

CHAPTER 12 ADAPTIVE MANAGEMENT

The Bellevue Utilities Department is an enterprise utility committed to providing excellent customer service in a timely manner at a reasonable cost. To achieve this goal requires employing continual improvement processes on a wide range of information and data management, and evaluating fiscal, operational, and environmental processes.

Adaptive management is the systematic use of information to improve operations, especially in the face of uncertainty. The concept is common in business practices, such as General Electric's "Six Sigma," as well as conservation planning, such as The Nature Conservancy's "Open Source." These two examples have been used by multiple governments, businesses, and non-profit organizations. While most business sectors use some type of system to determine actions, adaptive management is a focused, systematic approach to improve future work by learning from the outcomes of implemented actions. Establishing an intentional learning environment allows an organization to move forward in an uncertain environment, establish reasonable expectations and timeframes, as well as reduce the risk of misdirected actions and funding.

In a 2002 National Association of Flood and Stormwater Management Agencies (NAFSMA) discussion paper about a National Academy of Sciences (NAS) report, the uncertain nature of stormwater management was articulated.

The NAS report states that this "reality of uncertainty in water quality management" is a fact that must be acknowledged and addressed. It derives from "our incomplete (system) knowledge or lack of sufficient data to estimate probabilities," and the "inherent variability of natural processes." As noted in the NAS report, "we are limited by incomplete conceptual understanding of the systems under study, by models that are necessarily simplified representations of the complexity of the natural and socioeconomic systems, as well as by limited data." Further that "not only are waterbodies, watersheds, and their inhabitants characterized by randomness, but they are also open systems in which we cannot know in advance what the boundaries of possible (biological, for example) outcomes will be."

The key elements are usually condensed into an ongoing, cyclical process, as illustrated in Figure 12-1. Adaptive Management Concept.

An example to illustrate the adaptive management concept follows. A utility company has a goal of no street flooding of primary emergency routes. An assessment might find that flooding existed at one location. Staff would identify (hypothesize) whether the flooding was due to conveyance capacity, insufficient upstream detention, frequently obstructed storm drains, or other causes. If there was not a clear answer to the question, multiple options, including additional studies, would be considered. There are many factors in choosing the appropriate action plan, including the relative cost, likelihood of success, and other elements (economic, social, environmental) of a triple-bottom-line analysis, as discussed in Chapter 8 Asset Management. Action plans would then be designed towards the most likely stressor, such as re-engineering a storm drain to reduce leaf blockages or installing a high-flow bypass system. The chosen action would be implemented and street flooding would be monitored. An evaluation would determine if the chosen action resolved the problem. If the primary street flooding was resolved, then the goal may be reviewed and could be maintained or revised to include no street flooding of secondary emergency routes, depending on the desired level of service. Then the process would start again.

