Chocolay River Watershed Restoration and Adaptive Management Plan

Prepared by White Water Associates, Inc., under contract with the Marquette County Soil Conservation District and under direction of the Chocolay River Watershed Council. Funding provided by the Michigan Department of Environmental Quality, Surface Water Quality Division, using U.S. Environmental Protection Agency funds allocated from Section 319 of the Clean Water Act.

Preface

The assignment of White Water Associates, Inc., was to prepare a management plan for the Chocolay River Watershed that focused on long-term water quality and ecosystem health. It is, of course, presumptuous to assume that it is possible to assemble, analyze, plan, and convey sufficient expertise to manage for ecosystem health in such a complex system as the 160 square mile Chocolay Watershed. All scientists and resource managers share this predicament. We seek to understand even the simplest aspects of ecosystems and biodiversity and how human activities affect them. The time and budget resources available for this project, combined with the inherent diversity of the Chocolay system, make a prescriptive plan impossible, in fact undesirable. What is most desirable is an adaptive plan that includes and involves all of the potential stakeholders in the watershed. This document lays the groundwork and beginnings of an adaptive watershed restoration plan and suggests a system (in the form of *Watershed Restoration Action Cards*) for implementation. This document points the way to plan and implement actions directed at opportunities for improvement and maintenance of a healthy watershed.

Throughout this project, we have relied on our own research and education experience in watershed and ecosystem management with a variety of entities including the forest industry and other types of corporations, municipalities, state and federal resource agencies, watershed organizations, and environmental groups. Some of the ideas and words we present in this report stem from prior and ongoing work with these organizations. We have also relied on the large and valuable literature that has developed around watershed management throughout North America. We cite this literature where appropriate.

We find it exciting to work with communities and organizations whose sincere desire is one of sustainability – to leave similar or better opportunities for future generations in the form of healthy ecosystems and human communities. The Chocolay River Watershed Council displays this desire and an ongoing commitment to make a watershed restoration plan work.

Dean Premo, Ph.D.
White Water Associates, Inc.
June 1999

Chocolay River Watershed Council, 1999 Membership

Larry Gould...........Council Chair, Chocolay Township

Gregg Baldwin...... Council Vice-Chair, U.S. Fish & Wildlife Service

Lynn Emerick........Watershed Resident

Del Meister ....Watershed Resident

Richard Vivian ......Watershed Resident

Don Dameworth ...Watershed Resident

Carl Lindquist........Watershed Project Manager

Mike LaPointe ....NRCS District Conservationist

Jack Rydquist........Honorary Member

Steve Casey ....MDEQ, Surface Water

Mike Farrell ....County Drain Commissioner

Rich Reader .... Marquette Conservation District

Pat Farrell ....County Road Commission

Fred Benzie ....County Health Department

George Madison.......MDNR, Fisheries Division

John Driver ....MDNR, Fish Hatchery

Don Kristola ....West Branch Township

Hank Greenwood .....Sands Township

Dean Wilson ....Skandia Township

Susan Fowler ....Forsyth Township

Administered by Marquette Soil Conservation District

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The Chocolay River Watershed Council thanks leaders and citizens of Chocolay, Forsyth, Sands, Skandia, and West Branch Townships for their continuing commitment and financial support for activities intended to improve and preserve the quality of the Chocolay River Watershed and sustain the quality of life for its human community.

Photographic credits: Cover (Waterfalls on East Branch of Chocolay River) by Lynn Emerick; photos at the end of Chapter 3 by Carl Lindquist

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1

Who is the Audience for the Chocolay River Watershed Plan?

People who care about the Chocolay River Watershed are the audience for this plan. They will be the implementors and evaluators. They will be the reviewers and future plan writers. Many of them live in or near the watershed. These are the "grassroots"—the constituency most connected to the watershed. No watershed restoration effort has succeeded without this grassroots constituency fully engaged (Williams et al. 1997). *People who care* include those who live beyond the watershed boundaries. This part of the audience includes foundations and other funding agencies, resource and regulatory agencies concerned with environmental quality, and other citizen groups working on their watersheds.

People working in this watershed can protect and restore a healthy landscape ecosystem (including the human community) provided a long-term, strategic approach is taken. This is a *living* plan in the sense that it will grow and evolve. Implemented actions will be monitored. The plan will be evaluated. It will be reviewed and refined as years go by—as new generations take up their stewardship responsibility.

For those in the "grassroots" camp, this plan is intended to provide you with a practical approach to carrying out protection and restoration of your watershed. The plan does not have all the answers (it doesn't even have all the questions). It does not recommend every conceivable rehabilitation action. But the plan does provide more than enough to get started and it leaves room for your good ideas and contributions. The plan's recipe mixes a pinch of the theoretical with a cupful of the practical. Those who are "hands-on" have plenty to do.

For those from beyond the watershed boundaries, this document is intended to demonstrate that a practical, scientifically-based, culturally sensitive plan is in place and being implemented. It can serve as a model for grassroots restoration task forces in other locations. The plan exists to coordinate and monitor various restoration activities. It is a strategic plan that asks that management actions be questioned at several levels prior to implementation. It is a long-range plan that not only incorporates the guidance of the principal funder (Michigan Department of Environmental Quality Steps for Developing Watershed Plans, undated draft; MDEQ Surface Water Quality Division Watershed

Management Guidance, 1998) and other important restoration efforts (e.g., the Lake Superior Binational Program), but extends to include and integrate state-of-the-art scientific and social principles.

The mixed audience of this plan challenges the authors to present a plan that is scientifically grounded and technically oriented, but at the same time accessible and understandable by the public who will in large part be responsible for its implementation. Terms are defined where clarity is needed; other literature is cited for those interested in the source of a statement, or in learning more about the topic. The Chocolay River Watershed Council has interacted with the plan writers throughout the process and reviewed drafts of the plan. The Council has encouraged a practical approach so that application is easily adopted by people in the watershed.

The **Chocolay River Watershed Restoration and Adaptive Management Plan** organizes discussion in five chapters all titled with a question. *Who is the Audience?* (this Chapter) identifies important constituencies. *Why Have a Chocolay River Watershed Plan?* (Chapter 2) lays out the premise and methodology of the watershed restoration plan. *What Is the State of the Watershed?* (Chapter 3) describes the Chocolay River Watershed and many of its attributes (streams, geology, vegetation, human community, and so on) and identifies needs for more information. *What Goals Guide the Plan?* (Chapter 4) presents the desired future condition and goals established by the Chocolay River Watershed Council. Finally, *What Objectives and Actions Move Us Toward the Goals?* (Chapter 5) offers a logical system for devising, gathering, implementing, monitoring, and adapting actions on the watershed. Chapter 5 also provides a menu of practical management actions ready to be adopted and adapted by those interested in taking an active role in caring for the Chocolay River Watershed. Some information is provided as text boxes, tables, figures, maps, or photographs. Several appendices round out the document including Appendix A that cites literature and information used in the creation of this plan. Appendix B provides a Chocolay River Watershed Project List. Appendix C has several completed Watershed Restoration Action Cards. Appendix D includes several sample newsletters published by the Council. Appendix E contains a watershed site inventory. The document concludes with a summary of the Information/ Education Program, Appendix F.

We end this chapter with our strongest management recommendation:

Approach watershed management with a large degree of humility.

Watershed ecosystems are enormously complex. Our understanding of how they work is not complete. Our ability to predict outcomes from specific actions is uncertain. New discoveries are made every day that have important implications for future watershed management. We may never know all we need to know, but that fact need not stop us from continuing work on the Chocolay River Watershed today. The fact that ecosystems are inherently resilient is to our great advantage. They are able to rebound from disturbance and repair themselves from injury. In fact, some of today's best watershed managers state that "...successful restoration usually has less to do with skillful manipulation of ecosystems than it does with staying out of nature's way" (Williams et al. 1997). This plan is intended to complement nature's own processes.

Chapter

2

Why Have a Chocolay River Watershed Plan?

Why have a Chocolay River Watershed Plan? The gut-level answer is "because we care," but the question deserves a more thoughtful and descriptive answer. This requires consideration of environment, economy, history, and culture. This chapter also describes how this watershed plan was created. It defines some important terms. It presents the process and underlying assumptions.

Part 1—Why Should We Care?

The health of a watershed and the health of local economies like those that exist in the Chocolay River Watershed are highly integrated. A sustainable economy depends on a healthy environment. In fact all social and economic benefits are based on the biological and physical properties of watersheds (Williams et al. 1997). We should view our economy as being nested inside our environment (Lanoo 1996).

This link between a healthy environment and the economy is true at several scales. For example, most property owners in the Chocolay River Watershed (whether on a river, lake, farmland, or woods) have invested in an ecosystem. The reasons that they have purchased the property are typically linked to the quality of the environment. The economic value of their investment is, in turn, linked to the health of the river, lake, woods, and surroundings. If the ecological health declines, so does the value of the property in dollars.

At a slightly larger scale, this same principle linking the environment and economy applies to municipalities. The townships in the Chocolay River Watershed are caretakers of ecosystems. The long-term economic health of a township or city is tied to the health of Chocolay River Watershed. At even larger scales yet, this applies to Marquette County, to the State of Michigan, and so on. Other efforts in the region are realizing this important connection of sustainable economy and sustainable environment. Thus, the Chocolay effort has important potential connections with the *Central Lake Superior Watershed Partnership*, the *Central Lake Superior Land Conservancy*, and the *Lake Superior Binational Program*.

Despite this connection of economy and environment, political debate often centers on the divisive catch-phrase “economics versus the environment.” Acceptance of this “either/or philosophy” is changing, however, as watersheds become further degraded and less economically productive, and as more people come to realize the socioeconomic benefits healthy watersheds provide (Williams et al. 1997). A local example of this is the well-known importance of the Chocolay River system to the salmon and trout fisheries of Lake Superior and all of the recreational, economic, and biodiversity benefits this reflects. The Chocolay River Watershed provides dramatic evidence of the importance of a healthy watershed where many residents have located because of the high quality environment and generally feel a strong connection to the land and waters.

It is this connection to the landscape that the Chocolay River Watershed Council and this watershed plan aspire to cultivate. It is the people of the watershed that will make watershed management work. Watershed stewardship must be a cultural imperative. In some ways, watershed restoration is about cultural restoration—rejuvenating citizens' civic responsibility to care for the environment in which they live. This is what Aldo Leopold referred to as “the oldest task in human history: to live on a piece of land without spoiling it.” Many urban areas in this country that have recently experienced unbridled economic expansion are now having to face an enormous challenge. They must solve the problem of restoring the healthy environment that was important in attracting new businesses and families in the first place, and now is crucial to keeping them.

People need to feel vital by working to improve, beautify, or build. Sometimes that need is fulfilled by gardening, caring for a lawn, working to create green space, or volunteering on civic projects. The Watershed Council and this plan endeavor to harness that energy and apply it to restoration actions on the Chocolay River Watershed. Education, rehabilitation, and protection become outlets for this creative energy.

Why should we care about creating and implementing a practical watershed plan? Because we realize the economy and the economic options available to citizens in the watershed are tied to a healthy environment. Because we are all connected to the Chocolay River landscape in some way. Because we feel a civic responsibility to care for the watershed. Because we can feel vital by doing meaningful work on the watershed.

The watershed plan will be successful if it allows and organizes meaningful work on the watershed. It needs to make provisions for different kinds of approaches and different kinds of people who want to contribute to watershed restoration. It has to be strategic and integrated so that various actions complement one another, and harness the watershed's natural processes. The plan should discourage management actions that work at cross purposes or whose outcomes are undesirable. It should also discourage activities within the watershed that negatively impact ecosystems.

Part 2—What is an Adaptive Management and Restoration Plan?

Every discipline seems to have its own language. Resource management is no exception. It is important, however, to be precise about terminology in the context of this plan and Chocolay River Watershed management activities because (1) the management plan needs to be accessible and understandable by everyone, and (2) a language consistent with other watershed projects around the country promotes communication and learning. For these reasons we are devoting an entire section of this chapter to a clear understanding of watershed terminology.

Watershed restoration is a relatively new field of application with many approaches and techniques that, although promising, are often untested. An adaptive management process (Walters, 1986) is the most appropriate model to use in this case. In adaptive management a plan is made and implemented based on best available information and well-defined goals and objectives. Outcomes of management actions are monitored to ascertain whether they are effective in meeting stated goals and objectives. Based on this evaluation the plan is adapted (modified) in a process of continuous learning and refining.

Adaptive management concedes and confronts a truth that most resource managers are reluctant to acknowledge—uncertainty. Because natural systems are so diverse, so complex, and so variable, almost all management actions will have uncertain outcomes. An adaptive management approach essentially takes a position that says, "We will make our best attempt and get better as we go along. We'll listen to what the natural system tells us." In adaptive management, monitoring is crucial. Adaptive management uses information from monitoring to continually evaluate and refine management practices. Monitoring measures the success of restoration or management. Well-designed monitoring should indicate how well measures are working and give us new insights into ecosystem structure and function. Monitoring should provide needed information to adapt management goals.

Simply stated, restoration can be defined as the return of an ecosystem to a close approximation of its condition prior to disturbance (National Research Council 1992). Often restoration seeks to restore the system's *biological integrity*, that is, its ability to function in a natural way and to be resilient to natural and human caused disturbances. Since human communities are integral components of the Chocolay River Watershed, they are part of the system being managed. Because of a large human presence, returning to a completely "natural setting" (e.g., pre-European settlement) is unrealistic, but we can aspire to establish conditions that allow the ecosystem to function naturally and remain capable of self-correction when disturbances occur.

A watershed restoration program, as presented in this plan, is implemented through at least five kinds of management actions: rehabilitation, education, protection, research, and support. These five work in concert to achieve watershed restoration.

- ***Rehabilitation actions*** are those that manipulate site-specific elements of ecosystems. Examples include installation of a sediment trap, removal of a dam, planting stream side vegetation, replacing an old culvert, and placing a fish structure. Rehabilitation actions are local. Individual rehabilitation projects contribute to overall watershed restoration.

- ***Education actions*** are all of those activities that serve to promote watershed restoration and educate people about the watershed. These actions can be very local (e.g., a field trip with a class of 6th graders) or watershed-wide (such as a newsletter). Education actions can extend beyond the borders of the watershed as well. In fact, via the world wide web, education actions are potentially global in scope.

- ***Protection actions*** are used when existing or potential high quality areas are identified and need to be safeguarded. There are numerous forms that protection actions can take including public preserves and parks, conservation easements, zoning, buffer zones as part of voluntary best management practices (BMPs), restrictive deeds, and prescribed green-space in new developments.

- ***Research actions*** are important to learn about the system being managed. So often we know very little about the plants, animals, habitats, and ecosystems that our management actions are affecting. Research to identify the diversity of plants and animals, understand the movement of bedload in a particular stream, or outline the extent of a ground water contamination are all examples of research actions. The plan will point to information gaps that can be filled by research actions.

- ***Support actions*** are also important to implementing a restoration program. Support actions include the nuts and bolts of acquiring funds, administering projects, updating plans, and serving on a watershed council.

One word of caution is warranted. Our society typically thinks a long term planning horizon is twelve months. Unfortunately, this is not the way an ecosystem functions. An ecological clock ticks off time in years, decades, centuries, and even millennia. Restoration must be viewed from this perspective. In fact the final outcomes of some of the good work put in place today might not be apparent until a new generation of watershed managers is on the scene. Effecting changes in sediment load is an example of where the collective outcome of individual rehabilitation actions may only show up years from now. Likewise, community education is a long-term, but necessary commitment to watershed restoration.

Part 3—What are the Plan's Underlying Assumptions?

In an adaptive plan, a basic assumption is that the management actions will change over time under the influence of many stakeholders in the watershed. Through continuous refinement, the plan will more closely reflect the needs of the watershed and the people who care about it. This plan has assumed a desired condition: sustainable watershed health. The plan does not have as its goal the identification of all potential places for further human development, although that might be an aspect of future versions of the plan. Instead, the plan attempts to reflect the collective vision of the five townships whose boundaries overlap the Chocolay River Watershed: Chocolay, Sands, West Branch, Skandia, and Forsyth. Each of these townships have expressed in their various planning documents the importance of maintaining the health of the environment. These goals resonate well with this watershed plan (see sidebar).

