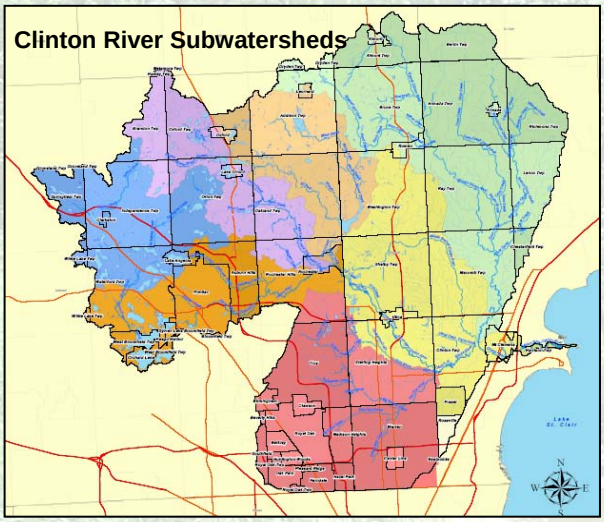
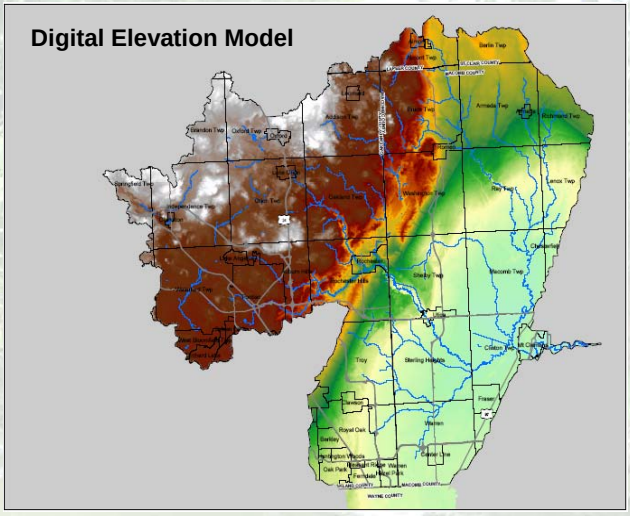
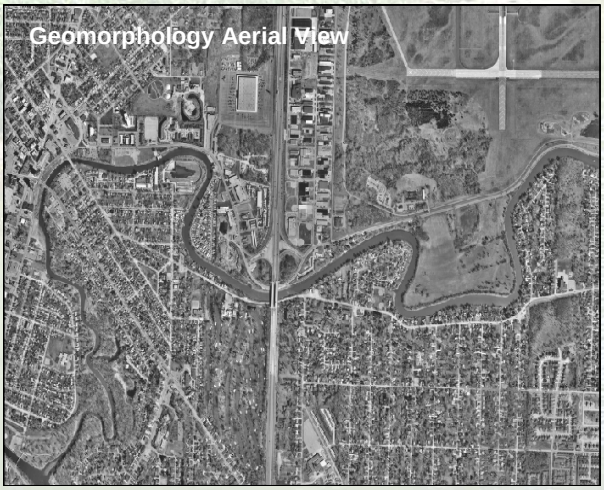
RESTORATION CRITERIA FOR THE CLINTON RIVER AREA OF CONCERN: PHASE I - FINAL REPORT

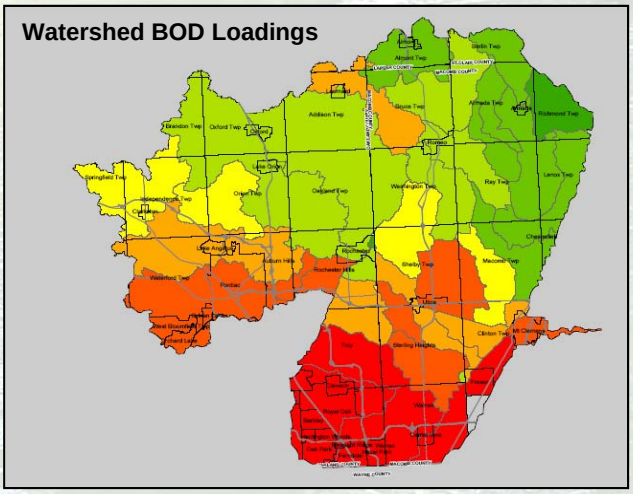
Submitted to Clinton River Watershed Council & Clinton River Public Advisory Council

