APPENDICES

Grand Traverse Bay Watershed Protection Plan

APPENDIX A

PLAN DEVELOPMENT PROCESS

APPENDIX A: PLAN DEVELOPMENT PROCESS

This Appendix includes information regarding the project steering committee, the planning process, our use of a website to disseminate information, and the public information and education strategy used during project.

Many tasks were conducted to develop the Grand Traverse Bay Watershed Protection Plan. Developing a protection plan for the 976-mi^2 watershed required a large amount of planning and cooperation among organizations, as well as compiling a large amount information into a single document. The following bulleted list highlights some of the key components of the plan development process.

- Steering Committee
  - A steering committee, comprised of local and statewide experts and interested citizens, was formed at the beginning of the project. This committee guided the project to completion and made key decision regarding findings and reporting information.
  - The committee met approximately every other month.
  - List of steering committee members (project vendors in bold):

    Sarah U'Ren, Anne Brasie, John Nelson, and Anne Hansen: The Watershed Center Grand Traverse Bay
    Greg Goudy: Michigan Department of Environmental Quality
    Jim Muratzki: Land Information Access Association
    Matt Heiman: Leelanau Conservancy
    Jim Haveman, Laura Keuhn: Conservation Resource Alliance
    Megan Olds, Viet Doan: Northwest Michigan Council of Governments
    Tom Wessels: Grand Traverse Regional Math, Science, and Technology Center
    Matt McDonough: Grand Traverse Regional Land Conservancy
    Gordon Hayward: Peninsula Twp. Planner
    Russ Adams: Silver Lake Association
    Mary Wilson, Patty O'Donnell: Grand Traverse Band of Ottawa and Chippewa Indians
    Steve Largent, Lew Coulter: Grand Traverse Conservation District
    Maureen Templeton: Grand Traverse County Drain Commissioner
    Tom Buss: Grand Traverse County Health Department
    Russ LaRowe: Kalkaska Conservation District
    Natasha Lapinski, Chris Grobbel: Ball Environmental Associates
    Tom Emling: MSU-North
    Barbara Nelson-Jameson: National Park Service
    Bob Cole: City of Traverse City, Department of Public Works
    Tom Kelly: Inland Seas Education Association
    Gerry Harsch: Garfield Township Planner
    John McKinney: MSU Sea Grant
    Bruce Knapp, Tom Adams, Buzz Long, Pepper Bromelmeier: Natural Resources Conservation Service
    Bryan Pijanowski: Purdue University (formerly of MSU)
- Project Website
  - As part of this project, the Watershed Center's website (www.gtbay.org) was extensively revamped in January 2003. It contains updated general information on The Watershed Center, as well as detailed information and data on the watershed as it was gathered and compiled for the project.

- The website also serves as a data repository for steering committee members; meeting notes and agendas, and project documents were posted for review by steering committee members.
- A calendar of events was also available for visitors to the website.

- Public Information and Education (I/E) Strategy

  To get the word out about the project and to generate public awareness regarding the Grand Traverse Bay watershed, an extensive information and education strategy was implemented throughout the project. The following items were used as either educational tools or as ways to gather information regarding stakeholders' opinions of threats to water quality, watershed goals, and desired uses.
  - Newsletters – a quarterly newsletter was printed and distributed to approximately 1,200 individuals outlining progress and projects pertaining to the plan.
  - Press Kit – A press kit containing general project and watershed information fact sheets was created.
  - Project Brochure – A simple brochure about The Watershed Center and the project was created. In addition, a simple flyer was created as a take-home piece for use at stakeholder meetings.
  - Bay Day – We hosted Bay Day in both June 2002 and June 2003, providing attendees with fun, interesting opportunities to learn about the watershed and the protection plan.
  - Regional Watershed Conference – We co-hosted a two-day conference in August 2003 to help educate regional government officials and others about watershed protection planning and other related issues, such as, water quality monitoring.
  - "Freshwater Focus: The State of the Watershed" – We produced a 16-page insert to the Record Eagle (c. 42,000) to educate area citizens about the plan and key issues that the plan will address including nutrients, sedimentation, land use and growth, etc. An additional 5,000 copies were printed for further distribution.
  - Household Survey – A survey was conducted by M-TEC Business Research Services, a division of Northwestern Michigan College, to determine what water quality issues area residents were concerned about, their level of knowledge on watershed issues and basic demographics.
  - Focus Groups – Conducted series of six business focus groups: agriculture, manufacturing, Grand Traverse County, Leelanau County, Antrim County, and Kalkaska County. Objective was to explore area business people/owners water quality concerns and ideas for protection, as well as perceived obstacles to natural resource protection. Report compiled by M-TEC Business Research Services of Northwestern Michigan College.
  - Friday Night Live – Had booth with project information at 3 downtown Traverse City "Friday Night Live" events (7/25, 8/1, 8/29)

- Stakeholder meetings

What	Where	When
Governmental and Public Stakeholder Meetings Meetings included: • presentation about the 319 Project • time for participants to share their water quality and pollutant concerns • handouts for participants to take back regarding general project information. *A partial summary of results of these meetings is in the Spring 2003 newsletter.*	Antrim County	Gov: 2/25/03 Pub: 4/10/03
	Grand Traverse County	Gov: 2/27/03 Pub: 4/28/03
	Kalkaska County	Gov: 3/4/03 Pub: 4/8/03
	Leelanau County	Gov: 3/6/03 Pub: 4/22/03
Other Stakeholder Meetings Meetings included a presentation explaining The Watershed Center and the Planning Project. Since the presentations were made at regular meetings of these organizations they were under time constraints and kept short.	TC Rotary Club	1/7/03
	TC Sunshine Rotary Club	1/8/03
	Three Lakes Association	5/12/03
	Elk Rapids Historical Society	4/24/03
	Northport Lions	6/11/03

APPENDIX B

PROJECT EVALUATION

APPENDIX B: PROJECT EVALUATION

An evaluation of the watershed protection planning process was completed by the Conservation Resource Alliance (CRA) during the mid- and final-project phases. CRA was subcontracted by The Watershed Center to conduct the evaluation using the "Seeking Signs of Success: A guided approach to more effective watershed programs" guidebook (Beyer et al. 2001).

The evaluation process involved tracking the progress and success of each of the project tasks outlined in the project work plan. CRA worked with the project steering committee to establish a task force to aid in the development of the evaluation process for the project. It was determined that goals and activities that needed to be completed to accomplish those goals should be developed for each task. The party accountable for each task was responsible for working with CRA to develop the goals and activities. CRA developed forms for evaluating progress towards reaching the goals and for retrieving general feedback (i.e.: project success and frustrations) from subcontractors and the steering committee at large. CRA worked with the steering committee to conduct an evaluation of the planning process at the mid-project point in November of 2002 and near project completion in November of 2003. The feedback was summarized, compiled into a report and presented to the steering committee by CRA.

The mid-project and final project evaluation reports and evaluation feedback questionnaire responses are available for review at The Watershed Center. The general findings from the mid-project evaluation indicated that progress was being made on all tasks, however complications with staff transition and the project contract at the start of the project resulted in some deviations from the project schedule. The Watershed Center worked closely with MDEQ to revise the project work plan and timetable to include an extension of one quarter. Participants felt that future proposals would benefit from inclusion of an advanced communications task to allow for set up prior to the first quarter of project activity. It was also decided that an evaluation strategy for the upcoming implementation phase of the watershed protection plan would be beneficial.

The final project evaluation indicated that all project tasks would be successfully completed and within schedule. A couple of project activities were dropped or revised due to change in the scope of a task. The biggest struggle in the final phase of the project was obtaining participation from the full steering committee for reviewing the draft portions of the watershed plan.

During the second year of the project, CRA worked with the steering committee to draft an evaluation strategy for the implementation phase of the watershed protection plan. The strategy discussed methods for tracking and evaluating the success of plan implementation. The plan can be reviewed in Section 7.2 of the Grand Traverse Bay Watershed Protection Plan.

APPENDIX C

FIELD ASSESSMENT OF THE GRAND TRAVERSE BAY SHORELINE

Grand Traverse Bay Watershed Planning Project

Field Assessment of the Grand Traverse Bay Shoreline

March 2003
The Watershed Center Grand Traverse Bay

Introduction

As part of the Grand Traverse Bay Watershed Planning Project, The Watershed Center (TWC) completed a shoreline inventory of the entire 132-mile shoreline of the Grand Traverse Bay. The Grand Traverse Baykeeper, John Nelson, along with TWC staff and local volunteers, walked and inventoried the bay's shoreline in order to assess the current conditions surrounding the bay.

"To have walked the 132 mile shoreline of Grand Traverse Bay was as much an adventure as it was a task. The magnificence of Grand Traverse Bay was exhibited on each of the thirty-two days needed to complete the survey," (John Nelson, Grand Traverse Baykeeper). "The process to inventory the shoreline competes in interest and importance with the actual data and information collected. Of the thirty-two days only eleven were walked solo. Over 13 very qualified volunteers offered their observations on the other twenty-one days."

John Nelson, Grand Traverse Baykeeper, on the Antrim County Shoreline.

Methods and Protocols

The development of the survey protocol began in Fall 2001 and consisted of the following activities:

- Christopher Wright (TWC), John McKinney (MSU Sea Grant), Pam Smith (Great Lakes Environmental Center), Anne Hansen (TWC) and John Nelson (TWC) walked the shoreline from the Leelanau Lighthouse to Northport Point and noted potential significant features to record. (October 2001)
- Doug Fuller (Tip of the Mitt Watershed Council) shared his experience, survey techniques, protocols and advice. (January 2002)
- Field survey forms from the Northwest Michigan Council of Governments (NWMCOG), Michigan Department of Environmental Quality (MDEQ) and the World Wildlife Federation as well as a historical shoreline classification study, completed by the Michigan State University (MSU) Department of Resource Development's Agricultural Experiment Station in 1958, were reviewed.
- Dr. Ted Cline, a local environmental activist and aerial photographer (now deceased), screened his aerial video of the Grand Traverse Bay shoreline and offered his advice. (January 2002)

- Advice and input was also solicited from the Grand Traverse Band of Ottawa and Chippewa Indians, Michigan Department of Natural Resources, The Grand Traverse Bay Monitoring Group, Inland Seas Education Association, and NWMCOG. (January and February 2002)

A draft feature inventory sheet was prepared and tested on two walks in early February 2002. The results were shared with the Project Steering Committee and a working inventory protocol was prepared. The first field trial with this protocol was in April 2002. This inventory protocol was then used with minor additions for the remainder of the survey (Appendix A).

The feature inventory field sheets were used in conjunction with 1992 series USGS digital ortho-quad aerial photographs. One hundred fourteen photos were used. Water levels of Lake Michigan were 579.2 ft in 1992 and 578.3 ft for most of the inventory. The level of the bay was 11 inches lower than the level when the photographs were taken.

The shoreline was divided into segments containing similar characteristics during the inventory. Features such as nearshore substrate (clay, sand, stones, rock, macrophytes, etc.), endangered and exotic plant species, streams, seeps, public access, human impact (shore hardening, beach alterations), and beach characteristics (sand/stone/rock, bluffs, dunes, wetland, beach width) were noted as either specific points or as general segment characteristics. A specific point was noted if it was only seen a few times along a segment, otherwise, if a feature was common it was noted as a segment characteristic. Features and beach segments were indicated by letters on the photos and keyed by letter on the inventory sheets.

The field data has been entered into a digital database and is available on the Internet at **www.gtbay.org**. The field notes, including the aerial photographs and field inventory sheets, are available for review at The Watershed Center.

The MSU Department of Resource Development's Agricultural Experiment Station completed a previous shoreline classification study in 1958. The results from this inventory were reviewed in detail for this summary. The shoreline in these reports was characterized by 10 shoretype descriptions. The descriptions of the physical characteristics of the shore are as valuable and accurate today as they were in 1958.

Example of Beach Dunes Along Old Mission Peninsula

For purposes of this summary of the shoreline features inventory, standard common sense definitions of beach, bluff, dunes, and upland dunes can be used. (Written definitions can be found in the glossaries of the 1958 MSU shoreline inventory reports and the MSU Department of Resource

Development's 1964 Water Bulletin #14 titled *Lake Terminology*, authored by C.R. Humphrys and J.O. Veatch.) "Nearshore" areas were observed from the water's edge and have variously been defined as the area of land from the water's edge to a depth of anywhere between 2 to 6 meters. Except for observations by kayak from the Leelanau Lighthouse to Northport Point, "nearshore" was from the water's edge to what could be visually observed offshore. For the most part, the inventory followed the wet beach. From time to time, the dry beach was investigated for particular points of interest.

For purposes of respecting riparian privacy, former Attorney General Frank J. Kelley's "1978 Opinion Number 5327" was studied. The 1966 notice by the Department of Conservation (now equivalent to the MDNR) titled "Riparian Rights and the Public Trust in Michigan Public Lakes and Streams" as well as the passage "Basic Law for Shore Users" in Walter J. Hoggman's Field Guide to Great Lakes Coastal Plants were also read. We encountered only great curiosity and support for our effort from people we met along the shoreline.

Great Blue Heron – Antrim County Shoreline

Shoreline Features Summary

Leelanau Lighthouse to Traverse City – West Side

Lighthouse to Cherry Home (Figure 1)

Stones and rock covered a gradual nearshore and dry beach from the lighthouse to the northern limit of the Cherry Home (Figure 1, Point A) residential area. The upland was natural and much of it was parkland. The shore along the Cherry Home area was a mix of sand, stones, and rock with the rock and stones dominating nearshore. Zebra mussel shells were found in abundance on shore. Also thick layers of decaying algae were encountered. This stretch is 100% developed with cultured and natural upland. Some shore hardening exists as many homes are close to eroding banks.

Cherry Home to Northport Point (Figure 1)

South of Cherry Home two beautiful crescent sand beaches exist. Wide sand beaches with upland dunes run for a mile to Northport Point. These beaches are very natural with most development set back in the upland dunes and woodlands. An extensive rocky reef separates the beaches. With the low water levels a bermed beach has developed in some areas with emergent wetlands forming upland from the berm. Northport Point shoreline is highly developed. It is an old summer colony dating to the 1930's. Beautiful old cottages sit side by side with expansive new summer homes. The beach is mostly rock and stone with one small crescent beach tucked in between Stoney Point and Northport Point. The nearshore is also mostly rock and stone. The upland is cultured in a way that compliments the natural beach. Milfoil was significant on the west shore of the Point.