The Chocolay River Watershed Plan adheres to the ten fundamental principles outlined by Williams et al. (1997) as necessary to coordinate an effective watershed-based program.

1) Authority must be vested in local entities with full representation of affected community members.

2) The political will to pursue riverine and watershed protection and restoration must be present, or it must be developed early in the project.

3) Many educational needs exist, and it is vital that they be identified, prioritized, and addressed.

4) Clear, well-developed goals should be established and a single authority (i.e., local committee, watershed board, agency) should lead planning and management efforts.

5) A watershed analysis should be conducted using the best available data.

6) Key stakeholders must be understood and their economic and social concerns addressed.

7) Programs and projects must have a strong scientific base that includes adequate trained staff.

8) Clear and frequent communication is needed among resource professionals, project stakeholders, and the general public.

9) Watershed projects should be user-friendly.

10) Project monitoring and evaluation should be ongoing and adjustments made as needed.

Chocolay, Forsyth, Sands, Skandia, and West Branch Township Plans (Excerpts)

The Chocolay Township Strategic Plan (October 1995) envisions a community which is forward thinking; where there is a strong sense of place, belonging, and pride; where development is compatible with the maintenance of our "quality of life"; where development is park-like; where quality of development is favored over quantity of development; where the community is environmentally conscious; where water is clean and accessible; where sound forestry and agricultural land use is encouraged; where the community is known for its beauty; where there are green zones which include parks, corridors, and naturally buffered activity areas throughout; where development is fostered along the "village concept"; and where the total community (public and private) supports the vision. In the Chocolay Township Strategic Plan goals that support the vision include: maintain the rural/natural landscape by preserving open space; earmark tracts of land for acquisition to fit with master plan (including provisions for maintenance, tax support, connectivity, and green belt concepts); inform residents, businesses and government about local environmental issues.

The Forsyth Township Comprehensive Plan (July 1996) states as one of its goals to preserve and enhance the natural environment of the Township for the enjoyment of residents and visitors. It lays out similar policies to West Branch Township Comprehensive Plan (1996). Its land use policies include "Establish land uses which are consistent with the ability of natural features, infrastructure, etc. to support development."

The Sands Township Zoning Ordinance (February 1995, Amended May 1996) includes as parts of its purpose: promoting and protecting public health, safety, and general welfare; protecting the character and stability of the Township's most valuable natural resources (minerals and forests); and enhancing the aesthetic desirability of the environment.

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The Skandia Township Comprehensive Plan states that the long-term goal for the environment and natural resources is to maintain the high quality of its own natural resources and those it shares or to improve the quality if it has been diminished. This goal is being addressed through policies such as: (1) ensure that development and other land use activities occur upon or in soils which are adequately suited for such use; (2) protect the integrity of wetlands so that their overall benefits and values are maintained; (3) maintain and improve the quality of surface waters; (4) regulate development adjacent to surface waters in such a manner as to protect water quality, wildlife, aesthetics, and other natural resources; (5) improve and protect the quality and quantity of ground water resources for current and future use; (6) maintain wildlife resources through habitat preservation; (7) maintain surface water quality suitable for fishery habitat; and (8) protect significant natural features from degradation. The Skandia-West Branch Township Recreation Plan 1994 states as one of its goals to "make maximum use of recreation opportunities offered by the natural environment."

West Branch Township Comprehensive Plan (October 1996) states several policies proposed to maintain high quality natural features. Examples include: (1) provide for future development in waterfront areas which is consistent with the ability of the environment to support development, (2) discourage intensive development in areas where site characteristics limit the suitability of sites, (3) provide for the conservation of open space and preservation of scenic resources, and (4) encourage the preservation of areas providing high quality fish and wildlife habitats. The West Branch Township Draft Recreation Plan (May 1998) states as one of its goals to "make maximum use of recreation opportunities offered by the natural environment."

The integrating features of this watershed plan are the streams and the stream corridors in the Chocolay River Watershed. These knit together the landscape and help focus our attention on these important features of the watershed. This focus is a recommendation of the Draft Steps for Developing Watershed Plans (MDEQ 1998). Finally, we assume that proper planning in the beginning of the restoration process will save time and money throughout the life of the project and that this can be accomplished by managing the causes rather than (or at least, in addition to) managing the symptoms of watershed degradation (Stream Corridor Restoration—Principles, Practices, and Process 1999).

Part 4—How was the Plan Made?

This plan has been prepared by a team of consulting scientists (White Water Associates, Inc.) working with the watershed manager (Carl Lindquist) and watershed technician (Heidi Volkhardt) under the direction of the Chocolay River Watershed Council. The process began with meetings between White Water scientists, the watershed manager, and members of the Council for the purpose of sharing ideas about the planning process and elements of the plan. Information gathering was conducted by the watershed manager and watershed technician, under the direction of White Water, and independently by White Water. Meetings, phone conversations, and e-mail correspondence were used to evaluate the kind of information gathered and to discuss status of the information gathering process. The planning process included two public meetings where preliminary findings and plans were presented and discussed in a participatory format. Ideas gleaned from public participants were appropriately incorporated into the plan where appropriate. A draft plan was submitted to the Council for review and comment. Changes to the plan suggested by the Council comments were incorporated and the resulting draft plan was submitted to the MDEQ for review. MDEQ comments were integrated into the final plan.

Several practical watershed planning references were used to guide development of this plan. These included Watershed Restoration: Principles and Practices (Williams et al. 1997), Stream Corridor Restoration (1999), Watershed Stewardship (Oregon State University Extension 1998), Restoration of Aquatic Ecosystems (NRC 1992), Environmental Restoration (Berger 1990), Methods in Stream Ecology (Hauer and Lamberti 1996), and Riparian Management* (U.S. Department of Agriculture-Forest Service 1993). These provided state-of-the-science underpinning to the planning process. Two references from the Michigan Department of Environmental Quality also provided useful guidance: Steps for Developing Watershed Plans (undated draft provided by Sally Hedin in January 1998) and Watershed Management Guidance (MDEQ Surface Water Quality Division 1998).

Existing information about the watershed formed the basis for the current planning activity. As watershed management proceeds, additional baseline information will be required for specific subjects and areas within the watershed. Collection of such information is part of the ongoing restoration process and can be incorporated into future versions of this adaptive plan. Existing information exists in many repositories and forms: anecdotal accounts of residents, resource agency reports and memos, municipal planning and zoning documents, scientific reports, old and new photographs, best guesses of knowledgeable people, and government land office records. Not all existing information is of equivalent value in the planning process. Some is not verifiable or the methods by which it was collected are unknown. We discovered no scientific peer-reviewed literature regarding the Chocolay River Watershed. As plan implementation proceeds it will be necessary to gather new information about specific areas in order to implement restoration actions.

**The term “riparian” refers to the zone adjacent to the water that both influences and is influenced by the water.*

Chapter 3

What Is the State of the Watershed?

Knowing where we start from is just as important as knowing where we are going. An understanding of the history, features, and conditions of the Chocolay River Watershed is the starting point for developing strategies that seek to protect and restore the biological integrity of the watershed. In fact, restoration ecologists suggest that not understanding the workings of the ecosystem prior to trying to manage it would make most efforts ineffectual or even detrimental. Watershed analysis has focused on existing information relating to the Chocolay River Watershed. The kind of information that will be useful to devising and implementing an adaptive restoration plan for the watershed has been sought. "What is known about the watershed?" has been the key question. The analysis has also highlighted what is not known. Important information gaps have been identified; the gathering of new information is considered in Chapter 5 as actions to be taken during ongoing plan implementation. Because this chapter is the basis for an adaptive management process for the Chocolay River Watershed, we have placed a special emphasis on those things that can be easily measured, practically acted upon, and efficiently monitored.

This chapter provides information about the Chocolay River Watershed. What are the streams like? What is the geology? What kinds of soils exist here? What is its land cover? What organisms live here? What is the human community? How healthy is the watershed? How have humans contributed (or detracted) from that health? Do threats to watershed health exist? Existing information is identified and organized. For those whose interest is piqued to explore further, original sources are identified.

For those new to the watershed, this chapter can familiarize you with features and conditions that exist here and provide some insight as to why things are the way they are. Lifelong residents may be familiar with parts of the discussion in this chapter, and may have things to contribute or correct. Become engaged! Improve the understanding of the watershed by adding your knowledge in future versions of the plan.

Chapter 3 is presented in four parts. Part 1 discusses several topics most easily considered at the watershed scale. This gives the broadest panorama of the Chocolay River Watershed by discussing topics such as history, hydrology, ground water, geology, vegetation and land cover, and the human community. Part 2 draws attention to a somewhat smaller view that, for convenience, is referred to as the "stream scale." Part 2 covers topics such as erosion, water quality, aquatic species, and habitats. Part 3 summarizes the many rehabilitation and education activities that have occurred on the Chocolay River Watershed since 1990 when the Chocolay River Watershed Council was formed. Finally, Part 4 presents a practical geopolitical scale from which plan implementation can take place—the Township. This part begins to bridge the gap between what we know and what we can do. Specific areas deserving management actions are identified in each of the five Chocolay River Watershed townships.

Part 1—The View from a Watershed Perspective

The Chocolay River Watershed is located in the northeast corner of Marquette County about midway between the 46th and 47th parallels (See Figure 1). The watershed drains directly into Lake Superior and is 160 square miles in surface area. The Chocolay Watershed includes 20 named streams and creeks that serve as tributaries to the Chocolay River. There are a total of over 150 stream miles within the watershed. There are sixteen lakes (see Table 1) (Chocolay River Watershed Project, 1995). This is the landscape of this adaptive management plan.

TABLE 1. Lakes Within Chocolay River Watershed

Lake	Acreage
Abraham	5
Big Trout	3
Brown	4
Engman	22
First	4
Kawbawgam	180
LeVasseur	150
Little Pellisier	5
Little Trout	5
Pellisier	95
Second	4
Silver	5
Sporely	45
Strawberry	5
Three	9
Wilson	12
Total acreage of 16 lakes	553

In this section and the next (Part 2), attributes of the Chocolay River Watershed are discussed within several topics. Each topic is denoted with a question and begins with a statement of why it is important to know about the particular topic when planning watershed restoration.

What was the watershed like "way back when"?

The Marquette Harbor of Lake Superior has long been a special place. The abundance of fish and wildlife made the area a favorite destination for native people and by the late 1600s the French Jesuits and fur traders were becoming regular visitors. Eventually the streams and rivers of the Chocolay Watershed played an important role in the logging, commerce, and settling of the area. Research indicates that Henry Wadsworth Longfellow likely based his epic poem, *Song of Hiawatha*, near the mouth of the Chocolay River. In many respects, the Chocolay Watershed has a truly "legendary" history. (Chocolay River Watershed, Project Newsletter, 1994)

Fred Rydholm, a historian of Marquette County and surroundings provided some accounts of known Chocolay history in a 1994 watershed newsletter as follows:

> While locations of the birthplace of Hiawatha in Longfellow's epic poem, have been claimed all the way from Duluth to Pictured Rocks, nowhere fits the description better than "Hiawatha Shores" near the mouth of the Chocolay River. Most experts believe this is the area to which the poet was referring. It has broad sandy beaches and the dark and gloomy pine trees. While Longfellow never visited the site, he got his information from Henry Schoolcraft, who knew the area well and held it in high esteem.
>
> Historically the Chocolay River has been one of the more important rivers in the Upper Peninsula. In fact, even before Michigan became a state in 1837, the Chocolay formed part of the boundary line for the Indian Treaty of 1836 (known as the Treaty of Washington), which ceded the land east of the river to the federal government.
>
> The origin of the word *chocolay* is unclear. The early maps of the French explorers show the "Chocolate River" (probably named for its dark brown color), but somewhere in the early settlement days it became 'Chocolay.' It has also been suggested that there may have been a Frenchman by that name who lived along the river in the early days.
>
> Chocolay Township (formed March 17, 1860) originally included all of the Chocolay River Watershed. In the years that followed, all or parts of six other townships were formed from within it boundaries. They are: Turin (1884), Sands (1892), Skandia (1892), West Branch (1895), Wells (1903) and Ewing (1921). The Chocolay area became home to many homesteaders and farmers starting in the 1860s. Ethnic groups within the watershed included English, French, German, and Scandinavian.

> The mouth of the Chocolay River has periodically moved up and down the shore of Lake Superior as can be seen by the many bayous that parallel the lake there today. In the 1860s, Charles T. Harvey financed a dredging project to establish the mouth at its present location with his iron furnace on the east side and his sawmill on the west. The river mouth has been stabilized at that spot ever since.

Knowing what the Chocolay Watershed was like under more or less natural conditions allows us to better understand the structures and functions that might be desirable to protect and restore through adaptive management. Humans are now an important feature of the watershed. The management plan recognizes that condition. Watershed history provides clues as to what is reasonable to hope for and what is not. It clarifies what natural and human disturbances exist and how they influence the watershed. Watershed history provides insights as to what conditions are reasonable to establish as goals.

In the not-too-distant past, the Chocolay landscape was molded and influenced by natural disturbances such as fires, blowdowns, floods, beaver, insect outbreaks, and climate. Today's landscape is the obvious result of the combined interaction of human and natural processes, with humans nowadays serving as the most significant agents of change. Recognizing this shift in primary agents of landscape change, forest vegetation is usually described under two divisions: pre-European settlement forest vegetation (sometimes referred to as original or natural) and current forest vegetation. Presettlement usually refers to a period before the extensive logging that occurred in the late 1800s and early 1900s (not the period before the first incursions of trappers, missionaries, and explorers into the region). Data for these vegetative reconstructions are based on soil-plant associations, direct observations from early biological and geological surveys and from early settlers' notes, and surveyors' records of witness trees and general notes from the original surveys contained in the General Land Office (GLO) notes. All these have limitations as sources of information, but still represent the best available information for the presettlement time period. Michigan has recently published a map of the presettlement vegetation of the entire state (including the Chocolay Watershed). This is available through the Michigan Department of Natural Resources. A description of presettlement vegetation does not represent an ideal, static state, but a useful snapshot in time. It is the best existing picture of larger landscape that primarily resulted from natural processes.

How does the water shed?

Every drop of water (or flake of snow) that ends up hitting a patch of earth flows somewhere and, since gravity influences water just like everything else, that somewhere is down. Some of it flows down into the ground and some flows down hill. Some of the water is soaked up by plants and some of this water in plants goes back to the atmosphere through transpiration. Some of the water goes back into the atmosphere as evaporation. As people within a watershed begin to take on the stewardship responsibility of caring for the watershed (managing, rehabilitating, and restoring), it is important to understand how watersheds work and the process of how water flows in the watershed (hydrological process).

A watershed is an area of land that collects rain and snow and discharges much of it to a stream, river, or other water body. A specific water body defines the watershed. In the case of this plan it is the Chocolay River; the land area that drains surface water into this river is the Chocolay Watershed. But the larger Chocolay Watershed is really composed of many smaller watersheds. Some large enough to be named by their stream (for example, the Silver Lead Creek Watershed). Others are tiny ravines that collect water and conduct it to permanent streams by surface flow only during spring runoff or heavy rainfalls. These tiny ravines are separated from adjacent small watersheds by ridges (small and large). Thinking about the watershed as space between the ridges and the river banks helps remind us that any activity on the land has a potential effect on the collecting stream and on all downstream resources. Watershed boundaries can be usually be identified by visible terrain and by using U.S. Geological Survey (USGS) topographic maps. Figure 2 gives a portion of a 1 x 2 degree USGS map overlaid by the Chocolay River Watershed boundary. Some larger watersheds are now delineated and available via the Internet (http://www.epa.gov/surf2/text.html).

According to U.S. Geological Survey, normal annual precipitation for Marquette County is 32 inches (rain equivalent). About 14-19 inches of this precipitation returns to the atmosphere through evapotranspiration (through green plants and evaporation). About 13-18 inches goes to runoff and about seven inches percolates into ground water reservoirs each year. (Twenter 1981).

