - Chemical	15	2004	2019	24,083
Groundwater Wells\Production Wells\Stoneridge Ammoniation System\	Ammonia Feed Pump #2	Pumps - Chemical	15	2004	2019	24,083
Groundwater Wells\Production Wells\Stoneridge Ammoniation System\	Ammonia Tank	Tank - Chemical	15	2004	2019	35,491
Wellfield Switchboard Replacement Project						
Groundwater Wells\Production Wells\Mocho #1\	Electrical/Instrumentation	Instrumentation	30	1987	2017	642,735
Groundwater Wells\Production Wells\Hopyard #6\	Electrical/Instrumentation	Instrumentation	30	1989	2019	431,724
Total Estimated Replacement Cost of Near Term Assets Recommended for Condition Assessment						$15,655,370

Notes:

(1) Replacement year is based on install year and OUL.

(2) Estimated replacement cost is based on data available in Zone 7's Asset Database. These values are presented in 2011 dollars, and are referenced to the ENR San Francisco CCI Index (10,116.29) for January 2011.

Project Name	Project Costs ($2011 Millions)											Total
	FY10/11	FY11/12	FY12/13	FY13/14	FY14/15	FY15/16	FY16/17	FY17/18	FY18/19	FY19/20	FY20/21	
Emergency Preparedness												
Security Improvements at Existing Facilities	$0.02	$0.05										$0.07
Vulnerability Assessment Review & Update		0.11										0.11
Groundwater Basin Management												
New Groundwater Management Program Monitoring Wells												0.00
Mocho Groundwater Demin Facility	0.05											0.05
Mocho Groundwater Demin Plant Easement from DSRSD		0.12										0.12
Well Destruction of Former Army Wells on DSRSD Property		0.13										0.13
Transmission & Distribution												
Airway Pump Station Relocation	0.10											0.10
Automation of Identified Turnouts and Line Valve		0.11										0.11
Corrosion Master Plan Update				0.22					0.23			0.45
System-Wide Installation of Line Valves		0.06	0.06	0.05	0.06	0.06	0.06	0.05	0.07	0.07	0.07	0.60
Transmission System Master Plan		0.04	0.07	0.08	0.08	0.08	0.07	0.07	0.08	0.08	0.08	0.73
Water Supply & Conveyance												
2010 Water System Planning	0.09											0.09
Arroyo del Valle Permit Extension	0.34	0.48	0.14									0.96
Bay Area Regional Desalination Project Feasibility Analysis	0.07	0.07										0.14
Enhanced Conservation Program	0.19	0.38	0.37	0.36	0.34	0.33	0.32	0.30	0.29	0.28		3.17
High-Efficiency Toilet Rebate Program	0.34	0.08	0.08	0.08	0.07							0.65
High-Efficiency Washing Machine Rebate Program	0.09	0.14	0.12	0.11	0.11							0.58
Water Conservation Best Management Practices	0.08	0.07	0.07	0.07	0.06	0.09	0.09	0.09	0.08	0.08		0.78
Water Treatment Facilities												
DVWTP Improvements	0.22											0.22
DVWTP and PPWTP Fume Hood Construction	0.03											0.03
DVWTP Sludge Handling Improvements		0.73	2.39									3.12
Power Purchase Agreement	0.13											0.13
PPWTP Improvement Project 2011		0.99										0.99
PPWTP Improvement Project 2012			0.98									0.98
PPWTP Improvement Studies 2011		0.16										0.16

Project Name	Project Costs ($2011 Millions)											Total
	FY10/11	FY11/12	FY12/13	FY13/14	FY14/15	FY15/16	FY16/17	FY17/18	FY18/19	FY19/20	FY20/21	
PPWTP Sewer Line Project	0.77											0.77
PPWTP Sludge Handling Improvements		1.04	0.73	3.11	0.31							5.19
Safety Improvements at Water Treatment Plants			0.42									0.42
Solids Handling Study	0.04											0.04
Water Quality - PPWTP & DVWTP Taste and Odor Treatment								2.29	9.26	16.74	7.26	35.54
Water Quality Management Program	0.04	0.01	0.06	0.03	0.06	0.03	0.06	0.03	0.07	0.03	0.03	0.47
Total System Wide Improvement Projects ($2011)	$2.58	$4.78	$5.48	$4.12	$1.10	$0.59	$0.59	$2.83	$10.08	$17.28	$7.43	$56.86

Notes:

a. All project costs are presented in 2011 dollars.