Northport Point to Village of Northport (Figure 1)

The shoreline into the Village of Northport is mostly rock and stone on the beach and nearshore. Two exceptions are Hall's Bay beach (Figure 1, Point B) and the half-mile long beach at the "bight" (a curve or bend in a beach shoreline). These beaches are gradual sand beaches with sandy, barred nearshore areas. The stony, rock beaches are highly vegetated with sedges, rushes and common shore grasses and plants.

From the "bight" to Northport Village the shore is mostly developed with cottages and homes and two marinas. Major seeps and small streams exist along Northshore Drive, draining wetlands to the west. One drains Woolsey Lake (Figure 1, Point C), or Mud Lake, and another empties into Hall's Bay. Northport Village hosts a full service marina, two small public sand beaches and riparian homes. The beaches in the village are mostly sand, as is the nearshore. Northport Creek enters the bay at the marina in town. A number of stormdrains discharging into the bay exist in the village as well. Several small streams exist between the Leelanau Lighthouse and the Village of Northport.

Village of Northport to Ingalls Bay (Figure 1)

The shoreline from the Village of Northport to Ingalls Bay (Figure 1, Point D) is very much developed. The nearshore is mostly stone and rock, as is the dry beach area. There are several small pocket sand beaches, and a half mile sand beach with adjacent sandy nearshore south of Ennis Creek (Figure 1, Point E). This shoreline has many small streams and extensive groundwater seeps entering the bay. Three private marinas exist with many small dredged basins

in the nearshore. Numerous small groins exist along with many attempts to harden the shoreline with rock or seawalls. Ennis Creek is the most significant stream entering the bay south of Timber Shores. Along this stretch of shoreline there are occasional 5 to 10 foot bluffs. Ingalls Bay is a north facing sand beach with sandy nearshore. It is a gradual beach with a natural upland and a good number of cottages.

Ingalls Bay to Village of Omena (Figure 1)

From Ingalls Bay to the Village of Omena the nearshore is mostly stones and rock with one small sandy nearshore area. The dry beaches are a mix of stone, sand and rock. A 5 – 10 foot bluff exists along much of the west shore of Omena Point. The upland is highly developed with cottages and homes. Similar to the shoreline north of Ingalls Bay, several private marinas and many small dredged areas are located along this shoreline area as well. Much shore hardening exists, mostly of rock but several major steel seawalls. Several spots containing groundwater seeps occur on the east shore of Omena Point. The residents of the Village of Omena enjoy a beautiful sand beach with a sandy nearshore. Several stormwater discharge pipes move water under M-22 to the bay. The village also houses a small private marina.

Village of Omena to Sutton's Bay (Figure 1 and 2)

Just south of the Village of Omena is a small sand beach with barred sandy nearshore. Weaver Creek (Figure 1, Pont G) enters at this beach. From this sand beach to Belanger Creek (Figure 1, Point H), which enters just south of McKeese Road, the dry beach is composed of stone and rock and is narrow with many small streams and groundwater seeps. Much of the shoreline in this area belongs to the Grand Traverse Band of Ottawa and Chippewa Indians. It is mostly a natural upland with a few homes near the shore and one marina (the Art Duhamal Marina) that services the tribe. The nearshore is comprised mostly of stones and rock.

The nearshore from Belanger Creek to Sutton's Bay is mostly stones with a little sand. The beach is narrow with a stone and sand mix. Several small streams and many groundwater seeps enter the bay along this shore. A dense mat of plant growth occurs where the seeps exist. This shoreline is heavily vegetated and the upland is very developed. Some shore hardening and groin building exists. Heavy shore hardening with rocks occurs where M-22 is adjacent to the shoreline. In addition, there are numerous stormwater discharge pipes crossing the road.

Example of a Groundwater Seep Entering the Bay

Village of Sutton's Bay (Figure 2)

A private marina has been built north of Sutton's Bay Village with significant shore impact. The upland is very cultured in this development. Sutton's Bay has developed a large boat access and parking lot at the junction of M-22 and M-204. Residents of the village also enjoy a public marina and sandy public bathing beach. Sutton's Bay Creek (Figure 2, Point A) enters the bay at the marina and has exhibited high *E.Coli* counts (Monitoring Results from The Watershed Center: Fall 2002-Summer 2003). Several stormwater pipes drain runoff from the village directly to the bay. The Inland Seas Education Association is located on the shoreline just south of the Sutton's Bay marina. Their educational schooner, *Inland Seas*, is docked on a private pier.

Village of Sutton's Bay to Stoney and Lee Points (Figure 2)

South and east of Sutton's Bay Village the beach and nearshore area are both sandy. This area is highly developed and cultured above the beach. Leo Creek also enters along this beach. The nearshore substrate quickly becomes more stone north to Stoney Point. The dry beach is narrow and combines stones and sand. The upland is developed with some open areas and upland farms. Stoney Point Road is adjacent to the shore for a long stretch. Several smaller streams enter the bay on this shoreline. The north end of Stoney Point has a wide, gradual stone and rock beach with stone and rock substrate nearshore. The houses are set back in the woods. Significant beach altering was done along the north end of Stoney Point. From Vic Steimal Park (Figure 2, Point B) to the road end of Nanagosa Trail the dry beach is mostly narrow and consists of stones with a little sand. There are very significant, thick layers of decaying algae in many areas. Many homes exist above the low bluff. There are also several small streams and significant groundwater seeps occurring. Sixty to seventy foot bluffs occur along the beach south of the end of Nanagosa Trail. This beach is very narrow. The bluffs are mostly clay, and groundwater seeps occur along the beach. The beach and nearshore substrate is mostly stones with areas of silt and sand. Thick clay, silt areas exist along the beach below eroded the bluffs. Homes have been built above the bluffs. The bluff tapers down to Lee Point.

Example of a Clay/Silt Beach Area

At Lee Point the dry beach widens and becomes sandier. The nearshore is a stony, sand mix. Lee Point has a very wide sand, pebble beach with a developed but natural upland. The beach from Lee Point to M-22 is sandy with a nearshore sand substrate. The beach is gradual up to a developed upland that is a mix of natural and cultured. A small bluff exists, above which is Lee Point Road. Homes here are built across the road from the beach. Several culverts under the road drain the wet areas from the north. Emergent wetlands are extensive on a bermed beach.

Lee Point to Cedar Creek (Figure 2)

From the Lee Point Road intersection with M-22 the beach can be generalized to Cedar Creek (Figure 2, Point C) in Elmwood Township. M-22 dominates the upland area. The highway is frequently adjacent to the shoreline. When development occurs between the highway and the shoreline, it usually is on a narrow lot. The dry beach is, for the most part, a mix of stones and sand. It is narrow, often with a 5 – 10 foot bluff above the beach. The beach is highly vegetated with emergent wetlands growing along much of the shore. Several small streams and groundwater seeps exist. There are also many groins, seawalls and rock erosion barriers. The shoreline here is developed to its maximum.

Where M-22 is next to the shoreline, heavy rock riprap along with stormwater discharge pipes and culverts are evident. There are three DNR scenic turnouts, discharging stormwater to the bay from paved surfaces. One sand beach exists with sandy nearshore just north of Crain Hill Road. There are areas of significant, thick layers of decaying organic matter, as seen near the DNR scenic turnout near Crain Hill Road. The nearshore substrate is mostly stones and rock with a little sand and silt.

Cedar Creek to M-72 (Traverse City – West Side) (Figure 3)

Near Cedar Creek (Figure 3, Point A) to the Harbor West (Figure 3, Point B) breakwall the dry beach is sandy and wide. A mat of decaying organic matter was in the water over a sandy, stony nearshore substrate.

From the Harbor West breakwall to M-72 the shoreline is highly modified by man. Marinas, dredged areas, piers, and public beaches are all located on a beach that naturally would be similar to that north of Sutton's Bay. Brewer's Creek (Figure 3, Point C) is the significant stream entering the bay near Elmwood Marina (Figure 3, Point D).

The shoreline from Northport Village to Traverse City is vegetated with sedges, rushes, grasses and other common shoreline plants whenever the stones and rock predominate. Where sand is the dry beach and nearshore substrate emergent wetlands appear when a berm is created at the water's edge.

Traverse City – West Side (Figure 3)

A significant stream enters the bay at M-72 and is culverted under the road. The dry beach from M-72 to the Traverse City Light and Power Plant (Figure 3, Point E) is sandy and varying in width. It is public land with public beaches and parking areas (West End Beach – Figure 3, Point F). The nearshore is a gradual sandy substrate. Grandview Parkway is adjacent upland and is armored with riprap in several spots. Three stormwater culverts empty into the bay along this area.

The Clinch Park Marina and Open Space (Figure 3, Points G & H) are located to the west of the Clinch Park public beach area. The shoreline along this area has significant shore hardening with concrete and large rip-rap. The Boardman River (Figure 3, Point I) empties into the bay just east of Clinch Park. The dry beach and nearshore are gradual in gradient and are sandy to Bryant Park (Figure 3, Point J) at the southwest corner of West Bay. The Maritime Academy Marina is a major dredged harbor on this stretch, with single-family homes located on sandy beaches between the Academy and Bryant Park. Two stormwater discharge culverts empty to the bay between the Maritime Academy Marina and Bryant Park. The entire section of the West Bay shoreline located in Traverse City is generous in its public access to this extraordinarily beautiful sandy beach shoreline.

Clinch Park Marina – aerial shot

Old Mission Peninsula

Traverse City – West Side to Bower's Harbor (Figure 3)

The shoreline of Old Mission Peninsula to Bower's Harbor, approximately eleven miles, is fairly uniform. Peninsula Drive runs adjacent to the beach. The shoreline is heavily developed with homes mostly located on the other side Peninsula Drive, but many have been built between the road and the beach. There are new homes being built on very marginal land on the waterside of the road that have the potential to impact the bay. The dry beach is, for the most part, narrow from the water's edge to a 5 – 15 foot bluff. This Nipissing Bluff is an ancient wave cut beach. The dry beach is a mix of sand and stones with much of this shoreline exhibiting vegetative growth of sedges, bulrushes, grasses and other common shoreline plants. There are numerous groins and small dredged areas where rocks have been pushed aside. The nearshore substrate is mostly stones and small rocks. There were several pockets of decaying organic mats observed. This shoreline is heavily developed. Several small streams and numerous groundwater seeps were observed.

Bower's Harbor to Old Mission Point

A private marina is in Bower's Harbor with a DNR boat launch adjacent to it. The dry beach that extends about one half-mile west is a wide, gradual sandy beach with emergent wetlands where a berm has been created by wave action. The nearshore is a gradual sand substrate. The upland on the beach is natural and cultured with many cottages. From this beach to Neahtawanta Point the dry beach narrows and the Nipissing Bluff reappears. The dry beach is a mix of sand and stones and is heavily vegetated with extensive emergent wetland. The upland is natural bluff with homes set back from the bluff. From Neahtawanta Point to Old Mission Lighthouse the shoreline is much less developed. The dry beach widens and is for the most part

a mix of sand and stones. The Nipissing Bluff parallels the shore at various elevations the whole length this shoreline. The nearshore area is composed of mostly stones and rock with some sand. Human impact on the beach is limited with a few spots of shore hardening where the beach narrows. M-37 abuts the shoreline for a substantial distance near Old Mission Point and is hardened with riprap. Old Mission Point is largely public access land and shoreline with a township and state park.

Old Mission Point to Haserot Point and Old Mission Harbor (Figure 3)

The shoreline from Old Mission Point to Haserot Point (Figure 3, Point K) is very natural and undeveloped. The dry beach is wide and gradual with mostly stones, rock and some sand. The nearshore substrate is stones and rock with a gradual slope to deeper water. The dry beach is vegetated with grasses and some emergent wetland plants. The Nipissing Bluff is present on the upland at varying heights for the entire shoreline and is quite steep and high at Haserot Point. Some bluffs are up to 30 feet in height.

From Haserot Point around Old Mission Harbor the dry beach is a mix of sand and stones with a beautiful, sand beach at the Township Park. The nearshore is a gradual substrate of stones and sand. Several hundred yards of the North end of the harbor is hardened with brick and steel seawall.

Old Mission Harbor to Traverse City – East Side (Figure 3)

The shoreline from Haserot Park in Old Mission Harbor to the East Bay Park Beach (Figure 3, Point L) in Traverse City can be summarized by a general description. The Nipissing Bluff is present along most of the fifteen-mile shore at varying heights, usually 5 to 15 feet. The nearshore is primarily stones and rock with little sand. Some pocket sand beaches do exist. The dry beach is narrow and mostly stones with some sand. This shore is very much developed with homes above the bluff or across the road when the road is adjacent to the shore. There is significant shore hardening, small dredged areas, and numerous groins. Much of the beach is vegetated. Just north of Bluff Road heavy beach erosion control efforts (rock riprap) have occurred below a 30-foot bluff.

Example of shore hardening using large rock rip-rap.

Traverse City – East Side to Eastport

East Bay Park to Mitchell Creek and the State Park (Figure 4)

The dry beach from the East Bay Park (Figure 4, Point A) to the southeastern corner of East Bay is a sandy, 25 - 100 foot wide gradual beach. US-31 parallels the beach with heavy developed property between the road and beach. This “miracle mile” is some of the most valuable real estate in the region. The value in 2003 of $7000 per front foot is quite high when compared with the “up to $100 per front foot” noted in 1958 (MSU historical shoreline inventory). The nearshore in this area is a gradual, barred, sandy substrate. Three major

stormwater discharge pipes are located at the west end of the beach. The Traverse City State Park (Figure 4, Point B) occupies about a quarter mile of this beach. Commercial and residential land uses share the beach with commercial use replacing residential where zoning allows. The southeast end of the beach has been built on fill over the years and the nearshore is shallow for several hundred yards from the water's edge. Emergent wetlands are lush and numerous here. Mitchell Creek (Figure 4, Point C) enters the bay just west of the State Park.

Mitchell Creek to Acme Creek (Figure 4)

A relatively overlooked small watershed is that of Baker's Creek (Figure 4, Point D), which drains the wetlands in the southeast corner of East Bay. Significant layers of decaying organic matter were observed on the southeastern corner of East Bay as well. US-31 dominates the shoreline for a mile north from the foot of the bay. The dry beach is narrow to non-existent with heavy riprap protecting the road bank. Two streams are culverted under the road. The nearshore is mostly stones and rock. The shoreline through the Village of Acme is heavily developed with commercial establishments. The dry beach is narrow and a mix of sand and stones. The nearshore is mostly sand and stones. The dry beach exhibits many emergent wetland areas. There is a DNR Roadside Park (Figure 4, Point E) and a private commercial marina. As in most marinas, milfoil and other macrophytes are numerous. There are several rock and steel seawalls. The beach to the north end of the village is where Acme Creek (Figure 4, Point F) enters the bay.

