Chapter 4 Charting a Roadmap for the Future – Implementation Principles and Strategies

In preparing for the *2010 Minnesota Water Plan*, the EQB convened an interagency team to identify strategic directions for guiding the water-related functions of the agencies over the next 10 years and beyond. While the next state water plan is scheduled for 2020, the vision of these directions is long-term, extending well beyond that date.

Planning, reporting and stakeholder involvement activities regarding Minnesota water resources management needs and challenges contributed to the foundation of this plan. In the last five years alone, agency personnel have engaged in coordination and planning efforts that have called on the expertise of hundreds of state professionals and thousands of engaged citizens. The results of these efforts, including the needs expressed and ideas for an improved future, contributed to the development of this plan.

The Legislature charges several state agencies with managing and protecting Minnesota's water resources. These agencies are committed to continuously adapting programs and direction to ensure sustainable water management. However, these programmatic changes take time. Furthermore, benefits are often complex and thus should be thoughtfully communicated to the public because the pace and presence of change can be inconspicuous. Additionally, land and water interactions are highly complex and dynamic systems; land and water improvement efforts often take years to demonstrate change, or change may be masked by other environmental conditions. Looking forward, the EQB and its member agencies recognize the need to continue to improve coordination of efforts, adapt programs to new information and communicate these initiatives and successes to the public.

Principles to Guide Implementation

The strategic directions frame the work that will occur, while these principles guide their implementation:

- Optimized coordination
- Prioritized resources
- Comprehensive land and water management
- Adaptive management
- Goals and measures
- Education and outreach
- Shared, long-term vision

This report outlines nine *strategies for guiding the work of agencies.* During the development of these *strategies*, certain overarching *principles* were recognized that cut across boundaries and are critical to each strategy. *These principles define how the work of the strategies will be implemented*. The implementation principles are discussed first, followed by a presentation of the strategies.

Implementation Principle #1 – Optimized Coordination

Coordination of efforts must be optimized across local, state and federal entities to maximize the benefits of combined actions.

Natural resource challenges are great, the implications of decision-making are significant and the resources to address the challenges are finite. There has been a clear call for improved coordination, and a responding increased effort among state agencies that is now expanding to include local government, the research community, federal entities and other interests.

The majority of day-to-day coordination efforts lack visibility because they are routine – but nonetheless critical – to successful water management. Effectively administered coordination leads to improved efficiencies and program adaptation. Coordination must continue to be promoted and expanded, as well as communicated to the public and Legislature.

Implementation Principle #2 – Prioritized resources

Priorities must be set to most effectively target resources and maximize opportunities.

Agencies recognize a need to effectively prioritize resources to maximize the effectiveness of their efforts by directing them to areas where the need is greatest and the impact is expected to produce the most beneficial results. Examples include:

- Monitoring – Gather data where the need is greatest, or in ways that are better coordinated with related efforts
- Protection – Target protection measures with consideration for factors such as where the threat is most imminent, or the land and water resource is considered of highest value
- Restoration – Apply restoration in concert with other activities based on consideration of the value of the resource, the potential impact of the proposed restoration, and the engagement of the local stakeholders, along with other site specific factors
- Research – Define the questions that are most in need of answers
- Problem identification – Identify the most critical water resource problems and target actions and/or resources to address them
- Stakeholder engagement – Target stakeholder engagement in concert with monitoring, protection or restoration activities
- Outreach – Target outreach efforts in a timely manner and where they are most needed (e.g. in advance of future resource management activities so that those activities will be done by engaged and informed citizens, industry and local government)

In a time when decisions often need to be made with incomplete data, it is critical that agencies at all levels of government prioritize their activities and dedicate personnel and resources toward areas that have the greatest need and can provide the highest benefit.

Implementation Principle #3 – Comprehensive Land and Water Management

Sustainable water resources can be achieved when land and water are managed as a holistic system.

Land and water must be viewed and managed holistically using a systems approach that recognizes their complex interconnections.. A raindrop that begins as surface water may soon become groundwater, only to be discharged later to the surface water system. Comprehensive water management recognizes this – and the way in which quantity and quality are intricately linked.

If water is not of sufficient quality for its defined use, it will not be available, without treatment, in the necessary quantity. Furthermore, both quality and quantity are directly connected to land management practices and land use changes, including those that result in water consumption. The vegetative habitat affects water quantity and quality in ways that directly impact the biology of the stream, all of which are indicators of ecosystem health. A degraded ecosystem can often be used as an indicator of a system from which water or fish may also be harmful for human consumption. Conversely, a healthy aquatic system often indicates a system that is adequate for sustaining human health. Looking to the future, no single part of the system can effectively be managed alone; rather, it must be evaluated and managed as a system with consideration of all respective interactions.

Implementation Principle #4 – Adaptive Management

Adaptive management must be employed to support informed decision-making while supporting the collection of information to improve future management.

Adaptive management is a structured, iterative process of optimal decision-making relative to changing demands, environmental conditions and uncertainty, with a goal of addressing change and reducing uncertainty over time by adequately monitoring the system and its response. In this way, decision making simultaneously optimizes resource objectives and generates information needed to improve future management. Adaptive management is often characterized as "learning by doing."

Minimizing Risk through Application of Adaptive Management

Managing water resources for the goal of water sustainability requires decision-making in the face of uncertainty. Waiting for the collection of more information is a decision in itself, with risk associated in waiting to act.

Some or all of the principles of adaptive management have been used to some degree in water resources management in the state for decades. Conversely, some programs and management strategies have not adequately responded to the need for change relative to improved understanding, while others have not been developed to collect sufficient information to assess effectiveness. Agencies involved with water management are more robustly integrating adaptive management into their respective programs and will continue to employ this approach in the months and years ahead. State programs must be transparent about what has worked and what hasn't, and how the

modified response will address what has been learned. Additionally, adaptive management calls for periodic examination of progress and review of each program's defined goals. As an example, the impaired waters process was intentionally designed to be an iterative effort, informed by newly generated information.

Water resources must be managed to meet a growing number of competing needs, at multiple scales, and over the long-term and in many situations where high levels of uncertainty exist. A foundational premise of adaptive management is that knowledge of water resources, and the services that they provide, is not only incomplete but elusive. However, these resources are and need to continue to be used, even in the face of uncertainty. Decision-making must take place using the best available information at the time. Adaptive management allows future decisions to improve based on new data. The ability to act must be supported by the ability to react – quickly and with the best resources currently available – when information indicates uses are unsustainable.

Restoring water quality, hydrology and ecosystems that have been degraded by significant human alteration of natural systems over decades will be challenging; progress may also take decades. Implementing effective programs that will result in environmental improvements requires the recognition that some trial and error is necessary. There also must be recognition that the complexity of natural systems which are being managed is so great that despite significant scientific work and understanding, even in the most well-studied systems, uncertainty will persist. However, with an appropriately designed monitoring and evaluation process, management decisions can be periodically refined to improve effectiveness and ultimately achieve management goals.

One tenet of the Great Lakes Compact (*Minnesota Statutes* section 103G.801) is "*to promote an adaptive management approach to the conservation and management of basin water resources, which recognizes, considers and provides adjustments for the uncertainties in, and evolution of, scientific knowledge concerning the basin's waters and water dependent natural resources,*" demonstrating the state's commitment to utilize an adaptive management approach in water resource management.

Implementation Principle #5 – Goals and Measures

A system to define targets and measure progress must be in place to determine whether water management strategies are achieving desired outcomes.

State agencies in recent years have begun to explicitly define targets and measures, and track them to gauge performance. It is critical to develop these measures specifically for the outcomes sought. These measures may be water resource improvement trends, indicators of social change or measures of adoption of BMPs or urban conservation practices.

TMDL Implementation Plans are written to include specific targets and defined measures, such as number of conservation practices adopted, pollution reduction schedules (e.g. a 25% reduction in phosphorus loading by the year 2020), and water quality improvement trends.

