ACTIONS *for* WATERSHED HEALTH

2005 Portland Watershed Management Plan

SUMMARY of the Framework for Integrated Management of Watershed Health

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ENVIRONMENTAL SERVICES
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working for clean rivers

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CHAPTER 1

Introduction

In the Pacific Northwest, rivers and the lands they drain are a living link with the region's history and heritage. They have supported human life for millennia, powered modern economic growth and development and nurtured species such as salmon and Douglas fir that have become icons of our unique region, people and lifestyle. In Portland, Oregon, it is the Willamette River, its tributaries and their watersheds that, economically and culturally, have defined the city for decades and continue to do so today.

However, during the last 150 years human activity in Portland has taken its toll on the area's rivers and watersheds. Local landscapes have been transformed, natural processes have been disrupted and habitats have become fragmented. Water quality in the area's rivers and streams has deteriorated, and populations of some native species have declined or disappeared. As a consequence, the City of Portland is subject to the requirements of a host of state and federal environmental laws and faces decisions about how to manage its rivers and watersheds into the future.

What is a watershed?

A watershed is a geographic area that includes a river or stream, its tributaries and the lands they drain.

Clearly, in an urban area it is not possible to re-create historical, presettlement conditions. Yet Portland's citizens and City Council repeatedly have stated that they want local rivers, streams and watersheds to be clean and healthy—as a way to protect human health, enhance community livability, invigorate the economy and support the area's native species and biological communities. Maintaining healthy watersheds also is a way of preserving for future generations the natural legacy on which our community was built, and that in some sense still defines who we are.

To advance these interests, the City of Portland has developed the *Framework for Integrated Management of Watershed Health*, which establishes urban watershed health goals and offers a process the City can follow to achieve them.

What Is the *Framework*?

The *Framework for Integrated Management of Watershed Health* describes how the City of Portland plans to go about achieving and maintaining healthy conditions and ecological functions in its urban waterways—specifically the lower Willamette River, the Columbia Slough, Johnson Creek, Fanno Creek, Tryon Creek, and Balch Creek and other tributaries—and their watersheds. The process is intended to do the following:

- Generate a base of scientific information about Portland's watersheds that can inform all City government decisions that affect watershed health.
- Integrate the City of Portland's responses to the federal Endangered Species Act, Clean Water Act, Safe Drinking Water Act and Portland Harbor Superfund listing across City bureaus and programs, to save money and increase effectiveness.

- Guide development and implementation of watershed management plans that will establish goals, objectives and benchmarks for each urban watershed and specify actions to improve watershed health.
- Guide City activities that do not focus on the environment but can affect it, to ensure that the activities foster healthier watersheds.

In essence, the *Framework* describes how the City will get from broad watershed health goals to on-the-ground actions that improve watershed health. Success will come in part by focusing on the root causes of environmental problems, instead of their symptoms (that is, fixing problems instead of merely managing them), and by designing urban activities so that they enhance rather than degrade watershed conditions.

The *Framework* is the first step in this larger undertaking. It is the technical foundation the City will rely on when dealing with the aquatic, streamside and upland components of the ecosystem that are essential to healthy watersheds.

Instead of being a onetime undertaking, the process presented in the *Framework* is iterative and ongoing. The City will use it to manage the area's watersheds into the future.

Why Develop the *Framework*?

Several factors spurred development of the *Framework* and the watershed management process it presents, including citizen recognition of the value of healthy watersheds in improving community vitality and livability and City government's belief that thriving natural systems provide a stronger economic base than degraded systems. This belief is expressed in part through the City of Portland's River Renaissance vision, which was endorsed by the City Council in March 2001. The vision involves a communitywide effort to revitalize the Willamette River and its tributaries so that they play an integral role in the natural, economic, urban and recreational life of the city. Ensuring a clean and healthy river for fish, wildlife and people is one part of the River Renaissance vision.

The *Framework* was also developed to help address federal regulatory requirements and City Council resolutions related to them. Specifically, steelhead trout and Chinook salmon that use Portland's waterways were listed under the Endangered Species Act (ESA) in 1998 and 1999. In response, the City Council adopted a resolution stating that the City will assist with the recovery of listed species. A second resolution endorsed the development of a comprehensive framework to guide the City's response to the ESA, the Clean Water Act (CWA), the Safe Drinking Water Act, Superfund and other laws, and City objectives. Lastly, in 2000 the Portland Harbor was added to the National Priorities List (NPL), making it a Superfund site under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA); a third City Council resolution expressed the City's interest in playing a leadership role in determining cleanup and restoration strategies for the harbor. The City must take certain actions to respond to these recent listings and comply with other federal laws related to watershed health, just as for years the City has had obligations under the CWA because Portland's combined sewer overflows and other discharges have affected water quality in local waterways.

At the regional level, the City must comply with Titles 3 and 13 of Metro's *Urban Growth Functional Management Plan*, which implement statewide land use goals related to the impact of development on streams, rivers, wetlands, floodplains and other natural resource areas.

The City also is coordinating and sharing insights with other entities involved in planning to restore fish and wildlife and improve water quality and watershed conditions throughout the Northwest. The *Framework* assists the City in both of these efforts.

A Definition of Healthy Urban Watersheds

Portland's citizens and government have said that they want healthy watersheds, but actually defining a healthy watershed can be complicated, particularly in an urban area. Does it mean meeting state and federal environmental requirements? Having rivers in which people can fish and swim? Fully restoring populations of native species? The Willamette River and Balch Creek watersheds differ greatly—is what's healthy for one healthy for the other? Is it even realistic to try to restore watershed health in an urban area?

The City of Portland believes achieving healthier watersheds is possible in urban areas, but—because each watershed is unique—what that looks like will differ from one watershed to the next. In general, though, the *Framework* defines a healthy urban watershed as follows:

> *A healthy urban watershed has hydrologic, habitat and water quality conditions suitable to protect human health, maintain viable ecological functions and processes, and support self-sustaining populations of native fish and wildlife species whose natural ranges include the Portland area.*

This definition is in keeping with the *Framework*'s multi-pronged vision of the future of Portland's watersheds:

> *Portland's urban form supports both a thriving economy and natural processes that maintain healthy ecosystems. Portland protects and restores properly functioning conditions throughout its watersheds to provide clean water and support abundant, self-sustaining populations of native fish and wildlife. These efforts enhance the livability and vitality of Portland for its citizens and help meet the City's obligations under the Clean Water Act, the Endangered Species Act, Superfund, the Safe Drinking Water Act and other laws.*

Goals for Watershed Health

The level of watershed health that is possible to attain varies from one watershed to the next, so the *Framework* approach involves setting unique objectives for each watershed. However, all of the objectives will support four main goals the City has for watershed health:

- **Hydrology:** Move toward normative[1] flow conditions to protect and improve watershed and stream health, channel functions, and public health and safety.
- **Physical Habitat:** Protect, enhance and restore aquatic and terrestrial habitat conditions to support key ecological functions and improved productivity, diversity, capacity and distribution of native fish and wildlife populations and biological communities.

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[1] A normative flow has the magnitude, frequency, duration and timing essential to support salmonids and other native species and resources.

- **Water Quality:** Protect and improve surface water and groundwater quality to protect public health and support native fish and wildlife populations and biological communities.
- **Biological Communities:** Protect, enhance, manage and restore native aquatic and terrestrial species and biological communities to improve and maintain biodiversity in Portland's watersheds.

If watershed conditions support a thriving salmon population, the watershed is almost certainly healthy and functioning properly.

The *Framework* focuses on the health of the aquatic components of the ecosystem, in particular the health of salmonids (salmon and trout) and their habitats, because salmonids are good measures of the health of most key watershed processes—especially hydrology, water quality and river and streamside habitats. If salmon populations are healthy, it can generally be assumed that watershed conditions are healthy; in that sense, salmon are akin to canaries in coal mines. However, the needs of terrestrial wildlife species and their habitats must also be addressed if healthy watershed conditions are to be achieved. For this reason, many of the scientific principles the *Framework* is based on apply to terrestrial species as well as aquatic species.

What Is the Watershed Management Process?