Acme Creek to Deepwater Point (Figure 4)

The beach from Acme Creek north has been kept relatively natural up to the Deepwater Point Nature Preserve. Along this stretch the dry beach is wide, gradual and primarily stones and sand. Homes above the beach exhibit cultured and natural settings. Significant milfoil was observed on the beach. The nearshore is mostly stones and drops off sharply to deep water.

Deepwater Point to Ptobego Natural Area (Figure 4)

The dry beach north of Deepwater Point is wide and gradual. A bluff arises and the developed land is set back from the beach or is above the bluff. The beach is very natural and is mostly sand with some stones. The nearshore is also sand with some stones. The shoreline along this area has many points (projections of land into the water). At each point, the sand gives way to more stones and extends in to the water to stony reefs.

Ptobego Creek and Pond Natural Area – aerial shot

This shoreline type continues to the Ptobego Natural Area (Figure 4, Point G). Yuba Creek (Figure 4, Point H) enters the bay on this shoreline. There are significant groundwater seeps to the bay along the shoreline as well. The Ptobego mile stretch of shoreline is a spectacular example of a

natural Lake Michigan shoreline. It is a wide, gradual, sandy, dry beach with both beach and upland dunes. The nearshore is a mix of sand and stones. Ptobego Creek (Figure 4, Point I) empties into the bay here.

Ptobego Natural Area to the Village of Elk Rapids (Figure 4)

The human impact on the shoreline from Acme Creek to Elk Rapids is minimal, probably because of the westerly winds, unprotected shoreline, and dynamic nature of the natural beach. From the Ptobego Natural Area to the Village of Elk Rapids the dry beach narrows to 25 – 100 feet. It is mostly sand with stones and rock. The beach gradually blends to the upland, which is developed to Elk Rapids. The nearshore is a mix of stones and sand. A fair amount of macrophytic growth occurs on the nearshore substrate. Emergent wetlands occur where a berm has formed but are not extensive.

The Village of Elk Rapids has, as do other urban areas, a diverse developed shoreline. Several public parks and open areas exist. A public marina is available which has been recently dredged. Three stormwater discharge pipes service the village. Milfoil and other macrophytes grow in the marina. The Elk River carries some 60% of the total surface water input to Grand Traverse Bay at Elk Rapids Village.

Village of Elk Rapids to Norwood (Figure 4, 5)

North of Elk Rapids the dry beach varies in width, usually 25 – 100 feet. The dry beach is sand and some stones and the nearshore substrate is comprised of stones with sand. An upland bluff that varies from 5 – 15 feet characterizes the shoreline. When the beach widens, beach dunes covered with beach grass and upland dunes occur. Development is residential homes and cottages. The development is consistent along the shore of Antrim County and is broken up by conserved land and public parks. Where development occurs, some dredging, groin building and shore hardening has occurred, especially on the narrow beach stretches, but not nearly as intense as on the Leelanau County side or the shoreline of Old Mission Peninsula. One private, dredged marina was observed along with one community, west of Williams Drive, that had a dredged harbor prohibiting access along the shoreline. Where a berm was created by the wave action, emergent wetlands occurred.

Twenty-four small streams were observed from Elk Rapids to Norwood. Many groundwater seeps were observed as well. The most interesting and beautiful seeps were observed north of Eastport seeping from the blue Antrim Shale Bluffs. Significant layers of decaying organic matter, chara, and chladophera were observed when caught on the lee side of reef points.

Close-Up of Antrim (Blue) Shale Bluff

North of Eastport to Norwood the beach narrows and becomes more stones than sand. The most unique observations of the whole shoreline inventory are the areas of exposed Antrim shale. The blue shale bluffs, the shale fragments on the beach and the layers of blue shale extending into the lake substrate were very impressive.

Power Island (Figure 6)

The last segment of the shoreline inventoried was Power Island in June 2003. Power Island, located in the central portion of West Grand Traverse Bay, is a public preserve owned and operated by Grand Traverse County. The shoreline of Power Island is a natural shoreline, which includes examples of many of the natural shore types surrounding Grand Traverse Bay.

From the public dock, located on the southeast side of the island, south to the middle of the southern shore, the nearshore is a mixture of sand and stones, as is the beach. The upland is natural with public picnic areas. The western end of the south shore has a mixture of stones and clay on the nearshore and beach areas with a 20-40 foot bluff to the upland. The western shoreline exhibits large rocks and stones both in the nearshore and on the beach. A 20-foot bluff runs above the beach for about 2/3 of the length of the western shoreline.

The north 1/3 of the island is low and flat with upland wetlands. These wetlands output groundwater into the bay in small streams and seeps. Some ephemeral ponds exist on the beach and emergent wetlands are found along most of this shoreline.

Bassett Island is connected to Power Island at the northeast tip. The beach and nearshore in this area is low, flat, and gradual with a mix of clay and stones. Except for the eastern shore near the public dock the nearshore is shallow shoal water. Near the public dock the nearshore drops off to deep water close to shore.

Endangered and Exotic Species

Exotic species observed during the shoreline inventory included purple loosestrife and zebra mussels. Purple loosestrife grows extensively along the shoreline. It mostly occurs where it is sheltered from direct wave action and on stony, rocky substrate. It may also occur on sandy substrate, although not as common, as demonstrated at the foot of West Bay and along the Boardman River. With relatively low lake levels, purple loosestrife has taken hold in some of the emergent wetland areas.

Purple Loosestrife

Zebra mussel shells were observed on the shoreline throughout much of the survey. Most shells were observed north of the 45-degree parallel. Some windrows of shells three feet deep were observed north of Northport and on the western side of Old Mission Peninsula.

Zebra Mussels

Pitcher thistle was the only endangered plant species observed and was found at one location north of Northport on the Leelanau Peninsula and at several locations north of the Village of Elk Rapids to Eastport.

Pitcher's Thistle

Other Areas of Concern

The areas of decaying detritus and organic matter (where the layers were of concern to riparian owners) occurred mostly on the Leelanau side of the bay. Some layers were 2 to 3 feet thick and resembled septage. Where the layers could be identified, the macrophytes were chara and chladophera.

Additional Inventory of Selected Tributaries

The Grand Traverse Baykeeper walked and explored four sub-watersheds. The Woolsey Lake (Figure 1) outlet was explored to its mouth at Seven Pines Road on the bay. The lake and much of its surrounding land is protected with conservation easements or public lands. The outlet of Woolsey Lake consists of a wetland complex that flows into the bay at Seven Pines Road.

Phil von Voigtlander of Northport hosted a walk from the mouth of Northport Creek (Figure 1, Point I) to its headwaters in the wetlands and springs off of Johnson Road. Phil and his neighbors have protected these headwaters with conservation easements. Northport Creek winds its way through woodland and fields to the Village of Northport where it finds its way to an old Mill Pond and then to the marina at its mouth. The hospital in Northport has a National Pollutant Discharge Elimination System (NPDES) permit to discharge wastewater into the Creek. The Village of Northport is also actively discussing wastewater issues in the village where only septic tanks handle wastewater.

Kid's Creek was walked with Sarah U'Ren from its headwaters to its entry into the Boardman River (Figure 3) in Traverse City. Kid's Creek is now an urban stream surrounded and encroached upon by development. Eroded stream banks and sedimentation impair the lower stream. Extensive wetlands remain adjacent to this stream and should be protected. There is an effort by Garfield Township, private sector interests, and non-profit organizations to restore and repair the impacted and impaired portions of Kid's Creek.

Larry Quimby hosted a walk of Baker Creek (Figure 4) that flows into East Bay at its southeast corner. This starts off as a small stream that drains from the high uplands to the South and East. The wetlands just south of US-31 are exquisite and deserve protective attention. These wetlands are under intense development pressure and are only a few hundred yards from East Bay.

Summary

In 1958 the MSU Department of Resource Development's Agricultural Experiment Station completed a similar shoreline inventory for Leelanau, Grand Traverse, and Antrim Counties (Humphrys et al. 1958) that identified 'shoretypes' in each county. The shoreline in these reports was characterized by 10 descriptive categories: location, length, access, use, erosion, services, upland, bluff, and dry beach and wet beach. For Leelanau County eleven shoretypes were identified and characterized. Grand Traverse County had four shoretypes and Antrim County only one.

The shoreline inventory that was completed for the Grand Traverse Bay Watershed Planning Project is much more detailed in its field observations than the 1958 MSU study. However, the general shoreline character remains essentially similar to 1958. The changes are mostly due to increased use and human impact. A significant increase in shore hardening is evident. The building of groins and the "creation" of beaches by moving the stones into groins is another significant change. Marinas have been constructed, both public and private, with their associated dredging. With lower water levels and increasing development along shoreline areas consisting of rock and stones or coastal wetlands, there is now evidence of activity to alter the shoreline to accommodate riparian landowner desires.

The upland lots along the Leelanau shoreline are close to 100% developed, meaning there is some sort of home or business along the entire shoreline. The shoreline itself has various degrees of human disturbance, with some areas left natural. If hardening, groins, and beach altering are included in the disturbance category, certainly more than half of the shoreline would be considered disturbed.

The Old Mission Peninsula shoreline is much the same as the Leelanau. From Bowers Harbor south to Traverse City, the human impact is much more significant, probably close to 80% disturbed. The East shoreline of the Old Mission Peninsula from Old Mission Harbor south is similarly disturbed. The Antrim shoreline is the least disturbed as it is open to the westerly wind effect of Lake Michigan.

Based on anecdotal evidence from the Inland Seas Education Association and the Leelanau Conservancy, as well as from riparian owners along the bay, there appears to be a significant increase in algae growth on benthic substrates in the bay over the past 10 years. A kayak trip taken by the Baykeeper in July 2003 just north of Northport Point and in Northport Point Bay in the nearshore area revealed observations of significant carpets (or mats) of cladophora and chara growing on the substrate, especially in water deeper than 3 meters, where wave action has less of an effect. These mats are extensive, covering most of the substrate along this shoreline. When these algal mats break loose from the bottom, they create large areas of rotting organic matter on shore, in some areas a half-meter thick and extending two to three meters off shore. Causes are probably numerous, interconnected, and complex. Zebra mussels have filtered the lake water, increasing clarity and allowing light to penetrate deeper. The increased nutrients carried to the benthic layers by the zebra mussels' filter activity have effectively fertilized the benthos of the bay. The increased growth shows up as increased decaying organic matter on the shoreline.

Over one hundred small streams were observed flowing into the bay; a list of these is found in Appendix B (Figure 7). Each stream is very important to those who live near it and cumulatively important to the health of the Grand Traverse Bay. Anecdotally, these small watersheds are under intense pressure from human activity and development. They must be protected. A minimum 25-foot setback and true riparian buffer could be established to protect these streams with little impact on the development rights of the landowner. Impairments of these streams are an impairment of the bay, by small incremental acts. Protection of the riparian wetlands of the bay is equally important as is evidenced by the observed frequency of groundwater seepage into the bay. If taken cumulatively, the small streams and significant groundwater seeps are found on 70-80% of the shoreline (Figure 8).

Both land development as well as economic development place pressure on the need for small shoreline communities to properly dispose of their wastewater. The discharge of wastewater, from both failing septic systems and over-taxed treatment facilities, has the potential to dramatically degrade the water quality of the bay. Added nutrients from wastewater would increase the amount of algae and plants noted in the water, causing even more of an increase than what was noted in this survey. At this time, the Northport Point Cottage Owners' Association, the Village of Northport, and the Village of Sutton's Bay are actively pursuing solutions to their wastewater issues. However, this will continue to be an important issue for all communities along the 132-mile shoreline.

Intense development increases the amount of stormwater discharge to the bay, due to increases in impervious surfaces. Numerous stormwater discharge pipes were noted entering the bay in Traverse City, as well as significant increases in the amount of impervious surfaces covering land adjacent to the bay. Increases in impervious surfaces increase the amount of stormwater and runoff directly discharged to the bay. Stormwater may contain harmful pollutants and excessive amounts of nutrients, both of which may harm aquatic life and pose health risks. Because of this, stormwater management must be of the utmost concern for growing shoreline communities.

Conclusions

Grand Traverse Bay's shoreline remains a beautiful commons for all to treasure. Increasingly, however, this concept of a commons is being segmented into a parcel-by-parcel view of what each riparian owner envisions for the shore. Cumulatively this is shortsighted and damaging to the long-term integrity of the shoreline of the bay.

Of increasing concern is the altering of the shoreline as development occurs in the shoreline that traditionally has been less desirable for homes and cottages. These are the shoreline segments of stones, rocks and coastal wetlands or marshes. One good example is the southeast shore of the East Arm of Grand Traverse Bay. This shoreline is an integral part of the Traverse City complex of the Lake Michigan coastal wetlands, as described in Hoagman 1994. This complex comprises 184 acres of wetlands to include the Baker Creek watershed.

In the Traverse City wetland complex area, this shoreline inventory identifies six small streams and very significant groundwater seeps in an approximate one-mile stretch. The nearshore here is shallow to 1000 feet offshore, before reaching a depth of 6 feet. This shoreline's beach and nearshore feature the growth of Great Lake wetland plants such as rushes and sedges. Development pressure has begun to alter this shoreline, attempting to create "sandy" beaches. The other examples are where homes are built on a stone, rock beach and equipment is used to scrape the stony, rocky material to the side to, again, attempt to create a "sandy" beach.

The water-land interface of Lake Michigan, and in particular Grand Traverse Bay, is a very dynamic space. The shoreline changes from day-to-day, year-to-year, and decade-to-decade. We can observe this dynamic change. What human activity occurs on a small part of the shoreline affects the shoreline adjacent to it for long stretches. The cumulative effect of many shoreline-altering acts eventually affects the erosion, habitat, and water quality of the bay. If these alterations continue, the natural beauty of this resource will eventually be destroyed and we will all suffer its loss. The public must protect its right to oversee shoreline altering as proscribed by law.

"In the past many activities have been undertaken in these beach areas with little or no awareness of the dynamic, ever changing properties of a shoreline area. Use must be planned in accordance with the natural characteristics and natural changes; otherwise the user may expect problems that are not only unpleasant, but expensive," (MSU 1958 historical shoreline inventory).