Year	Renewal Needs ($2011 Millions)[a]						System Wide Improvements ($2011 Millions)[a,e]	Other Fund 72 CIP Projects ($2011 Millions)[a,f]	Total Projects ($2011 Millions)[a]
	Existing CIP Projects[b]	New CIP Projects[b]	Projects Pending Condition Assessment[c]	Subsequent Replacements of Near Term Assets[d]	Long Term Renewal Needs[d]	Subtotal Renewal Forecast			
2011	$2.68	$0.00	$0.00	$0.00	$0.00	$2.68	$2.58	$2.87	$8.13
2012	1.33	0.00	0.00	0.00	0.00	1.33	4.78	1.45	7.56
2013	4.16	1.57	0.00	0.00	0.00	5.72	2.75	1.32	9.80
2014	2.32	2.23	0.00	0.00	0.00	4.55	4.12	1.55	10.21
2015	1.16	0.00	3.61	0.00	0.00	4.77	1.10	1.32	7.19
2016	3.51	0.50	0.00	0.00	0.00	4.01	0.59	1.41	6.01
2017	0.60	0.00	3.71	0.00	0.00	4.31	0.59	1.31	6.21
2018	1.41	2.18	1.07	0.00	0.00	4.67	2.83	1.39	8.90
2019	0.61	0.53	0.55	0.00	0.00	1.68	10.08	1.28	13.04
2020	0.60	0.00	0.00	0.25	3.76	4.60	17.28	0.63	22.51
2021	0.00	0.00	0.71	1.63	0.00	2.34	7.26	0.54	10.14
2022	0.00	0.00	0.51	0.25	1.55	2.30	2.35	0.54	5.20
2023	0.00	0.00	1.42	0.80	1.57	3.79	2.35	0.54	6.68
2024	0.00	0.00	1.18	0.77	5.63	7.58	2.35	0.54	10.47
2025	0.00	0.00	2.02	0.30	3.42	5.75	2.35	0.54	8.64
2026	0.00	0.00	0.41	1.92	1.39	3.72	2.35	0.54	6.61
2027	0.00	0.00	0.47	0.25	0.90	1.62	2.35	0.54	4.51
2028	0.00	0.00	0.00	3.26	15.94	19.20	2.35	0.54	22.09
2029	0.00	0.00	0.00	0.86	9.36	10.23	2.35	0.54	13.12
2030	0.00	0.00	0.00	0.80	1.07	1.87	14.24	0.54	16.66
2031	0.00	0.00	0.00	3.12	2.08	5.20	14.19	0.54	19.94
2032	0.00	0.00	0.00	0.98	4.36	5.34	2.35	0.54	8.23
2033	0.00	0.00	0.00	1.01	6.77	7.79	2.35	0.54	10.68
2034	0.00	0.00	0.00	1.03	8.74	9.77	2.35	0.54	12.66
2035	0.00	0.00	0.00	0.29	3.42	3.70	2.35	0.54	6.59
2036	0.00	0.00	0.00	5.30	0.21	5.51	2.35	0.54	8.40
2037	0.00	0.00	0.00	0.76	25.25	26.01	2.35	0.54	28.90

Total Renewal and SWI Funding Needs

Year	Renewal Needs ($2011 Millions)[a] Existing CIP Projects[b]	New CIP Projects[b]	Projects Pending Condition Assessment[c]	Subsequent Replacements of Near Term Assets[d]	Long Term Renewal Needs[d]	Subtotal Renewal Forecast	System Wide Improvements ($2011 Millions)[a,e]	Other Fund 72 CIP Projects ($2011 Millions)[a,f]	Total Projects ($2011 Millions)[a]
2038	0.00	0.00	0.00	1.43	4.75	6.18	2.35	0.54	9.07
2039	0.00	0.00	0.00	7.16	20.17	27.33	2.35	0.54	30.23
2040	0.00	0.00	0.00	3.51	2.43	5.94	2.35	0.54	8.84
2041	0.00	0.00	0.00	2.69	1.25	3.94	2.35	0.54	6.83
2042	0.00	0.00	0.00	2.69	0.01	2.70	2.35	0.54	5.59
2043	0.00	0.00	0.00	3.12	3.32	6.44	2.35	0.54	9.34
2044	0.00	0.00	0.00	0.96	7.56	8.52	2.35	0.54	11.41
2045	0.00	0.00	0.00	0.80	0.08	0.88	2.35	0.54	3.77
2046	0.00	0.00	0.00	2.46	0.83	3.29	2.35	0.54	6.19
2047	0.00	0.00	0.00	1.63	0.33	1.96	2.35	0.54	4.86
2048	0.00	0.00	0.00	2.99	4.34	7.33	2.35	0.54	10.23
2049	0.00	0.00	0.00	3.34	19.44	22.78	2.35	0.54	25.67
2050	0.00	0.00	0.00	1.90	50.79	52.68	2.35	0.54	55.58
Total	$18.37	$7.00	$15.66	$58.27	$210.70	$309.99	$145.85	$30.85	$486.69