Water flowing in streams is a combination of precipitation and water that has moved from the land into the stream channel (through surface flow and ground water). The amount of streamflow and its timing determines the ecological functions of the stream and its corridor. Flow can range from none at all to flood conditions. How variable the streamflow is influences the stream ecosystem. High flows transport sediment and periodically connect the stream and the flood plain. During these times, the flood plain is an important habitat for spawning and foraging fish. This connection also allows nutrients and carbon materials from the flood plain to enter the aquatic system.

The Chocolay River is a significant Lake Superior tributary. Michigan Department of Natural Resources (MDNR) stream flow data from a sampling station near the mouth of the river (T47N, R24W, SE1/4 NE1/4 of Section 6) reveals that the mean monthly flow is about 700 cubic feet per second (CFS) and ranges from an average low of 300 CFS (February) to an average high of 1720 CFS (April). See Table 2 for additional flow information. Specific information on flows and discharges of some Chocolay tributaries can be obtained through the MDNR Land and Water Management Division (Marquette, Michigan) and also through the USGS Water Resources Division (Escanaba, Michigan). Flow rates and stream discharges can also be measured by school students and volunteers and would be useful for planning certain stream rehabilitation actions.

TABLE 2. Monthly and Annual CFS Water Discharge of the Chocolay River

Month	50 percent	95 percent	Mean
January	310	190	320
February	270	180	300
March	330	190	570
April	410	370	1720
May	940	370	1200
June	550	170	710
July	320	100	480
August	230	91	360
September	330	95	490
October	480	120	620
November	560	210	660
December	420	210	460
Yearly Average	410	130	700

Stream flow for the Chocolay River in Chocolay Township, at the SE 1/4 of the NE 1/4 of Section 6, T47N, R24W, has been calculated by the Michigan Department of Natural Resources (MDNR), Land and Water Management Division, and is represented in cubic feet per second (cfs).

In addition to mean flow, 50 and 95 percent exceedence flows are given. A 50 percent exceedence flow means that half of the time, flow exceed the flow amount indicated. Likewise, a 95 percent exceedence flow means that 95 percent of the time, flow exceeds the flow amount indicated.

Streams in the Chocolay River have very consistent base flows, indicating a strong ground water influence. Base flows emanating from ground water is what provides water in streams during the driest parts of the annual cycle. Sandy soils in parts of the watershed capture most rainfall not lost to evapotranspiration and therefore little direct runoff occurs. Silver Creek, Big Creek, Cherry Creek, and Cedar Creek are all important tributaries in the Chocolay system that are fed by the Sands Plain aquifer (Grannemann 1984). Grannemann (1984) compared hydrographs of these four streams and points out that Big Creek has a higher and longer response to precipitation events than does Cherry Creek. Grannemann postulated that the difference in the hydrographs is caused in part by the size of the drainage area and in part by the less permeable glacial deposits in the Big Creek drainage. Generally, however, flood peaks in all four creeks dissipate quickly because stream gradients are steep, drainage areas are small, and sandy soils predominate. Base flow hydrographs for these creeks indicate that 95 percent of the average annual runoff is derived from ground water flow to the stream channels. A review of Grannemann (1984) provides useful insights into Chocolay system hydrology.

Periodically, parts or all of the Chocolay River Watershed experience flooding. Record flooding was experienced in 1985 following a 30-day period of record snowstorms, rainstorms, and high temperatures. A peak discharge of 5,400 CFS was estimated. This flood event was estimated to be on a 200-500 year recurrence interval (Croskey and Sorrell 1985). Some years, flooding in the lower reaches of the Chocolay River is caused by ice buildup and its damming effect at the mouth of the river in Lake Superior.

What about the water underground?

Some of the precipitation that hits the landscape moves into the soil where it can be either stored in the upper soil layers or in deeper areas that are completely saturated by water. This process of infiltration is driven by gravity and capillary action of water in the tiny spaces between soil particles. The size and density of pores between soil particles (known as the soil's *porosity*) determine how well soil infiltrates the soil. If the precipitation comes faster than the soil can soak it up, the water either runs off downslope or puddles and is later absorbed by the soil. Some of the water in the upper layer is taken up by plant roots, but some water continues to move downward under the force of gravity to the ground water table. If the water at this layer is able to provide a good supply to wells, it is known as an *aquifer*. Sometimes the water is held underground in confined areas where water is prevented from easily moving laterally (a *confined aquifer*). Watershed managers should give special consideration for locations where ground water and surface water are exchanged. *Recharge areas* are areas where the water can easily move from the surface to aquifers. Areas where the water table meets the soil surface and emerges are called *springs* or *seeps*.

There are several government reports that deal with ground water in Marquette County and the Chocolay River Watershed (Cummings 1980 and 1989; Doonan and VanAlstine 1982; Grannemann 1979 and 1984; and Twenter 1981). These reports variously describe topography and drainage, physical and cultural features, altitude of land surface, geology, glacial history, hydrologic data for wells and springs, ground water quality and availability, infiltration rates, recharge areas, chemical composition of ground water, and municipal water supplies. These references provide valuable information for certain restoration actions and should be referred to for their specific contributions.

Doonan and VanAlstine (1982) report that springs and wells in Marquette County yield water that is satisfactory for domestic and most other uses. In general, the hardness of water from wells in glacial deposits is less than 180 milligrams per liter (part per million), but the hardness of water from bedrock is higher. They report on several other ground water constituents and their significance. Reports by Cummings (1980 and 1989) provide a statewide context for chemical and physical characteristics of ground water (e.g., concentrations of dissolved solids, sodium, sulfate, chloride, iron, aluminum, titanium, and lead). Other information on attributes such as depth to ground water and ground water quality can be obtained through the USGS Water Resources Division (Escanaba, MI).

Twenter (1981) reviews general features and economy, population, location of mines and pits, physical setting and land surface, climate, water cycle, infiltration rates, bedrock deposits and glacial deposits, water supplies and quality, surface water resources, ground water resources, and sewage and refuse disposal. Infiltration rates throughout the Chocolay Watershed range from very rapid to very slow, but generally are in the highest categories of infiltration rates (i.e., have very good infiltration and good recharge of ground water aquifers).

The Michigan Department of Natural Resources classifies the Chocolay Watershed as a cold water system with a remarkably constant base flow. This base flow results from the large contribution of ground water runoff into the streams and is an important high quality characteristic as high base flows ensure a more stable aquatic ecosystem. As example of this phenomenon, we can examine the four important tributaries of the Chocolay: Big Creek, Silver Creek, Cherry Creek, and Cedar Creek. In discussing the Sands Plain recharge area, Grannemann (1984) states that glacial deposits as much as 500 feet in thickness comprise the principal aquifer. Most ground water flows through the glacial deposits and discharges in a series of nearly parallel tributaries to the Chocolay River. Principal tributaries of the Chocolay River from this source are Big, Silver, Cherry, and Cedar Creeks. Ninety-five percent of the discharge of these streams is ground water runoff. The aquifer is recharged by precipitation at an average rate of 15 inches per year and by streamflow losses from the upper parts of Goose Lake Outlet at an average rate of two inches per year.

What are we standing on here?

The previous subsection discussed the infiltration of water through the soil. A large part of how easily this phenomenon happens is based on the geology, soils, and topography of the watershed. These features also have a large influence on the kinds of plant and animal communities that can establish themselves in a watershed. Many would argue that knowledge of the geologic setting and soils of an area are essential to land use planning and any kind of sustainable development. In this area of glaciation, knowledge of Pleistocene (glacial) geology of the region is a particularly useful tool in understanding occurrences of ecosystems at a variety of scales.

The bedrock of the Marquette Iron Range area is composed of igneous, metamorphic, and sedimentary rocks of Archean and Proterozoic age (Precambrian) (Grannemann 1979). Except for occasional outcrops, it is overlain by unconsolidated glacial deposits and alluvium of varying thickness. Twenter (1981) and Doonan and VanAlstine (1982) contain more detailed descriptions of the geology and glacial deposits of the northern part of Marquette County.

The soils within the Chocolay River Watershed have been recently mapped and are published in hard copy by the Natural Resources Conservation Service, U.S. Department of Agriculture (USDA 1997a,b,c). Digitized forms are expected to be available in 1999. Soils within the Chocolay River Watershed have an extremely wide range of characteristics. The Natural Resources Conservation Service has identified over 140 different soil types in the watershed with almost half of those being classified as *highly erodible* or *potentially highly erodible*. This diversity of soils, however, can be grouped into several associations that can be used to summarize the overall soil characteristics of the watershed.

The Wallace-Alcona-Ocqueoc Association (see Figure 3, General Soils Map) covers a major portion of the watershed including parts of Chocolay, West Branch, and Sands Townships. Theses soils typically have surface textures that range from sandy to loamy and occur on moderately sloping to very steep landscape characterized by ridges and ravines. Many of these areas have intermittent streams that lead into larger perennial streams and finally into the Chocolay River.

The Skanee-Munising-Gay Association (see Figure 3, General Soils Map) covers another portion of the watershed throughout Chocolay and Skandia Townships. These soils typically have fine sandy loam surface textures. Also common in this association are many poorly drained areas with organic deposits overlaying mineral soils. Most of this area is characterized by gently rolling hills and is predominantly forest land with some agricultural land. Steeper areas in this association have a high potential for soil erosion and need to be managed appropriately.

The remaining soils throughout the watershed are extremely variable ranging from sandy to loamy soil types. Areas include sandy beach deposits along the Lake Superior shoreline and soils formed over sandstone bedrock further inland in Chocolay Township. Although these areas are not highly erodible, they have the highest amount of construction site development and need to be managed to prevent soil erosion along waterways.

Finally, there are a number of soil associations (see Figure 3, General Soils Map) that are classified as highly erodible. These areas have a number of landform characteristics ranging from rock outcrops and steep hills to moderately sloping areas with many ridges and ravines. The variability throughout these areas will require special management considerations.

The Chocolay River Watershed also has a diversity of landforms and slopes (See Figures 4 and 5). Landforms include:

- Bedrock Controlled Moraines—Gently rolling to very steep, bedrock controlled moraines interlaces with glacial outwash channels. The soils are formed from a thin mantle of loamy glacial till overlying igneous and metamorphic rock. Rock outcrops are common and spaced relatively close together.
- Dissected Moraines—Hilly to very steep sandy and loamy dissected soils that were deposited on the outer margins of the glaciers.
- Fluted Ground Moraines—Nearly level to gently rolling, loamy soils that are characterized by a series of low ridges and swales that are oriented in a north and south direction.
- Outwash—Nearly level to very steep, sandy and gravelly soils that were deposited from the melt waters of the glaciers.
- Sandstone Bench—Nearly level to very steep, sandy and loamy soils that have sandstone bedrock within 40 inches of the surface.
- Sandy Lake Deposits—Nearly level to rolling, sandy soils on beach ridges and dunes.
- Till Floored Lake Plain—Nearly level to very hilly, sandy and loamy soils that have a discontinuous thin layer of lake sediments overlying glacial till.

How does the watershed look today?

Today's conditions represent the "hand we have been dealt" when it comes to watershed management. The overall "look" of the Chocolay Watershed today results from a combination of natural and human factors that have been at work for some time. Identifying and understanding these conditions and causative factors is a big endeavor. Knowing which conditions are most influenced by human factors and which are part of a natural disturbance regime are crucial to those concerned with watershed restoration.

Much of the land surrounding the northern Great Lakes watershed is covered by forests, with the vast majority of these managed to produce wood products. These working forests include: corporate lands managed primarily for wood products, small private landowners for whom timber management is often a minor concern, public lands managed for multiple use (wood, recreation, hunting, water). The Chocolay Watershed reflects this general pattern. The working forests predominate, but they are interspersed with, and interact with, reserves and nonforested areas. Nonforested areas include natural openings (such as marshes, dunes, prairies), agricultural lands, lakes and rivers, urban development, and other smaller nonforested landscape features (such as roads, mines, and cliffs) (Rogers and Premo 1994).

Over the years there have been many names and descriptions applied to the forests of the northern Michigan region. One of the more recent and useful is Northern Hardwood and Conifer Region (Mladenoff and Pastor 1993). This name focuses on the transitional nature of the region. The entire Upper Peninsula (including Marquette County and the Chocolay Watershed) is part of a transitional region between two biomes (major biological regions): the boreal forest to the north and the central hardwoods to the south. In an ecologist's terms, it is a regional ecotone (ecological transition area). Its existence is related to the interactions of continental climatic zones combined with the moderating influence of the Great Lakes.

Ecotones are known as regions of high species diversity; the Northern Hardwood and Conifer Region is no exception. For example, botanical studies conducted on Grand Island in Lake Superior resulted in plant lists of 699 species, indicating an intermingling of boreal, southern, eastern, and western forms (Rogers et al. 1991).

As in most temperate systems, certain tree species dominate a particular ecosystem in terms of their abundance, biomass, or both factors. In the northern hardwood and conifer region:

- Sugar Maple (*Acer saccharum*) is the most commonly occurring species on mesic (moderately moist) sites where it co-occurs with the less abundant basswood *(Tilia americana*), yellow birch (*Betula alleghaniensis*), and eastern hemlock (*Tsuga canadensis*);

- Boreal species such as northern white cedar (*Thuja occidentalis*), balsam fir (*Abies balsamea*), and black spruce (*Picea mariana*) are typical of cool, wet lowlands;

- On xeric (dry) sites, jack pine (*Pinus banksiana*), eastern white pine (*Pinus strobus*), red pine (*Pinus resinosa*), and oak species (*Quercus* spp.) are typical; and

- Early successional species common throughout the region include quaking aspen (*Populus tremuloides*), bigtooth aspen (*Populus grandidentata*), and paper birch (*Betula papyrifera*).

The intermixing of boreal and deciduous forests with various nonforested ecosystems in the Upper Peninsula is also reflected in its diverse vertebrate fauna with over 200 species of birds and 50 species of mammals known from the area. Invertebrate communities reflect a huge diversity as well.

Change is an inherent feature of ecosystems and landscapes. Any ecological characterization that fails to consider the dynamic nature of a landscape is incomplete. The northern hardwood and conifer region has undergone profound changes since the retreat of the glaciers, and probably achieved a vegetative composition resembling the present day 2000 to 7000 years ago. The region is, undeniably, an ecologically young forest. Before European settlement reached this part of North America, natural processes such as fire, flood, drought, ice storms, insect population surges, and blowdowns were the primary agents of change, although alterations by aboriginal populations may also have played a role on certain landscapes. Logging at the turn of the century, the fires which followed, and the continuing agriculture and settlement of areas resulted in profound, long-term changes to the landscape. These were changes not only of plant species composition but also of stand structure, ecosystem processes, and wildlife habitat. The entire region has been altered at both the forest stand (species composition and structure) and landscape scales (the relations of size and location of various forest ecosystems). The interval between disturbances (except for fire) has been shortened over most of the current landscape. (Rogers and Premo 1994).

Current land use and cover of the Chocolay Watershed is available through the MDNR's Michigan Resource Information System (MiRIS) system. Current land use and cover is illustrated for each of the five Chocolay River watershed townships in Figures 6–10, with transparent overlays from portions of the MDNR county map for Marquette County.

TABLE 3. Broad Land Types Groupings for the Chocolay River Watershed

Type	Acreage	Percentage
Forestland (State/Federal/Private)	60,416 acres	59
Wetlands	16,384 acres	16
Residential/Urban	11,264 acres	11
Agricultural	14,336 acres	14

Broad land use and cover type groupings for the Chocolay landscape are given in Table 3 along with acreage and percentage.

There are many potential sources of data about the way the Chocolay landscape looks today and these should be researched during planning and implementation of specific restoration actions. Characterizing the affected landscape during the planning process is a crucial task. To use Naveh's (1991) comments regarding the discipline of landscape ecology, the resulting characterization should be oriented to both "problem solving and problem inquiring."

A geographical information system (GIS) is a valuable tool for the integration and analysis of all the types of spatial and temporal data that can become part of an ecological characterization (including evaluation of environmental risk). Such systems are currently used by a variety of public and private concerns within the Chocolay region (such as USDA-Forest Service, Mead Corporation, Central Upper Peninsula Planning and Development Region, and the MDNR). Marquette County is moving towards developing a county-wide GIS that can likely be integrated with watershed management efforts such as the Chocolay Watershed.