Thanks to Volunteers

The Watershed Center wishes to thank the following volunteers who accompanied the Grand Traverse Baykeeper on shoreline inventory walks:

Cory Arsnoe – Antrim Conservation District
Anne Brasie – Executive Director, The Watershed Center
Mike De Agostino – Grand Traverse Resort & Spa
Jerry Dennis – Poet and Author
Anne Hansen – Office Manager, The Watershed Center
Cal Karr – Teacher
John McKinney – MSU Sea Grant
Melody Myers – Biologist, Grand Traverse Band of Ottawa and Chippewa
Larry Quimby – Resident of Baker Creek Watershed
Christine Sleeman – Biologist
Pam Smith – Botanist, Great Lakes Environmental Center
Sarah U'Ren – Project Coordinator, The Watershed Center
Phillip von Voigtlander – Northport Resident and Scientist
Heather Wilson – Antrim Conservation District
Christopher Wright – Doctoral Student, MSU Department of Agriculture

Transportation to Power Island provided by:
Jay Craft – Bay Breeze Yacht Charters
Matt Heiman – Leelanau Conservancy

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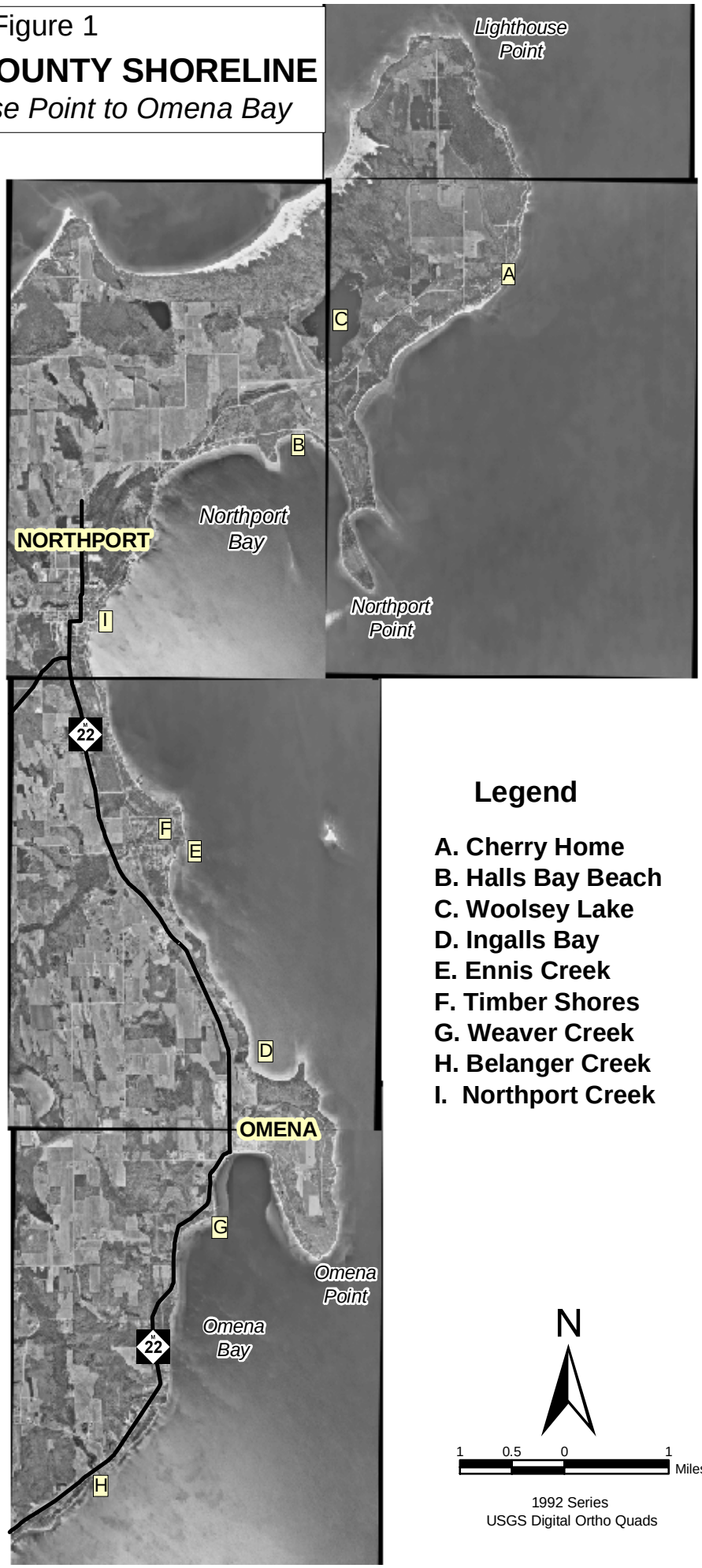
Figure 1

LEELANAU COUNTY SHORELINE

from Lighthouse Point to Omena Bay



Legend

A. Cherry Home
B. Halls Bay Beach
C. Woolsey Lake
D. Ingalls Bay
E. Ennis Creek
F. Timber Shores
G. Weaver Creek
H. Belanger Creek
I. Northport Creek

N

1 0.5 0 1 Miles

1992 Series
USGS Digital Ortho Quads

Figure 2

LEELANAU COUNTY SHORELINE

from Suttons Bay to Greilickville

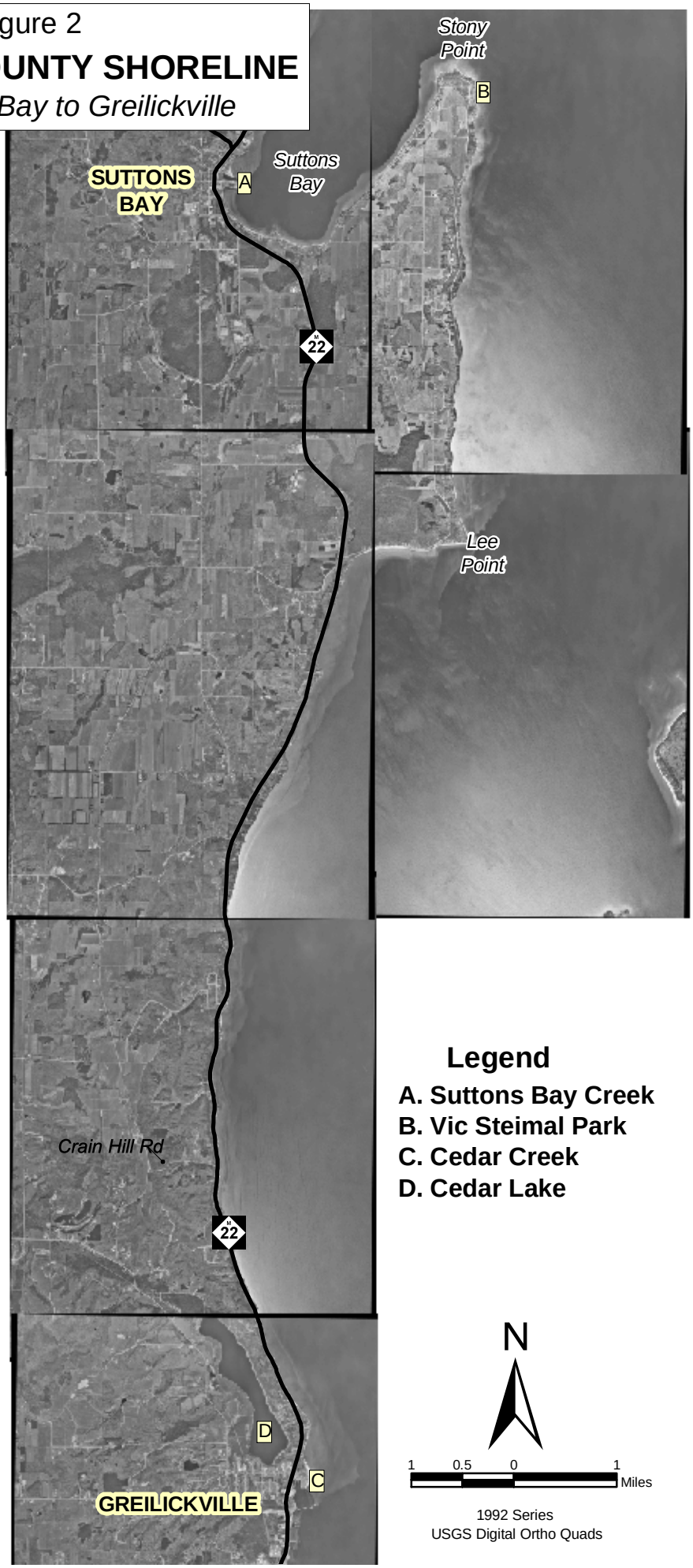


Figure 3

GRAND TRAVERSE COUNTY SHORELINE

Traverse City and Old Mission Peninsula

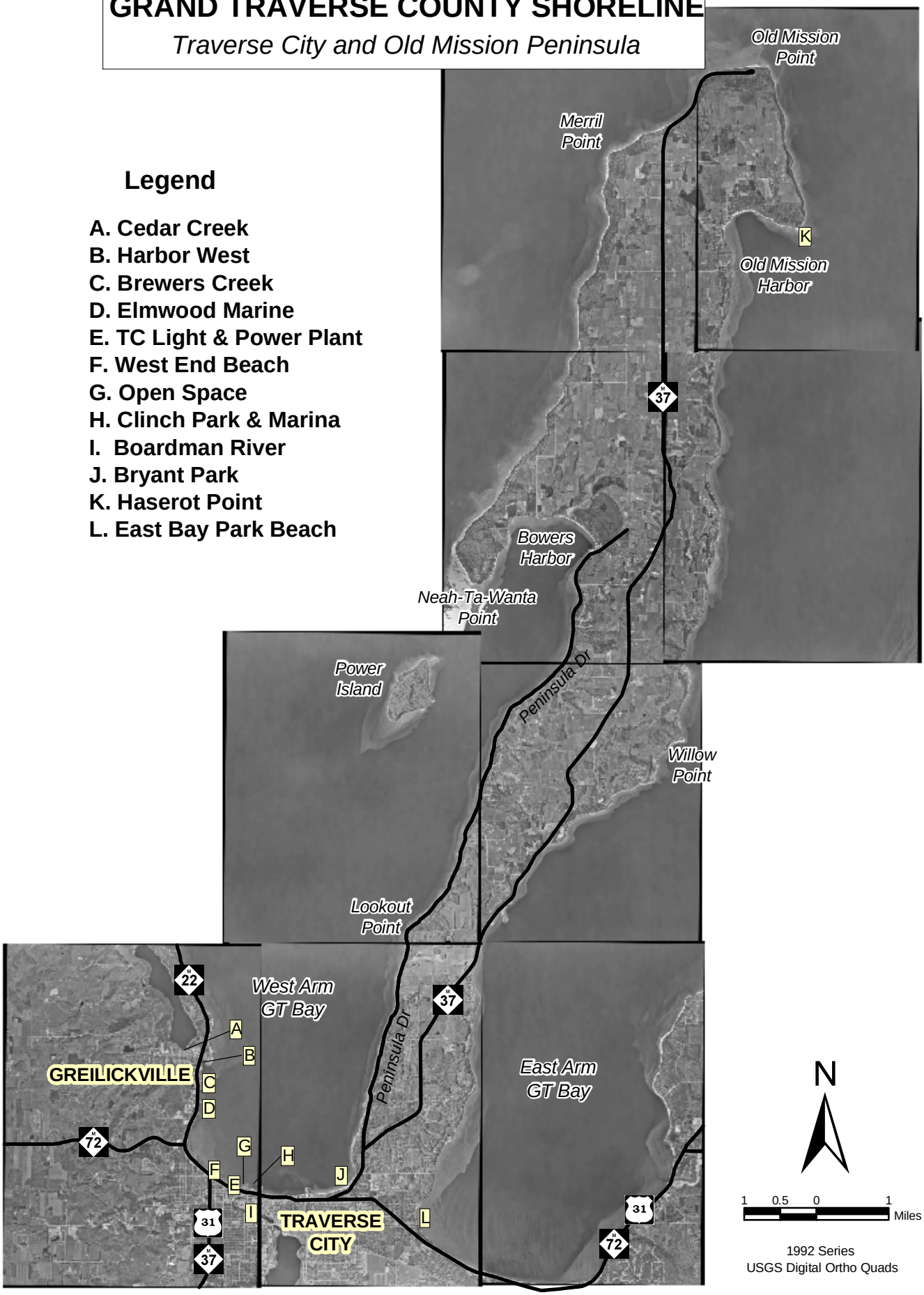


Figure 4

ANTRIM COUNTY SHORELINE

from Acme to north of Elk Rapids

Legend

A. East Bay Park Beach
B. TC State Park
C. Mitchell Creek
D. Baker's Creek
E. DNR Roadside Park
F. Acme Creek
G. Ptobego Natural Area
H. Yuba Creek
I. Ptobego Creek