Total Forecasted Capital Funding Need through FY49/50	$486.69
Less Current Fund 72 Balance	$17.74
Plus Required Remaining Fund 72 Balance at end of Planning Period	$9.40
Net Forecasted Capital Funding Need	$478.35

Notes:

a. All values are presented in 2011 dollars, and are referenced to the ENR San Francisco CCI Index (10,116.29) for January 2011.

b. Refer to Appendix E2.

c. Refer to Appendix E4.

d. Based on replacement of assets when they reach 100% OUL.

e. Refer to Appendix E5.

f. Refer to Appendix E3.

Appendix F

Board Agenda Item and Acceptance Resolution

ZONE 7
ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
BOARD OF DIRECTORS

RESOLUTION NO 11-4092

INTRODUCED BY DIRECTOR MACHAEVICH
SECONDED BY DIRECTOR QUIGLEY

Resolution for Acceptance of Asset Management Plan Update

WHEREAS, the Asset Management Program was originally developed in 2004 and those efforts were summarized in the October 2004 Asset Management Program Summary Report; and

WHEREAS, Zone 7 has recently updated the Asset Management Program through the Asset Management Program Update Project, which included an update of Zone 7's asset inventory, a revised asset renewal methodology, formalized decision processes, an asset condition assessment and pipeline risk assessment, modified asset classes and corresponding useful life estimates, and a recommendation of an annual funding level to adequately fund this program; and

WHEREAS, Zone 7 has summarized its efforts in updating this program in the 2011 Asset Management Plan Update Report.

NOW, BE IT RESOLVED that the Board of Directors of Zone 7 of the Alameda County Flood Control and Water Conservation District does hereby accept the Asset Management Plan Update Report with the revised funding recommendations incorporated; and

BE IT FURTHER RESOLVED that the Board of Directors of Zone 7 of the Alameda County Flood Control and Water Conservation District does hereby adopt the recommended funding transfer targets from the Water Enterprise Fund (Fund 52) into the Renewal\Replacement and System-wide Improvements Fund (Fund 72) for the future as follows:

$6,600,000 in Fiscal Year 2012/2013;
$8,500,000 in Fiscal Year 2013/2014;
$9,500,000 in Fiscal Year 2014/2015;
$10,500,000 in Fiscal Year 2015/2016; and

the total annual funding requirement beginning in Fiscal Year 2016/2017 and beyond, is $11,400,000 in 2011 dollars, which will be adjusted for other sources of revenue (e.g., actual interest income and Dougherty Valley Service Area facility use fees), increased for inflation based upon the ENR San Francisco Construction Cost Index and adjusted based on future AMP Updates.

ADOPTED BY THE FOLLOWING VOTE:

AYES: DIRECTORS GRECI, FIGUERS, MACHAEVICH, PALMER, QUIGLEY, STEVENS

NOES: NONE

ABSENT: DIRECTOR MOORE

ABSTAIN: NONE

I certify that the foregoing is a correct copy of a resolution adopted by the Board of Directors of Zone 7 of Alameda County Flood Control and Water Conservation District on

June 15, 2011

By John Greci
President, Board of Directors

ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT, ZONE 7

100 NORTH CANYONS PARKWAY • LIVERMORE, CA 94551 • PHONE (925) 454-5000 • FAX (925) 454-5727

ORIGINATING SECTION: Water Supply Engineering
CONTACT: Mona Olmsted/Jarnail Chahal