An ecological management landscape such as the Chocolay Watershed should always be considered in the context of a larger landscape that can be characterized in terms of its climate, soils, landforms, and associated vegetative cover (for examples of such classifications, see Albert et al. 1986; Bailey 1983; Omernik and Gallant 1988). Some of the finer resolution data from which these classification schemes were generated, such as county soil maps, watershed studies, geological maps, aerial photos, and climatic charts, can also provide information critical to the understanding of distributions of plants and animals on the landscape.

The primary functional building blocks of an ecological characterization of a working-forest landscape such as the Chocolay Watershed are maps of forest cover types. These may be in the traditional form of compartment maps (such as those of the MDNR, USDA-Forest Service, and forest industry), and/or part of a computer-based geographic information system. Typically, existing data are commodity oriented. That is, they are focused on marketable species of trees and harvestable stands, combined with other harvest-related information such as size and age classes, and ease of access. These data have been compiled through a combination of aerial photograph interpretation, field inventory, and sometimes remote sensing. Forest cover type data have the advantage of corresponding to many of the ecosystems and successional stages typical of the northern hardwood and conifer forest and thus can provide a valuable first look at the patterns on the landscape.

These data can, however, have certain limitations. For example, ecosystems without harvestable timber may be coarsely grouped in categories that cannot be translated directly to ecosystem classifications. To illustrate, on a particular ownership a sedge meadow, an open sphagnum bog, and a patch of lowland brush might all be lumped into one catch-all category of open wetland that fails to capture their distinct ecological differences, including associated fauna and flora. In such cases, additional aerial photo interpretation combined with actual on-the-ground inventory may be needed to fill in the data gaps for specific sites. Five acres is often the minimum size below which stands are not mapped, yet in many cases important ecosystems occur in smaller units, again necessitating additional field work.

Baseline data on distributions of ecosystems and species are vital if landscape planning and management are to move beyond general principles to concrete, productive actions. This is especially true in riparian ecosystems that are crucial to many elements of biodiversity. Information is needed about rare ecosystems (such as spring seeps, prairie, fens) and rare species, as well as data on distributions, life histories, population dynamics, and habitat associations of more common organisms. For example, the success of techniques such as rehabilitation, reclamation, easements, corridors and buffers, and preserves all rely on high-quality baseline data and monitoring. In fact, monitoring, in concert with ongoing management, can be a good means of acquiring additional baseline data.

Compilation of a working inventory is not a simple task. Existing data are scattered through a variety of sources. Up-to-date, accurate records are often scarce, particularly in a region of sparse human population, such as the Lake Superior Basin (of which the Chocolay is a part). Museums and herbaria contain a wealth of data on species' distributions, often commencing at the turn of the century (in this region) or before and continuing to the present time. Specimens and records may also be part of collections outside the region, having been placed there by the collector or as part of an institutional exchange. The computerization of museum and herbaria records is proceeding in many disciplines, making their ready access in the future much more feasible.

The Michigan Natural Features Inventory (MNFI) exists under the auspices of The Nature Conservancy and the MDNR. This program tends to focus on species with official status under state and federal endangered species legislation, or rare vegetative communities. This limited focus on rare occurrences makes such programs less likely to be a source of information on ecologically significant species that lack official recognition, yet are important as a component of biodiversity. Such programs contain even less data on common species and ecosystems. A listing from the Michigan Natural Features Inventory for the Chocolay Watershed area is available for inspection through the watershed manager or through MNFI.

Published regional floras and natural histories include information on life histories, habitats, and distributions of plants and animals. University presses are often the primary publishers of such topical publications. Broad-spectrum published lists of biota such as Benyus (1989), Benyus et al. (1992) or Patton (1992) are a good starting source of information on distributions of vertebrates. Resources for plant distributions are contained in publications such as Voss (1972, 1985).

Other potential sources of information even more specific to a particular area may also exist as raw data in file cabinets, unpublished reports, publications with limited circulation, or notes from a public presentation. Other sources for these data include natural history publications from resource agencies; papers from colleges, universities, or university research stations; and reports of limited circulation that have resulted from specific research projects. Maps such as the National Wetlands Inventory and USGS topographical maps and aerial photos are also valuable resources for specific projects. These resources are available at the Marquette County Natural Resources Conservation Service and MDNR offices.

Regional and local experts, both professional and amateur, represent another potential source of information rarely tapped, but potentially invaluable. Such information has potential to contribute greatly to a general database or geographical information system. A list of local experts is maintained by the Chocolay River Watershed Council.

What comprises the human community?

In the book, *Watershed Restoration: Principals and Practices* (Williams, Wood, and Dombeck 1997) the authors state that,

> ... in many instances successful watershed restoration depends on cultural restoration, meaning the good will, stewardship values, and participation of citizens. Hence, restoration programs and policies must reflect local watershed knowledge, create an integration between community and scientific concerns, and develop incentives that favor stewardship behavior. In short, we must work through the culture to succeed, not manipulate the people.

If watershed management is approached in the context of a bio-social ecosystem, it is recognized that the social and the biological ecosystems are partners. Human geographic boundaries (cities, counties, etc.) rarely coincide with natural ecosystem boundaries. With this in mind it is important to describe the human community within and surrounding the Chocolay Watershed.

The Chocolay River Watershed is located entirely within Marquette County (population of approximately 75,000) and borders on the City of Marquette (population of approximately 24,000). Because of the close proximity to fairly large concentrations of human population, the watershed has experienced pressures from residential construction and road development and increased recreational use. The year-round residential population of the Chocolay River Watershed has been estimated at approximately 11,500 with some increase during summer months. The watershed includes all or part of five townships: Chocolay, Sands, Skandia, West Branch, and Forsyth (See Figure 11).

As previously cited, about 11 percent of the Chocolay River Watershed is urban/residential (according to Michigan Resource Information System data), but most of the watershed has direct human influence. For example 14 percent of the watershed surface area is agriculture and 60 percent is forest land (most of which is managed for forest products). The watershed road system can be seen from several sources of mapped data including the *Marquette County Road/Street Atlas* (Marquette County 1995, 5th edition).

The waters within the Chocolay Watershed are used for a wide variety of recreational activities including fishing, boating, canoeing, swimming, and sightseeing. There are three waterfalls located in the watershed that are frequently visited by the public. Public access sites include the MDNR handicapped fishing access located on Highway M-28 in Chocolay Township; Chocolay Township Marina located on Main Street in the Village of

Harvey (includes a public boat launch); and Lake LeVasseur, Big Trout Lake, Engman Lake, Strawberry Lake, and Sporley Lake public access sites. There are informal access points used by the public at many river sites in the watershed.

A variety of government agencies serve the Chocolay River Watershed. These include Michigan Department of Environmental Quality, Marquette County Soil and Water Conservation District, Chocolay River Watershed Advisory Council, Michigan Department of Natural Resources, Natural Resources Conservation Service, Consolidated Farm Services Agency, USDA-Resource Conservation and Development, MDNR Fish Hatchery, USDA-Forest Service Dukes Experimental Forest, U.S. Fish and Wildlife Service (USFWS), Marquette County Road Commission, Northern Michigan University, Marquette County Drain Commission, Marquette County Health Department, and the previously mentioned townships. Addresses and contacts for these agencies are available through the watershed project manager.

The townships have planning documents of various kinds and vintages. Some of these documents have been prepared by a regional planning commission (Central Upper Peninsula Planning and Development or CUPPAD), others by the townships. All undergo periodic updates. Those that were reviewed as part of this plan development include:

- Chocolay Township Comprehensive Plan (January 1990) prepared by Township
- Chocolay Township Zoning Ordinance (May 1977) prepared by Township
- Chocolay Township Strategic Plan (October 1995) prepared by Township
- Forsyth Township Comprehensive Plan (July 1996) prepared by CUPPAD
- Forsyth Township Zoning Ordinance (in part)
- Sands Township Zoning Ordinance (February 1995, amended May 1996) prepared by CUPPAD
- Skandia Township Comprehensive Plan (in part)
- Skandia-West Branch Township Recreation Plan (February 1994) prepared by CUPPAD
- West Branch Township Comprehensive Plan (October 1996) prepared by CUPPAD
- West Branch Township Draft Recreation Plan (May 1998) prepared by CUPPAD

These documents have specifics about land use, population, and other resources relative to each township and are housed in various township offices and at the office of the Chocolay River Watershed project manager. Many goals and approaches are common among the townships. As an example, setbacks from water bodies are established and range from 35 to 100 feet depending on the township. Natural buffer zones are established in four of the five townships at 30 feet. These similarities provide opportunities for even stronger coordination and cooperation. Implementation of the *Adaptive Management and Restoration Plan for the Chocolay River Watershed* is one possible mechanism by which this cooperation can occur.

What significant watershed-scale threats exist?

Many significant watershed-scale events or conditions can threaten a landscape's watershed, and the Chocolay River Watershed is no exception. Although watershed-scale threats may overlap and combine, they can be organized in four categories: chemical threats, biological threats, physical threats, and social threats. Land use activities and associated human-caused disturbances undoubtedly have the greatest potential for producing long-term changes in the watershed ecosystem. Chemicals, introduced through many activities including agriculture and forestry (pesticides and nutrients), urban activities (municipal and industrial waste contaminants), and mining (acid mine drainage and heavy metals) have potential for degrading water quality. Biological disturbances due to improper grazing management, forestry practices, or recreational activities occur frequently and can also have significant negative impact. The introduction of exotic flora and fauna species can introduce widespread, intense, and continuous stress on native biological communities. Physical disturbance effects can occur at landscape scale. Activities such as flood control, forest management, road building and maintenance, and agricultural tillage all have high potential for introducing long-lasting changes to the watershed ecosystem. Finally, social threats can occur in many forms including ignorance, apathy regarding watershed stewardship, and inadequate zoning and land use planning. In the remaining paragraphs of this section, we provide some examples of potential threats within the Chocolay River Watershed.

Chemical threats to the Chocolay River Watershed exist in several forms and can operate via ground water, surface water, or both. Underground storage tanks throughout the watershed represent a potential ground water contamination source, primarily of volatile organic compounds (VOCs). Closed landfills pose a potential threat via leakage of materials into the ground water. Household hazardous wastes can also threaten water resources. Accidental chemical spills pose a danger to ground water and surface water resources. Use of herbicides, pesticides, and fertilizers in agriculture, silviculture, golf courses, and lawns also put ground and surface water at risk. Storm water runoff from streets and roads introduces salts, oils and grease, and other materials into ground and surface water. Known sources of ground water contamination at the former KI Sawyer Air Force Base include a closed landfill, above and below ground storage tanks, and fire training sites (where solvents were placed on the soil and ignited during fire control training). Ground water in these areas is currently being monitored. Some is being remediated. All pose a potential threat to the watershed in terms of VOCs. Because ground water is such an important part of the surface water in the streams of the Chocolay system, ground water quality is of major concern and should be carefully followed. Nutrients from animal wastes that find their way into streams in the Chocolay are a potential cause of harm. Some chemicals such as lampricides are introduced to the Chocolay system for biological control of pest organisms. Although purportedly specific to their targets, these chemicals do have side effects on other biota (Haas 1970). The advantages of any chemical application must be carefully weighed against the risks.

Biological threats to the Chocolay River Watershed exist in wide variety and are also of concern. Exotic (non-native) plants and animals are increasingly a threat to native species and ecosystems. Plants such as purple loosestrife have serious implications for wetland ecosystems in the Chocolay River Watershed. Sea lamprey that spawn in the Chocolay system, although not a source of injury to the watershed itself, do have a great impact on fish of the receiving waters of Lake Superior. Planting "native" and non-native fish in the Chocolay River system also poses several possible problems, such as diseases, low genetic variability, and other potential impacts on naturally reproducing populations (see Peck 1992 and 1994 for more on contribution of hatchery fish in Lake Superior tributaries at Marquette). Incremental impacts on the quality of the riparian area from logging, development, and agriculture also can add up to a loss of function in this important ecosystem. Wetland loss or degradation due to development or other land use also is a threat to the quality of the Chocolay River Watershed ecosystem.

Physical threats to the Chocolay River Watershed have their greatest source in earth-disturbing activities such as road construction, silvicultural activities, and development. These all serve to mobilize sediments into the streams and collectively represent the largest threat to the Chocolay River ecosystem because of the habitat impacts that sediments represent. Systematic monitoring of stream crossings, especially for small logging-type roads, is a crucial need in the watershed and needs to be addressed as part of restoration actions in Chapter 5. The Chocolay River Watershed is on the doorstep of the Upper Peninsula's largest city and experiences increasing development pressures from Marquette residents who want to be "out in the country." Anecdotal data indicates that Chocolay system stream banks continually erode and stream morphologies change beyond what might be expected under natural conditions. These are important observations that need to be carefully studied and corrected.

The Sands Plain area was discussed in a previous section, but warrants further attention in the context of landscape level physical threats to the Chocolay River Watershed. Gribben Basin, a settling basin for disposal of waste rock particles from iron ore concentrations, is in the western part of the Sands Plain. Because the Sands Plain is near iron ore deposits, but not underlain by them, parts of the area are being considered as sites for additional tailings basins. Grannemann (1984) modeled ground water flow to simulate water levels and ground water runoff under various conditions to determine the effects of continued operation of the Gribben Basin and construction and operation of four hypothetical tailings basins. Operation of Gribben Basin has decreased the average rate of ground water flow to Goose Lake Outlet by 0.9-1.6 cubic feet per second (CFS) but has increased the average rate of ground water flow to Warner Creek by about 0.2 CFS. Both Goose Lake Outlet and Warner Creek are tributaries of the Escanaba River system. Continued filling of the tailings basin to its design capacity is predicted to cause a slight increase in leakage from the basin to Goose Lake Outlet. The four hypothetical tailings basins, comprised a total of 11 square miles. The simulated basins reduced net ground water flow to streams by about 18 CFS with the model used in a study by Grannemann (1984).

Social threats also exist for the Chocolay River Watershed. Reluctance to institute and enforce zoning that relates to water quality and other environmental quality within the watershed needs to be addressed with a well-designed education program. *Michigan's Relative Risk Analysis Project* cited a lack of land use planning as one of the most important risks in the state. Lack of well coordinated and implemented land use planning (especially across ownership and jurisdictional boundaries and within and between various agencies, departments, and municipalities) poses a threat to the Chocolay River Watershed as well. Implementation of this adaptive management plan offers an opportunity to reduce this threat.

Part 2—The View from a Stream-Scale Perspective

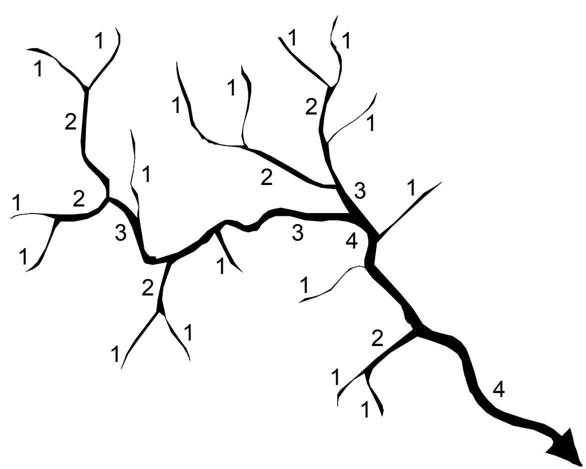
Watershed management actions usually occur at a spatial scale that is smaller than the overall watershed. Many watershed attributes are best observed and understood at this smaller scale as well. This section considers features at the stream scale. As in Part 1, each subject is identified with a question and begins with a statement of why it is important.

What kind of streams are in the Chocolay River Watershed?

Nature has provided a large variety of stream channels, and understanding their characteristics is important in watershed management. Some natural channels actively and rapidly change. Others are more stable. It is important to match rehabilitation actions to the dynamics of the stream type in order to achieve desired results.