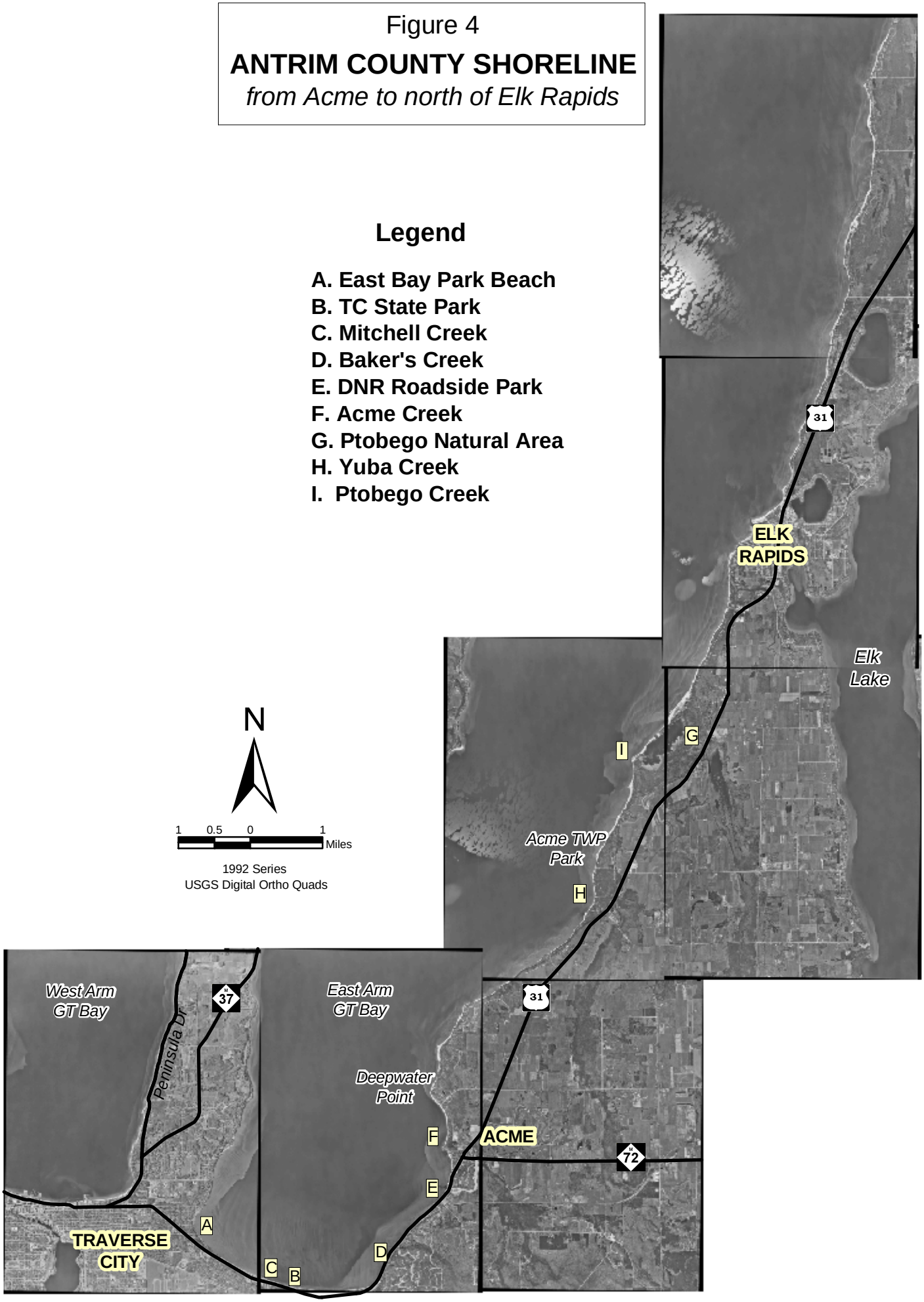
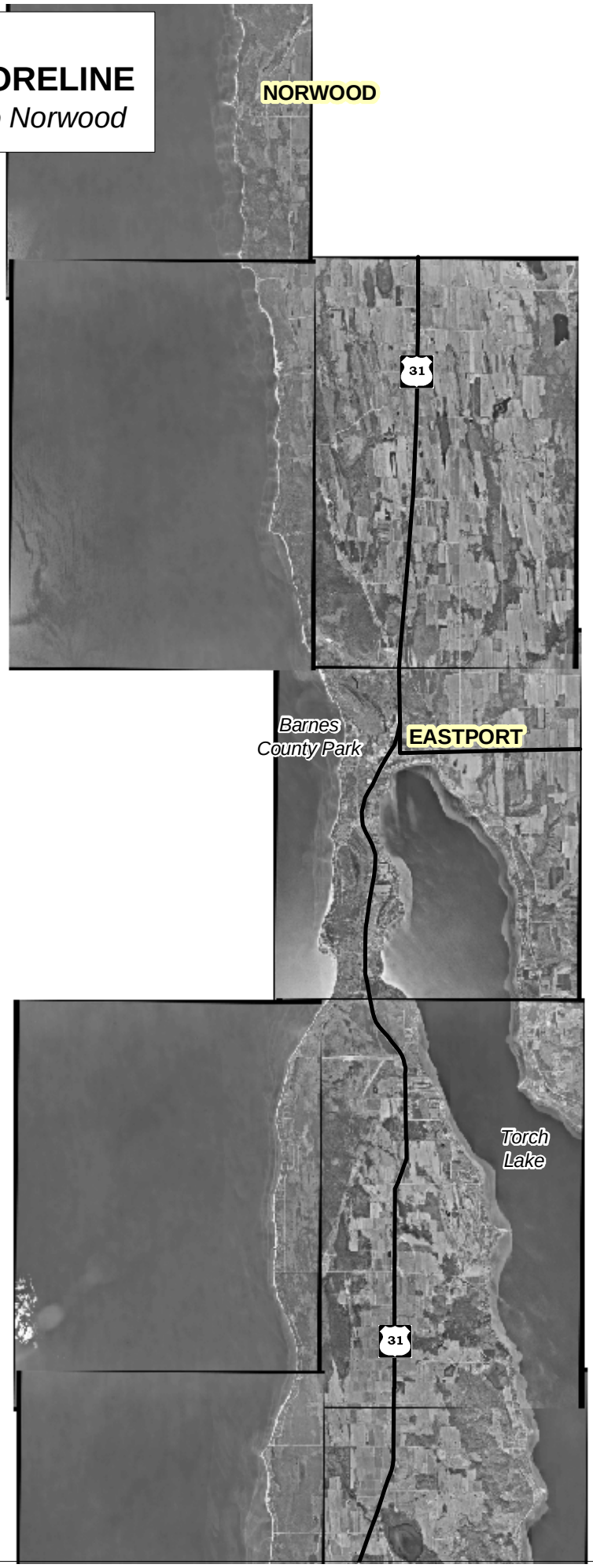


Figure 5

ANTRIM COUNTY SHORELINE

from north of Elk Rapids to Norwood



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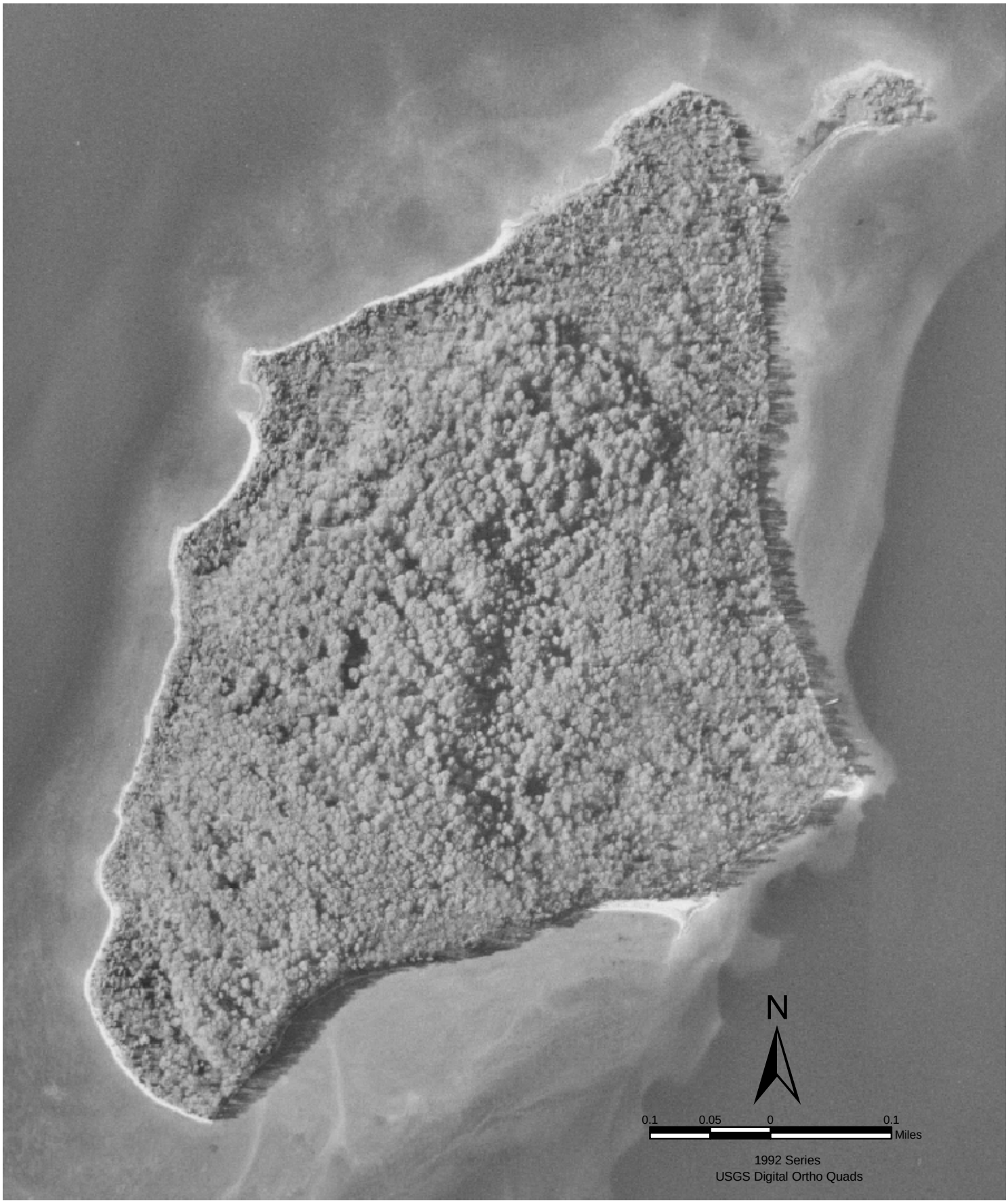
1 0.5 0 1 Miles