AGENDA DATE: June 15, 2011 ITEM NO. **10**

SUBJECT: Findings and Recommendations of Zone 7's Asset Management Program Update

SUMMARY:

- In 2004, Carollo Engineers assisted Zone 7 in developing and implementing an Asset Management Program (AMP). The resulting 2004 AMP report recommended ramping up to a funding level of $10 million annually by 2011 to fund the Renewal/Replacement and System-Wide Improvement (R/R and SWI) program. Treated water rate projections presented to the Board during the water rate setting process for the 2011 water rate included a ramp-up to the 2004 AMP set-aside target of $10 million by 2014.
- In February 2010, the Board hired HDR Engineering, Inc., to assist Zone 7 in preparing the update to the AMP. A Technical Review Committee, consisting of Zone 7 staff and Retailer representatives, was involved in the project scoping and the consultant selection process, and has been providing input throughout the project by reviewing technical memorandums and participating in stakeholder workshops.
- Staff provided an AMP Update status report at the March 2011 Board meeting and, on May 4, 2011, the AMP findings and recommendations, and staff's response to Retailer comments on the funding analysis were presented to the Finance Committee. The Committee recommended that the AMP Update be brought to the full Board for acceptance.
- Since 2004, the total asset value for Zone 7's water system has increased by 36 percent, to $423 million, as a result of new assets (MGDP, COL Wells, Altamont Pipeline, DAF, etc.) that have been built since the last update. The total R/R and SWI funding requirement through 2050 is approximately $440 million.
- The current annual funding level of $5 million is insufficient to sustain the R/R and SWI program. Based on Finance Committee input, staff recommends that the incremental increases through FY 2013/2014 that are used in the existing water rate projections be smoothed out over an additional two years such that an annual funding level of $11.4 million (2011 dollars) is reached in FY 2016/2017. This extended ramp-up allows Zone 7 to achieve the recommended funding level within the next six years in order to be able to manage our water system infrastructure over the long term. In response to Retailer comments, the Third Demineralization Facility and the water conservation programs were removed from this funding analysis.
- The annual funding level will be revaluated through future updates of the Asset Management Plan.

FUNDING: This project is funded from Fund 72 – Renewal & Replacement/System-Wide Improvements.

RECOMMENDED ACTION: Adopt attached resolution accepting the Asset Management Plan Update Report and approving the recommended ultimate AMP funding levels as outlined in the resolution.

ATTACHMENTS:

1. Memo providing additional background and discussion of agenda item
2. Resolution

Interoffice Memo

Date: June 15, 2011
To: Jill Duerig, General Manager
From: Mona Olmsted, Associate Engineer, Water Supply Engineering
Subject: Findings and Recommendations of Zone 7's Asset Management Program Update

The following provides additional background and discussion of the above-referenced agenda item.

BACKGROUND

In 2004, Zone 7 retained the consulting services of Carollo Engineers to assist in the development and implementation of an Asset Management Program (AMP). Zone 7's asset inventory was updated, detailed asset condition assessments were conducted, and true replacement cost and useful life of these assets were determined. The resulting 2004 AMP report recommended a ramp-up to a funding level of $10 million annually to fund the Renewal/Replacement and System-Wide Improvement (R/R and SWI) program, and to update the program every five years.

In February 2010, the Board authorized a consultant services contract with HDR Engineering, Inc., to assist Zone 7 in preparing the update to the AMP. A Technical Review Committee, consisting of Zone 7 staff and Retailer representatives, was involved in the project scoping and consultant selection process and has been providing input throughout the project by reviewing technical memorandums and participating in stakeholder workshops.

As described in a status report for the March 16, 2011 Board meeting, the following tasks have been completed:

- **Updated asset inventory:** The fixed asset inventory database was modified to provide greater flexibility for data management and updated with new assets that were constructed since the last update.

- **Revised asset renewal methodology:** For near term planning, identification of asset renewal projects is primarily based on condition. For long term planning, the long-term renewal forecast was revised from asset replacement at 50 percent of an asset's original useful life to asset replacement at 100 percent of an asset's original useful life. This revised methodology was subsequently used in developing the recommended annual funding level.

- **Developed decision processes:** To support near term asset renewal decisions, formal decision processes were developed. These processes ensure objective and consistent implementation of renewal practices, as well as provide clear documentation for renewal projects.

