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Asset Management Framework for Forested and Natural Assets

U.S. Endowment for Forestry and Communities

Asset Management Framework for Forested and Natural Assets

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Abstract and Benefits

Abstract:

Natural assets—such as forests and other watershed areas—provide many important core services and associated beneficial values to water utilities and the communities they serve. Like the built assets upon which a utility depends, natural assets require systematic attention and management to ensure that they deliver the types and levels of services upon which the utility relies. This document provides a framework, and associated practical guidance, for how utility professionals can apply the principles and tools of asset management (AM) to the natural systems that are critical to meeting the utility's mission and strategic objectives.

This guidance is intended for use by water utility professionals and other individuals looking to apply an AM approach to the natural assets that provide critical services and value to their utilities. This document describes an AM framework and provides practical step-by-step guidance for how the AM approach may be applied in a pragmatic fashion to forested watersheds, wetlands, and other natural assets that support the ability of water agencies to reliably deliver high-quality, safe, and affordable water to their customers. The AM Framework for natural assets is based on and adapted from the built asset version developed by American Water Works Association (Campanella et al. 2016), the U.S. Environmental Protection Agency, The Water Research Foundation, and the Institute of Public Works Engineering Australia.

For each step within the AM Framework, this research provides the technical basis and approach, as well as the process that will facilitate implementation of the AM Framework. Also included throughout are checklists, case study illustrations, clear definitions of key terms, and other practical information to help users implement the AM Framework to the natural assets relevant to their utility.

Benefits:

- This project provides a clear, step-by-step process to help utilities systematically identify, assess, prioritize, and manage risks associated with natural assets.
- The AM approach helps identify and assess potential changes in the quality and quantity of the natural systems and the associated levels of service (LOS) upon which utilities rely. It also contains illustrative examples and cross references to several existing tools, frameworks, and standards related to source water hazards.
- Implementing this guidance will help bring a utility's natural assets into better alignment with the approach and strategic objectives applied by many utilities to their built systems. For example, applying an AM framework can place source water programs on equal footing with pipe renewal, risk management, sustainability, and resiliency enhancement programs. This commonality across utility activities arises because these varied programs all typically apply a similar process, with a focus on meeting the utility's strategic objectives in a systematic, risk-based, prioritized, and cost-effective manner.

Keywords: natural assets, asset management, level of service, watersheds, source water protection, risk management, risk mitigation, ecosystem services, resiliency planning.

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Acronyms and Abbreviations

ABCUWA	Albuquerque Bernalillo County Water Utility Authority
ACOE	Armey Corps of Engineers
ALGENZ	Association of Local Government Engineers of New Zealand
ARIES	Artificial Intelligence for Ecosystem Services
AM	Asset management
AMP	Asset management plan
AWWA	American Water Works Association
BC	British Columbia
BCA	Benefit-cost analysis
BCE	Business case evaluation
BMPs	Best management practices
CAW	Central Arkansas Water
CE	Cost-effectiveness
CIP	Capital improvement Plan
CMMS	Computerized maintenance management system
CoF	Consequence of Failure
CORPUD	City of Raleigh Public Utilities Department
CPI	Conservation Priority Index
CTNC	Conservation Trust for North Carolina
Defra	Department of Environment Food and Rural Affairs
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
ESRI	Environmental Systems Research Institute
FASB	Financial Accounting Standards Board
GASB	Governmental Accounting Standards Board
GHG	Greenhouse Gas
GIS	Geospatial information system
HCP	Cedar River Habitat Conservation Plan
HEC-RAS	Hydrologic Engineering Center's River Analysis System
IC	Incremental cost
IIMM	International Infrastructure Management Manual
InVEST	Integrated Valuation of Ecosystem Services and Tradeoffs
IOUs	Investor owned utilities
IPWEA	Institute of Public Works Engineering Australasia
KPI	Key performance indicator
LGIM	Local Government Information Model
LOS	Level of service
LRFP	Long-range financial plan
MCDA	Multi-criteria decision approach
MNAI	Municipal Natural Asset Initiative

NAMS	National Asset Management Steering Group
NARUC	National Association of Regulatory Utility Commissioners
NRC	National Research Council
NFHL	National Flood Hazard Layer
NGO	Non-governmental organization
NWI	National Wetlands Inventory
Ofwat	Office of Water
O&M	Operation and maintenance
PES	Payment for Ecological Services
U.K.	United Kingdom
U.S.	United States of America
UNCWI	Upper Neuse Clean Water Initiative
USDA	United States Department of Agriculture
USFS	United States Forestry Service
USGS	United States Geological Survey
RPI	Restoration Priority Index
SAM GAP	Strategic asset management gap analysis tool
SFPUC	San Francisco Public Utilities Commission
SIMPLE	Sustainable Infrastructure Management Program Learning Environment
SMPI	Stormwater Management Priority Index
SPU	Seattle Public Utilities
SCVWD	Santa Clara Valley Water District
SWAT	Soil and Watershed Assessment Tool
SWRM	Source water risk management
TSS	Total suspended solids
USDA	United States Department of Agriculture
EPA	United States Environmental Protection Agency
WEIP	Watershed and Environmental Improvement Program
WERF	Water Environment Research Foundation (now Water Research Foundation)
WMPI	Watershed Management Priority Index
WRF	The Water Research Foundation
WRI	World Resources Institute
WSAA	Water Services Association of Australia

Executive Summary

Natural assets—including forested watersheds, aquifer systems, wetlands, and other natural features associated with the quantity, quality, and/or timing of water—provide a wide range of valuable services to water utilities. The high-value services provided by natural assets include contributions to source water quality, moderating runoff and floods, and groundwater recharge. Degradation of natural assets can reduce the level of service (LOS) provided, which in turn may pose significant risks for a utility. These risks include impaired water quality, reservoir sedimentation, stormwater flooding, and others that may adversely impact utility costs and the quality of the services provided to their customers. Ultimately, the condition and performance of natural assets are essential to supporting a water utility's ability to meet its strategic objectives of cost-effectively and reliably delivering safe drinking water to its customers.

ES.1 Background

The water sector is recognized as amongst the most capital-intensive sectors in developed economies, and yet this distinction only reflects built assets – primarily a utility's inventory of water mains, transmission lines, and treatment plants. At the same time, many essential inputs to the goods and services that water utilities deliver to their customers are provided by nature – namely the water itself, as well as the forested and other watersheds, aquifer systems, and other natural assets that convey, store, and protect the quality of source waters, and deliver other valuable water supply services. These natural assets also often generate important values for the greater community by providing wildlife habitat, recreational opportunities, commercial products (e.g., timber), carbon sequestration, visual aesthetics, and so forth.

Sustainability and efficiency require that water utilities recognize and prudently manage all of their critical assets—including natural capital—as well as built infrastructure and human capital. This research project developed a framework and guidance to strengthen water utilities' capacity to account for, invest in, and better manage their natural assets, by:

1. Enhancing recognition, quantification, and valuation of the important goods and services provided by forested and other natural assets;
2. Developing a framework for including forests and other natural assets within water utility asset management (AM) programs, and;
3. Recognizing and addressing the numerous barriers and challenges to placing natural assets on equal footing with built infrastructure within water utility planning and AM programs.

Natural assets typically include source waters and associated watersheds, as well as green infrastructure and other natural systems that utilities may (or may not) own, and that utilities aim to manage (often in partnership with landowners and other entities) to generate value, reduce costs, protect water quality, enhance water supply, improve resiliency, and enrich the quality of life for their broader communities. The research approach examines the challenges and opportunities for including natural assets alongside built infrastructure in how water utilities:

- Develop and apply business case evaluations (BCEs);
- Assess and manage risks, and plan for robustness and resiliency;
- Value and leverage their assets;
- Prioritize and manage their capital improvement programs, and operation and management (O&M) budgets;
- Gain access to financing;

- Recover costs through rates and other potential revenue sources; and
- Communicate and collaborate with outside parties (including watershed partners and other stakeholders).

ES.2 Assessing and Managing Natural Asset Risks to Utilities

Natural assets, along with the utility's other key assets, are subject to potential changes in condition that adversely impact the LOS the assets provide and, thereby, pose business risks to the utility. These business risks are important to recognize and mindfully manage, regardless of whether the asset is an engineered system (e.g., a treatment plant or pipeline) or a natural system (e.g., a forested watershed or natural reservoir).

Managing these risks enables the natural asset to sustainably generate value, reduce costs, protect water quality, enhance water supply, improve resiliency, sustain critical LOS, and enrich the quality of life for the broader community. Utilities thus will find value in developing an understanding of the risks posed by potential changes in a natural asset's condition, and the associated risks to the important flow of goods and services provided by that natural system.

For example, watershed lands may be subject to development, wildfires, flooding, and other events that would significantly alter the level and/or quality of services that flow from those assets. Utilities need to recognize these risks, and they need to apply the same principles and practices of risk management as they would for a built system. This entails understanding both the likelihood and consequences of a risk event.

One example of a risk event is a high-intensity wildfire in a forested watershed area. A utility supplied by a forested watershed needs to recognize the risks and consider how to try to reduce the likelihood and/or consequences of such risk event. Active risk management might thus entail actively supporting efforts to better manage forest lands in ways that reduce the likelihood, intensity, and spatial extent of potential wildfires, and that manage the sediment and debris loads that result after such events. The objective for the utility is to establish the level and quality of the services to be provided by the forested watershed, then monitor and manage performance in the face of the risks that apply to that asset.

ES.3 Drawing on the Practice of Asset Management

The research approach applied in this document draws from the rich field of asset management (AM) as increasingly applied by water utilities to their built systems (such as pipelines and treatment plants). The objective is to draw on the same principles and practices that are gaining maturity and broader sector-wide application for built systems, and to apply them to natural assets so that a water utility can manage all of its assets on equal footing.

Asset management, as described and applied in the AM literature and in this project, is a systematic and comprehensive approach for:

1. Creating a useful inventory of assets, and assessing their condition;
2. Defining the desired levels of service from the assets to meet utility strategic objectives;
3. Assessing the risk that the asset may degrade, or fail, and thus not deliver the target LOS required to meet the utility's higher-order strategic objectives;
4. Applying a risk management-based approach to identifying potential capital investments and/or maintenance expenditures for at-risk assets, to mitigate risks to the asset's ability to meet target LOS;

5. Conducting business case evaluations of the risk mitigation options to ensure they warrant investment of utility resources;
6. Implementing the selected risk mitigation options;
7. Monitoring asset conditions and performance periodically to ensure the mitigation investment is performing as planned; and
8. Adjusting the risk mitigation approach if/as needed to ensure desired asset conditions are attained and performance is meeting target LOS (and continuing the periodic review process to promote continuous improvement).

Because natural assets can be managed through capital investment and maintenance activities, the principles and methods of asset management can be applied to natural assets. In other words, natural assets can be integrated into asset management so that they are managed alongside (and on equal footing with) built assets to best meet utility business goals and strategic objectives.

The framework and guidance provided in this document offer a systematic, step-by-step approach for incorporating natural assets into an asset management program, building on standard asset management principles and practices. The framework and guidance also identify and address specific challenges of natural assets that may require unique approaches.

Some of the unique characteristics of natural assets may require an iterative approach to condition and risk assessment, setting of levels of services, and planning investments. In addition, natural assets are rarely owned by a utility, thereby often requiring different approaches to fund, finance, and execute management actions to preserve, protect, or enhance these assets.

ES.4 Related WRF Research

- Advancing and Optimizing Forested Watershed Protection (project 4595)
- Evaluation of Risk Management Frameworks and Tools and their Application for Managing Source Water Risks in the United States (project 4748)
- Practitioner's Guide to Economic Decision Making in Asset Management (projects 1725 and 1726)
- Quantifying the Potential Benefits of Land Conservation on Water Supply to Optimize Return on Investments (project 4702)
- Source Catchments as Water Quality Treatment Assets: Industry Best Practices and Triple Bottom Line Cost Evaluation of Catchment Management Practices (project 4570)
- Sustainable Infrastructure Management Program Learning Environment (SIMPLE), Version 1.1 (project 4013)

CHAPTER 1

Background and Rationale for Applying Asset Management to Natural Assets

What you will find in this chapter

This chapter presents a high-level overview of the rationale and process for applying asset management (AM) to natural assets. The materials are organized as a series of questions you might be thinking about as you consider whether natural asset management and this *guidance* are right for your utility. Each question is accompanied with an abbreviated answer. Subsequent chapters of this report provide a deeper dive on each of these topics.

1.1 Introduction and Overview: What Is the Purpose of This Document?

This document provides a framework and associated practical guidance to support water utility professionals in their efforts to better understand and better manage the natural assets upon which their utilities rely. The central premise is that natural assets—much like a utility's built systems—require prudent and active asset management (AM) in order to best address the utility's business risks and sustain desired levels of service (LOS).

Like built systems, natural assets provide critical goods and services for water utilities and the communities they serve. Regardless of whether an asset is provided by nature or built by humans, and regardless of who owns the asset, what is important is that a valuable asset be recognized and managed so as to continue to provide the desired LOS for the utility and its customers. As such, the objective of this framework and guidance is to help water utilities integrate natural assets into the asset management programs for built assets, so that all utility assets are managed in a comparable manner, well aligned with the utility's mission and strategic objectives.

1.2 How Is This Guidance Document Structured?

In Chapters 1 - 4, the general rationale and context is developed for applying AM to natural assets. Included is this introductory chapter that provides a high-level overview of the key issues and motivation for engaging in the AM process for natural systems. Chapters 2 – 4 offer an overview of natural assets, what AM is and the framework for an AM program, and why there is value for water utilities to consider actively managing those resources.

In Chapters 5 - 11, the step-by-step process of applying AM to natural assets is laid out, with a chapter devoted to each step in the process. Within each chapter, guidance is provided regarding both the process for successfully applying AM to natural assets, as well as the technical approaches for doing so. Key differences between AM for built and natural systems are also identified and addressed in each step-specific chapter, and case illustrations are provided as well.

1.3 What Are Natural Assets, and Why Should We Care About Them?

Natural assets typically include source waters and associated watersheds and other natural systems upon which utilities rely (i.e., that provide valuable goods and services to the utility). In fact, natural assets often provide the foundation for water utility services (i.e., the source water itself, as well as the processes that govern the quantity and quality of the water). And, the goods and services provided by natural assets typically are very difficult and expensive to replace if lost.

Natural assets include those land areas and other natural features which the utility may or (more typically) may not own. Natural systems relevant to water utilities include lakes, rivers, streams, aquifers and other associated features such as forested watersheds, grasslands, meadows, and wetlands that interface with riparian/aquatic resources and their ecosystem functions.

One may also consider some human-made features as natural assets, such as the construction and deployment of swales and retention basins as part of a green stormwater infrastructure (GSI) strategy to manage stormwater runoff. There also are human-built systems that mimic biologic functions that might be considered as either a built or natural asset, such as infiltration basins, aquifer storage and recovery systems, and the like.

To assist in distinguishing between natural assets and green infrastructure, the Municipal Natural Asset Initiative, developed and applied in Canada (MNAI 2017), describes each category as illustrated in Figure 1-1. Note that the MNAI terminology refers to the broad range of assets as green infrastructure, and distinguishes natural assets as a specific subset. For our purposes in this report and guidance, we focus on natural areas such as forested watersheds. However, the approach developed here may be applied more broadly, including to areas that might be called semi-natural (e.g., urban parks, restored stream channels.

Figure 1-1. A Canadian Approach to Categorizing Natural Assets.
Source: MNAI 2017.

1.4 What Types of Services Do Natural Assets Provide Utilities?

Natural assets such as forests provide many important beneficial services to water utilities and the communities they serve. Some of the important services provided to water utilities by natural assets include:

- Protecting and enhancing source water quality
- Helping to regulate the quantity of source waters available (e.g., maintaining base flows)
- Reducing flooding and related risks
- Maintaining storage capacity
- Improving water utility resiliency
- Providing cost savings (and avoided costs)
- Preserving habitat for special status species (e.g., endangered salmon)

1.5 What Types of Services and Values Do Natural Assets Provide the Broader Community?

In addition to providing direct and indirect value to water utilities, forests and other natural assets also provide considerable value to the broader community, and the planet as a whole (e.g., providing carbon sequestration, wildlife habitat, recreation, and aesthetic services). While many of these benefits may be external to the utility, they are nonetheless important considerations to water systems whose missions include providing broad notions of service and value to the people, businesses, and ecosystems in their service areas and beyond.

These external values may also provide an avenue for co-funding or other revenue streams from outside parties willing to partner with the utility to secure these services. We refer to these values provided to the broader community (i.e., parties other than the utility) as external benefits or stewardship values.

The value of some of these external goods and services may be reflected in observable market prices (e.g., the market value of any timber harvested as part of a forest restoration effort). However, the majority of the external stewardship values provided may be in the form of nonmarket values (i.e., outcomes that are important, such as preserved wildlife habitat, and that are valued by people and organizations, but that are not typically traded in markets and, therefore, do not have market-based prices with which to value those services).

Some examples of the market and nonmarket goods and services that natural assets provide to the broader society include:

- Providing recreational, ecotourism, and related opportunities
- Preserving and enhancing ecosystem services beyond those that benefit water supply (e.g., habitat that supports commercial fisheries)
- Providing habitat for ecologically important species and overall biodiversity
- Sequestering carbon

1.6 Why Should Water Utilities Aim to Manage Natural Assets?

Water utilities are recognized as amongst the most capital-intensive sectors in developed economies, and yet this distinction only reflects their built assets – primarily their inventory of water mains, transmission lines, and treatment plants. The water utility sector has made significant strides in recent years to develop more systematic approaches to managing their large portfolio of engineered assets, through the enhancement and widespread deployment of asset management plans (AMPs) and associated business practices.

At the same time, many essential inputs to the goods and services that water utilities deliver to their customers are provided by nature – namely the water itself, as well as the forested and other watersheds, aquifer systems, and other natural assets that convey, store, and protect the quality of source waters, and deliver other valuable water supply services.

Sustainability and efficiency are enhanced when water utilities recognize and prudently manage all of their critical assets – including natural assets. Natural assets tend to enhance utility resiliency to extreme weather events and other risks associated with climate change, and prudent management of natural assets may reduce costs associated with operating and maintaining utility built systems. Through source water protection programs and other efforts, natural assets can (and should) be prudently assessed and managed with the same care as a utility’s built systems (e.g., its water mains), information systems (including asset inventory and data systems), and the utility's human capital (i.e., its dedicated and well trained professional staff).

1.7 Are There Risks to Utilities Associated with Their Natural Assets?

Natural assets, along with the utility's other key assets, are subject to potential changes in condition that pose business risks. These business risks are important to recognize and mindfully manage, regardless of whether the asset is an engineered system (e.g., a treatment plant or pipeline) or a natural system (e.g., a forested watershed or natural reservoir).

Managing these risks enables the natural asset to sustainably generate value, reduce costs, protect water quality, enhance water supply, improve resiliency, sustain critical LOS, and enrich the quality of life for their broader community. Utilities thus will find value in developing an understanding of the risks posed by potential changes in a natural asset's condition, and the associated risks to the important flow of goods and services provided by that natural system.

For example, watershed lands may be subject to development, wildfires, flooding, and other events that would significantly alter the level and/or quality of services that flow from those assets. Utilities need to recognize these risks, and they need to apply the same principles and practices of risk management as they would for a built system. This entails understanding both the likelihood and consequences of the risk event.

One example of a risk event is a high-intensity wildfire in a forested watershed area. A utility supplied by a forested watershed needs to recognize the risks and consider how to try to reduce the likelihood and/or consequences of such risk event. Active risk management might thus entail actively supporting efforts to better manage forest lands in ways that reduce the likelihood, intensity, and spatial extent of potential wildfires, and that manage the sediment and debris loads that result after such events. The objective for the utility is to establish the level and quality of the services to be provided by the forested watershed, then monitor and manage performance in the face of the risks that apply to that asset.

1.8 What Does Managing Mean in the Context of a Water Utility Managing Natural Assets?

As is the case for built assets, the management options for a water utility seeking to help preserve or enhance the LOS it derives from a natural asset may include capital investments, O&M outlays, performance monitoring and condition assessment, and/or outreach and partnership activities with relevant stakeholders and asset owners. However, the term managing may have different ramifications when referring to a water utility's actions related to natural assets, as contrasted to its work managing its built systems.

For a built asset like a water main, the utility can opt to pull it out of the ground and replace it. Likewise, a water treatment plant can be upgraded, and/or provided with suitable routine maintenance by the utility. In contrast, the management options for a water utility looking to preserve or enhance a natural asset and its LOS will typically entail a different array of management choices and constraints.

For example, to help preserve the services provided by a source watershed, a utility may engage in active source water protection efforts, such as exploring options to acquire lands that may otherwise be subject to development that would increase nonpoint source runoff and impair water quality. The utility may then explore options that help manage or preserve those lands to ensure continued provision of watershed-related services, such as water quality protection. Or the utility may partner with other entities (e.g., a land trust) to acquire an easement on those lands that precludes land use activities that would likely impair water quality. Or, the utility may encourage the current landowner (e.g., a farmer) to use conservation tillage and other practices that reduce pollutant runoff (e.g., helping the farmer secure conservation grant moneys from the US Department of Agriculture (USDA) to implement suitable land management practices).

1.9 Does Ownership of the Natural Asset Have an Impact on What a Utility Can Do to Manage It, or Change the Challenges the Utility Faces?

In many if not most instances, key natural assets are not owned by the utility. Instead, source watershed lands such as agricultural parcels, forested areas and other relevant natural assets often are owned by other entities, such as private landowners (e.g., farmers, livestock operators, residential home owners, timber companies, land developers) and/or governmental entities (e.g., the US Forest Service or State government forestry or parks agencies).

Whereas utilities hold ownership for their built assets and can access and manage those assets as they deem appropriate, the lack of ownership of most natural assets means that the utility cannot readily dictate what happens on those lands unless they make an investment to acquire those lands or secure a right (such as conservation easement, priority use agreement, etc.), or partner with other entities, such as land trusts, to acquire those lands. Without ownership, cooperative arrangements with landowners and other key stakeholders are required, which entails additional effort and institutional complexity. Lack of ownership also creates accounting challenges, since the expense of helping to manage natural assets owned by other parties may be difficult to justify on the financial ledger (as described in greater detail in a subsequent section).

As a consequence, managing a natural asset on which a water utility relies typically entails supporting the efforts of the landowners to sustain the asset qualities that deliver the desired types and levels of service to the utility (e.g., as part of an active source water protection program). This may entail, for example, working cooperatively with forest owners to encourage and support tree thinning and related activities that reduce the risk of high-intensity wildfires that would significantly impair water quality and damage reservoir systems. Or, managing a watershed area owned by a residential community may entail the utility developing conservation easements and zoning requirements with the homeowners and local land management agencies, with the objective of reducing the erosion and nonpoint source runoff into source waters.

There are several models and tools for collaboration in managing natural assets held privately, however it is widely acknowledged to be a complex and challenging area with no single right answer. There are three broad approaches emerging for how to influence management of private land and/or land under the jurisdiction on non-municipal entities, but which provides core services:

- *Changing ownership rights*. In extreme cases where managed retreat is required for disaster risk reduction, local governments may have an opportunity for expropriation that leads to changes in natural asset management. There are recent Canadian examples of this.
- *Expanding collaboration*. Ownership rights and non-municipal jurisdiction exist within a broader societal context, and there may be opportunities to expand the degree to which ownership rights and jurisdiction are exercised.
- *Tools for collaboration*. MNAI has documented a range of tools that can be used to facilitate management of natural assets on private land (as can be found at www.mnai.ca). According to asset management principles, local governments should focus foremost on the services they receive, and

therefore include in their inventory natural assets that provide services even if they lack ownership or jurisdiction over them.

1.10 Why Does Managing Natural Assets Pose an Accounting Challenge for Water Utilities?

Forest watersheds and other natural assets provide goods and services that often provide high value to water utilities as well as the communities they serve. Utilities may therefore recognize the value of making considerable investments in these natural assets to preserve, enhance, or restore these high value services. Yet service values from natural assets typically are omitted from standard financial accounting frameworks. This omission creates a critical disconnect in how utilities can properly: (1) plan, prioritize, justify, and pay for their capital investments in natural assets, or (2) address natural asset management in their on-going operating budgets.

Accordingly, an objective of this guidance is to examine how accounting for the value of goods and services provided by natural assets may be applied in a water utility's:

- Business case evaluations (BCEs)
- Capital and O&M expenditure planning and approval processes
- Existing asset management approach
- Financial accounting standards and practices for utility valuation and rate development; and
- Access to loans, grants, and other sources of financing or revenues.

1.11 What Are the Benefits, Opportunities, and Challenges for Melding Natural Assets within Utility AM Programs for Built Systems?

Much of the water utility sector has become aware of and started to embrace the practice and principles of AM for their built infrastructure, with many tangible benefits in the form of improved business case evaluation practices, well-prioritized CIP planning and operating budgets, and other forms of improved business management. The growing emergence, maturation, and strengthening of AM programs for built assets provides an opportunity—and momentum—for extending the principles and practices of AM to natural assets.

While there are many benefits to extending AM principles and practices to natural assets, there are numerous challenges to doing so. Some of the potential and real barriers include:

- Financial accounting standards and protocols do not always align with the full economic value provided by natural assets or the services they provide.
- Natural assets typically provide a mix of market and "nonmarket" goods and services, but the level and value of these goods and services often are not directly observable.
- Access to financing for natural asset programs typically is very limited
- Services from natural assets, and outcomes from efforts to maintain or enhance those assets, often are not well defined or readily measured/quantified.
- Managing natural assets may expand the types and levels of staff competencies needed by utilities
- Ownership and/or control of natural resources are often held by outside parties
- Rate-setting regulations and policies make it difficult to recover expenditures on natural asset programs
- Many of the benefits provided by natural assets may accrue to parties external to the utility

- Utilities face many competing high priority needs, that outpace utility resources or fiscal appetite, and raise affordability concerns.

The long list of challenges provided above is daunting, but not insurmountable. There are several programs providing funding and/or technical support for watershed protection efforts tied to land management. For example, the US Department of Agriculture (USDA) provides funding through its Conservation Reserve Program, which has funded $35 billion worth of investment over the past 20 years to incentivize private landowners to remove sensitive lands from agricultural production and plant environmentally suitable plant species that will meet watershed management goals, including improving water quality. The recent United States Farm Bill, signed into law in 2018, expands the level of federal fiscal and technical support considerably for source water protection efforts through agricultural conservation efforts.

1.12 Do We Need to Have an Active AM Program for Built Assets to Pursue an Asset Management Approach for Our Natural Assets?

It certainly will be of great value to have a reasonably mature AM Program in place for built systems in order to make the best use of this framework and guidance for natural assets. Our approach is based on the premise that a utility with an active AM Program will have the foundation needed to most readily adapt its approaches to including natural assets within a unified AM Program.

However, our work with utilities with limited AM Programs established in their organizations for built systems have been able to move forward effectively with how they perceive and manage the services derived from their natural assets. So, while having an active AM Program in place for built systems is a very useful pre-requisite, a utility lacking such a program can still benefit by understanding and applying the general principles and approaches developed in these materials. In fact, by setting up a process for an AMP approach for natural assets, this work may enable those utilities to also move forward to extend the principles and tools of AM to their built systems as well.

1.13 What Is Provided in the Guidance Chapters That Follow?

Chapters 1 - 4 provide an introduction to AM and the relevance and value for applying AM to natural assets:

- Chapter 2 provides an overview of the tools and methods available for developing and applying an AM approach
- Chapter 3 builds on the AM tools and methods of Chapter 2 to develop a standard framework for AM for natural assets, and it serves as a foundation for the step-by-step guidance.
- Chapter 4 provides examples of AM as applied to natural assets.

Chapters 5 – 11 of this document provide step-by-step guidance for integrating natural assets into AM Programs, and is organized with a chapter dedicated to each key step of the AM framework process.

- Chapter 5 discusses the strategic context for applying AM to natural assets (i.e., how AM aligns with the utility's core mission), focusing on the facilitators that help promote the successful application of AM within a water utility
- Chapter 6 covers the challenges of creating an inventory for natural assets, and assessing the condition of those assets
- Chapter 7 explores the target Levels of Service (LOS) applicable to and desired from natural assets

- Chapter 8 examines the risks associated with natural assets and the risks posed to the level of services they provide
- Chapter 9 covers the options for making utility investments in natural assets to support the desired LOS these assets provide
- Chapter 10 describes long-term funding plans and issues for utilities seeking to make investments in the natural assets important to them, with a focus on accounting frameworks and the challenges and opportunities for applying utility resources to protect, restore, or enhance relevant natural systems and the services that flow from them.
- Chapter 11 offers insights for sustaining an effective on-going AM approach to natural assets, including insights to promote continuous improvement practices for managing natural assets, and for effective communication related to natural assets
- Chapter 12 provides conclusions and a suggested agenda for future research.

CHAPTER 2

Asset Management: What Methods and Tools Are Available?

What you will find in this chapter

A summary of asset management frameworks that are commonly used in the U.S. and elsewhere, including:

- An approach from EPA and Water Environment Research Foundation known as the "10-step, 5-question" approach
- Methods and principles from the International Infrastructure Management Manual
- AWWA's Asset Management Wheel, which builds on the EPA/WERF approach

All three are used to develop a framework for natural asset management (presented in Chapter 3), with the AWWA Wheel serving as the conceptual core of the approach.

This chapter provides an introduction to established Asset Management (AM) frameworks and practices for water sector utilities. Included are descriptions of the AM frameworks that have been developed and deployed by the American Water Works Association (AWWA) and its AM Committee, the United States Environmental Protection Agency (EPA), the Institute of Public Works Engineering Australasia (IPWEA), and the Water Environment Research Foundation.

For readers already familiar with AM, this material can be skimmed or bypassed. For those readers that are new to AM, this chapter is intended to offer a sense of the range and depth of AM guidance offerings available.

While widely adopted by many water sector utilities for their built systems (e.g., treatment plants, conveyance systems), the principles and tools of AM also may be usefully applied to the natural assets upon which utilities rely. Hence, we start here by providing an overview of relevant AM frameworks and tools that have been deployed across the water sector, to provide context for the following chapters that describe *why* and *how* natural assets may be integrated into AM programs.

2.1 What Is Asset Management?

Asset management is a coordinated, systematic and proactive set of activities to deliver on a utility's business objectives by cost-effectively managing its assets (IPWEA et al. 2015; EPA 2019a). AM involves assessing the:

- condition of assets,
- potential and probability (likelihood) of asset failure or degradation, and
- resulting risks to the services delivered by the utility.

The information from this business risk assessment is used to inform decisions about maintenance, rehabilitation, and capital investment for a utility's assets – typically its built infrastructure.

AM as traditionally applied entails a well-developed set of practices for built infrastructure, and consists of multiple principles, methods and techniques from engineering, finance, management science and other fields. The ultimate purpose of asset management is to "provide a desired level of service through the management of assets in the most cost-effective manner for present and future customers" (ALGENZ and NAMSG 2006). The same principles and practices may also be beneficially deployed for natural systems upon which utilities rely in the water sector (for reasons described elsewhere in this report).

The development of AM practices at a utility is typically an evolution involving continuous and on-going process development, skill enhancement, and refinement of operations. It is not simply an exercise in advancing from one state of practice to another as if it is a stand-alone project. As a result, AM requires employing a 'continuous improvement' philosophy and commitment to adapt over time.

2.2 Common Asset Management Frameworks

There are many different frameworks for utility Asset Management that are practiced throughout the world, which are discussed in multiple references (IPWEA et al. 2015; EPA 2014). While each framework has distinct elements, there is a common thread throughout them in that all contain similar basic characteristics as defined above, and they are all targeted at the same key objective of ensuring desired Levels of Service may be maintained by a utility in a sustainable, cost-effective manner.

Two of the most common AM frameworks are reviewed here: one from the US Environmental Protection Agency (EPA) and Water Environment Research Foundation (WERF), and another approach from the International Infrastructure Management Manual (IPWEA et al. 2015). These two AM frameworks serve to illustrate principles and elements that are most commonly referenced in literature and around which leading utilities have organized operations.

2.2.1 EPA/Water Environment Research Foundation SIMPLE Approach

In North America, EPA's collaboration with WERF produced what is commonly referred to as the 10 Step, 5 Question Framework (Figure 2-1; EPA 2014; EPA 2019b; WRF 2019). WERF presents this approach, together with a number of supporting practice and concepts, in their Sustainable Infrastructure Management Program Learning Environment (SIMPLE) (WRF 2019).

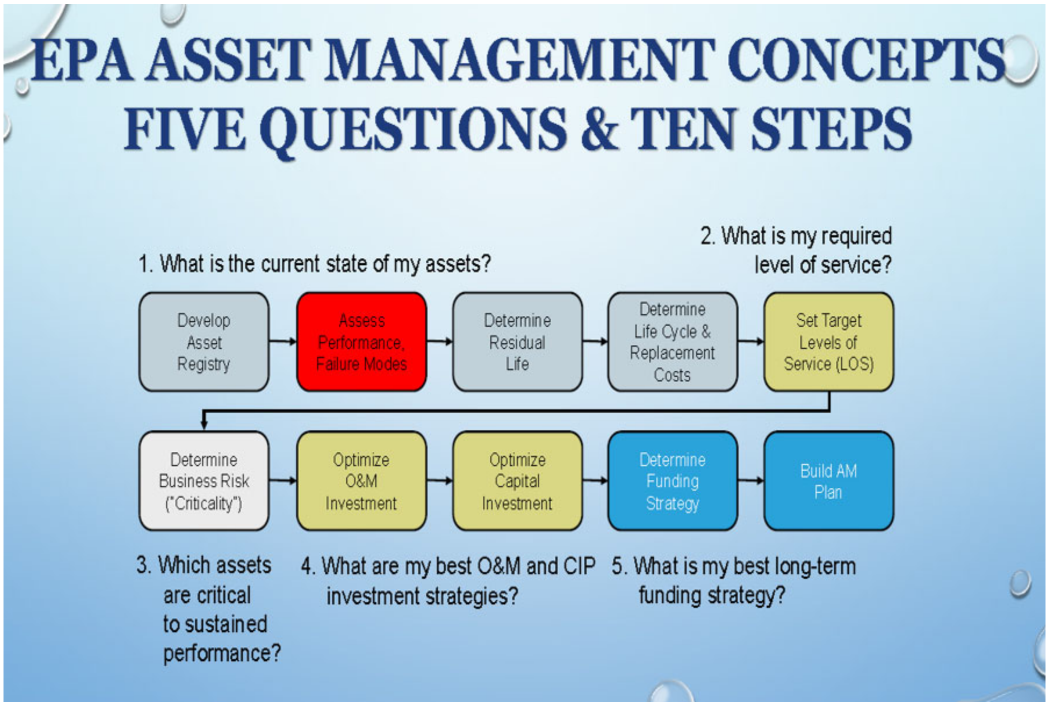

Figure 2-1. EPA/WERF Asset Management Framework.
Source: EPA 2014.

As shown in Figure 2-1, within this framework there are five key questions to address:

1. What is the current state of my utility's assets?
2. What is are your utility's required levels of service (LOS) such assets are to provide?
3. Which of the assets are critical to sustained performance?
4. What are the best operations and maintenance (O&M), as well as capital investment strategies to employ related to these assets to meet the LOS?
5. What are the best long-term strategies to fund those activities?

The American Water Works Association (AWWA) Asset Management Committee expanded upon the EPA/WERF SIMPLE framework by illustrating the iterative and continuous nature of the AM process. The AWWA approach thus is depicted in Figure 2-2 as a wheel, reflecting the asset management *lifecycle* as an on-going, continuing process. "Enablers" (or "facilitators") of the framework also are detailed as the hub of the AM wheel, and each of the five core questions are expanded upon as one makes their way around the wheel.

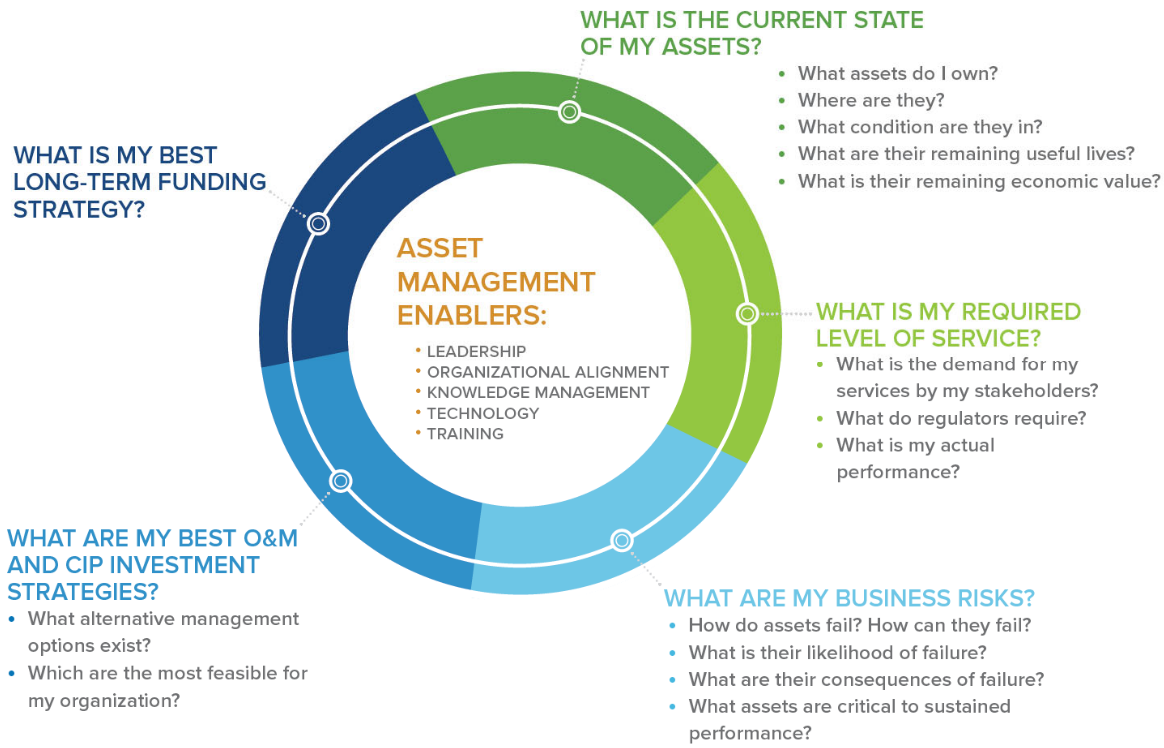

Figure 2-2. The AWWA Asset Management Wheel.
Source: Adapted from Campanella et al. 2016.

For each of the five questions, the AWWA approach identifies detailed issues that need to be addressed. These include issues that go to the heart of asset management processes: inventory; condition assessment; service levels and performance measurement; risk assessment; operations/maintenance and capital investment strategy development; and developing a viable long-term funding strategy. To provide the conditions necessary to operate effectively, *enablers* are identified (see hub of the wheel portrayed in Figure 2-2) that offer the guidance, direction, and support important to succeed. We adopt this AWWA-based AM wheel for this guidance document on including natural assets (although we make a few minor modifications, in Chapters 5 - 11, to better reflect instances where the application to natural assets creates a nuanced difference from applications for built assets). We also refer to *facilitators* for effectively applying AM within the hub of the modified AM Wheel for Natural Assets (rather than retain the term *enablers*).

2.2.1.1 International Infrastructure Management Manual

Another AM framework commonly referenced by practitioners in North America, as well as several other countries, is described in the International Infrastructure Management Manual (IIMM; IPWEA et al. 2015). The IIMM framework is more comprehensive than the EPA/WERF SIMPLE framework. Notably, the IIMM framework illustrates the linkage between asset management processes and other strategic thrusts of a utility organization. That is, AM is recognized in the IIMM framework as being integrally linked to the overall mission and strategic objectives of the utility (i.e., to reliably provide their customers with desired types and levels of services in a sustainable and cost-effective manner) The total asset management process developed by IIMM is illustrated in Figure 2-3.

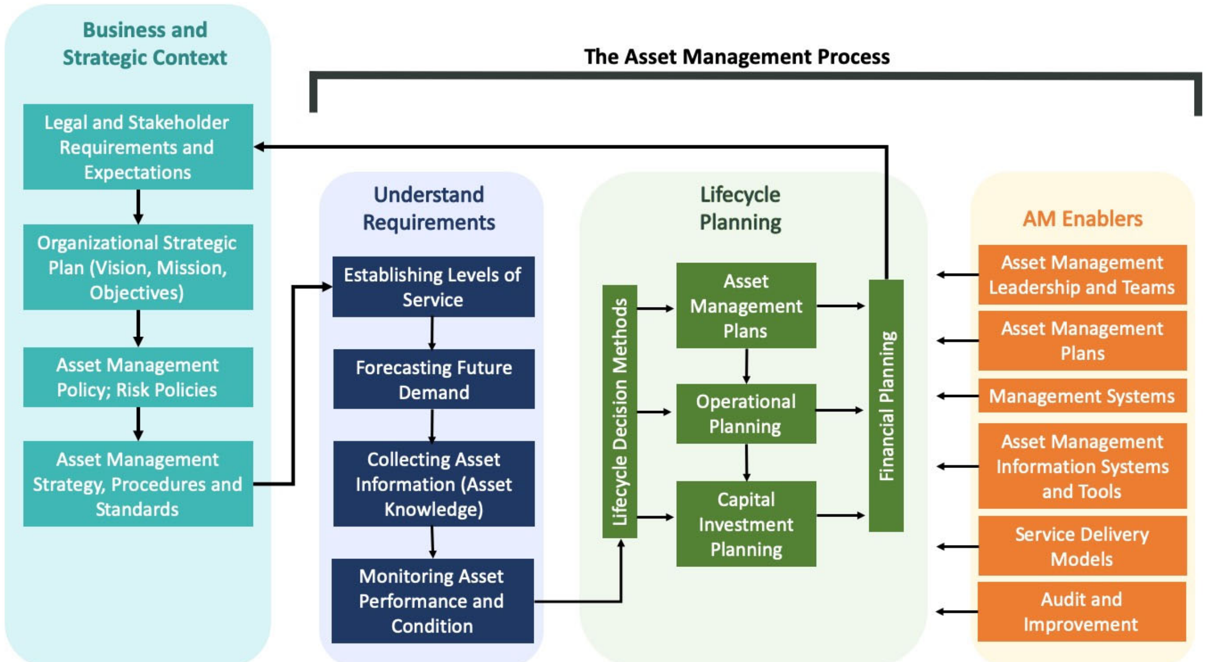

Figure 2-3. Asset Management Framework.
Source: **A**dapted from IPWEA et al. 2015.

Within this framework, asset management planning is linked with an organization's strategic plan, where the utility's vision, mission, strategic goals and objectives are defined. It also includes reference to business policies of the organization, and specifically a documented asset management policy. The asset management policy sets the conditions and outcomes by which asset management planning is to be performed. Asset management planning processes, solutions and outcomes are developed in a manner similar to the framework of the EPA/WERF SIMPLE model. Within the IIMM framework, explicit recognition of the importance of asset data and utility information systems is made, reflecting the importance of making data-informed decisions.

Further, this framework fits within a utility organization much like other facets of utility planning processes (e.g., customer service, human resources, financial plans, etc.) as illustrated in Figure 2-4.

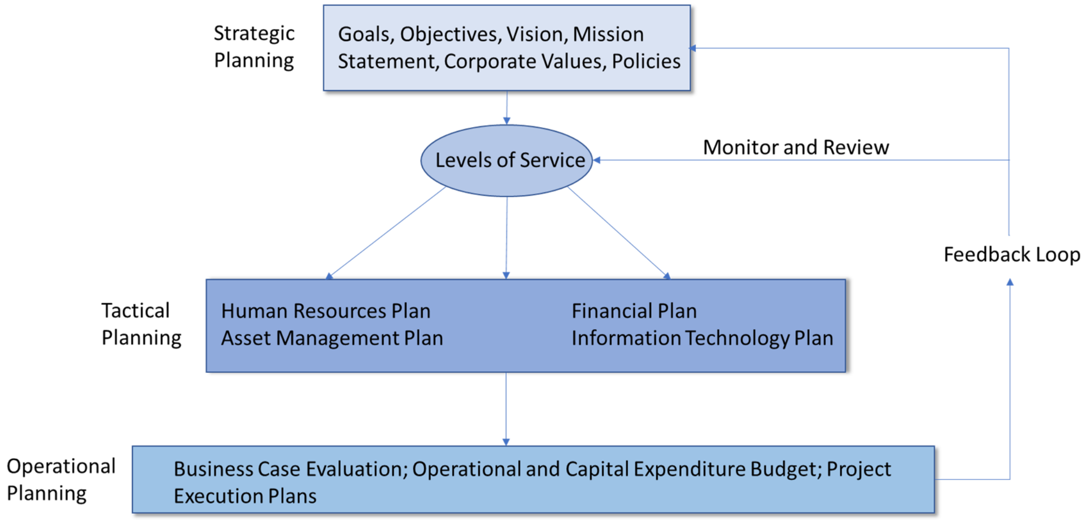

Figure 2-4. Relationship of IIMM Asset Management Planning and Other Utility Planning Processes.