Passage of the Clean Water, Land and Legacy Constitutional Amendment in 2008 sent a clear message to the Legislature and Executive Branch that the citizens of Minnesota strongly value natural resources, habitat, trails and parks. However, the 25-year commitment demands that progress must be achieved and that resources must be distributed wisely. Tracking measures of effectiveness demonstrates that Minnesota is improving its environment, gathering information that can support the adaptive management principle, and communicating progress to the citizens. An interagency team is developing measures specific to the Amendment resources and will be recommending long-term measures and targets to track:

- Agency performance, including activities and outputs;
- Financing, such as local efforts and leveraged funding;
- Environmental changes related to water resource trends; and
- Societal changes, such as adopting new homeowner practices.

None of these efforts are easy to track; both environmental and societal changes are particularly hard to measure because they take time to mature and cause/effect relationships are hard to untangle. Regardless, the end goal is wise use of resources and progress toward a sustainable environment.

Implementation Principle #6 – Education and Outreach

Effective water resource management efforts must bring together both science education and outreach

State agencies recognize that the desired actions to protect water resources must take place on the landscape, which often results from the actions of individual landowners, communities, local government and the business community. Landowners and decision-makers can benefit when the state provides guidance and direction based on the best available science and data. Thus, while strong water management demands good data and a sound understanding of system dynamics, there must also be a commitment to partner with landowners, stakeholders and local government.

Environmental education takes place in many different ways. Mechanisms include the traditional K-12 education, but also community programs, summer camps, environmental organizations, community education efforts and many others. Complementary to the work of state agencies is communicating with customer bases; engaging in active stakeholder efforts; communicating generally through print and electronic publications and mailings; and working with traditional educators in developing curriculum. These efforts must continue and grow in the future to affect positive actions and change on the

landscape. Mutually beneficial partnerships will need to be fostered to ensure that education by nongovernmental groups complement agency outreach and stakeholder efforts.

Success in achieving the water plan vision depends on all levels of government working in coordination of its implementation. State agencies provide the framework in which information is collected and programs are administered, but rely heavily on local government, stakeholders and landowners to apply conservation practices and restoration efforts. Equally important is the support from and open communication with our elected officials. Only working together as local, state and legislative partners can we effectively improve our natural resource trends. Education and outreach are important components to ensuring all partners have access to the same information and that effective dialogues take place.

Implementation Principle #7 –Shared, Long-Term Vision

Application of the Minnesota Water Plan vision to achieve sustainable water management can unite people into cooperative action, inspiring them to work together for a common future.

The *2010 Minnesota Water Plan* defines a shared vision of strategies to move the state toward long-term water sustainability. This document defines a long-term vision in which water is managed comprehensively for quantity and quality; for healthy ecosystems and citizens; and in a way that doesn't jeopardize the resources of future generations. For success, Minnesota must apply this shared vision; Minnesotans must commit to memory that water sustainability is our common goal and that achieving it will require sustained adaptive long-term action.

Minnesota Water Plan Defines Vision

The 2010 state water plan details a shared, long-term vision – one in which water is managed comprehensively for quantity and quality, for healthy ecosystems and citizens, and in a way that doesn't jeopardize the resources of future generations.

Summary of the Implementation Principles

These seven implementation principles are broad, overarching principles relevant to each of the strategies in this plan. The principles describe how the work of the agencies in carrying out the strategies should take place. In this next section, the nine strategies of the state water plan articulate critical activities that the state agencies have set out to accomplish in the next 10 years and beyond.

Strategy #1 – Increase Protection Efforts

Goal –Groundwater and surface water supplies are protected from depletion and degradation, recognizing that protection is often more feasible and cost effective than restoration

Minnesota has relatively abundant surface and groundwater supplies that are vital to human health, quality of life and economic stability. The significant value of water requires that Minnesotans protect their resources and prevent degradation and depletion.

Strategies

The ***strategies*** are ordered starting with those that are protective and involve local partners, followed by a discussion of management areas and their associated data and information needs, and ending with a discussion of decision-making tools.

1. Increase protection efforts
2. Promote wise and efficient use of water
3. Restore and enhance local capacity
4. Employ water resource management units
5. Collect information necessary for water management decisions
6. Improve access to environmental data
7. Provide current implementation tools
8. Employ a targeted approach for protection and restoration Apply a systematic approach for emerging threats

Value of Groundwater

Healthy and robust groundwater systems are critical. Though the citizens of the state may have difficulty visualizing groundwater or understand its complexity, they rely on the services it provides every day. Three-quarters of Minnesotans rely on groundwater as their drinking water source. Groundwater also is the source of a majority of the state's surface water systems, which support sensitive ecosystems and recreational economies throughout Minnesota. Healthy ecosystem functions help maintain the health of surface and groundwater supplies. Due to slow travel times within most aquifers, the consequences of unwise actions today can be challenging to detect as they occur, and may take years to be measured through groundwater monitoring efforts. If a contaminant is introduced, it cannot usually be immediately detected and, once detected, may be extremely difficult and expensive to clean up. All of these factors make sustainable groundwater management challenging and highlight the necessity of employing adaptive management.

Value of Surface Water

Many citizens in Minnesota's major metropolitan areas depend on surface water as their drinking water source. Surface waters support ecosystems, fisheries, recreation, navigation, power generation, industrial cooling and a multitude of other activities. Healthy surface waters help define Minnesota and support the economy. Yet, monitoring conducted by the MPCA indicates that at least 40 percent of the state's surface waters don't meet their designated uses and are considered "impaired." Similar to

groundwater impacts, restoration and quantification of associated improvement is a slow and expensive process. Limited water and financial resources make protection a high priority.

Benefits of Protection

The importance of protection has long been recognized. Specific to groundwater resources, the Groundwater Protection Act of 1989 articulated specific protection goals. The Clean Water Legacy Act of 2006 was passed for the purpose of protecting, restoring and preserving the quality of Minnesota's surface waters. And in more recent legislation, the Clean Water, Land and Legacy Constitutional Amendment passed by Minnesota voters on November 4, 2008 stresses protection.

The need for greater focus on protection extends beyond preserving water supplies: Preventing water quality problems before they occur is a key tenet of the 1972 Clean Water Act and state water quality laws and rules, equally as relevant today as it was in the past. The Department of Natural Resources' January 2010 report, *Long-Term Protection of the State's Surface and Groundwater Resources*, detailed a series of recommendations for the long-term protection of surface and groundwater using many of the same tools and strategies detailed in the *Minnesota Water Plan*.

Minnesota state agencies, in cooperation with the Clean Water Council, have developed ground- and surface-water protection strategies that reflect that well-managed land leads to healthy aquatic systems. Implementation of the strategies will take place in coming years through the *Minnesota Water Plan* strategies and other efforts. Protecting water resources leads to ensuring that the state will have adequate supplies of sufficient quality now and in the future. Many of the following recommendations recognize the steps that have been started; however, commitment to their continuation and advancement are key to their success.

Recommendations – Increase Protection and Prevention Efforts

- Continue development of protection and implementation strategies for ground and surface water resources and communicate the results of these efforts to stakeholders.
- Continue to identify and proactively address potential problems by focusing on protection activities and tools for preventing degradation, including pollutant source reduction, conservation and the fostering of sustainable practices.
- Recognize the importance of local partnerships in identifying and capitalizing on prevention opportunities. Work with local government to incorporate protection into local planning efforts.
- Employ compliance and enforcement techniques and voluntary practices as tools to prevent degradation and overuse while supporting the ongoing refinement of state management tools and techniques (e.g. refinement of water quality standards) to more precisely protect water resources.

Strategy #2 – Promote Wise and Efficient Use of Water

Goal – Water quality degradation and water quantity conflicts are minimized through the promotion of wise and efficient use of water

Unsustainable water withdrawals and allocations can have significant adverse consequences on human and ecosystem health, as well as cause significant financial burdens. Conversely, when water is used efficiently, there are multiple environmental and cost benefits. These benefits include reducing the need for construction and operation of larger supply and wastewater treatment systems; reduced energy and chemical consumption for treating water and wastewater; and protection of environmentally-sensitive features such as in-stream flows, groundwater levels, fens, wetlands and lake levels. Additionally, water quality degradation can be prevented when less water is used or is more efficiently managed. The simple act of conservation benefits both quantity and quality.