- **Conducted pipeline risk assessment:** The transmission pipelines were evaluated to determine relative risk, based on consequence and likelihood of failure, and prioritized for future condition assessments.

- **Developed condition assessment program:** A condition assessment program was developed to provide staff with standardized tools and a systematic process for determining an asset's condition in order to make informed maintenance and renewal decisions. Condition assessments of select assets were conducted, and asset classes and corresponding useful life estimates were determined.

Since the March Board meeting, HDR has completed the draft technical memorandum on the *Near Term Renewal CIP (Capital Improvement Program) and Long Term Funding Plan*, which has been incorporated into the draft *Asset Management Plan Update* report. The Retailers have reviewed and provided comments on the funding analysis. Subsequently, staff presented to the Finance Committee on May 4, 2011, the AMP findings and recommendations and staff's response to Retailer comments. The Committee recommended that the AMP Update be brought to the full Board for acceptance.

DISCUSSION

The development of the recommended funding level includes an update of the total estimated replacement value of the water system assets, identification of renewal capital projects, development of the long term funding forecast, and estimation of the SWI funding level.

- Accounting for the new assets that have been built since the last AMP update (e.g., Altamont Pipeline – Livermore Reach, Mocho Groundwater Demineralization Plant (MGDP), El Charro Pipeline, Chain of Lakes (COL) Wells, and Del Valle Water Treatment Plant 10-MGD Dissolved Air Flotation (DAF) Facility, etc.) increases the total estimated replacement value from $310 million to $423 million.

- The total estimated R/R funding requirement projected through 2050 is estimated to be approximately $310 million.

- The long-term funding forecast includes SWI projects since both R/R and SWI projects are funded from Fund 72. To establish future funding levels for SWI projects beyond the current CIP, a minimum annual funding level of $2.35 million per year for SWI is assumed beyond 2020. This SWI funding level is based on an average of the existing capital SWI funding needs, excluding a large taste and odor project for the treatment plants. This estimate is comparable to the SWI expenditures over the past ten years, which have averaged $2.4 million annually, excluding the Mocho Groundwater Demineralization Facility. The SWI funding level totals approximately $146 million.

The Retailers commented that we should be addressing SWI funding needs beyond the existing CIP as they arise, rather than burden current ratepayers by collecting funds for as-yet unknown projects. However, staff anticipates that there will be some SWI expenditures in the future and this is the best available estimate of the future SWI funding level. SWI projects are not only driven by regulatory requirements, but also environmental compliance, energy efficiency, operational flexibility, and aesthetic water quality goals (e.g., chemical system improvements, and VFDs for wells). Therefore, staff recommends retaining the SWI funding level beyond the CIP in the funding analysis. The SWI funding level will continue to be refined in future AMP updates.

The above funding forecast components plus $31 million in other costs funded from Fund 72 (e.g. administrative building lease and sinking fund, CIP and AMP program management, etc.) results in a total estimated capital cost for the R/R and SWI program projected through FY 2049/2050 of approximately $487 million. After adjusting for the existing Fund 72 balance and the annual fund transfer assumptions used in current water rate planning (through FY 2013/2014), the funding level recommended in the draft funding technical memorandum, beginning in FY 2014/2015 and continuing through FY 2049/2050, is approximately $12.5 million per year. However, in response to comments from the Retailers and Finance Committee, other funding alternatives were developed and evaluated. These alternatives and the corresponding funding levels are summarized below in Table 1.

Table 1. Funding Level Alternatives ($2011 Millions/year)

Funding Scenario	Alternative 1	Alternative 2	Alternative 3
	w/ T&O and w/ 3rd Demin[1]	w/o 3rd Demin	w/o T&O and w/o 3rd Demin[2]
1) Straight jump to funding level in FY11/12	$11.9	$11.2	$10.3
2) Ramping up to funding level in FY14/15 (example[3])	$12.5[4]	$11.7	$10.7
3) No increases until FY14/15 and straight jump to funding level in FY14/15	$12.7	$11.9	$10.9
4) Extend ramp up for 2 years, achieve funding level in FY16/17[5]	$12.9	**$12.0[6]**	$11.0
5) Defer ramp up for 2 years, achieve funding level in FY16/17	$13.0	$12.2	$11.1