2.3 Asset Management Framework for This Guidance

The guidance presented here draws from all of the resources highlighted above: the EPA/WERF 10 step and 5 question approach and SIMPLE, AWWA's enhancements, and the IIMM (IPWEA et al. 2015). The core steps of AM presented here closely follow the 5 questions presented in the EPA/WERF and AWWA frameworks. In addition, following from AWWA and the IIMM, the guidance here emphasizes the strategic context for asset management applied to natural assets and the necessary enablers for successful asset management. The next chapter summarizes how the AM elements and frameworks are used in this guidance.

CHAPTER 3

An Asset Management Approach for Natural Assets

What you will find in this chapter

This chapter builds upon the AM frameworks presented in Chapter 2, presenting an iterative approach to developing a natural asset management program, starting with a simplified *reconnaissance-level* implementation, followed by a *deep dive* implementation on prioritized natural assets and related risks.

Asset management steps are presented, drawing from each of the frameworks in Chapter 2. A modified version of the AWWA Asset Management Wheel is used to illustrate the new approach.

This chapter provides an AM framework tailored to practical application for natural assets. The framework and guidance presented here draws heavily from the AWWA framework, supplemented by key concepts and methods from the IIMM (ALGENZ and NAMSG 2006, IPWEA et al. 2015).

There are some differences in how the technical methods and techniques of AM are applied to natural assets, as compared to built systems. These differences are briefly described in this chapter, with cross references to applicable chapters of this guidance that address each of these steps in greater depth. Overall, the process presented here is very similar to the standard AM approaches from AWWA and others (although we have made some modest refinements to the AWWA AM wheel to accommodate some unique features of natural assets). This similarity to built system AM will make it easier to eventually integrate natural assets into a single, comprehensive (unified) asset management program.

In addition, to facilitate a practical application of AM approaches to natural assets, we recommend an iterative process that starts with a simplified, reconnaissance-level implementation of AM to relevant natural assets. The reconnaissance-level application is intended to help orient utility practitioners to the concepts and process, without getting bogged down in a level of detail that may not be warranted. The initial, reconnaissance-level effort is then followed by a more detailed level of implementation of the AM framework, where additional depth and/or breadth may be pursued, as informed by the initial screening effort.

> Because managing natural assets may be an entirely new endeavor for water utilities, it will be beneficial to start with a simplified implementation of AM methods called a reconnaissance-level implementation. For traditional AM with built assets, this is sometimes referred to as desk-top assessment. In other contexts, it may be described as a screening-level approach. The key is that it is a simplified version of the AM methods that sets a foundation for full implementation later.

The reconnaissance-level phase enables a utility to test AM approaches for natural assets, establish how AM for natural assets will benefit the utility and, in many cases, better address the uncertainties of managing natural systems. The reconnaissance-level phase provides information to prioritize which assets or types of assets should be addressed with more detailed implementation in the second phase. In reality, a sustained AM program for natural assets will include continuous iteration through these phases as the utility includes new natural assets over time.

3.1 AM Framework Elements Emphasized in This Guidance

The following elements of common asset management frameworks, which were covered in Chapter 2, are particularly relevant when incorporating natural assets into asset management activities. Each of the elements highlighted below is covered in detail within a chapter of this guidance (see Table 3-1). The descriptions below include references to relevant chapters of this guidance. The elements of asset management emphasized in this guidance can be used to create a modified version of the asset management wheel (Figure 3-1), emphasizing questions and concepts that focus on natural assets.

Table 3-1. Elements of Common Asset Management Frameworks Applicable to Inclusion of Natural Assets.

Chapter of this Guidance	Relevance to Asset Management for Natural Assets	AWWA Asset Management Wheel	IIMM
4 – Facilitators and Success Factors	Leadership commitment and utility strategic direction includes sustainability/resiliency/enhancement of affected environment	Facilitators (Enablers)	Organizational Strategic Plan (vision, mission, goals, objectives)
5 – Inventory and Condition Assessment	Inventory, condition, and valuation of important services from natural assets	Question 1: Current State of Assets	Asset Data and Information systems to inform decision making
6 – Level of Service for Natural Assets	Specify the level of natural asset services that will meet utility level of service as determined by customer expectations, regulations etc.	Question 2: Levels of Service Requirements	Legal and Stakeholder Requirements and Expectations
7 – Business Risk Associated with Natural Assets	Probability and consequences of natural asset degradation leading to failure to meet target level of service; assess criticality to business goals	Question 3: Business Risk Exposure	Risk identification, assessment and control
8 – Capital Projects and Maintenance for Natural Assets	Asset purchase, conservation easements, ecosystem restoration and on-going maintenance actions to improve natural asset performance; prepare business case evaluations	Question 4: Best O&M and CIP Investment Strategies	Asset Management Solutions (asset solutions/non-asset solutions)
9 – Long term funding strategies	Developing and leveraging partnership agreements to access external funding support; strategic natural asset investments; Payments for ecosystem services;	Question 5: Long-term Funding Strategy	Optimized Asset Management strategies, fiscally sustainable targets and plans

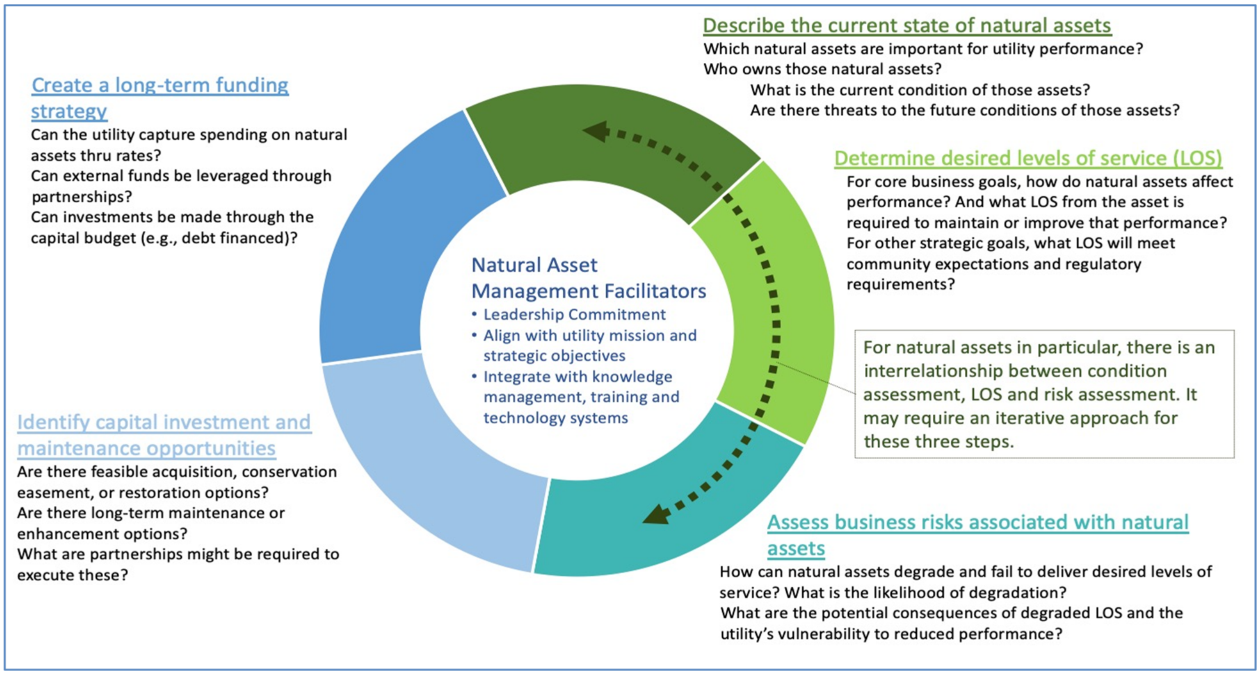

Figure 3-1. The Natural Asset Management Wheel.
Source: Adapted from Campanella et al. 2016.

3.1.1 Strategic Context: Facilitators and Success Factors (Chapter 5)

As recognized by the hub of the AM wheel (EPA 2014), at the core of successful AM are several critical *facilitators* (enablers) that are necessary ingredients to a utility's ability to attain success. These facilitators include having leadership that is engaged and supportive of AM in general, and its application to natural assets in specific.

For natural assets to be an element of a utility's asset management planning, alignment with strategic direction is necessary. Leading utilities who look to include natural asset services in planning and operations typically are adhering to the strategic direction issued by their top management and governing bodies, such as reflected in the utility mission statement. The strategic direction can take different forms. Utilities typically exhibit a strategic imperative that is centered around concepts of sustainability, resiliency, cost-efficiency, affordability, and/or explicit intent to address economic, social and environmental goals within their area of operation. For some, enhancement of the natural environment is part of the utility vision, aligns with the values held by the service area community, and may be explicitly reflected in the mission statement of the organization.

Second, the strategic direction of an organization often is captured in utility policy. An asset management policy can dictate implementation of the strategic direction and be accomplished through thoughtful use of both natural assets and other capital stock. Explicit, written policies provide the direction for the administration and staff of the utility to execute.

3.1.2 Natural Asset Inventory and Condition Assessment (Chapter 6)

With asset management planning, it is vital to understand what assets are in use, their condition and how they are performing, and asset values. Inclusion of natural assets is no different, but the methods and techniques useful for creating an asset inventory, assessing asset condition, assessing risks to asset-provided LOS, and managing those risks for natural assets are different than those used for built assets.

3.1.3 Desired Level of Service (LOS) for Natural Assets (Chapter 7)

Just as service level requirements, customer expectations, and legal/stakeholder requirements are needed elements for asset management of the built environment, the types and levels of service necessary from natural assets need to be defined too. Level of Service (LOS) targets for natural assets can be based on similar water supply business goals that drive levels of service for built assets, but they can also target other social and environmental goals.

Objectives and target LOS for built assets typically address specific water supply purposes, but the services and target service levels for natural assets may be defined by goals and objectives that are broader than the provision of water service to customers. For example, a forested watershed that protects source water quality is of direct value to the utility, but that asset may also provide critical habitat for an endangered wildlife species (providing a broader social and ecosystem value not specifically tied to the utility's main line of business). As a result, taking natural assets into account can create an additional layer of complexity in asset management planning (PG Environmental 2017).

3.1.4 Utility Business Risks Associated with Natural Assets (Chapter 8)

Natural assets may pose additional and/or different types of risks and challenges that do not exist for built assets. The concepts involved in risk assessment and risk management are structurally similar, in that the likelihood and consequence of a failure are involved. However, failure modes and risk assessments of natural assets providing valuable services to a utility require different tools to complete risk assessments.

For example, the term "failure" may be reasonably straightforward for a built asset such as a water distribution main, such as when a pipe bursts and disrupts water delivery services and causes other clearly evident forms of failure such as localized flooding and traffic disruption. However, natural assets and their services are more likely to be prone to become *degraded* (rather than fail *per se*) in their ability to deliver desired LOS.

For example, when development in a watershed increases erosion and thus reduces the water quality protection services of the landscape, a reduction in service offered by the watershed is evident, but the asset has not failed in a traditional sense. Likewise, a built asset like a water main can be replaced at the end of its useful life, but a forested watershed does not have a finite useful life, nor can it readily be replaced by a new forested watershed.

This points to the need for utilities who do not have the internal expertise to carry out natural asset risk assessments to adopt new approaches and find technical assistance in carrying out such assessments. Less unique to natural assets is assessing which services provided through natural assets are critical to the operation of the utility. Yet, even in this case, lack of quality information about such assets or such assets performance can lead to complications in integrating natural assets into a utility asset management program.

3.1.5 Capital Investment and Maintenance for Natural Assets (Chapter 9)

One of the key activities of asset management is optimized capital investment and maintenance activities in order to maximize the performance of the utility's built assets. This is no different with the inclusion of natural assets. However, there are some considerations that are unique to natural assets. First, many natural assets are not owned by the utility, which creates challenges for implementing maintenance or other AM activities for such assets. Second, capital investments for natural assets may include acquisition and/or major restoration of ecosystems, requiring technical skills and methods that may be new for most utilities. As a result, capital investments and maintenance activities typically require partnerships with other entities that have greater expertise in relevant ecosystems and/or have the authority to manage these ecosystems.

Further, the effects of utility interventions in ecosystems carry a greater degree of complexity and uncertainty than is typical for built assets. In addition, while performing a business case evaluation of alternatives employs similar steps for built versus natural assets, the techniques for defining value of investing capital or operating resources may be different. Again, different skill sets than presently exist within the utility may be needed.

3.1.6 Developing a Funding Strategy for Natural Assets (Chapter 10)

Incorporating natural assets into the overall funding strategy for a utility is a key step in asset management planning involving natural assets. Whereas funding for built assets involves transactions typical of any business, and engages utility finance staff to ascertain cash needs, cash flows, and commitments to funding partners (e.g., bondholders, SRF program administrators, municipal officials, etc.), a funding strategy and financing of plans including payment for natural assets and their services is an emerging practice.

Several accounting and financing challenges arise that are somewhat unique to utility efforts to invest resources in preserving or enhancing natural assets and the services they provide. For example, there may be institutional roadblocks to traditional financing or cost recovery for utility efforts to maintain LOS from natural systems the utility does not own.

3.2 Implementing a Two-Phased Approach for Applying Asset Management to Natural Assets

For many utilities, managing natural assets will be a new endeavor, and some may not yet have a robust asset management program for built infrastructure. Further, managing natural systems involves scientific complexity and uncertainty that can be challenging. For these reasons, this guidance proposes a phased approach to the application of AM to natural assets (Figure 3-2).

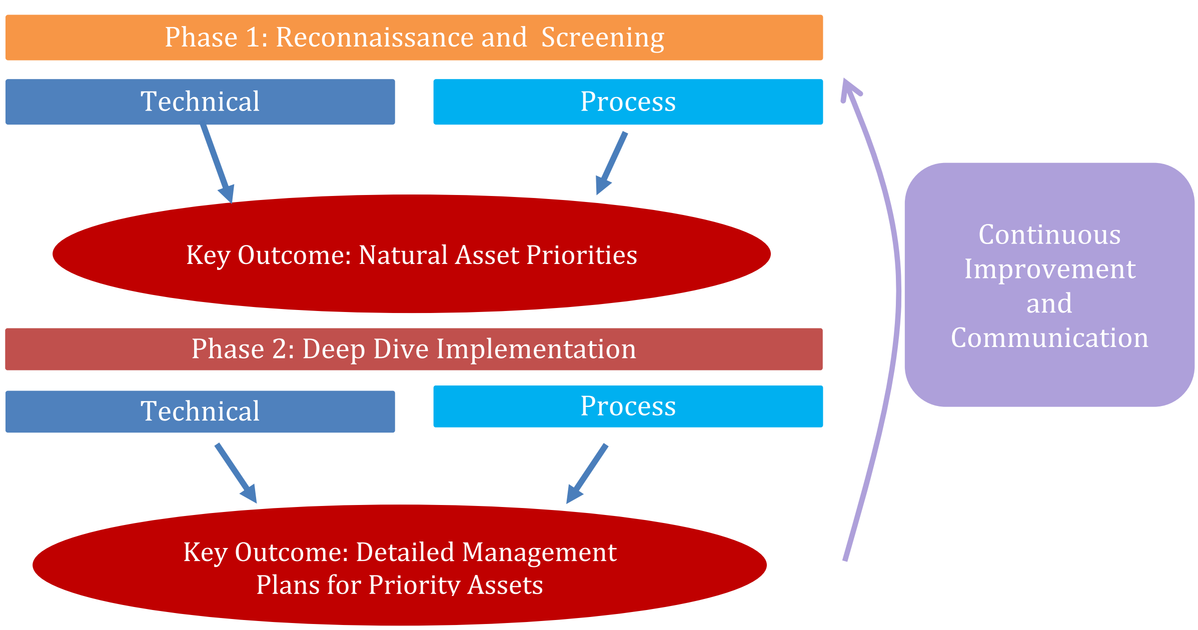

Figure 3-2. Phased Implementation of Asset Management for Natural Assets.

Phase 1 involves reconnaissance-level implementation of asset management principles and practices. Reconnaissance-level implementation differs from a detailed implementation in several important ways. For the technical aspects of AM, those differences include:

- Overall lower level of detail in data collection and analyses
- The use of readily available data and/or information or expert opinion with relatively little new or original data collection
- Physical processes and impacts are based on existing simple quantitative descriptions from existing work or expert opinion, rather than detailed physical process models
- When necessary condition or risk assessments can rely on qualitative or ordinal ratings
- Conceptual formulation of intervention alternatives (capital projects or maintenance) with order of magnitude cost estimates from literature, reports, or input from other agencies
- High level assessment of funding/financing feasibility

In addition, the overall framing of AM during the Phase 1 reconnaissance—and the process used to implement it—will be different from more detailed implementation in Phase 2.

3.2.1 Phase 1: Reconnaissance and Screening

For Phase 1, specific efforts include:

- The first time a utility goes through the screening level implementation, it is getting familiar with the concept of natural assets and how AM principles and practices may apply to them. In addition, the simplified first pass through the process will acclimate utility professionals to the concept of AM, as they take an expedited stroll around the AM wheel.
- The screening phase may be especially useful for the utility professionals to begin to explicitly recognize/identify those natural assets upon which their utility most relies, and perhaps identify one or two such natural assets that warrant additional attention. This may help to shape the thinking in the utility about those natural systems and the valued services they offer the agency. MNAI is developing and testing guidance for utilities starting out on the AM path by developing an inventory of the natural assets upon which they rely (MNAI forthcoming). Utility professionals may consider the screening phase as a pilot test of Natural Asset Management for utility, demonstrating its value to leaders and customers
- Engaging leadership and gathering input from internal and external experts and stakeholders may be a useful exercise to get the process rolling with the many individuals for whom the AM process will ultimately rely for knowledge and support.
- Communicating outcomes will help build support or help evaluate if the process does not yield expected results

Reconnaissance-level implementation is intended to be completed much more quickly than a detailed implementation. The key outcome from reconnaissance-level implementation is information sufficient to identify (and complete an inventory of) the natural assets the utility relies upon, and to initiate the process to prioritize which asset or types of assets will be focused on for more detailed evaluation and management. Factors to consider when prioritizing include:

- Those assets that currently support meeting level of service but there is sufficient likelihood of degradation to potentially justify intervention
- Assets that are currently degraded to the point that they limit and reduce performance against levels of service targets
- Assets that have significant implications (extremely consequential) for business risk

- Assets for which the utility has identified feasible options for potential interventions to manage the performance of such asset (including financial, institutional and regulatory feasibility) to meet desired LOS.

While the key objective of reconnaissance-level implementation is information to inventory natural assets and then prioritize assets for detailed AM evaluation and implementation, other outcomes might include better information on the value of including those assets in asset management planning to the utility and better understanding of the resources (data, models, expertise etc.) that the utility will need to complete more detailed implementation.

3.2.2 Phase 2: Deep Dive Implementation

The deeper dive of Phase 2 involves much more detail in assessing condition and risks, and for formulating and evaluating alternatives to manage natural assets. The level of detail will be sufficient to support utility decisions about potentially substantial expenditures in capital projects and/or maintenance activities. The level of detail in Phase 2 will be comparable to the level of detail in more fully developed, mature asset management practices for built assets. This might include:

- New field data collection to support full condition assessment of natural assets and/or new analyses of existing high-resolution datasets
- Use of detailed physical process models to assess or project trends in asset condition and estimate the beneficial effects of utility interventions (e.g., watershed runoff models to estimate water quality impacts arising from changes in forest cover, additional detail is provided in Chapter 6)
- Feasibility-level engineering designs for capital projects to estimate the effects of these projects and to support reliable cost estimates of interventions to manage risk.

For detailed implementation, we may need to broaden and deepen supporting processes. For example:

- The required expertise may lead the utility to develop formal working partnerships with agencies or NGOs who have experience in assessing natural resources (e.g., for assessing their condition, prioritizing them for management actions through quantitative risk assessment, and/or for designing and implementing risk reduction efforts tailored to a specific type of natural asset).
- Natural assets that the utility does not own may require contractual and funding agreements in order to execute management actions, including possible partnerships to access expertise or access to fiscal resources (e.g., grants).

Phase 2 implementation results in detailed management plans for top priority (critical) natural assets.

Finally, the objective is to ultimately arrive at a sustained, fully integrated asset management program that includes both built and natural assets for which business risks and utility investments are compared on an equal footing. Developing and maintaining a unified AM program will place built and natural assets on equal footing in terms of considering management actions and allocating utility resources to achieve the types and levels of service required (or desired) from all assets, and in terms of prioritizing utility capital and operating resources to best manage asset-related risks to the utility.

CHAPTER 4

Examples and Opportunities

What you will find in this chapter

- Summaries of four examples that illustrate the use of asset management or related approaches to manage natural assets
- Two of the examples are from the U.S., one from Canada, and one is from the U.K.
- Each example provides ideas and lessons that can be useful for developing a new natural asset management program, with or without an existing program for built assets, or for expanding natural resource or environmental programs by implementing asset management methods

This chapter presents illustrative examples of using asset management approaches for natural assets. In some of these examples, natural assets were incorporated into a formal asset management program. In other examples, the utility may not describe their approach as natural asset management, but there are clear similarities to the methods outlined in this guidance. Finally, in several cases, the utility is engaged in managing natural assets, but there are opportunities to improve their use of formal asset management methods for preserving or enhancing the services derived from these assets. The cases emphasize different aspects of asset management, across diverse jurisdictions from North America and the United Kingdom. Some of these cases are highlighted in other chapters of this guidance as examples of specific steps or activities within asset management.

4.1 City of Raleigh: Natural Asset Investments

The City of Raleigh Public Utilities Department (CORPUD), North Carolina, draws and treats water from Falls Lake to provide potable water to its 600,000 customers. Concern about growing development pressures in the watershed led CORPUD to look for ways to increase its contribution to protecting source water quality in the lake. To do so, the city implemented a Nutrient Reduction Fee for new developments, in 2005. Then, in 2011, it replaced that fee with its current volumetric Watershed Protection Fee for all water customers. Revenue from both fees was and is dedicated to the Upper Neuse Clean Water Initiative (UNCWI), a land trust partnership coordinated by the Conservation Trust of North Carolina. Participating land trusts use funds from CORPUD, as well as from other non-profits, state agencies, and local governments, to invest in natural assets that protect water quality in Falls Lake and its tributaries.

Through the UNCWI, CORPUD primarily invests in protecting stream buffers and forested land from development, and the utility plans to have preserved more than 30,000 acres of land through the UNCWI by 2045. Though the program has begun expanding to include non-acquisitional investments like agricultural improvements and urban Best Management Practices (BMPs), it believes that permanent land preservation is typically a sounder long-term investment.

CORPUD has an asset management program for its built assets, but the approaches used by CORPUD and UNCWI for natural assets do not comprise a formal natural asset management program. However, there are some similarities that exemplify concepts presented in this guidance for how asset management practice associated with a mature built asset management program can be applied beneficially for natural assets.

First, the UNCWI relies on a GIS-based conservation prioritization model to identify tracts of land that, if conserved, will best contribute toward protecting water quality. The model incorporates data on a range of factors that are related to water quality threats and/or opportunities for minimizing those threats, including use of several datasets highlighted in Chapter 6 of this guidance. The datasets are combined using weights or other methods that are designed from stakeholder input about regional priorities and objectives. The combined datasets result in a map that effectively ranks areas for suitability for conservation. The results are then used by partners and stakeholders to make decisions about targeting lands in which to invest.

Even though CORPUD funds and decides upon UNCWI's acquisitional investments, neither CORPUD nor the city of Raleigh legally owns these natural assets, partially due to laws regulating municipalities' ability to own land beyond their own jurisdictional boundaries. Instead, land trusts, private citizens, and other local governments own CORPUD's acquired natural assets, with land trusts being the largest owner. To protect its natural assets from the uncertainties of third-party ownership, all the natural assets CORPUD acquires have permanence language legally binding the land to conservation, included in their closing documents.

Some key lessons from Raleigh's experience with the UNCWI include:

- Raleigh's political leadership has been strongly supportive of and engaged with the watershed fee and natural asset investment program. A strategic imperative for this is contained within the City's mission statement, last reaffirmed by political leadership in 2009. This leadership support has helped the program thrive and gain momentum since its inception.
- Raleigh has overcome various obstacles – including restrictions on purchases of land outside of a local government's jurisdictional boundaries, failure of traditional accounting approaches to include natural assets on balance sheets, and a lack of public trust in the region – to create a robust natural asset investment program through creative administration and funds leveraging. Much of this success is associated with the partnership the utility has formed external entities (e.g., land trusts) that can leverage utility funds and access additional funding sources, as well as hold lands the utility cannot own.
- CORPUD's natural asset investments provide multifaceted benefits to the city of Raleigh, but are not subject to the same accounting treatment that built assets receive. CORPUD's significant natural asset investments do not appear on Raleigh's balance sheet and thus do not contribute to an increased value in the way an investment in built assets would.
- Raleigh delegates many key asset management responsibilities for its natural asset portfolio to the Conservation Trust for North Carolina (CTNC). CTNC is one of the state's largest land trust organizations and has extensive experience prioritizing, acquiring, and providing stewardship of natural assets.
- The approach CORPUD follows when investing in and managing its natural asset portfolio is very different from the approach it takes with its built assets. Though the two approaches differ greatly, both incorporate criticality analyses, prioritization, and investment planning. Ultimately, the utility meets its objective of protecting its source water assets through an active program that recognizes the value of the services provided by those natural assets, and by using effective partnerships to leverage funding and acquire/manage relevant land areas to reduce risks to the utility's water quality objectives.

4.2 Seattle Public Utilities: Protecting Public Health through Ecosystem Protection and Enhancement

Seattle Public Utilities (SPU) owns and manages over 90% of the land in the two watersheds that provide its water supply. SPU qualifies for filtration avoidance for waters from its Cedar River watershed, and it relies instead on high levels of source water quality and natural filtration. In addition, SPU's raw water storage is small compared to other major Western utilities, so it is highly dependent on predictable annual runoff. Finally, SPU's customers and the larger community prioritize environmental stewardship goals.

For these reasons, SPU has a robust program for investing in watershed health and enhancement. SPU considers protection of water quality for public health and avoided treatment cost as the most important element of its watershed protection program, while its customers also highly value water quality protection and the ecosystem services provided by the watershed. SPU's watershed management activities include:

- Substantial on-going efforts to monitor hydrologic conditions and to develop and deploy hydrologic models for forecasting and planning.
- Work with the University of Washington Climate Impacts Group, and other efforts to study the potential future impacts of climate change on water supply, forest health, and related other factors.
- Full-time staff to execute an on-going program for managing invasive weed species in the two watersheds.
- A substantial program in support of its Cedar River Habitat Conservation Plan (HCP). The HCP provides compliance mitigation activities to meet the requirements of the Endangered Species Act intended to protect and enhance a large array of complex ecological processes/functions across the 93,000-acre basin.

While SPU staff indicate that they can do more to integrate their watershed management activities into their mature built-asset management program, there are already elements of asset management in their approach. SPU has developed watershed management plans that are the basis for capital planning, budget development, maintenance, and projects that address natural asset needs. For example, in preparation for the South Fork Tolt Watershed Management Plan, SPU used the results of its 2005 ecological goods and services valuation study to substantially inform and guide decisions about management strategy of the landscape of the watershed.

Further, the utility has extensively implemented a forest inventory and stream assessment and inventory within its watersheds. Both these natural systems inventories have been undertaken with the explicit focus of informing SPU's prioritization of ecological enhancement needs. These are performed under a regulatory driver (i.e., the Endangered Species Act) and remain focused on efforts to enhance ecosystem service functions. The inventory work has included the use of traditional timber cruising to establish a sense of asset values for economic comparison.

Costs for the watershed efforts are accrued to either capital or operating budgets. Initial investment to acquire land or to conduct large scale ecosystem restoration construction projects are typically funded with capital monies. Operating budgets are oriented towards more traditional land management activities such as road system maintenance, drainage maintenance, fence/gate maintenance, and mowing/brushing. SPU also conducts extensive forest thinning operations annually in both supply watersheds that are aimed at improving the long-term ecological function and rate of successional forest structure development.

4.3 Integrating Sustainability and Asset Management in British Columbia

In British Columbia (BC), two key concepts – sustainability[1] and asset management – have been explicitly tied to one another in an initiative referred to as Asset Management for Sustainable Service Delivery: a BC Framework (Partnership for Water Sustainability in BC 2018). Several years in the making, the BC Framework is aligned with asset management requirements of the Province's capital grants programs.

The BC Framework defines asset management as a continuous process in which planning is only part of the overall process. The process includes all components necessary to refocus business processes to properly manage a community's infrastructure within the built environment. It also directs utility organizations to understand lifecycle implications of managing both built and natural assets as integrated components of a healthy system. The framework recognizes that natural assets and the ecosystem services they provide are a fundamental and integral part of the infrastructure used to meet the utility mission (Partnership for Water Sustainability in BC 2018).

Originally devised to address issues related to watershed planning such as stormwater management, the framework also applies to other services including provisioning of drinking water supplies. Figure 4-1 illustrates the BC Framework. Many of the same elements of the EPA/WERF SIMPLE and AWWA AM Committee frameworks identified in Chapter 2 exist in this framework. Examples include assessing asset conditions; explicit documentation of asset management policy and strategies; long-term financial planning; performance measuring and reporting; and finally, facilitators such asset data, finances and human resources.

Figure 4-1. BC Framework for Sustainable Services Delivery Incorporating Both Natural Capital and Built Assets.
Source: *A*dapted from Partnership for Water Sustainability i***n*** BC 2018.

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[1] See Chapter 5 for a brief discussion of how sustainability goals can help shape natural asset management within a water utility.

4.4 The Municipal Natural Assets Initiative

Local governments across Canada, including British Columbia, are faced with significant asset management challenges that arise from aging infrastructure, increased demands, climate change, and legal/regulatory imperatives. To provide services in a cost effective and efficient manner for current and future customers, government officials have been looking for ways to improve management of community assets that supply those services (MNAI 2019).

The Municipal Natural Assets Initiative (MNAI) has been developed to incorporate not just built assets, but also natural assets. The MNAI approach provides equal footing and inclusion of natural assets within asset management plans developed for engineered infrastructure. As a result, the MNAI initiative has documented how to use the BC Framework illustrated in Figure 4-1 to emphasize the need for including natural assets in asset management planning. An example approach is illustrated in Figure 4-2. In Figure 4-2, the three elements of the BC Framework (Assess, Plan and Implement) are illustrated to show how natural assets and their associated ecosystem services are incorporated into asset management planning processes for different scenarios of water supply provision, storm water management, and flood control.

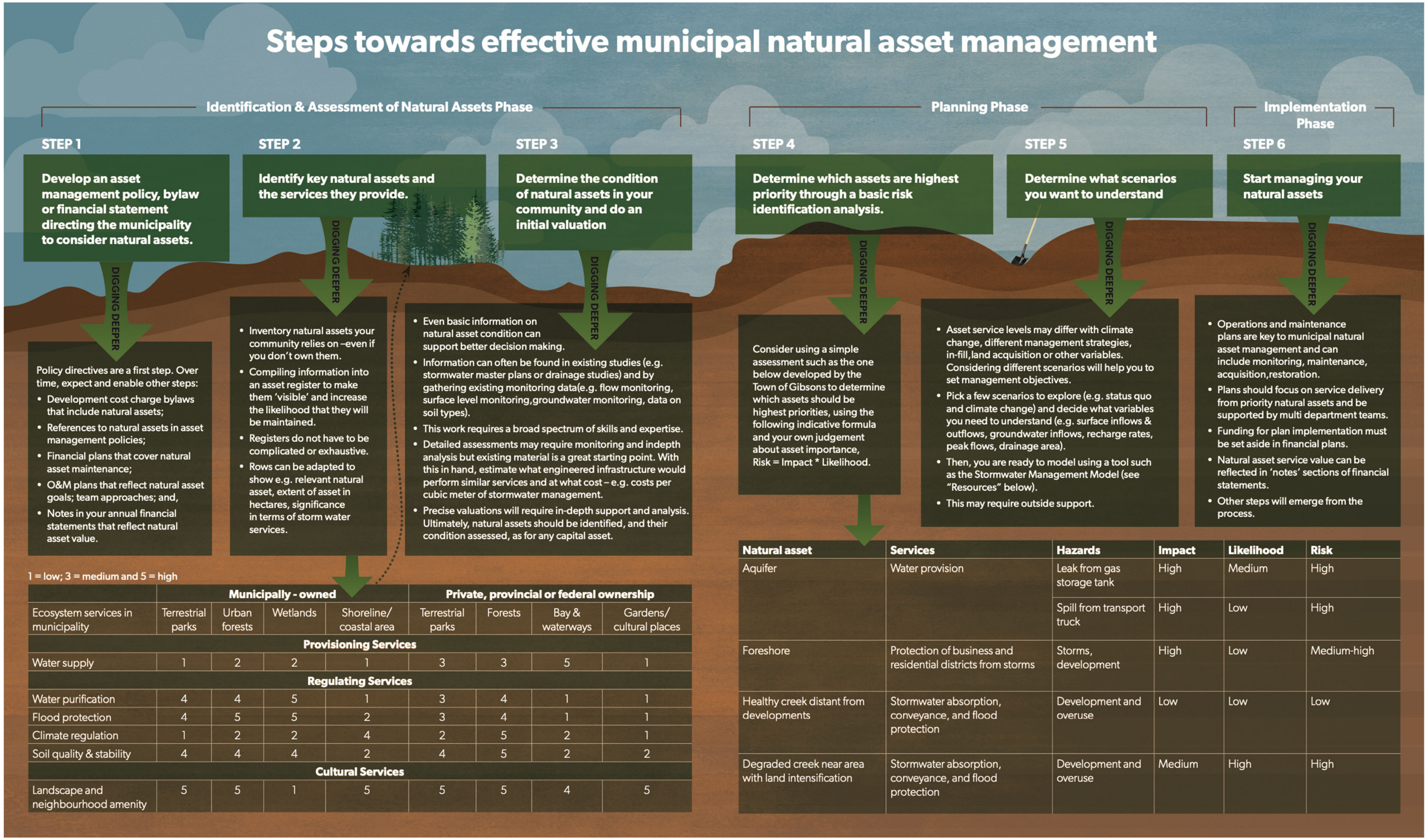
The Town of Gibsons, BC, represents itself as North America's first community to experiment with strategies to integrate natural assets into asset management and financial planning (Town of Gibsons 2017). Most of the Town's residents and business rely upon groundwater drawn from a confined sand and gravel aquifer for its municipal water supply. The Town embarked on its journey to establish policy, formulate programs, and initiate practices by taking several steps on its own to incorporate this natural asset into an asset management approach. The Town explicitly deemed nature to be a municipal asset, giving it the same consideration as traditional capital assets. Multiple actions then occurred, including:

- The Town's Strategic Plan now identifies the advancement of the Town's natural asset approach as a priority (Brooke et al 2017).
- An official Town Asset Management Policy was created, establishing guidelines for implementing asset management processes with the objective of ensuring adequate provisions are made for operations, maintenance, and long-term replacement of major engineered and natural assets.
- Policy was established to include a note in the Town's financial statements to acknowledge the value of natural assets to the community.
- A full condition assessment of the Gibsons Aquifer was performed. Risk assessment followed.
- Annual groundwater monitoring of the Gibsons Aquifer is now performed, deemed to be the cost-effective solution to providing safe drinking water in lieu of an engineered, built solution.
- The Town is developing financial plans for all assets within an Asset Management Plan.

MNAI's not-for-profit mission is to make natural asset management a mainstream practice across Canada. Building on the initial Gibsons example, MNAI has worked with local governments in British Columbia, Ontario and New Brunswick to support to enable communities to identify, understand, measure and manage natural assets. Experience to date has shown that this can lead to positive changes in operations and maintenance plans and associated financial planning; development cost and subdivision bylaws, financial planning and reporting, and many other aspects of local government. MNAI is also engaged in activities to create an operating environment more enabling of municipal natural asset management, including, for example, beginning to develop norms to ensure that natural asset management is effective, comparable, and replicable across Canada (Roy Brooke, personal communication, November 26, 2019).

4.5 The UK Initiative to Incorporate Natural Capital into Asset Management Planning

The Canadian experience described above incorporates several facets of asset management planning activities that are core to water sector companies operating in the United Kingdom. Review of the UK regulatory environment provides an additional example reinforcing the basic AM frameworks described in Chapter 2 (e.g., EPA/WERF SIMPLE framework, as built upon by AWWA and the IIMM framework). Within the UK framework, several of the building blocks we use for our framework become evident.



Ecosystem services in municipality	Municipally - owned				Private, provincial or federal ownership			
	Terrestrial parks	Urban forests	Wetlands	Shoreline/ coastal area	Terrestrial parks	Forests	Bay & waterways	Gardens/ cultural places
Provisioning Services								
Water supply	1	2	2	1	3	3	5	1
Regulating Services								
Water purification	4	4	5	1	3	4	1	1
Flood protection	4	5	5	2	3	4	1	1
Climate regulation	1	2	2	4	2	5	2	1
Soil quality & stability	4	4	4	2	4	5	2	2
Cultural Services								
Landscape and neighbourhood amenity	5	5	1	5	5	5	4	5

Natural asset	Services	Hazards	Impact	Likelihood	Risk
Aquifer	Water provision	Leak from gas storage tank	High	Medium	High
		Spill from transport truck	High	Low	High
Foreshore	Protection of business and residential districts from storms	Storms, development	High	Low	Medium-high
Healthy creek distant from developments	Stormwater absorption, conveyance, and flood protection	Development and overuse	Low	Low	Low
Degraded creek near area with land intensification	Stormwater absorption, conveyance, and flood protection	Development and overuse	Medium	High	High

Figure 4-2. Steps Toward Effective Municipal Natural Asset Management.
Source: MNAI 2017.

One such building block is a written imperative (policy direction) to operate a utility considering natural as well as built assets in producing desired outcomes for customers. Since privatization of the water sector in the UK, water and sewerage companies have invested to achieve significant improvements to the environment and the service customers receive. Companies' plans to manage assets and deliver services are regulated by both environmental and economic regulators. The economic regulator, the Office of Water (Ofwat), receives strategic guidance for its activities from the Department of Environment Food and Rural Affairs (Defra), the national governmental department responsible for water supply, flooding, and water quality in England.

Defra provided strategic guidance to Ofwat in 2017, via *The Government's Strategic Priorities and Objectives for Ofwat* (Defra 2017). Defra stipulated in pricing reviews of companies' plans that Ofwat promote a water industry working for everyone: one that is resilient, efficient and innovative and which takes forward the objectives of Defra's industrial strategy (Defra 2017). That strategy includes:

> Companies further the resilience of ecosystems that underpin water and wastewater systems and services, where this achieves best value for money over the long-term. For example, investing in the natural resilience of catchments can increase the availability and quality of water that can be taken without posing unacceptable pressures on the environment – avoiding the need for more costly infrastructure solutions….Ofwat should challenge companies to further the resilience of ecosystems that underpin water and wastewater systems, by encouraging the sustainable use of natural capital and by encouraging water companies to have appropriate regard to the wider costs and benefits to the economy, society and the environment. (Defra 2017).

The application of this top-down directed strategy is illustrated in another document, *Drainage Strategy Framework: Good Practice Guidance, commissioned by the Environment Agency and Ofwat* (Halcrow Group Ltd. 2013). The guidance was prepared to help water and sewerage companies develop plans that reflect long-term, sustainable solutions to deliver outcomes as the companies prepare their 5-year pricing submissions to Ofwat.

The guidance identifies that drainage strategies developed in the planning process are to be done in a manner that reflects the official government policy commitment for taking an ecosystems approach to environmental management which accounts for environmental, economic and social benefits that result from an improved water environment. Water and sewerage companies are encouraged to invest in natural as well as built infrastructure to deliver desired outcomes with benefits being determined using a 'payments for ecosystem services' (PES) approach (Halcrow Group Ltd. 2013).

To conform to policy, Ofwat stipulates that drainage plan submissions incorporate six key principles, all of which are consistent with the frameworks outlined in this document. It includes:

Partnership: Drainage strategies should be developed in partnership with customers and other stakeholders. The purpose is to solicit meaningful and effective engagement to demonstrate plans are acceptable to customers and meet service expectations.

Uncertainty: Strategies should be data informed; further, plans should document reliability of data and knowledge about current and future performance of systems. They should also explain what steps are planned to improve understanding and how this will benefit customers.

Risk based: Planning, operational and capital investment activities should be based on consideration of probability and consequence of failure of drainage function. Risks should be monetized, combined, and predicted into the future. The impact of interventions on the level of risk should be predicted. An understanding of overall level of risk in a catchment, now and in the future, should be developed.

1. **Whole life costs and benefits:** Plans should be informed by consideration of whole life (life cycle) costs and benefits. Costs relate to capital and operational expenditures to deliver interventions and monetized impacts of drainage failures. Benefits relate to reduction in risk but should also include wider societal impacts such as those calculated using "payments for ecosystems services" approach.
2. **Live process:** Plans should be adaptable and periodically reviewed. They should be reviewed at regular intervals to reflect investments already made, changing priorities of company and partners, and presence of emerging risks. Performance is to be monitored relative to performance measures designed to monitor progress towards achieving outcomes.
3. **Innovative and Sustainable:** Plans promote full evaluation of alternatives to test whether these offer lower whole life cost options or offer better responses to uncertainty. These should include asset solutions (such as active management, retrofit techniques, etc.), and non-asset solutions (e.g., education to enable customers to change behavior, enhancing incentives for customers to reduce contributions to problems, and innovative permitting arrangements across networks and treatment works). (Halcrow Group Ltd. 2013).

The framework for this approach is illustrated in Figure 4-3:

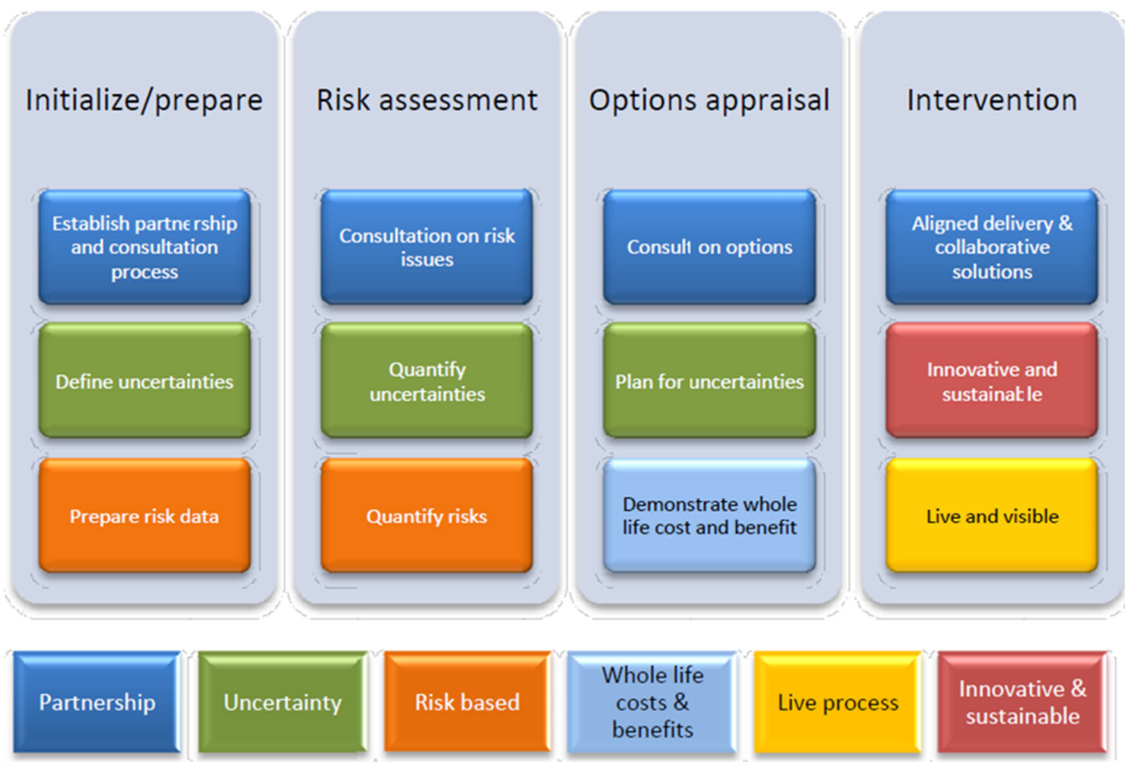


Figure 4-3. A UK Framework for Managing Natural Assets.
Requires that drainage plans include the six principles shown in the color-coded boxes here. Each of the principles plays a different role in the four phases of their planning cycle.
Source: Halcrow Group Ltd. 2013.