> Per capita water use over the last 10 years has increased 6 percent, from 156 to 168 gallons per day (GPD) in the metropolitan area, and 413 to 443 gpd outstate. This trend indicates the likelihood for increased future conflicts.
>
> – DNR *Water Availability Assessment Report* (Appendix C)

It is widely recognized that some areas of the state have limited water resources while others have supplies that appear to be plentiful or even excessive. Despite this disparity, Minnesotans tend to take water for granted in planning for development; expecting to find it available everywhere in a quantity and quality that meets their demands at minimal cost.

Historically, Minnesotans have spent a great deal of time and energy in attempting to rid the landscape of water as quickly as possible, with significant adverse environmental consequences. Additionally, this perception of excess water has affected public understanding regarding the need to conserve. Even in relatively water-rich regions, there are consequences for withdrawals. These include reduced discharge to surface water features and ensuing impacts to aquatic life; impacts on neighbors; potential influences on the migration of contaminants; and the rising costs associated with constructing new wells and associated infrastructure. While there are clear benefits from efficient use, it is also true that most Minnesotans rarely experience shortages or are even aware of them; therefore there is no sense of urgency to conserve. With growing demand for water and more limits on supplies for both quantity and quality reasons, water conservation will require much more serious attention by all users in years to come.

> Metro communities use roughly 2.6 times more water on the peak summer day than an average day presumably to accommodate lawn watering. This leads to costly construction of new municipal wells, treatment and storage facilities and increases the risk of water quality degradation. More importantly, it depletes the limited reserve of water more quickly.

Minnesota's laws have long recognized the benefit associated with employing water efficiencies, as well as the respective savings to both users and the state. However, the challenge is continuing to

communicate this message to citizens and industry in a state that has many resources and relatively inexpensive access to water. Tools that are being used, and will continue to be important in the future, include:

- State agencies are developing programs and leading efforts for water conservation, guided by *Minnesota Statutes* 103A.205 and 103A.206.
- *Minnesota Statutes* 103G.101 requires that the commissioner of the Department of Natural Resources (DNR) develop a water resources conservation program for the state that includes conservation, allocation and development of waters for the best interests of the people.
- *Minnesota Statutes* 103G.301 also allows for consideration of alternatives to the actions proposed in permit applications, including conservation measures to improve water use efficiencies and reduce water demand.
- *Minnesota Rules* 6115.0770 state that "*in order to maintain water conservation practices…it is necessary that existing and proposed appropriators and users of waters of the state employ the best available means and practices based on economic considerations for assuring wise use and development of the waters of the state in the most practical and feasible manner possible to promote the efficient use of waters*." The rule goes on to allow the DNR to "*require a more efficient use of water to be employed by the permittee or applicant*."
- The DNR, in review of all appropriation requests, considers efficiency of use and intended application of water conservation practices (*Minnesota Rules* 6115.0670). In addition, *Minnesota Statute* 103G.291 requires that public water suppliers serving over 1,000 persons employ water use demand reduction measures including a conservation rate structure and education program prior to requesting additional appropriations.
- *Minnesota Statutes* 115.03 requires that applicants for wastewater discharge permits evaluate in their applications the potential reuses of the discharged wastewater.
- Public water suppliers provide information on their water conservation programs as part of a water supply plan (*Minnesota Statute* 103G.291); most have a conservation payment rate structure in place, or will by 2013, to meet statutory requirements.

Water Conservation Programs

Many suppliers have some type of watering restrictions in place over the summer. These are typically odd/even restrictions that help reduce peak day demands, allowing utilities to develop systems for lower peak volumes. Communities also provide water conservation messages through bill inserts, websites, newsletters and other local media. Other conservation measures employed by water utilities include leak detection, tree or topsoil requirements and metering or monthly billing.

While it is clear that the DNR has an explicit statutory and regulatory role in ensuring wise use through the water appropriation permit requirements and review of municipal water supply plans, the remaining state agencies have a role in promoting water conservation. All are in agreement with the need to

incorporate conservation and promotion of water-use efficiencies in their water programs. Therefore, the agencies will seek opportunities to promote water conservation and wise use in all aspects of water management. Despite the variability in water availability across the state, a coordinated, consistent message from state agencies that wise and efficient use of all the state's water is critical. Similar to the first strategy, many of the recommendations in this section recognize that important steps have begun, but commitment to their continuation and advancement are key to their success.

Recommendations – Promote Wise and Efficient Use of Water

- Continue to promote water efficiency and seek opportunities to further advance water conservation and wise use in all aspects of water management.
- Encourage other entities with a role in managing land and water resources to incorporate water conservation goals into local water plans while evaluating options for incorporating water use efficiency in regulatory programs.
- Ensure a coordinated, consistent message that wise, efficient use of all the state's water is important.
- Develop guidance materials on best management practices for water conservation as well as explore and support opportunities for alternative methods to efficiently use resources such as storm water and wastewater.

Strategy #3 – Restore and Enhance Local Capacity

Goal – Recognition of and support for local capacity and actions is increased

The state is highly dependent on the day-to-day activities of local governments, nonprofits and landowners to meet its land and water management goals. State and community partnerships continue to achieve significant accomplishments, and harkening back to the earliest organized approaches of watershed management initiated by the federal Soil Conservation Service in the 1930s. The state recognizes that in order for water management to be effective, support is necessary from local governments, non-profits and landowners. While the assessment, funding and overall goals may originate with the state, implementation occurs at the local level.

In recent years, the foundation on which water resource management implementation largely depends – especially for addressing nonpoint source pollution – has eroded as local government funding reductions have limited local capacity for water resource management in some areas of Minnesota. For the state's efforts to be successful, existing capacity must be supported

Aligning Self and Public Interest for Clean Water

By Annie Levenson-Falk, Citizens League, July 16, 2010

During our study on water governance last year, I found a gem of a quote from a Citizens League report back in 1993:

"State lawmakers should embrace the view that the purpose of government is to design environments where individual citizens and institutions are systematically oriented to accomplish public purposes, and where they meet their own interests in the course of doing so."

This is exactly what we need to do to address problems like water pollution. The biggest water quality problems we're dealing with today are not the major industrial polluters of the past; they're caused by pollution from the activities of the millions of individuals, businesses, and communities on the land across the state. Reducing pollution is going to require the public (i.e., us) to acknowledge that we're the source of the problem and to take a central role in the solutions.

Science and engineering have told us a lot about what we can do to improve our waters. The question for the rest of us is not so much what can we do, but how are we going to do it?

Most of our water pollution comes from our activities on the land. And most of the land is in private ownership. So the people who own and care for the land are the ones who need to make the changes.

The key water policy question, not asked frequently enough, is:

How does Minnesota set up the environments in which individuals, businesses, farms and other organizations all work together with government toward the goal of clean water, because they meet their own interest in the process of doing so?

and lost capacity must be rebuilt. Increasing funding for local projects is not the only answer. While money needs to be provided for local projects, there also needs to be recognition of the capacity required for the local entity to apply for, receive and make the best use of the project funds. This capacity must be sustained across funding cycles.

Coordination of Local Effort

The health and sustainability of surface and ground water resources are directly related to land uses within watersheds that drain to surface water features and recharge aquifers. Land-use management and decision-making is conducted by local governmental units in coordination with private land owners and land managers. Decisions at the local level individually and cumulatively have the greatest impact on water resource management within the state. The local capacity to understand, access and evaluate information, as well as support and encourage good land use decisions and water resource management practices, is highly variable across Minnesota. A key aspect of state water plan strategy is to ensure that local governments have access to the needed information and use that information as part of decision-making, education and outreach efforts. New levels of coordination with local government (cities, counties, SWCDs, watersheds) are essential for implementation of sustainable water resource management.