The *Framework* presents a watershed management process that can be used to address multiple watershed-related goals simultaneously, whether those goals are to assist in salmonid recovery, protect key plant communities or wildlife habitats, achieve the River Renaissance vision or comply with the Clean Water Act. Simply put, the watershed management process recognizes relevant scientific principles and applies them to the following:

- Describing watershed conditions
- Diagnosing watershed problems and understanding properly functioning watershed areas
- Identifying, prioritizing, selecting and implementing actions that will solve watershed problems and maintain properly functioning areas, while taking into consideration various economic and social factors
- Monitoring results over time to refine techniques and measure progress in meeting goals

What is adaptive management?

Adaptive management is a way of systematically improving restoration activities by learning from experience and new information. It requires frequent monitoring and fine-tuning of restoration strategies.

Iterative and ongoing, the process uses adaptive management to adjust watershed activities over time. Eventually, applying the watershed management process will protect or reestablish key ecological functions affected by urban growth and development. At the same time the process will help the City of Portland achieve its own watershed-related goals and comply with state and federal laws.

The watershed management process will guide development of watershed management plans for each urban watershed. These plans will identify goals, objectives, targets and benchmarks for the watersheds and specify actions to improve watershed health.

A Unique Approach

The City already has taken many actions to improve watershed health, but the *Framework*'s approach differs from past approaches in several ways:

- It is scientifically based.
- It uses clear, measurable goals, objectives and benchmarks.
- It involves monitoring progress toward the goals, and refining actions and analytical tools when necessary.
- It is designed to improve overall watershed health, not just meet individual regulatory requirements.
- It strives to *solve* environmental problems and avoid planting the seeds of new ones.
- It integrates the efforts of multiple City bureaus and programs and stresses the importance of partnering with other jurisdictions and stakeholders in the region.

Integration is an important aspect of the *Framework* approach. Different City bureaus and programs will be coordinating work plans and timelines. They will draw on the same data and use commonly agreed-upon methods when taking actions to improve watershed health. They will all be working from the same watershed management plans, which set forth the goals, objectives, benchmarks and approved actions for each watershed. The result will be bureau activities that complement one another; increased consistency, efficiency and effectiveness; and the ability to measure overall progress in achieving the City's watershed goals.

The *Framework* process provides a lens through which all City activities can be viewed, so that their positive and negative impacts on watershed health can be understood.

Additionally, the *Framework* process will provide guidance to all City programs that affect watershed health. This will ensure that transportation, capital improvement, urban renewal, land use and other activities (including new projects) are compatible with watershed health goals.

Portland Within the Region: What We Do Matters

Portland's watershed management activities will be taking place at the local level but within the context of a larger, interconnected ecosystem that extends through much of the Pacific Northwest. For example, every salmonid migrating to and from every tributary of the Willamette River (and many Columbia River tributaries) must pass through Portland. And as water moves from upper river reaches toward the Columbia, the cumulative effects of land uses, agriculture, hydropower and flood control throughout the region are manifested in Portland. This ecological link means that the conditions in Portland's watersheds affect—and are affected by—watershed health in communities throughout the region.

Given this regional context, the City of Portland is active in many local, state and regional efforts aimed at improving conditions of fish and wildlife and their habitats in the Willamette and Columbia River watersheds. By participating in these efforts, Portland hopes to both improve the conditions of its watersheds and do its part to contribute to regionwide improvements in watershed health.

CHAPTER 2

Scientific Foundation

The City of Portland is basing its watershed management process on ecological principles that are supported by scientific research. The principles fall into three main categories:

To achieve healthy watersheds, both aquatic and terrestrial components will need to be addressed.

- Primary ecological principles
- Principles of river, wetland and upland ecology
- Principles of salmonid ecology

These ecological principles serve as the foundation for restoration guidelines that will guide the City of Portland's watershed improvement efforts. The principles and guidelines are summarized below and described in detail in the *Framework for Integrated Management of Watershed Health,* which includes extensive scientific citations.

Primary Ecological Principles

1. Ecosystems are dynamic, resilient and develop over time.
2. Ecological systems operate on various spatial and time scales that can be viewed hierarchically.
3. Habitats develop and are maintained by processes related to biotic and abiotic components of the ecosystem.
4. The abundance, productivity and diversity of organisms are integrally linked to the characteristics of their ecosystems.
5. Species play key roles in developing and maintaining ecological conditions.
6. Ecosystem function, habitat structure and biological performance are affected by human actions.
7. Biological diversity allows ecosystems to accommodate environmental variation.

Change Is Constant. The seven primary ecological principles describe the function and dynamics of ecosystems, and how species respond to and interact with them. A key concept in these principles is that ecosystems change over time. Ecosystems are disturbed by fires and floods, logging and commercial development. Being resilient, ecosystems can absorb a certain amount of disturbance and still maintain their original character. But beyond a certain point, natural or human-caused disturbances can shift an ecosystem into a new and possibly less desirable configuration—one that favors different species and ecological interactions. It is this type of change that can open the door for nonnative species that can compete with juvenile salmonids and native wildlife. Often, ecosystems in urban areas are particularly vulnerable because their resilience has been reduced by near-constant human disturbances.

One source of change within ecosystems is seasonal, annual and multi-year variation: rivers flood, fish populations rise and fall and forest fires break out. These natural variations spur the development of a diversity of habitats whose presence, in turn, helps keep ecosystems healthy and functioning. Although seasonal and annual variation can be anticipated, no two years, seasons, decades or even centuries are the same, so conditions vary greatly over time.

> **What is an ecosystem?**
>
> An ecosystem is a complex community of species, habitats and environmental conditions that functions as an integrated system.

Unfortunately, the same natural variation that fosters diverse habitats can be an obstacle to humans, who prefer predictable, controllable natural processes for the sake of public safety and economic stability. Fish hatcheries, dams and fire suppression measures represent human attempts to stabilize the environment and make yields of fish, irrigation water and timber even and reliable. This is probably an unrealistic goal because it runs counter to the fundamental nature of ecological systems to be constantly changing.

Looking at Multiple Scales. Ecosystems exist on a variety of scales, from regional (the Pacific Northwest) to local (Johnson Creek) or even smaller (a particular stretch of Johnson Creek). In trying to restore watershed health, management decisions must consider ecological "problems" from multiple scales: What processes occur at the regional level? Watershed level? Site level? Understanding a problem from various scales clarifies which information and actions are needed to solve the problem, how long a solution might take and what other jurisdictions or resource management agencies might need to be involved. This points to the need for regionwide coordination on issues of watershed health and raises the question of what role Portland can realistically and effectively play in the context of regional watersheds.

The Origins of Habitats. Habitats exist in specific localities, but they are created by processes that operate far beyond a specific location. For example, land uses throughout a watershed can affect the temperature and turbidity of its water and how much gravel is in the riverbed. When restoring habitat, it is important to identify the processes that form that habitat. Looking at geology, soils, hydrology, vegetation, topography and land uses at the watershed, basin and even regional levels is the correct place to start.

> **What are habitats?**
>
> Habitats are the resources and conditions present in an area that allow a species or group of species to exist and thrive.

River flow is one of the biggest shapers of aquatic habitat. In large rivers flow is often affected by dams, and in smaller rivers it is affected by impervious surfaces. To restore certain habitats it may be necessary to allow more natural flow variations, such as some controlled flooding that can reconnect floodplain areas.

Ecological Functions. Species and their environments are linked, having evolved together over time. Just as the ecological conditions in a given habitat allow certain species to thrive, so do individual species contribute to the healthy functioning of the ecosystem, creating a type of feedback loop. In a sense, each species has several ecological jobs to do, be it cycling energy and nutrients, structuring habitat or controlling the population of other species. Returning salmon, for example, transport ocean nutrients to headwater areas. Beavers create ponds. Bats help keep mosquitoes in check. If a species disappears from the ecosystem, that species' contribution to the healthy functioning of the ecosystem is lost and the ecosystem's ability to function properly is diminished. If a species is insulated from the ecosystem (such as through dam bypass systems and salmon barging), key ecological interactions are altered and the feedback loop is broken.

Humans are species, too. We play an integral role in the ecosystem and can choose to manage our activities so that they make the ecosystem more—or less—compatible with the needs of other species. For example, we may be able to reconnect the feedback loop by providing a limited piece of what the ecosystem is missing, such as by distributing the carcasses of hatchery salmon in streams to replace nutrients that wild salmon used to provide when they spawned and died in local streams. In many cases we need to learn more about the habitats and processes that fish and wildlife species need, and the ecological functions they provide.