4.6 Conclusions

There is widespread recognition that natural assets provide highly valuable services to water sector utilities and the communities they serve. There also is broad appreciation that active engagement by utilities is needed to ensure the services provided by those natural assets upon which utilities rely are preserved or enhanced.

- In some instances, governing bodies and utilities approach the management of their natural assets through approaches that are not necessarily labeled as “asset management” *per se*, but that nonetheless adhere to the basic underlying principles of leading AM practices (e.g., the Raleigh, NC approach).
- In other instances, a more formal and conscious effort is made to apply an AM program to natural assets (as evident in the Seattle and Gibsons case studies).

In Chapters 5 - 11, pragmatic, step-by-step guidance is provided on the technical and process elements for integrating natural assets into the AM process, so that they may be considered on equal footing with a utility’s built assets.

CHAPTER 5

Step 1 - Asset Management Facilitators and Success Factors

As a utility practitioner entering into the foray of natural asset management, it is easy to focus on the technical elements of AM. However, to implement and maintain a successful natural asset program, practitioners need to integrate natural asset management into the broader utility context. It is recommended that an asset management program include focus on four primary factors that facilitate a successful asset management effort:

- Leadership commitment
- Alignment with strategic vision
- Connecting natural asset management with sustainability, resiliency, and related goals
- Leverage existing utility systems, including knowledge management, training and technology systems

This chapter provides information about each facilitating factor and how to activate them. Each section also provides implementation tips for both the reconnaissance and deep dive phases. The asset management enablers discussed here are built upon the built asset AM processes discussed in Chapter 2 and illustrated in the core of the wheel in Figure 5-1.

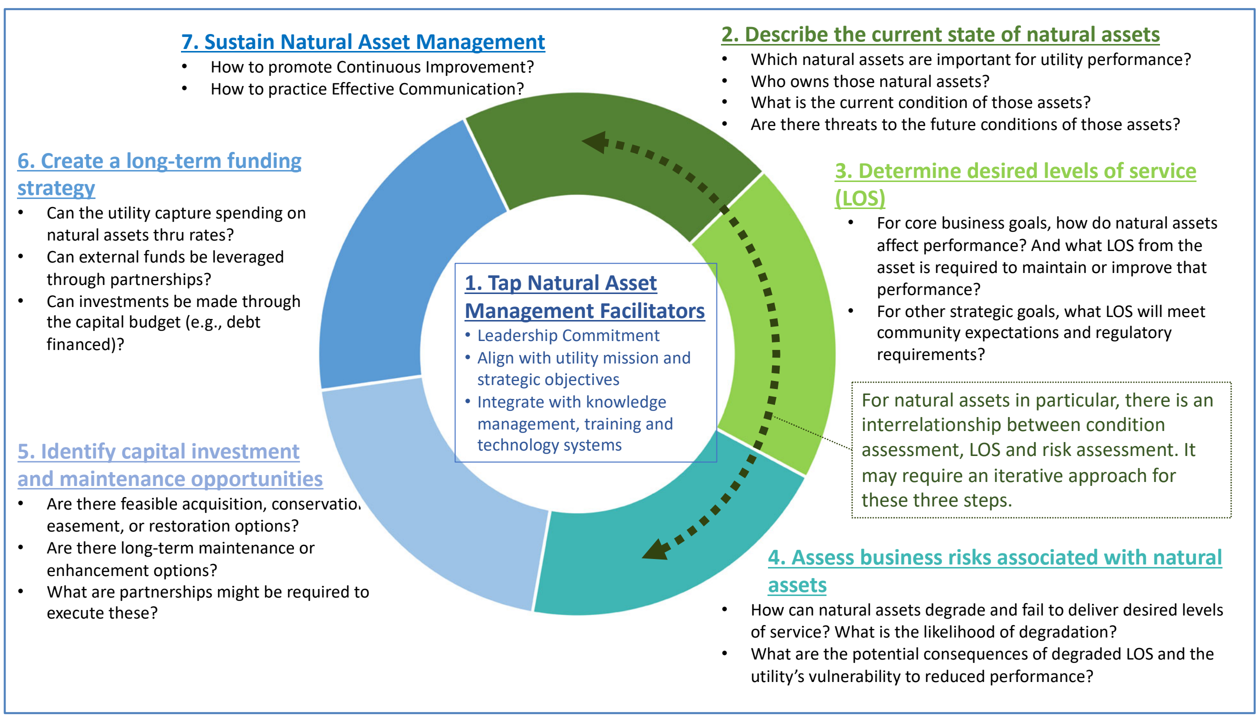


Figure 5-1. The Natural Asset Management Wheel.
Notice "Step 1 Tap Natural Asset Management Facilitators" at the center of the wheel; these support the entire AM process.
Source: Adapted from Campanella et al. 2016.

5.1 Leadership Commitment

Perhaps the most important success factor is leadership commitment. Without long-term leadership commitment, the organizational change required to integrate natural assets into asset management is almost impossible. AM involves multiple disciplines, requires collaboration across work units of a utility, and often involves operations where employees do not speak the same professional language and operate in 'silos.' Leadership is essential in addressing these situations, particularly in getting individuals to focus on service not the asset(s) delivering that service. Effective leaders thus communicate the long-term vision for an organization and its commitments to customers and stakeholders. Leadership must also communicate the importance of natural assets to the organization's mission. Leadership commitment ingrains the utility's vision into its day-to-day operations (PG Environmental 2017). The IIMM emphasizes the role of leadership in AM:

> Effective leaders demonstrate a strong commitment to AM and create a culture that enables success, aligns activity towards a common purpose and motivate employees and suppliers to achieve that common purpose…Leaders must foster a whole of organization approach to ensure that all the various arms of the organization are working towards aligned outcomes (IPWEA et al. 2015).

Strong leadership provides an organization with clarity, consensus and commitment (the three C's, see Vause and Helgeson 2019), as it moves from one performance level to the next. These three C's are critical for successful organizational change, such as applying asset management to natural assets. Clarity means there is a definite direction or vision of the future expressed by utility leadership. Consensus is attained when everyone is willing to accept the vision, even if all the details of how to move forward are not completely agreed upon. Strategies and goals will be defined by utility leadership. Commitment to create lasting improvement comes when utility leadership devotes real dollars, prioritizes asset management planning to attain the vision, and perseveres by overcoming roadblocks and resistance (Seiler 1999).

Reconnaissance Tips: *Leadership Commitment*

- Begin by developing an understanding of your utility leaders' views and perspectives on relevant matters, including asset management in general, environmental issues, and relationships with others involved in natural assets. Identify one or two areas of high concern to leadership that relate to natural assets and focus on those when communicating about natural asset management to leadership.
- Leaders are interested in organizational success; connect the potential benefit of managing natural assets with the utility mission (see discussion of strategy and goals below). Use the appendix to Chapter 6 to help identify significant system-specific opportunities.
- Scope out the level of effort, resources and partners required to manage one or two natural assets important to organizational success.
- Work with leadership support staff to understand leadership style for receiving new ideas.
- When bringing reconnaissance findings to leadership, focus on the issues that are important to that leader.
- Communicate the case for full-scale AM implementation with a clear articulation of the benefit to the utility. Clearly articulate next steps in a follow-up memo.
- Identify places within the organization that have positional power that could hamper or derail initiatives, and work in parallel with these groups to address concerns.

Deep Dive Tips*: Leadership Commitment*

- Articulate the clear connection between AM of natural assets and utility goals and objectives. To the degree possible, develop a quantitative description of reduced costs, reduced risks, better customer satisfaction and service level targets. Work with a wide range of utility departments to ensure the articulation is broad and inclusive.
- Develop a working group with internal and external (as needed and supported by leadership) partners using a meaningful engagement process. Working with a wide range of interested parties in a structured process helps ensure that natural asset management planning will address a full range of utility and community objectives and opportunities and is sustainable.
- Utilize your working group as you move through the asset management steps. Develop means of assuring accountability for actions. Share updates regularly with leadership including how natural assets contribute to a utility's vison and service level targets. This will help keep natural asset management planning fresh and important in leaders' minds.

Differences Between Natural Assets and Built Assets: *Leadership Commitment*

- Leadership commitment is crucial for AM, with or without the incorporation of natural assets.
- The benefits of AM for natural assets may not be as obvious or intuitive as it is for built assets. You may need to do more research and work more closely and frequently with others in the utility before you have enough information to make the case, and to communicate it effectively for sustained leadership support.

5.2 Align with the Utility's Strategic Vision, Goals, and Objectives

Integrating the practice of natural AM into the utility's strategic vision and goals is another key to success. A utility's strategic vision, goals, and objectives[2] represent the meaningful context for asset management, and, in particular, for applying asset management to natural assets. Each organization approaches strategic planning differently, depending on its social, political, economic and business context. Strategic visions often take the form of mission statements, descriptions of core values, and high-level performance goals (e.g., to pursue innovation in its operations, to be a responsible steward of the natural environment).

A utility's strategic vision also guides the articulation of the business goals and objectives that guide organizational decision making.

Figure 5-2 illustrates how strategic elements works down through the utility structure, providing guidance and ensuring that even the design of individual asset management forms support the ability of the utility to cost-effectively meet service targets.

The operational elements of a natural asset management that benefit from guidance from the strategic elements include:

- detailed planning processes including guidance on methods of accounting for utility expenditures;
- use of whole life-cycle cost analysis to establish spending priorities;
- making payments for ecological services (i.e., recognizing the value provided by natural assets); and

[2] Note – different approaches to strategic planning, management, and decision analysis define the terms *goal* and *objective* differently. Often goals are seen as broader statements, while objectives are more specific. Other terms often come into play, such as criteria, targets, performance metrics, and others. In general, we use the terms goal and objective interchangeably here, so that the discussion and guidance can easily be generalized to any utility's approach.

- establishing new partnerships with non-traditional partners.

In developing asset management plans by asset class, it can include plans detailing new arrangements for river/stream flow/water body coordination with others; watershed investment options; and operations and maintenance strategies involving natural assets. The development of the specific procedures and processes, including business case evaluations to inform decision making as it relates to investments and/or operating expense adjustments emphasizing natural asset use and inventory, valuation and condition assessment of natural assets (either owned or non-owned), will also be guided by strategic vision. Other operational needs that will be guided by strategic elements include adjustments, and new skill sets for asset management planning (e.g., natural resource economics and technical expertise), and public outreach and partner communication to increase and demonstrate the linkages between natural assets and desired (valuable) utility outcomes.

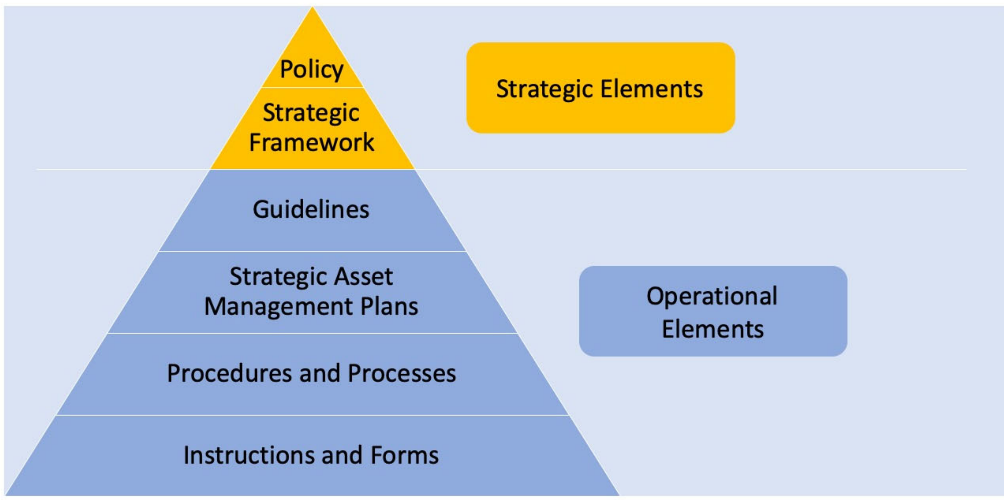


Figure 5-2. Importance of Strategic Context in Asset Management Planning.

In addition, you may be required to develop guidance for how to integrate natural assets as part of (ALGENZ and NAMSG 2006):

1. Introducing Lifecycle Asset Planning
2. Identifying cost efficiency measures (e.g., identify opportunities for investments with greatest return; prioritizing asset needs to deliver service objectives)
3. Reducing Corporate Risk Exposure
4. Satisfying stakeholder/customers and improving the organization's image
5. Improving understanding of real asset costs
6. Meeting/improving compliance with accounting standards

Business goals/objectives provide important context for the definition of target levels of service. Level of service targets and natural assets are discussed in more detail in Chapter 7. They, in turn, help the utility shape business risk assessments and guide decisions about capital investments and maintenance funding.

For natural assets, it is useful to think about two different types of business goals or objectives:

- *Core business goals/objectives.* Core business goals focus on the primary mission of the utility (e.g., to deliver safe and reliable water to customers at reasonable cost). These are the objectives that have always shaped what utilities do.

- *Environmental responsibility and stewardship*. Utilities may focus on such goals due to regulatory requirements (e.g., requirements under the Endangered Species Act) or in response to the values and preferences of utility customers and the larger community in which the utility operates (e.g., a community and utility commitment to restore streams or reduce carbon footprint). For this guidance, we refer to these as *environmental stewardship goals/objectives.* These objectives will lead the utility to dedicate resources (revenues, staff time etc.) to carry out actions that may not contribute much or at all to its core water supply business.

Core business goals and environmental stewardship goals may overlap in the sense that some investments and other actions can contribute to both (e.g., investing in more efficient pumps reduces life cycle costs but will also reduce the carbon footprint of a utility; restoring forest in a watershed will create habitat, but also protect source water quality). In other words, both types of goals are important for applying asset management to natural assets.

Reconnaissance Tips: *Aligning with Strategic Vision*

- Take the time to write down the individual elements of your utility's overall strategic vision and goals. Think about what the utility is aiming to achieve, and the role natural assets play in this vision. Work this down to a short speech that includes: 1) a summary of an important aspect of the utility vision, and 2) the role of natural assets in achieving that goal. Work with your partners to refine this message to one that feels comfortable for everyone to share as a starting place.
- In order to guide where and how you will take a deeper dive, take the time to clearly articulate the specific objectives for priority actions. Work closely with partners as you establish your first set of program objectives. Use the Smart goal outline in the text box to help you set implementable objectives.
- Consider, does the utility's strategic vision provide a clear rationale for embarking on a reconnaissance level implementation of AM? Specifically:
    - *Are there specific business goals or objectives about natural resources and/or environmental stewardship?* If so, how can AM help the utility achieve those stewardship goals?
    - *Are there core business goals that provide a strong rationale for natural asset management? For example, is there a high-level strategic goal about improving source water quality?*
- If the utility's strategic vision does not easily provide a rationale for natural asset AM, then you need more detailed information about your utility's water sources and the natural assets that affect those water sources. In other words, begin to think about a very preliminary and very general inventory of natural assets and how they affect your utility's operations. Then think about the effects of those operations on your utility's strategic goals. This will help you tie the value of natural assets to the utility's strategic goals.

Deep Dive Tips: *Aligning with Strategic Direction*

- For each aspect of your deep dive, make sure your clearly articulate your objective and how it aligns with your utility's strategic vision.
- Each internal department may have slightly different strategic elements they focus on. Take the time to identify and provide the strategic information to each department that drives their individual strategic objectives. Building support within departments supports success across the utility and the community.

Natural Assets vs Built Assets: *Implications for Aligning with Strategic Direction*

- Strategic direction of the utility will shape AM with or without the incorporation of natural assets.
- There are two important ways in which this might be different for natural assets:
  1. Some utilities will have strategic goals or objectives that specifically call for environmental stewardship or similar directives
  2. For core business goals, you will have to gather information about the value of natural assets and their impacts on those goals in order to make sure natural asset management is aligned with the overall strategic direction

5.3 Connect Natural Asset Management with Sustainability Goals

Many utility organizations have adopted a sustainability policy or goal in response to growing community interest in resource constraints. The sustainability goal is likely to be an important element of the strategic vision and therefore shape your utility's decisions. Utilities with both an asset management and a sustainability policy or framework for 2018 include Salt Lake City Public Utilities; San Francisco Public Utilities Commission, and Denver Water. Integrating natural asset management and sustainability goals is another important enabler of success for utilities that have sustainability programs.

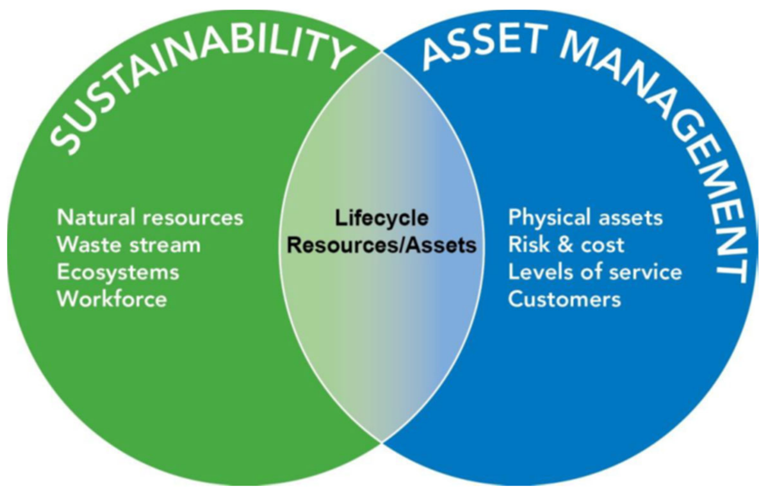


Figure 5-3. Overlapping Frameworks for a Sustainable Utility Practicing Advanced Asset Management.
Note key element incorporated into both frameworks is consideration of whole lifecycle of resources/assets.
Source: Bloomfield et al., n.d.

Integrating these two concepts—asset management and sustainability—can provide an additional rationale for incorporating natural assets into asset management. This is because both sets of goals have shared visions: sustainability has an internationally accepted objective of "meeting the needs of the present without compromising the ability of future generations to meet their own needs" while asset management aims to ensure good decision making, minimized life cycle costs, improved reliability, and effective use of infrastructure's lifecycle (Bloomfield et al., n.d.). Therefore, integration of these two frameworks allows utilities to consider best overall management practices, including consideration of natural assets to meet an organization's objectives.

Figure 5-3 illustrates the integration of these two frameworks with a key element at the intersection of the two: the key element is a focus on lifecycle and whole life cost considerations. Whole life cost considerations include planning, design, construction, operation, maintenance, repair and replacement, and ultimately, retirement and/or disposal of residual assets.

When a utility explicitly recognizes the inherent relationship between asset management and sustainability, it allows for a broadened definition of an asset as not only infrastructure, but also the organization's people and the natural assets that the entity relies on to execute its mission (Bloomfield et al., n.d.). Explicit recognition comes through strategic plans, goals and objectives and becomes memorialized through policy. The policy becomes the underlying foundation on which programs are structured. Examples from Canada and the United Kingdom (see Chapter 4) illustrate this joint focus on sustainability and asset management.

In addition, sustainability may not be the only high-level utility objective with which to align natural asset management. For example, *resiliency* is emerging as a focal area for many utilities, and resiliency programs and frameworks align in a very organic manner with natural assets and whether and how those assets are managed by a utility. Utilities who operate in conformance with voluntary standards—-such as American Water Works Association J-100 Standard for *Risk and Resilience Management of Water and Wastewater Systems*—will find that the processes and practices described in the J-100 standard align with inclusion of natural assets in utility asset management practice (AWWA 2010). Likewise, utilities pursuing an active and comprehensive *risk management* strategy will have a framework for examining natural assets and how they may need to be managed to ensure the utility can continue to operate and deliver on its mission.

Reconnaissance Tips: *Sustainability*
▪ If your agency has a sustainability program, work with participants as a starting point to identify leadership values and information needs, how to align with strategic values, and how to leverage knowledge management, training and technology ▪ Bring together sustainability professionals with asset management professionals to recon important attributes of natural asset management and sustainability.

Deep Dive Tips: *Sustainability*
▪ Work with sustainability professionals to identify areas for deep dives that will provide benefits to both groups ▪ Present information to leadership from both asset management and sustainability perspectives to increase support.

5.4 Knowledge Management, Training, and Technology

Knowledge management, training and technology systems are also used to increase on-going interest and support for natural asset management. Integrating natural asset considerations into knowledge management, training and technology support systems increases both the profile of natural asset management activities and builds the agency's capabilities to manage them successfully.

Knowledge management systems are designed to ensure the data collected by utilities is turned into information that provides the basis for decision makers to improve their knowledge and, hence, their ability to make good decisions. Developing and integrating systems that create and manage knowledge resources, combined with appropriate business practices that leverage such knowledge, allows natural assets to become an integral element in utility strategic management.

Knowledge management systems for natural assets may need to introduce different areas of expertise, potentially including forestry, geomorphology, and resource economics. In addition, the utility may need additional expertise in developing partnerships with outside organizations. One example of this will be in data sharing between organizations. A utility that makes the decision to incorporate natural assets will find it useful to share and/or utilize data sources with others who have a vested interest in those same assets (See Chapter 6). It may not be crucial for the utility to develop this expertise in-house, as long as there is a system in place to find, manage and retain the expertise so that it is available when needed. Training tailored to the needs of natural asset management and the processes set up to manage those assets can support a knowledge management system.

In addition, the utility may need access to skills with new types of technology to support asset management practice. This may include software for tracking or modeling natural systems, remote sensing technology to gather data about natural systems, and other ways to work with partner data.

Information technology and knowledge management needs to be flexible to meet changing leadership over time. On-going training, not just for new systems but for visioning new systems, provide great strategic value to a utility.

Reconnaissance Tips: *Knowledge Management, Training, Technology*
▪ Work closely with those developing knowledge management, training and technology programs to identify where natural assets might fit in. ▪ Identify the benefits of integrating natural assets to the professionals developing the programs as well as the professionals utilizing the programs. Use this information as a foundation for your reconnaissance phase

Deep Dive Tips: *Knowledge Management, Training, Technology*
▪ Develop an iterative process with both users and designers of information and information support systems. ▪ Actively identify ways to further integrate natural asset information collection, analysis, and sharing processes into knowledge management, training, and technology systems. ▪ Use the out of the box nature of natural assets as a catalyst for looking at systems from a different lens – a critical attribute of effective utility leadership.

5.5 Conclusions

Integrating natural assets into the way utilities manage their built assets and pursue other high-level organizational goals will be greatly facilitated by identifying and tapping into opportunities to align with the strategic objectives and processes already in place at the utility that support asset management, sustainability, and related high-level goals. By recognizing and aligning with existing utility strategic objectives, processes, and leadership priorities, the path to successfully integrating the sound management natural assets into the utility will be greatly facilitated.

CHAPTER 6

Step 2 - Describe the Current State of Natural Assets: Building an Asset Registry and Assessing Asset Condition

What you will find in this chapter

This chapter provides an overview of Step 2 of the natural asset management approach. It focuses on principles and techniques for addressing key questions related to developing a natural asset registry and assessing asset condition:

Questions for Developing a Natural Asset Registry (Step 2a):

1) What natural assets contribute to achieving my utility's level of service (LOS) targets?
2) How do these assets influence LOS?
3) Who owns these assets and how are they currently managed?
4) Where are they, especially in relationship to the utility's source watershed and built assets?

Questions for Assessing Natural Asset Condition (Step 2b):

5) What is the condition of inventoried natural assets?
6) How does the current condition influence LOS?
7) What future changes in condition are likely to affect LOS?

The chapter provides detailed information on the types of natural assets that are important for water utilities and the types of services natural assets provide. Also included is an overview of data management issues and potential sources of relevant data. Tips for reconnaissance-level and deep-dive implementation are provided throughout the chapter.

In conventional AM for built systems, a utility begins by identifying the assets they own, their location, condition, and remaining life and value (See Chapter 2). The basic steps are the same for natural assets, but some of the methods and data sources will be different and, in some instances, more challenging (e.g., because the utility may not own the natural asset, and/or may not be the only entity with control over or access to the asset). This chapter covers how AM approaches can be applied to develop a natural asset registry and to assess natural asset condition.

Figure 6-1 reveals where on the AM Wheel Step 2 is positioned, and in this chapter the material is broken down into two sub-steps:

- Section 6.2 covers Step 2a: Building and Maintaining a Registry of Natural Assets; and
- Section 6.3 covers Step 2b: Assessing and Documenting the Condition of those Natural Assets

In addition, Section 6.4 offers information on data sources useful for building a natural asset registry and assessing asset condition, and Appendix A describes the types of valuable services that typically are associated with a range of natural asset types.

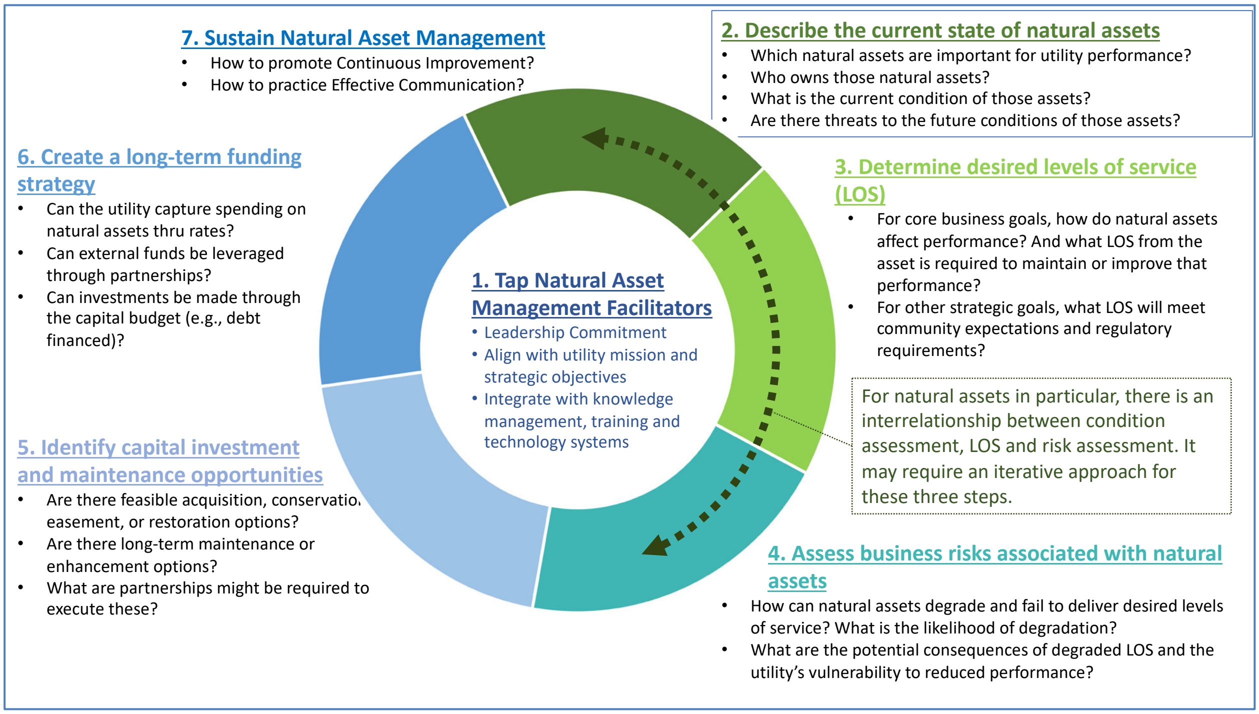


Figure 6-1. Step 2 Along the Natural Asset Management Wheel.
Source: Adapted from Campanella et al. 2016.

6.1 Important Natural Assets May or May Not Be Owned by the Utility

Utilities may own some relevant natural assets, but rarely own, control, or have exclusive access to all of the natural assets that provide them with important benefits. Responsibilities and management options for natural assets will differ depending on whether they are utility-owned or owned by others, and/or whether or not the utility can control use and access to the resource (such as where a forested watershed is open to recreational use, development, etc.). However, rather than a focus on ownership, the utility must begin with a consideration of service provision at the heart of asset identification.

The approach for natural assets that the utility owns will be very similar to that for built assets, emphasizing a solid inventory of which assets the utility owns and addressing the questions covered in the box above. In addition, when natural assets are owned by a utility, there may be legal requirements, such as compliance with the Endangered Species Act, that can constrain how these areas can be managed.

For natural assets a utility does not own or control, there still needs to be a good assessment of which assets provide beneficial services and how these services contribute to level of service (LOS) targets. In addition to understanding condition and risks, it will be important to know who owns them, how they are currently managed or protected, and how current management affects LOS targets. Experience also indicates some asset owners will be willing and eager to collaborate with utilities, while others will be highly resistant, and the rest somewhere in the middle (D. Warne, New York City Dept of Environmental Protection, Personal communication, November 27, 2019). It also is important to understand and articulate the ways in which a utility can influence management to maintain beneficial services through partnerships and collaboration with the asset owners (see Chapter 10 for further discussion).

6.2 Step 2(a): Building (and Maintaining) the Natural Asset Registry

There may be many natural assets that benefit utilities. Detailed inventories or condition assessments for all of these assets may not be necessary to inform the asset management program and could result in unnecessary costs for the utility. The appropriate level of granularity or detail in the inventory and condition assessment can be determined by considering aspects of LOS (Chapter 7) as well as the consequences if natural assets are lost or degraded (Chapter 8).

Another consideration is that building an inventory is but one element of work involved in a registry. Utilities create, maintain, and routinely update an engineered asset inventory because asset use (and asset condition) is not static. Additions, removals or rehabilitations of existing assets must be documented to assure the organization knows what it owns, operates and relies upon. Likewise, building a natural asset registry requires a similar level of maintenance of a proper register of natural assets. The total cost of ownership of a registry is influenced by maintenance requirements of data and the systems used to manage the registry, and thus should be considered at the time of creating an initial inventory. Considerations involved in deciding what to include and why, are discussed in greater detail in Section 6.2.4.

6.2.1 Which Assets Provide Important Benefits to Utilities?

With built assets, a utility determines which assets they own and how they contribute to meeting LOS targets that support the utility's core business. The logic is similar for natural assets but rather than identifying assets the utility owns, the focus is on identifying which assets affect how successfully the utility is able to meet its LOS targets. A useful starting point is to ask: Which natural assets affect the utility's ability to meet its LOS targets, now and in the future?

In determining which natural assets are important, utilities should consider both LOS targets for their core business of ensuring supplies of drinking water that meet relevant regulatory standards, as well as assets that contribute to other strategic objectives of the utility, such as environmental stewardship or community relations goals.

6.2.1.1 Natural Assets and Utility Core Business

Natural assets influence site- and watershed-level hydrological processes that deliver beneficial services in terms of water supply, water quality, and regulation of water hazards that are important to a utility's core business (see Table 6-1). The beneficial services to utility core business outcomes are summarized in a table that can be found in Appendix A.

6.2.1.2 Natural Assets and Environmental or Social Responsibility Goals

Many natural assets that are of consequence to the utility's core business functions (e.g., water supply) will simultaneously provide services that help a utility meet broader environmental and stewardship objectives (see Table 6-2). For example, many utilities are making climate commitments related to reducing energy use and greenhouse gas (GHG) emissions. Forests can contribute to these commitments by sequestering carbon and offsetting some utility GHG emissions, as well as providing habitat for wildlife preservation and biodiversity, and recreational opportunities. Natural assets can also directly reduce energy use by utilities in some cases (e.g., controlling erosion and reducing the number of times reservoirs need dredging not only has cost savings, but also reduces GHG emissions). Forests and wetlands that help maintain very high source water quality help utilities reduce the number of required treatment steps can also reduce energy use.

Table 6-1. Natural Asset Benefits to Utility Core Business.

Site/Local Hydrological Process Regulated by Natural Assets (primarily vegetation and soils)	Watershed / Basin Level Effects	Hydrological Service Beneficial to Utility Core Business
– Interception of rainfall by canopy – Evaporation and Transpiration – Runoff / Overland flow – Infiltration (soil, subsoil) – Soil moisture and organic mater – Infiltration to deep groundwater – Erosion – Nutrient uptake and removal or retention of pollutants	– Regulate peak flows – Maintain dry season flow – Groundwater recharge / storage – Flood water storage – Regulate sediment, nutrient, pollutant inputs to source waters	**Maintain Regular Supplies:** – Maintain dry season flows / supply – Maintain groundwater supplies / recharge **Maintain / Improve Source Water Quality:** – Control erosion and reduce sediment in water supplies – Reduce nutrient and pollutant levels in water supplies – Reduce / avoid saltwater intrusion to coastal water supplies **Hazard Mitigation (Avoid/Reduce Costs and Supply Disruption):** – Buffering the effects of drought conditions (including risk of wildfire and resulting water quality impacts) – Reduce flooding risk and damages (for small to moderate size events) – Reduce landslide / catastrophic sedimentation risk and damaged (moderate to large but not extreme events)

6.2.2 Which Natural Assets Should Be Tracked?

Determining which of the many natural assets are important to achieving a utility's core business and other strategic environmental or social objectives is a first step in establishing the natural asset registry. Which built assets need to be included in an asset register is relatively straightforward (assets owned by the utility). For natural assets, additional factors should be considered: which natural assets are of significance to the utility; and what level of detail is appropriate in terms of which units should be tracked and how much data to collect. Utilities will likely need to seek additional support from experts in natural resource mapping and assessment, ecosystem services, and ecosystem condition assessments.

Table 6-2. The Extent to Which Different Natural Asset Types May Potentially Contribute to Meeting Utility Goals Beyond Core Business Goals.

Subjective and site-specific, number of green diamonds reflect relative potential benefit.

Goals and Beneficial Services	Forest	Wetland	Grassland	Rivers, Lakes	Glaciers, Snowpack
Climate Goals					
Carbon sequestration, climate mitigation	♦♦♦♦♦	♦♦♦	♦♦♦♦♦	♦♦	
Climate resilience, adaptation	♦♦♦♦	♦♦♦♦	♦♦♦	♦♦♦♦	♦♦♦♦
Environmental Goals					
Habitat protection, biodiversity	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦
Protection for species of special concern[3]	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦	♦♦♦
Water quality (non-regulatory)[4]	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦		
Community Social Responsibility Goals					
Cultural and spiritual services[5]	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Wild harvest foods (e.g., salmon, shellfish)	♦♦♦♦	♦♦♦	♦♦	♦♦♦♦	
Recreational services (hiking, fishing, ecotourism)	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Aesthetic services (iconic landscapes)	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Improved health outcomes[6]	♦♦♦♦	♦♦♦	♦♦♦	♦♦♦	

6.2.3 Which Natural Assets Are Critical and Should Be Included?

The natural assets that can substantially influence services important for achieving core business LOS targets are 'critical' and most important for a utility to understand and manage. Three factors should be considered in determining which assets are critical:

- First, critical assets are those that provide essential services that, if lost, can result in significant supply and/or water quality disruptions and/or substantial costs to the utility (e.g., influencing the levels of treatment required). For example, forests that protect raw water quality that meets regulatory standards at minimal cost.
- Second, critical assets are those in locations that have the most influence on a utility's core business, such as forests in contributing areas to headwater streams, forests and wetlands in aquifer recharge zones, and riparian forests adjacent to surface water and storage reservoirs. Also important are natural assets that are adjacent to, or can help protect, the utility's built assets (e.g., forests around storage reservoirs, or floodplains upstream of treatment plants). Whether or not these natural assets are owned by the utility, they perform critical functions that are a benefit to the utility.
- Third, critical assets may include those that are highly vulnerable to events causing impairment of the ecological functions upon which the utility relies (See Chapter 8). Addressing assets vulnerable to a range of natural events (e.g., a forested watershed subject to drought, wildfire, pest infestation and changing climactic conditions) can be more important than assets that are sufficiently buffered from such events.

Other important natural assets are those that contribute to a utility's strategic environmental and social objectives, as these are increasingly significant aspects of utility business. Guiding questions can help

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[3] Endangered, threatened, or special concern under Federal, State, or Local laws.

[4] Natural assets that help utilities meet regulatory water quality standards can also help the utility contribute to improving regional or local water quality outside of regulatory requirements for drinking water, for example forests and wetland areas can help protect water infrastructure from flooding while improving water quality in coastal areas important for recreational shellfish harvesting.

[5] Culturally significant animals such as salmon, places with spiritual or cultural significance (e.g., Bristol Bay, Alaska).

[6] Natural spaces, especially in cities improve physical and mental health, by promoting physical activity, improving air quality, and mitigating effects of heat waves.

identify which natural assets should be included in the inventory, such as:

1. Which natural assets in my source watershed(s) **provide important hydrological services** relevant to core business LOS?
2. Which natural assets **are adjacent to, or could affect the performance of my built assets**?
3. Which natural assets in my service area or within a region impacting the service area can **contribute to my strategic environmental and stewardship goals**?
4. Which natural assets can contribute to my other strategic **stewardship or community service goals**?
5. Which natural assets are most relevant to my **sustainability framework**?
6. Which natural assets do I **own and can manage directly**?
7. Which critical natural assets are **owned by others and will require collaboration and partnerships to maintain beneficial services**?
8. Which natural assets that provide important services are **most vulnerable to be impaired by the possible range of events that cause the impairment**?

6.2.4 Determining Level of Detail

The natural asset types noted above are broad categories and can be broken down into their component parts, similar to how built assets may be tracked at different levels (see box below).

Assets vs. Components
For built assets, utilities track valves but not the components of a valve as separate assets. There is a strong need for each valve to be tracked as a discrete asset, but very little benefit for the additional cost of tracking the valve components as discrete assets. Additionally, the standard system of record for the valve assets is a geospatial information system because valves are spatially located throughout a water main network and that location is critical. Most geospatial information systems do not naturally track those types of components.

Once the types of natural assets to be included into the asset register have been defined, the next step is to define the appropriate level of detail for tracking and assessing the condition of those assets. This level of detail typically is defined by three drivers:

- The type of information available and the system used to track the information,
- The value provided by a higher level of detail,
- The cost of collecting, editing and maintaining that level of detail.

How detailed the inventory needs to be, and the relevant components or appropriate units to be tracked will depend on a number of factors:

- What is the relevant unit to assess in terms of how the asset delivers beneficial services? For example, a small forest patch within a larger developed or agricultural area may not have a significant effect on water quality while a large area of contiguous forest above a river, lake, or storage reservoir can help maintain water quality by filtering sediments and removing nutrients. Forests in the riparian buffer of a river, lake, or storage reservoir can have a significant influence on water quality and be tracked as a separate unit from watershed forests.
- What data are available and what is the spatial resolution of the data? (e.g., simple land-use/land cover data may be all that is available, so that forest areas may not be identified by different forest types).
- What area scale is relevant to include in the assessment or geographic scope (e.g., source watersheds, riparian zones around source waters or infrastructure such as storage reservoirs)?

- How much does it cost to gather data and what is the incremental cost of additional detail?

For natural assets within an inventory, in addition to the key *characteristics* defining the asset (e.g., indicating a given wetland has a size of 3 acres), there should also be relevant *attributes* associated with each natural asset type. Attributes for a wetland asset may include, for example, the volume of water stored within the asset. For a stream/flowing river reach identified as a discrete asset, the *characteristics* for the registry may include its length and average width, whereas an important attribute to document in the registry may be its base flow rate. The selection and assignment of attributes to be associated with each asset type within the inventory will likely involve similar considerations as outlined above, such as:

- The type of data available and the system used to track the information,
- The value provided by maintaining, and using such data,
- The cost of collecting, editing and maintaining those attributes.

Utilities will often find the number and level of detail of attributes to be associated with assets in an inventory is driven by the criticality of the specific asset to utility operations. A low priority natural asset may be sufficiently characterized by using off-the-shelf data, whereas a higher priority natural asset will warrant more detailed characterization that may include in-field sampling and measurements.

6.2.5 Hierarchy

In Asset Management, hierarchy is an important function which creates a pathway for communication of data, risk, and services from a lower granular level to a high level. A well-developed hierarchy allows for a direct line between asset operators and maintenance staff to management and outside stakeholders. Frequently asset hierarchies are based on the process being serviced, for example, source, treatment, transmission, or distribution (see Figure 6-2). Generally, natural assets may most strongly influence source water for most utilities, however, natural assets also influence other functions such as treatment and storage, through for example mitigating hazards such as floods.

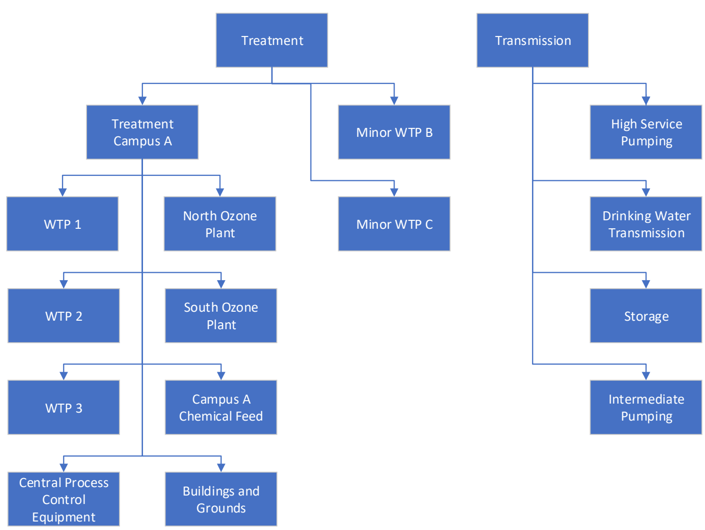

Figure 6-2. Sample of a Built Asset Hierarchy.

The next subset in the source hierarchy would be the type of source; surface or groundwater. Here we would start to separate the assets based on type. However, there are likely to be cases where a natural asset such as a forest may serve both source types (e.g. pre-filtration for a surface source and aquifer recharge for a groundwater source). When that is the case, the first solution would be to see if the asset could naturally be divided into two assets which each distinctly serve the two purposes. If not, then the asset should be located under the more dominant service provided.

There are however instances where they serve other purposes and would then be located in the appropriate location in the hierarchy. This applies equally to all assets.

6.2.6 Example Inventory

A detailed and extensive inventory of natural assets does not need to be undertaken before utilities can begin to consider natural assets in their planning. An initial reconnaissance-level assessment can be undertaken to start building an understanding of what assets are important, how they contribute to LOS targets, and what risks they may be subject to. An example from the Municipal Natural Assets Initiative in the town of Gibsons in British Columbia illustrates this approach (Figure 6-3).

The town first identified the kinds of natural assets that could provide benefits and categorized these in three types: 1) natural assets such as wetlands and forests; 2) 'enhanced assets' such as rain gardens, urban trees and forests, or parks; and 3) 'engineered assets' such as green roofs and green streets. From this they selected the assets that were considered most important by the benefits they could provide, mapped them using available data and existing GIS platforms for the town and then identified major threats to service provision with a qualitative ranking of whether the risk was low, medium, or high.