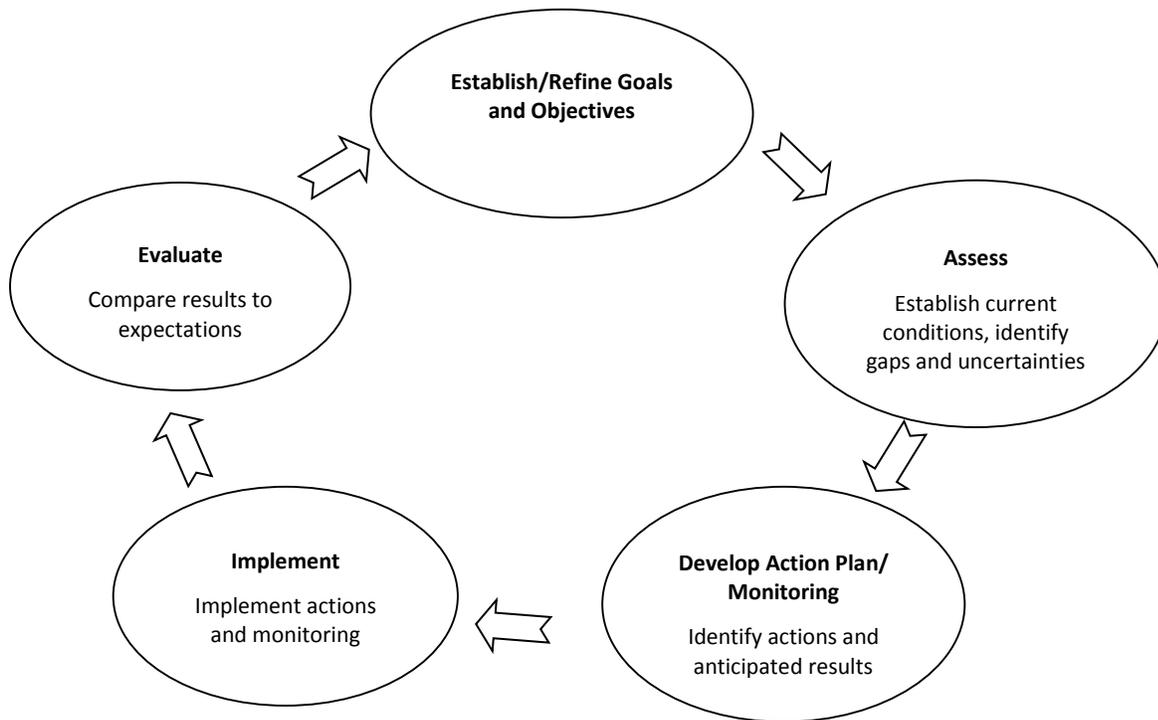


Figure 12-1. Adaptive Management Concept.

The adaptive management process can be applied at any scale from budget processes to individual projects to overall stormwater management programs. Adaptive management is a systematic process that identifies uncertainties, monitors results, and informs actions. A formalized program that clearly articulates the uncertainties and monitors results reduces the risk of errors and allows programs to move forward in the face of uncertainty.

Bellevue Utilities Department Monitoring and Adaptive Management Programs

The Bellevue Utilities Department is an entrepreneurial institution that expects staff at all levels to review and evaluate data for program effectiveness and efficiency on a regular basis. Some of these adaptive management programs are briefly described below.

APWA Accreditation Process

The Utilities Department voluntarily participates in a review and accreditation process for public works programs by the American Public Works Association (APWA); it received its first certification in 2004, demonstrating that the Utilities was compliant with industry best practices. The department was reviewed and recertified in 2007 and 2011.

Financial Review and Bond Ratings

As described in Chapter 11 Financial Information, the stormwater management financial program undergoes rigorous reviews every 2 years as part of the City's budget process. The Utilities Department has financial reviews through Moody's Investors Service, which establishes bond ratings. Customer

views of the quality and value of the Utilities services are also rated during the budget process to ensure that the types of services and costs are meeting customer expectations.

Capital Investment Program Plan Biennial Review Process

The Capital Investment Program (CIP) Plan (see Chapter 9 Utilities Operations) comprises individual projects and programs that are identified through system evaluations related to the public stormwater system operations regarding flooding, water quality, and habitat. These programs are operated on a 7-year basis with capital program review occurring every 2 years in off-budget years to inform the budget process. The capital programs review the goals and objectives of each program, evaluate current conditions and needs, develop project lists and preliminary budgets, and then review the action plan with the Environmental Services Commission (ESC) for recommendation for approval to the City Council as part of the budget process. Individual project designs utilize a team approach for triple-bottom-line evaluation of best solutions. CIP projects for streams typically have permit conditions requiring a 5-year monitoring plan for plant survivability. While the effectiveness of individual projects is evaluated in the larger system assessment for flooding, water quality, and stream habitat, there is currently no formal process for adaptive management for specific capital project design elements, such as which plants have the best survival rate or which design for improving fish passage has the least impact for maintenance. An adaptive process to evaluate individual design elements should be considered to improve success and reduce the application of ineffective designs.

Asset Management Program

As described in Chapter 8 Asset Management, Bellevue's asset management program is a formalized adaptive management program that is reviewed every 5 years. The program acknowledges that the assessment phase of adaptive management is currently a challenge because only approximately 25 percent of the piped system's installation date is known and about 2 percent of the pipes is inspected annually. The Stormwater Video Inspection Project (D-107) project was implemented in 2015 and will inspect 25 percent of the pipeline system by mid-year 2019. The information gained from this effort will give more information of the state of the system and inform immediate needs and potential future needs. Inspection rates and replacement expectations will be better defined as a result of this program.

Program Evaluation

Performance measures have been developed to formally set goals and evaluate the effectiveness and efficiency of individual programs throughout the Utilities Department. Performance measures are used for operational decision-making, evaluating whether program objectives are being achieved, helping plan the priorities and best uses of resources, aligning budgets with program needs, providing accountability about how well a program is operating over time, facilitating communication among different levels of management, and providing a framework for the Utilities Department's strategic planning and goal-setting processes. Each program administrator is responsible for maintaining records and reviewing data against program goals. Program evaluation processes occur at different time scales depending on the program, though many measures are reviewed annually.