Humans are species, too, and play an integral role in ecosystems.

Biological Diversity. Ecosystems are resilient when they are biologically diverse. As ecosystems change through time, biological diversity permits individual species to wax and wane while allowing the overall biological community to thrive. While a particular individual or population within a species might not survive natural or human-caused changes in the environment, other individuals or populations might—usually because they have a somewhat different set of genes and thus slightly different biological characteristics that make those individuals or populations better suited to the new circumstances. Because change cannot be predicted, neither can the specific future ecological circumstances in which species will need to survive—or the particular genes and biological characteristics that will give a species an edge. Thus, simplifying an ecosystem by reducing the variety of its species or habitats can undermine the long-term functioning of that ecosystem.

Principles of River, Wetland and Upland Ecology

1. Rivers are not separate from the wetland and upland areas they drain.
2. Watersheds are defined by and operate across the spatial and temporal dimensions of riverine, wetland and upland ecosystems.
3. Hydrologic modification (outside of normative flow regimes) and changes in upland land use can reduce habitat diversity, decrease native biodiversity, increase nonnative species and exacerbate water pollution, landslides and flooding.

The Scope of Watersheds. Rivers, wetlands and upland areas are connected, in part through water. Although a river itself exists only between two banks, its flowing waters inextricably link the other elements of the watershed: the upstream lands that it drains, the shallow aquifers that it recharges with water, the wetlands and floodplain areas that it periodically inundates. These elements reflect three of the four important dimensions of watersheds:

Water in a stream reflects the surfaces over and through which it flows before reaching the stream.

- **Longitudinal dimension:** the upstream-downstream connection of rivers and habitats, from steep, forested headwater areas to estuaries. This dimension comes into play, for example, when polluted stormwater is transported miles downstream.
- **Vertical dimension:** the connections linking groundwater, aquifers, rivers, vegetation and the atmosphere. River water seeps through the riverbed, saturating underlying soils and recharging shallow aquifers. Groundwater recharges the river. Trees take up groundwater through their roots and respire through stomata in their leaves.
- **Lateral dimension:** the connection of the river with adjacent lands (the floodplain) through flooding and the dispersal of species across the landscape. Periodic floods change surrounding habitats and deposit nutrients throughout the floodplain, creating areas of high biodiversity and ecological production that are hydrologically linked to the river at certain times of year. Plants and animals spread from one patch of habitat to another.

When ecological connections between habitats are severed, such as when humans attempt to control flooding, biodiversity is reduced.

The fourth dimension is time, as ecological conditions (temperature, river level, mix of vegetation, etc.) vary through the day, season, year and century. To understand watersheds scientifically, one must look at all four dimensions and the connections they create among habitats.

Effects of Hydrologic Modification. Humans have significantly modified both the hydrology of rivers and the ecological connections that rivers create. Dams have altered natural flood patterns, water temperatures, the degree of variation in daily water flow, and the amount and type of material (sediment, gravel, woody debris and nutrients) that river waters transport downstream and across floodplains.

What is hydrology?

Hydrology is the science that deals with the properties, distribution and circulation of water, both on and below the earth's surface.

In urban areas, filling, paving, piping, draining and development have reduced the amount of actual, physical habitat both in streams and on land. Much of that habitat has been replaced by impervious surfaces whose presence increases stormwater runoff and decreases groundwater recharge. Increased stormwater flows alter the stream hydrology, changing the river's speed, width, depth and connection to floodplains.

The combined effects of hydrologic modifications can be profound:

- Simplified structure of the river channel
- Increased erosion
- Compromised connections among habitats
- Substantial reductions in habitat diversity
- Increased water pollution
- Decreased native biodiversity
- Proliferation of nonnative species

Native species are consistently less abundant in river reaches where flows have been extensively modified than they are in unmodified reaches.

When a previously complex ecosystem, where native species thrived in a diverse network of habitats, is simplified both structurally and ecologically, it becomes less productive over time.

When Upland Land Uses Change. Every species needs habitat. In upland areas, though, terrestrial species often have been caught short. As land uses change and natural habitats are disturbed, invasive species such as English ivy and Himalayan blackberry easily find a foothold and the ecosystem can start shifting away from configurations that support native species. Also, when roads and buildings replace the forests, shrubland and grasses that native plants and animals depend on, there is simply less habitat available.

> **What are uplands?**
>
> Uplands are non-aquatic, non-streamside areas such as hillsides and meadows. Generally, they are uphill of rivers, streams, and wetlands.

Too often, the habitat that does remain exists in individual blocks or patches that isolate plant and animal populations. Species that normally use migratory corridors may not be able to do so. Less mobile species have difficulty dispersing and establishing new populations. As larger habitats are broken up into smaller patches, ecological processes are disrupted and, consequently, biodiversity is reduced. This happens partly because in small patches there is less of the "interior" habitat that many native species are adapted to and more "edge" habitat, which gives edge-adapted predators more access to interior species. Land uses affect the size, type, distribution and connectivity of upland habitat patches; these factors in turn help determine the viability and diversity of native plant and animal species.

Principles of Salmonid Ecology

1. Life history diversity, genetic diversity and metapopulation organization are ways salmonids adapt to their complex and connected habitats and are the basis of salmonid productivity and salmonids' ability to cope with environmental variation.
2. Sustained salmonid productivity requires a network of complex, diverse and interconnected habitats that are created, altered and maintained by natural physical processes in freshwater, estuarine and ocean environments.
3. Restoration of salmonids must address the entire natural and human ecosystem, encompassing the continuum of freshwater, estuarine and ocean habitats where salmonids complete their life histories.

Chains of Habitats. Salmon are migratory species. To complete their life cycle, salmon use a chain of interconnected habitats that stretches hundreds of miles, from high mountain streams to estuaries to the ocean—a type of ecological highway. But just as there are genetic variations from one individual to the next, in any species, so too are there variations in (1) the geographical strings of habitat that different salmon populations need, (2) the times of year at which populations need those habitats, and (3) corresponding behavioral characteristics, such as the timing of migration or preferences in spawning habitats. For example, one returning salmon population might travel from the ocean to the Clackamas

River in the spring and then wait until fall to ascend a small tributary and spawn. Another population might migrate directly to the Clackamas in the fall for spawning. In following its own route and timing for migration, each population expresses its own life history. This variation from one population to the next is called life history diversity.

The Value of Life History Diversity. As with biodiversity, having a diversity of life histories within a species enhances that species' overall survival. The more life histories there are, the more likely it is that the biological characteristics, behavior and string of needed habitats of some of those populations will be well-suited to actual conditions. Originally, the life history diversity of salmon in the Willamette River ecosystem was substantial, owing to the system's varied topography, large number of tributaries, highly variable flow regime and oceanic circulation patterns. But numerous factors—human-caused hydrologic modifications among them—have significantly reduced the diversity of habitats and the corresponding salmon life histories.

Dependence on Habitat. It follows that, to maintain salmon populations, we must maintain the particular chains of habitats upon which different salmon populations depend. Each population must have the right habitat, at the right time, under the right conditions, to perform its essential life functions: spawning, rearing, migrating, feeding and avoiding predators. What's more, these habitats must remain connected so that they can be accessed at the appropriate time. If a particular habitat degrades such that it does not support salmon at the time when the salmon need it, the ecological chain for that population is broken. The salmon may not be able to take an alternate route or "postpone their trip." Instead, that population risks dying out, reducing both the diversity of salmon life histories and the biological diversity within the region.

Restoration Guidelines

1. View the whole picture: Watershed restoration efforts need to be placed within the context of the entire watershed; species recovery efforts must be placed within the context of complete life cycles.
2. Characterize existing conditions and use the results to inform the entire restoration planning process.
3. When planning watershed restoration actions, prioritize and sequence them to maximize long-term success in meeting the stated objectives for the restoration.
4. To the maximum extent practicable, use natural processes to achieve ecological functions and societal goals.

The ecological principles discussed so far have significant implications for the implementation of restoration activities. They are the foundation for the four restoration guidelines, which will guide the City of Portland's watershed restoration efforts.

Viewing the Whole Picture. The restoration guidelines emphasize developing a thorough understanding of a watershed before taking action. This includes understanding (1) the geographical extent of the watershed, (2) the ranges over which species' life histories are carried out, (3) upstream, downstream, lateral and vertical influences throughout the watershed, and (4) hydrology, physical habitat, water quality and biological communities. Any site-specific restoration activity should be understood in terms of its effects and potential for success in relation to the processes and impacts occurring over the entire watershed. Viewing the whole picture also clarifies what outcomes can realistically be expected to result from restoration actions.