Natural asset	Services	Hazards	Impact	Likelihood	Risk
Aquifer	Water provision	Leak from gas storage tank	High	Medium	High
		Spill from transport truck	High	Low	High
Foreshore	Protection of business and residential districts from storms	Storms, development	High	Low	Medium-high
Healthy creek distant from developments	Stormwater absorption, conveyance, and flood protection	Development and overuse	Low	Low	Low
Degraded creek near area with land intensification	Stormwater absorption, conveyance, and flood protection	Development and overuse	Medium	High	High

Figure 6-3. Rapid Assessment of Natural Assets Important for the Town of Gibsons, BC.
Source: Town of Gibsons 2017.

Beyond this type of rapid assessment, the Santa Clara Valley Water District worked with the San Francisco Estuary Institute to conduct a watershed assessment of the West Valley Watershed (Lowe et al. 2019). As part of Valley Water's *Safe, Clean Water and Natural Flood Protection* Program, this assessment evaluated the baseline ecological condition of the watershed, in terms of assets that contribute to water quality and flood mitigation, as well as other objectives such as access to recreation for the community and protecting wildlife habitat. They used a three-pronged approach with an initial landscape level assessment using GIS data on vegetation and natural features such as wetlands and riparian areas, followed by field-based rapid condition assessments, and finally more intensive evaluations at specific sites. Ecological conditions were assessed using standard methods developed for California streams and wetlands (e.g., California Rapid Assessment Method for streams).

The information on the presence and condition of streams, wetlands, and riparian areas is used to guide management decisions to meet the goals of the program (see Table 6-3). The evaluation incorporates many of the elements that would go into a natural asset inventory and condition assessment. Furthermore, the approach uses many of the same types of data and methods that are familiar to drinking water utilities from source water protection programs (EPA 2019c). Further information about the linkage of source water protection programs to this guidance is found in Chapter 8.

Table 6-3. Management Questions Addressed in Santa Clara Valley Water District's West Watershed Assessment.

Distribution and Abundance of Aquatic Resources
1. How many miles of streams in the watershed? 2. How many acres of wetlands? 3. What is the extent and distribution of stream-associated riparian areas? 4. If there is information on the historical extent of these areas, how do the current areas compare? What is the extent of resource loss or change from historical conditions? 5. What land uses and vegetation types occur in the watershed (e.g., percent cover of forest, grassland, wetland, agriculture, urban)?
Ecological Condition (focused here on streams)
1. What is the overall ecological condition of streams (water quality parameters, biological condition, recreational values)? 2. How does this ecological condition compare to other Valley Water's watersheds? 3. What are the major stressors that are impacting stream condition?

Reconnaissance Tips: *Asset Registry*

- If your utility has a mature AM program for built assets, use the established LOS and determine which natural assets currently help or hinder the utility's ability to meet those LOS.
- If your utility does not have a mature AM program, consider utility business goals and objectives, even if they are not quite the same as standard AM LOS targets (see Chapter 7 for more on LOS).
- Include both assets the utility owns and those it does not own. At this stage, determine categories of ownership (e.g., private, government, conservation organization) but it may not be critical at this point to determine specific landowners.
- For natural assets the utility owns, describe legal and regulatory requirements, at least at a general level (e.g., does the asset include designated critical habitat for threatened or endangered species?).
- Focus on identifying natural assets that are most likely to be critical for your utility, and that are likely to present feasible options for managing the asset to improve performance.
- Use readily available data and information from published reports and established data sources (see Section 6.3) to support a simplified registry
- Work with utility and outside experts to supplement available data with expert judgement
- Describe the potential impact of natural assets on utility goals using qualitative, ordinal ratings, as was used by the Town of Gibsons in the example above
- A low level of detail in the registry and the underlying data is acceptable for this phase; assets may be identified as asset classes (e.g., forest in a reservoir drainage area) and it may not be necessary to define different levels of the asset hierarchy at this stage
- While natural assets can have many impacts on utility performance, a reasonable rule of thumb for the reconnaissance phase is to focus initially on core business goals and assets that affect source water quality and reliability. In later iterations of asset management planning you might start to include assets that serve other functions (e.g., mitigating flood risk).
- If stewardship or other goals are included in the reconnaissance phase, initially prioritize the goals that are driven by regulatory or other legal requirements (e.g., Endangered Species Act).

Deep Dive Tips: *Asset Registry*

- Based on results of reconnaissance phase, select assets that are most critical and for which that do detailed asset management plan have not yet been developed.
- Increase the level of detail so that it is sufficient to fully execute subsequent steps of the AM process (e.g., quantitative risk assessments, site specific capital investment planning).
- Fully define the natural asset hierarchy for selected assets. If necessary, divide large natural assets into smaller segments or areas depending on data available, impacts on LOS and feasibility of planning of investment or maintenance activities.
- Use LOS from your AM program for built assets and/or LOS from previous iterations of the natural asset management approach; these LOS can be used to prioritize which natural assets are selected for a deep dive (i.e., those that have the most impact on meeting LOS targets).
- Determine ownership of each selected asset. If not owned by the utility, engage with the property owner(s) and gather information they may have about current management and environmental conditions.
- Consider collecting new field data about prioritized natural assets; if necessary, partner with other organizations who have expertise in studying and evaluating relevant assets (e.g., wetland conservation agencies or groups).

6.3 Step 2(b): Assessing Natural Asset Condition

The next step after the identification and inventory of natural assets is to determine the state of those assets. It is important to link asset condition to the desired level of service targets. This requires understanding *how* natural assets provide the services that help a utility achieve LOS targets (see Appendix A). Delivering these services will depend on the condition of the natural asset in much the same way that conventional or built asset conditions affect performance. However, the factors affecting natural asset conditions and capacity to provide services are more varied and not as well-understood as those for conventional built assets. For example, natural asset condition and ability to provide services will depend on the type of asset, the surrounding landscape (e.g., intensity of adjacent development), the size of the asset (e.g., wider riparian buffers are more effective at removing sediments), local site conditions (e.g., soil type, slope), and climate (regional climate as well as short-term variability and longer-term changes).

A caveat on ecosystem service valuation assessments

There are a growing number of studies that estimate the economic value of ecosystem services and these can provide useful information for utilities, for both inventory and condition assessments. However, the primary goal of these studies is to provide information on the monetary value of these services, often focusing on society at large, rather than to inform utility decisions for maintaining or improving the services to its customers and community. These studies also may use fairly general land cover-ecosystem service relationships and typically assume spatial homogeneity of services within a land cover type. For the reconnaissance phase this information can provide some guidance for utilities, but it is probably not sufficient for managing natural assets to maintain beneficial services.

The registry identifies the assets that are important because they contribute to achieving LOS targets, and the condition assessment should focus on determining:

- Which attributes of the asset itself influence service delivery and what is their state?
- What external factors affect the ability of an asset to deliver services?

The assessment of current condition also feeds into a consideration of the threats an asset is exposed to, how these will affect the future condition of the asset, and what measures can be taken to manage risks arising from natural asset impairment (see also Chapters 8 and 9).

6.3.1 What Factors Affect Natural Asset Condition and Capacity to Deliver Services?

A very wide range of factors at multiple scales will determine natural asset condition and therefore the capacity to deliver beneficial services. There often are uncertainties and gaps in the scientific understanding of which factors are most important and when for specific assets. Natural assets are natural systems that are dynamic and self-organizing, meaning that conditions can be quite variable from one place to another even within the same asset type and can change over time. All of these characteristics make it challenging to assess asset condition, especially compared to conventional built assets.

Despite this, by focusing on how natural assets provide services, a set of attributes related to condition can be identified and assessed through a variety of qualitative to quantitative methods. For example, there is extensive information on how riparian buffers benefit water quality (Stutter et al. 2019). By slowing the movement of water across the buffer and increasing surface roughness through plant stems, leaf litter, and roots, the settling and retention of sediments and pollutants is enhanced. The retention of sediments is related to the length of the flow path across the buffer. A diversity of actively growing vegetation, deep soils, and healthy soil microbial communities enhance the uptake of nutrients and processing of pollutants and pathogens. Based on this, vegetation type and diversity, soil type and structure, and buffer width are important condition variable for estimating how effective a buffer will be in retaining sediments, shading and reducing water temperatures, or removing nutrients and pollutants.

Indicators used to evaluate ecological health of ecosystems can provide reasonable proxies for natural asset condition. For example, a number of indicators have been developed for general forest health (e.g., US Forest Service) (USDA 2019) that are relevant to how forests contribute to regulating water flow and quality. These include for example, degree of fragmentation[7], presence of invasive species, insect or disease damage, wildfire risk, extent of road network (related to potential for erosion and sedimentation), extent of tree mortality, vegetation diversity, and soil condition (depth, degree of compaction). State and

Virginia Watershed Model

Three attributes assessed to evaluate asset condition:

- **Soil sensitivity.** A measure of the potential for erosion and runoff. Highly erodible, with low drainage capacity, on steep slopes are most sensitive and loss of forest on these lands has high potential to impact water quality; restoring or protecting forests on these lands can significantly benefit water quality
- **Landscape position**. Locations with the most impact on water resources based on proximity to surface water intakes or groundwater wells, forests in headwaters strongly influence downstream waters, distance along flow path to nearest stream, river, waterbody, or wetland, forests in buffer zones.
- **Watershed Integrity**, as a proxy for how well watershed assets are performing. Index of Biotic Integrity, pollutant loads, percent cover of impervious area (significant impacts on water quality, peak flow, runoff, and erosion), percent cover of forests and wetlands combined (reducing moderate flood events).

[7] Whether there are large areas of contiguous forest or if the forest is broken up in smaller pieces by agricultural or urban development.

Federal forest management agencies may maintain forest health assessments that can be used to evaluate the condition of forest natural assets in a utility's watershed. There are some useful tools for tracking forest assets in terms of forest conversion to other land cover types or forest loss (e.g., WRI's Global Forest Watch) (World Resources Institute 2019).

Much of the information needed for condition assessments will already exist in a variety of sources that the utility can access. Source water protection assessments and plans, watershed management plans, habitat restoration plans, and local critical areas assessments and plans are some examples that have data relevant for evaluating the condition of natural assets. As noted under the asset inventory, establishing partnerships and leveraging the expertise of organizations that maintain these data will be an important step in completing the inventory and condition assessment, as well as being a first step in forming collaborations for managing the assets the utility does not own.

6.3.2 A Range of Approaches to Condition Assessment

In the same way that the natural asset inventory can be conducted in phases or stages (see Chapter 5), the condition assessment can range from a rapid qualitative or semi-quantitative assessment in the reconnaissance phase to more intensive field monitoring or modeling exercises. For example, the Municipal Natural Assets Initiative (MNAI) in British Columbia suggests an approach that uses only basic information on asset condition, derived from existing information such as natural areas inventories or stormwater master plans, and a simple scoring (from 1 to 5) to denote the condition of an asset to deliver a service (see Figure 4-2). Depending on the detail of information needed for asset management, utilities could begin planning with only this type of rapid assessment, qualitative estimation of condition.

A more detailed approach is illustrated by the Virginia Watershed Model (see Virginia Watershed Model box above) that combines GIS analysis with some modeling of hydrological outcomes. The Virginia Conservation Vision Watershed Model quantifies the relative importance of lands for protecting water quality and watershed integrity (Hazler et al. 2018). The model incorporates topographic and edaphic characteristics that are related to service delivery, position in the landscape relative to hydrological features and drinking water sources, and sub-watershed integrity based on landscape composition, aquatic species assemblages, and estimated pollution loads. Condition of assets are scored on a scale of 0 to 10 based on the ability to provide services.

The Santa Clara Valley Water District example noted above illustrates developing inventories and condition assessment that begins with a more general rapid assessment approach that helps identify and prioritize natural assets most important for service delivery and/or in need of management. This is then combined with more detailed analysis using field assessments, monitoring and/or modeling for specific assets or sites based on their importance.

6.3.3 Examples of Tools for Assessing Condition and Ecosystem Services

New tools are being brought into commercial use to help perform multi-ecosystem assessment inclusive of condition assessment of natural assets. These tools are designed to aid in decision making about flow of ecosystem services and their values, predicated upon a dynamic analysis of those services being provided by natural assets. Models that offer open-source, web-based technology to perform rapid ecosystem service assessment and valuation are being developed (ARIES 2019). Users will reportedly be given flexibility in specifying data sources, outputs and reporting options including spatial assessments and economic valuations of ecosystem services (Batker 2010).

The Natural Capital Project (Stanford University 2019) has developed a number of models for assessing the flow of ecosystem services based on the natural assets and conditions in a given landscape. The

InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) models include those focused on water purification, sediment retention, and water yield and can estimate the benefits under different land use (or natural asset condition) scenarios. The Natural Capital Project also partners with end users to develop new models for particular purposes.

6.3.4 The Inventory and Condition Assessment, and Next Steps in the Asset Management Planning Process

The inventory and condition assessment should inform and be informed by the next steps in the asset management planning process—level of service and addressing risks. How the utilities LOS targets are defined will determine which natural assets are important. The inventory and condition assessment must consider how these assets contribute to LOS targets and what attributes can be measured or evaluated to establish the current state of assets and their level of service delivery.

The current condition assessment should also feed into and be informed by the evaluation of threats to the assets and the risks to the utility of degraded or lost asset conditions – how will asset degradation or loss affect the utility's ability to achieve LOS targets?

- Conventional assets such as pipe or pumps are engineered with a set design life, with well-defined installation and maintenance practices to achieve that life. Over time those assets begin to degrade due to operational circumstances, and as they age, they are evaluated for continued effectiveness.
- Natural assets are generally self-maintaining or self-regulating and do not follow the same degradation patterns as built assets. However, natural assets are affected by many factors in the environment and as conditions change, the ability of a natural asset to continue to provide services will also change. While natural assets may not need the kind of regular maintenance that conventional assets do, in many cases some protection or management interventions will be needed to maintain the ability of these assets to provide beneficial services (see Chapter 9).

The condition assessment will inform the assessment of risk as these are often linked to a change in the factors that affect asset condition. For example, development and land use changes that encroach on riparian buffers and reduce the width of those buffers lower the condition of the asset and affect its ability to provide water quality benefits.

Reconnaissance Tips: *Asset Condition*

- Rely on existing studies and plans, such as source water quality documents, critical habitat assessments and similar documents
- Ecosystem service valuation studies may provide useful information for this phase, but keep in mind that these studies may be based on assumptions that do not match well with utility management goals and questions
- At this point, simplified analyses and qualitative ratings are sufficient to develop high level condition assessments that can be used to support prioritization for the deep dive phase. Use information from available reports and other sources to assign qualitative ratings.
- Work closely with experts in ecology, forestry, hydrology and other natural science fields to find available information and to use it for qualitative ratings. Partner with natural resource agencies, and environmental or conservation NGOs (e.g., watershed groups).
- Qualitative ratings can be based on expert judgement using readily available information for support.
- The key is to develop qualitative ratings with enough confidence that you can justify prioritization of natural assets for deep dive implementation.

Deep Dive Tips: *Asset Condition*
▪ Based on results of reconnaissance phase, select assets that are most critical and for which detailed asset management plans have not yet been developed. ▪ Work closely with organizations that have expertise in assessing ecosystems and natural resources. ▪ Consider collecting new field data to support condition assessment ▪ Consider using available physical process models (e.g., geomorphology models) or developing new models to support detailed assessment of how a natural asset affects LOS targets. ▪ At this stage, condition assessments should be quantitative (e.g., a quantitative description of a how a forest affects water quality criteria, such as total suspended solids, at raw water intakes). This will support detailed quantitative risk assessments and planning for management interventions.

6.4 Data and Data Management

6.4.1 What Types of Data Should Be Included in the Inventory?

The types of data tracked will depend in part on the appropriate level of detail discussed above. It is also possible to start the registry with more general data to begin tracking important assets as a first step, and then develop more detailed data in iteration with other steps in the planning process, such as the LOS and business risk assessments. Some key types of data will be important to include in the inventory from the start (Table 6-4; see also MNAI example in Section 4.4).

Table 6-4. Examples of Relevant Data for Natural Asset Inventory and Condition Assessment.

Description of Relevant Data	Indicative Examples
Natural Asset Type and Unit Asset types that deliver beneficial services; types can be broken down into greater detail as needed (see examples). Asset units can be defined by type of asset, depending on the level of detail needed in the inventory, such as individual wetlands, streams by stream reaches, miles of stream by Strahler stream order or hydrologic unit code (HUC).	Headwaters Forest − Conifer Forest − Deciduous or Mixed Forest Riparian Buffer − Conifer Forest o >50 yards wide o 25-50 yards wide o 10-25 yards wide o < 10 yards wide − Deciduous or Mixed Forest o >50 yards wide o 25-50 yards wide o 10-25 yards wide o < 10 yards wide Wetland − Slope − Depressional − Lacustrine/Riverine Floodplain River / Stream
Contribution to Level of Service Targets For each asset, the specific service provided and whether this is important for core business LSTs or other utility goals.	**Core business Level of Service targets** Water Supply: − Protect and improve the quality and supply of utility's groundwater and surface water resources Water Quality: − Reduce treatment costs by 30% over five years − Meet Federal and State Drinking Water Standards 100% of time o Turbidity − Customer Satisfaction o Fewer than 2 odor, color complaints per month Water Hazards o Reduce reservoir dredging costs from excessive sediment inputs by 50% o Fewer than 2 supply disruptions from flood or landslide damage in a 5-year period **Environmental and Sustainability LOS targets** − Reduce energy use by 2% per year − Offset 20% of GHG emissions − Protect and improve the region's natural resources, iconic landscapes, and important habitats − Protect and improve nature-based recreational opportunities for current and future generations (hiking, fishing, canoeing)
Location Location of the asset provides information on asset condition and exposure to risks. Where natural assets are located relative to a utility's built assets can also be important.	− Inclusion in Geographic Information System (GIS) (esp. relative to critical built assets) − Simple overlay maps of natural assets, built assets, and ownership

(continued)

Table 6-4. Continued.

Description of Relevant Data	Indicative Examples
Area or Size Area or size is related to the capacity of an asset to deliver services, and also is important for assessing condition, threats, and management options. For example, very small areas of forest will have very small or undetectable effects on water quality; narrow riparian buffers are less effective at retaining sediments and pollutants than wide buffers.	– Acres (forest, wetland) – Linear feet (streams) – Linear feet by width (riparian buffer)
Ownership Influences management options, utility legal responsibilities, and type of partnerships and collaboration that will be need for asset management.	**Utility-owned** **Other ownership** – Private – City/municipality – County – State – Federal
Protected Status Can influence threats assets are exposed to. Determines need for additional protection or management to maintain desired services, as well as which management options are feasible.	– None – Wilderness Area – National Park – National Forest – State Park – Local Critical Area or Environmentally Sensitive Area
Active Management Type of active management will influence how well and how long an asset will deliver beneficial services. Current management regimes can illustrate what additional management options are feasible, as well as what kinds of threats an asset is exposed to.	– None – Forest fuels reduction (wildfire risk) – Forest management (sustainable timber harvest, road decommissioning) – Wildlife management area (e.g., wetlands) – Habitat Management Plans for protected species – Conservation agriculture, climate smart agriculture, organic agriculture (e.g., no-till, cover crops, no chemical pesticides, herbicides, or fertilizers

6.4.2 The Importance of Spatial Data for Natural Assets

In the case of natural assets, a geospatial information system (GIS) is undoubtedly the best system to use to keep track of assets. Many utilities already use GIS to track and manage built assets or for Source Water Protection programs, so that creating GIS data sets for natural assets can build on already established data collection and management processes. Maintaining spatial data can help streamline natural asset management and allows the integration of natural and built assets in AMPs. Depending on a utility's specific needs, GIS can support simple to complex asset management tasks, from basic mapping of data layers (e.g., in Table 6-4) and visualization, to interactive mapping, to spatial analysis and analytics.

There are many open source as well as commercial options for GIS software, which can be pared with a wide range of spatial data sets that can be used to map natural assets. ESRI (ESRI 2019) is by the far the world leader in GIS, the developer of ArcGIS, and has created many tools and guides to assist users in developing and managing spatial data. For example, ESRI has developed a number of data models, or templates for building project-specific models. While ESRI has not defined a natural assets data model, other data models, such as the *Forestry* data model and the *Groundwater* data model, could be used as a template for a natural asset model. In addition, the *Local Government Information Model* (LGIM) (ESRI

2019) includes features that are relevant to many natural assets for which publicly available datasets exist, including wetlands, lakes/rivers/streams, and floodplains (see Table 6-5).

6.4.3 Data Management

Natural asset data often reflects assets not directly owned by the utility. As a result, the data for those assets is also generally obtained through a different agency. Once a data source and data model has been defined for each asset type, the last step will be to define the data management process.

- Identify and document what processes/activities will rely on the data
- Identify the frequency of those activities and their dependency of data currency
- Define how frequently will the data be updated from the source
- Define the data source for updates
- Identify who is responsible for the update
- Document the QA process

How frequently natural asset data is updated will depend in part on how rapidly watershed conditions change. If development in a watershed is very rapid, with resulting conversion of forest to developed or agricultural land, then assets should be evaluated more frequently.

6.4.4 Data Sources for Natural Asset Inventories

To complete the inventory and condition assessments, utilities may want to partner with relevant experts or collaborators who already have many of the relevant data sets and have expertise in gathering and analyzing these data. City planning departments, State natural resource agencies, conservation organizations, and Federal scientific and natural resources agencies (e.g., USGS, USFS) are examples of entities that maintain many useful spatial data sets that utilities can access to build their inventory. Initiating partnerships to create the inventory can also begin to form the kinds of collaboration that will be vital for utilities in managing natural assets that they are owned by others. Table 6-5 provides additional detail on a range of viable data sources that may be tapped for a natural assets inventory.

There are many data sources at the national, state, and local level in the US that maintain information on the types of natural assets important to utilities. Most of these allow data to be downloaded to a user's GIS platform. Some, but not all, of these sources periodically update their data with new information. Some of these data may not be useful if they are no longer current and reflect landscape conditions from more than five years ago.

Table 6-5. Examples of Data Sources That Utilities Can Use for Natural Asset Inventory and Condition Assessment.

Asset Type	Example Data Sources	Notes and Considerations
Forests (including riparian forests) and other Vegetation Types	National Land Cover Database 2016	Updated every five years, low to high intensity developed land; deciduous and evergreen forests
	USDA National Forest Data Sets	A wide range of data but includes land cover, existing vegetation, potential vegetation, invasive plants, hazardous fuels treatment areas
	USFS Forests to Faucets	The USFS Forests to Faucets program maintains data on forest areas in the US that are important for ensuring the quality of drinking water supplies. Also useful information on threats to these forests from wildfire, insects and disease, and development.
	GAP/LANDFIRE National Terrestrial Ecosystems	Vegetation map of the US, with detail on different types of forest/woodland, shrub/woodland, native grasslands, pasture/hay, agricultural crops, developed land
Wetlands (including coastal wetlands)	National Wetlands Inventory (NWI)	Wetlands mappers and data available for download; new data added in 2019; can be downloaded by state and HUC8 watershed
	State and Local Wetlands Inventories	Many states, counties, and municipalities also maintain wetlands inventories and maps, for example the State of Oregon Division of State Lands inventories (https://www.oregon.gov/dsl/ww/Pages/Inventories.aspx) and local wetland mapping by the City of Medford (http://www.ci.medford.or.us/page.asp?navid=3955). These sources will have location, size, and frequently wetland type, as well as some measure of condition or health.
Floodplains	Federal Emergency Management Agency hosts a National Flood Hazard Layer (NFHL)	FEMA maps regulatory flood plains under the National Flood Insurance Program; these include only the areas affected by the 100-year flood and in some areas the 500-year flood, so that these do not capture all floodplains that maybe important as natural assets for utilities. Data on smaller flood frequencies (e.g., 10-year, 25-year) can identify additional floodplain areas that can be important assets. FEMA NHL maps show areas that are subject to inundation at a given frequency but will include many developed areas that would not be mapped as natural assets.
	US Army Corps of Engineers National Levee Database	The national levees database can be used to identify areas where floodplain restoration (e.g., through levee setback) *may* restore beneficial services from floodplains without compromising flood protection.
	Local River Mapping Projects (Puget Sound River History Project)	Reconstruction of historical river landscapes can identify areas where non-regulatory floodplains existed and/or could be restored.
	NWI Wetland Mapper (riparian zones).	The USFWS Wetland Mapper also includes riparian zones; these areas are transitional between wetlands and uplands. Riparian areas along rivers are most often in floodplains; while the amount or duration of inundation is usually less than that of wetlands, riparian areas have hydrologic connections to both surface and groundwater. They can provide short-term storage for high frequency flood events.

(continued)

Table 6-5. Continued.

Asset Type	Example Data Sources	Notes and Considerations
Grasslands	National Land Cover Database 2016 GAP/LANDFIRE National Terrestrial Ecosystems	Updated every five years, low to high intensity developed land; deciduous and evergreen forests The national terrestrial ecosystems project covers the entire US and includes vegetation types, including native grasslands, pasture/hay, agricultural crops (based on the National Vegetation Classification system).
Lakes, Rivers, Streams	USGS National Hydrography Data Sets	USGS detailed maps and data for the national hydrography data set (NHD), the NHDPlus High Resolution data, and the Watershed Boundary data set. Data for a range of waterbody types; including streams, rivers, lakes, ponds, canals, reservoirs.
Aquifer Recharge Zones/Groundwater	USGS Groundwater Data King Co., WA Critical Aquifer Recharge Areas data; EPA guidance on wellhead protection areas	USGS maintains data on principal aquifers of the US, with a focus on water quality in the aquifer and less emphasis on protecting recharge zones. Data at state or local levels may be more likely to contain information on where critical aquifer recharge zones occur. Some local jurisdictions maintain data on areas that are important for protecting groundwater resources, wellhead protection areas, or critical aquifer recharge zones where assets such as forests or natural grasslands can protect recharge volumes and water quality (e.g., Washington State, Edwards Aquifer in TX).
Mountain Snowpack, Glaciers	USGS Data on Glaciers in the US Natural Resources Conservation Service USDA Snow Telemetry Data; NRCS State Snowpack Data (e.g., Colorado); EPA Climate Indicators (Snowpack)	USGS has monitored changes (retreat) in major glaciers in the US (e.g., Glacier National Park). Unlike many of the other natural assets, utilities have really no options for active management, but if glaciers are significant water sources, then they should be monitored to understand how they are changing. Because climate change will affect the services provided to utilities by both glaciers and mountain snowpack, modeling of future glacier and snowpack conditions with regional climate models will help utilities plan for uncertain future conditions (e.g., USGS climate change modeling for the US). The USDA, especially through local NRCS offices maintains data on snowpack conditions. EPA's climate indicators for snowpack shows trends in snowpack conditions across the western US (1955 – 2016).
Multiple Assets	EPA's Enviro Atlas State Natural Heritage Network (NatureServe)Ecoatlas (multiple natural assets, California focus)	National, state, or local agencies have information on multiple natural assets that are of interest to utilities. Local data, such as that compiled for local critical areas or environmentally sensitive areas regulations may be most useful to utilities (e.g., King Co., WA).

CHAPTER 7

Step 3 - Defining Level of Service (LOS) for Natural Assets

What you will find in this chapter

This chapter describes how Levels of Service (LOS) may be defined, measured, and deployed to help utilities manage natural assets and, thereby, help the utility meet its strategic objectives. LOS are statements that describe outputs or outcomes the utility intends to deliver, typically focusing on service characteristics such as quality, reliability, and cost.

For *core business goals*, the guidance recommends that you start with the utility's LOS related to water supply reliability, water quality, cost management, and other related high-level (strategic) objectives. Then consider two questions: (1) how do natural assets affect utility performance in relation to core business goals? (2) What level of service from the asset is required to maintain or improve the utility's performance?

For environmental stewardship goals, consider what LOS will meet community expectations and regulatory requirements.

7.1 Introduction

Defining Levels of Service (LOS) for natural assets is a key step in the AM process (Figure 7-1) LOS are statements that describe the outputs or outcomes the utility intends to deliver to its customers and other stakeholders. LOS focus on characteristics of the service from the customer standpoint, including quality, reliability, sustainability, and costs (IPWEA et al. 2015). LOS can also focus on regulatory requirements. In a fully developed asset management program, the utility will have adopted several LOS statements that serve as the broadest objectives for its asset management decisions.

Examples of LOS for a water utility might include:

- Water supply reliability – provide sufficient water from designated sources for base water demands (i.e., without voluntary or mandatory restrictions) through droughts similar to the drought of record
- Water quality – meet or exceed all federal and state drinking water quality standards 100% of the time
- Distribution system reliability – planned or unplanned outages will be limited to an annual average of no more than 0.5% of customers per month
- Financial - water rates will be affordable for the entire utility customer base

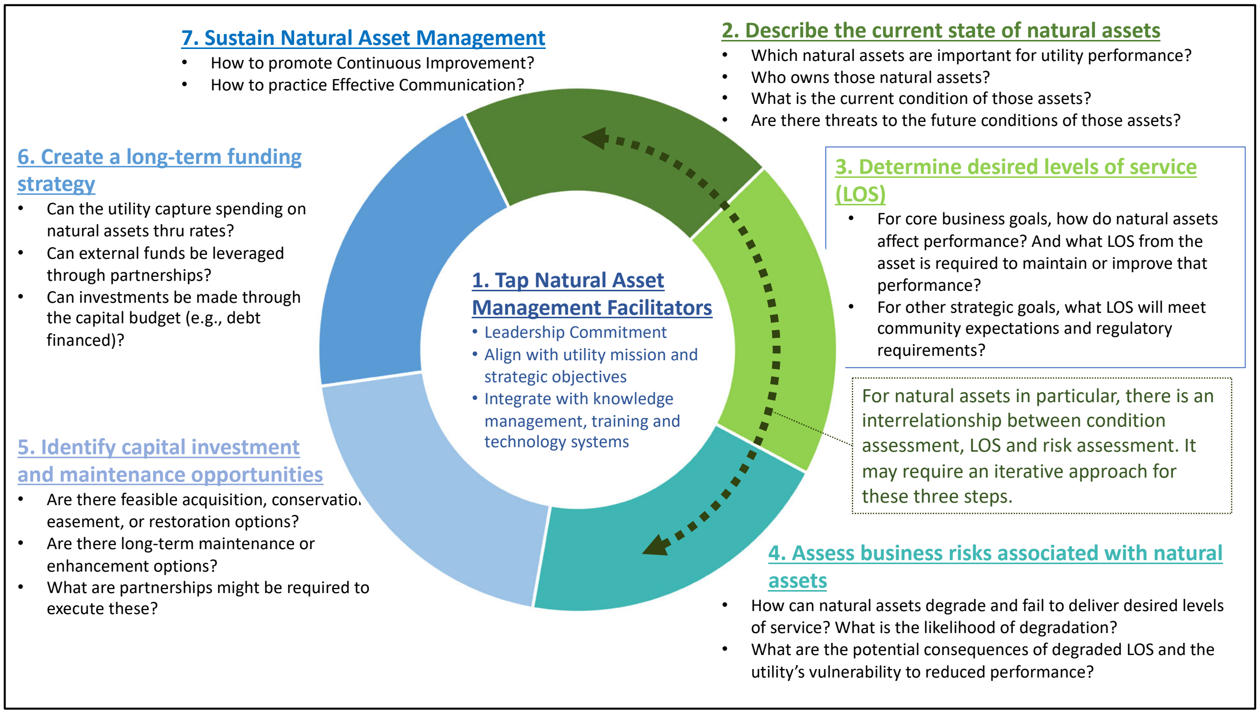

Figure 7-1. Step 3 - Establishing Level of Service Targets for Natural Assets.
Source: Adapted from Campanella et al. 2016.

Utility LOS set the context for managing both built and natural assets. A fundamental point of asset management is that the operation, maintenance and capital investment for a utility's built assets determine how well the utility meets its target levels of service. Likewise, a fundamental point of this guidance is that natural assets also determine how well a utility meets its target levels of service. These LOS need to be developed within the context of the utility's *core business goals*, and also within the context of its additional *environmental stewardship goals*.

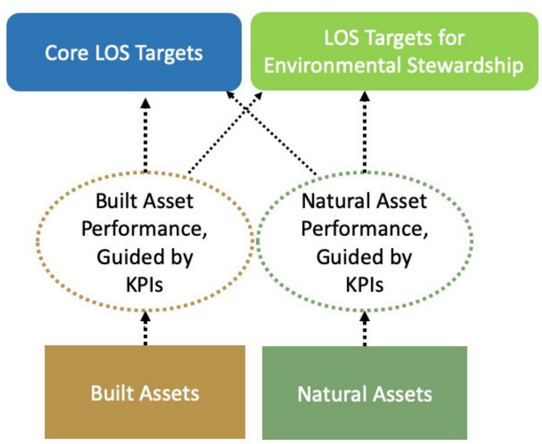

Figure 7-2. Natural Assets Contribute to Core Business Goals and LOS, but May Also Have Broader Environmental Stewardship Goals and LOS.

A utility will have LOS related to its *core business goals*, such as the examples shown above.[8] Natural assets can be managed to support meeting these LOS. This require two steps. First, there must be

[8] It is assumed that most users of this guide already have an asset management program in place and, therefore, will already have LOS related to core business goals; for additional information see IIMM Section 2.2 (IPWEA et al. 2015.)

recognition of how natural assets complement built assets and how performance of natural and built assets contribute to meet targeted levels of service that are focused on outcomes or outputs (see Figure 7-2).

Second, once we understand how natural assets fit into overall performance, we must designate key performance indicators (KPI) that align with the LOS and can serve as a means to measure and regularly adjust performance of the natural asset.

The second type of LOS for natural assets will be related to *environmental stewardship goals*. Examples of LOS related to environmental stewardship include:

- Restore X miles of stream by 2025 to provide healthy habitat for threatened native trout
- Meet minimum instream flow target 99% of the time
- Restore healthy upland forest to 90% of reservoir watershed by 2030

Terminology
*Asset management frameworks differ in some of the terminology used for key concepts in this section. In general, most asset management approaches define level of service similarly: a description of desired service outcomes that customers can expect. To be useful, LOS must shape how assets are managed. To do this, the utility formulates operational or performance objectives for each asset and, in some cases, components. This is where terminology sometimes differs. For this guidance, the term **key performance indicator,** or **KPI,** is used. LOS and KPIs are distinct concepts. LOS are more general and describe customer level outcomes (see examples). They are too general to directly guide operational or management decisions. KPIs are more specific, often quantitative, targets for asset or component performance.*

Managing natural assets is crucial for meeting LOS associated with stewardship goals. There may be overlap in how natural asset management contributes to the purpose of each type of LOS (those for core water supply goals, and those related to stewardship goals).

7.2 Natural Assets and Core Water Supply Levels of Service

Levels of service, which describe specific process objectives in a concrete and relatable manner, are also linked to the organization's primary high-level asset hierarchy and strategic goals. Beginning at the highest level and moving down through every layer of the organization, strategic service level goals have a connection to how each individual process asset performs and produces outcomes. For built assets, at the plant floor level, characteristics of asset performance may be described as key performance indicators, in much finer detail. At that level, activities and outcomes are described, allowing staff to make decisions about operations and maintenance over individual, serialized assets. They ultimately affect achievement of service reported at the highest level.

Using this concept, the first step in building LOS for built assets involves identifying the services which they intend to provide, then the utility can describe how those assets deliver that service. The logical order in which built assets contribute to LOS, and the associated risks of asset failure, are used to develop a utility's asset hierarchy (e.g., per Section 2.4.2 of IIMM) – from large facilities (e.g., the entire distribution system) down to individual components (a pump).[9] Overall, LOS targets shape management, operations and investment decisions down through each level of the hierarchy.

Based on the LOS, the utility sets KPIs for each asset and components of the asset. For example, the City of Portland, OR, established Customer Service strategic service level reliability targets (Jones et al. 2017). It determined 90% of its valves should be properly working in order to provide overall reliable service. It established a valve maintenance program based on that strategic service level with an objective that 90% of valves will be operating and less than 5% of customers will experience a cumulative outage of water for more than 8 hours per year. It translated that objective into a key performance indicator involving the inspection and exercising of all 2000 large valves in its system annually. It then built a hierarchy of assets to include valves in a way to regularly assign work, inspect and document performance of those assets.

The same logic can be applied to natural assets (see Figure 7-3). Using the example of a forested watershed, overall LOS targets are used to establish the expected services for the entire watershed. With the LOS target, an asset hierarchy is established. There will be large, general natural assets (a reservoir's watershed) that can be broken down into sub-assets (e.g., breaking the watershed down into different forest types or areas, stream corridors, and wetlands). Then specific KPIs can be established for discrete elements (assets) that are within the watershed. The utility will need to determine where natural assets fit into its asset hierarchy and how they relate to the high-level service level targets.

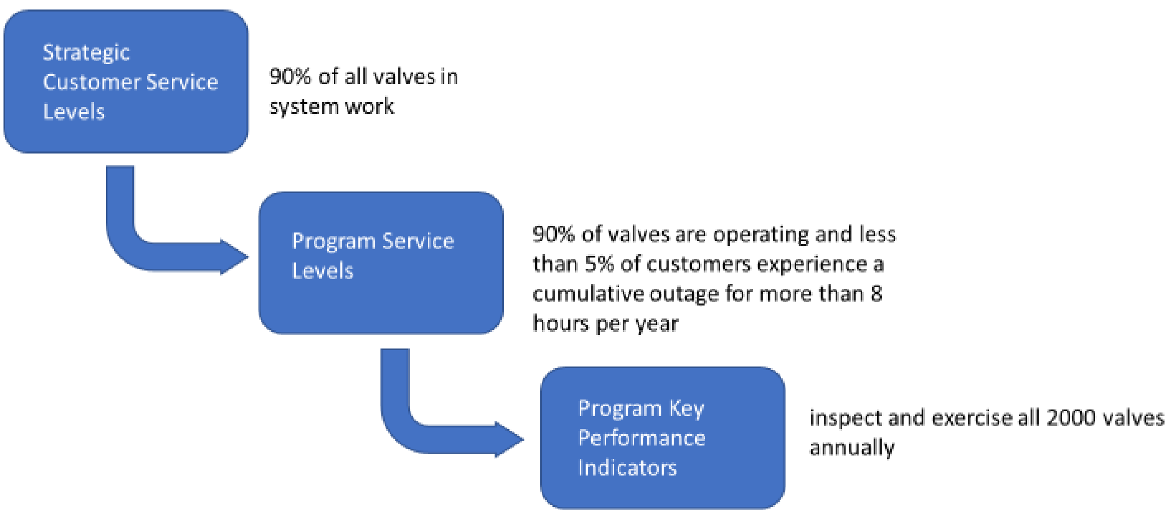

Figure 7-3. An Example of the Relationship between Levels of Service and Key Performance Indicators for Built Assets.

Source: Adapted from Jones et al. 2017.

For example, as part of a utility's overall LOS target to provide reliable water supply through anticipated drought conditions and with anticipated growth in demand, it might set a KPI for one of its reservoirs to minimize annual storage capacity loss due to sedimentation. There are various operational (e.g., optimizing use of different release valves) and maintenance activities (periodic dredging) the utility can

[9] Different sources (IIMM, vs AWWA vs EPA) use different systems of terminology for this. EPA training calls everything a level of service for each level of the hierarchy. IIMM limits that term to the high-level, customer-facing objectives. For lower levels of the hierarchy, IIMM uses terms like "operational objectives" and "technical performance measures." Regardless of terminology, the same basic logic applies.

perform at the dam and reservoir, and they can use the overall LOS target to set performance targets for these activities.

As depicted in Figure 7-4, alongside management of built assets (the brown boxes in Figure 7-4), the utility can identify KPIs for managing natural assets to minimize the amount of sediment coming into the reservoir (the green boxes in the figure). For example, the utility can choose to set KPIs for reducing erosion from recreational trails and to minimize the risk of large wildfires which often result in enormous amounts of erosion and sediment. This ability to meet the LOS target in different ways is at the heart of optimizing asset management.

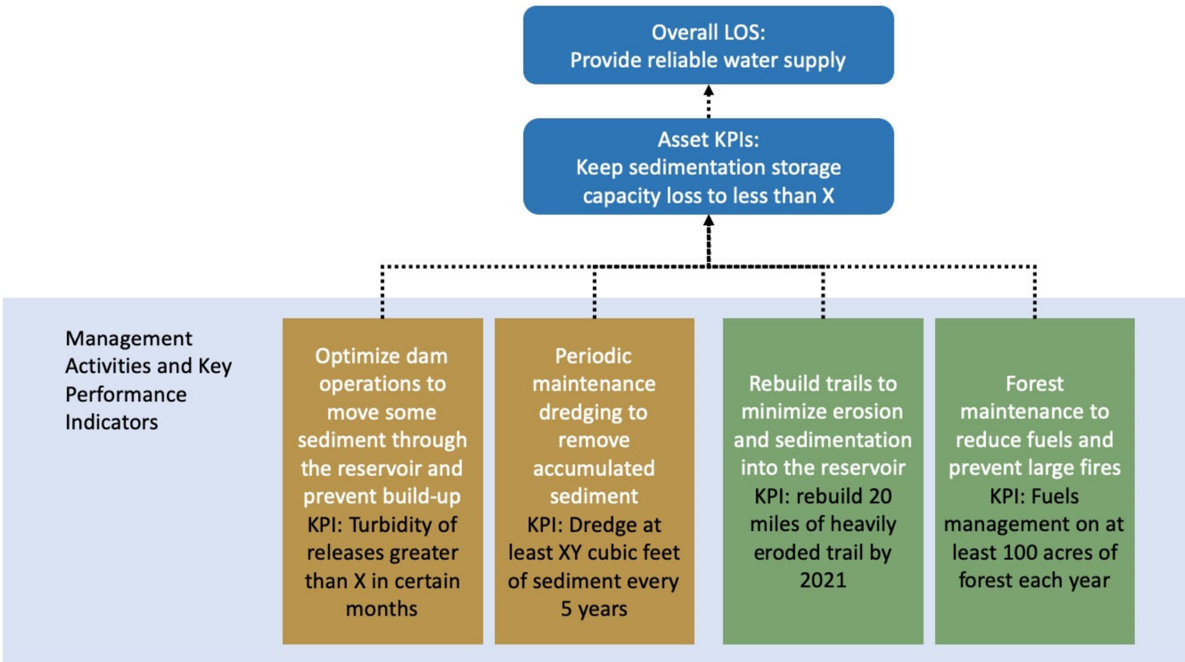

Figure 7-4. Example of Using Overall LOS Targets to Set KPIs for Built and Natural Assets to Minimize Sedimentation in a Reservoir.

7.2.1 Natural Asset Condition, Risks, and Level of Service for Core Business Goals

More so than for most built assets, there is substantial overlap in how we approach natural asset condition, risks of asset failure, and setting LOS targets (Figure 7-5). Many of the concepts and methods we use for built assets are not applicable to natural assets. For example, natural assets generally do not face a remaining useful life nor do we think of them as depreciating over time. Even the concept of *failure* may need to be considered differently for natural assets.

Figure 7-5. LOS, Condition Assessment, and Understanding Business Risk for Natural Assets Are Inter-related and Driven by Overall LOS Targets.

A utility's LOS and KPIs for a natural asset, and its monitoring of the condition of that asset, should be driven by the requirements it understands are needed to satisfy customer and stakeholder needs. The target LOS and associated KPIs will serve as a key in characterizing a natural asset (as the utility places that natural feature within its asset inventory), assessing the asset's condition (per Chapter 5), and determining business risks associated with the asset (Chapter 8). Several questions can help us understand this interaction, see Table 7-1. These questions help you understand the interplay of natural asset condition and future risks so that you can establish a realistic LOS target.

Table 7-1. Questions to Help Frame the Relationship between LOS, KPIs, and Natural Asset Condition for Core Business Goals.