Each of the adaptive management programs within the Utilities Department described above are designed to promote ongoing improvements in services and a general atmosphere of engaged learning by staff at all levels in the department.

Bellevue Monitoring Programs

In addition to the formal adaptive management programs, there are monitoring programs in place to provide information to guide these larger adaptive management programs.

Various monitoring programs and analysis and communications tools support the Utilities Department in managing the storm and surface water system (see Chapter 9 Utilities Operations). Monitoring programs involve collecting and analyzing information about stormwater system performance for efficient operations, to quantify system capabilities, and to identify system problems or deficiencies. Computer models of the storm and surface water system are developed, maintained, and used to map and predict flooding. The models allow accurate assessment of the system's ability to accommodate scenarios such as planned population growth or changed land uses; these data are then made available for basin or comprehensive planning. Computer models and trend analyses rely on up-to-date, accurate information. Data about facilities are provided by the Operations and Maintenance Division and analyzed by Engineering Division staff. Physical, chemical (water quality), and biological information about streams are collected for analysis of fish use, environmental health, and beneficial uses of surface waters such as fishing and swimming.

Telemetry and Hydrologic Systems

As discussed in Chapter 9, the Telemetry and Supervisory Control and Data Acquisition (SCADA) equipment are automated systems used to remotely monitor surface water elements such as precipitation, flow rates, and water level elevations. These systems allow staff to operate and regulate the gate settings at the regional detention facilities for stormwater based on current conditions. Telemetry and SCADA equipment warns in real time when systems are operating outside normal parameters, alerting staff so they can make manual adjustments. Currently, 12 stormwater structures and 11 rain gauges are monitored remotely using telemetry equipment.

Monitoring of rainfall and stream flows is critical to stormwater management and is used to inform emergency response, facilities operations, system evaluation, and capital investments. The hydrologic monitoring program serves both long-term and short-term objectives of the Utilities Department. Long-term hydrologic monitoring needs include planning, conducting ongoing operations, evaluating field safety, and monitoring trends such as climate change. Generally, a record of up to 50 years or more is needed for effective long-term hydrologic monitoring. Long-term records are often used for calibrating models for specific projects, such as basin studies or CIP Plans, and for providing data for statistical stream flow forecasting. Short-term needs generally encompass less than 5 years, which include using temporary flow gauges to plan and design CIP projects or guide operation of facilities with adjustable outlets. Short-term monitoring systems may be moved or abandoned depending on project need. The complete Hydrologic Monitoring Plan is provided in Appendix B-11.

Rainfall and flow monitoring is done at multiple sites across the city to address differences in elevation, stream size, and land use, as well as to facilitate operational needs. These data are also important when combined with other regionally collected data to recognize data trends, such as increased intensity of rainfall. If long-term climate change impacts are anticipated, the Utilities Department could consider changing development standards or constructing capital projects to reduce flooding risks.

The Water Supply Forum of Snohomish, King and Pierce Counties comprises regional public water systems purveyors, including the Cascade Water Alliance. In 2009, the Forum published the Water Supply Outlook report that evaluated municipal water demand through 2060. The report also considered uncertainties associated with water supply, including the implications of Climate Change on snow pack, stream flows, and precipitation intensity (Water Supply Forum 2009). The Utilities Department will monitor information provided by the Forum as a basis for adapting its stormwater management program in response to climate change.

Operations and Maintenance

Maintenance programs monitor many facilities for improved operations and maintenance, such as the sediment levels of catch basins or flood storage capacity at regional detention facilities. These are project-specific efforts that are reviewed and modified as part of a continual improvement process for both effectiveness and efficiency of field operations. Many of these monitoring efforts are articulated in performance measures and some are required through the National Pollutant Discharge Elimination System (NPDES) Permit. These monitoring efforts are anticipated to increase in response to future permits. New technology, such as rain gardens or pervious pavement, currently has limited information on maintenance requirements. It is recommended that ongoing monitoring programs that evaluate these new technologies be implemented to inform future maintenance practices and design considerations.

Illicit Discharge Detection and Elimination and Water Quality

As discussed in Chapter 9, the Utilities Department performs water quality monitoring to detect and eliminate pollutant sources discharging to the municipal stormwater system; to investigate water quality issues and reports of pollutant spills; to determine long-term water quality trends in a few water bodies; and, as needed, to inform management actions. The IDDE Program also includes locating and mapping drainage outfalls, preparing documentation, and providing City-wide support for illicit discharge training and response.