Stream order is a method that stream ecologists have used to classify streams that have some similar features and processes. In this system, the initial stream channel (the most headwater stream) is called a *first-order stream*. First-order streams in Michigan are typically tiny unnamed creeks, rivulets, and springs. Many are not evident from aerial photos, 7.5 minute USGS quadrangle maps, and most GIS maps used by land managers in Michigan. Stream ecologists would define a first-order stream as a perennial stream or one that persists at least long enough to develop a biota (Hynes 1970). The order is increased with each successive downstream junction with a stream of equal or higher order (small streams have lower order numbers, large streams have larger ones). See Figure 12 for an illustration of this classification system. Stream order numbers can range up to 10 (for streams like the Mississippi River), but lower numbers are the norm. The Chocolay River is a fifth-order stream in its downstream reaches.

FIGURE 12. Stream Order Classification System



It is usually found that there are between three and four times as many streams order *n-1* as there are of order *n*, and that each is, on average, rather less than half as long (Hynes 1970). The former pattern seems to more or less hold for stream orders 2–5 in the Chocolay River watershed. To estimate the number of first-order streams and their total length, one could extrapolate from this relationship. Therefore, we would predict from the general relationship three to four times as many first-order streams as second-order ones or 45 to 60 such streams. The total length would be estimated as about one-half the length of the second-order streams or approximately 40 miles. In fact, we found 83 unnamed first-order streams in the Chocolay watershed using USGS topographical maps, fitting the general pattern outlined by Hynes (1970). In our own experience working with Upper Peninsula forest managers, there are many first-order streams that require mapping and careful protection during harvest operations. In fact, many first-order streams do not appear on USGS topographical maps. Although these unmapped first-order streams might be predicted by an examination of topographical maps, nothing can substitute for ground inspection. Based on our inspection of map resources, there are no named first-order streams in the Chocolay watershed. As more careful field inspection and mapping occurs, these important headwater streams will become better understood in the Chocolay system.

In areas where there is little slope and valleys are more flattened, large and small streams have flood plains that interact with the stream. The shape and movement of a stream can be confined (where bounded by bedrock or other restrictive substrate); where substrate is softer, streams exhibit greater meander (sinuosity) and may even become braided (that is, several side channels). Streams have areas of active channel erosion (usually faster areas) and sediment deposition (usually slower reaches). Channel slope (steepness) and sediment particle size both influence erosion and deposition. The dynamic processes of channel erosion and deposition are linked to upland processes and are important to the stream ecosystem and any measures taken to rehabilitate degraded areas.

The Chocolay Watershed includes 20 named streams and creeks that serve as tributaries to the Chocolay River. Table 4 provides names and other information about these streams. Hydrology and ground water influence of Chocolay River Watershed streams is discussed in a previous section. Stream flow data for some individual streams is available at the MDNR Land and Water Management Division.

TABLE 4. Streams of the Chocolay River Watershed

Stream	Length	Order	Townships	No. 1st Order Tribs.	
				Cnty. Map	USGS Map
Chocolay River (main)	19.4 mile	5	West Branch, Skandia, Chocolay	4	7
Chocolay River (West Branch)	6.9 mile	3	West Branch	2	7
Chocolay River (East Branch)	21.9 mile	4	Forsyth, West Branch	5	7
Silver Creek	6.9 mile	2	Sands, Chocolay	2	3
Cherry Creek	6.0 mile	2	Sands, Chocolay	0	1
Cedar Creek	7.4 mile	2	Sands, Chocolay	1	3
Big Creek	14.1 mile	3, 4	Sands, West Branch, Chocolay	6	10
Peterson Creek	7.0 mile	2	Sands, West Branch	0	5
Norby Creek	4.0 mile	2	Sands, West Branch	0	3
Voce Creek	3.4 mile	2	Chocolay	2	5
LeVasseur Creek	10.5 mile	2, 3	Skandia, Chocolay	0	1
LeVasseur Creek (East Branch)	5.5 mile	3	Skandia, Chocolay	0	4
Dorow Creek	2.6 mile	2	Chocolay	0	2
Nelson Creek	11.5 mile	2	West Branch, Skandia	0	5
Nelson Creek (West Branch)	3.1 mile	2	West Branch, Skandia	2	2
O'Neil Creek	2.0 mile	2	West Branch, Chocolay	0	1
Foster Creek	7.8 mile	2, 3	West Branch, Chocolay	4	5
Silver Lead Creek	3.1 mile	2	Forsyth, Sands, West Branch	3	4
Wiseman Creek	5.8 mile	2	West Branch	5	5
Sheen Creek	5.7 mile	3	Forsyth, West Branch	3	3

How good is the water?

Perpetuating water quality that supports human uses and fish and wildlife habitat is a major interest for all watersheds. All water contains chemical constituents, inorganic particles, and organic material. Some of these materials are natural constituents of water while others are introduced through human causes. Watershed conditions strongly influence the materials that find their way into the water. Water quality standards are established by state and federal resource agencies (e.g. Michigan Department of Environmental Quality and U.S. Environmental Protection Agency). These standards set forth water quality suitable for human water uses (see below). The aquatic organisms present in a stream can indicate a great deal about water quality. For example, naturally reproducing brook trout in a stream indicate high water quality (cool temperatures, high dissolved oxygen, and plenty of food organisms). Water quality is often discussed in terms of three attributes: physical, chemical, and biological.

- ***Physical water quality characteristics*** include temperature and sediment. Stream temperature determines the kinds of organisms that can thrive in a stream and is primarily a factor of the amount of sunlight that impinges on the water surface, cool ground water seeps, the volume of water in the stream, and upstream water temperatures. Sediments caused by weathering and erosion are natural constituents of streams. Suspended sediments are fine materials that are carried in the water column. Bedload sediments are heavier and remain on the bottom of the stream most of the time. Too much suspended sediment can cause stress to aquatic organisms and reduce light penetration into the water. Excessive bedload can cause a reduction in habitat quality for many aquatic organisms. According to MDNR Fisheries Division, sediment problems within the Chocolay watershed are severe, especially on the highly erodible western part of the watershed. This means that impacts from logging, roading, and stream crossings are especially severe in the west. According to MDNR, their files document an historical era of settlement where erosion in the 1940s and 1950s due to agriculture was significant and that the watershed still feels these effects.

- ***Chemical water quality characteristics*** include parameters such as dissolved oxygen, nutrients (such as nitrogen and phosphorous), human-made chemicals, and pH. Dissolved oxygen concentration in water is affected by temperature, aquatic plants, mechanical mixing, and other factors. The cooler the water, the more oxygen it can hold (this is why trout live in “cold water streams”). Nutrients are crucial for plant and animal growth, but excess amounts can cause an overproduction of algae and other aquatic plants and have a negative effect on the aquatic ecosystem. The relative acidity or alkalinity of water is measured by pH with neutrality being at pH 7 (acidic conditions display pH less than 7). In the Chocolay watershed, dissolved oxygen concentrations may be reduced where water temperature is elevated. This can result in areas where stream canopy is reduced or turbidity is high, or where humans or beaver impound water. Silver Lead Creek provides a good example where chemical contamination may have resulted from human activities at the former K.I. Sawyer Air Force Base.

- ***Biological water quality characteristics*** include dead organic material and living plants and animals. Natural amounts of leaves and woody debris in the stream is extremely important for the aquatic food base. Headwater streams completely depend on these organic inputs to fuel their ecosystem. Retaining leaves and woody debris in the stream is important to maintaining aquatic organisms. All stream water contains invertebrate organisms and bacteria and most are natural components of the stream community. Sometimes bacteria inputs from human or animal sources can cause problems for stream health and human uses. So-called fecal coliform bacteria are indicators of potential disease-causing organisms. Measures of biological water quality are quite useful in characterizing the stream. Such measures include biological oxygen demand, rate of organic material processing, diversity and biomass of invertebrates, coliform counts, and fish production. According to MDNR Fisheries Division, large woody debris is lacking in much of the watershed from Skandia downstream and within the Nelson Creek drainage. Absence of large and small woody debris is significant for several reasons. For one, it translates directly to a lack of physical habitat for fish and invertebrates. Perhaps more importantly, the absence of large and small woody debris allows deciduous leaves entering the stream during the fall to move downstream too quickly, reducing the ability of stream organisms to fully process leaf litter. In this case, important energy and nutrients is lost from the system.

The Michigan Department of Environmental Quality (MDEQ) recognizes seven designated uses in surface waters of Michigan and sets as an underlying goal of all watershed projects to restore and/or permanently protect waters such that they meet all seven designated uses (Michigan Department of Environmental Quality Steps for Developing Watershed Plans, undated draft). The seven designated uses are:

1) Agriculture (i.e., crop irrigation, water for livestock)

2) Navigation

3) Industrial water supply

4) Public water supply at point of intake

5) Warmwater fishery/coldwater fishery

6) Other indigenous aquatic life and wildlife

7) Partial body contact recreation (i.e., boating and fishing) and total body contact recreation (swimming) between May 1 and October 31.

Streams within the Chocolay Watershed meet these designated uses as far as known, but quality has been degraded generally and in specific areas.

The Chocolay River Watershed Project Manager drafted the following Water Quality Statement:

> The Chocolay River Watershed is a designated cold water fishery that is managed for trout and salmon and is a crucial watershed for the natural reproduction of many Lake Superior fish species. Excessive instream sand and sediment bedload is the primary factor limiting the natural production of aquatic invertebrates and fish. The primary objective of the Chocolay River Watershed Plan is to decrease non-point source pollution, decrease the instream sediment bedload, and improve water quality and aquatic habitat in the watershed.

What's in the riparian corridor?

The riparian area is the zone adjacent to the water that both influences and is influenced by the water. In general terms, this zone of influence is the land (including wetlands and flood plain) adjacent to the stream. For some stream functions, the riparian corridor is quite broad; for others, it is quite narrow. In ecological terminology, the riparian area is an ecotone or transition area between two ecosystems. Because of this it has high biodiversity (many kinds of plant and animal species). Williams et al. (1997) indicate that the importance of riparian areas far exceed the relatively minor proportion of the land that they occupy in most watersheds. Thus, a focus on the riparian corridor is of paramount importance in stream restoration. Much about stream management is, in fact, riparian area management.

The riparian corridor provides habitat and areas of activity for many animals and plants in a landscape. Frequently, the vegetation along a stream conforms to soil types and drainage resulting in a naturally delineated riparian zone, visible from aerial photography. But riparian areas are more complex than what is represented by obvious vegetative patterns, and their features and functions are only partially understood.

One recognized attribute of riparian areas is their role as landscape corridors for movement of organisms. Plants, mammals, birds, reptiles, amphibians, and other creatures all travel and disperse along the riparian areas of streams. As an example in the Upper Peninsula, southern species such as burr oak, fox squirrel, and blue-gray gnatcatcher extend their ranges northward along the Menominee River corridor. Riparian areas are also used as travel routes by black bear, river otter, mink, and other mammals.

Maintaining natural vegetation along stream corridors is important for perpetuating these features and functions (Premo and Rogers 1997).

Riparian areas provide habitats for many organisms. Mammals often concentrate their activities in riparian areas, finding food, water, and cover there. Maintaining natural vegetation in the riparian areas optimizes this function. Riparian areas are hubs of activity for bird feeding and breeding. Some bird species apparently require fairly wide forested buffer zones in order to maintain breeding activities in the vicinity of the stream. Some rare birds, like the bald eagle, and game birds, like the wood duck, use the riparian forests for nesting and perching sites. Upland gamebird hunters know the fondness woodcock have for probing the soft riparian soils for worms. Some reptiles find critical habitat in the riparian area. For example, wood turtles spend most of their long lives near a stream, finding foraging and nesting habitat in the riparian area. Managing for natural stream side vegetation will benefit this rare turtle species. Finally, riparian areas provide habitats for a large number of rare plants (Premo and Rogers 1997).

Landowners such as the forest industry and state and federal governments have policies regarding activities in the riparian areas. Best management practices (BMPs) also address these issues. How well these guidelines work to maintain the integrity and functions of riparian areas is not known, although this is an important area of research. In addition, simply cataloging the riparian areas and their features in the Chocolay system is an important and worthwhile restoration activity.

How well connected is the watershed?

A healthy watershed is a well-connected one. Rivers and their watersheds have several dimensions that are interconnected. Ward (1989) defined four dimensions of a river system and landscape connections for each: longitudinal (upstream to downstream), lateral (flood plains to uplands), vertical (subsurface to riparian), and temporal (because the other three dimensions change over time). Human activities tend to change or break these connections, for example where the natural vegetation of the riparian area is removed and replaced with a road or lawn. One goal of watershed restoration is restoring the landscape connections and not creating new discontinuities. Riparian areas are the critical connection between upland and aquatic habitats and the most important to maintain.

The Chocolay River Watershed is generally “well connected.” For example, the tight connection between the ground water and stream flow was discussed in a previous section. By the same token, use of part of the Sand Plains areas as a tailings basin and its subsequent impact on ground water runoff (Grannemann 1984) illustrates how landscape connectivity can be disrupted by human actions.

Discontinuities at the stream scale have not been well documented in the Chocolay River Watershed. Impacted areas of riparian forest, impervious surfaces near the streams, and areas where flood plains are disconnected from the river are examples of discontinuities that should be identified, mapped, and addressed with restoration actions.

What significant stream-scale threats exist?

Threats to the health of aquatic ecosystems and communities exist at the stream scale as well as the watershed scale. These threats can be chemical, biological, and physical in nature and tend to be more localized in their source and effect. Social threats, as described in a previous section, can also play a role at the stream scale. These smaller scale threats, however, should generally be considered cumulative: their impacts are added to other similar impacts elsewhere in the system. Threats such as improper culvert installation can be a chronic source of sediment input to a stream. Allowing unlimited access of cattle to the stream can have a similar effect. Logging practices that remove canopy from over headwater streams may have temperature impacts on these important tributaries. Runoff from parking areas can introduce warm water or grease and oil into streams and have significant local impact. A "back forty" illegal dump on the edge of an intermittent stream or wetland is a social threat that operates on a small scale but may impact the wider area.

Some stream-scale threats can have an apparent natural cause. For example, the localized impacts of beaver on cold water streams. High numbers of beaver dams along a stream system can raise water temperatures and interfere with fish movement. This “beaver problem” likely results from a combination of factors, including forest management practices that produce optimal food sources such as young aspen close to the stream. It should be noted that beaver ponds form other extremely important habitats and provide important wetland functions, so it is important to temper a concern for cold water fisheries with a broader ecological perspective.

Non-native or “alien” species can pose important stream-scale threats. Purple loosestrife for example, can establish in small wetland pockets and out-compete the native flora, thus degrading important wildlife habitat.

Although in rare cases, sedimentation and other types of pollution directly affect fish in an aquatic ecosystem, changes are more often subtle and indirect, involving organisms near the bottom of the food chain. For example, turbidity can limit the light available to algae and rooted plants diminishing their ability to transform solar energy into a food source for herbivorous invertebrates. In other cases, sediment fills the empty spaces between particles of the bottom rubble, reducing the habitats available to invertebrates and reducing biodiversity. When plant and invertebrate communities are simplified, nutrient and energy processing in the stream becomes less efficient and fewer fish can be supported by the ecosystem. Simply placing fish structure and cover will not increase their populations since the abundance and diversity of food has become a limiting factor. Other fish-eating animals such as osprey and otter are affected as well. A strategy of managing a riparian area so it is able to protect aquatic ecosystems from runoff-borne pollutants such as sediment is well-worth developing in a watershed restoration plan (Premo and Rogers 1997).