LOS Question	Example for a Forested Watershed
Does the natural asset play a role in meeting LOS targets? What services does it provide?	The forest helps maintain high source water quality by filtering waters reaching the riparian system and the downstream reservoir and by limiting the amount of sediment and other nonpoint source loadings from watershed lands to the receiving waters and reservoir
Does asset degradation threaten these services and make it harder to meet LOS targets? (see Chapter 6 on condition assessment)	60 acres of the forested watershed was recently cleared to build a housing development, which increases impervious surface and may contribute to multiple water quality problems. A large portion of the watershed is crowded with dying trees due to pest infestation, threatening a large wildfire which would lead to large sediment loads
What is the degree of risk from the natural asset failing to provide the required LOS? I.e., what is the relationship between degradation of the natural asset and the utility's ability to cost-effectively meet LOS targets?	If/when more development occurs, there is a high likelihood source water quality will decline. If the source quality declines to X, the current treatment process will no longer function creating a treatment failure. The cumulative effect of these impacts is Y. Based on this assessment, we anticipate the Business risk to the utility has increased to Z. Continued degradation of forest health due to pest infestation increases the likelihood of a major fire. The consequences of this would include dramatic increase in sediment for 1-3 years after the fire. The increased sediment would increase treatment costs and threaten storage capacity. The cumulative effect of such an asset failure is ZZ. We categorize this as increasing business risk to the utility to a level of A.

(continued)

Table 7-1. Continued.

LOS Question	Example for a Forested Watershed
What are the drivers of degradation that the utility could potentially control or influence?	For private landowners, the forest no longer generates income from logging, grazing or other uses, so there is pressure to sell the land for development. The density of mature trees in many parts of the forest enable rapid spread of the pine beetle infestation, which leaves behind a high density of dead trees that are highly conducive to intense wildfire.
Given the current condition and potential future degradation, what KPIs should the utility set from this natural asset to meet the customer water quality LOS.	Maintain at least 60% of the watershed as healthy forest. Activities such as conservation or restoration activities may be considered to manage business risk exposure to a level consistent with the risk management policy of the organization. Specific activities to undertake must be considered in accordance with the utility's procedures such as business case analysis and prioritization of resources that address all utility risks.

Accordingly, an iterative process is recommended that is centered around the utility's most general LOS:

1. Document and describe the natural asset for placement in the asset inventory (Chapter 6)
2. Characterize the natural asset's current condition in the asset inventory (Chapter 6)
3. Assess the asset's value to the organization in achieving utility strategic outcomes (Chapter6)
4. Building from the utility's LOS, establish KPIs for the natural asset that are linked with the LOS
5. Conduct an analysis of risk of natural asset degradation and resulting failure(s) to meet KPIs and, as a result, risk of failing to meet LOS (Chapter 8)
6. Consider possible utility actions to maintain or enhance the KPIs (under and future current conditions; Chapter 9)

Using the example of a forested watershed and its impacts on source water quality, for asset inventory and condition assessment purposes, the key is to define the assets and asset attributes that are best associated with the desired impacts on source water quality. This LOS-oriented asset information may include the acreages that are in conservation easements or another land use category, and a relevant characterization of the features that impact the forest's filtering and erosion control potential.

For LOS associated with core business goals, this does *not* necessarily require a detailed forestry assessment of the mixes of vegetation by age, tree types and diameters, timbering potential, an inventory of the fauna inhabiting the area, and so forth. In addition, the notion of risk management also comes into play in the iterative approach, because it is the risk of impairment of the natural asset to provide the functions needed to meet service level commitments to customers that needs to be recognized and managed.

7.3 Levels of Service for Environmental Stewardship Goals

For built assets, the services provided to the utility in support of its core business goals are likely to be the only values that are relevant. For example, a water main in good condition provides a valuable service to the utility by enabling the utility to fulfill its mission of reliably delivering water to its customers. The served public and businesses may appreciate the service reliability the main provides, but they do not assign any appreciable value to the pipe beyond its role in providing a core utility-provided service.

With natural assets, however, there often are valuable services to the broader community that extend well beyond the LOS associated with the utility's core business goals. For example, stewardship services and values may arise in the following context:

- A forested watershed area provides water quality services that are of direct relevance for the water utility and its core business functions. These utility-specific services include contributions to the quantity and quality of source waters.
- That same forested watershed is also likely to provide highly valuable services to members of the broader community, such as providing recreational hiking opportunities, habitat for wildlife, and aesthetic values in the form of a forested viewshed.
- Additional third parties may also have an interest in preserving the quality of a natural asset. For example, if the watershed serves as critical habitat for a threatened or endangered species, then the US Fish and Wildlife Service will have oversight of how the landowners and users treat and preserve that area, under the Endangered Species Act.

These external/stewardship values to the broader community and other relevant parties are important to consider, especially if they are a focus of a utility's strategic objectives. The importance of these broader values will vary across communities – i.e., in one community, the ecosystem stewardship values associated with a well-managed forested watershed may be high, whereas in another service area the external values may be low, reflecting the value-system of the local population. When services associated with a natural asset are highly valued by the community or important partner agencies or organizations, the utility may opt to establish formal LOS targets to reflect these values. In some cases, a utility may have strategic level business goals related to environmental stewardship (see example for Seattle Public Utilities in the text box below), in which natural assets (watersheds) play a role in water supply & water quality but also serve other purposes critical to the community, regulators, and/or other important external entities. These overlapping considerations will then require service levels that meet multiple objectives to guide how the utility manages natural assets to meet those goals. It is important to note that in an economically regulated environment, the governing body with jurisdiction over rates may view the expenditure of funds for such external activities as being something beyond what is necessary for provision of water service and, thus, outside of what the utility may recover in its rate-based revenues from customers.

Seattle Public Utilities (SPU) considers protection of water quality for public health and avoided treatment cost as the most important element of its watershed protection program. Preservation of watershed ecology is also important to SPU because its rate-payer constituency highly favors forest and environmental protection and enhancement. Climate change is a considerable additional concern, and implications for forest health and resiliency in warming conditions are the subject of SPU strategic planning and programs in the watershed. SPU ratepayers also decided, in 1999, to support prohibition for eternity of all commercial timber harvest in the watershed. This decision included protection of ecosystem services beyond water supply, even if not explicitly described as such to SPU customers and elected leaders. Therefore, the utility expends resources on the protection and enhancement of a large array of complex ecological processes/functions across the 93,000-acre Cedar River watershed basin it owns, beyond those services directly linked to water supply.

For environmental stewardship goals, LOS will target conditions that approximate the natural condition and processes of the ecosystem. Establishing LOS and associated KPIs for environmental stewardship goals will likely be driven by methods and concepts from applicable portions of ecologic and ecosystem restoration science. For example, a LOS related to critical fishery habitat may refer to minimum levels of instream flows and/or instream water temperatures.

7.4 Conclusions

Levels of Service (LOS) are defined, measured, and deployed to help utilities manage natural assets and, thereby, meet the utility's strategic objectives. LOS are statements that describe outputs or outcomes the utility intends to deliver, focusing on service characteristics such as quality, reliability, and cost.

The same basic approach to developing and applying LOS applies across both built and natural assets. The first step is to establish LOS targets tied to specific outcomes or outputs. The second step is to define metrics—Key Performance Indicators (KPIs)—for activities that contribute to achieving the LOS targets. It also may be useful to distinguish between LOS targets that support *core business objectives* (e.g., reliably and cost-effectively providing high quality water), and those that support *ancillary utility objectives* (e.g., enhancing environmental stewardship).

Defining suitable LOS targets can be challenging for natural assets, but it is essential for (1) establishing what is needed or expected from natural assets to compare against current conditions, (2) understanding the risk to the utility from potential changes in asset condition, and (3) establishing which types and levels of utility investment (capital or operating) are required to preserve or enhance asset conditions that, in turn, support the utility's broader efforts to meet its overarching mission and strategic objectives.

CHAPTER 8

Step 4 - Assessing and Managing Business Risks Associated with Natural Assets

What you will find in this chapter

This chapter covers concepts and approaches for thinking about how natural assets degrade and affect business risk. We use a standard definition of risk as the product of the likelihood of asset failure and the consequences of failure.

Describing the likelihood and consequences of natural asset failure can be quite complex and fraught with uncertainty. The chapter presents tools and examples for describing likelihood and consequences in categorical or qualitative terms. This allows for the development of a risk profile matrix, similar to what often is done for built assets.

The matrix enables overall risk to be characterized as a categorical risk rating, which can be used to support decisions about risk mitigation actions. And, where data are available, there are opportunities and approaches for more quantitative assessments of probabilities and monetized values for the consequences of failure.

8.1 Overview

A primary objective of asset management is to implement risk-informed decision-making in support of meeting a utility's strategic goals about service to its customers. As with built assets, natural assets can degrade and fail to meet their LOS targets. When any key asset fails to meet its LOS targets, there are implications for the utility's ability to meet its desired level of performance. This chapter focuses on assessing risks to natural assets and the LOS they provide (i.e., risk assessment), and for prioritizing these risks and considering utility options to reduce priority risks (i.e., risk mitigation).

To understand the risks associated with the degradation of natural assets, it is important to first identify the services they provide (described in detail in Chapter 6). Next, the utility needs to assess how those asset-provided services support LOS, and how associated KPIs may be established to attain those LOS targets (per Chapter 7). Then, the utility must understand the ways in which those assets could degrade and fail to provide the types and levels of services desired by the utility, and then consider its options to mitigate those risks. This sequence of steps leading up to and including risk assessment and risk mitigation are shown in Figure 8-1.

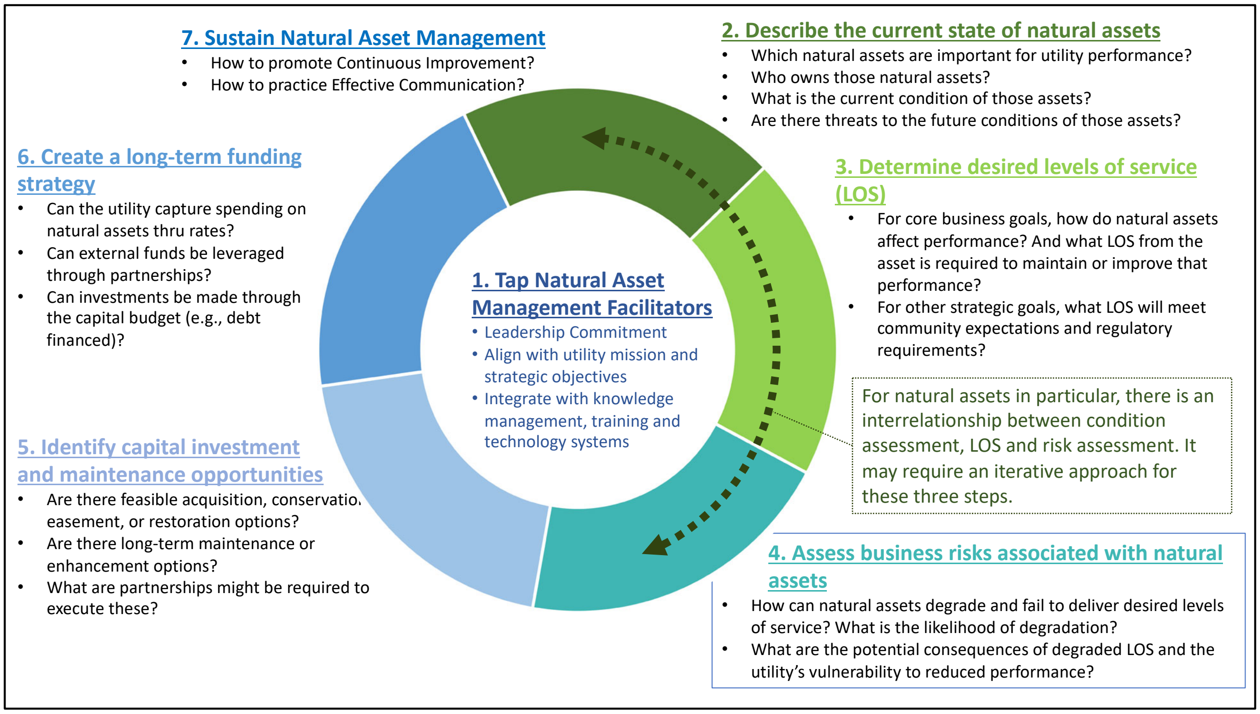

Figure 8-1. Assessing Business Risks as Step 4 Along the AM Wheel for Natural Assets.
Source: Adapted from Campanella et al. 2016.

The term "risk" is defined here in the standard manner, as the *probability* (or likelihood) of an adverse event occurring, multiplied by the *consequences* that would arise if the event were to occur. There are many factors or forces that can lead to natural asset degradation and its associated risks (Section 8.2). Once potential drivers of degradation have been identified, the next step is to assess the probability of degradation, the associated likelihood of failing to deliver target LOS, and the consequences of that failure (Section 8.3).

The consequences (impact) and probability (likelihood) of the failure should be assessed in the context of the overall utility risk profile, so that the assessment of risk from natural asset failures is placed on a comparable basis with risk assessments associated with built assets. Once that has been done, the final step is to develop and deploy the appropriate risk response mechanisms to mitigate the likelihood and/or adverse consequences of those risks (Section 8.4).

Assessing the *likelihood* of failure for natural assets can be challenging, because natural systems are complex and dynamic, and sufficient data about the system may not be available. The same may be true for assessing the *consequences* of potential failure of natural assets. Nevertheless, effectively managing natural assets requires a characterization of the degree of risk that is comparable to risk from built assets. There are ways to deal with uncertainty in likelihood and consequence of failure while maintaining an approach that is consistent with risk assessment for built assets Figure 8-2 describes a Foundation project exploring how risk management may be applied in the context of risks to source waters.

WRF Project 4748: ***A Risk Management Framework for Managing Source Water Risk*** (Raucher et al. 2020) provides a source water risk management (SWRM) framework that is well-suited to natural assets. The approach focusses on watershed-related risks, and it includes approaches to deal with uncertainties inevitably arising from data gaps or lack of other relevant information.

For this chapter, covering Step 4 of the AM framework for natural assets, the text addresses several elements that are similar to the approach deployed in the WRF 4748 SWRM framework and guidance, and that can be found in other risk management frameworks. The SWRM approach, as well as the risk management approach developed in this guidance, describe a process that includes:

1. Identifying natural or human-caused hazards that can degrade natural assets;
2. Characterizing (assessing) the risks associated with natural assets;
3. Prioritizing risks to help focus utility efforts on the largest risks;
4. Identifying options that mitigate (reduce) the priority risk(s);
5. Evaluating the risk mitigation options so that the most effective and suitable risk reduction approach(es) can be identified;
6. Developing the business case to secure the utility (and/or external) resources needed to implement the selected risk mitigation option(s);
7. Implementing the selected risk mitigation option(s); and
8. Monitoring the performance of the risk mitigation and adjusting as necessary as part of a process of continuous improvement.

Figure 8-2. A Source Water-Oriented Risk Management Framework for Natural Assets.

In addition, this chapter includes ways to describe risk using qualitative methods, as is especially useful in the reconnaissance phase of the AM approach. Applying subjective assessments of probability and/or consequences of natural asset risks is also essential where inevitable data gaps render more empirically driven risk assessments impractical or infeasible. Through a continuous improvement effort, subsequent iterations of risk assessment will help to reduce subjectivity and reduce uncertainty in the results.

8.2 Natural Asset Hazards: Degradation and Failure

There are numerous ways that natural or human-caused hazards can degrade natural assets and lead to a failure to meet target LOSs. The Appendix A provides a table of natural asset types and the services they provide to utilities. A useful way to think about natural hazard degradation and failure is to consider how natural and human-caused hazards can disrupt those services. Table 8-1 shows a sample from Appendix A and adds descriptions of how the selected natural assets might fail to provide these services. Once the utility has developed a registry of natural assets and prioritized one or more assets for management, the table in Appendix A can be used to structure an assessment of ways assets can degrade and potentially fail to deliver desired services.

Table 8-1. Examples of Threats to Natural Asset Services.

Hydrological Service to Utility	Natural Asset Type	
	Aquifers and Aquifer Recharge Zones	**Mountain Snowpack, Glaciers**
Hydrological Service to Utility: Maintain dry season flows / dry season supply	Aquifers that are connected to surface waters (e.g., floodplain aquifers, springs in headwaters to streams) can augment dry season flows as groundwater is discharged to streams or rivers.	By slowly releasing water stored in snowpack and glaciers during spring and summer, mountain snowpack and glaciers contribute significantly to maintaining dry season flow.
Examples of potential degradation and Failure to provide target Levels of Service	Declining aquifer levels driven by reduced natural recharge due to human uses of recharge zones, including urban or industrial development. Over-pumping (e.g., due to unregulated well development and use) can also deplete aquifer levels and discharge to streams.	Increasing temperatures due to climate change can reduce annual snowpack or increase long-term melting of glaciers. Deposition of dust or other pollutants on glaciers can accelerate melting due to increase absorption of solar radiation.

While the same overarching risk management framework applies to all assets, there are some specific challenges and opportunities associated with applying the framework to natural assets, including considerations related to the different types and degrees of failure that may apply:

- For natural assets, the concept of asset failure often differs from that of built systems. For example, a water main may fail by bursting, resulting in a clear impact on service and a fairly well defined and implementable risk response (pipe repair or replacement). In contrast, most natural assets may *degrade* rather than completely fail, such as when development in a watershed increases nonpoint source pollutant loadings to source waters. In such cases, the risk is more challenging to quantify, and may emerge gradually over time (and the risk mitigation options more complex to implement).
- For natural assets, it may be more challenging to develop a data-driven, empirical risk assessment of probability and consequence levels. There are several reasons.
  - First, data on the likelihood and impacts of relevant hazards may not be readily available.
  - Second, collecting such data may require expertise that is outside the typical knowledge of a water utility (e.g., forestry, geomorphology).
  - Third, the hazards are relatively infrequent yet potentially high consequence events—such as a wildfire, earthquake, tornado, or hurricane—making it difficult to come up with reliable probability estimates.
  - Further, climate change and continued development pressures are changing the likelihood, frequency, and severity of many of these risk events.

  In contrast, utilities have considerable first-hand experience and decades of their own data on their built systems (e.g., the number of breaks per mile associated with a given vintage and pipe material for its distribution system).
- Built assets typically have a well-defined, finite life, and can be readily replaced or repaired as a risk management strategy (e.g., a pipe segment with escalating levels of breaks per mile per year). In contrast, natural assets typically have an indeterminant lifetime (e.g., a forest, absent development), and often appreciate in value rather than depreciate, and cannot be readily replaced if lost to a risk event. Hence the nature of the risk, and of the options available to manage that risk, are more challenging for natural assets.

When considering the wide range of possible services from natural assets and the hazards that may degrade these services, there are several key themes upon which to focus:

- Focus (especially in reconnaissance implementation) on core utility services provided by natural assets, including water supply, flood mitigation, and maintaining water quality.
- Consider the location of key natural assets relative raw water intakes, reservoirs, treatment plants, or other major facilities, as well as the locations relative to key regulatory requirements, such as stream reaches with minimum in-stream flow requirements (i.e., focus on those natural assets that may impose the greatest consequences of failure, CoF). These will likely include those deemed critical assets to the utility.
- Focus on natural assets that face major potential disruptions due to human activity, including new urban or industrial development or resource extraction.

Other considerations especially important when including natural assets pertain to recognizing the manner in which natural assets may fail:

- Utilities often experience failure of built systems in episodic and catastrophic ways (e.g., a water transmission main rupture suddenly and extensively disrupts service).

- While the same can be true for natural assets (e.g., a high-intensity forest fire may result in a catastrophic failure of the watershed to deliver high quality, low turbidity source waters), it is also possible that natural asset degradation happens over a long period of time. Examples include the gradual loss of erosion control and source water quality protection as watershed areas undergo development and/or suffer from adverse impacts on forest ecosystem functions due to climate change or invasive species.
- As a result, the tipping point at which a natural asset fails to provide the desired service level to a utility may be difficult to recognize.
- Therefore, recurring inventories and assessments of natural asset conditions are of significant importance, so that adverse trends in LOS, and the potential for reaching a key failure-related tipping point, can be discerned and addressed proactively.

8.3 Risk Assessment: Determining Risk of Failure for Natural Assets

Risk assessment of natural asset failures is a key step that should be performed as part of a utility asset management program (as shown in the framework outlined in Chapter 3 and shown in Figure 8-1). Risk assessment entails evaluating the probability of failure and consequences of failure, such that an overall risk profile is established. Risk for natural assets is characterized as it is for other asset classes, as the product of probability and consequence of failure. Putting natural asset business risks on par with other utility business risks should be a component of developing an integrated utility-wide risk mitigation strategy, as part of a unified asset management program at a water utility.

8.3.1 Likelihood of Natural Asset Failure

Natural asset risk assessment must employ a process to establish the likelihood of failure of a natural asset to meet its target LOS. This may include estimating the likelihood of specific hazard events that impact natural assets, the susceptibility or vulnerability of natural assets to damage or disruption given the hazards, and temporal issues related to capacity.

The likelihood of some natural hazards are reasonably well-established in existing datasets and studies. For example, existing climatic and hydrologic records and studies provide reliable estimates of the likelihood of large floods based on documented past events. Climate change is altering the frequency and magnitude of several of these risks, adding a layer of uncertainty. Nonetheless, a utility can develop scenarios for the plausible future frequencies and magnitudes of future floods, droughts, and other events that impact key service flows from natural assets.

Some events may be harder to predict the likelihood, such as man-made hazards (e.g., arson, the introduction of disruptive invasive species) and uncommon natural processes, such as the explosion of native pine beetles in Western forests over the last decade.

When data are available, assessing likelihood can involve desktop studies using computer models or other algorithms that have been developed to mimic natural physical processes. When detailed data are lacking, a utility can rely upon estimates of the condition of natural assets and, in some cases, this may be bolstered by actual condition assessment to serve as a surrogate measure of likelihood of natural asset failure (see Appendix B for examples). In the absence of a model, algorithm or actual condition data, expert judgement will be needed to develop estimates of probability of failure.

Likelihood can be characterized in qualitative or categorical terms. A likelihood value for a failed built asset (e.g., a water main) expressed in terms of a probability must be comparable with a similar assessment of the probability of failure of a natural asset to provide its desired service level. This requires the utility to make informed judgements as to the likelihood of a failure across all types of assets. There are no industry standards to apply to this, so fundamentally this is a user estimate, often requiring subjective judgements in the absence of applicable empirical data.

One example of a corporate-level likelihood of failure approach is illustrated in Table 8-2. Assets undergoing a risk assessment are categorized as having one of four degrees of subjective likelihood of occurrence, from highly unlikely to very likely.

Table 8-2. Example of a Corporate Level Likelihood Matrix.
Source: Courtesy of anonymous water utility.

Likelihood Descriptions	
Levels	**Descriptions**
Very likely	The even could happen at any time (>90%) A strong probability of multiple occurrences within a 12-month period.
Likely	The event could happen sometime (50% - 90%) Will probably occur at some time within a 12-month period.
Unlikely	The event could happen but very rarely (10% - 50%) Might occur at some time in a 12-month period.
Very Unlikely	The event could happen but probably never will (<10%) Unlikely to occur within a 12-month period.

Proxy measures can be developed to help characterize the vulnerability or susceptibility of natural assets to degradation or failure that would impact a utility-desired LOS. For example, factors that contribute to the potential for nonpoint source erosion to adversely impact source water quality – such as type and extent of development, slope, and proximity to water body – may be applied to rank which land areas within the watershed may be most directly associated with risks to source water quality. Figure 8-3 provides an example illustrating how data on natural asset condition and potential threats can be used as proxies for likelihood assessment. For additional, more in-depth examples, the reader is referred to examples illustrated in Appendix B.

The Albuquerque Bernalillo County Water Utility Authority used multiple source water assessments as data to support creation of its Rivers and Aquifer Protection Plan (ABCUWA, 2018). The results of source water assessments produced rankings that express the susceptibility of ABCWUA supplies.

Susceptibility rankings for a source water protection area provide the ABCWUA a qualitative method for identifying priorities based on vulnerability and sensitivity of sources. Results are used to inform investment decisions and other action regarding all forms of assets (natural and built) to protect the drinking water supply for future generations. Specific actions are intended to meet the ABCWUA goal of reducing moderately high surface water susceptibility rankings and maintaining moderately low susceptibility rankings. Actions are aimed to decrease “high” and “moderately high” susceptibility rankings, and maintain “low” and “moderately low” susceptibility rankings for groundwater sources.

Utilities interested in reviewing the detailed procedures applied in developing susceptibility rankings may access details at: *http://abcwua.org/uploads/files/Your%20Drinking%20Water/RAPP_vDRAFTFINAL.pdf*

Figure 8-3. Assessing Source Water Susceptibility.

8.3.2 Consequences of Natural Asset Failure

Estimating consequences of natural asset failure is similarly challenging. The relationship between hazard events that affect natural assets, and the consequences for utility business goals, can be highly uncertain. This uncertainty arises from the complexity of the underlying physical, hydrological and ecological processes.

The first step is to describe the types of potential consequences, and this may come directly from the utility's information about the types of service the natural assets provide. For example, if a wetland near a treatment plant helps attenuate some flood events, then the consequences of wetland deterioration would probably include increased flood impacts.

As with likelihood estimation, detailed data and models may help in predicting the consequence of natural asset failure. For example, watershed (e.g., SWAT) and/or hydraulic (e.g., HEC-RAS) models can be used to quantify the effects of a fire on erosion and water quality in an affected source water river.

If such data and models are not available, there are simpler, more qualitative approaches. Some of the same tools and data about natural asset conditions (e.g., see Figure 8-4) can be used as proxies for consequence estimation. Well defined levels of service and consequence characterization tools developed for built assets may be a good starting point to complete a consequence assessment (including unitization approaches described in text box below).

The ABCWUA experience (see example provided previously, in Figure 8-3) serves as an excellent example of the application of mandated source water assessments to inform decision making. And, developing a prioritization scheme to make decisions on which natural asset ecosystem functions to preserve forests or undeveloped lands is also useful for decision making.

Integrating these types of analysis with similar efforts to prioritize asset management decision making for built assets requires an additional step, however. The additional step is to compare results of the source water assessment or an analysis of land preservation within a risk framework applicable for all assets. The actions contemplated to address source water assessment issues or prioritize lands for preservation are then able to be considered on a comparable basis with business risk exposure associated with built assets.

Application of this concept may be found through Water Research Foundation efforts (WRF project 4656, Vause and Helgeson 2019). In evaluating risk of asset failure, Vause and Helgeson discuss how to produce a utility-specific method of defining risk in a manner that allows comparability between risk assessments when the assessments are prepared differently. It involves developing tools to "unitize" both likelihood and consequence of asset failures so risk can be compared on an equal footing.

In the event system wide discrete unitization is not feasible, a comparable units method can be used instead. The underlying concept behind this approach is the ability to define in units of a common measure degrees of consequence to a utility based on factors uniquely important to the utility. The method described in The Water Research Foundation project 4656 report titled *Integrating Master Planning and Condition Assessment: A Road Map* is used to quantify failure consequences in a manner that unitizes consequences between asset types. A consequence rating detailing the consequences of a particular built asset failure becomes comparable with a consequence rating given for failure of a natural asset. The concept is illustrated in Figure 8-5.

Figure 8-4. Describing Consequences of Failure When Detailed Data Are Not Available.

Consequence Assessment	Health and Safety of Public and Employees		Direct Financial Impact		Public Image & Confidence	Regulatory Compliance	Service Delivery	Environmental Impact	3rd Party Loss/Liability
	Safety (Employee & Public)	Public Health	One Time Event Costs	Recurring Operating					
5 – Extreme	Fatality, amputation of limb, person on life support, other immediately life threatening incidents, widespread serious injuries or illnesses	Widespread illness and/or fatalities	>250K Incident impact	> 20K Annual Impact	Widespread loss of community confidence in govt, sustained adverse large-scale media	Significant compliance breach - may result in operating license sanction and/or high impact prosecution.	Complete Disruption to services > 1week and affecting > 30% of customers	Large Scale, Irreversable, uncontained harm to environment	>50K Incident impact
4 – High	A serious injury or long term illness or lost time injury (minimum 1 day lost per injury)	Serious illness requiring hospitalization	100K-250K Incident impact	10K - 20K Annual Impact	Considerable community concern, adverse local media	Compliance breach - may result in severe enforcement action, regulatory sanction or prosecution	Partial disruption > 2 days, affecting 10-30% of customers in system	Large Scale, Long-term (>2 years), uncontained harm to the environment	25K-50K Incident impact
3 – Medium-High	Significant near miss incident, injury or illness requiring medical treatment	Deterioration in water quality parameters, reportable event, increase in illnesses	50K-100K Incident impact	5 - 10K Annual Impact	Some public concern raised, local media concern	Compliance breach - may result in ministerial corrective action or business requirement, Possible fine	5-10% of customers affected, significant increase in # of complaints	Small Scale, Medium Term (1-2 years), uncontained harm to the environment. Eg small fire on utility property that damages adjoining protected wilderness	10K-25K Incident impact
2 – Medium	Illness or injury requiring first aid Eg. Minor burns, abrasions, strains	Deterioration in water quality parameters, reportable event, no increase in illnesses	25K-50K Incident impact	3K - 5K Annual Impact	Minor public concern	Compliance breach - may result in minor corrective action or business requirement	Multiple customer complaints	Short-term (<1 year), reversible, contained harm to the environment. Eg damage to a heritage building	10K-20K Incident impact
1 – Low	Near misses/accidents	Non-reportable event	<25K Incident impact	< 3K Annual Impact	Minimal public concern	Technical compliance breach with limited material impact	Isolated customer complaints	Temporary reversible environmental degradation eg industrial noise emissions at night.	<10K Incident impact

Figure 8-5. Consequence Factors Example for Use in Risk Assessments Including Natural and Built Assets.

Figure 8-5 shows an example of producing a consistent measure of consequences of various failures—regardless of whether the failure be one of a built asset or a natural asset—to provide the desired service level to a utility. In this example, consequence ratings range from 1 to 5, with 1 being a "low consequence" and 5 being "extreme consequence." The matrix includes consequence factors that are important to the utility. For each consequence rating, a general description of degree of impact is assigned. These descriptions reflect different degrees of economic, social or environmental impact from asset failure.

Each consequence factor is generic so that it can describe the impact from an asset failure whether the asset is a built or natural asset. This allows each asset type to be considered for its impact in a common way. Scoring impact by this method allows utility planners to assess whether the impact from a degraded natural asset renders the same degree of impact to the utility as a degraded built asset function. To build a matrix specific to a particular utility, the reader is referred to Vause and Helgeson (2019).

To map source water assessments or another type of natural asset issue to this comparable units consequence approach, a utility is encouraged to apply a pairwise comparison process to establish an approach that defines the relative importance of the consequence factors. This will allow the matrix to be useful for all risks.

If a utility has advanced to the point where it monetizes consequence of failure, be it from a natural asset function or a built asset, then the process of monetizing consequence of failure suffices and this approach will be reflected in its risk assessments. However, if the utility has not yet advanced to the point where monetization is part of its risk assessment procedures, the comparable units approach provides an alternative method to enable comparability between asset classes. Guidance on how a utility can monetize consequence of failure is offered in *Managing infrastructure Risk: The Consequence of Failure for Buried Assets* (Raucher et al. 2017). Note that while it is desirable to use dollars (or another common metric) to assess the consequences of failure for all assets, it can be a challenging exercise to structure and complete, especially where important impacts include hard-to-value nonmarket outcomes such as ecosystem disruptions.

8.3.3 Combining Likelihood and Consequence in a Risk Profile Matrix

Results from using the approaches and tools described above can be combined to create a risk profile matrix (Figure 8-6) much like is often done for built assets. A risk matrix outlines both the estimated probability and consequence of natural asset degradation and failure, often in categorical or qualitative terms, and helps create an overall risk score or rating. Putting such risk assessments on par with risk assessments of other asset classes will result in a utility-wide comparable risk profile. This allows for direct comparison of risk between events associated with natural assets and built assets.

	Very Likely	Likely	Unlikely	Very Unlikely
Catastrophic	1	1	2	3
Severe	1	2	3	4
Moderate	2	3	4	5
Minor	3	4	5	6
Insignificant	4	5	6	6

Figure 8-6. Example Corporate Level Risk Matrix.
Risk Assessments of various types are to be estimated using common likelihood and consequence factors.
Source: Courtesy of anonymous water utility.

In the example portrayed in Figure 8-6, there are four categories of likelihood, and five consequence levels. However, it is also possible to have more or fewer categories of both likelihood and consequence, provided there is consistent application of the same factors for risk assessments of different asset types. Mapping source water assessments or land preservation prioritization schemes to a unitized risk framework are two situations where utilities need to generate comparability in assessing different business risks so that different risks can be judged on a consistent basis.

As noted earlier, likelihood and consequence estimation for natural assets can be highly uncertain (and, in many cases, this is true for built assets as well). In Raucher et al. (2020), uncertainty in likelihood and consequence assessments is described directly on the risk matrix. In this case, a natural asset's risk is charted on the matrix with an oval, with the width and height proportional to the degree of uncertainty (including elongated ovals that reflect whether the uncertainty is predominantly along the consequence (vertical) dimension, or the likelihood dimension (horizontal axis). The degree of uncertainty can be based on modeling or other analytics, or it can be based on expert judgement. Figure 8-7 shows an example.

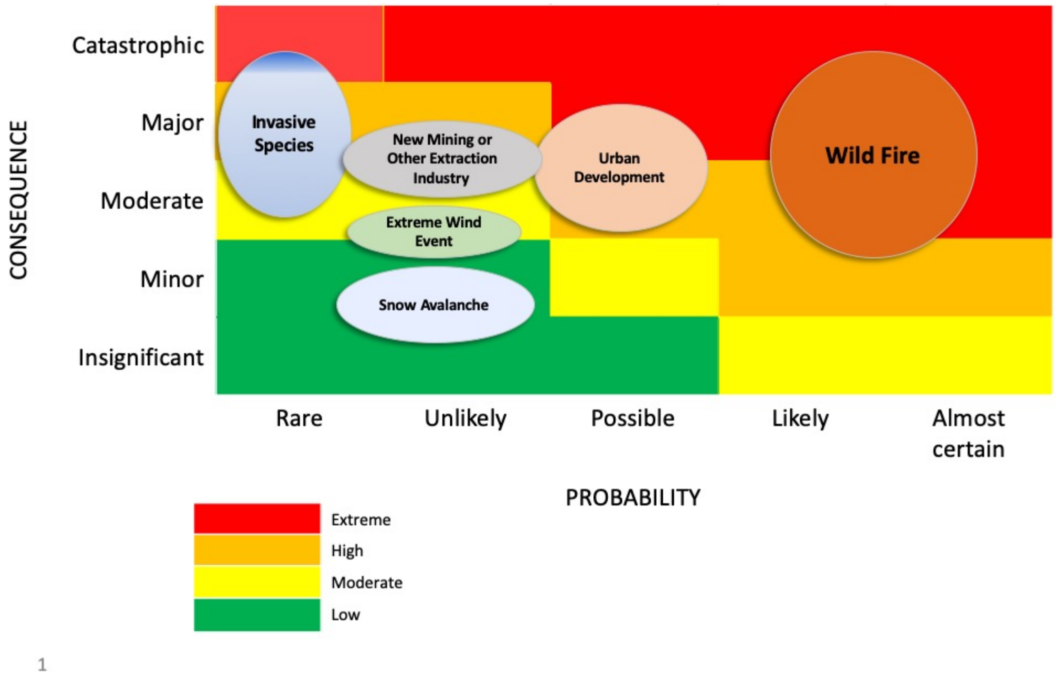

Figure 8-7. Example of a Risk Matrix Reflecting Uncertainty in Likelihood and Consequence Ratings.

8.4 Factoring Risk into Policy and Mitigation Strategies

Using a corporate or utility-wide risk framework to develop actionable policy is the next step for utility decision making. Policy sets the direction and sets the conditions by which mitigation options are explored.

Whether asset failures are from natural or built assets, the risk framework serves as the starting point. A risk response plan anchored by utility policy is then developed to specify levels of risk tolerance. Risks judged to be intolerable are to be mitigated in accordance with the utility's risk policy. Risk policies are unique to each utility and depend upon numerous local factors. To illustrate, making reference to the example corporate level unitized risk matrix in Figure 8-6, risks are assigned a value 1-6, with 1 being the greatest risk, 6 being the least risk. For each degree of risk estimated, the risk response plan identifies what action, if any, asset managers should take to manage such risk.

A risk response plan will typically specify the type of management action necessary and timeline for action. It will also specify whom within the organization is responsible for risk mitigation. This is independent of whether actions relate to natural or built assets. Table 8-3 illustrates one example risk response plan.

In developing a risk response plan, the utility should also set policy with respect to the types of mitigation measures asset managers should take in dealing with risk. The risk response plan may dictate mitigation is to be accomplished through cost-effective measures, meaning that the expenses and/or investments made must not exceed the liability associated with the risk. The risk response plan may also stipulate that certain overall corporate strategic goals must be achieved through mitigation without regard to cost-effectiveness of a specific intervention. The risk response plan is utility-specific, and it should reflect the overall strategic challenges the utility encounters.

Table 8-3. Example Risk Response Plan for Corporate Risk Matrix.
Source: Courtesy of anonymous water utility.

Risk Rating	Level	Report to	Level	Management Action	Timeframe: Corporate (strategic, divisional, non-project operational)	Timeframe: Project [1]
1	Very High	Division Head / appropriate level manager	Intolerable	Immediate action to eliminate risk or reduce to acceptable level.	Implementation: Immediate Review: Weekly	
2 & 3	High	Division Head / appropriate level manager	Conditional tolerable	Conditional tolerable if all cost effective measures to treat the level of risk are implemented. Where cost effective measures can be applied, additional action required to reduce level of residual risk.	Implementation: 6 months Review: Quarterly	Implementation: 3 months Review: Monthly
4 & 5	Medium	Senior Manager / appropriate level manager	Conditional tolerable	Conditional tolerable if all cost effective measures to treat the level of risk are implemented. Maintain watching brief, quarterly review by management. Where cost effective measures can be applied, longer term additional action required to reduce level of residual risk.	Implementation: 12 months Review: 6 monthly	Implementation: 6 months Review: Quarterly
6	Low	Immediate Supervisor	Tolerable	Broadly acceptable, cost effective measures to reduce level of risk unlikely.	N/A	N/A

[1] Timeframes for management actions related to projects are a guide only and should be revised based on the length and complexity of the project.

The use of a risk response plan does not dictate what mitigation strategies are best to employ to address specific issues. It does provide guidance consistent with utility policy to asset managers so that various plans affecting capital investment and/or operating expenses may be evaluated. Natural asset mitigating strategies may come in the form of alternatives derived in the course of developing source water protection plans (e.g., see ABCWUA 2018) or in computer optimization applications looking at specific impacts such as climate change (e.g., see Sydney Water Board 2019). They may also be derived through collaborative agreements with others having jurisdiction over natural assets the utility relies upon for core services. In that case mitigation strategies for natural assets could involve third party interventions that are not required to address built asset risks. These methods will likely be different than what is used to develop mitigation strategies for built assets in the sole ownership/control of the utility.

When natural assets are integrated into the utility's asset management program, it is appropriate to review the utility's own asset management policy to specifically validate risk response plans. Part of the validation should be to ensure appropriate stakeholders are engaged in developing the specific responses to risks. A risk response plan developed for built assets owned and/or controlled by the utility may specify management actions that are appropriate from the perspective of the utility, consistent with the risk tolerance of the governing body of the utility itself. However, if natural assets are included, and such assets are not owned and/or directly controlled by the utility, risk tolerance between the stakeholder interests involved in management of those natural assets may be entirely different. The risk tolerance levels of such stakeholders are not going to necessarily align with those of utility policy makers. Getting agreement on business risk tolerance with those on the outside of the governing body for situations involving natural assets is required. This requires the utility incorporate other elements of its own strategic goals in developing a unitized risk approach for all assets used. Stakeholder engagement actions on this issue thus becomes an important consideration when incorporating natural assets into the utility program.

Reconnaissance Tips: *Business Risk*

- Beginning to understand business risk associated with natural assets requires that you first understand the services that natural assets provide and how those services support the utility's target LOS.
- Then the utility must identify how natural and man-made hazards could degrade natural assets and, as a result, threaten target LOS
- Rely on established risk assessment processes, including methods covered in WRF project 4748
- At this stage, there may not be sufficient data to quantify the probability of hazards and resulting asset degradation or the consequences of natural asset failure. Instead, rely on qualitative ratings such as the examples shown above.
- If available, use other sources of information, such as source water assessments, watershed assessments, USFS Forest-to-Faucets maps, or others, to provide information that can serve as reasonable proxies for probability and consequence estimates
- Uncertainty will be high, so use qualitative ratings (see Figure 8-6) in a way that allows for a range of probabilities and consequences.
- Even without precise, quantitative estimates of probability and consequences, you can develop a risk profile matrix to help prioritize risks for subsequent action. At this stage, the risk ratings may be highly uncertain. If so, the prioritization should be used to identify new data collection, analysis and modeling that can help you reduce uncertainty and eventually develop information that can be used to make decisions about investment, maintenance or other activities.

Deep Dive Tips*: Business Risk*

- Continue to employ established methods to support risk assessment, including WRF Projects 4748 (Managing Source Water Risk), 4656 (Integrating Master Planning and Condition Assessment), and 4451 (Consequence of Failure for Buried Assets). A risk profile matrix remains an indispensable tool.
- Strive to develop more detailed quantitative descriptions of probability and consequences of natural asset failure. Focus on natural assets and hazards that were prioritized as highest risk from the reconnaissance phase assessment.
- If possible, monetize the consequences associated with natural asset degradation and failure; this is especially valuable if your utility monetizes risk for built assets because it will make for consistent risk ratings across asset types and better enable utility decisions about risk reduction activities.
- If data are lacking for fully quantifying probability and consequences, then refine the qualitative assessments from the reconnaissance phase using all available data and expert opinion. Considering including experts from outside the utility.
- Develop a detailed risk response plan that prioritizes risks for actions; action can include risk reduction investments (see Chapter 9) and additional data collection and analysis to reduce uncertainty and better understand the risks.

8.5 Conclusions

Utilities face a wide range of threats that may impact their ability to deliver their target service levels. Risk management is a widely applied framework utilities can deploy—agency-wide—to identify, assess, and mitigate the broad array of risks they face.

Natural assets, like their built system counterparts, are subject to hazard events that contribute to the risks faced by the utility. Accordingly, a standard risk management approach that characterizes the different business risks on a comparable basis can be deployed. The systematic use of risk management principles and tools enable utilities to better understand the potential impacts on their high-level LOS targets that natural assets affect. This in turn will better enable utilities to identify, evaluate, and implement programs and policies to reduce those risks, with associated implications for utility capital and operating budgets.

While the same overarching risk management framework applies to all assets, there are some specific challenges and opportunities associated with applying the framework to natural assets. For example, for natural assets, the concept of asset failure often differs from that of built systems. Built assets also typically have a well-defined, finite life, and can be readily replaced or repaired as a risk management strategy (e.g., a pipe segment with escalating levels of breaks per mile per year). In contrast, natural assets typically have an indeterminant lifetime (e.g., a forest, absent development), often appreciate in value rather than depreciate, and cannot be readily replaced if lost to a risk event. Hence, the nature of the risk, and of the options available to manage that risk, often are more challenging for natural assets.

Further, natural assets often are owned, managed, and/or accessed by third parties. This feature makes the range of risk mitigation options typically is much narrower, and the complexity of implementation much greater, than for built systems. For example, efforts to reduce runoff from development in the source watershed typically entails working to develop partnerships with the external parties who own, manage, and/or have access to the natural asset (and such partnerships can be highly beneficial to utilities in a number of ways). In contrast, for a built asset such as a pipe, the asset is owned and managed by the utility, and risk mitigation includes a suite of well-defined options in direct control of the utility (e.g., repair the pipe and restore service, and consider if pipe renewal may be prudent for that pipe segment). Risk mitigation strategies are addressed further in Chapter 9.

CHAPTER 9

Step 5 - Investing in Natural Assets to Manage Risks

What you will find in this chapter

This chapter covers options and strategies to intervene in natural assets to manage risks and increase the likelihood of meeting KPIs and target LOS. Strategies to manage risk are structured by the risk response plan that was covered in Chapter 8.

As with built assets, utilities can make capital investments in natural assets, and/or they can implement on-going maintenance programs. Capital investments can include acquisition, often in partnership with other organizations, and restoration activities. Maintenance might follow capital investment or be performed independent of capital investments.

Finally, the chapter covers different approaches than can be used to evaluate and select investment and maintenance alternatives, including benefit-cost analysis and other methods.