The solutions developed to restore a watershed will be appropriate and effective only if the nature and dynamics of the problems that degrade the watershed are clearly understood.

Understanding Existing Conditions. The City of Portland has identified four areas to focus on in evaluating watershed health, both now and after restoration measures have been implemented:

- **Hydrology.** Hydrology affects virtually everything else in a watershed, including the physical form of the stream channel; water temperature and quality; the fate and transport of pollutants; the extent, composition and location of vegetation; material deposited and habitat created in floodplains; and the connectivity of channels and floodplains.
- **Physical habitat.** Physical habitat encompasses both upland and streamside vegetation, logs and large wood debris, substrata such as gravel and sediments, and off-channel areas in floodplains. Restoring such habitats secures a foothold for native species, which are adapted to those particular conditions. In addition, restoring physical habitat improves other measures of river and watershed health, such as stream temperature and nutrient cycling.
- **Water quality.** Aquatic organisms are greatly affected by water quality, including temperature and the amount of dissolved oxygen, nutrients, suspended sediments and contamination. In urban areas, water quality can be degraded by stormwater runoff, sewer overflows, removal of native vegetation, erosion and other factors.
- **Biological communities.** What plant and animal species live in the watershed? Are they native or nonnative? What are their habitats? Who is preying on whom? The presence, abundance and interactions of aquatic, riparian and terrestrial species give a picture of overall watershed health.

In each of these four areas, the City of Portland has identified potential environmental indicators that reflect the health of a watershed, such as seasonal patterns of flow, percentage of native vegetation, water temperature and salmonid productivity. For each watershed, a set of environmental indicators will be established, along with a quantitative target value or a descriptive (but measurable) desired condition to be achieved for each indicator. The target value or desired condition is a specific, measurable level at which the indicator is considered to be healthy or functioning well. Human influences (such as the amount of impervious surfaces) and landscape factors (climate, soil type, gradient and the like) also will be considered as the City determines how existing conditions are affecting watershed health.

The Importance of Order. For greatest success, restoration actions must be prioritized in terms of effectiveness, need and effect on future projects. Then they must be implemented in a sequence consistent with the principles already discussed. For example, it does not make sense to reintroduce native fish stocks until functioning habitat has been established. This, in turn, depends on having more normalized river flows. The scientific principles, then, point to the following as a sensible order for restoration efforts:

1. **Protect existing fish and wildlife populations and their habitats.** Rebuilding an existing population is far more likely to be successful than reintroducing a population that has been greatly reduced. Genetically, because existing populations are adapted to local conditions, they may have better long-term survival rates than introduced populations would. Also, existing populations point to habitat that provides at least the minimum level of ecological functions needed for survival. Similarly, protecting existing functioning habitat and areas that have close to normative hydrology and good water quality should be a high priority.

2. **Reconnect favorable habitats.** This allows existing populations to provide "colonists" that can reestablish satellite populations in nearby habitat where populations have been extirpated.

In the long run, it is easier and more effective to protect existing functioning habitats than it is to create new ones.

3. **Identify and control sources of degradation.** Causes of degradation should be identified and quantified before their impacts within the watershed are addressed. Without sufficient understanding of the processes that are causing an environmental problem, the most important causes may not be addressed and the "solutions" may be misapplied or inappropriately designed. In other words, it is important to get to the source of the problem, rather than merely focus on actions that address symptoms.

4. **Restore the processes that maintain watershed health.**

   – **Normalize hydrology.** Hydrology is one of the most basic and critical forces shaping the structure and function of river and wetland ecosystems. While full restoration of hydrologic conditions may not be possible because of changes in the watershed, the degree to which hydrology is restored will affect all other processes and components of the ecosystem.

   – **Restore physical habitat.** The City of Portland recommends that existing high-quality habitat be protected and made accessible to migratory species, that intermediate-quality habitat be evaluated for restoration and that low-quality habitat be evaluated to determine whether it is impeding access to higher quality habitat. Restoring physical habitat to conditions to which native species have adapted over evolutionary time is key in reducing the dominance of invasive species.

   – **Improve water quality.** Many aspects of water quality will be greatly improved by controlling sources and restoring hydrology and physical habitat. Further efforts should focus on aspects of water quality not fully addressed by restoring hydrology and physical habitat, such as toxic contamination.

– **Reestablish biological communities.** To a degree, biological communities will be reestablished as a consequence of other protection and restoration efforts (that is, protecting existing populations, improving conditions and connections among habitats, controlling sources of degradation, etc.).

Making Use of Natural Processes. The ecological principles make it clear that, to be successful over the long term, restoration must focus on reestablishing normal ecological processes and functions in watersheds, rather than rely solely on technological solutions to ecosystem problems. Too often, technological "solutions" turn out to be expensive failures, for multiple reasons. They may reflect an incomplete understanding of the existing conditions and processes, be implemented at the wrong scale for the problem they are trying to solve, be designed to operate counter to ecological or biological processes, or address only the symptoms of environmental degradation, rather than its causes.

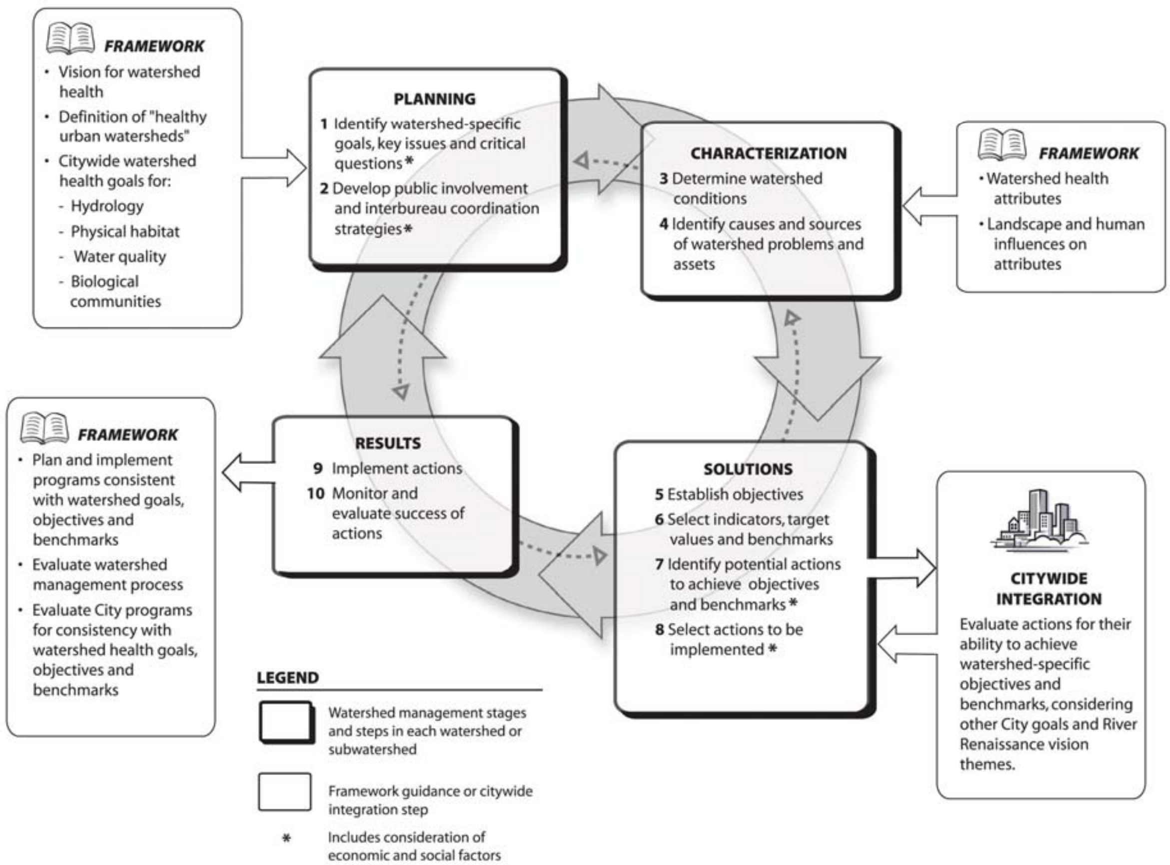
Consider, for example, the 70 years of traditional flood control approaches in Johnson Creek, which have been ecologically detrimental to the watershed, without controlling floods. As an alternative to flood "control," the City of Portland has instituted flood management measures that provide room for the creek to flood. This puts nature to work in reestablishing normal hydrologic processes and habitats, while still preserving human safety and property. Flood management measures include purchasing properties within the floodplain from willing sellers, demolishing structures and removing fill. As a result, floodplains are being reconnected, flood storage is being reestablished in the watershed and off-channel fish and wildlife habitat is being created.