1992 Series
USGS Digital Ortho Quads

Figure 6

GRAND TRAVERSE COUNTY SHORELINE

Power (Marion) Island



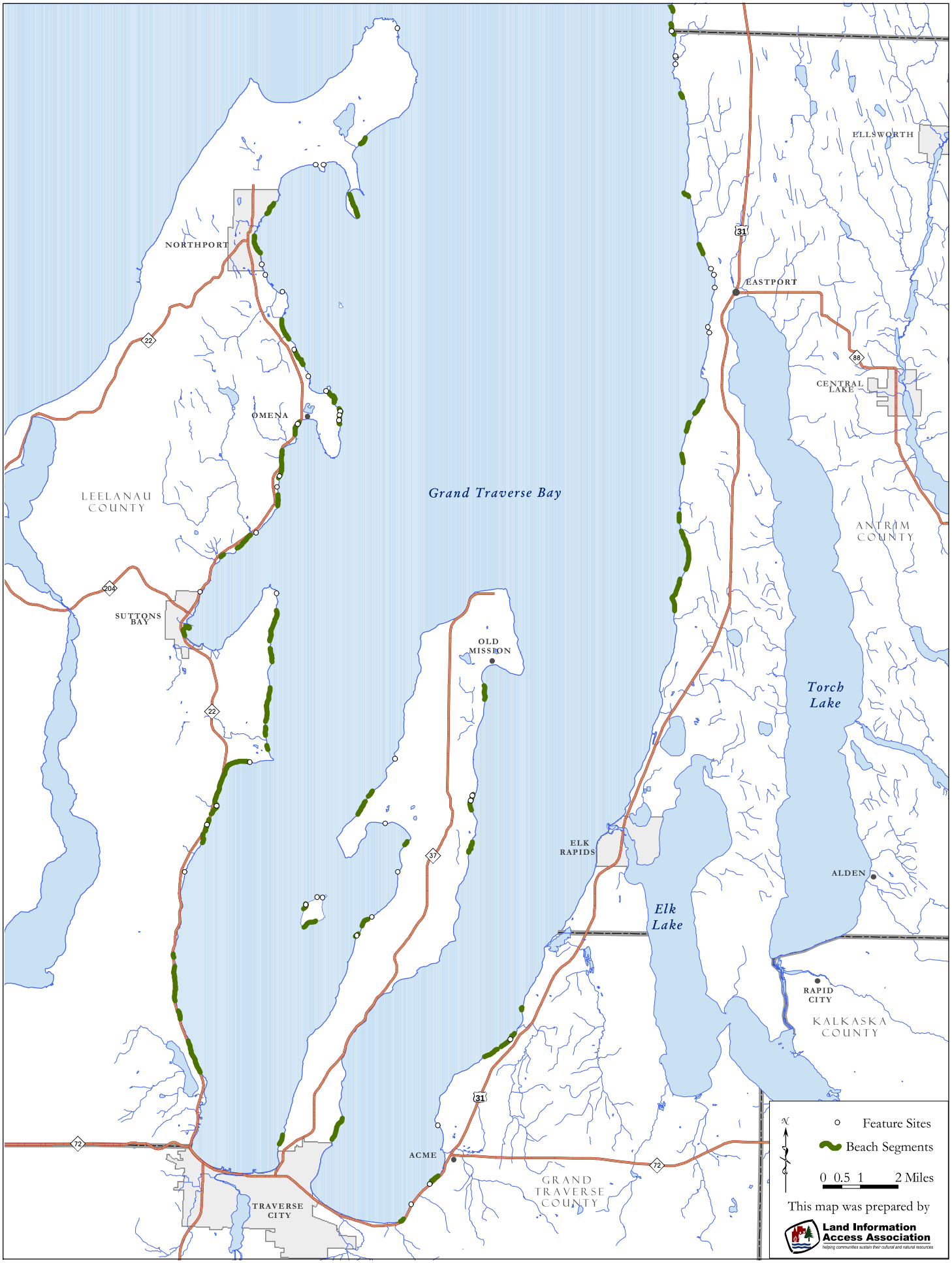


FIGURE 7: FEATURE SITES AND BEACH SEGMENTS WHERE STREAMS WERE OBSERVED ENTERING THE GRAND TRAVERSE BAY

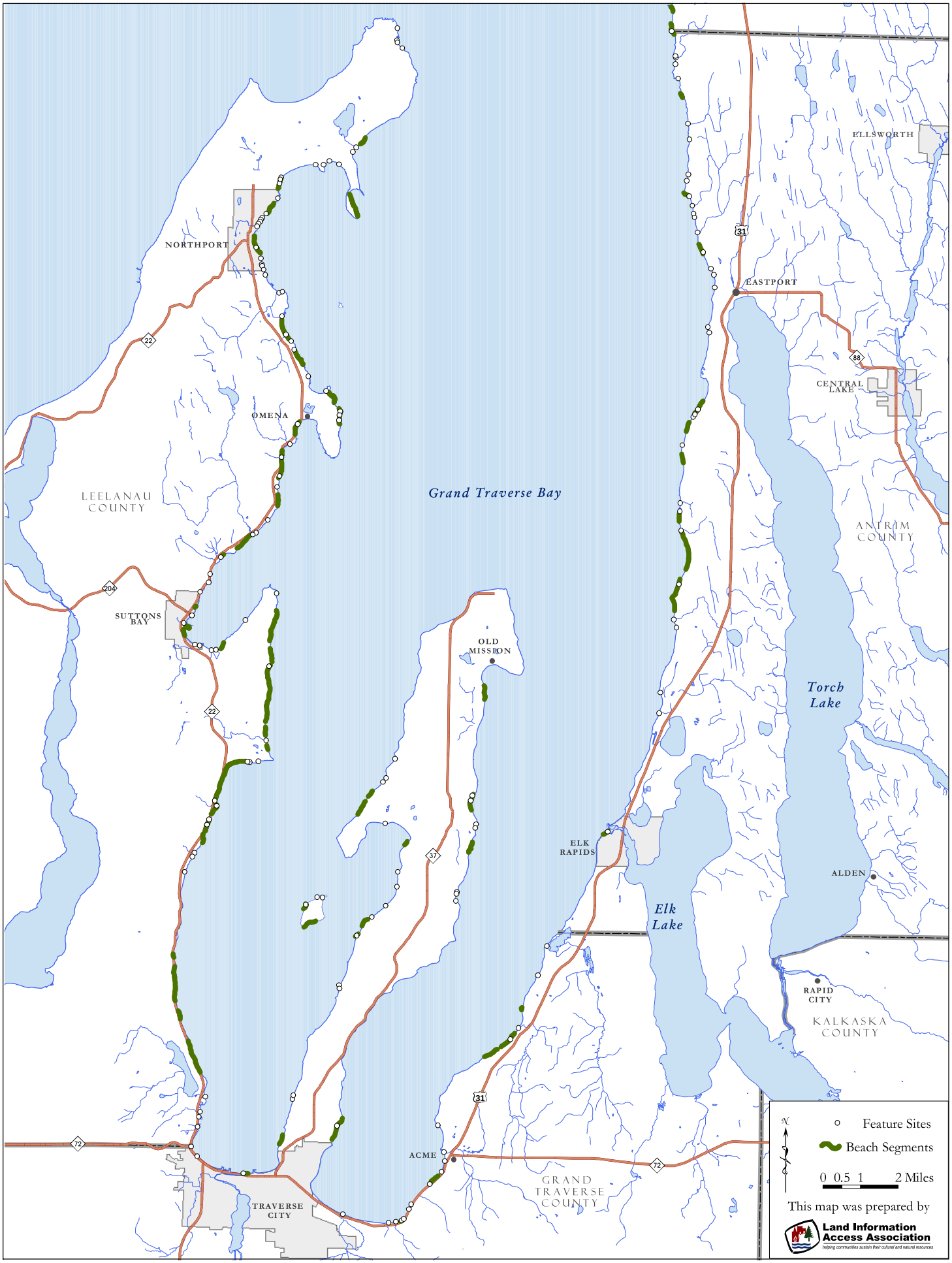


FIGURE 8: FEATURE SITES AND BEACH SEGMENTS WHERE STREAMS AND/OR GROUNDWATER SEEPS WERE NOTED

Appendix A
Field Inventory Sheet

GRAND TRAVERSE BAY WATERSHED
SHORELINE INVENTORY DATA COLLECTION FORM

MAP NAME:_____

DATE COLLECTED:_____

NAME OF SURVEYOR(S):_____

Location	(I). Near-shore Features	(II) Flora	(III) Groundwater	(IV) Public Access	(V) Human Impact	(VI) Beach	Comments

Key to data codes:

(I) Nearshore Features: 1-cladophora 2-other algae 3-macrophytes 4-silt/clay/detritus 5-sand 6-stones 7-rock

(II) Flora: 1-endangered 2-exotics

(III) Groundwater: 1-seeps 2 streams

(IV) Public Access: 1-pedestrian 2-boatlaunch 3-permanent pier 4-auto (end-of-road)

(V) Human Impact: 1-shore hardening: a-steel b-stone c-groin
2-beach altering: a-landscaping b-erosion c-raking d- clearing e-dredging
3-stormwater drainage discharge
4-private permanent pier
5-water withdrawing

(VI) Beach: 1-sand 2-stones 3-rock 4-gradual 5-bluff 6-dunes 7-algae deposition 8-wetland
9-width: a-less than 25' b-between 25'-100' c-more than 100'
10-adjacent upland: a-natural b-cultured c-paved d-bluff e-dune

Other keys:
(+) = present
(++) = abundant

sand < 1/12"
stones 1/12" – 10"
rock > 10"

Appendix B
Streams Draining Directly to Grand Traverse Bay

Streams Draining Directly to Grand Traverse Bay

Antrim County		
Data Sheet	**Number of Streams**	**Location**
?	1	Elk River at Elk Rapids
ANT 6	2	Just North and South of Winters Road
ANT 8	2	South of Erickson Road
ANT 9	1	Intermittent stream North of Erickson Road
ANT 10	1	South of Croswell Road
ANT 11	1	North of private marina north of Croswell Road
ANT 12	1	North of Croswell Road
ANT 13	2	
ANT 16	2	South of Core Road
ANT 17	4	Includes Guyer Creek
ANT 18	3	
ANT 19	2	Antrim Creek, 1 stream South of Antrim Creek
ANT 20	1	At Bank Township Park Road
ANT 22	1	At Norwood
Total	**24**	

Grand Traverse County		
Data Sheet	**Number of Streams**	**Location**
GTC 1	1	
GTC 2	1	
GTC 5	2	
GTC 8	2	
GTC 10	2	
GTC 11	1	
GTC 12	1	
GTC 16	3	
GTC 28	1	
GTC 29	1	
GTC 30	2	
GTC 37	1	
GTC 40	1	Mitchell Creek
GTC 41	3	Includes Baker Creek
GTC 42	3	
GTC 43	3	Includes Acme Creek
GTC 47	1	Yuba Creek
GTC 49	2	Includes Ptobego Creek
Total	**31**	

STREAMS DRAINING DIRECTLY TO GRAND TRAVERSE BAY CONT'D

Leelanau County		
Data Sheet	**Number of Streams**	**Location**
LEE 2	2	At Cherry Home
LEE 5	1	Woolsey Lake Outlet
LEE 8	2	Halls Bay
LEE 10, 11	8	Including Northport Creek, many draining wetlands West of Northshore Drive
LEE 12	4	
LEE 13	2	Including Innes Creek
LEE 14	1	
LEE 15	1	
LEE 20	2	Including Weaver Creek
LEE 21	1	
LEE 22	1	Belanger Creek
LEE 23	3	
LEE 24	2	
LEE 25	2	
LEE 26	3	
LEE 27	1	
LEE 30	6	
LEE 31	2	
LEE 32	3	
LEE 33	1	
LEE 34	1	
LEE 35	2	
LEE 36	1	
LEE 42	2	
LEE 43	3	
Total	**57**	

APPENDIX D

SUMMARY OF EXISTING WATERSHED PLANS AND OTHER RESEARCH STUDIES

Summary of Existing Watershed Plans and Other Research Studies

Subwatershed	Existing Studies	General Findings	Environmental Stressors/ Pollutants	Sources
Elk River – Chain of Lakes	1. Watershed Master Plan July 1989 – NWMCOG 2. Watershed Management Plan July 2001 – CRA	1. WQ threats and concerns = planning/zoning for development, septic tanks, loss of wetlands/natural areas/open space, use conflicts, stormwater runoff, erosion/sedimentation, industrial pollution, oil/gas/brine wells and LUSTs, low and fluctuating water levels in upper Chain of Lakes area Conclusions: *headwaters just as impt. as more visible lakes/streams *economics based on maintaining high quality resources for recreation and quality of life *maintaining natural vegetation and wetlands is key *reduce man-made inputs from septic/stormwater/chemicals/other 2. Lists 5 specific watershed Goals with corresponding Objectives, and Strategies: *protect/improve quality of water resources *protect integrity of system *preserve the distinctive character and aesthetic qualities *establish land management practices which conserve natural res. *establish and support educational programs *utilize steering committee as coordinating body <u>General facts:</u> 491 mi^2, 23% water, 200^+streams, 138 miles of Desig Trout Stream	Sedimentation Toxins Nutrients Hydrological Flow Thermal Poll?	Rd. Str. Cross Bank erosion Construction Wells Indus.Poll Stormh20 LUSTs Septics Stormh2o H2O levels Dams Stormh2o Lack canopy

Subwatershed	Existing Studies	General Findings	Environmental Stressors/ Pollutants	Sources
Acme Creek (including a study with Yuba Creek)	1. Acme Creek Watershed Planning Project June 1995 – GT County Drain Commission 2. Acme/Yuba Creek NPS Implementation Project April 2000 – GT County Drain Commission	1. WQ concerns: sedimentation, nutrient loading (golf courses), res. and ag. lands, and stormwater runoff (from inc. imperv surfaces) *Developed watershed database (wetlands, parcel lines, slopes, land cover, twnp zoning, potentially sensitive areas) *Existing ordinances weak and not targeted to protect creek/fish hab *Specific streambank erosion sites/inadequate culverts noted *Public concerns: golf course practices, road construction, and protection of headwater areas *DEQ bio 1994 bio survey: macros slightly impaired <u>General facts:</u> 12.6 mi^2, drains to East Bay; Acme, East Bay, Whitewater Twp., 62%forest, 12%urban, 10%open, 9%wetlands 2. Land Protection: Deepwater Point Natural Preserve, Frost property, Spindrift property I/E: watershed landowner's handbook, road signage BMPs: corrected all severe runoff erosion sites (prevented 73 and 70 tons of sed/year from entering Acme and Yuba Creeks)	Sediment Nutrients Toxins? Thermal Poll?	Rd St Cross Bank erosion Construction? Stormh2o Golf Course Ag. Runoff Stormh2o Stormh2o Lack canopy
Acme/Yuba/ Mitchell Creeks	Mapping Impervious Surface Coverage for Watershed Monitoring and Land Use Planning GT Co. Drain Commissioner's Office and GIS Dept – ####	Defined as any surface in urban landscape that can't effectively absorb or infiltrate rainfall (road, sidewalk, parking lot, roof) Impervious surface important WQ indicator; stream degradation occurs at % impervious levels bt/n 10% - 20% Mitchell Creek: 8.9% impervious; 7 of 29 subbasins > 10% Acme Creek: 4.2% impervious; 2 of 11 subbasins > 10% Yuba Creek: 2.4% impervious Efforts to control impervious areas could be an effective approach for protecting WQ and quantity; Land use planning; impacts of zoning buildout…	<u>Imperv. Areas</u> Stormwater Nutrients Thermal Pollution Toxins Hydrology Sediment Red. Infilt.	

Subwatershed	Existing Studies	General Findings	Environmental Stressors/ Pollutants	Sources
Mitchell Creek	1. NPS Pollution Study 1991 – Gosling Czubak Associates and Battelle Gr. Lks. Env. Center 2. Implementation Project Final Report 1995 – GT Co. Drain Comm. 3. Watershed Protection Strategy 1995 – GT Co. Drain Comm.	1. Critical areas = wetlands & gh2o recharge areas General recommendations: GT County Soil Erosion and Stormwater Runoff Control Ordinance, preserve wetlands, install riparian buffer zones, create/preserve forest cover, protect gh2o recharge Specific recommendation: install agricultural, golf course, and urban stormwater BMPs 2. Outputs: * Watershed protection plan; * BMPs (246 acres in ag. management program & 1200 ft. streambank stabilized); * Land Protection: land owner database, land owner's handbook, 158 acres protected; * Organizational structure/ intergovernmental support; *GIS database; * I/E: cleanups, tree plantings, signage, video "Beyond Boundaries, A Community Approach" 3. Contains recommendations relating to the amt, type, and location of development, size of stream setbacks and wildlife corridors, viewshed opportunities, and other components <u>Assessment of Natural Systems:</u> Aquatic Resources: fisheries quality fair-excellent, numerous stream segments have excessive sediment deposits Wildlife Resources: lower portion has good diversity Wetlands: 4 critical wetland areas, development pressure Aquifer Recharge Area: located in headwaters, higher elevations <u>WQ Problems:</u> excessive sediment, elevated nutrients, urbanization threatening gh2o recharge, drinking h2o threats WQ and aquatic diversity are good in spite of obvious degradation – recommended to control erosion/sedimentation and thermal poll <u>General facts:</u> 14.7 mi^2; drains to East Bay; Blair, East Bay, Garfield Twp and City of Traverse City; headwater area = steep slopes, middle/lower = flatter w/ wetlands; 16 miles of high quality trout stream; significant gh2o contrib. (gaining stream); land use shifting from agriculture and forest to urban (13%)	Sedimentation Nutrients Hydrological Flow Thermal Poll Urbanization?	Stormh2o Rd St Cross Bank erosion Construction Stormh2o Reduc. of Wetlands Reduction of gh2o recharge Lack canopy Stormh2o

Subwatershed		Existing Studies	General Findings	Environmental Stressors/ Pollutants	Sources
Boardman River	Boardman River (entire)	1. Section 319 Success Stories 1997 – EPA 2. Restoration and Protection Project 1999 – GTCD	1. Stabilized 96 sites on River, Prevented 1200 tons sed/yr, Used bioengineering practices (native plants, whole tree revetments, log cribbing, vegetation to water's edge, veg. w/ rock rip rap, fish lunkers, composted leaves), Installed 4 sand traps, Educational materials (brochures, display, t-shirts, video-"Currents of the Boardman", three 30-second PSAs), GT Reg.Land Conservancy protected 600+ acres and established endowment fund 2. No *impaired* designated uses: ch2o fishery and total body contact threatened, has list of pollutants and sources with paragraphs detailing information DNR P51('93-'96) = 54% index stations good, 46% fair; occasional health advisories (sewage); 600+ erosion sites neg. impacting aq. habitat; DNR ('86) lack of adequate trout cover and spawning gravel, ('94) improving, need for continuous erosion control work and sand trap maintenance Steering committee prioritizations: road/stream crossings, streambank erosion, recreational activity, urban stormwater runoff, and land fragmentation Six project goals: Implement BMPs to reduce sedimentation… Permanently protect critical riparian areas thru conserv. easements Evaluation effectiveness thru WQ/bio monitoring & public comment Monitor & maintain all past and future restoration activities Education Involve citizens, public agencies, user groups and landowners W/in 5 years, develop Boardman R. Restoration & Protection Fund <u>General facts:</u> 295 mi^2, GT and Kalkaska Counties, Blue Ribbon Trout Stream and Natural River, 50+% forested-12% urban	Sedimentation Thermal Poll. Nutrients Pathogens	Rd St Cross Bank Erosion Rec activities Stormh20 High flow Velocity Ag activities Impv surface Hydro prod Timber harv Animal waste Stormh2o Septic Riparian graz Sewage Trt. Stormh2o Riparian graz Animal waste