October 30, 2005









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1.0 EXECUTIVE SUMMARY

The Clinton River Watershed restoration/delisting criteria development project was initiated to define "how-clean-is-clean" for the Clinton River watershed and develop endpoints that would allow for the ultimate delisting of the watershed as an Area of Concern (AOC) under the Great Lakes Water Quality Agreement. The project interfaced extensively with the Michigan Department of Environmental Quality (MDEQ) who were developing statewide delisting criteria concurrently with the development of the Clinton River criteria by the Clinton River Remedial Action Plan (RAP) Public Advisory Council (PAC), the Clinton River Watershed Council, and the project Technical Committee.

The project reviewed the delisting/restoration criteria that had developed in our AOCs and in other states to determine the applicability of these criteria to the Clinton River watershed. During this review, and during collaboration with the MDEQ on development of the Michigan state-wide delisting criteria, it became apparent that although criteria developed in other AOCs and generic state-wide criteria were good starting points, the final criteria developed for an AOC had to be site specific and adapted to the specific circumstances associated with the watershed under consideration. This philosophy was utilized in tailoring the Clinton River watershed delisting/restoration criteria that were reviewed and adopted by the Clinton River PAC at their September 15, 2005 meeting.

Although not a specific BUI, it should be noted that all the BUIs are impacted by flow variations, both low-flow and high peak to low-flow ratios. Attaining restoration criteria will be extremely difficult within the Clinton River watershed unless these flow extremes are addressed and measures implemented to control these variables.

The project reviewed the current state of the river based on existing data and available draft sub-watershed area management plans. Many of these plans were being developed in a draft form and finalized for submittal to the MDEQ during the completion of the delisting criteria project. The final plans should be revisited and evaluated for potential impacts on the conclusions of this project during the next iteration of the criteria development. Similarly, the Michigan Department of Natural Resource (MDNR) Fisheries Division Clinton River Assessment is currently being finalized and although the draft reports were reviewed and information considered in development of both the fish related criteria and the state of the watershed fisheries information within the project report, the final version of the Assessment should be reviewed for implications to the conclusions of this project.

Draft delisting criteria for the eight BUIs were initially developed by the RAP PAC, the CWRC, and the project consultant Environmental Consulting & Technology, Inc. (ECT). These criteria were then reviewed by the Technical Committee and refined for presentation to the sub-watershed groups and the RAP PAC as a whole. The final criteria adopted by the RAP PAC are contained in this report.

2.0 PROJECT INTRODUCTION AND RATIONALE

The listing of Areas of Concern (AOCs) was based on the presence of beneficial use impairments (Statewide PAC for Michigan Areas of Concern Program 2004). Since it was easier to identify the impairments than to identify the sources and causes for those impairments, we are now faced with developing site-specific restoration criteria in order to move forward with delisting. Annex 2 of the Great Lakes Water Quality Agreement (GLWQA) provided no guidance for listing or delisting BUIs. The first set of guidance for delisting criteria was put forth in 1991 by the International Joint Commission (IJC). These criteria were fairly general, and led to a more specific set of guidance published by the U.S. Environmental Protection Agency (EPA) in 2001.

In February, May, and October 2005, the Michigan Department of Environmental Quality (MDEQ) released draft delisting documents that are currently undergoing further review (Criteria for Restoration of Beneficial Use Impairments Michigan's Great Lakes Areas of Concern [MDEQ Water Bureau, Inland Lakes and Remedial Action Unit 2005]). According to MDEQ guidance, Michigan AOCs may adopt more stringent delisting criteria than MDEQ guidance, but MDEQ is not obligated to support efforts beyond what is recommended in the guidance document of 2005. MDEQ will review and approve the final delisting criteria for each AOC. The State of Ohio has also released a delisting guidance document (Ohio EPA 2005). These and other AOC-specific criteria were considered in the development of delisting criteria for the Clinton River AOC.