The Utilities Department has conducted and/or participated in numerous storm and surface water quality monitoring studies. These studies have included comprehensive characterization investigations of urban stormwater quality, water body-specific monitoring studies, and assessments of effective best management practices (BMPs). Water quality studies are expensive. The Utilities Department uses studies strategically to identify options to address specific water quality issues and inform management actions to adaptively manage programs over time, resulting in improved water quality protection and reduced pollutant discharge to the storm and surface water system.

The Utilities Department conducts summer nutrient and water clarity monitoring in Phantom and Larsen Lakes to determine the continued effectiveness of a reduction in phosphorus. This information is incorporated into systems analyses and capital program reviews, but stable conditions over the last 10 years have not indicated a need for management changes.

The current 5-year NPDES Phase II Municipal Stormwater Permit (2012 to 2017), requires monitoring. To meet this requirement, the city of Bellevue is participating in the Regional Stormwater Monitoring Program to gain greater understanding of stormwater impacts within urban areas and more rural areas of the Puget Sound lowlands. The regional program has three parts:

1. Status and trends monitoring to identify changes that affect beneficial uses of surface water over time;
2. Effectiveness monitoring to determine improvements in municipal stormwater management activities; and
3. Source control monitoring to determine more efficient and effective methods of detecting and eliminating pollution.

The status and trends monitoring began sampling small, wadeable streams and nearshore marine areas in 2015. There are two regional stream sites within the City of Bellevue, one on Yarrow Creek above I-405 and one on Coal creek downstream of Coal Creek Parkway.

Ten projects were selected for the initial effectiveness monitoring of stormwater techniques for improving water quality.

The source control element is being initiated with a review of source control information submitted as a permit requirement. Future actions to facilitate illicit discharge and other pollutant response programs will be developed after review and gap assessment is conducted of the actions and improvements currently being conducted by jurisdictions.

More information about the regional stormwater monitoring program can be found at:

<http://www.ecy.wa.gov/programs/wq/psmonitoring/swworkgroup.html>

Environmental Indicators

Monitoring streams, small lakes, and aquatic life provide data to determine progress towards the overall stormwater vision and help guide or evaluate capital investment projects that affect stream habitat and fish passage.

The Utilities Department plays a major role in maintaining and monitoring aquatic habitat in areas with the conditions to support aquatic life, as discussed in Chapter 5. The number and type of animals living in streams are a good indication of the relative condition of the streams. Biological information about streams collected by the Utilities Department includes surveys of spawning salmon in the fall; summer fish use of streams; annual sampling of benthic macroinvertebrates (the “bugs” that live in the stream gravels and can be seen with the naked eye) from streams; and peamouth minnow spawning surveys each spring. Staff, professional consultants, and volunteers collect biological information that is used to assess the environmental health of Bellevue’s open streams.

Aquatic benthic macroinvertebrates, resident fish, and spawning salmon populations are considered an indicator of aquatic health because the diversity and types of organisms reflect the water quality and physical habitat conditions of the stream over the course of their life span. Water quality samples can reflect the condition of the water only at the time of sampling and for the pollutants that were analyzed. While aquatic benthic macroinvertebrates cannot provide specific information on the types of pollutants that may be present, they can indicate general influences, such as toxics, sediment, or water temperature that have biological significance over the course of their aquatic life.

Summer fish populations provide indications of water temperature and physical habitat conditions typically relating to spring and summer conditions. Decreased or absent trout, sculpin, or juvenile coho populations in summer sampling can indicate increased temperature, loss of in-stream pool habitat, increased heavy metals, or significant water quality concerns. Both aquatic macroinvertebrate and summer fish populations respond to local habitat conditions and are not directly linked to outside influences such as harvest or ocean conditions.

Spawning salmon surveys, while influenced by outside influences, provide direct information about fish passage through culverts, as well as indications of physical habitat conditions. Salmon spawning surveys provide information about habitat conditions during the fall and winter, including late summer water temperature, flows, fine sediment, and stream stability. Using the aquatic indicator information as a whole helps to determine the types of projects and sequencing of stream projects that would best support aquatic life. For instance, increasing the complexity of habitat with large woody debris could help areas that spawning salmon or aquatic macroinvertebrates indicate have been affected by fine sediment. Salmon spawning surveys provide direct evidence whether salmon are utilizing habitat created through CIP or basin improvements in flow or sediment. While monitoring the number of

successful juveniles from those spawning adults would provide a direct measure of habitat health and the success of salmon habitat improvements, aquatic benthic macroinvertebrates have been used as a less expensive surrogate.