	Kid's Creek	Stormwater Management Plan 1991 – FTC&H (for Garfield Twnshp and TC)	Project Goals: protect nat. resources, existing residential units adjacent to stream, and to control potential detrimental impacts resulting from stormh2o runoff <u>Specific Problems in Kid's Creek:</u> Flooding – due to inc. stormwater runoff, Soil Erosion and Sedimentation, Streambank Erosion, and Water Quality – potential thermal pollution included Contains both structural and non-structural recommendations <u>General facts:</u> 4.3 miles long, trib to Boardman, designated trout stream, heavy and rapid urbanization	Sedimentation Thermal Poll Hydrologic Flow	Rd St Cross Stormh2o Bank erosion Stormh2o Lack canopy Flooding (stormh2o)
	Miller & Jack's Creeks	NPS Pollution & Stream Habitat Report March 1998 – GT Conservation District	Major Resource Concerns: 1. Perched Culverts – 4 of concern (2 in each), greatest threat to biological health 2. Sediment – Miller = 22 sites, Jack's = 8 sites 3. Nutrient Loading – buffalo farms in hw of both 4. Trash – esp. Miller behind GT Crossings u/s to US 31 5. Stream Habitat – Miller u/s Cass Rd = sandy, d/s = good hab; Jack's u/s Cass Rd = lacks wdy debris and cover, d/s = good 6. Riparian Land Use – steep slopes and gh2o seeps impt. (developers must strictly adhere to soil erosion and sed. control ordinances) <u>General facts:</u> 14.7 mi^2; subwatersheds/tribs to Boardman, located entirely w/in Garfield Twnshp	Sedimentation Nutrients	Rd St Cross Bank Erosion Ag farms Stormh2o
	Boardman Lake/ River	The Collection and Analysis of Sediment Samples from the Boardman LakeRiver GLEC – 2002	Report done for DEQ: *July 1997 – sediment core sampling to det if lake sediments had been impacted by the Q of contam from pt and nonpt sources – current report reanalyzes toxicity of sediments from 3 spots *Results indicate that there are elevated conc of contam in the sediments in B Lake and River at sampled locations, in some areas are toxic and have potential to neg affect benthic organisms (measured = PAH's, metals, toxicity to zooplankton)		

	Silver Lake	1. Silver Lake Summary & Issues 2002 – S.L.Assoc. 2. Fish Collect. Data 1994 – MDNR 3. Silver Lake WQ Trend Analysis 2000 – GLEC	1. Runoff and spring fed; Land use from ag to residential, GT County pop increased 272% from 1950-2000; 300 properties year round residences w/ approx 100ft of shoreline; ¼ mile of 8mi perimeter is undeveloped; Overflow drain completed in 1987, max of 862 ft above sea level (to Beitner Crk, trib to Boardman), sporadic flow, turned off when temp is 68°F+; Development has eliminated small wetland pockets; 53 erosion sites identified; WQ testing spring and fall since 1993 – TP/secchi disk/chlorophyll a/temp/DO Designated uses threatened: Navigation, other indigenous aquatic life, warmwater fishery, total/partial body contact 2. Lack of bluegill and yellow perch special concern, which were abundant in 1982; walleye/smallmouth bass/ largemouth bass growing below state average 3. Water quality data collected from 1993-99 P is primary algal growth limiting nutrient; Bottom-water has low DO in north end, demonstrates potential for WQ degradation; Elevated near bottom phosphorus levels- WQ has been compromised; further deterioration of WQ will likely result if P and sediment loading are increased <u>General facts:</u> 10 mi^2, 600 acre surface area, 2-4 mi SW of TC, Garfield and Blair Twp,	Sediment Nutrients Invasive aq. species	Bank erosion Stormh2o High P Eurasian Milfoil

Summaries of Studies Done on the Grand Traverse Bay and Watershed

Name of Study/ Subwatershed	General Findings
Assessment of the Lake Michigan Monitoring Inventory: A report of the Lake MI tributary monitoring project Great Lakes Commission – August 2000 Full Report at: www.glc.org/monitoring	Part of the GLC and EPA's Lake Michigan Lakewide Management Plan. Purpose: assess existing monitoring efforts in LMI basin and subwatersheds; comprehensive review of monitoring programs at the federal, state, and local levels; analysis of gaps, inconsistencies and unmet needs; assessment of the adequacy of existing efforts to support critical ecosystem indicators, and recommendations for addressing major monitoring needs. Done by: surveying potential local monitoring organizations and follow-up interviews; survey of state and federal monitoring; all compiled into database Summary of Grand Traverse Bay Watershed: Watershed protection plans for five sub-basins: Mitchell, Acme, Yuba, Elk River/Chain of Lakes, Boardman – includes short summary of pollutants and sources for each subbasin. Pollutants of Concern and Synopsis of monitoring efforts for each of the following: Aquatic, Pollutant Release, Nutrients and Bacteria, Meteorological and Flow Monitoring, Sediments, Fish Contaminants/Fish Health/Aquatic Nuisance Spp, Benthos, Air, Wildlife and Land Use

State of the Bay 2000 The Watershed Center	Summary: • Average water clarity increased 20% from 1990-2000 in W. Arm of Bay • Sediment quality very good at nearshore sites – typical substrate is coarse sand with numerous nearshore areas of cobble and gravel; 100+ft depth, bottom is silt/clay • Total Phosphorus: - Sig. differences in TP bt/n offshore surface and bottom samples for Omena Bay - TP higher at nearshore than offshore - TP continued to decline since 1970 - Sig. higher levels of TP at mouth of Boardman River and Acme Creek • Urban tribs and stormwater drains are a sig source of nutrients to the Bay; elevated levels of bacteria may pose health risk after large rain events • Weed bed numbers have nearly doubled from 64 (1991) to 124 (1998) • Seiche events (large scale periodic movements of water) can resuspend sediments in deeper portions of the Bay. If carried into the water column, they can release contaminants deposited decades ago. • Sig changes in dates of freeze-up and break-up bt/n 1851-1993 in Bay - Av. freeze-up date is 12 days later - Av. break-up date is 19 days earlier - Did not freeze over in 2001, marking the 5th consecutive year of not freezing over in past hundred years of record • Five federally listed endangered or threatened species (+1 candidate): Bald Eagle, Kirtland's Warbler, Piping Plover, Pitcher's Thistle, MI Monkey Flower, Eastern Massasauga Rattlesnake • Two new exotic species found in Bay since 1999: Fishhook Water Flea and Rusty Crayfish (since 2000, the Spiney Water Flea has been discovered) Additional Info: EPA recommends measuring recreational WQ by the abundance of *Escherichia Coli*: Water is unsafe for swimming if – 130+colonies/100mL in 5 samples over 30-day period or 300+colonies/100mL in any 1 sample • *E.Coli* is common intestinal organism – presence indicates Fecal Pollution, the kinds measured in water don't generally cause disease; those that cause disease are **pathogens** (i.e., other bacteria, viruses, protozoa, small worms) • EPA studies indicate when *E.Coli* exceeds set standards, increased risk of gastroenteritis from pathogens in Fecal Pollution Sources: urban runoff, inadequately treated wastewater, ag runoff, illegal sewage discharge from boats, animals, etc.

Cont'd… State of the Bay 2000 The Watershed Center	*Parameters summarized in State of the Bay and not GLEC Habitat Study:* Water and Habitat Quality – Most common nearshore bottom feature is sand or combo of sand, gravel, and cobble Increase in silt and organic detritus along nearshore bottom 39 spp. of native and non-native fish live in Bay; diverse assortment of other insect and inverts Minerals – Levels of Ca, Mg, Sulfates, and Chlorides are all consistent among sample sites and years Concentrations are typical of high quality freshwater lakes, no suggestion of WQ degradation Toxic Metals Data – Cd, Cr, Pb, Zn, Ni: all relatively low, consistent with other lakes Cu decreased by 60% => 1ug/L (1975), 0.4ug/L (1998) Hg levels low => 0.26ng/L, slightly higher at South end of W.Arm and North end of E.Arm; b/c of loadings from Boardman and Elk River Report comes with informational CD containing the following sections: • History of Land Use • Bay Ecology and Natural Processes • Impacts on the Bay • Efforts to Protect the Bay • Regional Maps • Virtual Flight over the Bay

Integrated Habitat and Water Quality Inventory for the Grand Traverse Bay GLEC – April 2000 **<u>With historical references to:</u>** 1. The Limnology of Grand Traverse Bay, Lake Michigan, Auer et al., 1975 2. Some Aspects of the physical Limnology of Grand Traverse Bay, Lauff, 1957 3. Final Report for the GTBWI: PartII, Water Quality of the Bay and Tributaries, Shuey et al., 1992 4. The Acme Creek Ecological Project: Natural Features Inventory and Land Management Plan, GLEC, 1994 5. Peshawbestown and Omena Bay Baseline Water and Sediment Quality Study, GLEC, 1998	Study designed to compliment past and ongoing studies – make it comparable Purpose: Characterize the state of the GTBay regarding chemical and bio indicators, by conducting habitat and WQ inventories of near-shore waters. *Links near/off-shore WQ to nearshore habitat **Findings:** Typical of other oligotrophic embayments in Gr.Lakes; deep, clear, cold, DO/temp indicate little stratification, DO at or near saturation most of year, h2o transparency exceeded 7-8m, nutrients and chlorophyll a were relatively low (continually declined), overall productivity low Sediment – Quality is good, typically coarse sand w/ numerous areas of cobble and gravel Isolated areas relatively rich in inorganic matter (Omena Bay); does not contribute significant concentrations of nutrients to water column; few rooted macrophyte beds (b/c of lack of suitable substrate?); most of sediment Phosphorus is organically bound Macrophyte Beds – Weed bed numbers have nearly doubled from 64 growth areas (in 1991) to 124 areas (in 1998) Most concentrated at S end of W.Bay (where higher amts of P enter) highly influenced by rapid development Nutrient inputs and the amount of water flushing an area were most important determinants for locations of beds Total Phosphorus – <u>Growth limiting nutrient</u> for the GT Bay *Sig differences bt/n offshore surface and bottom samples in Omena Bay (sediment quality, incomplete mixing of Omena Bay w/ GTBay): Spring'99- 2ug/L at surface; 64ug/L at 80ft *Nearshore TP concentrations higher than offshore: near av = 4.6ug/L, off av = 2.8ug/L * Continued decline since early '70's: 1975 - 7.8ug/L, 1992 – 5.4ug/L, 1994 – 4.9ug/L, 1998 – 3.8ug/L, 1999 – 3.0ug/L Nitrate – <u>Not a growth limiting nutrient</u> for the GT Bay, sufficient quantities for growth Generally higher in offshore near bottom than surface samples (except Omena Bay) 1998 – 0.2mg/L (0.25mg/L in Wbay), measurements similar to historical (Auer, Shuey, GlEC) Silica – Found in colloidal/suspended matter or in biomass (diatoms) Declined dramatically in past 40yrs: 1957 - 3.6mg/L, 1976 - 0.423mg/L, 1992 - 0.410mg/L, 1998/9 - 1.06mg/L

Cont'd… Integrated Habitat and Water Quality Inventory for the Grand Traverse Bay GLEC – April 2000 **<u>With historical references to:</u>** 1. The Limnology of Grand Traverse Bay, Lake Michigan, Auer et al., 1975 2. Some Aspects of the physical Limnology of Grand Traverse Bay, Lauff, 1957 3. Final Report for the GTBWI: PartII, Water Quality of the Bay and Tributaries, Shuey et al., 1992 4. The Acme Creek Ecological Project: Natural Features Inventory and Land Management Plan, GLEC, 1994 5. Peshawbestown and Omena Bay Baseline Water and Sediment Quality Study, GLEC, 1998	Chlorophyll a – Pigment found in plants, necessary for photosynthesis – indicates amt of suspended algae Varies w/ seasons; No significant change since 1975 Overall Bay chlorophyll a average = 1.04ug/L, even though slight increases have been shown for chlorophyll a, the Bay is still oligotrophic w/ overall low productivity Secchi Disk, Transparency – Measure of h20 trans. – directly linked to inorganic suspended solids and plankton abundance Varies throughout year, generally greater in Spring: 1957-10.5m, 1975-7.0m, 1992-5.7m, 1999-8.5m; Spring 2000 Inland Seas – 32ft lower W.Arm, 38ft Suttons Bay Increase in water clarity correlated to decrease in TP since 1991, suggested that this is strongly linked to proliferation of increased zebra mussels in bay since that time Phytoplankton – Greatest abundance in Spring, 21 total spp; dominant ones typical of oligotrophic systems Historically: Auer 1957 stated W.Arm transitioning towards eutrophication Current: W.Arm more organisms/L than E.Arm in late summer, *suggests* more nutrients available in W.Arm and higher level of eutrophication Overall though, typical of oligotrophic and no suggestion of eutrophication Zooplankton – Assemblages are similar to those typically found in L. MI and Great Lakes Benthic Macroinvertebrates – Spiny water flea observed in Omena Bay Greilickville abundance of zebra mussels, 58% of population Fish – Total of 19 spp. (9 families, 2 invasive: alewife, 3-spined stickleback) Substrate, Plant Life, and Functional Wetland Assessment – 13 specific substrate/habitat types identified; GIS mapped

Stormwater Source Identification, Sampling and Analysis at Select Storm Drains and Tributaries to GTBay (L.MI) GLEC – 2001	*This report is also summarized in State of the Bay 2000:* Objectives/Purpose: Map the locations of stormdrains that discharge to Bay Quantify the mass loading of nutrients (TP, Nitrates, Fecal Contaminants) via urbanized tribs and direct discharges to Bay *used 1 normal low flow (August) and 1 normal high flow (Nov) *Boardman River, Elk River, Stormdrains: E. 8th St., E. Bay Park, Maple St., Hope St., Bryant Park, Suttons Bay, Northport *Historically*: Shuey et al 1991 – nutrient loadings for 20 tribs and 6 storm sewers; concluded that stormwater outfalls carried the greatest single concentration of nutrients to Bay *(Storage capacity in Elk River is much greater than Boardman River; Elk has lakes to store and buffer water, Boardman has more imperviousness and quicker flow through system)* Total Phosphorus: * TP concentrations mush higher in wet weather samples than for dry weather *Highest concentration of TP are found at stormwater outfalls; however flow is much less, so loading may be less than in Elk or Boardman Rivers; also numerous stormwater outfalls drain directly to Boardman and Elk Rivers… *See Table 2 in State of the Bay 2000* Bacteriological: Combined sewer overflows and Stormwater outfalls are activated during high rainfall events, may result in direct discharge of untreated sewage with Stormwater into waterbody; Sources also include: improp functioning septic tanks, illegal snitary sewer connections, food process plants, animal feeding operations, outdoor pets, and feral animals *Sig potential for fecal contamination following storm events; Extremely high conc of *E.Coli* and enterococci were noted during wet weather sample… *See Table 2 in State of the Bay 2000* *Summer storm even has potential for sig public health risk at local beaches b/c of Stormwater outfalls: At risk= West End, Clinch Park, and Bryant Park Beaches, East Bay Park, Elk Rapids City Park, Northport Beach, Southshore Park Beach (Suttons Bay), and waterfront homes Conclusions: • Implementation of Stormwater retention programs is **critical**: urban and high imperv areas • Stormwater management plans integrated into local land use zoning ordinances

APPENDIX E

AVERAGE RATES FOR COSTS OF INSTALLING STANDARD BMPS
(COMPILED BY: FISHBECK, THOMPSON, CARR & HUBER, INC.)