Shoreland Management Act

The Shoreland Management Act is an example of recognizing the importance of local land use regulation to statewide water resources. Shoreland and riparian areas are critically important to water quality, flow regime, recharge and ecosystem function. The concept of the Shoreland Management Act is to provide statewide minimum standards for land uses in shoreland areas, which are then implemented by local governments through land use ordinances. This component of riparian land use management is a critical piece of water resource management that needs additional resources for updates and implementation.

Local Engagement

State government tends to interact with its local partners on a program-by-program and project-by-project basis, rather than in an integrated way. Opportunities to solve root problems or address larger state and community concerns may sometimes be missed. Local capacity to manage water and related land resources is limited, and some local governments are concerned that they must navigate through a maze of multiple federal and state agency interests, perspectives and requirements. The state is currently exploring opportunities to engage local governments across issues and at a variety of scales, including major watersheds and groundwater management areas, and increasing program delivery through local governments to accomplish better outcomes for Minnesota communities and natural resources.

Recommendations – Restore and Enhance Local Capacity

- Implement organizational structures that enhance local contacts and coordination with local governments. Explore programmatic opportunities to attract additional funds for local implementation by using state funds to leverage federal, local and landowner contributions.
- Deliver assessed data and trend information to local managers.
- Participate in the established 10-year planning cycles at the community level.
- Look for opportunities for federal-state-local fund to be co-leveraged for multiple benefit projects and activities.
- Utilize local governments to cost-effectively provide state program services when appropriate by integrating functions with other local services.
- Increase recognition of and stabilize support for local capacity and actions – local capacity cannot thrive while going from potential grant to potential grant.
- Continue to explore ways to support state and local collaboration to provide consistent messages and information to local interests.
- Develop a system of incentives to reward local units of government that incorporate water availability and sustainability considerations into their water and land use plans and decisions.
- Build and maintain the capacity to work across projects, programs and agencies to meet local as well as state needs.
- Implement organizational structures that enhance contacts and coordination with local government.

Strategy #4 – Employ Water Resource Management Units

Goal – State-level water resource management activities are improved by defining water resource management units for coordinating a systems approach to management

One of the big challenges for the state in effectively managing its water resources is organizing and coordinating management efforts at a scale that promotes efficiency, engagement and implementation success. Experience has shown that addressing water resources at a too-small scale, such as a waterbody-by-waterbody approach, can miss opportunities to identify related problems and address them more comprehensively and, in the process, realize economies of scale. Conversely, selecting a management area that is too large – such as the state as a whole, ecoregions or even river basins – can make it difficult to coordinate activities with the area's many federal, state and local partners and can present barriers to fostering local engagement. Delineation of surface and groundwater management units provides a way to define the natural resource to improve coordination of mapping, monitoring and management.

Water Resource Management Units

- Surface water managed through the 81 major watersheds
- Groundwater managed using source water protection areas and groundwater management units

Surface Water Management Units

A key strategy that has emerged from the implementation of the Clean Water Legacy Act and activities supported by the Clean Water Fund is the use of the state's 81 major watersheds as the organizing framework for surface water quality management under the act (Figure 3). The major watersheds, while large enough to provide a systems approach to solving problems and gain economies of scale, are small enough to promote targeted and coordinated efforts and are hydrologically-based units. Additionally, a coordinated watershed approach enables addressing protection and restoration for multiple impairments simultaneously. This does not mean that the major watersheds are a one-size-fits-all scale to address every question. Rather, this strategy is about using the appropriate scale to achieve resource goals. Other management scales (individual water bodies, basins, etc.) continue to be valuable; the employment of the major watershed scale is simply a tool for enhancing the coordination and efficiency of monitoring and management.

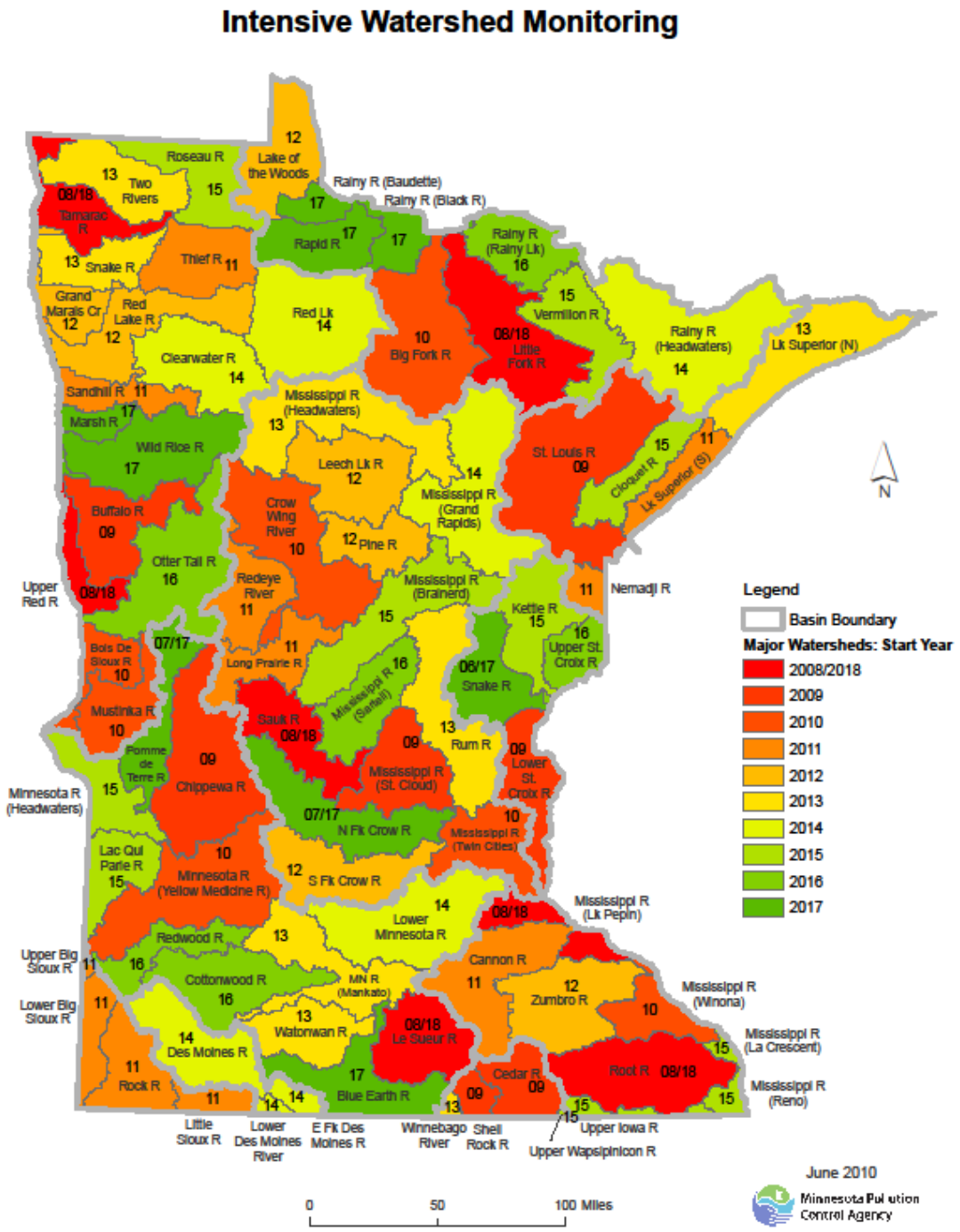

Figure 3. Minnesota's 81 major watersheds and their respective monitoring schedule.

Groundwater Management Units

Similarly, for groundwater, source water protection areas and groundwater management areas are being developed to define the boundaries and flow pathways for subsurface water movement. While it is recognized that surface watershed and groundwater aquifer boundaries are different, both systems need to be managed in an integrated manner when possible, recognizing that land-use management choices will impact the sustainability of human and ecological health. Merging the understanding of surface and groundwater movement will foster increased coordination and collaboration among state agencies and with federal and local groups as the state and its partners continuously improve management tools based on new information and system understanding. Additionally, characterizing the larger system will improve quantification of flow through the resource to enhance management of sustainable withdrawals.