The goal of developing restoration (or delisting) criteria is to create a plan for the restoration of the watershed. There are social and economic consequences of the current beneficial use impairments of the Clinton River. In addition, the designation of AOC may also have economic impacts to a region. A 2003 study by the Northeast-Midwest Institute estimated that remediation of contaminated sediment in Waukegan Harbor, Illinois could increase individual property values by a range of $21,000 to $53,000. On the other hand, in Kalamazoo, a Natural Resource Damage Assessment (Ritter Appraisals Inc. 2001) concluded that there would not be any significant impact to property values from a cleanup since waterfront properties in the AOC already had the highest values in the area. In Thunder Bay, Sustainable Futures et al. (1996) estimated that $50 million in investments in economic development would ensue from cleanup of contaminated sediments in this AOC (cited from the Sediment Priority Action Committee 2000).

Restoration of the Clinton River AOC will result in benefits that can be described both qualitatively and quantitatively (i.e., in terms of economic benefits). Restoration is expected to enhance the beneficial uses of the watershed, including perhaps, ones that are not listed as impaired. Beneficial uses include swimming, boating, transportation, tourism, fish for recreational and commercial catch and consumption, wildlife viewing, clean and healthy drinking water, biodiversity and genetic preservation, agriculture and natural products for food and medicines. In addition, the quality of life is improved with enhanced aesthetics from the natural beauty of the watershed. Many people experience the environment in positive ways, such as a relief from the stresses and pressures of urban life or by having a spiritual experience or a connection with nature. In general, we can attribute many social and psychological benefits to preserving the natural beauty of our environment.

There are measurable and immeasurable benefits to restoring the river in terms of human health effects. At beaches with degraded water quality associated with storm water runoff or sewage discharges, bacterial and parasitic infections can be measured in direct medical costs or in sick days off of work for afflicted adults or caring for sick children. Restrictions on fish consumption lead to losses in market revenues from fisheries, and consumption of contaminated fish can cause health effects. Restoration should lead to improvements in human health that cannot easily be quantified due to a lack of our understanding or ability to establish cause-and-effect from exposure to biological and chemical agents from contaminated sites. For example, gastroenteritis can result from swallowing contaminated water while swimming, or from eating contaminated food. The relative contribution of cumulative exposures to chemicals in the environment to major disease processes is very difficult to assess. PCBs, one of the major contaminants in sediments, water, and fish tissues of the Clinton River, contributes to several health effects including thyroid problems, reproductive and immune system impairments, decreased IQ in children of mothers with PCBs stored in their bodies, diabetes, and cancer. Mercury, another contaminant in sediments and fish tissues that lead to the listing of the AOC, is known to cause neurological and developmental effects including cerebral palsy. There is some speculation that mercury is a causal factor in autism, which has been on the rise in Michigan.

It is equally important to reduce or eliminate chemical discharges into our waterways. Chemicals released to the environment cycle between air, soil, water, sediments, and biota and are transported globally through the atmosphere. Thus, we cannot eliminate our exposure to toxic chemicals by merely avoiding direct contact with known contaminated sites. Routes of exposure to toxic chemicals include dermal, oral, and respiratory/inhalation from swimming and other recreational uses, and oral exposure to chemicals in our drinking water, since the Clinton River drains into Lake St. Clair and the Detroit River that are sources of our drinking water.

A high biological loading by nutrients from fertilizers and erosion leads to undesirable algal blooms which can affect boating and water quality. Algae increase the natural organic matter content of the source water, which upon disinfection with chlorine, forms toxic disinfection byproducts in our drinking water. Algae also add an undesirable taste-and-odor to the water. Although drinking water was not a basis for the listing of the AOC, restoration would likely improve drinking water quality.

Ecosystem health is important to humans as well as to the fish and wildlife. Maintaining genetic diversity and healthy populations of fish and wildlife will result in immediate as well as long term beneficial uses.