[1]DVWTP and PPWTP Taste and Odor Treatment project (T&O project) for water quality improvements, and Third Demineralization Facility (3rd Demin)
[2]The annual funding level under Alternative 3 increases by $2.6M for the period of the loan if T&O is debt-financed
[3]Analysis uses ramp-up values from current water rate planning
[4]Funding level as recommended in draft funding technical memo
[5]Funding scenario developed in response to Finance Committee comments
[6]Revised funding level recommendation ($11.4M, after moving water conservation programs)

Staff evaluated the impact on projected water rates for the different funding ramp up scenarios shown in Table 1. The analysis showed that water rate increases in the range of 13 to 20 percent were necessary in some years in order to achieve the funding level under Scenarios 1, 3, and 5. Under Scenario 2 (ramp-up to funding level in FY 2014/2015), water rate increases were limited to 10 percent for two consecutive years. In response to comments received from the Finance Committee, staff developed Scenario 4, which extends the ramp-up under Scenario 2 by two additional years in order to smooth out the water rate increases, thereby achieving the funding level in FY 2016/2017. Under Scenario 4, water rate increases were limited to 7.5 percent. Note that AMP related water rate increases account for approximately 15 to 20 percent of the total water rate increases, and that the actual water rates depend on other factors, such as volume of water sales and operating expenses.

As shown in the table, the annual funding level would be reduced if the Third Demineralization Facility was excluded from the funding analysis (Alternative 2). The estimated cost for this project is approximately $32 million (in 2011 dollars), of which 90 percent, or $28.4 million, would be funded by the R/R and SWI program. Since this project is not scheduled for completion until around 2030 and the project need and feasibility will be further evaluated as part of the Salt Management Plan update, it would be reasonable at this time to consider excluding this project from the determination of the R/R and SWI program funding requirement. In the next AMP update, the funding level can be adjusted based on the Salt Management Plan evaluation.

In 2009, Water Quality Technical Solutions (WQTS) completed a study that was developed with our Retailers, which evaluated the effectiveness of ozone treatment for taste and odor control. The report recommended ozone treatment for the existing capacity at Del Valle and Patterson Pass water treatment plants in order to help meet our taste and odor treatment goals per the Water Quality Management Program and the Joint Water Quality Resolution. The DVWTP and PPWTP Taste and Odor Treatment project is estimated to cost $36 million and is scheduled to begin design in 2017, with construction completed in 2021. The Retailers recommend that we consider debt-financing, specifically for the large system-wide improvement projects, such as this project. Based on in-house staff calculations, debt-financing the taste and odor project could increase the funding level by $2.6 million (2011 dollars) in annual payments beginning around 2018 and for the duration of the loan, assuming a six percent interest rate on a 30-year loan. Staff recommends retaining the taste and odor project in the funding analysis, and funding it with pay-as-you-go, which is current Board policy.

Additionally, the Retailers commented on the appropriateness of including water conservation programs in the R/R and SWI program since the conservation program funding level may fluctuate year to year. Excluding water conservation programs from this funding analysis reduces the annual funding level by approximately $500,000. However, it should be noted that moving the water conservation programs to the operating budget would have an equivalent impact on water rates since those programs would still be funded from the Water Enterprise Fund (Fund 52).

Currently, the program is being funded at an amount of approximately $5 million per year. This level is insufficient to sustain the R/R and SWI program and the fund balance has been dropping over the past several years. Existing treated water rate projections, as previously presented to the Board during the water rate setting process for the 2011 water rate, include incremental increases up to $10 million by FY 2013/1014 in order to fund the program. Based on Finance Committee input, it is staff's recommendation to extend the ramp-up by two years, which will enable Zone 7 to reach $11.4 million (in 2011 dollars; Alternative 2 / Scenario 4, after removing water conservation program funding) in annual R/R and SWI funding in FY 2016/2017. The funding amount will be adjusted for other sources of revenue (e.g., actual interest income and Dougherty Valley Service Area facility use fees), and increased for inflation based upon the change in the ENR San Francisco Construction Cost Index using January 2011 as the denominator value (10,116.29). This extended ramp-up allows Zone 7 to achieve the funding level within the next six years in order to be able to manage our water system infrastructure over the long term. In response to Retailer comments, the Third Demineralization Facility and the water conservation programs were not included in the determination of this funding level. It is recommended that the Board accept the AMP report with this revised annual funding level recommendation. The annual funding level will be revaluated through future updates of the Asset Management Plan, approximately every five years.

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