Defining Benefits

The benefits of this "water resource management unit" approach to organizing and coordinating the work of water resource protection and restoration are many, including:

- Identifying most, if not all, water resource problems in an area at one time. Additionally, enabling the opportunity to address the problems through a coordinated, efficient process.
- Fostering increased local understanding of how water moves through, across and beneath the landscape, which will help identify causes and solutions to both water quality and quantity issues.
- Providing citizens, stakeholders and local government an opportunity to proactively engage in the resource management work, first through volunteer and local monitoring activities, and then through implementation efforts. This up-front engagement helps set the stage for local involvement in water resource management and enhances the information available for good planning efforts and successful implementation of restoration and protection strategies.
- Developing effective management strategies based on hydrologic boundaries.

This approach also provides an opportunity to integrate and prioritize protection and restoration efforts at the management unit scale, relying on data to determine what actions are needed and how resources can be most effectively allocated. With this approach, protection becomes an integral part of the identified management strategies and management and implementation efforts can then include both protection- and restoration-focused activities.

Recommendations – Employ Water Resource Management Units

- Utilize water management units to organize and communicate data, trend information and preferred strategies to local planning processes and organizations.
- Continue to employ a major watershed approach to protecting and restoring surface water quality, while enabling scaling efforts up or down as appropriate.
- Define and employ groundwater management areas.

- Achieve the goal of a 10-year cycle for monitoring and assessment, Total Maximum Daily Load allocation and protection strategy development, and implementation of regulatory and nonregulatory actions to protect and restore surface water quality.
- Develop schedules collaboratively for groundwater monitoring, mapping and management activities to foster cross-agency coordination and efficiency.
- Align major watershed and source water protection or aquifer management area monitoring, planning and implementation schedules where possible to foster a better understanding of surface water/groundwater interactions, identify opportunities to concurrently meet groundwater and surface water management needs, and help avoid unintentionally transferring problems from one water resource to another.
- Use and enhance existing local delivery systems to deliver conservation locally within water resource management units.

Strategy #5 – Collect Information Necessary for Water Management Decisions

Goal – Information necessary to support sustainable water management decisions is collected efficiently and collaboratively

The state is employing a thoughtful, integrated and collaborative approach for collecting prioritized information, in targeted locations, and within timeframes that will inform water management decisions. It has long been recognized that effective water resource management requires sufficient data and information about the hydrologic systems to inform sound decision-making. While a great deal of information has been collected, an understanding of status, trends, stressors and interactions (between groundwater and surface water, water and land use, climate and recharge, ecosystem components, etc.) is essential to identifying and achieving water resource goals and supporting adaptive management principles.

> *"Sustainable water management requires sound data to support understanding of the various elements of the hydrologic system. This includes high resolution landscape and soils information, precipitation, aquifer recharge, aquifer discharge, aquifer withdrawals, ecosystem services needs, surface water quality, ground water quality, evapotranspiration, surface water and ground water interconnections and flow pathways, among other traits."*
>
> 2008 EQB report, *Managing for Water Sustainability*

The state has made significant progress towards meeting this need in recent years, particularly in the surface water arena with the advent of the Clean Water Legacy Act and Clean Water Fund support for monitoring and information-gathering efforts. Furthermore, there has been a renewed effort in the past year to generate new critical groundwater data. While gaps remain, the state is on a trajectory to address many of those gaps over the next 10 years, provided that funding continues.

Each agency has a specific need for collecting information relevant to its statutory mandates

and agency objectives. To gain a more complete understanding of the hydrologic system, these information sources must be considered together. State agencies routinely coordinate ground and surface water sampling activities to eliminate redundancy and maximize efficient use of limited resources. In addition, information collected for a variety of purposes is routinely shared across agencies. This collaborative approach is working well, and is further enhanced by efforts to identify and employ "water resource management units" (discussed in Strategy 3) to prioritize, schedule and communicate future data collection efforts.

While discussion of the collection of water information often occurs in the context of surface and groundwater, it is important to remember that these systems are connected and also include landscape and biological systems. The following sections on surface water, groundwater/surface water interaction, and groundwater provide further discussion on the collection of existing information as well as priorities for the collection additional information.

Surface Water

The state is on track to monitor and assess its surface waters on a 10-year cycle and to monitor the outlets of major watersheds for flood warning, pollutant trend and adaptive management purposes. The Clean Water Legacy Act and the Clean Water Fund have greatly accelerated data collection for surface water quality (biology, physical characteristics and chemistry). There is a need to continue that effort over the 10-year cycle, expand the effort through local parternships and use adaptive management concepts to measure progress and identify information gaps.

Additional efforts are needed to collect information that will assist in determining the water quality and quantity requirements of healthy ecosystem functions and drinking water. Typical approaches to address ecosystems have tended to orient around the minimum requirements (quantity and quality) of an ecosystem, rather than what is needed to support a healthy ecosystem. The natural variability of flows within a year (season to season) and between years (dry to wet years) is a factor that biota have adapted to and depend on. Understanding and addressing the variability requirements of ecosystems has been a challenge for water managers.

Five Key Components for Ecological Functions

- Hydrology
- Connectivity
- Biology
- Geomorphology
- Water quality

The relationship of surface water to the landscape or watershed is also critically important to understanding the system. For example, information is needed about the role of small headwater streams and wetlands in the overall system health. This better understanding will be used in the development of predictive tools that use hydrology, connectivity, biology, geomorphology and water quality information to assess watershed health. These tools will ultimately help inform land use decisions that are protective of water resources.

Groundwater and Surface Water Interaction

Groundwater and surface water management has traditionally occurred independently of the other, which has led to unintended consequences. Groundwater pumping, for example, can reduce aquifer levels that adversely impact seeps, springs, wetlands and discharge to streams. Conversely, groundwater recharge from unsustainable land use and surface water can transport chemical constituents into the groundwater system. Additional information on site-specific geology, hydrology and identification of sensitive landscape features will better inform water appropriations, best management practices and land use decisions to avoid adversely affecting ground and surface water interactions. An improved understanding of surface and groundwater interactions will help ensure that both components of water resources are being protected, and we are not inadvertently transferring problems from one component to another (i.e. from surface water to groundwater, or vice versa).

Groundwater

Efforts to develop information for understanding groundwater systems are ongoing. Agencies are making significant progress toward addressing information gaps related to aquifer characteristics, water quality and water sustainability. While trend data is available for several important pollutants, it is still lacking for others; monitoring and information gathering efforts being implemented through recent funding initiatives are designed to address some of these gaps. Regardless, sufficient time is necessary for collection of data that support rigorous trend analysis.

Continuing development of county geologic atlases and development of groundwater monitoring networks, such as the groundwater level monitoring network for the 11-county metro area, are examples of ongoing efforts that will better inform land and water management decisions. However, additional information is required to better understand aquifer characteristics such as recharge, storage and movement of water in these underground systems, and to identify areas at high risk for depletion and/or contamination.

Groundwater systems data are particularly challenging because the main information source is typically a single point (i.e. a well) on the landscape, requiring significant interpretation between points (wells) to define the system. For these reasons, it is important to maximize the information obtained from each point and prioritize those areas of investment for information collection. State agency programs will need to increase monitoring requirements and coordinate efforts under existing authorities to ensure enough information is collected to understand and manage groundwater systems.

Concurrently, more work is necessary to characterize the quality of private drinking water wells. Monitoring efforts exist for public water supplies (through the Department of Health), and ambient groundwater quality (through the Pollution Control Agency and the Department of Agriculture). With the exception of a requirement for testing newly constructed wells, Minnesota lacks a systematic effort to monitor and understand private drinking water well quality. Traditionally, well owners have been encouraged to conduct annual testing of their water, but few do and the data that is generated is not aggregated in a single location for public use. There have been some recent efforts coordinated by counties with state agency support – most notably the Southeastern Minnesota Nitrate Study – but

more work is needed to assure that these water supplies, which are outside the Source Water Protection Program, are sufficiently understood and protected.