Restrictions on dredging impact navigational uses of the AOC related to recreational uses and commercial transportation. Economic impacts from AOC delisting and restoration are expected including an increase in property values, business and tourism revenues. Cost-benefit analysis in terms of remediation can easily be justified. Remediation for PCB and other contaminant removal is a short-term investment that leads to long-term benefits. Long-term projects to sustain the environment, such as storm-water management plans lead to continuous economic benefits, but will require operation and management costs in addition to capital investments in infrastructure improvements and technological BMPs.

The development of delisting/restoration criteria for the BUIs within the AOC is an essential part of the upcoming RAP update. These criteria will be utilized to specify measurable endpoints that will enable the PAC and associated stakeholders to know when the remediation in the AOC has accomplished the specified RAP goals. Each BUI will be evaluated with respect to the applicability of that BUI to each of the AOC sub-watersheds as part of this project. This information will be utilized in the RAP update to determine which criteria should be applied where within the AOC.

3.0 RIVER PERSPECTIVE: WHERE WE ARE NOW

The Clinton River watershed (CRW) is a designated Area of Concern (AOC) under the Great Lakes Water Quality Agreement, signed in 1972 by the governments of Canada and the United States. The watershed is located immediately north of the City of Detroit and encompasses 760 square miles of Southeast Michigan. The watershed has a full spectrum of land uses ranging from urban to forested and agrarian, and is one of the most populous watersheds in the Midwest. The watershed is mostly glacial lake bed with well-stratified glacial deposits of low permeability that result in low infiltration and a natural tendency toward rapid response to surface runoff. This natural tendency has been intensified by the large population density (more than 1.5 million people, making it the most populous watershed in Michigan) and the resultant increased impervious area in the watershed. The designated Area of Concern (AOC) also includes the area of Lake St. Clair shoreline between the natural river channel and the spillway. The designated sub-watersheds within Clinton River are shown in Figure 3.1.

This watershed has experienced substantial growth in the last 100 years (see Figure 3.2). Per SEMCOG (1996), this trend is expected to continue and the watershed is expected to experience significant growth over the next thirty years, including a 10% increase in population, a 20% increase in the number of households, and a 14% increase in the number of jobs. This watershed's topography is typical of southeast Michigan plains, and the longitudinal slope along the stream, on an average, is roughly 0.5% with glacial action shaping the downstream portions of the watershed that are at a much lower elevation than the western, upstream section (see Figure 3.3). Trends in land use changes are presented for 1950 versus 2000. Figure 3.4 shows that less than a fifth of the watershed was urbanized in 1950 whereas Figure 3.5 shows a majority of the southern portions of the watershed as completely urban area as of 2000. Per Booth and Reinelt (1993), the water quality in a watershed declines substantially once the imperviousness in a watershed increases to ten percent or more. Figure 3.6 shows the calculated imperviousness in the Clinton River watershed based upon the methodology proposed by Cappiella and Brown (2001). It is evident that more than 50% of the watershed is highly impervious and thus the overall water quality is expected to be poor. The northern portion of the watershed, however, is still largely rural and is expected to be in good overall shape based on this analysis.

Water quality priorities in the Clinton River watershed include elimination of combined sewer overflows and sanitary sewer overflows, nonpoint source pollution control, Superfund waste site and contaminated sediments remediation, spill notification, habitat restoration, and elimination of illicit connections and failing septic systems.

3.1 EXISTING BENEFICIAL USE IMPAIRMENTS

Based upon the 1995 Clinton River Remedial Action Plan (RAP) Update, a total of eight beneficial uses are considered impaired and are listed in Table 3-1 below.