Best Management Practices Cost Estimates*

Task	Costs	Units	Output	Notes	Source
Agriculture					
Conservation Tillage	$ 10.00	acre			NRCS
Fertility Testing	$ 2.75	acre		Lab testing done to MSU standards	MDA Conservation Service 1992 adjusted for inflation
IPM	$ 5.75	acre			MDA Conservation Service 1992 adjusted for inflation
Windbreaks	$ 2.00	foot		4200 feet needed for a square 40 acre field. Protects ten times as trees are high	NRCS
Cover Crop	$ 14.00	acre		sweet clover if using forage for harvest results in gain of $125/acre	NRCS
Critical Area Planting	$ 1,300.00	acre		Includes: grading, planting, herbicides, mulch, and labor.	NRCS
Livestock Exclusion	$ 3.50	foot			NRCS
Agriculture Crossing	$ 1,200.00	crossing	2/day		NRCS
Watering site	$ 5,100.00	site	.5/day	Well, pump, pipe and water facility	NRCS
Rental Rate	$ 58.00	acre		10 year lease $150/acre with grants	NRCS
Riparian Forested Buffer	$ 900.00	acre		Use of herbicides and establishiment and maintenance	NRCS
Riparian Herbaceous Buffer	$ 225.00	acre		On tilled land includes establishment and maintenance	NRCS
Filter Strip	$ 190.00	acre		establishment, herbicides, fertilizer, and lease	NRCS
Zebra Mussel Control	$ 440.00	acre		Irrigation system to control Zebra Mussels for a 1800 acre establishment	American Water Works Association, 1990 adjusted for inflation
Solar Irrigation Pump	$ 2,500.00	unit	3/day	Pump, controller, pipe, and collector	www.solarelectric.com
Waste Storage Lagoon	$ 45,000.00	unit			NRCS
Stream Erosion					
Live crib wall	$ 25.00	square foot	25 ft/day	see habitat restoration	Rogue River National Wet Weather Demonstration Project
Live staking	$ 2.50	stake		with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project
Vegetated geogrid	$ 20.00	square yard		with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project

Live fascine	$	9.00	foot	with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project
Brush layer	$	13.00	foot	with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project
Branch packing	$	25.00	foot	with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project
Coconut roll	$	15.00	foot	with 3 crew and foreman	Gull Lake Shoreline Project
Joint Planting	$	9.00	stake	with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project 4 member crew with foreman
Riprap	$	60.00	square yard	includes geotextile fabric: 2 member crew and foreman using heavy equipment	Means 1996 and adjusted for inflation: Includes heavy equipment rental
Tree revetments	$	12.00	foot	with 3 crew and foreman	Means 1996 and adjusted for inflation
Bank Shaping	$	15.00	cubic yard	With Heavy Equipment	NRCS
Average Bio-Engineering	$	22.00	foot	Using soft methods only	NRCS
Average Streambank Restoration	$	32.00	foot	Using hard methods and bioengineering	NRCS
Hydroseeding and Mulch	$	2,200.00	acre		NRCS
Tile Outlet					
Riprap	$	75.00	square yard	includes geotextile fabric: 2 member crew and foreman using heavy equipment	Means 1996 and adjusted for inflation
Vegetated geogrid	$	20.00	square yard	includes geotextile fabric: 2 member crew and foreman	Means 1996 and adjusted for inflation
Pipe	$	30.00	linear foot	10" pipe steel: 3 member crew, foreman, backhoe	Means 1996 and adjusted for inflation
Inlet/outlet structure		$3,500	each	concrete with riprap splash pool and vegetated geogrid slopes	Means 1996 and adjusted for inflation
Soil Stabilization/Repair		$2.50	square yard	2 member crew and foreman with heavy equipment	Means 1996 and adjusted for inflation
Trash and Debris					
Volunteer Mobilization	$	60.00	day	Includes flyers, meetings, and memberagement	
Tree removal	$	325.00	hour	includes crew, equipment, and removal fees	Means 1996 and adjusted for inflation: Includes heavy equipment rental
Waste hauling fees	$	75.00	load	should include a $2 tip fee for each tire	
Heavy Obstructions	$	890.00	each	includes, crew, equipment, and removal fees	Means 1996 and adjusted for inflation: Includes heavy equipment rental
Rill and Gully					

Berm and Tube	$ 1,500.00	each		with 3 crew, foreman, heavy equipment and materials	NRCS
Water Bars	$ 300.00	each			NRCS Nebraska Cost Estimator
Grassed Waterway	$ 690.00	acre		Best case Scenario with loose soil, no brush, and already tilled ($2245 ave.)	Means 1996 and Rogue River National Wet Weather Demonstration Project
Grassed Waterway	$ 3,800.00	acre		Worst Case Scenario in hard soil, with brush and dense vegetation ($2245 ave.)	Means 1996 and Rogue River National Wet Weather Demonstration Project
Stone Spillway	$ 9.50	square yard		3 member crew, foreman, heavy equipment and material	Means 1996 and adjusted for inflation
Diversions	$ 3.75	linear foot		grassed terrace to divert flow from tilled earth	NRCS and Means 1996
Habitat restoration					
Wetland Restoration	$ 2,350.00	acre		average of $500/acre and up	NRCS and Zbiciak
Channel block	$ 340.00	log structure	3-4/day	single log	Rogue River National Wet Weather Demonstration Project
Channel block	$ 480.00	log structure	2-3/day	triple height log	Rogue River National Wet Weather Demonstration Project
Channel block	$ 1,600.00	log structure	.5-1/day	crib wall: requires heavy equipment	Rogue River National Wet Weather Demonstration Project
Boulder Cluster	$ 59.20	cluster	25/day	varies depending on distance moved: requires heavy equipment	Rogue River National Wet Weather Demonstration Project
Cover logs	$ 290.00	log structure	5-10/day	3 member crew (requires heavy equipment)	Rogue River National Wet Weather Demonstration Project
Root wads	$ 300.00	wad	6-8/day	4 member crew (requires heavy equipment)	Rogue River National Wet Weather Demonstration Project
Tree Covers	$ 172.00	tree	8-12/day	If dropped in place or already in stream (requires heavy equipment)	Rogue River National Wet Weather Demonstration Project
Tree Covers	$ 215.00	tree	4-8/day	If they must me moved to site (requires heavy equipment)	Rogue River National Wet Weather Demonstration Project
Crib wall	$ 9.50	square foot	120+ feet/day	If done with heavy equipment	Rogue River National Wet Weather Demonstration Project
Crib wall	$ 36.50	square foot	20-30 feet/day	If done by hand	Rogue River National Wet Weather Demonstration Project
Log or Bank Shelter	$ 1,080.00	log structure	2/day	use in small streams with a low gradient (requires heavy equipment)	Rogue River National Wet Weather Demonstration Project
Deflectors	$ 390.00	log structure	2 pairs/day	requires highly experienced foreman to correctly size and place the structure	Rogue River National Wet Weather Demonstration Project
Channel Constrictors	$ 2,520.00	structure	1 pair/day	requires highly experienced foreman to correctly size and place the structure	Rogue River National Wet Weather Demonstration Project
Cross log	$ 680.00	structure	1-2/day	requires highly experienced foreman to correctly size and place the structure	Rogue River National Wet Weather Demonstration Project
Wedge and "K" dams	$ 1,360.00	dam	1/day	requires highly experienced foreman to correctly size and place the structure	Rogue River National Wet Weather Demonstration Project

Soil Stabilization				
Mulch	$ 500.00	acre	Using farm equipment	NRCS
Geotextile Fabric	$ 4.50	square yard	3 member crew, foreman, and material	Means 1996 adjusted for inflation
Seeding	$ 450.00	acre	includes site preparation using heavy equipment and 3 member crew	Means 1996 adjusted for inflation
Sodding	$ 13,068.00	acre	includes site preparation using heavy equipment and 3 member crew	Means 1996 adjusted for inflation
Check Dams	$ 15.00	linear foot	includes site preparation using heavy equipment and 3 member crew	Rogue River National Wet Weather Demonstration Project
Silt fence	$ 1.75	linear foot	Done with 3 member crew	Rogue River National Wet Weather Demonstration Project
Sediment Trap	$ 175.00	each	Done with 3 member crew	Rogue River National Wet Weather Demonstration Project
Road Crossing				
Box Culvert	$ 382.00	linear foot	36" culvert: excavation, crew, foreman, transporation, and installation	NPC Inc.
Bridge	$ 1,125.00	linear foot	72" culvert: excavation, crew, foreman, transporation, and installation	Bark River Culvert and Equipment
Cleaning	$ 8.50	cubic yard	Backhoe excavation of sediment	Rogue River National Wet Weather Demonstration Project
Equipment and Operator Rental				
Loader	$ 150.00	hour	includes operator	Rogue River National Wet Weather Demonstration Project
Excavator (backhoe)	$ 175.00	hour	includes operator	Rogue River National Wet Weather Demonstration Project
Dozer	$ 150.00	hour	includes operator	Rogue River National Wet Weather Demonstration Project
Crew	$ 30.00	hour		Rogue River National Wet Weather Demonstration Project
foreman	$ 50.00	hour		Rogue River National Wet Weather Demonstration Project
Design & legal			typically 25% to 30% of construction costs	Rogue River National Wet Weather Demonstration Project
Mobilization			3 to 5% of construction costs	Rogue River National Wet Weather Demonstration Project
Land Clearing	$ 300.00	acre	clearing and grading smooth	NRCS
Excavation	$ 3.50	cubic yard		Means 1996 and NRCS
Backfill	$ 12.00	cubic yard		Means 1996 and NRCS

Grade and Compact	$	2.00	square yard	Means 1996 and NRCS

*** Prices are in 2002 dollars**

Information and Education Cost Estimates

Task	Costs		Units	Notes	Source
Promotional					
Flyer	$	0.28	each	black and white	Grand Valley Community Survey
T-shirts	$	12.50	each	Three color m,l, and XL	Grand Valley Community Survey
Video Production	$	6,000.00	each		Grand Valley Community Survey
Telephone book inserts standard	$	0.07	each	min order of $2500	Verizon Super Pages
Telephone book inserts new resident	$	0.20	each	min order of $2500	Verizon Super Pages
Bathroom Advertising	$	75.00	each/month	monthly rate for 11"x 17" plus $95 design and $2 reproduction	Johnny Avertising
Bathroom Advertising	$	35.00	each/month	monthly rate for 8.5" x 11" plus $95 design and $2 reproduction	
Newspaper Ad	$	32.00	square inch	Sunday paper full page ad about $4000	Muskegon Chronicle
Newspaper insert	$	0.05	each	Cost of service only, reproduction is not included (1 sheet max)	Berrien County Drain Commission
Utility bill inserts	$	0.50	each	Reproduction and distribution	Grand Valley Community Survey
Yellow Pages Ad	$	5,000.00	each/year	Half Page Add in Yellow Pages	Verizon Super Pages
Watershed Logo Signs	$	90.00	each	11x17" sign	Grand Valley Community Survey
Operational					
Project Manager/year	$	29,120.00	$15/hour		Bear Creek Watershed Project
Intern/year	$	20,800.00	$10/hour		Bear Creek Watershed Project
Vehicle/year	$	15,000.00	each	does not include maintenance or insurance	Bear Creek Watershed Project
Mileage	$	3,840.00	$0.32/mile		MDEQ
Fringes (20%)	$	13,752.00		20 percent of total	MDEQ
Community Development					
Oridinance Development	$	8,000.00		lawyer fees and meetings	Grand Valley Community Survey
Education					
School Presentation	$	250.00	each	plus 20 hours preparation	Grand Valley Community Survey
4H Program	$	39,000.00	annually	Management, Staff, and programs	Bear Creek Watershed Project
Demonstration Sites					
Agriculture	$	1,350.00	each		Grand Valley Community Survey
demonstration booth	$	200.00	each		Grand Valley Community Survey
Outreach					
Riparian Club	$	8,000.00	annually		Grand Valley Community Survey
field trips	$	16.00	each student		Grand Valley Community Survey
phone hotline	$	1,142.00		first year startup	Bell South

Oil recycling container	$	2.79	each	min order of 300 and $750 delivery	GEOPlastics
Adopt-a-Stream Program	$	3,200.00	annually		Grand Valley Community Survey
Evaluation					
Water Quality Monitoring	$	180,000.00	annually		Bear Creek Watershed Project
Stream Monitoring	$	25,000.00	annually		Bear Creek Watershed Project
Fieldwork					
Canoe trip	$	250.00	each		Grand Valley Community Survey
Watershed tours	$	200.00	each		Grand Valley Community Survey
Public Relations					
Public Meetings	$	250.00	each		Grand Valley Community Survey
Workshop	$	500.00	each	plus 40 hours preparation	Grand Valley Community Survey
Committee Meeting	$	25.00	each		Grand Valley Community Survey
Newsletters					
Mailing	$	0.30	each	bulk non-sorted	USPS
	$	0.12	each	presorted bulk mail rate	USPS
	$	600.00	year	application and accounting fees for bulk mailing	USPS
Color glossy	$	2.30	each		Allegan Conservation District
Inserts	$	0.12	each	black and white	Berrien County Drain Commission
Envelopes	$	0.03	each	business envelopes box of 500	Staples.com
Letter	$	0.27	each	envelop, postage, and form letter	