Natural processes are generally far more effective and cheaper than the technological processes designed to replace them. Wherever possible, restoration plans should make use of natural processes.

Even at their best, technological solutions cannot replace the functions provided by habitats and species that have evolved together over millennia to create diverse, resilient, productive ecosystems. Simply put, the cost and effectiveness of natural processes are hard to beat.

Restoration in a City Setting. Native species—both endangered and not—have a reasonable chance of survival with the right hydrology, the right habitats, adequate water quality and biological diversity. With these elements functioning properly, the ecosystem itself is likely to become more diverse, complex, resilient and self-sustaining as time goes on. Portland's rivers, streams and creeks in many places are arguably in better condition now than during the mid-twentieth century, demonstrating that improvements to watersheds are possible even in a thriving urban area.

FIGURE 3-1
Stages and Steps in the Watershed Management Process



CHAPTER 3

Managing Portland's Watersheds

Successful watershed management requires actions that focus on improving the health of watersheds, plus a way of ensuring that City activities not directly related to watersheds are nonetheless consistent with the scientific principles and watershed health goals and objectives. The *Framework* addresses both these aspects of watershed management. Although the steps presented below will be used to develop watershed plans, they can be applied to other City activities, including planning new projects, such as urban renewal and transportation projects. The steps also will guide day-to-day City activities and decisions.

The Watershed Management Process

The City of Portland's watershed management process translates the watershed health goals, scientific principles and restoration guidelines into a set of prioritized watershed protection and restoration actions for each of Portland's urban watersheds. The process has four stages:

- **Planning**. Goals, key issues (including social and economic factors) and coordination and public involvement strategies are identified for each watershed.
- **Characterization**. A detailed "snapshot" of current watershed conditions is created and, when possible, compared to historical conditions. Both watershed problems and healthy, properly functioning watershed conditions are identified, as are their sources or causes.
- **Solutions**. Potential protection and restoration actions are identified and analyzed. A preferred set of actions is recommended that incorporates City aspirations not directly related to watershed health.
- **Results**. Actions are implemented and their effects are monitored. Through adaptive management, the actions are adjusted as their impacts become clear, as scientific understanding of watershed functions increases and as techniques for watershed restoration improve over time.

The watershed management process will result in a watershed management plan for each watershed. The plans will lay out activities necessary to achieve watershed health, such as on-the-ground capital improvement projects or habitat improvement projects, and will guide other City activities so that they are compatible with the watershed health goals.

Figure 3-1 shows the individual steps within these four stages. The figure conveys the iterative, continuous nature of the watershed management process, as protection and restoration actions are refined in response to information gained from ongoing monitoring. The steps in the process are described below.

Step 1: Identify watershed-specific goals, key issues and critical questions.

All four of the watershed health goals apply in each watershed. However, because each watershed has its own characteristics and watershed health issues, they may be supplemented by goals that address other City concerns, such as public health and safety.

Key issues and questions about each watershed will be identified, to provide guidance throughout the watershed management process. Many of the critical questions will be about hydrology, physical habitat, water quality and biological communities: What are the flow conditions, flooding patterns, habitat types, ecological functions, species and pollutants in the watershed? How are they distributed? What affects them?

Other questions will address such issues as public health and safety, economic factors, public involvement and coordination within the City as those issues relate to watershed health.

Step 2: Develop stakeholder, public involvement and interbureau communication and coordination strategies.

Success of the watershed management process will rely in part on shared understanding, consensus and cooperation among those whose actions affect watershed health—namely, stakeholders and the public, various City bureaus and programs, and other jurisdictions in the Willamette and Columbia River basins. Step 2 entails identifying ways for the public to help shape watershed-related decisions (including the social and economic aspects of watershed management), involving staff from multiple City bureaus in the development of the watershed management plans, clarifying relevant roles and responsibilities within the City and coordinating the watershed restoration efforts of Portland and other entities in the region. Detailed work plans will document activities, procedures, responsibilities and resources related to the work to be done in each watershed.

Step 3: Determine watershed conditions.

Describing Watershed Conditions. The first step in the watershed characterization stage involves describing watershed health attributes, such as water temperature and the condition of the streambank, to understand the current (and sometimes historical) conditions and ecological functions in the watershed. Of particular value is understanding which areas have ecological problems (and therefore may need restoration activities) and which areas are functioning well. In the *Framework*, healthy, properly functioning conditions are considered watershed assets, potentially deserving protection.

A watershed characterization is a snapshot of how the watershed functions today and will continue to function in the near term.

Watershed health attributes are discrete, measurable components of the ecosystem. Together, they paint a picture of the ecosystem's overall health and reveal which ecological functions it currently provides. Table 3-1 shows the watershed health attributes the City of Portland will focus on during characterization of each watershed.

The City also will examine the factors that influence the watershed health attributes—primarily various human activities and characteristics of the landscape (see Table 3-2). For example, in a given watershed, landscape factors such as the steepness of the hillside, soil type and rainfall pattern all may affect the amount of sediments that enter a stream, as do human activities such as channel and wetland alterations. Identifying landscape factors and human influences helps define the potential and limitations of particular stream reaches.

TABLE 3-1
Watershed Health Attributes to Be Characterized

Hydrology	Water Quality
Hydrograph alteration Floodplain presence and connectivity Groundwater	Water temperature Dissolved oxygen Nutrients and chlorophyll *a* Total suspended solids Toxic contamination of water, sediments and biota Groundwater quality Other 303(d)-listed TMDL parameters Other parameters (as determined by weight of evidence)
Physical Habitat	**Biological Communities**
Floodplain quality and connectivity Riparian condition: width, composition and fragmentation Stream connectivity Habitat types Bank erosion Channel substrate (fine/coarse) Refugia (depth, boulders, undercut banks, wood) Large wood Terrestrial habitat Wetland habitat	Biotic integrity Benthic communities Salmonid population structure (abundance, productivity, spatial structure, diversity) Riparian wildlife Terrestrial wildlife Plant communities

TABLE 3-2
Factors That Influence Watershed Health Attributes

Landscape Factors	Human Influences
Climate	Land use
Physiography	Impervious surfaces
Lithology/soils	Dam impacts
Watershed morphology	Water withdrawals
Hydrology	Drainage network
Vegetation	Vegetation management
	Wetland alteration
	Outfall discharges
	Exotic species
	Harassment
	Hatchery management
	Spills and illicit discharges

Existing data about current and (where available) historical watershed conditions will be compiled, and any information that is still needed will be identified. Relevant information could include rainfall data, monitoring data for flow and water quality, stream survey results and aerial photographs or geographic information system (GIS) data on land use. Information will be stored in a GIS-based data management system that can generate base maps and overlays.

The watershed characterization will build on existing information as much as possible.

Additional data will be collected as needed. In some cases the compiled data will be used to model current watershed conditions. For example, state-of-the-art hydrologic, water quality and habitat models will show (1) the impacts of stormwater runoff, waterborne pollutants and habitat conditions on different species, and (2) how those impacts occur.

Identifying Problems and Watershed Assets. The City of Portland will identify watershed problems and assets in part by using the compiled data and modeling results to compare current watershed conditions with reference conditions. (Reference conditions reflect the watershed's condition if all of its environmental attributes were functioning properly.) The point of such a comparison is to see where and how far existing conditions diverge from the reference conditions. This will reveal both problem areas in the watershed and opportunities to protect existing watershed assets.

Reference conditions are determined by reviewing historical information, data from similar but less disturbed areas, scientific literature and regulatory standards.

For example, a comparison of current watershed conditions and reference conditions might reveal that, toward the mouth of a particular stream, there currently is an excess of fine sediment during the winter—too much for salmon rearing. Or the comparison could show that habitat along the entire stream is unsuitable for salmon fry emerging from gravel in the spring, but that at other times the stream could support salmon relatively well. This highlights existing watershed conditions during most of the year that, if maintained, could help sustain important species and habitats.