Small and intermittent (temporary) streams are often ignored or overlooked when land management actions occur. For the most part, these features are not mapped on resource maps of land managers. This is unfortunate as these small first-order streams and spring seeps are the headwaters of rivers and as such their quality directly influences downstream communities (the longitudinal connection at work). At least two rationales for protecting these resources with a natural vegetative buffer stem from an aquatic ecosystem perspective. First, vegetative cover shades small streams, moderating the water temperature. Second, the energy source that “fuels the engine” of small streams is organic material from the edge of the stream (mainly deciduous leaves that enter during the fall); diminishing this source has a negative impact on the stream (Premo and Rogers 1997). Large woody debris in large and small streams of the Chocolay system not only provides direct habitat for plants and animals, but serves an important function of holding back many of the leaves by forming leaf dams. This allows stream invertebrates more time to thoroughly process this material and make the nutrients and energy available to the aquatic food chain. Removal of natural woody debris from streams without regard to this important function poses an important threat to stream health. Converting stream side vegetation from deciduous cover to coniferous (as sometimes recommended to limit beaver activity) has the undesirable side effect of removing a hugely important source of easily convertible energy and nutrients from the stream system. Tag alders, often cited as the curse of trout anglers, actually provide one of the best sources of raw materials to the stream ecosystem—nitrogen rich leaves. (Tag alders are nitrogen-fixing wetland plants.) This is not a simple story; human impacts from the past have increased sediment bedload in streams and may have resulted in saturation of riparian soils, thus providing better habitat for tag alder (MDNR Fisheries Division, pers. com.). Trying to manage for a “natural” system is a difficult balancing act, but any management action benefits by asking the question: “Are there any undesirable outcomes?”

Sediments in streams (especially cold water, trout streams) are a threat (Hansen et al. 1982). Sediment bedload and ongoing erosion of sediments into streams in the Chocolay system is the major problem cited by the Chocolay River Watershed Council. Because this is such a pervasive problem, it has been the subject of many rehabilitation projects in the Chocolay River Watershed. In spite of this attention, sediments continue to be the major threat to aquatic ecosystems in the watershed. Sources for sediments are many, but primary among them are stream crossing devices including fords, culverts, and bridges. According to MDNR Fisheries Division, road culverts are a serious threat to the future of the Chocolay watershed. Any land disturbance in the watershed has potential to contribute sediments to the system. Thus excessive sediments introduced into the Chocolay system by agricultural tilling, grazing of cattle in the riparian area, clearcutting of forests, poorly designed selective cutting operations, housing and other developments, road construction and maintenance, and poorly designed and maintained gravel pits.

The Watershed Site Inventory (see Appendix E) is an ongoing effort to catalog threats to the Chocolay River Watershed. The inventory identifies specific sites where problems exist or are highly likely and points towards possible solutions. The inventory should strive to contain all categories of threats to the watershed (chemical, biological, and physical). The Watershed Site Inventory needs to be continually updated.

Part 3—Hard Work Toward the Cause

Concern about the Chocolay River Watershed is not new. In fact, generations of trout anglers and other nature enthusiasts have appreciated and cared for the streams in the watershed. Farmers and forest managers have looked to the land for sustainable yields. Researchers have sought to understand more about the ecosystems in the watershed. State and federal environmental laws and resource agencies have acted on behalf of watershed quality. The year 1990, however, is a milestone in the way the human community in the Chocolay River Watershed has chosen to address the river. This is the year that a grassroots watershed council was founded and people deliberately and collectively adopted a stewardship approach to the watershed’s environmental health.

Since the Chocolay River Watershed Council was formed almost a decade ago, numerous actions (rehabilitation projects) have been implemented. Appendix B, *Chocolay River Watershed Project List*, summarizes 75 projects undertaken by the Chocolay River Watershed Council at various locations. The Chocolay River Watershed Council and staff have periodically published newsletters to report information of watershed importance. Example newsletters are provided in Appendix D. In addition, significant effort has been devoted to a watershed site inventory. A report of this inventory is found in Appendix E. Education and transfer of information have been important aspects of restoration in the Chocolay River Watershed. The Information/Education Program is summarized in Appendix F.

The following bullets describe several completed projects:

- In 1995, a stream restoration project was completed on a 1.5 mile section of Big Creek. Using summer youth crews, Northern Michigan University students, and volunteers, the Chocolay Project was successful in eliminating braided channel conditions and improving overall stream conditions. MDNR monitoring documents a 43 percent increase in available spawning gravel, a 53 percent reduction in sediment, and over 200 percent increase in populations of trout and salmon.

- In the fall of 1997, the Chocolay Project funded the removal of a large earthen dam located on the headwaters of Silver Lead Creek at the former K.I. Sawyer Air Force Base. By draining the reservoir and removing the dam, over 2 miles of prime brook trout habitat began the process of restoration. Local community organizations including the Boy Scouts and the Cedar Tree Institute have planted hundreds of trees at the site.

- The Chocolay Project has completed over a dozen stream crossing improvements including many high-profile County Road Commission crossing improvements or replacements. A good example was work on the old metal culverts on County Road 545 where the West Branch of the Chocolay River crosses. The Project provided $15,000 in cost sharing to replace the culverts with a larger single concrete culvert. This project controlled historic erosion at the site, improved stream flows, and improved fish migration conditions.

- The Chocolay Project has completed a number of agricultural assistance projects including two very successful cattle crossings: one on Big Creek and one on Cherry Creek. Both of these projects controlled bank erosion, excluded cattle from sensitive stream corridors, and improved stream conditions.

- The Chocolay Project has several Forestry Best Management Practices including both remedial practices and preventative BMPs. These projects also included culvert installations or improvements, timber bridge construction, erosion control, road seeding, and buffer strip establishment.

- The Chocolay Project has installed a series of sediment traps throughout the watershed. After controlling upstream sources of sediment, these traps are effective in capturing instream sediment bedloads and improving downstream substrate conditions. The project has a cooperative agreement with MDNR Fisheries Division to provide regular trap maintenance.

As mentioned in previous sections, townships within the watershed have also addressed environmental health and recreational opportunities in their various planning and zoning documents.

It is important that these significant efforts be monitored so that their effectiveness is documented. In this way, the spirit of an adaptive management plan would be carried out: management actions are monitored so that we learn how to improve the next generation of management actions.

Some monitoring efforts have been ongoing. The Michigan Department of Natural Resources and the U.S. Fish and Wildlife Service have been monitoring several projects completed by the Chocolay River Watershed Council. Another example is a student project (Northern Michigan University) that examined outcomes of rehabilitation actions on Big Creek. (This report is available through the watershed project manager's office.) In addition, a long-term monitoring program has been established with the Environmental Science Department at Northern Michigan University.

Part 4—A Township Approach to Plan Implementation

"Protect the Best and Restore the Rest" has become the credo of successful watershed managers across the country. This simple phrase acknowledges that watershed restoration is more than identifying the worst areas and trying to rehabilitate them. It recognizes that of equal or greater importance is identifying those areas that are of high or moderate quality in the watershed and establishing mechanisms to maintain that quality. "Protect the Best and Restore the Rest" also implies the importance of identifying imminent threats to watershed health and working to eliminate them. This principle is founded on the restoration ecology fact that the most certain way to successfully restore the structure and function of part of a broken watershed ecosystem is to rely on intact areas of the watershed to serve as the donors of healthy "parts" (such as aquatic insect species or good quality water). "Protecting the Best" allows us to "Restore the Rest" more effectively and economically, but protection is the prerequisite.

The Chocolay River Watershed Council recognizes that each of the five townships in the watershed form the most practical geopolitical units from which plan implementation can occur. With guidance and coordination from the Council and the adaptive management plan, a township can implement actions that are appropriate for the specific watershed work that needs to be addressed within its boundaries. The townships can match their undertakings to the financial and human resources they can muster.

Regardless of where the township lines are drawn, the streams and the landscape knit the townships together. What happens (or doesn't happen) in one township has consequences that will influence other townships. This chapter on the State of the Watershed closes by providing a focused view of the state of the townships. Specifically, for each township, at least one "High Quality Area," one "Threatened Area," and one "Critical Area" is identified and described. This does not imply that only one of each type occurs in any township, but provides real examples that can be addressed later with specific actions. In future editions of this adaptive plan, additional high quality, threatened, and critical areas can be identified, described, and addressed through management actions. This approach is intended to emphasize that our management attention and efforts need to be applied not only to what is wrong with the watershed, but to what is right as well. Appendix E provides additional detailed site inventory for many parts of the watershed.

For the purposes of this plan, our definitions of high quality, threatened, and critical areas are as follows:

- ***High Quality Area***—This designation refers to an area of an outstanding resource or great ecological importance. It might be a stream or stretch of river or perhaps a high quality area of upland or wetland. A high quality area should be addressed by a protection action (or maybe already is protected by some mechanism such as a research natural area). High quality areas can serve as natural sources of restoration capital as other parts of the watershed are rehabilitated.

- ***Threatened Area***—This designation refers to an area of good quality, that needs some kind of intervention to ensure its perpetuation as a functioning part of the watershed. It might warrant a combination of rehabilitation and protection actions.

- ***Critical Area***—This designation is borrowed from the terminology used by the MDEQ Surface Water Quality Division (MDEQ Steps for Developing Watershed Plans, undated draft; MDEQ Surface Water Quality Division Watershed Management Guidance, 1998). The MDEQ defines critical area as the "part of the watershed that is contributing all or most of the pollutants in the water body." Because of this orientation, critical areas are areas of streams or parts of the watershed that have a direct influence on water quality. Critical areas will likely be addressed by more aggressive rehabilitation actions.

This approach resonates with that of the Lake Superior Binational Program (LSBP 1996) where it is recognized that the integrity of the Lake Superior basin ecosystem cannot be restored or maintained by addressing issues at only one scale and areas of important habitat will play an important role in restoration.

In reality these three kinds of areas are part of a continuum ranging from pristine to heavily impacted, but the subdivisions are helpful in identifying and describing their attributes. Candidate high quality, threatened, and critical areas were identified by Chocolay River Watershed staff, Watershed Council members, and the public for inclusion in the plan. These areas have been identified as result of a problem/opportunity identification process. Because the Chocolay River Watershed is so large (160 square miles) and diverse, there are many high quality, threatened, and critical areas throughout its landscape. New areas can continue to be identified, characterized, and addressed through future editions of this plan. Table 5 summarizes the areas identified to date in the Chocolay River Watershed for each of the five townships. All of these areas require the collection of specific information so that restoration actions can be refined and implemented.

Following Table 5, Chapter 3 concludes with several captioned color photographs depicting the resource, its challenges, and the efforts brought to bear within the landscape of the Chocolay River Watershed.

TABLE 5: Example High Quality, Threatened, and Critical Areas in the Townships of the Chocolay River Watershed

Township	Type of Area	Name / Identifier / Location	Description / Rationale
Chocolay	High Quality	Chocolay River Rapids from Highway US41 to Section 10 (T47N, R24W)	High quality trout stream conditions with stable banks, good cover, and healthy substrate conditions. Generous buffers have been left adjacent to farming operations.
Chocolay	High Quality	High Banks Area; Sections 25 and 36 (T47N, R24W)	This is a pristine area and is an area that is subject to high erosion.
Chocolay	High Quality	LaVasseur Creek (T46N, R23W; T47N, R23W)	High quality trout stream with little development
Chocolay	High Quality	Section 5 and 6 (T47N R24W)	These high sandbanks areas along the Chocolay River were stabilized by the DNR in the late seventies but al lot of the protective measures have deteriorated. This highly erodible area needs to be protected from future erosion.
Chocolay	High Quality	Sections 13, 14, and 15 (T47N, R24W)	This large flood plain area along the Chocolay River serves a flood area (reservoir) to help alleviate flooding in the lower reaches of the river and especially in the area near the village of Harvey.
Chocolay	Threatened	Autumn and Wintergreen Trails areas, Sections 8 and 9 (T47N, R24W)	These areas along the Chocolay River, Cedar Creek, and Cherry Creek are currently being developed for residential use. These quality areas have had some natural erosion over the years and the concern is to not accelerate this process and cause deterioration of the quality of these areas.
Chocolay	Threatened	Chocolay River Trail Area, Section 8 (T47N, R24W)	Planned housing developments could aggravate natural bank erosion and have other negative impacts.
Chocolay	Critical	Big Creek from the middle of Section 32 (T47N, R24W) (end of previous restoration project) to US41	This section has a heavy sand bedload. There is potential for improvement by installing sediment traps, conducting stream restoration practices, and improving stream crossings.

Township	Type of Area	Name / Identifier / Location	Description / Rationale
Chocolay	Critical	Cedar Creek (from crossing at Cherry Creek Road to Highway US41)	Natural erosion and sedimentation from development pressures have impacted stream conditions.
Chocolay	Critical	Chocolay River Mouth	This is very shallow and is constantly changing depth and direction. This causes flooding problems in the winter and spring in the mouth and upstream areas. It also impedes navigational access to Lake Superior.
Chocolay	Critical	Road crossings (private and public)	There are several areas throughout the township at creek crossings and the Chocolay River that could use some routine best management practices to protect the waters.
Chocolay	Critical	Silver Creek (Chocolay and Sands Townships)	From the headwaters in Sands Township to its discharge point in the Chocolay River has a major bedload of sand. This has substantially reduced its fishery potential. Work has been done to reduce the sources of sand and a sediment trap has been installed but substantially more work is needed to restore the stream.
Forsyth	High Quality	East Branch Chocolay River Headwaters Wetlands (T45N, R24, Section 2, 10, 11, 12, 13)	These sparsely populated wetland areas are significant for constant stream flow conditions and water quality.
Forsyth	Threatened	Sporley Lake and Wilson Lake (T45N, R24W, Section 5)	Potential impacts from increased lakeshore development pressures.
Forsyth	Critical	Silver Lead Creek on KI Sawyer (T45N, R25W, Sections 1 and 2)	Potential impacts from K.I. Sawyer Air Force Base groundwater contamination plumes.
Sands	High Quality	Cherry Creek Headwaters (T47N, R25W, Sections 13, 14, 23); Mostly on State land above fish hatchery.	Important "buffer area" upstream of State Fish Hatchery.
Sands	Threatened	Big Creek (T46N, R25W, Section 24)	Potential site of ground water/surface water contamination (related to K.I. Sawyer)
Sands	Threatened	Cedar Creek (T47N, R25W, Sections 23 and 24)	Logging pressures
Sands	Critical	Sands Plains Aquifer	Important recharge area for many watershed streams. Potential threats from planned tailings basins.

Township	Type of Area	Name / Identifier / Location	Description / Rationale
Sands	Critical	Silver Creek (T47N, R25W, Sections 12, 13, 14)	Heavily impacted from residential development and road crossings. Logging pressures in the headwaters has also been a concern.
Sands	Critical	Snakey Creek (T46N, R25W)	This tributary to Big Creek is being impacted by heavy logging pressures.
Skandia	High Quality/ Threatened	Nelson Creek Headwaters (T45N, R23W, Sections 4 and 9 and T46N, R23W, Sections 20, 21, 28, 33)	High quality trout stream. Threatened from potential logging and development pressures.
Skandia	Threatened	Wilson Creek (T46,N, R23W, Sections 6, 7, 8, 17)	Potential impacts from logging, agricultural, and development pressures.
Skandia	Critical	Nelson Creek (T46N, R23W, Sections 18 and 19)	Pressures from Village of Skandia
West Branch	High Quality	East Branch Chocolay River, Waterfalls (T46N, R24W, Section 36)	High quality trout stream with waterfall acting as a natural impasse to upstream fish migration.
West Branch	High Quality	Silver Lead Creek Headwaters from KI Sawyer to Frahling Falls (T46N, R24W, Sections 29, 31)	High quality trout waters.
West Branch	Threatened	Big Creek (T46N, R24W, Sections 5, 7, 8)	Potential impacts from upstream logging activity.
West Branch	Threatened	Big Trout Lake (T46N, R24W, Section 32)	Potential impacts from lakeshore development
West Branch	Threatened	Engman Lake (T46N, R24W, Section 32)	Potential impacts from lakeshore development
West Branch	Threatened	West Branch Chocolay River (T46N, R24W, Sections 22, 23)	Heavy instream sediment load. Significant upstream sources have been controlled. Sediment trap installed and maintained.
West Branch	Critical	Peterson Creek (T46N, R24W, Section 6)	This area includes recent logging pressures and an eroding earthen dam.

Chapter

4

What Goals Guide the Plan?

Developing goals for a watershed restoration program should begin with defining the ***desired future condition*** of the stream corridor and surrounding landscape. This desired future condition should reflect the common vision of the participants in the restoration program. This vision serves as a foundation for goals and objectives.