Table 3-1: Summary of eight beneficial impairments in the Clinton River watershed

USE IMPAIRMENT	EXPLANATION OF IMPAIRMENT	SCOPE	IMPACT TO GREAT LAKES
Degraded fish and wildlife populations	Degraded native mussel populations attributable to in-stream sedimentation; zebra mussel presence may also threaten native mussel fauna; warm water fishery impaired by sedimentation, impoundment, changes in hydrology; cold water fishery in Main Branch, Paint Creek, Stony Creek, East Pond Creek threatened by sedimentation, low flows, habitat loss, elevated summer temperatures	Watershed-wide	Yes
Beach closings and other "full body contact" restrictions	CSOs, urban and rural storm water runoff, failing septic systems, animal waste, and illegal connections to storm sewers all contribute to elevated fecal bacteria levels in many locations throughout the watershed	Watershed-wide	Yes
Loss of fish and wildlife habitat	Urban sprawl and inadequate land use planning; erosion, wetland loss, dams, hydrological changes, alteration of riparian habitat	Watershed-wide	Yes
Restrictions on fish and wildlife consumption	Fish consumption advisory for PCB contamination specific to Carp; current sources of PCB are contaminated sediments, and potentially Nonpoint sources	Localized	Yes
Eutrophication or undesirable algae	Excessive algal growth occurs in the lower Clinton River and inland lakes primarily due to high nutrients from storm water runoff, and low flows	Localized	Yes
Degradation of benthos	Benthic communities are impaired throughout the watershed because of sedimentation, and at specific locations due to contaminated sediments	Watershed-wide	No
Degradation of aesthetics	Widespread erosion and in-stream sedimentation; localized algal blooms, habitat degradation, litter, log jams	Watershed-wide	No
Restrictions on dredging activities	Guidelines for open water disposal of sediments from the navigational channels are exceeded in the lower Clinton River for PCBs, oil, grease, and metals; Confined disposal of sediments required	Localized	No

As presented above, three of the BUIs have impacts restricted to the watershed. Three others namely, "restrictions on fish and wildlife consumption" (specific to Carp), "eutrophication", and "beach closings" do have impacts on the Great Lakes, but are confined to the western near-shore areas of Lake St. Clair. The remaining two BUIs have a Great Lakes wide impact. These include "degraded fish and wildlife populations" and "loss of fish and wildlife habitat".

Although historically industrial and municipal discharges were the primary causes of environmental degradation in the Clinton River, there are currently no major industrial discharges to the river or its tributaries (only non-contact cooling water and storm water) and municipal facilities have instituted industrial pretreatment programs and combined sewer control plans. Ongoing contamination problems within the watershed are largely of Nonpoint source origin and the increasing prevalence of impervious surfaces exacerbates the runoff associated problems.

Clinton RAP Update 1998 estimates that storm water runoff, as a category, is the single largest source of water quality degradation. Erosion and sedimentation contribute significantly to use impairments, thus sediments are considered the primary contaminant in the Clinton River. Urban expansion and the subsequent loss of wildlife habitat is the second significant environmental problem related to water quality in this watershed. Wetlands and other wildlife habitat have been drastically reduced in the downstream portion of the basin.

Although fecal contamination from wastewater treatment plants was greatly reduced in mid-1980s, failing septic systems and an increased density of people, illegal storm sewer connections, and contaminated runoff originating from domestic animals and wildlife have led to higher incidences in the last ten years. Long-term beach closures and severe economic losses to area businesses as a result of those closures, such as was experienced in the summer of 1994, are a real problem of concern.

3.2 TRENDS IN WATER QUALITY AND QUANTITY

MDEQ routinely monitors the water quality in streams near the mouth of the stream. In 2002 they sampled 35 stream locations throughout the state. Nine of these sites were "intensely" sampled locations which means they were sampled twelve times during the year in high flow and base/low flow conditions, with emphasis on the high flow periods. The only Clinton River watershed station is located at Shadyside Park on Gratiot Avenue in Mt. Clemens, Macomb County. Among intensely monitored stations that were part of the MDEQ 2002 water quality monitoring program, the Clinton River station showed the highest median normalized to stream discharge for total phosphorus and chloride (0.17 mg/l and 126 mg/l respectively). The Clinton also ranked highest in median normalized total chrome, copper, and lead (1.5 ug/l, 4.3 ug/l, and 1.7 ug/l respectively). Total PCB in the water column was measured at 4.231 ng/l, exceeding the Rule 57 water quality value of 0.026 ng/l. Similarly the 4.823 ng/l mercury concentration exceeds the Rule 57 1.3 ng/l value. Review of the 2003 MDEQ monitoring program data shows similar results for Shadyside Park.