Because many river and stream reaches already provide good, healthy habitat or other important ecological functions, the watershed management process will identify opportunities to protect and maintain existing functioning conditions.

One of the models the City will use in identifying watershed problems and assets is Ecosystem Diagnosis and Treatment, or EDT, which among other things can compare the relative ecological contributions of different stream segments. In other words, EDT can predict the ecological benefit that individual reaches would provide if they were restored—or the ecological loss if they were allowed to degrade. This is useful in prioritizing protection and restoration actions.

Step 4: Identify the causes, sources and effects of watershed problems and assets.

It is not enough merely to understand what problems exist in a watershed and then devise possible solutions. For restoration actions to be successful, the underlying causes and sources of a problem also must be identified. Without this crucial step, restoration actions might address only the symptoms of the problem, without solving the problem itself. Likewise, if a watershed asset is going to continue into the future, the underlying reasons for its existence must be understood. That way, the conditions that create the asset can be maintained rather than inadvertently disrupted (to the detriment of the asset).

For example, a stream reach might not have enough gravel to support spawning. This could be the result of (1) excessive sedimentation, (2) an upstream barrier that "starves" the reach of gravel, or (3) changes in hydrology that prevent gravel from being deposited in the reach. Although there are three possible solutions to the problem, only one of them may be effective, depending on the underlying cause and source. Similarly, an asset such as cool summer water temperatures might be the result of (1) deep pools in the stream, (2) shade from native streamside vegetation, (3) inflow of groundwater, or (4) a combination of these.

Step 4, then, focuses on understanding the processes that create a given problem or asset in a watershed. To tease out the cause-and-effect links, the City may use a variety of hydrologic and pollutant models to answer the following questions for each identified watershed problem or asset:

- What resource is being affected, and where?
- What watershed processes, pollutants or materials (sediments, nutrients, heat, etc.) are involved?
- What mechanism is causing the effect, and what activities trigger or contribute to the effect? (An example might be a storm that increases runoff and thus causes erosion.)
- What physical features are present that provide critical habitat for fish or wildlife species or populations?

Correctly identifying the cause and source of a problem is key in determining an effective solution.

For example, Steps 3 and 4 might reveal that excessive sediment is being deposited in lower Balch Creek as a result of bank erosion, which in turn is caused by increased flows and inadequate bank vegetation. The high flows come from stormwater discharged into the stream via stormwater drainage pipes.. The effects of the sedimentation are a decrease in the amount of usable spawning area, smothering of trout eggs and, ultimately, fewer trout.

Step 5: Establish watershed-specific objectives.

Once the source-cause-effect links that clarify the origins of watershed problems and assets are understood, the City can start setting objectives to reach its goals and take other steps that lead to restoration or protection actions. This "solutions" stage of the watershed management process begins with establishing objectives.

Objectives state specific desired outcomes with respect to certain ecological functions or conditions—outcomes that must be achieved for a watershed health goal to be attained.

Using the example above, an objective can be established as follows:

Good objectives

… consider the cause-effect relationships underlying watershed problems or assets.

… are specific.

… are measurable.

… describe the desired outcome for a particular resource.

- **Problem**: Sediment deposition on the substrate of Balch Creek.
- **Cause**: Erosion resulting from high flows and lack of bank vegetation.
- **Source of high flows**: Stormwater runoff discharge from stormwater drainage pipes.
- **Effect**: Limited spawning area, smothering of eggs and reduced trout production.
- **Desired outcome**: Reduced sedimentation and increased trout production.
- **Objective**: Reduce erosion-caused sedimentation in the channel substrate, to enhance cutthroat trout spawner and juvenile production in lower Balch Creek.

This objective expresses the problem, something about its cause, and the desired outcome. Later in the watershed management process the objective can be refined to specify one or more measurable environmental indicators, a geographical area and a time frame, as follows:

- **Refined objective:** Reduce streambed fine sediment embeddedness to 20 percent or less in lower Balch Creek by 2040 to support cutthroat trout spawning and egg incubation.

Step 6: Select indicators and establish target values and benchmarks.

Environmental Indicators. What is really important about watersheds is the ecological functions they provide, such as the cycling of nutrients and energy. Essentially, ecological functions are what truly define watershed health, for it is only when a full suite of functions is provided that watershed conditions support the diversity of healthy, self-sustaining populations of native fish and wildlife that is considered representative of a healthy watershed.

Ecological functions are the ultimate measure of watershed health, but they are often impractical or impossible to measure directly.

It is often impractical and sometimes impossible to measure ecological functions directly. Instead, scientists typically measure environmental indicators that, taken together, represent the ecological functions provided by an ecosystem. It is easier, for example, to measure the width, vegetative composition and connectivity of a streamside area than it is to quantify the water quality, microclimates, food and structural habitat such an area provides.

Environmental indicators must be selected carefully, so that they are objective, readily measurable and comprehensive. They also should convey an understanding of how the ecosystem functions and provide insight into the cause-and-effect relationships between stressors to the ecosystem and how the ecosystem responds to those stressors.

From Goals to Actions

Watershed health goals
↓
Objectives
↓
Environmental indicators
↓
Reference conditions
↓
Target values
↓
Benchmarks
↓
Restoration and protection actions

As a way of measuring watershed health over time, the City of Portland will select and monitor a unique set of environmental indicators for each watershed—one that reflects that watershed's conditions, problems and assets. The indicators will be selected from the watershed health attributes and human influences in Tables 3-1 and 3-2; these are based in part on indicators developed by the National Marine Fisheries Service in the National Oceanic and Atmospheric Administration (referred to as NOAA Fisheries).

How Will the City Know When a Watershed Is Healthy? The City will be taking actions to improve ecological functions, and the indicators will be used to determine whether these functions are improving. For example, the City will be reducing pollutant loads, cooling stream water and providing off-channel fish habitat. But how will the City know how much to cut pollutants, how cool is cool enough and when sufficient habitat has been restored? In other words, what functions or conditions would be present if the watershed were healthy, and where in the watershed should they be occurring?

To answer this question, the City will consider the reference conditions for each watershed when setting target values for each indicator. A reference condition is the ideal condition for an indicator in a particular watershed, subwatershed or even stream reach, given the unique physical conditions and constraints at that location. Target values represent desired conditions, taking the reference conditions into account but also being realistic about the constraints posed by the urban environment. In other words, target values acknowledge aspects of the environment that are unlikely to change, such as the fact that a city will continue to have roads and buildings. Essentially, target values define a level of ecological functioning in an urban setting that the City of Portland will strive to reach in order to achieve its watershed health goals and objectives.

Target values reflect both the watershed's potential and the constraints posed by its surrounding urban environment.

Deciding on appropriate target values is difficult because healthy ecosystems are always changing. Even pristine and fully functioning ecosystems have areas that, considered in isolation, would seem unhealthy. The challenge is to set a single value that accommodates the natural variation in ecosystems—from one location to another and through time, as ecosystems are disturbed and then recover, thereby creating new habitats and a more complex (and stable) system. One solution to this problem is, for each indicator, to establish a range of acceptable values.

What seems unattainable now may become attainable over time, and what seems easily attainable now may prove more difficult than expected.

Measuring Progress. To measure progress in achieving objectives—and ultimately the watershed health goals—the City will set benchmarks for each indicator. The benchmarks will state specific values to be reached in particular watersheds, at particular points in time, as the City moves toward the target values. Benchmarks will reflect the physical, biological, social and institutional factors that affect the rate of progress. Such factors include funding limitations, the need to protect human health and safety, and the fact that some projects are already under way.

Objectives, target values and benchmarks all will be refined as new information becomes available.

The relationship among reference conditions, current (baseline) conditions, target values and benchmarks is shown in Figure 3-2. In reality, benchmarks may not follow a linear path as depicted in Figure 3-2. For example, it could take 50 years for trees planted now to provide sufficient shade to have a cooling effect on water temperature.