The Chocolay River Watershed Council has considered the desired future condition of the watershed. In May 1998 they articulated a set of vision statements directed toward that condition:

- A program exists that maintains the integrity of the recharge areas of the watershed so that a continued, high quality, sustained volume of water supports the tributaries.
- Restoration of the substrate and other trout habitat of the streams has returned the river to its full potential.
- Our educational efforts have successfully developed a citizenry that values the restored watershed and actively works to continue prevention efforts.
- We have successfully developed a self-sustaining watershed management program.
- We take advantage of the latest technology to provide us with the best possible data to further our restoration work.
- Our project work in the areas of sediment control, prevention, public education, restoration and monitoring systems, has achieved international recognition and serves as a model in the Lake Superior basin.
- We have established long-term funding for both administration and project work.
- The streams of the Chocolay River have been returned to an ideal overhanging canopy with a multitude of riffles and pools and is once again a "legendary" river system that provides anglers with a high quality, memorable fishing experience.

The mission of the Chocolay River Watershed Council is:

> Working to restore and protect the streams of the Chocolay Watershed for the benefit of Marquette County residents and Lake Superior (Strategic Plan Draft, May 1998).

Restoration of the Chocolay River Watershed, in a holistic context, is the fundamental and overarching goal that supports this mission. *Restoration is reestablishment of the structure and function of an ecosystem including its natural diversity* (Cairns 1988; National Research Council 1992). It implies rehabilitating and protecting sufficient components of the watershed so that it functions in a more or less natural way, provides habitat for native plants and animals, and supports reasonable human uses.

Several supporting goals have been established by the Chocolay River Watershed Council. The plan writers have added some additional goals. In an adaptive plan, new goals can be adopted as the plan evolves. This chapter concludes with a presentation of these goals organized under topical headings.

Restoration

- Apply rehabilitation, protection, and education actions under the direction of specific objectives to the identified high quality areas, threatened areas, and critical areas.
- Continue and expand restoration projects.
- Improve public education and exposure with a public relations program.
- Gather information that is useful in planning and monitoring restoration actions and devising education programs.

Monitoring

- Establish a monitoring system in the Chocolay River Watershed to provide data that reveal the quality of the watershed streams, and establish a method to evaluate the effectiveness of rehabilitation efforts.

Cultural Climate

- Encourage a political and cultural atmosphere within and surrounding the watershed that allows and promotes good watershed stewardship including cooperation between citizens, businesses, public agencies, and municipalities.

Sustainable Economy

- Foster an environment that promotes a sustainable economy, provides a diversity of economic options for the residents of the watershed, and does not diminish opportunities for future generations of watershed residents.

Recreation

- Develop a sustainable and integrated system of recreation in the watershed where all citizens can enjoy the opportunities of the natural and human-sustained environment while respecting the rights of fellow citizens and property owners.

Program Maintenance

- Provide for continual funding to support the administration and staff necessary to facilitate the implementation and periodic update of the watershed restoration plan.

- Maintain a watershed manager

In the final chapter of this plan, possible objectives and actions that will serve to move toward these goals are presented. This is not an exhaustive treatment, but a starting point, integrated with monitoring so that adaptive management can take place in subsequent years.

Chapter

5

What Objectives and Actions Move Us Toward the Goals?

Abraham Lincoln is attributed with the following wisdom: "*If I had an hour to cut down a tree, I'd spend the first 45 minutes sharpening my ax.*" Planning and preparation are important for any task, but especially when working with a system as complex as a watershed. The vision and goals described in Chapter 4 provide the basis for developing objectives and actions to achieve the desired future outcomes for the Chocolay River Watershed.

Chapter 4 outlined four major goals under the category of ***restoration***. The ultimate source of actions to be implemented stem from both the Watershed Site Inventory (Appendix E) and the Education/Information Plan (Appendix F). Rehabilitation actions should be undertaken on prioritized sites described in Watershed Site Inventory. This inventory provides good information for specific planning and implementation of actions. This will continue and expand upon restoration projects already implemented in the watershed. Public education and exposure should be enhanced by drawing from the Education/Information Plan found in Appendix F. Implemented rehabilitation projects will also be a good source of information for public education efforts. Finally, the restoration goals outlined in Chapter 4 will be achieved by planning rehabilitation and education actions with a strong monitoring component so that the effectiveness of both kinds of actions will be assessed and future actions refined. This is truly in the spirit of adaptive management.

Chapter 4 listed a single goal under the category of ***monitoring***: establish a monitoring system that provides information regarding the quality of the watershed streams and the effectiveness of rehabilitation efforts. This should be accomplished by pairing monitoring actions with rehabilitation actions and by devising some broader stream quality monitoring activities. Working with Northern Michigan University staff and students provides good opportunities for some monitoring to be accomplished. Professional scientists should be consulted for other monitoring questions. Monitoring is the cornerstone of adaptive management but too often is given diminished importance in terms of human effort and funding. This should be given significant priority in future Chocolay activities.

Chapter 4 set forth a single goal under ***cultural climate*** that was intended to foster good watershed stewardship and cooperation between stakeholders. Again, the education/ information program will be a principle avenue for accomplishing this goal. In addition, striving to include all possible participants in a variety of watershed activities is beneficial toward long-term stewardship. (Some examples follow in a bulleted list later in this chapter.)

Chapter 4 stated two related goals under the categories of ***sustainable economy*** and ***recreation***. To maintain and enhance the opportunities of future generations to live and recreate in the Chocolay Watershed is the fundamental hope of Chocolay River stewards. By patiently working through protection, rehabilitation, and education actions these goals will be realized.

The final goals of Chapter 4 are found under the category of ***program maintenance*** and strive to provide funding for a watershed manager, staff, and activities on the watershed. The long-term existence of the Chocolay River Watershed project is primarily in the hands of the people who care about the watershed. The project has developed considerable momentum that will help sustain progress from a volunteer standpoint. The Watershed Council is engaged and will continue to meet and function. This management plan will be the Council's guiding document. It will also provide the basis for funding requests for specific project needs. Education efforts will serve to broaden the base of participants in watershed activities. The Council recognizes the importance of maintaining a watershed manager. Efforts are currently underway to obtain funding for this position through local municipalities, foundations, and public agencies. Examples include the five Chocolay River Watershed townships, Marquette County, Clean Michigan Initiative of MDEQ, Great Lakes National Programs Office (USEPA), and Great Lakes Fishery Trust. Funds for specific actions within the watershed will be sought from appropriate local, state, or federal sources.

In keeping with the spirit of an adaptive plan, we have developed a system for creating and organizing objectives and actions that is flexible and allows the insertion of new ideas and actions at many points along the path of watershed restoration. This system is envisioned as a *virtual card file* that contains "file cards" with individual actions described. Interested watershed stewards of all interests can come to the file to identify or propose the kind of action that is appropriate to their means and abilities. It is a way that resource agencies, townships, watershed staff, teachers and students, service groups, individual landowners, and others can all participate in watershed restoration in an integrated and coordinated way. Working from a completed *Watershed Restoration Action Card* means that a systematic process is followed. It helps ensure that progress is made toward reaching the overall goals of Chocolay River Watershed restoration and minimizes activities that work at cross purposes.

Watershed Restoration Action Cards can easily be linked together in a relational database, further increasing their value as a management tool. Such a database will allow the watershed manager and council to sort data in various ways. For example, the database could allow a manager to compile a list of all projects that occur on State land. A manager might wish to see what types of projects are proposed for a particular five-year period or select all projects that are of an educational nature. The possibilities for adaptive management are unlimited. In addition, this database can be geo-referenced and become part of a geographical information system (GIS). Such a system would be able to house all project information and track restoration progress. It would also be able to interface with the county-wide GIS being implemented in Marquette County.

This action card approach creates bite-sized tasks that are part of a bigger picture of watershed restoration. Rather than being daunted by an overwhelming 160 square mile watershed to restore, stewards can make significant contributions one step at a time. Collectively these steps make up the restoration program. This approach also fosters diverse approaches to watershed restoration and allows for many participants as exemplified in the following possibilities:

- A citizen interested in birdwatching could contribute valuable data to the program by carrying out this avocation under a *Watershed Restoration Action Card*. In this example, a *research action* is undertaken.
- A student in need of a special project might study aquatic insects as part of a needed *monitoring action*. In this way, the student participates in a real project with a genuine information need.
- A corporate forest landowner who plans to upgrade stream crossings by replacing culverts could do so under a *Watershed Restoration Action Card*, making this *rehabilitation action* part of the bigger program.
- A municipality, eager to create permanent green space in the community, could complete a *Watershed Restoration Action Card* so that this *protection action* becomes part of a greater body of actions supporting a healthy watershed.
- Sea lamprey control by USFWS could be done using a *Watershed Restoration Action Card*, so that it fits into the bigger picture as a watershed *rehabilitation action*.
- A MDNR sediment trap or effort to remove problem beaver could likewise be done under a *Watershed Restoration Action Card* thus adding this *rehabilitation action* to the entire suite of activities on the watershed.

- A teacher looking for a project-based teaching activity could focus his students on identifying amphibians in a wetland of the watershed, thus participating in an *education action* under a *Watershed Restoration Action Card*.

- A farmland owner who fences off a stream from cattle could do so under a *Watershed Restoration Action Card* so that this *rehabilitation action* is given credit by the overall restoration program.

- A high school student who wants a social studies project could spend a semester attending watershed council meetings or interviewing long-time watershed residents for their oral history of the watershed. This easily qualifies as an *education action* in support of Chocolay River Watershed restoration and should be included on a *Watershed Restoration Action Card*.

Of course, doing these actions under various *Watershed Restoration Action Cards* would not be mandatory, but conducting activities under action cards helps integrate ongoing and future activities under one restoration umbrella. It helps various stewards in the watershed become aware of each other and the many activities going on in support of a healthy watershed. The Watershed Council or Watershed Project Manager could help coordinate many kinds of actions under this system and efficiently track progress and outcomes. They could create new *Watershed Restoration Action Cards* at their regular meetings and identify resources appropriate to carry out specific actions. Interested individuals or organizations could propose or announce actions to the council through *Watershed Restoration Action Cards.* Part of the education and public relations activities of the watershed manager would be to bring action card ideas to service groups, landowners, agencies, teachers, and students. The manager could also solicit ideas for new action cards at these opportunities. After actions are implemented and monitored, follow-up evaluations could be conducted to help plan advantageous adaptations in restoration actions.

The *Watershed Restoration Action Card* is composed of two parts: (1) the *Action Front-End Card*, and (2) the *Action Information Card*. The *Action Front-End Card* is a simple, user-friendly card designed to be efficiently filled out by anyone proposing or announcing an action on the watershed. A completed *Action Front-End Card* would be submitted to the Chocolay River Watershed Manager or to the Chocolay River Watershed Council. The more detailed *Action Information Card* will be completed by the watershed manager with help from the proposer. Each type of card is described in more detail in the following paragraphs.

FIGURE 13. Action Front-End Card

Watershed Restoration Action Front-End Card

This *Watershed Restoration Action Card* describes an action intended to support the goals of the ***Chocolay River Watershed Restoration and Adaptive Management Plan***. Planning and implementing actions under *Watershed Restoration Action Cards* helps integrate ongoing and future activities under one restoration umbrella. An important purpose is to link monitoring activities with specific actions.

This *Watershed Restoration Action Card* is composed of two parts: (1) the *Action Front-End Card*, and (2) the *Action Information Card*. The *Action Front-End Card* can be completed by anyone proposing or announcing an action on the watershed. It is submitted to the Chocolay River Watershed Manager or to the Chocolay River Watershed Council. The more detailed *Action Information Card* will be completed by the watershed manager with help from the proposer.

Proposer:	Date of proposal
Contact person Name: Phone: E-mail:	Address
Proposed action name:	Action reference no.:
Proposed action abbreviated description:	Objective(s) of action:
Proposed date of action:	Location of action:
Land ownership at site of action:	Map attached? Y/N

The *Action Front-End Card* would record the individual or organization proposing or announcing the action, along with contact information. Also recorded would be the date of the proposal, a name of the action, and a brief description. The front-end card would also state the objective(s) of implementing the action and an anticipated date for implementation. Finally the *Action Front-End Card* would record the location and land ownership for the site of the action. A sample *Action Front-End Card* is shown in Figure 13.

The *Action Information Card* provides necessary details for successfully implementing, monitoring, and adapting the action. It will ensure that good planning for each action has occurred. The *Action Information Card* will contain detailed information in three basic categories: descriptive, monitoring, and post-action follow up. A sample *Action Information Card* is shown in Figure 14.

WATERSHED RESTORATION ACTION INFORMATION CARD

FIGURE 14. Action Information Card (2 pages)

DESCRIPTIVE INFORMATION			
Proposed action name:		Action reference no.:	
Type of restoration action: protection, rehabilitation, education, research, support			
Action addresses: high quality area, threatened area, or critical area			
Detailed description of action (including time required for implementation)			
Describe alternative actions that were considered			
Literature or other sources for technical /conceptual plans			
Formal statement of objective(s)			
Watershed goal(s) supported by the action			
Description of possible negative effects of the action			
Description of area to be affected by the action (spatial scale: watershed, township, entire stream, stream reach)			
List landowners, agencies, or other stakeholders who need notification or permission			
Resources needed and possible sources for resources (human, financial, equipment)			
Budget attached? Y/N			
Potential funding sources			
Responsible party/person for implementing the action			
Required permits to obtain prior to implementing action			

MONITORING INFORMATION
Monitoring action description (including length of monitoring period)
Performance indicators

MONITORING INFORMATION
Describe location and characteristics of reference site for comparison or baseline purposes
Existing pre-action information
Plans for collection of new pre-action information
Responsible party for monitoring
Required monitoring resources and expertise (human, financial, equipment)
Describe likely maintenance requirements for the action
Adaptive management decision schedule (evaluate after one year, five years.....)

POST ACTION FOLLOW-UP ***(Adapted from National Research Council 1992)***
To what extent were restoration plan objectives achieved?
How similar in structure and function is the restored corridor ecosystem to the reference ecosystem?
To what extent is the restored corridor self-sustaining (or will be), and what are the maintenance requirements?
If all stream corridor structure and functions were not restored, have the critical structure and functions been restored?
How long did the restoration initiative take?
What lessons have been learned from this effort?
Have those lessons been shared with interested parties to maximize the potential for technology transfer?
What was the final cost, in net present value terms, of the restoration work?
What were the ecological, economic, and social benefits realized by the restoration initiative?
How cost-effective was the restoration initiative?
Would another approach to restoration have produced desirable results at lower cost?

The descriptive information section of the *Action Information Card* will record the type of restoration action and whether the action addresses a high quality, threatened, or critical area. It will give a detailed description of the action and implementation schedule and will list alternative actions that were considered. It will provide a formal statement of the action's objective(s) and list the watershed goal(s) (see Chapter 4) that are supported. The descriptive information section of the *Action Information Card* will describe the area affected by the action and possible negative effects. It will identify necessary resources (labor, financial, and equipment) and summarize a budget. It will identify the responsible party for implementing the action and list required permits that must be obtained.

The monitoring information section of the *Action Information Card* will describe the monitoring action(s) and indicator(s) that will be used to measure effectiveness of the action. It will identify reference sites for comparison purposes. This section will also identify any existing pre-action information and describe plans for collecting pre-action information. A responsible party for monitoring will be identified along with required resources to conduct the monitoring. Likely maintenance actions will be recorded and a decision schedule for adaptive management will be proposed.

The post action follow-up information section will record responses to several questions (Adapted from National Research Council 1992) that should be addressed after action implementation and monitoring have occurred. This is intended to evaluate the action and provide information for future planning and adaptive management.

For some *Watershed Restoration Action Cards* minimal information will be required. For more elaborate actions, however, considerable effort and research may be necessary to arrive at appropriate action design and funding. These cards may require attachments to provide additional information.

Using *Watershed Restoration Action Cards* is a strategic approach because it integrates the monitoring activity with a specific action. In this approach monitoring is not so easily postponed or forgotten. It is important to monitor meaningful outcomes of each action. The level of restoration effort (e.g., number of trees planted, BMPs installed, dollars spent, meetings attended, or programs given) may not give much indication of how water quality is improving, or whether more fish are spawning, or how a particular management action is working. We need to strive to measure the right things—those that measure real ecosystem progress toward objectives and goals.