9.1 Introduction

Once you have inventoried and assessed the condition of natural assets that are important for your system (Chapter 6), determined how they support desired levels of service (LOS) (Chapter 7), and evaluated risks to those natural assets that may adversely impact LOS targets (Chapter 8), you are ready to evaluate and plan investments that will manage risks by protecting, enhancing or improving natural assets and, thereby, support meeting your utility's targeted LOS. This sequence of steps along the AM wheel for natural assets is depicted in Figure 9-1.

Similar to life cycle planning and risk management for built infrastructure:

- A utility can manage its risks by performing maintenance on natural assets (e.g., by supporting land management activities that reduce erosion), or it can make capital investments for natural assets (e.g., acquiring sensitive source watershed lands to limit future development and degradation).
- The utility's risk policy and risk response plan (see Chapter 8) should guide choices about capital investments or O&M to reduce risk.
- Regardless of the type of utility expenditure (capital or O&M), a systematic approach is required to evaluate the risk mitigation options available so that the most advantageous approach(es) may be identified and prioritized for implementation in conjunction with identified options for built assets.

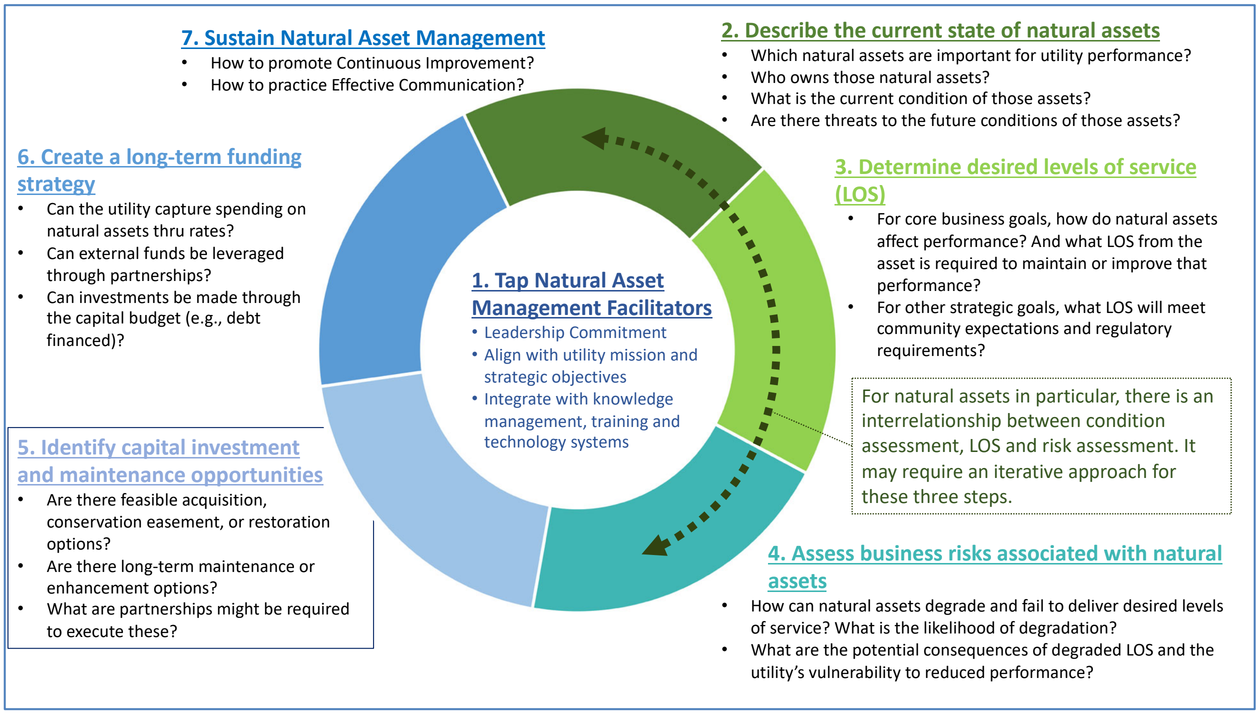

Figure 9-1. Step 5 - Investing in Natural Assets to Mitigate Risks and Preserve or Enhance Levels of Service.
Source: Adapted from Campanella et al. 2016.

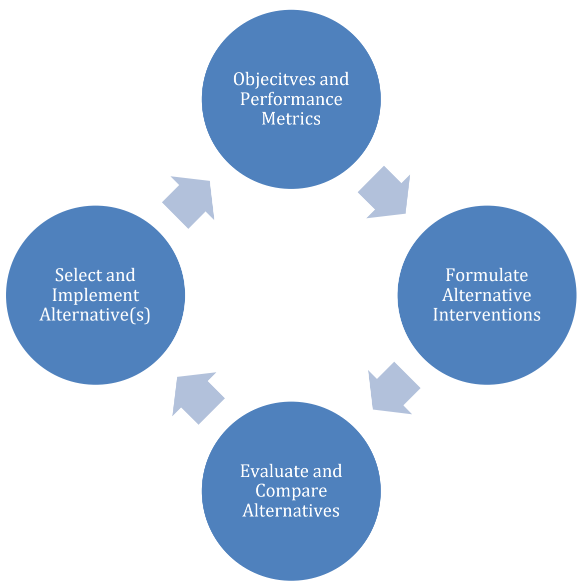

Figure 9-2. Iterative Cycle for Risk Mitigation Planning.

Whether for capital investment or O&M, planning for the risk mitigation activities can be thought of as having four major components that make up an iterative cycle (Figure 9-2):

1) Establishing Objectives and Performance Metrics – describing problems to solve or achievements to pursue, and specific ways to measure performance.
2) Formulating specific, alternative interventions (i.e., capital projects or maintenance activities for natural assets) based on the objectives.
3) Evaluating and comparing alternatives for their likely performance against the objectives.

4) Selecting one or more alternatives that provide the most effective means for achieving objectives, and for building a business case for the associated utility expenditures.

This chapter covers each of these four components, and it is organized into three broad topics. First, the types of capital investments that may be applicable to water utility natural assets are described, including a discussion of project objectives and metrics that will shape capital investments (Section 9.2). Second, a similar overview is provided of the types of O&M-type activities that may be applicable to water utility natural assets (Section 9.3). Finally, the last section provides an overview of evaluation and decision-making methods that can be applied to both maintenance and capital investments for natural assets (Section 9.4, and Text Box 9-1).

Box 9-1. Forested Watersheds and Treatment Costs

A frequent rationale for investing in the preservation or restoration of forested watersheds is the potential for maintaining or improving source water quality, with an associated anticipated reduction in water treatment costs. Such cost savings typically are highly site-specific, and often are very difficult to quantify. Nonetheless, there is generic evidence of a likely treatment cost savings payoff for utilities that protect source waters, as noted by two studies described here.

A watershed does not have to be 100% forested or protected to provide good raw water quality. For example, a 2004 study of 27 water suppliers by Ernst et al. (2004) suggests that the forest-water quality relationship exists as a continuum, with greater forest percentages in upstream watersheds generally producing lower water treatment costs. While the empirical results from the Ernst et al. study are not robust (e.g., it is based on a regression that leaves out two outlier datapoints), the general finding is that a forested watershed can support a balance of other land uses and good water quality, as long as a suitable proportion of watershed forest cover is maintained. This concept was explored in more depth by Warziniack et al. (2016) in a study evaluating the linkage between land cover and turbidity and TOC.

Daigneault and Strong (2018) came to a similar conclusion in their evaluation of a forested watershed serving as the source of supply for the City of Portland, Maine. The 282,000-acre Sebago Lake watershed provides drinking water to more than 200,000 users in the greater Portland, Maine region. The watershed contains abundant forests and cold-water lakes and streams. It is considered by some as an exemplary case of intact forests filtering clean drinking water. In this study, the authors cite recent literature as indicating the likely 'threshold' where water treatment costs start to measurably increase is when there is less than 60-90% forested area in a watershed. Their assessment found that reducing the area of forest cover in the Sebago Lake watershed from its current level of 84% down to about 76% could lead to a noticeable increase in pollutants (nitrogen, phosphorus, sediment), particularly if that forestland were converted to various types of development. However, their analysis highlighted that the water quality consequences will depend strongly on where and what type of development occurs.

9.2 Capital Investment in Natural Assets

Capital investment in natural assets can serve any of several purposes for a water utility. As described earlier, natural assets provide a range of goods and services that contribute to meeting target levels of service. Capital investments in natural assets can sustain, improve or restore those services, and may offer effective ways for a utility to deliver its target level of service. In addition, capital investments can help a utility meet its goals for environmental stewardship and sustainability.

Drawing from the IIMM (IPWEA et al. 2015), capital investment can include purchase of new assets, major renewal of existing assets, or investments that are held for future financial return or other future opportunities. There are analogous approaches for natural assets, which are described below.

To facilitate effective decision-making processes (described at the end of this chapter), it is crucial for utilities to identify and describe objectives and targets for its capital investments. In other words, *what does the utility aim to achieve by making a capital investment in a natural asset?* The objectives and targets should build on desired levels of service and the condition assessment of the asset. Objectives and targets should also be in alignment with a utility-wide risk response plan that reflects policy guidance for how the utility should address risk (e.g., objectives aim to reduce risk to acceptable levels in a reasonable timeframe). Further, the amount of resources applied to manage the risk should be within acceptable bounds given the degree of risk reduction to be achieved.

- *Objectives* are conceptual statements of conditions we wish to pursue, while;
- *Targets* define specific levels of achievement against the objectives, as measured by performance metrics. Targets reflect what a utility risk response plan indicates asset managers should do to manage risks.

Figure 9-3 illustrates this logic with an example.

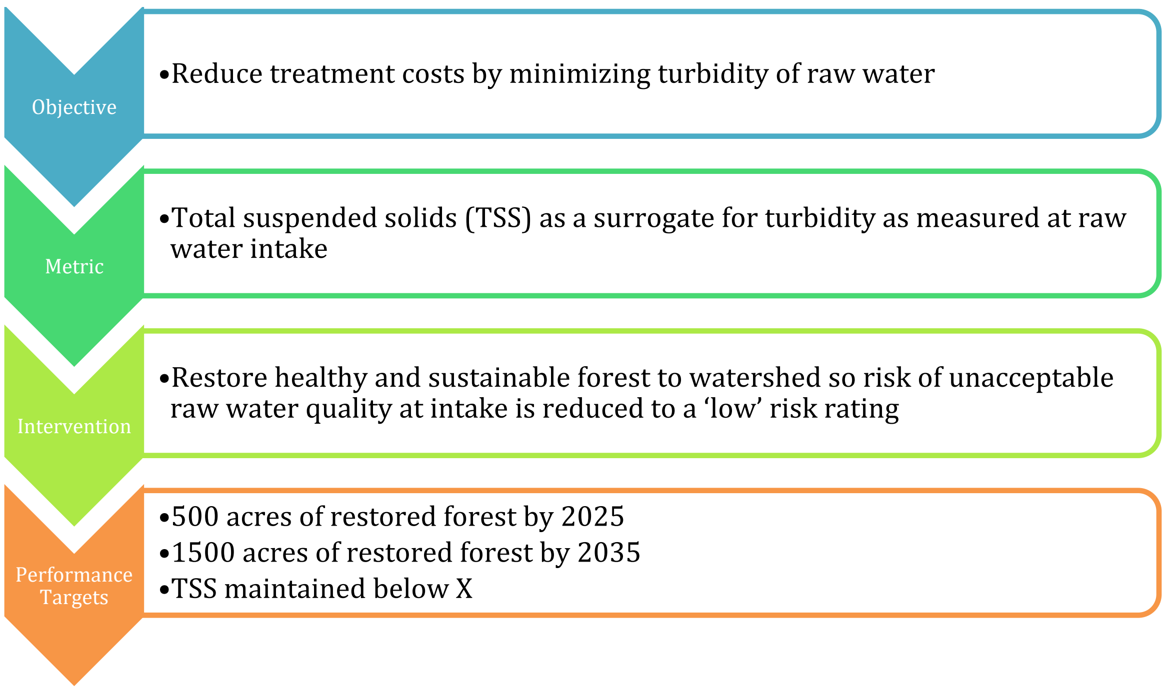

Figure 9-3. An Example of Using Objectives and Performance Targets to Guide Capital Investment Decisions.

9.2.1 Conservation of a Natural Asset

Just as a utility might purchase (or build) a new built infrastructure asset, they can acquire a new natural asset to preserve that asset. This can involve purchasing the land outright or purchasing a conservation easement on the land. Either of these can be done in partnership with other entities (e.g., a non-profit conservation organization or a local natural resources government agency, see Text Box 9-2 illustration for City of Raleigh).

The purpose of purchasing a natural asset or funding a conservation easement for a natural asset is to prevent, minimize or remove land uses that degrade or threaten to degrade the condition of the asset. For example, privately owned land within a drinking water source watershed could eventually be used for suburban housing development, mining, timber production, agricultural uses, or other uses that could adversely impact source water quality. Acquiring the land allows a utility to implement land use and management practices that protect the valued water supply and water quality-related services provided by the natural landscape. This helps maintain the condition of the asset and, often, can improve its condition over time, with the ultimate result of sustaining the asset's contribution to the utility's desired service level.

Two common targets for acquisition and conservation of natural assets within the water utility sector are forested watersheds and groundwater recharge areas. Acquisition and conservation of forested watersheds can prevent development and degradation to source water quality (see example for the Upper Neuse River, in Table 9-1). Acquisition and conservation of land that contributes to aquifer recharge can help maintain groundwater quality (i.e., reduce the likelihood of contamination form surface activities) and aquifer levels for utility use, and minimize detrimental effects of groundwater extraction on streams supported by the aquifer (e.g., the Edwards Aquifer Protection Program spearheaded by the City of San Antonio).

In some cases, utilities may allow agricultural, recreational or other uses on acquired forest or recharge land, but they are generally managed with the primary goal of sustaining valued water quality and related ecosystem services for meeting utility target levels of service. For example, the Edwards Aquifer Protection Program has executed conservation easements on many ranch properties that are still used for livestock grazing, but land use is restricted to minimize impervious surface and other land uses that would reduce recharge or degrade water quality.

Table 9-1. Examples of Partnership Organizations That Water Utilities Help Fund and Manage with the Goal of Acquiring and Conserving Valuable Natural Assets.

Partnership Name	Participating Utilities	Partnering Organizations
Upper Neuse Clean Water Initiative (see description below)	City of Raleigh Public Utilities Department	Conservation Trust for North Carolina, The Conservation Fund, and others
Rio Grande Water Fund	Albuquerque Bernalillo County Water Utility Authority and City of Santa Fe	The Nature Conservancy, US Forest Service and others
Savannah River Clean Water Fund	City of Savannah, Beaufort Jasper Water and Sewer Authority, City of Augusta, City of North Augusta, SC and Columbia County	Central Savannah River Land Trust, The Nature Conservancy, and others

In some cases, utilities directly own and manage conserved natural assets (e.g., the City of Seattle owns its source watersheds and they are managed by the Public Utilities Department). More commonly, however, utilities partner with other entities to create third-party non-profit organizations that acquire and manage natural assets. Some examples of partnerships that are at least partially funded by water utilities are shown in the Table 9-1.

Box 9-2. Natural Asset Management in Practice: Capital Investment

The City of Raleigh and the Upper Neuse Clean Water Initiative

The Upper Neuse Clean Water Initiative is a partnership of multiple conservation organizations, municipalities and others. The Initiative's goal is to conserve watershed land that will protect the region's drinking water quality. The city of Raleigh is heavily involved. Raleigh's Public Utilities Department charges a watershed management fee and those funds are used only for watershed protection investments. In conjunction with other funding sources, Raleigh's watershed protection fund has enabled the Initiative to protect 90 properties covering 85 miles of stream banks on 7,698 acres. The long-term goal is to protect 30,000 acres over the next 30 years. The Initiative is an excellent example of water utilities purchasing watershed land to preserve the watershed's contribution to utility service levels, and doing so with a multi-organization partnership.

Speaking of a recent purchase of watershed land, Raleigh's Mayor, Nancy McFarlane, said: "As the city grows and the cost of treating our water increases, it's important to take steps to preserve the land that is upstream of our main water supply. As we protect Falls Lake from additional nutrient runoff into the lake, we help preserve the quality and cost of maintaining clean water for our residents" (Johnson 2018).

9.2.2 Restoration of a Natural Asset

A utility can also invest in restoring a natural asset. The Society for Ecological Restoration defines ecological restoration as the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Restoration is generally meant to return an ecosystem to a level of function that is considered more in line with what would be expected under natural conditions (NRC 1992). This can include activities that would qualify as capital investment for a utility (consistent with the utility's criteria for capital expenditures), as well as activities that might better fall under a utility's operating and maintenance (O&M) budget. Capital investment restoration activities have similarities with capital construction activities for built infrastructure. They consist of one-time, major project investments that, depending on the utility's criteria for capital investment, might involve activities such as:

- construction activities, including re-grading landscapes, replacing or rehabilitating soils, constructing major features within a stream or river channels, and/or removing human-built structures such as concrete channels in order to restore ecological function
- major efforts to remove and eliminate invasive species that may be degrading the ecosystem
- planting or otherwise introducing native species

For a utility, restoration can improve performance of the natural asset so that it better contributes to meeting desired levels of service. For example, a stream channel can be physically restored to reduce erosion and turbidity (e.g., through streambank restoration), thereby increasing source water quality and supporting a core utility business objective.

Some restoration activities may have relatively little effect on a utility's core business goals and associated target levels of service. For example, in some cases there may be little difference between source water quality with or without the presence of invasive species within stream riparian areas. However, restoring such natural features and functions may contribute to a utility meeting environmental stewardship and sustainability goals.

Reconnaissance Tips: *Capital Investment*

- At the reconnaissance stage, it is very unlikely that you will gather enough information to plan and justify capital investments. Instead, at this stage the purpose is to determine whether there are investment options that are plausible and feasible for natural assets that you focus on.
- Questions to consider include: Have other organizations or agencies made major investments in natural assets in the same region that you could learn from? If so, were they land purchases, conservation easements, major restoration projects or something else? What was the cost of the investment and what were the benefits?
- For natural assets that are in relatively good condition (see Chapter 6), but face long-term threats that may degrade the asset, acquiring land or putting the land in a conservation easement may be a good option. For natural assets that are already significantly degraded and pose risk to the utility's business, restoration investments may be the best option.
- The reconnaissance phase is good time to build or strengthen partnerships with conservation organizations or agencies. The utility may not be in the best position to execute conservation or restoration activities, and a partnership can be the best way to proceed (as demonstrated in the example from Raleigh).
- Begin to integrate natural assets into your utility's standard CIP process. Evaluate whether natural assets require changes to standard CIP procedures and/or policies.
- Finally, begin to consider objectives that will guide the investment. In other words, what does the utility aim to achieve with a potential capital investment in a natural asset? Consider your LOS and KPIs when determining objectives for capital investment. Investments should also be consistent with risk management policy and risk response guidance offered to asset managers.

Deep Dive Tips*: Capital Investment*

- As with built assets, capital investment for natural assets will require detailed planning and business case evaluations. Identifying, planning and implementing an investment is a multi-year process.
- Always start with a clear description of objectives and desired outcomes for the investment. What exactly does the utility aim to achieve and how will you know whether the investment was successful in attaining the desired outcomes? Is the investment of resources contemplated consistent with risk response guidance and in line with the anticipated risk reduction to be achieved? Use this to guide formulation of investment concepts.
- Seek to integrate capital investment planning into your utility's overall capital investment planning process. This will enable you to compare the costs and benefits of a full range of investment opportunities and compare them to select the most cost-effective activities.
- Conservation investments – whether purchasing land or purchasing a conservation easement – involve significant transactions that will require collaboration and negotiation with landowners, regulators and others.
- Restoration projects will require engineering, detailed ecological evaluations, and, in most cases, permits from local, state and Federal agencies. The utility may need to tap into relevant engineering and ecological expertise from outside the utility. In addition, early and continuous coordination with regulatory agencies will minimize problems with obtaining necessary permits for project implementation.
- Leverage your utility's partnerships with environmental organizations to bring in necessary expertise, share in the costs, and collaborate on site selection, planning and other activities.
- Prioritization and selection for conservation investments will rely heavily on outputs from condition assessment and evaluation of business risk. For example, in many cases, forest assets in relatively good condition that play a pivotal role in maintaining source water quality would be top priority targets for conservation.
- Restoration may require additional watershed, hydraulic, ecological and other data collection and modeling to evaluate the degree of impairment and the extent of function that can be returned to the asset with engineered restoration projects. Balancing investment expense with benefit derived (i.e., degree of risk reduction achieved) should be considered.

9.3 Maintenance for Natural Assets

In general, the purpose of maintenance is to sustain the level of performance of the asset and its contribution to the utility's target levels of service. While the specific activities would differ, a utility may carry out maintenance activities on natural assets for the same reason they do maintenance on built assets: to sustain or enhance performance.

Many of the asset management principles and concepts about maintenance apply to maintenance for natural assets. First, a ***maintenance plan*** (see Section 3.3.2 and 3.3.3 of the IIMM) is a useful way to structure maintenance activities, and it would include the following key elements:

- Performance objectives (based on LOS) and metrics (i.e., KPIs) for the natural asset
- Performance levels (as measured by the metrics) that would require intervention
- Procedures for preventive maintenance (also called pro-active or planned maintenance)
- Description of reactive (also called corrective or unplanned) maintenance that would be performed when unpredictable events (e.g., large fires) affect natural assets
- Emergency response plans

Table 9-2 shows an illustrative example of these maintenance plan elements for a forested watershed that is managed by a utility to minimize sediment in its source water.

The types of maintenance activities that may be required will differ across different types of natural assets. Further, maintenance activities may be tailored to different stressors or hazards that affect natural assets. Table 9-3 shows examples of maintenance for common types of natural assets that utilities might manage.

Table 9-2. Examples of Key Elements in a Maintenance Plan for a Natural Asset.

Maintenance Plan Element	Example
Performance objective	Maximize raw water quality at the intake
Performance metric	Turbidity measured at the raw water intake
	Maintain turbidity of intake water to less than X at least B% of the time
Preventive maintenance actions	• Thinning forest fuels on annual basis • Grading and treating dirt roads
Intervention levels	If turbidity of intake water is measured above X more than three times in Y days
Reactive maintenance actions	• Measure turbidity at tributary streams to locate source of significant loadings • Inspect streams for erosions hotspots • Restore eroding stream channels

Table 9-3. Examples of Specific Maintenance Activities for Different Natural Assets.

Natural Asset Type	Asset Stressor or Hazard	Maintenance Activities	Purpose
Forested watershed	Wildfire	▪ Thinning mature trees and debris on forest floor ▪ Prescribed burns	Minimize the likelihood of large, intense fires which can result in high consequence, massive sediment and debris flows into source waters and reservoirs
	Erosion on trails	▪ Install and maintain water bars, diversions, and breaks to slow runoff on trails	Minimize sedimentation to reservoirs and reduce suspended solids in source water
	Cattle grazing	▪ Implement best management practices with livestock owners who graze cattle in the forest	Minimize nutrient loads into streams which reduces likelihood of algae blooms
Restored stream	Large storms	▪ Maintain healthy vegetation along stream banks and riparian	Stabilizes the stream bank which minimizes erosion and
Aquifer recharge areas under conservation easements	Impervious surface	▪ Monitor and inspect conserved lands to track and enforce restrictions on the construction of impervious surfaces	Maintains adequate land area for target recharge rates
	Cattle grazing	▪ Work with ranchers to ensure regular rotation of grazing plots to prevent overgrazing	Maintains stable ground vegetation which slows runoff and allows for increasing percolation and recharge

For natural assets that a utility owns, they have the primary responsibility for performing maintenance. However, a utility can partner with other organizations to fund and perform maintenance activities that benefit the utility. This can include partnering with local, state or federal government agencies that manage public lands or partnering with private landowners. Text Box 9-3 provides examples of effective partnerships between utilities and other entities, including a program between Denver Water and the U.S. Forest Service.

Text Box 9-3. Natural Asset Management in Practice Through Natural Asset Maintenance
Denver Water, the USDA Forest Service and the *From Forest to Faucets* Partnership *From Forests to Faucets* is a partnership started in 2010 as a response to the costly impacts from a series of wildfires, including the 1996 Buffalo Creek and 2002 Hayman wildfires, which cost over $27 million for restoration and repairs to Denver Water's collection system. Denver Water committed $16.5 million for an on-going program of forest restoration work, such as thinning and clearing, prescribed burns and creating fuel breaks. These restoration activities influence how quickly and intensely a wildfire can burn. Preventing large, intense wildfires helps avoid the major adverse impacts of these fires to the utility, including substantial sediment and debris flows into reservoirs and other water collection infrastructure. **The City of Santa Fe, USDA Forest Service Espanola District, the Santa Fe Watershed Association and The Nature Conservancy Partnership** Over the past 10 to 15 years, large fires have destroyed watersheds and caused severe erosion that filled man-made water storage reservoirs with sediment and ash. In response, in 2007, a collaborative planning group including the City, the USFS Espanola District, the Santa Fe Watershed Association and The Nature Conservancy developed a 20-year watershed management plan, the Santa Fe Municipal Watershed Management Plan, which provides a framework and recommendations for ongoing watershed management, environmental monitoring, educational outreach and long-term funding. The plan addresses four areas critical to project success: 1) vegetation management and fire use, 2) water management, 3) public awareness and outreach, and 4) financial management based on a Payment for Ecosystem Services model. The plan is unique in that it identifies City water customers as the beneficiaries of a healthy watershed. Based on significant cost savings to the utility, the costs associated with ongoing water source protection activities in the watershed are paid for by the public through the Water Source Protection Fund. Based on recent wildfires, it is estimated that fire suppression and rehabilitation costs associated with a 10,000- to 40,000-acre wildfire impacting some portion of the Municipal Watershed could be between $11.9M and $48M. The cost to dredge, haul and dispose of 2,000 acre-feet of sediment and ash from the City's reservoirs would likely be between $80M and $240M. These costs exclude increased water treatment costs, increased water utility operating costs associated with production of water from different water sources, and impacts to the local economy from loss of tourism income. In comparison to these avoided costs, the cost to treat and maintain forests within the Municipal Watershed is expected to be $5.1 million over 20 years, an average of $258,000 per year.

From a practical perspective, incorporating natural assets into a utility maintenance management system is done through inclusion of those assets in the asset register (see Chapter 6, Section 6.2) of that system. Current practice typically includes the utility using some form of computerized maintenance management system (CMMS), and a set of business practices that are supported by the CMMS. As constructed for built assets and other utility infrastructure (e.g., rolling stock, buildings, etc.), a CMMS should incorporate natural assets too. Business practices such as developing an asset hierarchy, asset registers, links to other utility information systems (e.g., Customer Service, GIS, Enterprise Resource Planning) should be considered. Job plans, scheduling tools, reports, and performance dashboards can be modified to also include natural assets.

For example, the maintenance actions illustrated previously, in Table 9-3, can be associated to specific natural assets included in the asset register of a CMMS as a set of maintenance actions. Associated with those maintenance actions are specific job plans describing how the utility is to undertake those activities. Costs associated with specific maintenance activities are then tracked against specific natural assets, to allow life cycle cost analysis of owned and/or managed natural assets.

An example utility that has incorporated natural assets into its maintenance management approach is Santa Clara Valley Water District (Baker and Sen 2015). The utility has in its asset inventory over 15,000 assets; of the approximately 350 different asset types, the inventory includes both natural and built assets. Data stored in District's CMMS includes condition information, and these data help to determine maintenance project priorities. Work orders are generated from the CMMS that include regular condition assessment of natural assets. Both natural and built asset data stored in CMMS is accessed similarly and is used as a component in developing probability of failure estimates in calculating risk scores per each asset. Risk scores are then used to developing maintenance plans for the coming year.

Reconnaissance Tips*: Maintenance for Natural Assets*

- You may be able to begin implementing some maintenance activities at this stage, depending the quality of information from reconnaissance level implementation of previous steps. It may be helpful at this stage to approach maintenance activities as kind of a test from which you can learn as you add more detail to your asset management program (see box on adaptive management below)
- Begin to integrate natural assets into your utility's standard maintenance management program. Consider whether natural assets require any changes to your maintenance system.
- Use the utility's LOS and KPIs to begin formulating maintenance plans for natural assets, including maintenance strategies to meet objectives, standard maintenance procedures and action levels for unplanned maintenance.
- As with capital investment, determine whether other organizations are actively engaged in regular maintenance activities for similar natural assets in the region. If so, learn what you can from their work and consider partnering with those organizations to implement maintenance for the natural assets you focus on.

Deep Dive Tips*: Maintenance for Natural Assets*

- Fully integrate maintenance for natural assets into your utility's standard maintenance management system, including clear maintenance objectives and procedures. This will allow you to compare and prioritize all maintenance activities to maximize performance and ensure the utility meets its LOS.
- Capital investments for natural assets may create a need for detailed maintenance plans for those assets. This may be particularly true for major restoration investments.
- Use KPIs to establish clear maintenance action levels for unplanned maintenance.
- Monitor performance to assess whether a change in maintenance levels and/or approaches may be needed.

9.4 Evaluation and Decision Making

For both capital investments and O&M for natural assets, a utility will typically have many options for interventions it can implement. As with investing in built assets, the utility will need to evaluate the business case for each option and make data-based, risk-informed decisions about actions to implement. Many of the methods used for evaluating and selecting investments in built assets also apply to natural assets, but there are some key differences with natural assets that may call for different approaches. This section provides an overview of how standard evaluation and decision-making methods will differ for natural assets.

9.4.1 Key Differences for Natural Assets

Evaluating and decision-making methods for investment in natural assets are largely the same as those used for built assets, including benefit-cost analysis, cost-effectiveness analysis, triple-bottom-line assessment, and multi-criteria methods. However, there are some key differences in applying these methods to natural assets. These differences are summarized below, followed by a brief overview of several evaluation and decision-making approaches.

9.4.1.1 Characterizing the Effects of Interventions

Planning for capital investments and O&M will require the utility to estimate the likely effects of its interventions and to compare those projected effects across multiple alternatives (see Figure 9-4). Importantly, the projection of future effects must include a description of the *baseline* condition, sometimes called the "without-project" or "do-nothing" scenario (shown in red in Figure 9-4). The baseline condition is a description of the condition of the natural asset without intervention in terms of how the asset will perform against the utility's objectives. This future baseline should include a description of how the asset's condition will evolve over time. Establishing the baseline condition would use the same types of information and approaches as the condition assessment discussed earlier.

In addition, the utility will need to project how the condition of the asset will improve due to alternative interventions (capital investments or maintenance activities). This is shown in brown and green in Figure 9-4. The difference between future conditions under the baseline and each of the intervention alternatives can be seen as the benefits of each intervention alternative. The benefits can be estimate for a single future time or an integration over some planning horizon (e.g., 20 years into the future).

As noted earlier, it can be challenging to predict or estimate how a particular intervention will affect the performance of a natural asset in delivering the desired level of service. A first step in selecting management interventions and evaluating their effectiveness is to identify the important factors that influence the capacity of the asset to deliver services. For example, wildfire intensity is related to fuel loads, so thinning forests and reducing fuels can reduce the likelihood of large fires and the intensity of fires when they do occur. Similarly, assessing the effectiveness of management actions or restoration of riparian buffers would be based on how the interventions increase the width of the buffer, the diversity of trees and shrubs, and/or soil depth and structure.

Adaptive management can be an effective approach for dealing with uncertainty in managing natural assets. In adaptive management, we address uncertainty by treating interventions, at least in part, as experiments from which we can learn more about the system. For example, a utility (with its partners) may choose to implement different approaches to forest restoration (thinning fuels, prescribed burns) in different portions of the management area and track which of these approaches were most successful in yielding desired results. As the utility learns more about which approaches are most successful in yielding desired results and why, they can proceed to implement that approach in more places. For more information see Holling (1978) and Lee (1993).

Resource agencies have useful resources for estimating the effectiveness of some interventions. The USFS has developed and compiled resources for quantifying the effectiveness of fuels management in forests in reducing fires, as well as the economic benefits or cost-effectiveness of fuels management. The USDA has resources for estimating the effectiveness of conservation practices under the Farm Bill, some of which are relevant for utilities, such as nutrient or sediment removal effectiveness of riparian buffers.

As with condition assessment for natural assets, developing projections of future conditions will require analytics and/or modeling about the behavior and dynamics of the natural ecosystem. Modeling and projecting future conditions of natural assets will involve substantial uncertainty, driven by different factors than those for built assets. Natural systems are dynamic and constantly evolving and it can be challenging to project how they will behave in the future, especially with interventions. With management or restoration actions, there is a time-lag in natural asset performance that should be factored into assessments of effectiveness. Some of the tools mentioned in Chapter 6 (e.g., InVEST, ARIES) on condition assessment can be used to model performance of natural assets under different management scenarios to compare the future benefits of different management options.

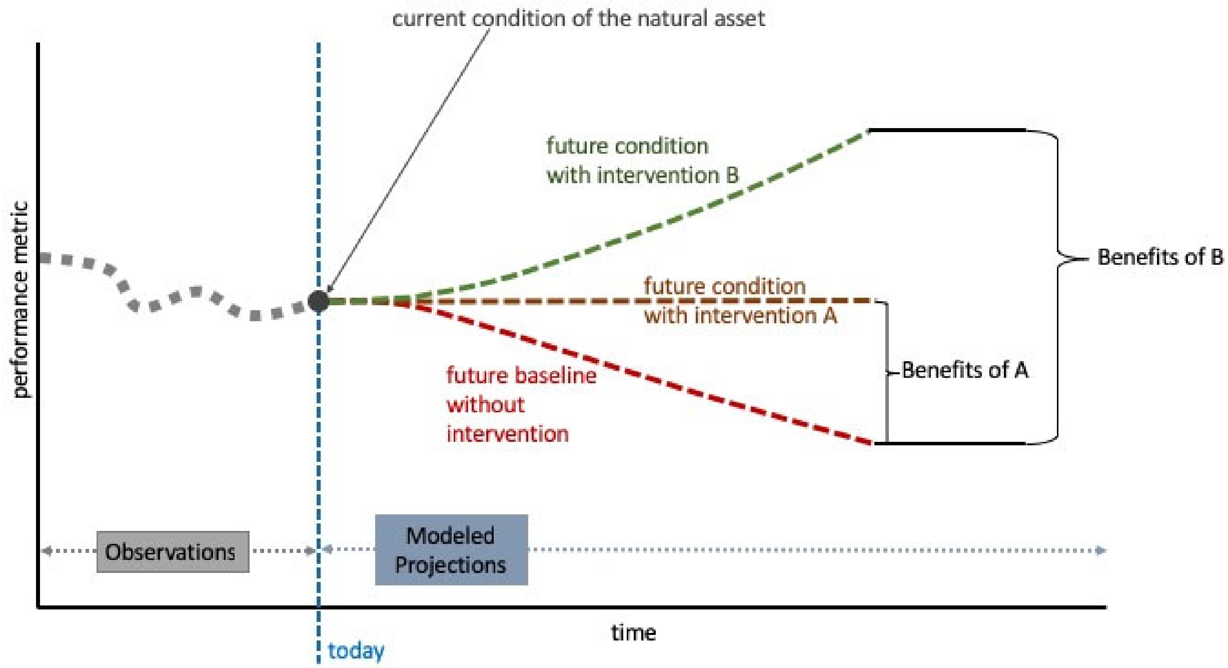

Figure 9-4. Projecting Future Effects of Interventions to Improve Condition and Performance of a Natural Asset.

9.4.1.2 Multiple Objectives and Benefits

The logic and analysis illustrated by Figure 9-4 will likely be applied multiple times for any given natural asset investment or maintenance decision because natural assets tend to affect water supply and environmental stewardship goals in multiple ways. For example, restoring and/or maintaining a healthy forest in a watershed can have the following effects on core business goals and environmental stewardship goals:

- Core water supply business goals
  - Minimize erosion and sediment load into source waters
  - Minimize nutrient runoff to source waters
  - Attenuate runoff, increase groundwater recharge and support baseflows in source waters
- Environmental stewardship goals
  - Provide habitat for threatened or endangered species
  - Provide habitat for wild game populations
  - Moderate stream temperatures for native trout populations

This will often be a key difference with built systems. Built assets perform very specific functions within an engineered system. For example, a segment of distribution system pipe is meant to move water at a certain pressure. If the asset fails, it no longer performs that function and service may be interrupted or reduced until it is repaired. But natural assets perform many functions and provide multiple services. This may require a utility to employ a multi-objective or multi-attribute decision-making system.

A further complication is that some of the services of natural assets do not directly relate to water supply services and, as a result, some of the benefits do not accrue to the utility. For example, restoring a forest in a source watershed may offer benefits for recreation (trails, habitat of game species), endangered species, and overall environmental sustainability. These are important co-benefits of investing in natural assets, but they may or may not be benefits that the utility is directed or authorized to pursue and fund in accordance with its primary mission to reliably supply safe and affordable water. Therefore, in addition to a multi-objective or multi-attribute approach, the utility will need to consider which benefits provide justification for utility investment and whether partnerships with other organizations can help fund natural asset investments if some of the associated benefits are outside the utility's scope.

9.4.1.3 Effect of Investments on Utility Bottom-Line

Two projects—one involving investment in built assets, the other investment in natural assets—can have different effects on the utility financial condition. The two project opportunities can have the same cost, provide the same degree of risk mitigation, and support equally important strategic priorities, yet the effect on the utility bottom line can be different. This is because the treatment of these two investments may not be subject to the same accounting rules:

- First, land does not depreciate; hence, its effect on the utility's finances is different than a built asset placed into service for which depreciation occurs.
- Second, should a governing body make the determination that the expenditure of funds is an expense as opposed to a capital expenditure, the timeline for cost recovery is different.
- Further, rate making formulas used by economic regulators typically allow a return on capital investments adding to rate base, but not on operating expenses.

Therefore, decision making with respect to natural assets is subject to these differences.

9.4.2 Methods for Evaluation and Decision-Making

9.4.2.1 Benefit Cost Analysis and Triple Bottom Line Analysis

Benefit-cost analysis (BCA) involves quantifying and monetizing all the benefits and costs that will accrue to the utility as the result of an investment (capital or maintenance). BCA is it ultimately used to estimate net benefits (i.e., total benefits minus total costs). If net benefits are positive, the investment is worthwhile. BCA can be used to compare multiple options and rank them according to their net benefits.

In an ideal context, BCA is applied when all the costs and benefits can be quantified in monetary units. This may limit the applicability of BCA for natural assets in many cases because many of the benefits cannot readily be monetized. For example, benefits to endangered species has no observable market value. Non-market valuation methods can be used to assign monetary values, but they can be complex and expensive to implement. Further, BCA is most useful when all the costs are borne by and the benefits accrue to the decision-making entity. As described above, natural assets may offer benefits that accrue to entities other than the utility, such as enhanced recreational opportunities.

Nonetheless, BCA can be applied, if done so carefully, even when some key components of the benefits (or costs) are not readily conveyed in monetary terms. Further, a Triple Bottom Line (TBL) perspective may be applied in a BCA and provides a framework for articulating all the important benefits and costs that may accrue from an investment, spanning the financial, social and environmental consequences. Even where several key benefits and costs may not be readily amenable to credible monetary estimation, a clear qualitative discussion of the key benefits and costs, alongside those that can be monetized, can provide valuable insight to decision-makers for ranking and selecting which projects to endorse.

Using approaches similar to BCA, the World Resources Institute has developed guidance specifically for water utilities in comparing the cost-effectiveness of natural assets (green) and built infrastructure (gray) that incorporates economic costs and benefits along with environmental and social 'co-benefits' (Gray et al. 2019).

9.4.2.2 Cost-Effectiveness and Incremental Cost Analysis

Cost-effectiveness and incremental cost analysis (CE/IC) are an alternative to BCA that can be used when the benefits of an investment are not readily monetized, as will often be the case with projects that involve natural assets. In CE analysis, the cost of different alternatives is compared to their outputs to assess which alternatives provide the most bang for the buck. CE/IC is first used to identify efficient alternatives, meaning those that are at least as good as any other plan on cost, output, or both. Incremental costs are then analyzed for cost-effective plans to evaluate whether additional output is worth the added costs of available alternatives. Figure 9-5 shows an example of CE/IC analysis.

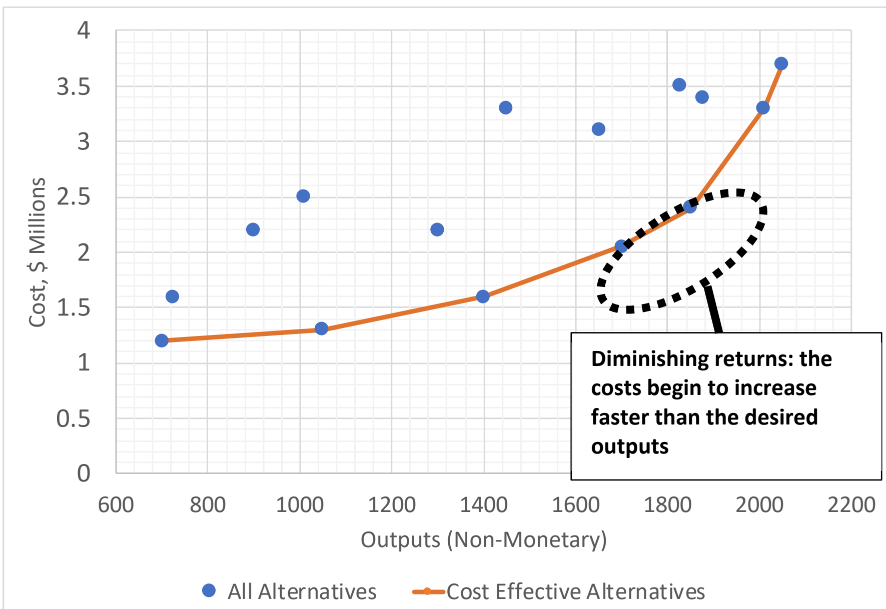

Figure 9-5. An Example of Cost-Effectiveness and Incremental Cost Analysis.
The blue points display all available alternatives. The orange line traces cost-effective plans. The area where the slope of the orange curve begins to increase (the "knee of the curve") is where the incremental costs per unit of output increase rapidly.

9.4.2.3 Multi-Criteria Methods

Another way to expand on traditional BCA and incorporate objectives and values beyond financial impacts is to employ a multi-criteria or multi-objective approach. Further information regarding application of a multi-criteria decision approach (MCDA) can be found in the literature (e.g., Linkov and Moberg 2011). While there are a wide range of such methods,[10] they generally consist of a few key characteristics. First, multi-criteria methods are designed to deal with objectives and measures of

[10] We include these as one category of decision-making methods, but there are many variations of multi-criteria or multi-objective analysis. The various methods differ in their quantitative methods, the manner in which they frame and analyze a decision problem. Explore the full variation if not possible here, but there is a vast literature where the reader can learn more.

performance that are seen fundamentally different and not fungible. For example, such an approach might be used to support a decision about infrastructure investment that involves financial costs and benefits, ecological impacts, and the potential for significant public safety risks. While methods exist to assign a dollar values to these factors, in many cases such monetization methods can be challenging, and decision-makers may prefer to work with non-monetized measures of impact.

Second, multi-criteria methods are well-suited to evaluate tradeoffs between conflicting, non-fungible measures of impact. This can help decision-makers understand how key objectives interact and to answer questions such as: how much would it cost financially to implement a solution that doubles ecological quality results without harming public safety?

Finally, because multi-criteria methods can work with measures in their natural units (e.g., habitat units restored, measures of fishery population, expected numbers of human injuries or illnesses, expected lost or gained wages), they are well-suited to decision situations involving multiple decision-makers who may apply different values to the objectives and impacts. This can be done with formal weighting methods, ranking schemes or other approaches. In these cases, multi-criteria methods are best viewed as *supporting* a collaborative decision process that aims to reach consensus, majority support or some other decision outcome.

In general, multi-criteria methods entail a subjective scoring process (e.g., on a scale of 1 to 10) for two components:

- How well a member of the decision-making group believes each option is expected to perform for each criterion established by the group (e.g., how well is a given option expected to reduce sediment loadings to source waters); and
- how important each criterion is to the member of the ranking group (e.g., how important sediment loading reductions are compared to other defined criteria, such as cost, for example).