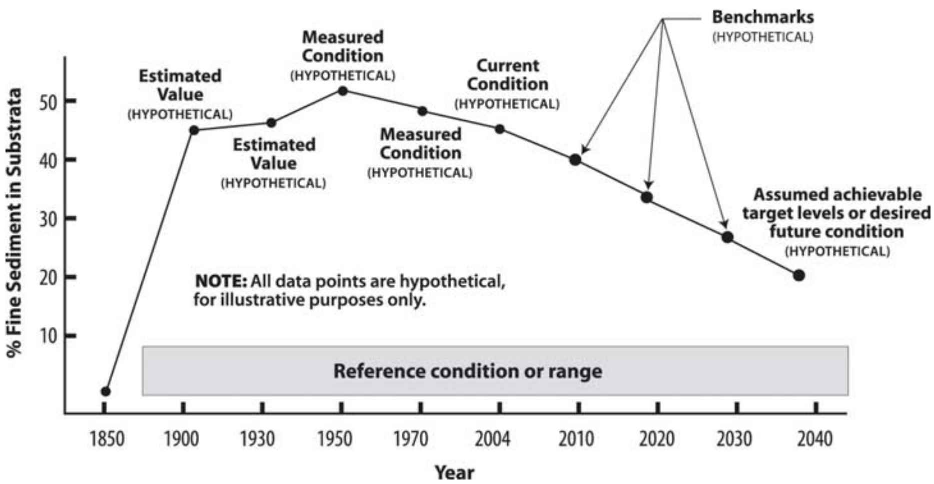


FIGURE 3-2
The Use of Reference Conditions, Target Values and Benchmarks

Step 7: Identify, evaluate and prioritize actions to achieve watershed health objectives and benchmarks.

In this step, a "long list" of potential watershed actions will be developed, and the actions will be screened to create a "short list" that will be evaluated further in Step 8.

Generating the Long List. Potential actions will be identified by reviewing scientific literature, considering the results of the watershed characterization, conducting inventories of ongoing and planned actions, and consulting with stakeholders who already are working in the watersheds. Likely types of potential actions include on-the-ground projects that require capital expenditures, modifications to ordinances or codes that affect watershed conditions and processes, and nonregulatory programs or initiatives such as education and conservation easements.

Potential actions could include nonregulatory measures (such as conservation easements, land acquisition, erosion control, pollutant source reduction, water quality treatment, septic system management, or the protection or restoration of instream habitat, stream-banks, wetlands and terrestrial habitats) or regulatory measures (overlay zoning, for example).

Checking Against the Restoration Guidelines. The potential actions then will be analyzed in terms of how well they align with the restoration guidelines. Priorities will be roughly as follows:

1. Existing high-quality habitat and properly functioning watershed processes
2. Connections among healthy habitat areas
3. Source control
4. Stream flow and hydrology
5. Physical habitat
6. Water quality
7. Biological communities

Actions that deal with the most fundamental aspects of restoration—and thus are likely to have the greatest impact—will be considered most favorably. Also highly valued will be actions that deal with more than one system or restoration element at once.

Screening for Implementability. Potential actions will be screened for general cost and technical feasibility. How effective will the action be? How much will it cost? Will it conflict with other priorities, either public or private? Is it likely to be supported by regulators? By the community? Asking such questions will help separate those actions that are clear "winners" from those that currently are infeasible, inordinately expensive or socially unacceptable; the latter will not be considered further at this time.

Grouping. The remaining "short list" of potential actions will be sorted into logical groupings based on the type of watershed objective, problem and solution. Organizing potential actions this way will help in determining whether a single action could address multiple problems (an example would be planting streamside vegetation to both improve water temperature and stabilize eroding streambanks). Conversely, multiple actions might best be grouped together because they all are needed to achieve a single objective (for example, several erosion and sediment control actions might be grouped together because they all improve water quality). Of particular interest will be actions that address more than one watershed process at a time and thus offer multiple—and perhaps far-reaching—benefits. Modeling tools will be used to help determine the relative effectiveness of various sets of actions.

Projects that address multiple problems or affect several watershed processes at once will likely make the "short list" of potential actions.

Step 8: Select the set of actions to be implemented.

The analysis, screening and grouping in Step 7 will result in several alternatives (that is, sets of potential actions), all of which would achieve the City's watershed health goals, albeit in different ways. In Step 8, a set of actions is selected for each watershed, taking into consideration social and economic factors and other nontechnical values.

Structured Decision Making. To assess the relative merits of the different sets of actions, the City of Portland may use a structured decision-making tool, such as multi-attribute analysis software. Typically, such a tool analyzes each alternative using evaluation factors that reflect the City's watershed health values (protecting high-quality habitats, maximizing habitat access and connectivity, etc.). For each evaluation factor, each alternative receives a numerical score that expresses how well that alternative would achieve the values reflected in the evaluation factor. In addition, the various evaluation factors are weighted according to importance. The scores and weightings are then used to generate a total score for each alternative. These total scores provide a means of comparing the different alternatives.

Although structured decision making may seem complicated or mechanistic, it has many advantages, especially when the "easy" decisions have already been made, the alternatives reflect competing values and disparate benefits need to be compared. It provides objective information about the merits of different alternatives and a means of documenting the decision-making process.

Incorporating Other City Values. The watershed management process will generate accurate, scientifically based information and recommendations about possible actions that would achieve the City's watershed health goals, objectives and benchmarks. However, the scientific information must be considered within the larger context of decision making at the City of Portland—a context that includes public debate, other City goals (such as public safety, neighborhood livability and aesthetics) and the financial impact of particular policy decisions.

Cost, regional issues, public input, City values not directly related to watersheds, such as economic viability and transportation—all will play a role in the City's decisions about watershed management.

These other values must be considered before a final set of actions is selected. To ensure that City values not directly related to watersheds are incorporated into the watershed management process, the City may use a multi-objective decision-making methodology similar to the multi-attribute analysis software just discussed. Such a methodology would help clarify the socioeconomic and environmental impacts of various restoration options as the City decides what level of commitment it wants to make to achieve watershed and river health. The City may also use a cost-benefit analysis that, among other things, pinpoints the ecosystem services (water purification, precipitation interception, etc.) provided by each alternative and the dollar value (compliance costs avoided, reduced flood damage costs, etc.) associated with each of those services.

Completing the Watershed Management Plan and Other Plans. At the conclusion of this step, the City of Portland will produce—for each watershed—a watershed management plan and related documents that lay out the recommended set of actions for achieving watershed health goals, objectives and benchmarks. Additional plans or documents may be needed to comply with regional, state and federal regulations. For example, these plans could include a water quality management plan, a habitat conservation plan or amendments to the City's Comprehensive Plan.

Step 9: Implement the selected set of actions.

Implementation will involve the following:

- Sequencing protection and restoration actions based on the severity of the environmental problems, the effectiveness of the actions, the restoration guidelines, technical feasibility, cost, regional considerations and other City goals, plans and fiscal priorities
- Identifying bureaus and programs that will be responsible for ensuring that actions are designed and implemented properly, funds are secured and spent appropriately, implementation proceeds on schedule and public education about the actions takes place
- Identifying capital improvement projects that may affect watersheds, rivers or biological communities and determining whether those projects require more formal consultations with regulatory agencies

- When necessary (such as when a change in the zoning code is recommended), conducting additional public involvement and following City Council approval procedures

Step 10: Monitor and evaluate the success of actions.

Because scientific understanding of watersheds is incomplete, the City of Portland will not be able to predict the effects of its watershed actions with certainty. Yet the City cannot afford to wait until scientific knowledge is complete. Instead, the City will proceed by documenting its assumptions about watershed ecology and processes in the watershed management plans and then implementing the recommended actions.

Adaptive management provides a way for the City to continually update its understanding of and assumptions about watershed processes so that they are more accurate and can point to more effective solutions to watershed problems.

The watershed management plans are not the be-all and end-all for watershed management in Portland, and Step 10 of the watershed management process reflects this. Step 10 involves monitoring and adaptive management. Adaptive management is a dynamic process of improving management activities incrementally as decision makers learn from the results of actions that have been implemented and as better information and analytical tools become available. In other words, the effect of adaptive management is to gradually improve protection and restoration approaches over time. Adaptive management involves checking progress made in achieving watershed goals; adjusting actions, benchmarks, targets and objectives accordingly; rechecking; and readjusting—all the while incorporating new data and scientific knowledge.