The *Watershed Restoration Action Card* approach is intended to cultivate a process akin to conducting a small-scale environmental assessment on an action to ensure that it is well-conceived and planned. It guides people to ask questions about potential alternative approaches and undesirable outcomes, increasing the likelihood of a beneficial outcome.

Appendix C contains several completed *Watershed Restoration Action Cards.* This beginning will launch a new generation of watershed stewards on an exciting undertaking of caring for a river system.

The watershed restoration plan appeals to the sense of stewardship in people who care about the Chocolay River Watershed. For the most part, it relies on volunteer actions and participation. The Chocolay River Watershed Council believes this is the preferred approach, but is also aware that state and federal laws as well as local zoning ordinances provide additional tools to help implement watershed restoration.

Township zoning ordinances can and should be of great importance to maintaining the health of the Chocolay River Watershed. It would be desirable for the five Chocolay River watershed townships to have improved and uniform zoning ordinances that serve to protect the watershed and its elements. This a process that requires deliberate and strategic steps to achieve—as well as a degree of patience.

The first important step can be part of the information and education program. This program must address and promote the important issues of zoning as one of its emphases. The educational efforts need to communicate a vision of a healthy shoreland development to the public and community leaders. It must recognize that shoreland and other zoning ordinances influencing the health of the watershed depend upon understanding and accepting the purpose and intent of the ordinances. Educational efforts need to work with traditional and new partners. Unexpected coalitions (consisting of developers, watershed council, students, real estate agents, land owners, farmers, environmental groups, industry, and others) must build a common ethic and understanding of watershed stewardship and the role that zoning can play.

A second step toward uniform and strengthened zoning ordinances can occur as the educational efforts develop a “critical mass” of interested people (including leaders from each township). At this point a set of draft uniform zoning ordinances can be created, distributed, and debated. Common interests and benefits among the townships should be stressed. Important differences should be accommodated. There are examples that can be used as reference guides. The townships’ existing zoning ordinances are a good starting point. The Wisconsin Department of Natural Resources has a *Shoreland Zoning Resource Guide: An Annotated Model Shoreland Zoning Ordinance* (1997) that provides insights and examples. The *Whetstone Brook and Orianna Creek Watershed Management Plan* (1998) develops ideas regarding a watershed overlay ordinance in an attempt to bring multiple jurisdictions under a single watershed umbrella. The purpose of such an ordinance is to allow each affected jurisdiction to maintain its own master plans, recreation plans, and zoning ordinances but provide standardized special land development and other regulations for areas within the watershed of interest.

The third step toward uniform zoning within the watershed is to pass the draft ordinances within the necessary jurisdictions and enforce their application. This will take considerable political will, but will be successful if the initial education and information step is well-implemented and sustained.

The Chocolay River Watershed serves its human residents well. But, in order for future generations to enjoy all of the opportunities and free services that the watershed can provide, steps outlined in this adaptive plan must be taken. It may seem slow at first, but considerable momentum already exists because of the hard work that has already occurred. The Chocolay River Watershed will enter the next millennium with a well-prepared and duly concerned human population ready to take up a rewarding stewardship responsibility.

Appendix

A

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Appendix

B

Chocolay River Watershed Completed Projects

Sediment Trap Installation and Maintenance

- West Branch Chocolay River 545/Township Hall property
  TRS: 46N, 24W, Sec. 22
  Township: West Branch
- West Branch Chocolay River Townhall Road
  TRS: 46N, 24W, Sec. 23
  Township: West Branch
- Cedar Creek Landowner: Zintman
  Street/Address: Co. Rd. 480
  TRS: 47N, 24W, Sec.18
  Township: Chocolay
- Chocolay River MDNR access site on M28
  TRS: 47N, 24W, Sec. 8
  Township: Chocolay
- MDNR Fish Hatchery
  TRS: 47N, 24W, Sec. 18
  Township: Chocolay
- Silver Creek
  US41
  TRS: 47N, 24W, Sec. 7
  Township: Chocolay
- West Branch Chocolay River
  West Branch Township Hall
  TRS: 46N, 24W, Sec. 22
  Township: West Branch
- Cedar Creek
  Below CR 480, on
  Zintman property
  TRS: 47N, 24W, Sec. 18
  Township: Chocolay
- Cherry Creek Trap
  TRS: 47N, 24W, Sec. 8
  Township: Chocolay
- KI Sawyer Trap / Silver Lead Creek
  TRS: 46N, 24W, Sec. 12
  Township: West Branch
- Chocolay Trap / Bahrman's with MDNR
  TRS: 46N, 24W, Sec. 12
  Township: West Branch

Immediate and Anticipated Benefits:
Catch instream sediment bedload and improve downstream aquatic habitat conditions.

Stream Crossing Replacement and Bank Stabilization

- County Road 545
  TRS: 46N, 24W, Sec. 23
  Township: West Branch

Immediate and Anticipated Benefits:
Control erosion, improve stream flow and enhance fish migration.

Concrete Dam Removal and Sediment Trap Installed

- Townhall Road
  TRS: 46N, 24W, Sec. 23
  Township: West Branch
- Dupra's on West Branch of the Chocolay River
  TRS: 46N, 24W, Sec. 23
  Township: West Branch

Immediate and Anticipated Benefits:
Restores stream conditions to natural state, improves habitat, flows restored, fish migration improved, erosion controlled, and sedimentation reduced.

Earthen Dam Removal and Sediment Trap Installed

- KI Sawyer AFB on West Branch of the Chocolay River
  TRS: 46N, 24W, Sec. 31
  Township: West Branch

Immediate and Anticipated Benefits:
See previous practice

Beaver Dam Removal

- East Branch of the Chocolay River
  TRS: 46N, 24W, Sec. 23
  Township: West Branch
- West Branch of the Chocolay River
  TRS: 46N, 24W, Sec. 14
  Township: West Branch
- Cherry Creek
  TRS: 47N, 24W, Sec. 8
  Township: Chocolay
- Silver Lead Creek
  TRS: 46N, 24W, Sec. 21
  Township: West Branch
- Nelson Creek
  Bahrman Property
  TRS: 46N, 23W, Sec. 20
  Township: Skandia

Immediate and Anticipated Benefits:
Original stream conditions restored, stream flow, temperature, and fish migration improved.

Bank Stabilization

- Beckman Road
  TRS: 46N, 24W, Sec. 13
  Township: West Branch
- Stream: Big Creek (Norby Creek)
  Landowner: Escanaba Paper Co.
  Street/Address: CR BFA off of Karen Rd.
  TRS: 46N, 24W, Sec. 6--S 1/2
  Township: West Branch
  Mead Paper 1997
- Betker's - Chocolay River
  TRS: 46N, 24W, Sec.14
  Township: West Branch
- Chocolay River
  Kristola property
  TRS: 46N, 24W, Sec. 13
  Township: West Branch
- Chocolay Township Marina
  TRS: 47N, 24W, Sec. 6
  Township: Chocolay
- Shimons - East Branch of the Chocolay River
  TRS: 46N, 24W, Sec. 23
  Township: West Branch
- Nelson Creek Anderson Site
  TRS: 46N, 23W, Sec.18
  Township: Skandia
- McDonald lower Chocolay
  TRS: 47N, 24W, Sec. 28
  Township: Chocolay
- Norby Creek logging site
  TRS: 46N, 24W, Sec. 7
  Township: West Branch
- Cherry Creek
  TRS: 46N, 24W, Sec. 6
  Township: Chocolay
  Completed:
- Silver Creek
  TRS: 47N, 25W, Sec. 14
  Township: Sands
- Bahrman Property
  TRS: 46N, 24W, Sec. 12
  Township: West Branch
- Beckman Road
  TRS: 46N, 24W, Sec. 14
  Township: West Branch

Immediate and Anticipated Benefits:
Stabilize bank, control erosion, improve habitat, decrease sedimentation.

Cattle Crossing

- Stream: Big Creek
  Landowner: Renee DeVooght
  Street/Address: Little Lake Road
  TRS: 47N, 24W, Sec. 28
  Township: West Branch
- Cherry Creek
  Landowner: Stenglein
  Street/Address: Hwy. 41
  TRS: 47N, 24W, Sec. 8
  Township: Chocolay

Immediate and Anticipated Benefits:
Stabilize and restore trampled banks. Control erosion and reduce sedimentation.

Cattle Exclusion/ Stabilizing Critical Area

- Bill DeVooght
  TRS: 46N, 24W, Sec,. 3
  Township: West Branch

Preventative/ Remedial Forestry BMP's

- Silver Creek
  Hurley property
  Street/Address: Silver Creek road
  TRS: 47N, 25W, Sec. 14
  Township: Sands
- Silver Creek headwaters
  Bradley logging site
  TRS: 47N, 25W, Sec. 15
  Township: Sands

Immediate and Anticipated Benefits:
Prevent sediment from entering stream.

Lined Channel with Diversions

- Cherry Creek
  Road Commission, DNR hatchery
  Street/Address: Cherry Creek Road (Co. Rd.551)
  TRS: 47N, 24W, Sec.18
  Township: Chocolay
- Silver Creek
  Road commission
  Street/Address: Silver Creek Road
  TRS: 47N, 25W, Sec. 11
  Township: Sands

Immediate and Anticipated Benefits:
Stabilize bank, control erosion, improve habitat, decrease sedimentation.

Paved Ditch Diversion and Rip-Rap

- Cedar Creek
  Landowner: unknown
  Street/Address: Cherry Cr. Rd South of CR 480
  TRS: 47N, 24W, Sec. 19-NW 1/4
  Township: Chocolay

Immediate and Anticipated Benefits:
Stabilize bank, control erosion, improve habitat, decrease sedimentation.

Rock Lined Channel with Geotextile

- Big Creek
  DeVooght property
  Street/Address: Little Lake Road
  TRS: 47N, 24W, Sec.33
  Township: West Branch
- Cherry Creek
  Landowner: unknown/unknown
  Street/Address: Apple Trail off of Ortman Rd.
  TRS: 47N, 24W, Sec. 18/17-N 1/2
  Township: Chocolay

Immediate and Anticipated Benefits:
Stabilize bank, control erosion, improve habitat, decrease sedimentation.

Stream Crossing Replacement and Rip-Rap
- Big Creek
  Baldwin property
  Street/Address: Off Karen Road
  TRS: 46N, 24W, Sec.5
  Township: West Branch

Immediate and Anticipated Benefits:
Stabilize bank, control erosion, improve habitat, decrease sedimentation.

Rip-Rap, Diversions, and Rock Lined Ditch
- Cherry Creek Rd. (Hatchery Hill)
  TRS: 47N, 24W, Sec. 18
  Township: Chocolay

Immediate and Anticipated Benefits:
Stabilize bank, control erosion, improve habitat, decrease sedimentation.

Culvert Replacement, Rip-Rap/Seeding
- Unnamed tributary/Sporley Lk.
  TRS: 46N, 24W, Sec. 31
  Township: West Branch

Immediate and Anticipated Benefits:
Control erosion and improve fish migration.

Culvert Removal and Stream Restoration
- KI Sawyer AFB (Peg St. crossing) on West Branch Chocolay River
  TRS: 45N, 25W, Sec. 1
  Township: Forsyth

Immediate and Anticipated Benefits:
Control erosion and improve fish migration.

Rip-Rap, Check Dams and Runoff Diversions
- Cedar Creek/Cherry Cr. Rd. crossing
  TRS: 47N, 24W, Sec. 19
  Township: Chocolay

Immediate and Anticipated Benefits:
Prevent sedimentation from entering into the stream and control erosion.

Rip-Rap Installation
- Kreiger Rd. Ditch
  TRS: 46N, 23W, Sec. 13 & 18
  Township: Skandia

Immediate and Anticipated Benefits:
Prevent sedimentation from entering into the stream and control erosion.

Rip-Rap, Diversions and Seeding
- Big Creek/Karen Rd. Crossing
  TRS: 47N, 24W, Sec. 32
  Chris Burnett’s property
  Township: West Branch

Immediate and Anticipated Benefits:
Prevent sediment from entering into the stream and control erosion.

Runoff Diversions
- Silver Creek Rd. near Silver Creek
  TRS: 47N, 25W, Sec. 11
  Township: Sands

Immediate and Anticipated Benefits:
Prevent sediment from entering into the stream and control erosion.

Stabilization-Seeding
- Hurley logging site
  TRS: 47N, 25W, Sec. 14
  Township: Sands

Immediate and Anticipated Benefits:
Control erosion on the site.

Native Grass Seeding
- Lower banks of the Chocolay
  Lakewood Lane/Main St.
  TRS: 47N, 24W, Sec. 6
  Township: Chocolay

Note: This practice did not take at this site.
Anticipated Benefits:
Control erosion on site.

Tree Planting and Grass Seeding

- McDonnells on the lower Chocolay
  TRS: 47N, 24W, Sec. 5
  Township: Chocolay
- KI Sawyer dam removal site
  TRS: 46N, 24W, Sec. 31
  Township: West Branch
- MDNR fishing site
  TRS: 47N, 24W, Sec. 8
  Township: Chocolay
  Note: Also painted fishing pier
  Work done with the Cedar Tree Institute.
- Lower Chocolay banks
  TRS: 47N, 24W, Sec. 6
  Township: Chocolay

<u>Immediate and Anticipated Benefits:</u>
Control erosion on site.

Storm Sewer Maintenance and Street Sweeping

- Silver Creek
  MDOT property
  Street/Address: Hwy 41
  TRS: 47N, 24W, Sec. 6 & 7
  Township: Chocolay

<u>Immediate and Anticipated Benefits:</u>
Prevent road sediment from entering into Silver Creek and to protect habitat.

Storm Drain Stenciling

- Along US41
  TRS: 47N, 24W, Sec. 7
  Township: Chocolay
  Completed:
- 3rd Street, Marquette
  TRS: 48N, 25W, Sec. 14 & 23
  City of Marquette

<u>Immediate and Anticipated Benefits:</u>
Help in the prevention of the dumping of hazardous compounds into Lake Superior by people and businesses along 3rd Street.

Stream Restoration

- Big Creek
  Baldwin and Burnett property
  Street/Address: Karen Road
  TRS: 46N, 24W, Sec. 5
  Township: West Branch
  Completed: 1.5 miles using volunteers

<u>Immediate and Anticipated Benefits:</u>
Restore original channel, improve aquatic habitat conditions and stream flow.

Adopt-A-Stream Program

- Silver Creek, US41 to M28
  TRS: 47N, 24W, Sec. 7 & 8
  Township: Chocolay

<u>Immediate and Anticipated Benefits:</u>
Educate children on the importance of keeping streams healthy and clean.

Stream Monitoring

- West Branch Chocolay River
  TRS: 46N, 24W, Sections 12, 13, 14, 20, 21, 22, 29, and 30
  Township: West Branch
- Big Creek
  TRS: 47N, 24W, Sec. 32 and 46N, 24W, Sec. 5
  Township: Chocolay
- Silver Creek
  TRS: 47n, 24W, Sec. 7
  Township: Chocolay

<u>Immediate and Anticipated Benefits:</u>
Documented improvements as a result of dam removals and other stream monitoring practices.

Abandoned Well Closure

- Golf Course
  Randy Gentz's Property
  TRS: 47N, 24W, Sec. 20
  Township: Chocolay
- Alpaca Farm - Avalon Farm
  TRS: 46N, 24W, Sec. 9
  Township: West Branch

<u>Immediate and Anticipated Benefits:</u>
Protect groundwater/drinking water and prevent unwanted runoff into abandoned well.

Groundwater and Surface Water Testing

- Baldwin's property on Big Creek
  TRS: 46n, 24W, Sec. 5
  Township: West Branch

<u>Immediate and Anticipated Benefits:</u>
Test for groundwater contamination from KI Sawyer Air Force Base. Results were negative.

Appendix

C

Watershed Restoration Action Cards

Appendix

D

Sample Project Newsletters

Appendix

E

Watershed Site Inventory