While MCDA does not provide monetized insights into how benefits compare to costs, it does provide a systematic approach through which groups of decision makers can evaluate their options and explicitly deliberate on the weighted values to apply to the criteria they have selected to guide their decision-making.

9.5 Conclusions

Managing natural assets will typically require that some level of support—requiring the allocation of utility (and/or other) resources to protect, restore or enhance the natural asset—with the objective of managing risks that may arise and that would impair the valued services the asset provides the utility and its customers. This is no different than how a built asset requires periodic investment to ensure its continued ability to provide the desired LOS for the utility and its customers. These investments may be in the form of capital outlays, and/or in the form of O&M expenditures by the utility (and may include support garnered from partnerships established between the utility and relevant partners).

As with any action requiring the deployment of utility resources, the options for managing the risks linked to natural assets should be subject to careful analysis—such as through a business case evaluation—to ensure that the options with the greatest anticipated return can be identified. The level of resource investment should provide a commensurate value of risk reduction.

Further, options for managing risk for natural assets should be considered with reference to risk management and response policies that apply to all assets, natural or built, in a consistent fashion, Not only should risk assessments be done on a comparable basis, but also a utility’s response in managing those risks should be comparable. The high-ranking options then may proceed toward implementation, if there are mechanisms in place to pay for them. Funding approaches for such utility investments in natural assets are described in Chapter 10.

CHAPTER 10

Step 6 - Developing a Long-Term Funding Strategy for Natural Assets

To develop a long-term strategy for funding investment in and maintenance of natural assets, a utility must understand the long-term needs posed by the natural assets, the structure of the financial planning to be done, and evaluate alternative options to determine a best course of action (Figures 10-1 and 10-2).

An important factor to consider when planning for natural asset investments is that replacing a natural asset rarely is something that can be readily accomplished. After being degraded, natural assets often take significant time to recover and return to full function, unlike built assets that can be repaired or replaced more rapidly. If it takes 10 to 20 years to repopulate a forest to protect a watershed, then the planning horizon must recognize and accommodate this fact. This puts even greater importance on long-range planning for managing natural assets.

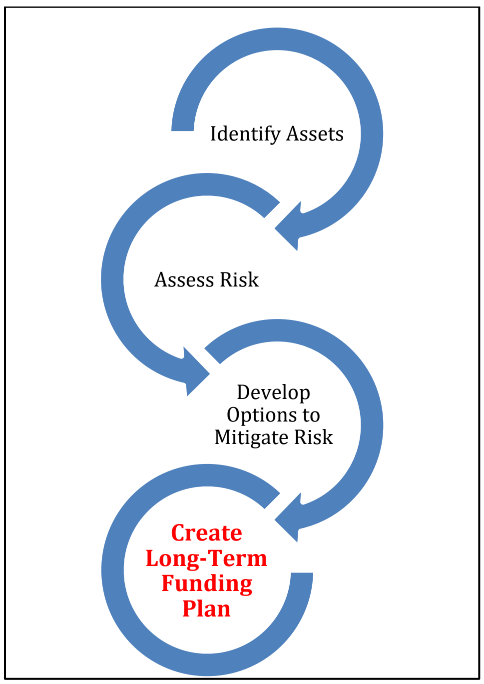

Figure 10-1. Building Up to a Long-Term Funding Plan.

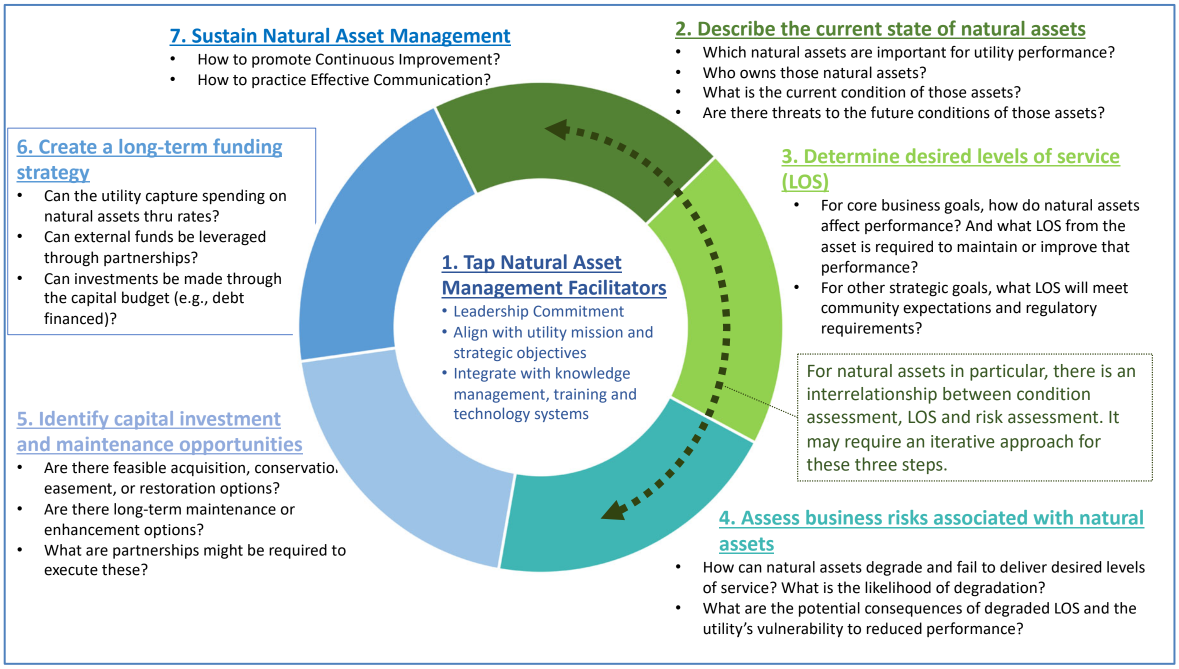

Figure 10-2. Step 6 Entails Creating a Long-Term Funding Strategy to Sustain or Enhance Asset Performance and LOS.

Source: Adapted from Campanella et al. 2016.

Forecasting the long-term needs of natural assets will be an iterative process related to determining the appropriate level of investment for a utility. Realizing that resources are limited means that this investment decision process must be looked at in the context of the entire organization. In Chapter 8, there is a discussion about the importance of being able to compare the risk of natural asset failure against the risks associated with other utility assets. In the same way, the investment decisions regarding natural assets must be looked at in the context of utility-wide financial planning and budgeting. Finally, the utility should also look at third party options external to the utility itself for managing those assets, and in securing or leveraging external funding sources to contribute to the investment. This could be in the form of investment in a land trust, or another entity whose role would be to manage and maintain the natural resource for a desired set of goals.

10.1 Forecasting Long-Term Asset Investment Needs

The first step in developing a long-term funding strategy is to understand the long-term asset needs. Tools have been developed and deployed for this purpose for water sector-owned built assets for more than two decades. While it is beyond the scope of this research effort to outline all the various options, these tools are designed to look at existing inventories, estimated lives, life distributions and decay curves and, from those, to determine a rough forecast of future funding needs. Other Water Research Foundation reports provide additional information (e.g. WRF Project 4367, Ellison et al. 2014; Marlow et al. 2007). Typically, these tools are based on the assumption that the current service level, operating conditions, and replacement efforts are appropriate. This may or may not be the case, so there is a need to look at the forecast in a variety of future scenarios which assess the funding needs over various asset service (or performance) parameters. By doing this, it becomes possible for a utility to better understand the long-term impacts of the different funding decisions to be made.

10.1.1 Modeling Tools

While there are a variety of models for forecasting long-term asset replacement needs for built assets such as Buried No Longer, Nessie and Kanew (Helgeson 2019), there does not appear to be any such tools currently on the market for use with natural assets. To better understand how to use existing tools for this type of forecast, it is important to understand the basics of how the tools function.

Table 10-1. Steps in Asset Investment Needs Forecasting.

Long Term Forecasting Steps	Built Asset
1	Assess inventory data
2	Develop cohorts
3	Assess estimated service life for each cohort
4	Assess distribution type for each cohort
5	Assess operating changes as a result of asset aging/ deterioration
6	Run forecast for each cohort
7	Aggregate Cohorts
8	Compare Future needs to expected funding levels

The majority of the asset investment forecasting tools that exist in the marketplace today follow the general structure depicted in Table 10-1, beginning with a built asset inventory (some of the differences in developing a natural asset inventory are discussed in Chapter 6). This inventory is grouped into different asset types (or cohorts) based on a variety of characteristics such as type of asset, materials used, and environmental degradation factors). This grouping is aimed at compiling a group of assets that will share lifespan and aging characteristics (such as estimated mean life, a distribution around that mean, and costs associated with the aging). In conjunction with the age of the assets, a forecast can then be made for each asset group or cohort. This forecast can be aggregated showing the replacement and operating costs over time to maintain and replace the asset group.

In applying this type of forecast to natural assets there are several changes that the modeling will require. As discussed in Chapter 6 on assessing the condition of natural assets, and in Chapter 8 in assessing the risk associated with assets, natural assets frequently do not have a finite life as would most built assets. Instead, they degrade and lose function in other ways such as land development or natural events such as wildfire or flooding. This lack of a finite life in this case does not mean these models cannot work, but it does mean they have to be approached in a different way.

Many of the long-term asset investment needs forecasting models that exist are centered on water mains, as these are a substantial portion of a utilities inventory. However, the life cycle of a water main is generally one of install -> degrade -> fail -> replace. This does not relate well to natural assets. Instead, natural assets are better compared to a well-designed treatment facility. With proper maintenance and operation, a treatment facility can be operated for a very long lifespan. Without proper maintenance and operation, they quickly fail.

Natural assets can be viewed similarly. In order to provide a consistent level of service, a natural asset such as a watershed must be maintained appropriately. While wildfires are a natural occurrence, they can wreak havoc to a watershed's ability to provide high quality source water. Therefore, minimizing fire danger is a natural part of maintaining a watershed. *Understanding and developing the maintenance requirements and investments needed to maintain a natural asset at the desired level of performance are a critical part of developing the long-term needs forecast.*

10.1.2 Relationship to Service Level Expectations

When doing a long-term needs assessment, it is important to understand the relationship between service levels and the long-term investment needs forecast. There is a natural focus on assets that currently are not meeting required service levels, and an associated focus on planning projects to increase the service level being provided. However, there are also times when the level of service being performed by an asset, whether built or natural, may exceed the desired service level. When doing long-range planning it is important to understand if this is the case. Even well-performing assets face drivers that will cause the asset's delivery of service to decline over time, which means that future investments may also be needed for those assets that currently are performing at or above targeted LOS. These are the factors that are important to account for in forecasting future investment needs for all assets.

10.1.3 Overall Needs Assessment

The final key point in performing a long-term needs assessment is to be certain to incorporate the needs of the natural assets into an overall utility-wide long-range needs assessment. In the same way that the risk of natural assets can and should be included in and be part of a utility-wide risk assessment/risk profile, the long-range needs forecast for natural assets provides the most value for a utility if it is part of a larger overall utility-wide needs assessment.

One example where taking a broad, utility-wide perspective is important is how Seattle Public Utilities (SPU) manages its two watersheds. Because of their ownership of the Cedar and Tolt River watersheds used for municipal water supply, SPU must incorporate overall long-range watershed needs in the context of asset management. Over 90% of the watershed land areas are owned and managed by SPU. SPU considers protection of water quality for public health and avoided treatment cost as the most important elements of its watershed protection program. In addition, it is believed by rate payers to be of central importance. Preservation of the watershed ecosystem is also important to SPU because its citizen ratepayer constituency is highly supportive of forest and environmental protection and enhancement (B. Lackey, Seattle Public Utilities, Personal communication, October 26, 2018).

Thus, SPU manages its two large, regional watersheds for water supply, flood mitigation, wildlife and fish habitat. Those watersheds are part of the habitat areas covered by recovery plans for wildlife protected by the Federal Endangered Species Act (ESA). The SPU program includes its Cedar River Habitat Conservation Plan (HCP). The HCP provides compliance mitigation activities to meet the requirements of the ESA. The HCP is a 50-year ecosystem plan prepared to address the declining populations of salmon, steelhead and other fish and wildlife species in the basin. The plan involves a $100 million investment to help protect the water supply as well as restore habitat of 83 species of fish and wildlife that may be affected the City of Seattle's water supply and hydroelectric operations on the Cedar River (B. Lackey, Seattle Public Utilities, Personal communication, October 26, 2018).

The HCP program is not aimed at natural asset management as an economic activity per se, but the protection and enhancement of a large array of complex ecological processes and functions across the 93,000-acre basin. SPU ratepayers also decided in 1999 to support prohibition of all commercial timber harvest in the watershed for eternity. This decision included protection of ecosystem services beyond water supply even if they were not described as such to stakeholders and elected leaders.

Watershed and aquifer management plans are additional examples of utility efforts that help forecast maintenance, investment, and/or enhancement actions for key natural assets. These plans typically are constructed around applying best management practices to protect water and natural resources and the important ecosystem services, while balancing financial costs and benefits. These plans are directed at implementing practices and procedures that promote established utility goals and policies (SFPUC 2019).

In such a plan, existing conditions and resource inventories are outlined. Consistent with utility goals, objectives and policies, specific management actions and guidance for activities within the affected natural assets are developed. Monitoring and reporting requirements are often included, leading to a phased implementation plan that aligns with a financial plan. Activities and programs may include a diverse set of actions such as capturing key watershed/aquifer data; fire and/or contaminant management; public and community education, access, and engagement; pest and invasive species management; soil or specialized resources management; recreational and cultural activities management; natural capital management; and/or legislative/regulatory/policy development.

10.2 Financial Planning and Budgeting

Once the long-term needs of maintaining the natural asset have been identified, the next step is to incorporate those needs into the utility's long-range financial plan. To do this it is important to understand:

- the impact of accounting standards,
- whether those investments in natural assets are capital or operating costs,
- how and when those costs need to be included in the budgeting processes, and
- the impacts those costs have on the long-range financial health of the utility.

10.2.1 Impacts of Accounting Standards

In order to determine how to fund asset management work on natural assets, it is important to understand the governing accounting structure of the utility. This structure will set the stage for how to account for the money spent on natural assets, and what type of funds (capital versus operating budgets) may be tapped for desired investments in natural assets. Accordingly, the accounting structure and associated accounting standards have a significant impact on developing a long-term funding plan for natural assets.

US water utilities' accounting practices are governed by either the Governmental Accounting Standards Board (GASB) guidelines (for publicly owned utilities), NARUC (primarily for privately owned utilities), or by both GASB and the NARUC guidelines (publicly owned and economically regulated utilities). GASB sets the standards for accounting practices used by government organizations. These standards are used to ensure accurate and consistent methods of accounting and are the baseline for financial audit purposes. NARUC is a similar organization, focused on investor-owned or other economically regulated utilities.

10.2.1.1 GASB and Government-Owned Utilities

GASB accounting standards provide discretion for utilities to treat many natural asset investments similarly to built assets, but prevailing practices and local conditions, as well as state-level policies, often lead to natural assets being accounted for quite differently than built assets.

A recent policy clarification for GASB Standard 62 reveals the complicated relationship between accounting, budgeting, and other issues such as the decision to debt finance an asset. The clarification now provides local government utilities wide discretion in labeling something as a regulatory asset if the revenue used to pay for the asset or debt service for the asset derives from rates which are regulated at the local level.

For example, a utility that agrees to commit $200,000 each year to improve forest management on land owned by a land trust in theory could treat this as an asset investment and use debt financing under GASB 62. However, the ability to use debt is often dictated more by state laws than accounting standards and, in many states, utilities may only be allowed to borrow money for specified purposes or for assets that they own or legally control. In the forest example above, approaches such as creating contractual or easement limits that the contributing utility control might satisfy the requirement.

The advantage of treating these types of expenses as capital budget items or in a long-term capital improvement plan is that many utilities will rely heavily on debt to finance their capital plans which has the impact of spreading the expenses over time, fostering intergenerational equity by requiring present and future customers to participate in paying for items that benefit them. Items included in capital budgets also are presented to the public and governing board as long-term essential investments into the utility's future and justified or not, may be seen on a more favorable basis by the governing board and public than an operating expenditure. Items in capital budgets also tend to be larger in value.

For some natural assets investments this could be the difference of being able to implement a large comprehensive effort rather that more fragmented investments done as a small operating budget items. In other words, a local utility that scrapes together $200,000 per year for watershed protection as an operating budget item may be able to establish a $2 million-dollar program in a capital budget allowing for larger more accelerated investments.

To summarize, accounting standards to the non-accountant may be viewed as black and white rules that allow for no discretion. While many accounting standards do fit this description, there are others that require interpretation and application to local conditions. Based on the current landscape, local government utilities likely have pathways to treating their natural assets similarly to their built assets, but this likely requires changing historic approaches and modifying financial planning processes in an intentional manner. In most cases, constructing natural asset investments in a way that fit into (and can compete for resources) a local utility's capital budget likely would have the biggest impact in changing how natural assets investments are viewed and evaluated. Developing processes that frame natural asset investments in a way where they are included in a local government's capital budget or capital investment program may have a larger impact than altering national accounting standards.

Additional discussion is provided in Appendix C.

10.2.1.2 NARUC and Investor-Owned, Economically Regulated Utilities

Investor Owned Utilities (IOUs) are generally regulated by state utility commissions and how much these regulated utilities can profit in each state is governed by state regulations and rules. IOUs generally adhere to accounting standards that are set at the state level usually following national guidance recommendations such as the Uniform System of Accounts developed by the National Association of Regulatory Utility Commissioners (NARUC) and the accounting standards from the Financial Accounting Standards Board (FASB).

IOU expenditures fall into two general categories – capital type expenditures for items that get included in a utility's rate base, and other expenditures that do not add to a utility's rate base.

- Expenditures such as personnel and supplies that are required to operate and maintain the utility are treated as operating expenses. In most states utilities can pass the full cost of annual operating expenses on to customers through rates on an at cost basis.
- Investments in built or plant assets are considered capital investments that increase the amount of recorded equity the IOU has invested in their utility. The value of these assets goes into a rate base that is treated much differently than operating costs. In most states and for most utilities, the bulk of an IOU's profit comes from a return on equity (ROE) applied to this category of costs. The rate of return varies across the country and is set by each state's regulatory commission. The rules surrounding what is included as equity are ultimately set by the state regulatory commission but are heavily influenced by accounting standards and guidance from professional organizations such as NARUC.

While natural assets such as protected forestland in critical areas of the utility's watershed may play as much of a role in the provision of safe drinking water as built assets such as water tanks, pumps and treatment works, they can be treated very differently for accounting and rate setting purposes. From an accounting standpoint, built assets typically involve assets with a financial value that can be readily quantified, and which are solely owned by the investing utility. The value of these assets is added to the utility's balance sheet, depreciated over time, and standard accounting rules are then used for rate justifications.

In contrast, several accounting challenges arise that are very different for a natural asset than for a built asset. For example, a utility wishing to invest in protected forest land may find it most efficient and cost effective to partner with a land trust and local landowners. A typical transaction could involve the utility covering a portion the cost of land or the cost of a conservation easement for land that will be owned by a third party. Depending on the exact circumstance, these expenditures and assets could be treated differently for accounting purposes, but it is unlikely to be a simple and straightforward as recording the investment as utility equity.

At a recent NARUC conference (NARUC Summer Policy Conference, July 22, 2019), several state regulators were asked for their opinion regarding the above natural asset investment acquisition scenario (Hughes et al. 2019). The general response was that their regulatory systems would have a difficult time allowing for a return on equity for this type of asset investment. The general opinion was that the investment would be recorded as a contribution or operating expense that could be included in rates at cost without any return on investment, such that existing rules would allow for a much greater profit and therefore incentive for investing instead in a built asset. However, there are some exceptions, such as examples where expenditures for tree planting on land not owned by the utility or similar investments were ultimately allowed to be included in the IOU's rate base, but only after making a significant case for them.

In general, the current economic regulatory system and guidance for IOUs is much more oriented to assets that can be easily valued and depreciated, but could probably accommodate other types of assets if they could be shown to be of high value to service provision and there was policy support at the state level. Further, the area of natural asset investment is not the only type of expenditure that defies the historic operating vs. capital equity dichotomy. Regulators and NARUC have identified similar situations where the existing regulatory framework dilutes a utility's incentive for making certain types of investments, including acquisition of water rights. Another example is the increased importance placed on energy and water conservation, which has led to some state commissions to finding new ways of treating conservation programs within the rate base. In time, with making a compelling case, there may be increased opportunities for economically regulated utilities to fold investments in natural assets into their capital programs and rate base.

10.2.2 Capital Asset vs. Operating Expense

In order to develop a funding plan for natural assets, a utility must understand whether the money to be spent on a natural asset is a capital investment or operating expense. In typical built asset management, capital expenditures are frequently the dominant spending type used to facilitate recommended solutions. On the public utility side, this is largely due to GASB accounting standards, utility policies that define what constitutes a capital expenditure, as well as the overall costs associated with the performing significant projects. As covered above, GASB guidelines set the stage for capitalization of significant projects to replace or rehabilitate assets. Debt financing for capital outlays is useful because it spreads the expense over a long timeline, promotes intergenerational equity, is consistent with the theme that "cost causer becomes cost payer" thereby having a moderated impact on revenue requirements and customer rates.

For economically regulated utilities, there are several reasons for capitalizing expenses where possible. For economically regulated utilities, the costs of capital assets are depreciated over a time window and both the depreciation costs and other investment costs are considered recoverable in rates. Additionally, the rate of return a utility is allowed is commonly calculated using the assets owned by the utility. Therefore, investment in assets has the ability to generate higher profits for a private, investor-owned utility subject to economic regulation as a regulated monopoly.

In the case of natural assets, solutions requiring operating expenditures are more likely to be the case. In order to capitalize the costs associated with the natural asset, the utility typically would have to own the asset. While this does happen in some cases (e.g., SPU's ownership of its forested watersheds) and is an excellent solution if the utility can accomplish this, often the utility will not own the asset and therefore will not be able to capitalize expenses which otherwise would be capitalizable.

To illustrate this, assume a utility owns a significant portion of their watershed area and spends $500,000 to restore a forested area that suffered a wildfire. The utility may be able to capitalize the $500,000 as a rehabilitation of the asset so that the asset can again perform the service for which it was originally purchased. If the utility does not own that asset, they typically would have to expense that $500,000 as an operating cost. For an economically regulated utility, this is a big difference as those costs that are capitalized would become an asset which would then earn a rate of return.

Where investments in natural assets need to come out of operating budgets, this imposes a significant fiscal challenge for utilities. Few utilities have millions of dollars in spare in their operating funds, which typically need to be recovered in the same fiscal year as it is incurred as part of a pay as you go (or PayGo) approach directly impacting customer rates. Thus, the provisions of GASB Statement 62, which facilitates the use of capital (debt) funds to cover a utility's distributed assets provides a valuable opportunity for utilities to avoid tapping operating funds to address the investment needs for natural assets it owns.

In California, the signing into law of AB 2480, "Source Watersheds: Financing," in 2016, opens the door to treating investments in natural assets as capital for inventorying and financing purposes (State of California 2016).

10.2.3 Long-Range Financial Planning

In order to fully plan for and fund the future needs of natural assets, it is important for a utility to develop a long-range financial plan. While best practice for utilities is to develop a long-range financial plan, many utilities have not done so.

A long-range financial plan (LRFP) typically covers an extended window beyond normal budgeting cycles (between 5 and 15 years) and is used to better understand the long-term impacts of shorter-term decisions as well as assessing the impacts of future investment decisions. A LRFP looks at the utilities forecasted rates, operating budgets (both revenue and expense) and capital budgets over a long-time window, often 10+ years. A long-term needs forecast with asset needs for both operating and capital investment is used to look at changes in those two areas over the 10+ year window. The capital budgeting also informs the operating budget to reflect changes in asset depreciation, financing costs, return on equity, and any other areas impacted by that capital investment.

An example of a LRFP model is illustrated in Figure 10-3. Utilities are advised that preparing a LRFP is an exercise that requires detailed knowledge of the utility’s financial condition, associated commitments, bond covenants, governing conditions, charter obligations, cash flow needs, etc. The use of a LRFP goes beyond the purpose of asset management, extending to all phases of utility operations.

Anchorage Wastewater Utility
Long Range Financial Plan Summary

LRFP UPDATE
2012 Budget

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Selected Balance Sheet Accounts									
Operating Cash	14,636,461	9,516,504	6,784,504	5,725,504	6,213,504	7,402,504	8,189,504	8,460,504	9,299,504
Construction Cash	(8,583,628)	1,400,304	(12,678,246)	10,809,104	7,736,904	(7,766,996)	41,858,064	21,256,304	2,078,804
Net Capital Assets	347,941,222	357,855,992	376,615,756	393,972,615	401,396,711	422,748,415	466,412,237	486,615,890	507,631,477
Net Long Term Debt	125,891,602	137,270,332	138,854,332	182,099,332	182,548,332	182,058,332	272,276,332	268,418,332	264,108,332
CIAC	171,540,516	172,657,299	170,039,070	167,550,841	169,462,612	171,224,387	169,574,387	167,854,387	166,064,387
Net Assets (Equity)	61,756,428	61,815,996	61,407,787	61,815,538	63,816,309	68,927,084	74,006,083	79,195,083	87,684,083
Summary Income Statement									
Operating Revenue	35,999,449	37,467,331	42,407,000	46,979,000	51,379,000	56,279,000	60,679,000	65,279,000	70,579,000
Operating Expenses	(22,007,019)	(22,860,945)	(25,961,000)	(27,853,000)	(29,210,000)	(30,610,000)	(32,060,000)	(33,210,000)	(34,410,000)
Depreciation	(4,189,089)	(5,528,534)	(6,504,000)	(7,600,000)	(8,050,000)	(8,480,000)	(10,090,000)	(11,040,000)	(11,760,000)
Total Operating Expenses	(26,196,108)	(28,389,479)	(32,465,000)	(35,453,000)	(37,260,000)	(39,090,000)	(42,150,000)	(44,250,000)	(46,170,000)
Operating Income	9,803,341	9,077,852	9,942,000	11,526,000	14,119,000	17,189,000	18,729,000	21,029,000	24,409,000
Investment Income	1,197,783	383,195	157,000	120,000	300,000	350,000	430,000	750,000	710,000
Other Income/Exp	741	2,639	-	-	-	-	-	-	-
Interest expense and amortization on	(4,072,847)	(4,229,546)	(6,090,000)	(5,430,000)	(6,280,000)	(6,210,000)	(8,220,000)	(10,120,000)	(9,890,000)
Allowance for Funds Used During Co	1,019,157	524,722	601,000	380,000	360,000	380,000	380,000	420,000	450,000
Intergovernmental Revenue	-	-	-	-	-	-	-	-	-
Total, non-operating	(1,855,166)	(3,318,990)	(4,332,000)	(4,930,000)	(5,620,000)	(5,480,000)	(7,410,000)	(8,950,000)	(8,730,000)
Income Before Transfers	7,948,175	5,758,862	5,610,000	6,596,000	8,499,000	11,709,000	11,319,000	12,079,000	15,679,000
Special Item & Transfer	-	-	-	-	-	-	-	-	-
MUSA: mill rate based	(4,097,804)	(5,011,065)	(5,330,000)	(5,500,000)	(5,810,000)	(5,910,000)	(6,240,000)	(6,890,000)	(7,190,000)
Net Income (Loss)	3,850,371	747,797	280,000	1,096,000	2,689,000	5,799,000	5,079,000	5,189,000	8,489,000
Less 1.25% MUSA	-	-	-	-	-	-	-	-	-
Less Dividend Paid	-	-	-	-	-	-	-	-	-
Change in Equity	3,850,371	747,797	280,000	1,096,000	2,689,000	5,799,000	5,079,000	5,189,000	8,489,000
Capital Program	25,600,000	30,780,000	37,946,000	30,381,000	31,863,000	31,863,000	33,345,000	34,200,000	35,150,000
New Debt Issued	16,801,626	16,499,419	6,000,000	50,000,000	7,000,000	7,000,000	98,000,000	7,000,000	7,000,000
Rate Increase	6.50%	2.50%	15.00%	11.00%	9.50%	9.50%	8.20%	7.10%	8.00%
Residential Rate	28.54	29.26	33.65	37.36	40.90	44.79	48.46	51.90	56.06
Actual Debt/Equity Ratio:									
Debt	68%	69%	69%	75%	74%	73%	79%	77%	75%
Equity	32%	31%	31%	25%	26%	27%	21%	23%	25%
Financial Policy Debt/Equity Ratio:									
Debt	66%	68%	71%	73%	73%	73%	75%	75%	75%
Equity	34%	32%	29%	27%	27%	27%	25%	25%	25%
Dividend to MOA (including 1.25% MUSA)	-	-	-	-	-	-	-	-	-
Operating Margin	27%	24%	23%	25%	27%	31%	31%	32%	35%
Revenue Bond Debt Svc Coverage	2.99	2.76	3.10	2.98	2.45	2.97	2.62	1.94	2.25
Total Debt Svc Coverage	-	1.19	1.33	1.23	1.28	1.50	1.47	1.26	1.42

	2018	2019	2020	2021	2022	2023	2024	2025	2026
Selected Balance Sheet Accounts									
Operating Cash	10,576,504	9,570,504	11,246,504	15,270,504	19,868,504	17,966,504	18,940,504	22,156,504	25,422,504
Construction Cash	60,521,304	38,613,804	19,756,304	(51,196)	63,191,304	45,676,304	26,261,304	4,946,304	91,731,304
Net Capital Assets	531,001,314	554,981,152	574,990,989	595,110,826	615,320,663	636,727,838	659,037,512	682,207,187	706,336,861
Net Long Term Debt	339,400,444	332,035,444	324,302,444	316,097,444	391,506,444	379,897,444	367,980,444	355,547,444	452,454,444
CIAC	164,204,387	162,274,387	160,274,387	158,204,387	156,064,387	153,854,387	151,574,387	149,214,387	146,764,387
Net Assets (Equity)	97,193,083	107,192,083	119,441,083	133,720,083	148,179,083	163,278,083	180,697,083	199,966,083	218,985,083
Summary Income Statement									
Operating Revenue	75,479,000	79,479,000	83,679,000	88,379,000	92,579,000	96,779,000	101,279,000	105,779,000	110,379,000
Operating Expenses	(35,650,000)	(36,930,000)	(38,260,000)	(39,640,000)	(41,070,000)	(42,550,000)	(44,080,000)	(45,670,000)	(47,310,000)
Depreciation	(12,530,000)	(13,360,000)	(14,160,000)	(14,950,000)	(15,750,000)	(16,590,000)	(17,470,000)	(18,380,000)	(19,340,000)
Total Operating Expenses	(48,180,000)	(50,290,000)	(52,420,000)	(54,590,000)	(56,820,000)	(59,140,000)	(61,550,000)	(64,050,000)	(66,650,000)
Operating Income	27,299,000	29,189,000	31,459,000	33,789,000	35,759,000	37,639,000	39,729,000	41,729,000	43,729,000
Investment Income	730,000	1,110,000	1,100,000	760,000	870,000	1,340,000	1,370,000	1,030,000	1,220,000
Other Income/Exp	-	-	-	-	-	-	-	-	-
Interest expense and amortization on	(11,470,000)	(12,920,000)	(12,590,000)	(12,260,000)	(13,870,000)	(15,320,000)	(14,830,000)	(14,330,000)	(16,460,000)
Allowance for Funds Used During Co	460,000	480,000	500,000	510,000	520,000	560,000	590,000	610,000	640,000
Intergovernmental Revenue	-	-	-	-	-	-	-	-	-
Total, non-operating	(10,280,000)	(11,330,000)	(10,990,000)	(10,990,000)	(12,480,000)	(13,420,000)	(12,870,000)	(12,690,000)	(14,600,000)
Income Before Transfers	17,019,000	17,859,000	20,469,000	22,799,000	23,279,000	24,219,000	26,859,000	29,039,000	29,129,000
Special Item & Transfer	-	-	-	-	-	-	-	-	-
MUSA: mill rate based	(7,510,000)	(7,860,000)	(8,220,000)	(8,520,000)	(8,820,000)	(9,120,000)	(9,440,000)	(9,770,000)	(10,110,000)
Net Income (Loss)	9,509,000	9,999,000	12,249,000	14,279,000	14,459,000	15,099,000	17,419,000	19,269,000	19,019,000
Less 1.25% MUSA	-	-	-	-	-	-	-	-	-
Less Dividend Paid	-	-	-	-	-	-	-	-	-
Change in Equity	9,509,000	9,999,000	12,249,000	14,279,000	14,459,000	15,099,000	17,419,000	19,269,000	19,019,000
Capital Program	36,100,000	37,050,000	38,000,000	38,950,000	39,900,000	41,800,000	43,700,000	45,600,000	47,500,000
New Debt Issued	87,000,000	7,000,000	7,000,000	7,000,000	91,000,000	7,000,000	7,000,000	7,000,000	117,000,000
Rate Increase	6.80%	5.20%	5.40%	5.20%	4.60%	4.40%	4.50%	4.30%	4.20%
Residential Rate	59.87	62.98	66.38	69.83	73.05	76.26	79.69	83.12	86.61
Actual Debt/Equity Ratio:									
Debt	78%	76%	73%	70%	73%	70%	67%	64%	67%
Equity	22%	24%	27%	30%	27%	30%	33%	36%	33%
Financial Policy Debt/Equity Ratio:									
Debt	74%	73%	71%	70%	68%	66%	65%	63%	61%
Equity	26%	27%	29%	30%	32%	34%	35%	37%	39%
Dividend to MOA (including 1.25% MUSA)	-	-	-	-	-	-	-	-	-
Operating Margin	36%	37%	38%	38%	39%	39%	39%	39%	40%
Revenue Bond Debt Svc Coverage	2.22	1.90	2.08	2.24	2.15	1.89	2.02	2.15	2.05
Total Debt Svc Coverage	1.45	1.33	1.43	1.51	1.50	1.38	1.47	1.54	1.50

Figure 10-3. Long-Range Financial Plan Example.
Source: Courtesy of Anchorage Wastewater Utility.

This long-range financial planning assists utilities by showing the impacts of decisions over a longer time window, and how some changes and decisions can compound over time creating unsustainable financial situations. Utilities also can set rate increase limits to adjust revenue forecasts, and thus show limits to changes in operating and capital budgets. Further comparisons between operating expense and capital investment decisions can show potential for focusing on different types of solutions to asset concerns. For example, how does doing more maintenance rather than capital replacements change the long-term financial standing of the utility.

By incorporating natural assets into the LRFP, a utility creates engagement from staff in finance and other areas. This engagement has the ability to open opportunities for maintaining and developing further funding mechanisms.

10.3 Other Funding Options

There are several options for securing financial assistance for investments in natural assets beyond the utility's own rate base and capital program. Partnerships with land trusts and other nature conservation organizations can provide access to funding sources not typically available to water utilities or municipal governments. These partnership-derived funds may also be more flexible in their application than funds from municipal utilities. The partnership developed with several NGOs by the Raleigh, North Carolina water utility provides an excellent example, wherein not only was access gained to a significant amount of funding for targeted acquisitions and restoration of watershed lands acquisitions, but the NGOs are also able to invest in lands beyond the City's boundaries (which would be precluded if only utility funds were available). Additional discussion of the Raleigh case study is provided in Appendix C.

Another useful approach that can be applied entails developing special fees (e.g., a modest monthly charge applied to every meter) dedicated to acquiring or managing/restoring sensitive watershed lands or other targeted natural assets. Central Arkansas Water (CAW) provides an example wherein a dedicated fee (a modest fixed charge applied to every meter) provides a revenue stream to the utility that is dedicated solely to purchasing or managing targeted lands in its watershed. This approach is an example of the Payment for Ecological Services (PES) concept, wherein downstream beneficiaries (utility customers) pay a fee that is used to secure desired environmental services from upstream entities (i.e., the landowners who sell their properties to the utility program).

Several other examples exist in which utilities creatively partner with outside organizations, or through other mechanisms gain access to funds beyond the utility's traditional rates-based or debt service funding stream, to secure resources to invest in natural assets. Several examples are described briefly throughout various portions of this report.

10.4 Conclusions

Investing in natural assets is a critical aspect of managing the risks faced by utilities that derive valuable (if not essential) services from natural systems. As with built assets, investing in prioritized capital or operating (maintenance) programs addressing natural asset risks need to be based on a sound business case, and factored into the utility-wide financial planning system.

Natural assets provide some challenges for investment that do not occur for built systems, because the natural assets may often be owned by third parties, and they may be located beyond the utility's service area or municipal boundary. There may also be applicable accounting standards that place limits on what might be covered through capital programs, shifting more fiscal burden to utility operations budgets that tend to be more highly constrained. At the same time, there are some valuable opportunities afforded by natural assets to form effective partnerships with third parties (e.g., NGOs, trusts, farmers) that provide the utility with access to funding sources (e.g., opportunities to leverage Farm Bill monies) for which the utility would not itself be eligible.

CHAPTER 11

Step 7 - Sustaining a Unified AM Program: Commitment, Continuous Improvement, and Effective Communication

Once natural assets are incorporated into a robust AM Program, there are three additional ingredients for long-term success.

- First, the utility needs to adopt a *continuous improvement* approach to natural asset management. Incremental progress, much like the approach to built asset management, is a key for success for any asset management program, and there are some challenges that may be unique to natural assets.
- The second ingredient for success covered in this chapter is *effective communication*. Successfully incorporating natural assets into AM requires effective communication of the benefits of natural asset management, including benefits to the utility and the broader community. It also requires effective communication within the utility organization and with outside partners and the community at large.
- The third ingredient is to formally recognize the contribution of natural assets to the success of the utility mission by maintaining natural asset management as a stated objective within the utility's long-term strategic plan. This demonstrates commitment to managing a portfolio of valuable natural assets, including those that may be outside of the utility's direct control. The strategy entails applying life-cycle asset management principles to natural assets, consistent with the utility's other business plans. While specific actions will evolve over time, sustained commitment leads to concrete results.

11.1 Continuous Improvement

Continuous improvement is crucial for any successful asset management program, and it is part of the natural asset management framework presented in Chapter 3. Figure 11-1 shows a standard *plan-do-check-adjust* model for continuous improvement. Most of what was covered so far in this document focuses on the "plan" and "do" phases.

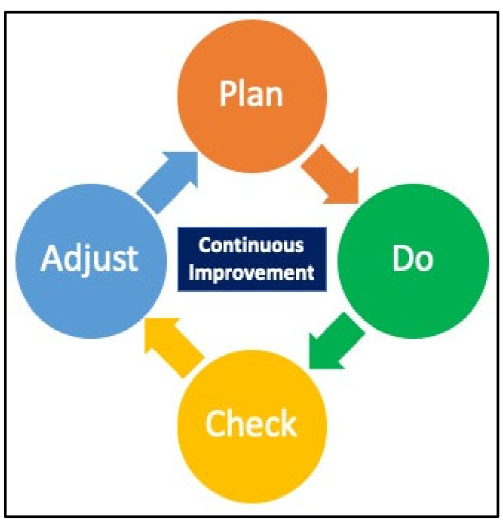

Figure 11-1. A Standard Conceptual Model for Continuous Improvement.

The “check” phase involves evaluating whether the utility is meeting its objectives. This proceeds on two levels. First, the utility can assess and evaluate whether its asset management program is meeting overall AM goals. This is covered in depth in the IIMM (see Section 4.6.1) and other asset management resources. This step is applicable to any AM program, whether it includes natural assets or not.

A few key ideas are may be particularly helpful. First, it can be helpful to learn from other utility organizations about their successes, challenges, barriers they overcame, and failures. Utilities who are just beginning to expand asset management efforts to include natural assets will find benchmarking its program against other utilities a good way to identify areas of strength and areas for improvement. Various benchmarking approaches are available (WSAA 2016; EPA et al. 2017; Graf 2010) -. However, benchmarking needs to be conducted with care, because utilities often face unique circumstances that may make direct comparisons to other utilities misleading. Accordingly, benchmarking to evaluate applying AM to natural assets may best focus on the process steps (i.e., what steps have been taken), rather than numerical comparisons (e.g., amount invested in natural assets, amount of sediment load reductions).

The second way that continuous improvement applies is that the utility must monitor conditions for managed natural assets and evaluate whether interventions are achieving the utility’s objectives for those assets. This requires monitoring natural asset conditions over time to determine whether the assets are improving due the utility’s interventions. Improvement is measured against established LOS and KPIs. For example, if a utility establishes water quality LOS and associated KPIs for erosion and sediment loading from a forested watershed, it can track whether these targets are being met.

In a similar way, when a “do nothing” decision with respect to intervention has been applied, the utility is also advised to monitor the results. A “do nothing” decision should be followed by monitoring of asset conditions over time to assure the organization its decision is valid, that a LOS is being maintained, or whether the decision should be re-evaluated or adjusted (i.e., whether degradation has occurred, and an active intervention to protect or enhance the asset may now be warranted).

In either case, if the targets are missed, the utility will need to assess why. Are built or natural assets performing as desired? In an application to managing source water quality for sediment loads, the question may be framed as: Have dams, diversions and/or return flows, including those not owned or managed by the utility, changed in ways that mobilize more sediment? Have weather conditions resulted in more erosion or mobilization of sediment? Finally, are managed natural assets performing as expected given the utility’s interventions in those assets?

One example of this are the techniques employed by the San Francisco Public Utilities Commission (SFPUC 2016). A comprehensive annual report is produced by the Commission to describe the results of SFPUC’s Watershed and Environmental Improvement Program (WEIP). The report focuses on accounting for the progress made during the previous fiscal year, and outlines priorities for current and future fiscal years. In addition, a report documenting the first 10 years of progress of the WEIP program was produced. The WEIP is a program providing $50 million over at least 10 years for SFPUC to proactively manage, protect and restore environmental resources that affect or are affected by the operation of the SFPUC water supply system.

As with condition assessment, monitoring natural assets to evaluate whether LOS are met may require methods and skillsets that, in some cases, may not be part of a utility’s standard competencies. For example, this may require monitoring forest health or the stability of plant communities in a wetland. This may be especially true if environmental stewardship is a key goal for managing the natural asset. In that case, the asset is managed for overall ecological health, rather than or in addition to objectives directly related to water supply and source water quality.

Further, assessing how well interventions (capital investments and/or O&M activities) for natural assets are performing can be very challenging. Natural systems are complex and the connection between interventions, asset condition and desired LOS can be non-linear in nature and highly uncertain.

Adaptive management (Holling 1978; Lee 1993) can be an effective approach for dealing with these challenges. In adaptive management, uncertainty is addressed by treating interventions, at least in part, as experiments from which we can learn more about the system. For example, a utility (with its partners) may choose to implement different approaches to forest restoration in different portions of the management area and track which of these approaches were most successful in yielding desired results. As the utility learns more about which approaches are most successful in yielding desired results and why, they can proceed to implement the more successful approaches in more places.

Adaptive management is in essence an approach to continuous improvement that is focused on dealing with uncertainty in the behavior of complex natural systems. Figure 11-2 shows an approach to adaptive management and similarities to the logic of continuous improvement.