Making Adaptive Management Work. For an adaptive management program to be successful, it must have the following:

- Clear, measurable objectives against which to measure success in achieving watershed and river health goals
- Benchmarks linked to timelines, to map out the desired rate of progress in achieving the objectives
- A monitoring program to determine how well actions have been implemented, detect changes in environmental conditions, and check progress in achieving the benchmarks and target values
- Regular review of the monitoring data, comparison of the data with the benchmark or target values, and a method of adjusting actions in response to this comparison

Monitoring data must be compared to the benchmarks and target values on a regular basis to determine what progress is being made and whether actions need to be changed.

The City will lay out these elements of adaptive management in the watershed management plans. In addition, on a regular basis it will compare monitoring data to the benchmark and target values and adjust actions accordingly. Periodically, the City will analyze the monitoring results in depth and their implications.

Depending on the results of the monitoring, Step 10 of the watershed management process could involve the following:

- Collecting additional information where there are data gaps and uncertainty
- Updating the scientific foundation, assumptions about watershed processes and indicators that underlie the watershed management process
- Revising objectives to reflect the most current scientific information
- Adjusting targets and benchmarks in light of new information
- Refining the models used in the characterization and solutions stages
- Improving or replacing ineffective solutions

The Role of Monitoring. Monitoring is an essential element of adaptive management. A monitoring program that answers the following questions will be developed for each watershed:

- Have the actions been carried out as planned?
- Are the actions functional and working?
- Are the actions having the intended effect?
- Are the actions helping to achieve the benchmark values, the objectives and the City's ultimate goals for watershed health?

As much as possible, the monitoring needed for Step 10 will build on existing City monitoring programs. In some instances, new monitoring projects may be required.

Ensuring That City Projects Are Compatible with Watershed Health Goals

Although the watershed management plans generated through the watershed management process will provide valuable guidance, the City will not achieve its watershed health goals simply by implementing the protection and restoration actions called for in the watershed management plans. Additional guidance will be needed, and the City must have processes for ensuring that all City projects are as compatible as possible with the watershed health goals. These processes will apply to transportation plans, capital improvement projects, urban renewal activities, land use reviews and other City activities that do not in and of themselves focus on watersheds but that have the potential to affect watershed health.

Compatibility Process for Major New Projects and Programs. As major new projects and programs are developed at the City of Portland, they should be planned and designed to be as consistent as possible with the scientific principles, restoration guidelines and watershed health goals in the *Framework* and with the relevant watershed plan. Briefly, a process for ensuring compatibility will involve the following:

- Identifying any relevant watershed goals, objectives and benchmarks early in the project planning process; determining how the proposed project can help achieve those goals, objectives and benchmarks; and setting appropriate project goals that reflect watershed health goals

- Planning the project to include coordination with City programs that are involved in watershed health management
- Incorporating relevant watershed-related policies and recommendations into the project
- Modeling the project's positive and negative effects on watershed health and, as needed, either redesigning the project or identifying mitigation measures to achieve project watershed goals
- Monitoring the project using adaptive management

Regular Review of All City Programs. To ensure—to the greatest extent possible—that City programs, plans, projects and practices do not adversely affect watershed health, and that they are as consistent as possible with the watershed management plans and goals, City bureaus periodically may be asked to report to the City Council on the compatibility of their programs and activities with the City's watershed health goals. In brief, the bureaus would do the following:

- Identify programs and activities that could affect watershed health.
- Evaluate each program or activity in terms of (1) its potential impact on watershed health, (2) ways those impacts can be avoided, reduced or mitigated, and (3) opportunities to enhance watershed health.
- Identify funding and other resources needed to avoid potential impacts and enhance watershed health.

The City's natural resources staff will provide additional guidance in the form of technical memoranda, "how-to" manuals and checklists, day-to-day technical assistance, training sessions, workshops and policy manuals to bureaus whose actions affect watershed health.

These compatibility processes are not intended to be onerous or rigid. Rather, they are ways of periodically checking to see whether the City's bureaus and programs are—overall, and on balance—applying the principles of watershed management to both their everyday activities and their long-range programs. As needed, the City's natural resources staff will aid the bureaus as they go through this process of determining whether their activities are compatible with the City's watershed health goals.

CHAPTER 4

Ongoing Elements of Watershed Management

As explained in Chapter 1, the citizens and government of Portland have a vision for the City that involves a thriving natural river system with clean, healthy urban waterways and watersheds. Such a system would benefit fish, wildlife and—by enhancing Portland's livability, environmental health and economic vitality—people, too. Although the *Framework for Integrated Management of Watershed Health* represents an important step in making this vision a reality, the *Framework* approach is iterative and will necessitate ongoing efforts over the coming decades, including the following:

Applying the scientific principles and guidelines in the *Framework* and following the watershed process it describes will necessitate many ongoing efforts.

- **Addressing existing uncertainties** about species, habitats and water quality conditions in the City's watersheds, and how certain aspects of the ecosystem function in an urban setting. This will involve continuing to study salmonid use of the City's watersheds, studying the distribution and habitat needs of key riparian and terrestrial species, and filling data gaps about ecosystem relationships and functioning.
- **Delineating certain elements of the *Framework*** in more detail, such as specific roles and responsibilities, data management protocols, and processes for evaluating and selecting potential actions, applying adaptive management, and providing guidance on the *Framework* to City staff.
- **Developing a monitoring program to track progress** in achieving the watershed health goals. This is an essential part of adaptive management.
- **Providing appropriate funding** to develop and update the watershed management plans; implement, monitor and evaluate the selected actions; and ensure the compatibility of City projects with the watershed health goals.
- **Involving stakeholders and others** in the watershed management process. The City will need to engage the public, agencies and stakeholders in both policy-level and project-level decisions about watershed health in Portland. To ensure the scientific soundness of the watershed-related documents the City generates, the City should seek review of its work by (1) its Watershed Science Advisory Group, and (2) scientists who can provide independent peer reviews.
- **Providing regional coordination and leadership** in addressing watershed health issues. This includes continuing to build relationships with entities throughout the region; coordinating with regional, state and federal agencies to share the City's scientific information and approach and make sure that the City's approach is in step with their work. Forging strong public and private partnerships at the local and state levels also is vital to success.

- **Addressing the tough issues**. It is likely that following the processes in the *Framework* will raise fundamental questions about Portland's future and spark communitywide discussion about how urban growth and development in the metropolitan area can best occur while the City strives to achieve its watershed health goals. In addressing these issues, the City will seek solutions that integrate seemingly competing values and that provide the best possible outcome for both citizens and natural resources.

Appendixes

The main body of the *Framework for Integrated Management of Watershed Health* is supplemented by technical appendixes that provide background information related to the City of Portland's watershed management approach:

- Appendix A: Presents the City's River Renaissance vision for Portland's future and strategies for achieving the vision.
- Appendix B: Summarizes the federal, state, regional and City regulations that most directly affect the City's approach to watershed management. These regulations include the Clean Water Act (encompasses stormwater and wastewater discharges and pollutant load limits), the Endangered Species Act, the Safe Drinking Water Act, Superfund/CERCLA (including natural resources damage assessment), Oregon's statewide planning goals and guidelines, Titles 3 and 13 of Metro's *Urban Growth Management Functional Plan*, and the City's Environmental Overlay Zone and Greenway Overlay Zone regulations.
- Appendix C: Lists watershed-related activities the City already is conducting that the *Framework* builds upon.
- Appendix D: Describes how the City is coordinating its watershed-related activities with those of entities throughout the region.
- Appendix E: Describes Portland's natural environment, particularly its watersheds, habitats and biological communities.
- Appendix F: Presents NOAA Fisheries' population performance measures for salmonids and its guidelines for setting salmonid population goals.
- Appendix G: Details considerations in selecting indicators of watershed health and presents a comprehensive set of suggested indicators for potential use in the City's watershed management process.
- Appendix H: Describes some of the technical methods and analytical tools the City will use during the watershed management process. These include data collection efforts, the habitat model Ecosystem Diagnosis and Treatment (EDT), integrated hydrologic and water quality models, the Habitat Equivalency Analysis (HEA) and net environmental benefit analysis (NEBA) techniques for comparing the costs and benefits of different resource management alternatives, GIS for spatial analysis, multi-attribute analysis software for decision making and an environmental management system to help plan, implement and track restoration and protection activities.

The *Framework* also contains a glossary of terms and an extensive Literature Cited section.

RIVER
RENAISSANCE

ENVIRONMENTAL SERVICES
CITY OF PORTLAND
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