Recommendations – Collect Information Necessary for Water Management Decisions

- Continue work on collaborative and integrated systems of groundwater and surface water information collection.
- Continue recently accelerated data and information gathering efforts, such as the 10-year cycle of watershed monitoring, enhanced groundwater monitoring, and increased efforts to better understand aquifer characteristics.
- Focus on the following priority areas for additional information collection:
  - Water quality and flow requirements to sustain healthy ecosystems.
  - Ground and surface water interactions.
  - Aquifer characteristics such as recharge, use, storage, and transmissivity.
  - Resource thresholds and performance standards to inform management decisions
- Identify defensible criteria for assessing the critical water levels or flow conditions required to support ecosystems. The criteria should consider ecosystem-sensitive practices that protect critical components of the hydrograph, including:
  - A habitat- and population-based minimum flow
  - A high flow protection standard that protects critical habitat-forming and silt-flushing high flows
  - Protections for downstream needs
  - Protections for the natural variability of flows over time (hydrograph shape)
- Increase efforts to characterize the quality of private drinking water wells.

Strategy #6 – Improve Access to Environmental Data

Goal – Decision-makers and the public have ready access to environmental data to support sound management decisions

Good data have diminished value if they are not readily accessible. Agencies are committed to making easy and efficient access to data a high priority of their respective programs. Many reports call for improved data collection and monitoring efforts, but it is equally important to ensure access to the data to support planning efforts.

Recent Progress

Great strides have been made recently. Agencies have focused on strengthening their water monitoring efforts and defining clear, long-term plans for data collection and communication of trends. Concurrent with enhanced data collection efforts, agencies have made significant progress in recent years toward enhancing access to environmental data through web portals, such as the Minnesota Pollution Control Agency's Environmental Data Access site (which includes Department of Agriculture monitoring data), and the use of data standards such as Department of Health's County Well Index unique well number.

The Department of Natural Resources (DNR) recently received resources to implement a foundational water level monitoring program in the 11-county metropolitan area. As a part of this project, the DNR will begin the development of a groundwater level data management framework that will improve storage, access and sharing of data between agencies and other levels of government. Additionally, the Metropolitan Council, DNR and MPCA are working together on defining better database tools.

The MPCA received a modest Clean Water Fund allocation to begin development of a "Watershed Information Management System" that will serve as a portal that will connect multiple sources of water data and information. These efforts are foundational and should be built upon to ensure that resource managers and decision-makers have access to the information they need to support a more sustainable water resource management system.

Defining Goals

Easy access to accurate data and information ensures sound management decisions and efficient use of resources. Furthermore, to ensure cost-effective use of existing information and funds, agencies will accelerate cooperative efforts to share and simplify public access to environmental and technical data. The goal will be to provide information in a variety of formats to encourage adoption by citizens, interest groups, local units of government, watershed groups and other interested parties and to facilitate the exchange of information among professionals. A well-designed data access system will improve the state's ability to clearly communicate trends in areas such as surface water discharge, groundwater withdrawals, water quality conditions and ecosystem health.

Recommendations – Improve Access to Environmental Data

- Establish data standards that provide a common format for accessing and sharing identified categories of water data (e.g. surface and groundwater quality, surface and groundwater quantity, biological, meteorological data, etc.).
- Identify and prioritize gaps in the current data management system. For example, state agencies are aware of the need for a repository to store and share surface and groundwater flow data collected by local government and other partners, and are actively evaluating options for meeting this need.
- Develop an implementation plan for enhanced data management that includes system requirements, a prioritized list of needs, agency roles and responsibilities and a work plan and cost for filling gaps and implementing identified improvements.
- Continue to provide more and better opportunities to share water data and information through web portals, analytical tools (such as the DNR's Watershed Assessment Tool and the Environmental Quality Board's Water Availability Information System), map interfaces and upload/download functions.
- Continue efforts to develop and apply water sustainability models and planning tools, integrating new information and research results, as well as additional social, economic and environmental data.

- Provide the contextual information needed to understand and use water data, such as standards and benchmarks, trend information, and supporting data about land use, climate, hydrogeology, geomorphology, soils, native plant communities, protected features and ecosystems.
- Identify water quality and quantity targets and use an improved data access system to measure progress towards them.
- Build on recent and current data access projects to identify the users of state water data and their information needs, and use that knowledge to guide future data access enhancement projects.
- Develop guidance information for the public on agency monitoring, mapping and management activities. Clearly articulate the roles and responsibilities of the various entities involved in natural resource management.

Strategy #7 – Provide Current Implementation Tools

Goal – Water resource concerns are addressed through the use of an adaptive approach to updating management tools

A variety of management tools are used by state agencies, local governments and stakeholders to protect and improve water quality. These tools can take many forms – community-based outreach efforts; voluntary best-management practices and guidance; incentives; and regulatory rules and standards based on scientific information that supports policy objectives. It is important to that these tools are current and effective to ensure that protection and restoration efforts are successful.

The selection of one or more management tools to address water quality and quantity concerns may be driven by the scope of the problem, by the water quality issue being addressed (i.e., is it acute or chronic in nature?), or by other complexities that require development of other tools.

Best management practices (BMPs) offer guidance to users regarding the management of pollutants, processes, land and waste. BMPs and other tools offer guidance so that impacts to water quality are prevented or resource degradation is minimized to the greatest extent possible. Certain conservation practices help protect against or reverse damage to water and adjacent land resources to ensure that ecological and resource protective functions are maintained or improved.

Examples of Water Resource Protection Management Tools

Successful management tools can include such things as education, rules, enforcement and incentives:

- Stormwater drain stenciling
- Construction site silt fencing
- Liquid waste management and recycling guidance
- Local ordinances regarding land management and impervious surfaces, including shorelands
- Best management practices for use of pesticides in agricultural and residential settings
- Rules for management of feedlots and the land application of manure
- Regulations for industrial and non-industrial discharges to waterways
- Enforcement programs for compliance with storage tank rules and containment structure requirements
- Incentives or recommendations for alternative crop rotations, production systems or land management approaches in agricultural settings
- Incentives to protect health ecosystems such as conservation design developments and transfer of development rights

When BMPs and other recommended practices fail to be effective or are not adopted, despite their practicality, other solutions – such as the development of incentives or regulations based on science and stakeholder input – may be necessary.

Management practices, protection incentives and regulations should continue to be optimized and refined over the next 10 years. For example:

- Considerable progress has been made refining management practices, rules and standards to reflect new understanding of water quality and ecosystem interactions, and to address changing land-use conditions. Continued refinement is needed as new information becomes available and to reflect new issues and opportunities.
- Many water resource protection laws and rules are working well and achieving desired results. Others are not as effective, which could be due to myriad factors such as inconsistent adoption across the state, lack of adequate funding or the need for additional education/technical assistance. These tools should be fully optimized to enhance water resource protection and restoration.
- Efforts to avoid problems before they occur through pollution prevention, compliance activities, education and product stewardship have accelerated in recent years. These activities should continue to improve our ability to address potential threats to water resources before they become costly restoration problems.

Ultimately, recommended practices, guidance and law, supported by adequate education and outreach, should create a set of extremely flexible, robust and diverse tools that are periodically reevaluated to ensure their effectiveness and practicality and incorporate new information/learning.

Practices to protect land and water systems are detailed in the following two sections. However, these tools apply to all of Minnesota's landscapes. The sections include examples related to agriculture, but the same practices are relevant to any activity across the state that modifies the landscape, including forestry, mining, urban development and industry.

Water Quality Best Management and Conservation Practices

For many ground and surface water contaminants, recommended management practices (e.g., Best Management Practices) and conservation practices are the primary tool for protecting and restoring water quality. However, the cost and effectiveness of many practices can vary considerably depending on multiple variables. One size does not fit all, and what may be beneficial for one area of the state, one municipality or one business may not be appropriate in another. Some practices may be more difficult or expensive to implement or may have undesired consequences on non-targeted contaminants. In some situations, the practices and technologies promoted may be less effective in certain settings, may change over time, or understanding may advance since the practice was last revised. For these reasons, and to ensure that limited funding is spent wisely, it is important to periodically review and quantify, to the extent practical, the costs, benefits, limitations and environmental outcomes, both intended and unintended, from specific management and conservation practices.