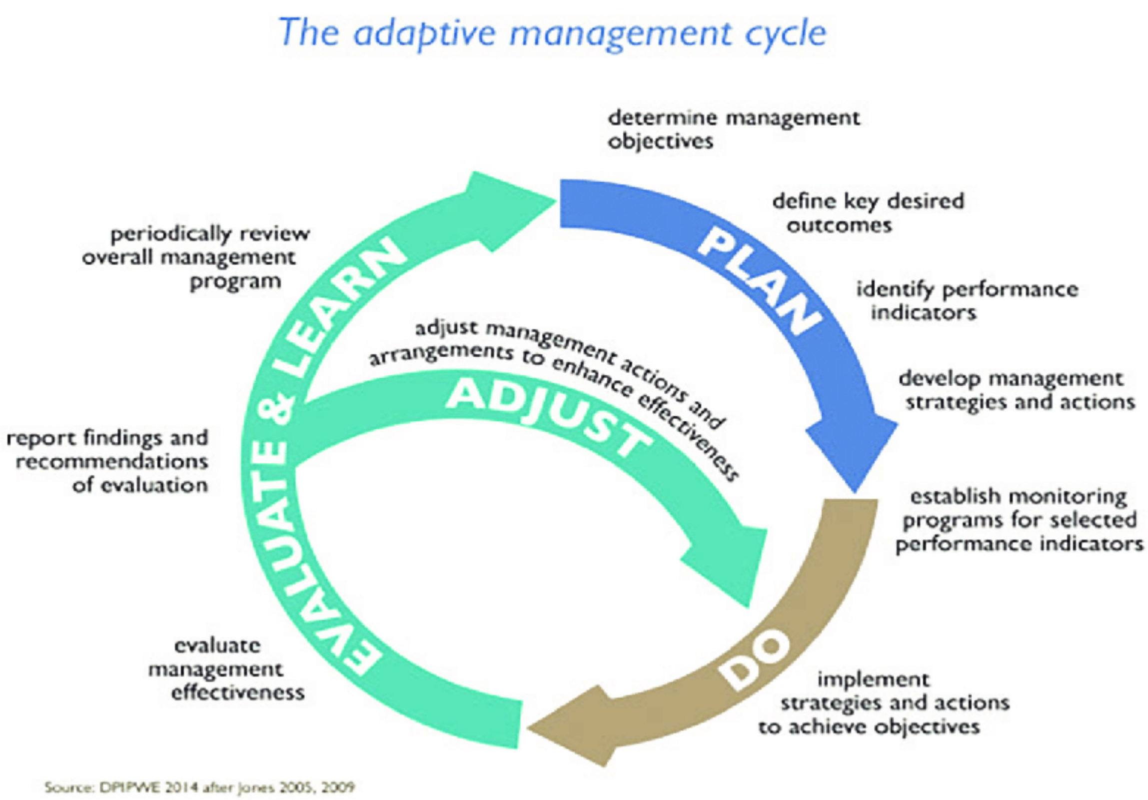

Figure 11-2. Adaptive Management Provides an Approach for Continuous Improvement in the Face of Uncertainty in Managing Natural Systems.

The phases of adaptive management are similar to standard continuous improvement models and can be applied to natural asset management.

Source: DPIPWE 2016 after Jones 2005, 2009.

11.2 Communication

Communication is a critical factor for on-going success of natural asset management. Champions for natural asset management will need to communicate early and often with utility leadership to build and sustain support (as discussed in Chapter 5). In addition, continuous and effective communication with customers and thought leaders in the larger community will help the utility understand community priorities for natural resources and environmental stewardship. The utility can then better reflect those priorities in natural asset management decisions, and it can share results with the interested parties.

Effective communication with leadership, customers or any other audience requires planning. In particular, you need to know something about the audience(s) and, based on that knowledge, select the most effective messages, messengers, and means for delivering those messages. The sections below cover some principles and methods for communication planning, with a focus on unique challenges for communicating about natural asset management. Most utilities have active programs and staff dedicated to internal and external communication. The information below will help the utility build on those communication practices to support successful natural asset management.

> *"Effective AM needs to meet the demands of rapidly changing social, political, legislative, and business environments" (IPWEA et al. 2015).*
>
> To understand these demands, utilities will need effective ways to communicate with leadership, oversight bodies, customers, partners, and the larger community.

11.2.1 Communication with Leadership

Natural asset management is not a traditional approach for water utilities, so buy-in among senior leadership, oversight boards or commissions, and regulatory bodies will be vital for success. As discussed in Chapter 5, leadership commitment is a critical facilitator for successful asset management. Sustained commitment from leadership requires continuous and on-going communication about the role that natural assets play in achieving utility business goals, the risks to natural assets and, by extension, risks to the utility's goals, and how the utility could invest to reduce the risks.

Important messages about natural asset management that are valuable to deliver to senior leadership and oversight groups include:

- An overall description of the natural assets that are important for the utility's business goals and the services they provide. The description may include an estimated monetary valuation estimate of those services to put natural asset services in perspective with other utility investments, although a good descriptive narrative may suffice as a starting point.
- Risk to the utility if natural assets are not adequately managed and are allowed to degrade to a point where functions normally provided by natural assets decline, or where natural hazards threaten to degrade the asset and the services provided.
- The benefits of managing natural assets including, to the extent feasible, a quantitative description of the return on investment. This requires an assessment of risk exposure, typically as a Triple Bottom Line assessment, and usually in terms of risk cost that will be reduced through some utility action to protect or restore the natural asset.
- The degree of customer and community interest and support for natural asset management, as evidenced by data gathered via surveys or other engagement techniques.

- Once natural asset management has been in place for some time, examples or stories that demonstrate success and the benefits of asset management.

The utility's internal champions for natural asset management cannot communicate these messages to the senior leadership and other audiences that may lack the underlying information. The champions will require information to make the case, which they can obtain from this document, case studies on natural asset management, and available literature, as well as the utility's own experience as they proceed with natural asset management.

Planning communication with leadership and oversight groups requires some knowledge about those audiences. In particular, it will be helpful to know how individuals within these audiences view issues relevant to natural asset management, such as:

- Are they aware of the utility's existing asset management program and have they been supportive of the program?
- What are their views or positions on issues related to natural resources or environmental stewardship? How are these views or positions relevant to natural asset management, and is natural asset management recognized as a strategic objective for the utility?
- What types of communication messages have been most effective with these audiences in the past? Are they most interested in quantitative information or narrative descriptions? Are they most responsive to strict business case evaluations or are they interested in values-based arguments?

In many cases, you may not be able engage directly with leadership or members of oversight bodies to gather information from them about these types of questions. Knowledge from past experience among your team and other colleagues may be the best source of information about the best way to communicate about natural asset management with utility leadership.

11.2.2 Communication with Customers and the Community

Asset management must be driven by utility goals and associated target levels of service that, in part, come from customer expectations. Three elements of customer communication are critical for managing natural assets.

- First, a utility must gather input from customers to set appropriate customer-focused levels of service (see IIMM Section 2.2.5 for ideas and approaches). An element of leading practice is to include an educational component with customer conversations; for example, helping customers reach a common level of understanding in order to obtain valuable input on desired levels of service (WSAA et al. 2017).
- Second, some utilities will include broader environmental stewardship goals in their asset management programs. These goals are usually driven by the priorities and values of their customers and the broader community in which they operate. Establishing these goals and setting associated levels of service will require input from customers, community thought leaders and elected officials, and other relevant entities (e.g., landowners, regulators, conservation organizations) about environmental priorities and preferences.
- Finally, even in the absence of formal stewardship goals, managing natural assets almost certainty provides benefits beyond those focused on core utility business goals for water provision. Gathering input from customers and the broader community will help the utility better understand and value those co-benefits.

In addition to gathering input from customers and the community, utilities will need effective ways to communicate out to the community about its decisions and actions related to natural assets. This will help customers and the larger community remain aware of the utility's actions for natural assets and the reasons that the utility is investing resources in these assets. Clearly communicating about business goals, LOS, and investments related to natural assets will prevent misunderstanding among the public and will enable the public to provide feedback about the utility's actions.

As with communication with leadership, information about customer and community audiences will help the utility communicate effectively. Information about messages and delivery mechanisms that tend work with your customers, as well as predominant attitudes and values toward natural resources and environmental issues will help.

There are many ways to gather input from the community, disseminate information to the community and to engage directly with members of the community. Many of these are already active practices within your organization. Some of these approaches are summarized in Table 11- 1.

Table 11-1. Methods for Communicating with Customers and the Broader Community in Which the Utility Operates.

	Gathering input	Disseminating information	Two-way engagement
Purpose	To better understand the values, preferences and priorities of your customers and broader community	To inform customers and the larger community about utility decision and actions	To enable a deeper dialogue between utility staff and members of the public
Methods and Approaches	▪ Phone, paper, or web-based surveys ▪ Focus groups ▪ Formal public meetings (i.e., presentation and comment format)	▪ Social media (Twitter, Facebook etc.) ▪ Traditional media (press releases, radio ads) ▪ Websites and multi-media ▪ Fact sheets and other handouts ▪ Format public meetings (i.e., presentation and comment format)	▪ Workshops and open house events ▪ Participation at community events (e.g., farmer markets, county fairs etc.)

A leading practice is illustrated by the Albuquerque Bernalillo County Water Utility Authority's (ABCWUA) customer conversation program which consists of quarterly topic forums (WSAA et al. 2017). They are intended to educate and inform customers while also soliciting ideas and opinions. ABCWUA's program has addressed topics such as long-term water supply, adaptive management planning, water reuse, infrastructure renewal, conservation activities and rates. The process includes facilitated interactions, workshops with education and feedback components, and customer credits for attendees.

11.3 Conclusions

As with any important endeavor at the utility and with key partners, best practice must embody a sustained process for continuous improvement, as well as on-going effective communication. Continuous improvement requires a repeating sequence of periodic evaluation of progress compared to stated objectives, and then making adjustments as may be needed to enhance performance. Effective communication entails efforts to gain a clear understanding your various audiences' needs, questions of critical concern, and current understanding of the issues. Effective communication also requires effective outreach to share relevant information with a wide array of internal and external audiences, using communication strategies (e.g., messages and messengers) that will resonate with each target group.

CHAPTER 12

Conclusions and Agenda for Future Research

12.1 Conclusion

Natural assets—including forested watersheds, aquifer systems, wetlands, and other natural features associated with the quantity, quality, and/or timing of water—provide a wide range of valuable services to water utilities. The high-value services provided by natural assets include contributions to source water quality, moderating runoff and floods, and groundwater recharge.

Degradation of natural assets can reduce the level of service (LOS) they provide, which in turn may pose significant risks for a utility. These risks include impaired water quality, reservoir sedimentation, stormwater flooding, and others that may adversely impact utility costs and the quality of the services provided to their customers. Ultimately, the condition and performance of natural assets are essential to supporting a water utility's ability to meet its strategic objectives of cost-effectively and reliably delivering safe drinking water to its customers.

Managing natural asset risks helps ensure that these assets meet their target LOS. Utilities thus will find value (often in the form of avoiding costly adverse consequences) in developing an understanding of the risks posed by potential changes in a natural asset's condition, and the associated risks to the important flow of goods and services provided by that natural system.

The research approach applied throughout the framework and guidance developed in this document draws from the rich field of asset management (AM), as increasingly applied by water utilities to their built systems (such as pipelines and treatment plants). The objective is to draw on the same principles and practices that are gaining maturity and broad sector-wide application for built systems, and to apply them to natural assets. In this manner, a water utility can manage all of its assets by applying the same basic steps and processes. The AM Wheel initially developed by AWWA for application to built systems has thus been adopted, and slightly adapted, for application to natural assets. Thus, natural assets can be integrated into asset management so that they are managed alongside (and on equal footing with) built assets to best meet utility business goals and strategic objectives.

The framework and guidance provided in this document offer a systematic, step-by-step approach for incorporating natural assets into an asset management program, building on standard asset management principles and practices. The framework and guidance also identify and address specific challenges of natural assets and that may require some unique approaches.

Some of the unique characteristics of natural assets may require an iterative approach to condition and risk assessment, setting of levels of services, and planning investments. In addition, natural assets are rarely owned by a utility, thereby often requiring different approaches to fund, finance and execute management actions to preserve, protect, or enhance these assets.

12.2 Recommended Future Research

Future research will enable the important task of prudent utility management of natural assets to progress further. The research team recommends the following potential avenues for future research:

- Developing detailed case studies and evaluations of utility programs in which natural assets have been viewed and managed through an AM lens. The integration of natural assets into AM programs is in its infancy in many locations, and perhaps not yet in the radar screen for many utilities. There is a lot that may be gained, for all water sector utilities, by developing a small number (e.g., 3 or 4) detailed case studies and assessments of select utility efforts to manage natural systems using the AM Framework. This effort would provide important insights into the challenges, opportunities, and rewards of applying the basics of AM to all utility natural and built assets, and offer clear examples of how this may be done successfully in a water sector utility setting (including clean water, stormwater, and recycled water agencies as well as water supply agencies).
- Exploring and documenting the process of building successful partnerships to help manage natural assets. In many if not most cases, natural assets of significance to water utilities are not owned, managed, and/or accessed solely by these utilities. Instead, private landowners, and/or state and federal agencies often hold ownership and primary management authorities; and access is often open to the general public (e.g., for recreation in forest lands). There have been several successful partnerships that have been developed by or including water utilities, with the objective of protecting or enhancing key portions of watershed areas and other important natural assets. A practical study of several types of potentially valuable partnerships, funding opportunities, and other institutional arrangements would provide a menu of viable options for water utilities to consider for how to form successful partnerships, and for discerning what types of partners and partnerships might be most useful and feasible in their settings.
- Development of asset registers of natural assets. Efforts to develop a systematic approach to defining natural assets so such assets may be included in a utility asset register will help organizations. Already, Canadian efforts to build natural assets into asset registers can be used as a starting point. The ability to include natural assets into an organization’s asset register is viewed as an important step in capturing data on condition, value, and operations and maintenance activity, all important facets of mature asset management practice.
- Guidance related to inclusion of natural asset functions in Utility accounting practice. Apart from natural capital accounting, practices which allow a utility to report out to investors, stakeholders, and the public on the utility’s reliance upon ecosystem functions should be developed. Given that utilities may operate under accounting guidance emanating from different sources, it would be helpful for guidance to be developed that relate to prevalent accounting standards employed in North America. Such guidance should address how and whether utilities engaging in partnership with other owners of natural assets can present information that informs and discusses the dependence of the utility’s financial position on the ecosystem services it receives, as well as expenses the utility incurs associated with such assets to create customer and stakeholder value.

APPENDIX A

Common Natural Asset Types and Their Contribution to Beneficial Hydrological Services

Table A-1 provides examples of how various types of natural assets provide valuable services.

Table A-1. Natural Asset and Contribution to Beneficial Services.						
Hydrological Service to Utility	**Forest – Watershed and Riparian Zone**	**Wetlands and Floodplains**	**Grasslands**	**Lakes, Rivers, and Streams**	**Aquifers and Aquifer Recharge Zones**	**Mountain Snowpack, Glaciers**
Maintain Regular Supplies						
– Maintain dry season flows / dry season supply	By increasing infiltration (root depth and soil depth) forested vegetation can maintain or increase dry season flows; however, in some cases forests can decrease dry season flows, if increases in ET reduce infiltration. The effect will depend on the scale of forest area relative to watershed or catchment area.	Evaporation from wetlands can be relatively high (compared to other land cover types) and in some cases may reduce dry season flow in rivers downstream. In other cases, especially where wetlands occur over permeable soils or rocks, dry season flows can be increased (e.g., floodplain wetlands over permeable gravels or sands).	Grasslands with deeper rooted native vegetation and soils that have not been compacted also promote infiltration and can contribute to dry season flows downstream, although the effect is generally smaller than for forests.	NA[11] (other natural assets contribute to dry season flow in streams and rivers)	Aquifers that are connected to surface waters (e.g., floodplain aquifers, springs in headwaters to streams) can augment dry season flows as groundwater is discharged to streams or rivers. In these cases, protecting aquifer recharge zones can contribute to maintaining dry season flows.	By slowly releasing water stored in snowpack and glaciers during spring and summer, mountain snowpack and glaciers contribute significantly to maintaining dry season flow.
– Maintain groundwater supplies / recharge	Forests can affect groundwater recharge in a variety of ways; if deep infiltration is greater than interception and ET, recharge can be enhanced. Removal of forest (e.g., by development or wildfire) tends to increase runoff and decrease the potential for recharge.	Wetlands with hydraulic connectivity with groundwater contribute to groundwater recharge.	Where grasslands with native vegetation and deep soils exist over permeable substrates, contributions to groundwater recharge can be significant.	Lakes, rivers, and streams with hydraulic connectivity to groundwater can be important sources for groundwater recharge.	Natural vegetation that maintains or enhances infiltration in critical aquifer recharge zones will contribute to maintaining groundwater recharge.	Mountain snowpack and glaciers can contribute to groundwater recharge via streamflow as well as diffuse recharge from mountainous areas to adjacent alluvial aquifers.

[11] Not applicable or not a significant effect.

Table A-1. Natural Asset and Contribution to Beneficial Services.						
Hydrological Service to Utility	**Forest – Watershed and Riparian Zone**	**Wetlands and Floodplains**	**Grasslands**	**Lakes, Rivers, and Streams**	**Aquifers and Aquifer Recharge Zones**	**Mountain Snowpack, Glaciers**
Maintain or Improve Source Water Quality						
– Control erosion and reduce sediment in water supplies	Forest vegetation reduces erosion by protecting soils from the erosive force of rainfall, enhances infiltration which reduces runoff. Tree roots help stabilize soils and hold sediment in place.	By slowing the movement of water across the landscape and storing water for short to long periods, sediments settle out and are retained in wetlands.	Healthy grassland vegetation will protect soils from erosion and hold sediments in place, especially compared to bare soil or developed areas.	NA (other natural assets contribute to sediment in streams and rivers)	NA (other natural assets are primary determinants of water quality in aquifers)	Gradual melt from snowpack and glaciers can help maintain soil moisture and organic matter in soils, as well as helping maintain vegetation, contributing to reducing erosion and sedimentation.
– Reduce nutrient and pollutant levels in water supplies (surface and groundwater)	Pollutants can be carried with sediments so by reducing erosion forests help keep pollutants out of water supplies. Forest vegetation and soil microbes also take up nutrients and process pollutants. Shading from forest vegetation, especially in riparian areas can reduce water temperatures, which can help minimize occurrence of harmful algal blooms.	Wetlands are particularly important for uptake of nutrients, denitrification, and bioremediation of some pollutants. Wetlands can help maintain cooler water temperatures and by removing nutrients can help minimize occurrence of harmful algal blooms. Floodplains are zones of very high microbial activity, processing of nutrients and bioremediation of pollutants, as well as contributing to moderating water temperatures.	Grassland vegetation and soil microbes also take up nutrients and process pollutants, helping to keep excess nutrients and pollutants out of water supplies.	NA (other natural assets are the primary contributors to nutrient and pollutant levels in streams and rivers)	NA (other natural assets are primary determinants of excess nutrients, pollutants or toxins in aquifers)	Gradual melt from snowpack and glaciers can help maintain soil moisture and organic matter in soils, which supports microbial activity, nutrient uptake, and processing of pollutants and toxins. Snowmelt contribution to surface waters can help moderate water temperatures and minimize occurrence of harmful algal blooms.
– Reduce / avoid saltwater intrusion to coastal water supplies	Forests that maintain infiltration (i.e., maintain pervious land cover) and contribute to recharge of coastal	Wetlands in coastal areas can help maintain groundwater (freshwater) elevations and minimize saltwater intrusion; draining coastal wetlands	Grasslands in coastal areas (e.g., salt marshes) retain sediments and build up organic matter, keeping land	Streams and rivers are important sources of freshwater flow into coastal areas, including into coastal aquifers, maintaining	NA (other natural assets are primary determinants of health of coastal aquifers and saltwater intrusion)	Other assets are more important but where snowpack and glaciers are important sources for freshwater flow in

Table A-1. Natural Asset and Contribution to Beneficial Services.

Hydrological Service to Utility	Forest – Watershed and Riparian Zone	Wetlands and Floodplains	Grasslands	Lakes, Rivers, and Streams	Aquifers and Aquifer Recharge Zones	Mountain Snowpack, Glaciers
	aquifers help maintain groundwater (freshwater) elevations that prevent saltwater intrusion.	can lower groundwater levels and allow saltwater intrusion.	elevations high relative to sea level and minimizing saltwater intrusions. Land subsidence is a major contributor to saltwater intrusion.	high groundwater (freshwater) levels that can minimize saltwater intrusion. Dams and/or over-exploitation that reduces freshwater flows (e.g., Colorado River delta) can result in saltwater intrusion to aquifers.		coastal areas (e.g., coastal mountain systems) they contribute to maintaining freshwater groundwater elevations.
Hazard Mitigation (Avoid/Reduce Costs and Supply Disruption)						
− Buffering the effects of drought conditions (including risk of wildfire and resulting water quality impacts)	Healthy forests that contribute to maintaining soil moisture, infiltration, dry season flow, and groundwater recharge can provide some buffer against seasonal and short-duration drought conditions.	Wetlands with hydraulic connectivity to groundwater can buffer some drought conditions by maintaining groundwater supplies. Some wetlands with hydraulic connectivity to surface water (e.g., floodplains, lakeshore) can also provide some buffering against drought by augmenting river or lake levels during dry periods.	Healthy grasslands that contribute to maintaining soil moisture, infiltration capacity, dry season flow, and groundwater recharge can provide some buffer against seasonal and short-duration drought conditions.	Water storage in lakes and rivers can provide buffering against short- to moderate-duration drought conditions.	Aquifers provide some of the most important buffering for droughts but are vulnerable to over exploitation.	Glaciers in particular serve as storage reservoirs and can continue to provide supplies during drought conditions; however, this effect is under increasing threat from climate change. Elevated soil moisture can help protect forested areas from drought conditions and may help reduce risks of wildfire, but this effect will be influenced by the size of the snowfield and will decrease with distance downslope from the snowfield.
− Reduce flooding risk	Forests can reduce peak flows and provide some moderation of	Floodplain wetlands in particular can reduce and/or delay flooding by	Grasslands can reduce surface runoff compared to agricultural or	Some protection that is dependent on maintaining adjacent floodplain or	NA	Very rapid snowmelt contributes to flooding in spring or early summer.

Table A-1. Natural Asset and Contribution to Beneficial Services.						
Hydrological Service to Utility	**Forest – Watershed and Riparian Zone**	**Wetlands and Floodplains**	**Grasslands**	**Lakes, Rivers, and Streams**	**Aquifers and Aquifer Recharge Zones**	**Mountain Snowpack, Glaciers**
	downstream flooding. The effect on reducing peak flows and downstream flooding declines as the size of precipitation events increases so that flood mitigation may be effective at moderate-sized events but not for very large precipitation events.	providing short-term flood storage. Wetlands can reduce flooding from small to moderate precipitation events but have limited effect on flooding from very large events; small wetlands in headwaters areas are unlikely to reduce flooding significantly and can increase runoff during larger events.	developed land and can provide some flood protection during moderate events.	lakeshore wetlands that can absorb and store floodwaters.		With climate change 'rain on snow' events in some mountain areas (e.g., Pacific Northwest) may increase, contributing to increased flood event.
– Reduce landslide / catastrophic sedimentation risk and damaged	By stabilizing soils, forests can protect against landslides, but this effect is limited in the case of large or extreme events, such as long periods of intense rainfall on steep slopes. Healthy forests that reduce risk of wildfire can minimize sedimentation to storage reservoirs, dredging costs, and supply disruptions.	NA	Grasslands may provide some limited protection by stabilizing soils, but this effect is limited in the case of large or extreme events, such as long periods of intense rainfall on steep slopes.	NA	NA	NA

APPENDIX B

Examples of Using Proxies for Natural Asset Risk

Two examples are provided in this appendix to illustrate how data on natural asset condition and potential threats can be used as proxies for assessing the likelihood of natural asset failure.

B.1 USFS Forests to Faucets Program

The USFS Forests to Faucets program developed a tool that can support assessment of risk of forest asset degradation and resulting failure to target LOS. Spatial analysis, with a Geographic Information System (GIS), is used to incorporate spatial data, model spatial processes, and clearly display the results (Weidner and Todd, 2011).

The logic behind this decision support tool is illustrated in Figure B-1. The project uses available data sets to combine 3 separate analyses to produce an aggregate identification of threats and hazards that could result in loss of forest services related to protecting raw surface water quality. The hazards assessed in the tool include wildfire, development, and damage from insects/disease.

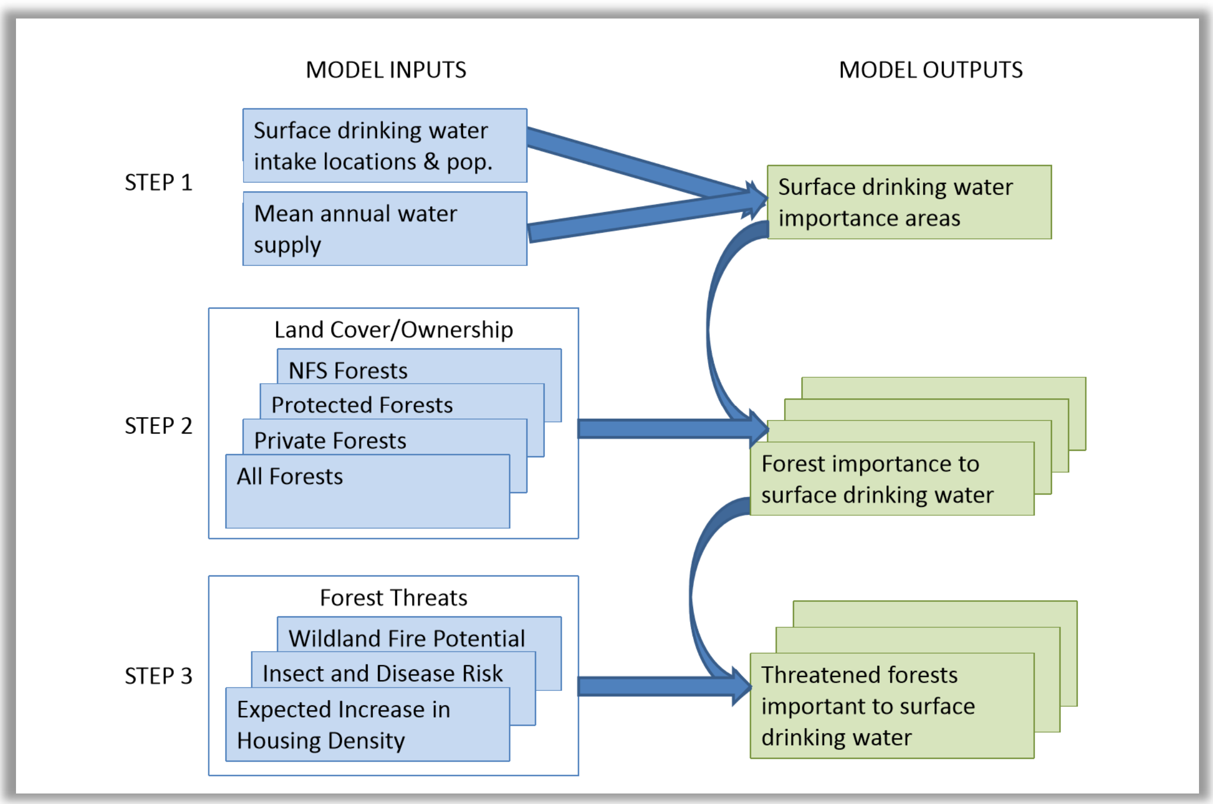

Figure B-1. USDA Forest Service Forest-to-Faucet Risk Assessment Tool for Surface Water Supplies.
Source: Weidner and Todd 2011.

Output of the tool are maps (see Figure B-2) illustrating threats to surface water supply at a watershed scale. Web maps provide a watershed index of surface drinking water importance, a watershed index of forest importance to surface drinking water, and a watershed index to highlight the extent to which development, fire, and insects and disease threaten forests important for surface drinking water.

Tabular datasets are joined with the NRCS Watershed Boundary Dataset HUC-12 to produce images illustrating the threats to drinking water supplies at a watershed scale. Watershed indexes are color coded to represent different degrees of threat for each type of hazard. Utilities interested in accessing these data for their own purposes can use data sets and results at: https://www.fs.fed.us/ecosystemservices/FS_Efforts/forests2faucets.shtml.

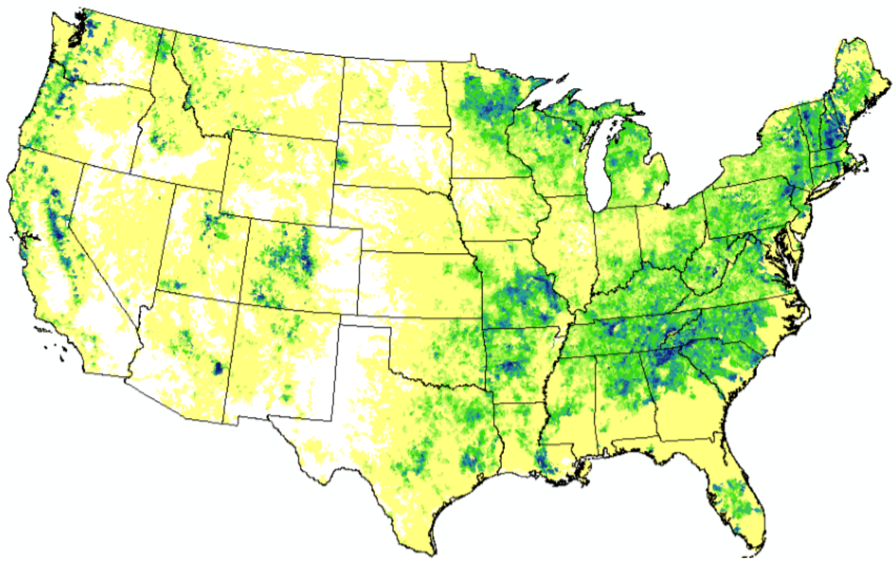

Figure B-2. Example of Forest-to-Faucets Map Output.
showing sub-watersheds with high surface drinking water importance, high amounts of forested lands, that are threatened by development. Threat level is reflected by color shading and ranges from low (areas of no color) to high (dark blue).
Source: Weidner and Todd 2011.

The authors explain this type of analysis affords the opportunity for summarizing findings at larger watershed scales and standardized comparison across the country. Due to the geographic scope of this project, the Forest Service employed models general enough to work at the national scale. However, specific forest management decisions should be based on local considerations. Because of this, a water utility employing such a technique is encouraged to do further spatial analysis conducted at a finer scale to better incorporate localized data, and local knowledge (Weidner and Todd 2011).

B.2 Savannah River Fund Watershed Management Priority Index

An example of further refining risk assessment applied to surface source waters is employed by the Savannah River Clean Water Fund. Connecting land use to water quality, a partnership of utilities and state governments reviewed several landscape modeling approaches. They settled on developing a Watershed Management Priority Index (WMPI) Tool (Krueger and Jordan, n.d.).

The WMPI is a GIS-based tool that allows users to analyze and layer landscape factors that affect water quality. The WMPI contains three sub-modules: (1) the Conservation Priority Index (CPI), (2) the Restoration Priority Index (RPI), and (3) the Stormwater Management Priority Index (SMPI).

The core objective of the Fund is related to protecting surface water quality for drinking water, and over 75% of the watershed is presently in undeveloped status. Hence, a strategic focus was on conservation of lands with high potential to impact water quality. Accordingly, the WMPI is currently focused on using the CPI to assess lands for potential preservation, with a future focus being on using the RPI to support restoration-based mitigation actions.

The CPI is an expression of the degree of impact that conversion of natural land to other uses at a particular point in the watershed will have on water quality. A higher CPI score means there is a greater impact to water quality from land use. It does not attempt to characterize the nature of the impact, nor does it attempt to characterize the downstream fate of contamination from upstream changes in land use. Instead it only is to point out which areas are most important to maintain in natural land use so that water quality is maintained in its current state. In this sense, it is identifying specific areas within a watershed contributing to the likelihood of an impact to water quality.

The WMPI is built upon seven factors, and the sub-modules are derived from different arrangements of the factors as illustrated in Figure B-3.

Scored on 0-3 scale	CPI Conservation Priority Index	RPI Restoration Priority Index	SWMPI Storm Water Management
Land Use	3 = Forested, Natural Land Cover	3 = Ag, Barren, Sparse Veg 2 = Grasslands	3 = High Intensity Urban 1 = Low Intensity Urban
Proximity to Streams	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters
Proximity to ponds/wetlands	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters
Soil Hydrologic Group	3 = C/D: Low Infiltration Rates 2 = B: Moderate Infiltration 1 = A: High Infiltration Rates	3 = C/D: Low Infiltration Rates 2 = B: Moderate Infiltration 1 = A: High Infiltration Rates	3 = C/D: Low Infiltration Rates 2 = B: Moderate Infiltration 1 = A: High Infiltration Rates
Soil Erodibility (Kfact)	3 = High 2 = Moderate 1 = Low	3 = High 2 = Moderate 1 = Low	3 = High 2 = Moderate 1 = Low
Slope	3 = greater than 18% 2 = 8% - 18% 1 = less than 8%	3 = greater than 18% 2 = 8% - 18% 1 = less than 8%	3 = greater than 18% 2 = 8% - 18% 1 = less than 8%
100 yr Floodplain	3 = In Floodplain	3 = In Floodplain	3 = In Floodplain

Figure B-3. Factors and Weightings of WMPI and Its Sub-modules.
Source: Krueger and Jordan, n.d.

The index is combined with information on individual parcel tracts within the study area. This is to transform the CPI to a useful tool for targeting individual parcels for conservation real estate transactions. CPI scores are accumulated inside of legal tract boundaries and divided by acreage of individual parcels to produce a single tract score. The highest scored parcels become the highest priority lands to be protected, based on the assumption those parcels have the highest likelihood of creating water quality impact, that preservation will maintain existing ecosystem function of protecting water quality. The Fund then uses this prioritization scheme to pursue land acquisition or land rights to preserve selected parcels. The Fund does this by mapping out these parcels as illustrated in Figure B-4.

An approach of this type is dependent upon use of spatial data sets specific to a region, as well as detailed parcel data available through commercial means. The approach is designed to support land conservation decisions, so use of this is for risk assessment purposes is limited.

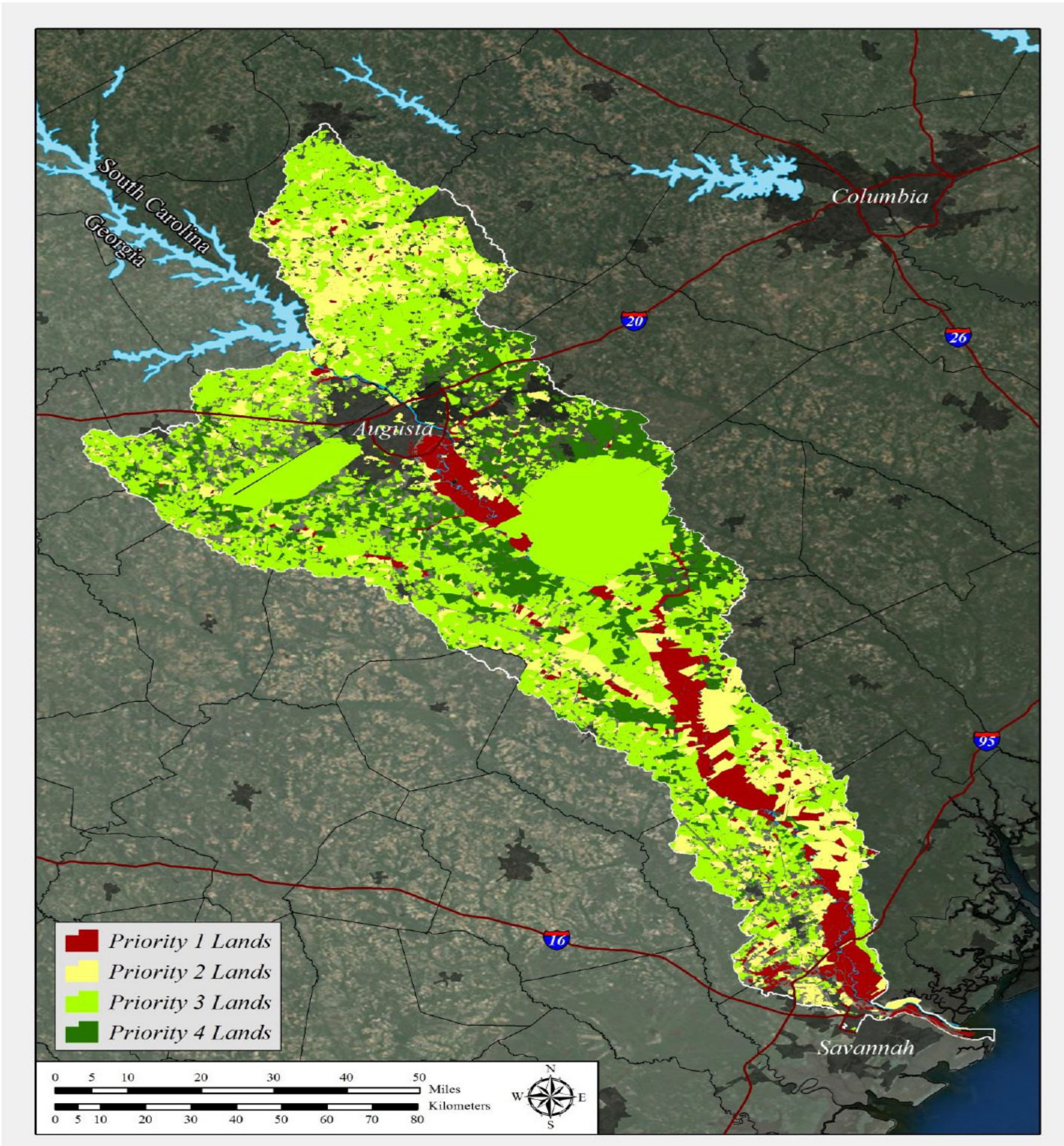

Figure B-4. Prioritized Lands Targeted for Risk Mitigation Using WMPI.
Source: Kreuger and Jordan, n.d.

APPENDIX C

Accounting, Rate Setting and Budgeting Treatment of Natural Assets for Government-Owned Utilities

- GASB accounting standards provide discretion for utilities to treat many natural asset investments similarly to built assets, but prevailing practices and local conditions often lead to natural assets being accounted for quite differently than built assets.
- Developing processes that frame natural asset investments in a way where they are included in a local government's capital budget or capital investment program may have a larger impact than altering national accounting standards.

The rate setting and accounting framework for government-owned utilities can vary across states and communities, but in general local government utilities have far more discretion in their accounting and rate setting process than regulated utilities (see Chapter 10 on regulated utilities). Local government utilities rely on a mix of locally implemented policies, state laws, and national standards to carry out their financial planning and reporting. Utility financial planning and reporting includes expenditures presented in annual operating and capital budget documents as well as an accounting of their finances in the form of financial reports. Financial reports are often audited to confirm their adherence to accounting standards and practices.

Governing boards have a proactive role in setting rates and developing budgets, and more of a tacit review responsibility related to formal annual accounting reports. Some metrics that are critical to investor-owned utility (IOU) operation and incentives such as depreciation, net assets and equity do not play nearly as significant role in most governmental utilities than they do for IOUs. Local government financial reports and audits are quite important for assuring general financial accountability and may play a significant role in disclosing financial metrics and fiscal condition information to lenders. However, it is the annual operating and capital budgets that typically get the most attention from governing boards and serve as the most important financial planning and decision-making documents for many utilities.

Unlike accounting which has generally accepted accounting principles, budgeting is more of art and is significantly influenced by standard practices and local conditions. It is feasible and quite common for two neighboring local governments to have very different budgeting processes. Annual budgets may be presented in very different formats across communities. Multi-year capital budgeting and planning programs is quite common but planning periods vary among communities and can range from 3 to 10 years or more.

Definitions of what constitutes a capital expense versus an operating expense are often set at the local government/utility level taking into consideration standards but allowing for customization at the local level. For example, one utility may only designate something as a capital expense if it meets certain criteria <u>and</u> costs at least $15,000, whereas another utility might use slightly different criteria and have a threshold as low as $1,000. Finally, rate setting for local government utilities in most states is not regulated by an independent economic regulator and is at the discretion of the local government board. Ideally utilities will base their rates on a careful assessment of the true cost of providing adequate service, but this is not always the case.

Accounting items such as depreciation and equity which have a major influence in IOU pricing, may not even be considered by local government utilities when they are setting their rates. Larger utilities typically rely on external consultants to carry out periodic rate studies that are informed by general accepted practices and guidance documents from professional associations.

In order to better understand local government approaches related to natural assets, the research team reviewed annual operating budgets and capital budgets/capital improvement plans, engaged with a group of utility finance professionals at a state meeting of the NC Government Finance Officers Association[12], and studied aspects of the GASB standards that might influence these practices.

The City of Raleigh has shown leadership in investing in natural assets and is one of the few utilities across the country that has a dedicated charge on customer's bill that goes towards high impact land protection in their watershed. According to finance officials with the city, Raleigh has chosen to treat their natural asset investments very similar to built assets in several key ways.

Raleigh uses the revenue from their watershed fee to fund a variety of high impact natural asset acquisitions in their watershed. Funds have been used to acquire easements, purchase land, and invest in acquisition planning costs. The purchase of land is often done through a third-party land trust and the land or easement once purchased and designated as protected is not typically owned by the City. The expenditures for these acquisitions are presented in Raleigh's capital budget, and the purchase price is used to value an intangible asset that is recorded on their utilities balance sheet as a non-amortizing (non-depreciating) asset. The assets however are not part of Raleigh's the formal asset management program it deploys for built assets and to date the assets have been acquired without issuing debt.

Finance officials from several other large utilities very close to Raleigh with similar watershed protection interests were asked in an informal focus group[13] how they currently or would treat natural assets like those in Raleigh. From the perspectives of the other cities, the asset would be treated as an expense to the utility and considered non-capital. When asked if they thought not recording the value of the assets as Raleigh does would make a difference to their community's interest in natural assets, they did not think it would matter. They believed their public officials do not care that much about formal asset accounting, but rather will do what needs to be done to accomplish a goal. If it makes sense for the utility to pay for a natural asset, they will do it regardless of how its treated from an accounting standpoint. They did not see a problem including the natural asset investment in their capital budget even though it may not be accounted for a capital investment on their balance sheet.

Furthermore, they expressed little interest in recording the natural asset as an asset largely because of the difficulty in valuing it accurately. One individual cited a real example of an agreement they have with the Army Corps of Engineers (ACOE) to own and pay for the water supply pool of an ACOE lake. This agreement had been in force since the 1970s and the city has treated payments to the ACOE as an expense and have not placed any of the asset on their balance sheet because of how challenging it would be to value. There was consensus that the decision to put a needed expenditure in a capital budget was more important than how the expenditures or assets were recorded for accounting reports.

A recent policy clarification for GASB Standard 62 further shows the complicated relationship between accounting, budgeting, and other issues such as the decision to debt finance an asset. The clarification

[12] Informal discussions and interviews with Finance Officers. NC Summer GFOA Conference. July 23, 2019

[13] NC Summer GFOA Conference. July 23, 2019

now provides local government utilities wide discretion in labeling something as a regulatory asset if the revenue used to pay for the asset or debt service for the asset derives from rates which are regulated at the local level.[14] For example, a utility that agrees to commit $200,000 each year to improve forest management on land owned by a land trust in theory could treat this as an asset investment and use debt financing under GASB 62. However, the ability to use debt is often dictated more by state laws than accounting standards and in many states, utilities may only be allowed to borrow money for specified purposes or for assets that they own or legally control. In the forest example above, approaches such as creating contractual or easement limits that the contributing utility control might satisfy the requirement.

The research team reviewed numerous capital and operating budgets from across the country to see if there was a specific trend in how utilities budgeted non-traditional natural asset investments such as land protection easements, watershed improvement programs etc. As was the case with the NC utilities, there did not seem to be one approach – sometimes the expenses would appear in the operating budget and sometimes they would appear in the capital budget.

The advantage of treating these types of expenses as capital budget items or in a long-term capital improvement plan is that many utilities will rely heavily on debt to finance their capital plans which has the impact of spreading the expenses over time. Items included in capital budgets also are presented to the public and governing board as long-term essential investments into the utility's future and justified or not, may be seen on a more favorable basis by the governing board and public than an operating expenditure. Items in capital budgets also tend to be larger in value. For some natural assets investments this could be the difference of being able to implement a large comprehensive effort rather that more fragmented investments done as a small operating budget items. In other words, a local utility that scrapes together $200,000 per year for watershed protection as an operating budget item may be able to establish a $2 million-dollar program in a capital budget allowing for larger more accelerated investments.

Accounting standards to the non-accountant may be viewed as black and white rules that allow for no discretion. While many accounting standards do fit this description, there are others that require interpretation and application to local conditions.

Based on the current landscape, local government utilities likely have pathways to treating their natural assets similarly to their built assets, but this likely requires changing historic approaches and modifying financial planning processes in an intentional manner. In most cases, constructing natural asset investments in a way that fit into (and can compete for resources) a local utility's capital budget likely would have the biggest impact in changing how natural assets investments are viewed and evaluated.

[14] Personal Correspondence with Ed Harrington. August 1, 2019.

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