The Macomb County Health Department (MCHD) has been conducting water quality sampling at several Clinton River watershed locations since 1998. In addition, a multi-million dollar effort is currently underway that targets dry- and wet-weather data collection in Lake St Clair watershed that includes Clinton River watershed (see measurement locations on Figure 3.7). Data from these sample stations is presented in the 2002 Lake St. Clair Water Quality Assessment report. All the 2002 and 2003 watershed samples collected exceeded the critical value for nitrate (0.3 mg/l) and total phosphorous (0.05 mg/l). All the watershed samples also exceeded the wildlife protection value for mercury (1.3 ng/l). One of the notable findings in the 2002 report is that six of the nine aqueous chemistry parameters measures (chloride, nitrate, TKN, ortho-phosphorous, total phosphorous, and TOC) showed a higher dry weather average concentration that the wet weather concentrations.

The United States Geological Survey (USGS) either currently maintains or has maintained a total of sixty-one flow measurement stations in the watershed. Such a large number of measurement stations is a direct indication of the importance of this highly urbanized watershed in Southeast Michigan. It is also a measure of the concern that various agencies have in the changes that the watershed has

undergone or is undergoing. Of these sixty-one flow measurement stations, sixteen stations (locations shown on Figure 3.8) provide a significant historical record of the flow. As a part of an on-going watershed-wide geomorphology study in the Clinton River (ECT Inc. 2004), these data have been statistically analyzed to provide insight into the overall flow trend patterns of the Clinton River watershed.

The flow data analyses include a trend analysis of the peak stream flow, annual mean stream flow and bankfull discharge data normalized for the past forty years. The results of these analyses, presented in Figure 3.9, show that in some locations in the watershed there is a multi-fold increase in the peak stream flows over the past 40 years. In the same time period, although not presented here, annual mean stream flows and the bankfull flows have also dramatically increased. Understanding the relationship between percent change in peak stream flow and mean annual flow at each measurement station provides another approach of the data interpretation, and is presented in Figure 3.10. Figure 3.10 shows a direct correlation between the two sets of data which in turn, point to the increased imperviousness of the watershed.

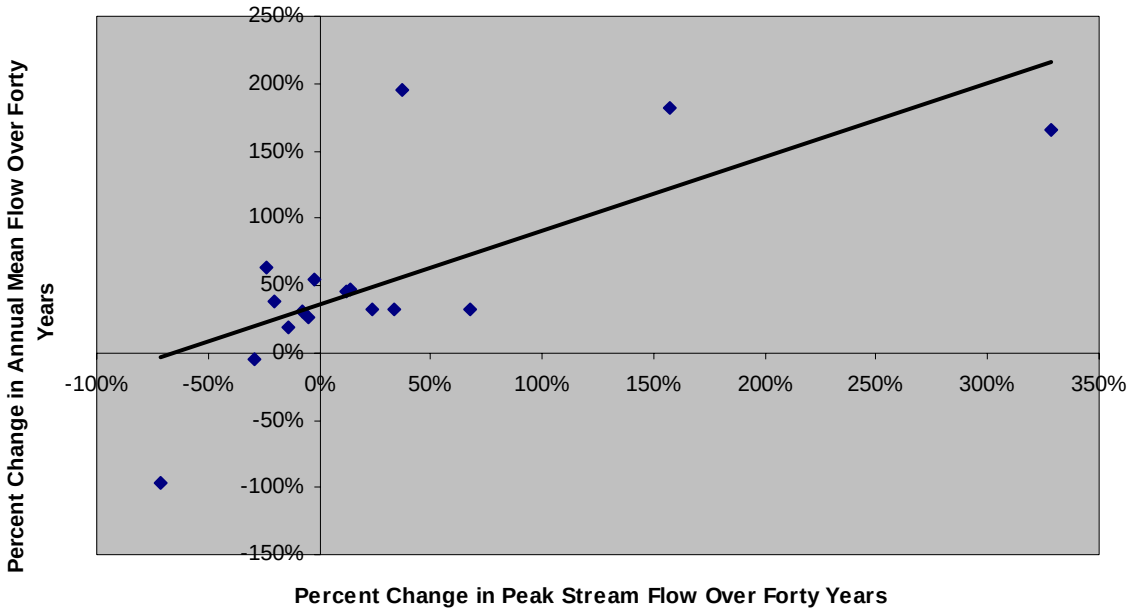

Figure 3.10: Change in Peak Stream Flow Versus Change in Mean Annual Flows within Clinton River watershed