In a similar manner, BMPs can be applied for enhancing water quantity. These water quantity conservation practices are detailed more explicitly in Strategy 2 to promote wise and efficient use of water.

Agricultural Best Management Practices

BMPs for agricultural contaminants often need to be developed or updated to address environmental concerns and to keep pace with evolving technologies and crop production practices. New plant hybrids or new methods for the precise application of fertilizer are examples of innovations that may require new BMPs. Because agricultural BMP development depends on understanding and incorporating multiple variables, and for reasons outlined above, it is important to develop and implement a step-wise systematic process to review BMPs.

There are three steps in this process. The first step is to establish a systematic process to screen existing BMPs and identify those that require a more detailed review; gaps in current BMPs; and new practices or technologies which may require a BMP. There should be an easily understood transparent process for the systematic review of BMPs and the identification of issues or concerns regarding their implementation. This process should determine whether there are sufficient technical data to develop a BMP and, if not, recommend additional required projects to acquire such data. The process should also include a feedback loop where growers and crop advisors can provide input into the review process on the obstacles for their successful implementation.

The second step is to undertake BMP evaluation projects to fully understand and quantify their costs, benefits, limitations and environmental impacts. BMPs may vary from extremely simple practices that are easy to implement to potentially complex and expensive practices that might require considerable funding and knowledge for their implementation. For many agricultural BMPs, to fully understand and optimize their implementation will require plot or field scale evaluation supported by water monitoring and computer modeling.

The third step in the process is to support local BMP demonstration sites that facilitate their successful adoption. Demonstration sites for BMPs will help fine-tune the BMPs to address potential variability in conditions that frequently exist on a regional or local scale. For example, a local demonstration site would help educate farmers on how a specific practice will complement their cropping system. Demonstration sites also help address the human dimension of BMP adoption because an individual will be much more likely to adopt a practice if a friend or neighbor can personally explain and demonstrate that it works. Demonstration sites should be integrated into local and regional efforts to promote BMPs.

Research that is used for agricultural BMP development should be easily available to the public online. The BMPs should be compiled in an easily accessible format that identifies where, when and how they might be used, as well as the potential tradeoffs between different contaminants or practices that might be impacted by the BMP.

Agricultural BMPs are an important tool for protecting water quality and a fundamental building block for other actions, including regulations, to protect groundwater and surface water. If they are not effective, the state is at risk of expending considerable resources without achieving the desired improvements in water quality.

Recommendations – Prioritize Development, Evaluation and Implementation of Water Quality Protection Management Tools

- Develop a summary of existing laws and rules that are not yet fully implemented and identify the barriers (financial, policy, administrative, etc.) that are preventing their effective implementation.
- Provide appropriate guidance to landowners and local government to ensure that all management and conservation practices are adopted in the most effective manner for their site-specific application.
- Support efforts to evaluate, develop and advance management and conservation practices.
- Develop a systematic process to screen existing management practices, further refine existing practices when appropriate and develop new practices. Part of this process is to understand and quantify the costs, benefits and limitations of formal BMPs and other management and conservation practices.
- Support local demonstration sites to facilitate the successful adoption of BMPs and other practices. Share findings of research studies used for BMP and conservation practice development through an easily available online access point.
- Continue to refine standards and rules as needed to reflect new information and issues.
- Identify connections between regulation, education, incentives and protection activities, and continue to optimize the use of these tools, in combination, to achieve water quality goals.

Strategy #8 – Employ a Targeted Approach for Protection and Restoration

Goal – Land management projects are targeted to high risk areas to protect and restore water resources

The state applies a targeted approach to implement protection and restoration projects to ensure that limited resources are allocated in a manner that provides the greatest possible return on investment. Effective deployment of implementation tools begins with a tailored understanding of where on the landscape activities are impacting water resources. Minnesota targets activities on two levels: broad targeting occurs at the state program level while refined, smaller-scale targeting is employed at the local level. This two-tier approach increases the effectiveness of the strategy. This strategy is strongly linked with the second implementation principle that calls for prioritizing limited resources to be applied where the greatest benefit may be realized.

In some situations, a relatively small section of the landscape may be contributing a disproportionately high percentage of contaminants. Identifying these vulnerable areas, also known as priority management zones, is a necessary first step in implementation. Once these priority management zones are identified, quantifying the change needed to protect or restore water resources is also necessary.

It is important to note that using a targeted approach does not signify that best management practices or other implementation tools are ignored in less vulnerable land areas. A certain percentage of funding and effort should be allocated to promoting BMPs in all areas where their adoption will provide increased protection of ecosystem functions and water resources. However, it is intended that increased resources should be expended in those locations that pose the greatest risk as sources of contaminants, or that will have the most benefit.

Tools to Identify High Risk Areas

A successful targeted approach, requires the existence of tools for identifying high risk areas on the land. For example, recent developments in the use of LiDAR technology, as well as enhancements in modeling and stressor identification capabilities, are enabling a new level of risk identification. The detailed topographic maps provided by LiDAR can be combined with soil, wildlife, floodplain and other data to create GIS layers that, when used in conjunction with computer models and field evaluation sites, form the basis for a much more precise method for targeting than has previously been available. These and other landscape-based methods will have applications for both urban and agricultural settings.

Similar tools for targeting high-risk areas are also available for potential sources of groundwater and drinking water contamination. The capture zones, times of travel and hydrogeologic vulnerability of aquifers are already defined in Source Water Protection Areas (SWPAs) for municipal water supply wells. More detailed hydrogeologic vulnerability maps could be created, possibly incorporating crop or other source-specific GIS layers in areas outside of SWPAs.

Broader Application of Targeting

The strategy of "targeting" is important to apply in a variety of areas. Targeting allows the best application of resources to the areas in which they are most needed or effective, including monitoring, protection and restoration efforts.

State agencies already use targeting to set priorities for water quality sampling; monitoring of flows in rivers and streams; enrollment of conservation easements; and to inform installation of wells for groundwater level assessments. Local plans then refine targets for local conditions.

Risk Inventory

Identification of ecologically intact locations on the landscape will allow targeting of areas that are providing high-quality ecological services (water quality, infiltration, flood retention, habitat, etc.) within the watershed. These areas are high risk in the sense that allowing degradation of these functions would result in degradation of water resources in the area as well. There is an important correlation between intact ecological function and sustainable water resources. Information from the Watershed Assessment Tool, combined with Minnesota County Biological Survey data, can be used to identify areas that need to be maintained to prevent ecological degradation.

In addition to targeting intact ecological areas, the state must focus on areas of degraded ecological function that provide the best restoration opportunities. The National Wetland Inventory Update project will eventually allow coarse evaluation of wetland functions that can be used to target restoration of ecological functions that are limited within a watershed. These information sources should also be used in combination with other information, such as soils, hydrology, and land cover type, to target sites that are providing some ecological services but have stressors that are limiting the function of the system.

Risk Evaluation

Once high-risk areas are identified, a systematic approach should be used for selecting and funding the appropriate management and conservation practices given the unique landscape, land use and specific contaminants of concern in the watershed or area. Two considerations are especially important in the selection of recommended practices.

First, it should be recognized that for many land uses, there may be a significant cost and complexity to changing land-use practices. For example, if a farmer has been using the same crop rotation, or has a significant investment such as an irrigation system, it might be very difficult, expensive and risky to implement a major change in practices. Conversely there might be some practices that are relatively easy to adopt. Priority should generally be given to those practices that have the greatest probability of success and environmental benefit with consideration for cost.

Second, in some watersheds or aquifer recharge areas, there may be more than one contaminant of concern and practices that may help minimize adverse impacts of one contaminant may increase negative impacts of another.