Because environmental indicators are instrumental in evaluating aquatic habitat conditions and informing where stream CIP projects should be constructed, it is recommended that the Utilities Department do the following:

- Continue to conduct salmon spawning surveys;
- Continue to collect macroinvertebrate data;
- Start to collect in-stream habitat data for large woody debris structures and in-stream pools;
- Stay current on research evaluating the effectiveness of stream habitat standards that guide CIP Plan design; and
- Develop a program for ongoing review of previously constructed CIP open-stream projects to inform future design strategies.

Monitoring Data from Outside Entities

Information collected and analyzed by outside entities is also used for adaptive management programs within Bellevue.

King County

City of Bellevue swimming beaches are monitored by King County. If bacteria are detected above certain levels, the information is used to close beaches for public safety and initiate source control investigations. Beaches are reopened after King County monitoring shows improved water quality and public safety is ensured.

King County has conducted water quality monitoring in a number of Bellevue streams for status and trends of surface waters. These data are incorporated into systems analyses, such as the state of the system, and county performance measures for environmental quality (see Chapter 6 Current Conditions – State of the Storm and Surface Water System).

Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Salmon Recovery Program

The regional salmon recovery program in Water Resource Inventory Area (WRIA) 8 conducted status and trends sampling in Kelsey and Coal Creeks for aquatic macro-invertebrates, summer fish populations, and physical habitat conditions between 2009-2014. This information is critical for assessing regional progress in salmon recovery. In addition, Bellevue uses these regional data sets for environmental indicator analyses rather than conducting local monitoring in those major stream reaches.

Washington State Department of Ecology

Ecology works with local governments to conduct special investigations into water quality related to streams and lakes that have been identified as having impaired water quality. This monitoring is associated with establishing Total Maximum Daily Load (TMDL) allocations as directed under the Clean Water Act. Currently, Bellevue is not engaged in any TMDL investigations, but Ecology has stated that investigations may be required within the next several years for at least one and maybe more of the five drainage basins identified in 2008 as having some water quality impairments (see Chapter 6).

Ecology also manages the Technology Assessment Protocol - Ecology (TAPE) program that screens and evaluates new technologies for stormwater management. This program provides research and

monitoring of best management techniques for approved use in stormwater management and land use development activities.

Future Direction

Adaptive and data-driven management is gaining greater momentum at all levels of government to show the responsible use of public funds and that the funds are being used efficiently and effectively. Bellevue continues to develop city-wide programs for more data-driven management as part of its continual improvement processes.

Regional and State Initiatives

State and federal funding sources are increasingly requiring proof that anticipated outcomes are actually occurring. Regional monitoring programs coordinated through the Puget Sound Partnership, Ecology, U.S. Environmental Protection Agency (USEPA), U.S. Geological Survey (USGS), NOAA Fisheries, local governments, and others will provide data to determine whether action plans for cleaning up Puget Sound, recovering endangered species, and reducing impacts from stormwater are working. As previously noted, Ecology and the Puget Sound Partnership have encouraged the development of a regional stormwater monitoring program for Puget Sound. Regional stormwater monitoring can be incorporated into a larger regional ecosystem monitoring program evaluating the health and recovery of Puget Sound.

Other Drivers for Monitoring and Information

As technology improvements allow greater opportunities for data sharing, there will likely be increasing demand for increased access to information, such as stream flows, salmon returns, or water quality. The City is currently investigating development of a Sustainable Eastside Web Portal to make environmental information more accessible to the public.

In state and federal processes, such as USEPA standards and rule-making, there has been increasing public demand for transparency of data and decision-making information. It is likely that increasing public disclosure of information and greater ease of access will become part of local government processes as a general protocol to maintain public trust.

The City of Bellevue is developing methods for increased communication among departments. As noted in Chapter 5 Storm and Surface Water Management Roles, Responsibilities, and Communications, there are numerous departments within the City that may want access to data collected by the Utilities Department regarding rainfall, stream flows, salmon utilization, water quality, or surface water.

Summary

The Utilities Department is committed to continual improvement processes at all levels of operations. As the internal and regional adaptive management programs mature and improve, data needs will be modified and refined. Continued review and evaluation of processes and projects to provide opportunities for increased learning, efficiency, and effectiveness will be an operational expectation. Data and summary information will likely have more broad application and interest in access to information will likely continue to increase.