For example, soil incorporation may be a desired practice to reduce runoff of nutrients or pesticides, but it may also increase the runoff of sediment, which may be the more significant concern in the watershed. This potential for tradeoffs and unintended consequences is very real and is likely to increase over time as more waters are listed as impaired for multiple contaminants.

To help address this concern, the state should develop and make accessible lists of contaminants of concern for specific water resource management units. The state should also develop lists of practices for specific contaminants and resource protection goals and the potential contaminant and resource tradeoffs with other practices. Local land use managers and local governmental units (LGUs), with the assistance of state technical personnel, should select appropriate practices in consideration of the contaminants of concern, land use, land characteristics and potential tradeoffs.

It may be expensive to implement major changes in land use practices. For example, changes in an agricultural setting may include implementing an alternative crop rotation or removing land from production. For some contaminants, such as nitrogen in groundwater, the state should explore options for creating sustainable markets including, if necessary, subsidies for low nitrogen input crop rotations in high-risk areas. A sustainable market-driven alternative crop rotation option such as alfalfa may be a highly desirable solution to local contamination problems. This might be linked to alternative energy

crops. The significant cost of implementing major changes in land use practices reinforces the need for careful targeting of land use changes that optimize the use of limited resources.

The state has made significant progress in employing targeted strategies, including progress in adopting BMPs, but still has persistent water quality and quantity concerns. Some of the easier solutions have been employed, leaving the state with a need to rely more heavily on targeting to efficiently and soundly dedicate limited resources in a manner that is as efficient as possible. A targeted approach can be applied in coordination with new tools that have been and are being developed to help with that targeting, including LiDAR and resource models.

Recommendations – Employ Targeted Approach to Identify and Protect High Risk Areas

- Use a targeting approach to optimize locations for monitoring and sampling.
- Use a targeted approach to identify high risk areas on the landscape in greatest need of specific BMPs and ecosystem protection.
- Employ targeting methods to determine the optimal places on the landscape to achieve the maximum benefit from the use of limited resources for protection and restoration efforts.

Strategy #9 – Apply a Systematic Approach for Emerging Threats

Goal – A Systematic approach is developed for identifying, assessing and responding to emerging threats

Minnesota's water resources, while abundant, face a variety of recently recognized threats such as aquatic invasive species, possible changes in climate, PFCs, and endocrine-active compounds, to name just a few. A state strategy for identifying, assessing and responding to new threats to water quality and quantity and ecosystem health is needed to provide a coordinated plan for federal and state agencies, working with local government and citizens in response.

State agencies are working tirelessly to identify emerging issues and threats to water resources, gather relevant information and establish strategies for addressing emerging issues. Many of these efforts have followed an "ad hoc" approach with the lead state agency identifying and investigating the threat, bringing in the other water agencies as needed based on their expertise and authorities regarding the specific issue at hand. This approach has generally worked well, in part because of the concerted efforts of the state water agencies to work together in establishing strong communication and coordination and to clarify roles and responsibilities.

While this ad hoc approach has produced effective results (for example, in addressing contaminants such as PFCs), the continued increase in complexity along with new concerns suggests that a more systematic approach across agencies for identifying and understanding new threats is warranted. It is important to note that it will not always be possible to identify threats prospectively; at times, state agencies will still be in a reactive mode. While this more systematic approach cannot prevent that from

occurring, it can help ensure continued strong coordination of agency investigations and responses as new threats emerge.

Recommendations – Systematic Approach for Emerging Threats

- Develop a systematic approach for identifying, assessing and responding to emerging threats in consideration of the following steps:
  - Identify and evaluate emerging threats to water resources on a regular basis.
  - Prioritize efforts to investigate and address potential threats, and determine an approach to funding high-priority efforts.
  - Clarify and further coordinate roles and responsibilities for investigating threats including presence and extent, impacts (human, aquatic and ecosystem health), stressors and sources.
  - Establish diverse teams, including personnel from federal agencies, state government, local government, academia, industry, environmental organizations or other relevant parties, specific to the threat under consideration.
  - Identify management tools, both available as well as needed, for addressing the stressors and sources, and coordinate management efforts.
  - Share information with interested stakeholders and the public as it becomes available.
- Convene interagency teams as needed to address emerging threats to mitigate their potential adverse environmental and health impacts.

Contaminants of Emerging Concern

Progress is being made to better characterize surface and groundwater systems. With that said, there are gaps to be addressed during the next 10 years. One area of need involves contaminants of emerging concern (CECs), including endocrine-active chemicals, pharm-aceuticals and personal care products, where the state is continuing to assemble information about the presence, extent and potential impact of these chemicals. A limiting factor can be the lack of available analytical methods for analyzing these chemicals at appropriate detection levels. Also lacking are benchmarks for many of the chemicals, which are needed to help interpret the potential impact of what exists in the environment. As analytical methods improve and new studies from academia, state, federal and other sources are published about CECs, state agencies will need to regularly re-evaluate data collection efforts to ensure we are gathering the information needed to adequately inform decision-making about these chemicals.

Summary of the Strategies

These nine *strategies define what* the state agencies have set out to accomplish in the coming 10 years, and beyond. The seven *implementation principles describe how* the strategies will be implemented. The principles are broad in nature and are meant to be applicable to each of the strategies discussed above.

Chapter 5 Conclusions and Next Steps

The face of the water, in time, became a wonderful book – a book that was a dead language to the uneducated passenger, but which told its mind to me without reserve, delivering its most cherished secrets as clearly as if it uttered them with a voice. And it was not a book to be read once and thrown aside, for it had a new story to tell every day.

– Mark Twain a.k.a. Samuel Langhorne Clemens (1835-1910)

Minnesota – derived from the Dakota language word minisota, meaning "water that reflects the sky" – has a rich history of respectful resource stewardship. Citizens, land and business owners, local and state officials and so many others clearly see the new stories Twain mentions of our changing landscape and of progress made. They also see the challenges ahead for protecting and restoring surface water, groundwater and ecosystem health in the Land of 10,000 Lakes.

The 2010 *Minnesota Water Plan* defines a vision for Minnesota's water resources in which healthy ecosystems will meet the needs of future generations. The plan puts forth a series of strategies and principles to guide state efforts toward protecting and restoring surface water, groundwater and ecosystem health over the next decade. The strategies frame the work that agencies have set out to accomplish, working in partnership with federal and local entities, as well as academia and citizen groups. The principles guide their implementation. The goal, shared across Minnesota, is sustainable water and land management.

In recent years, nonprofit organizations, stakeholder groups, state and federal agencies and academia have led numerous efforts and studies regarding water and water-related issues. Their work endows value, articulates opportunities for growth and informs subsequent activity. Their work also improves understanding and benefits state agencies' water protection and restoration efforts, which have expanded in recent years. Moving forward, this shared knowledge will become even more important to prioritize limited resources, apply adaptive management principles to programs, and build and foster effective relationships with local government and stakeholders.

Each state agency must also continue its leadership and create collaborative partnerships across boundaries. Agencies must continue to be efficient, identify quantity and quality targets, and discover and deliver improved products together, with engagement of citizens and local government.

The Environmental Quality Board also must provide support to agencies to ensure effective implement of the plan. In five years, the EQB will revisit the plan to gage its continuing relevance as a guide to achieving Minnesota's vision of sustainable land and water resource management.

The next steps will be challenging. However, for Minnesota to protect its resources for future generations while continuing to provide goods and services to the world, it will be critical to apply, evaluate and improve these strategies and principles. A strong, sustainable future calls for a proper and prudent balance among Minnesota's environmental, social and economic priorities. This will ensure many new and good stories for decades to come.

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Appendix A – *Biennial Assessment of Water Quality Degradation Trends and Prevention Efforts*, *Minnesota Pollution Control Agency and Minnesota Department of Agriculture*

Appendix B – *2010 Groundwater Monitoring Status Report*

Appendix C – *2010 Water Availability Assessment Report*

Appendix D – *Metropolitan Area Water Supply Planning: Report to the Legislature as part of the 2010 Minnesota State Water Plan*