To further explore the effect of increased imperviousness on the bankfull discharge, additional analysis of the data available at these sixteen gages was undertaken. Daily flow values were plotted versus time and the increase in flow values were carefully examined. These increases were grouped into intervals of time based on consistent flow conditions. An interval was established when either the maximum value of the spikes began to increase or decrease (see Figure 3.11, 12, 13). Once the flow was categorized into time intervals of constant flow conditions, the bankfull flow value was established by finding the flow rate that corresponded to an average occurrence of once per 1.5 years within that

time interval. As presented in Figures 3.11, and 3.12 typically the bankfull values have increased significantly over time. However, due to increased detention/retention facilities, several USGS gages indicate fairly constant bankfull discharge values (Figure 3.13).

Based on the results from the various flow analyses in the Clinton River watershed, the following conclusions are evident:

- At most stations, increased imperviousness has led to an increase in peak stream flows as well as in annual mean flows.
- Analysis of the data from most stations also indicates increased bankfull discharge values over the last few decades.
- There is a strong correlation between peak stream flows and annual mean flows. As indicated in Figure 2-6, systematic increase in one is expected to lead to an increase in the other. Vice-versa, it is expected that a decrease in one will lead to a decrease in the other.
- The mean annual flows have generally increased significantly more than peak stream flows over the last forty years implying that there is a higher incidence of increased flows over time.

3.3 FISHERIES TRENDS IN THE CLINTON RIVER

There is a significant lack of information regarding the historical fish community in the Clinton River watershed. Zorn and Seelbach (1992) reviewed historical literature regarding the Clinton River fisheries and provided a summary of the data that is available.

> "The upper and middle mainstem, being warmed by lakes and cooled by groundwater, contained a coolwater fish fauna which required clear waters and coarse substrate. This included fishes such as small mouth bass…darters…suckers and minnows. The fish fauna of Paint and Stoney creeks consisted of fishes such as sculpins…dace, and chubs which require similar habitat conditions but cold water. By the 1880's, these creeks supported brook trout populations, which originated from hatchery plants.
>
> The lower mainstem (especially below Utica), the North Branch, and Red Run provided different conditions for fish. With their flows being dominated by runoff, these streams were warmer, had lower flow in the summer, and were more prone to flooding than other reaches. Fine substrates (silt and sand) were more common due to the extremely low gradient of these streams, and riparian wetlands were also abundant. These reaches supported pikes, smallmouth bass, largemouth bass, other sunfishes, suckers, and minnows."

The Michigan Department of Natural Resources Fisheries Division is in the process of completing a Clinton River Assessment (Francis & Haas 2005). The watershed was divided into five sub-areas for the purpose of the assessment work. As shown in Figure 3.14, the assessment segments are the headwaters segment, upper segment, middle segment, lower segment and mouth segment. The watershed shows varied temperature regimes with lowest temperatures in the middle segment. The upper portions of the watershed have warmer water temperatures due to the large number of surface impoundments. The middle portions of the watershed are more groundwater fed, and hence the

temperatures tend to be lower. Finally, the lower portions are heavily urbanized and have higher water temperatures. As with most urban rivers, high base to peak flow ratios coupled with low base flows tends to have a significant negative impact on the existing and potential fisheries within the watershed.

The Headwaters Segment is generally in good condition from a fisheries perspective in that it has a good gradient and substrate and a large population of warm water fish. The fish community has been rated as excellent/unimpaired in this segment. One Headwaters Segment site sampled in 2001 showed 14 species of fish consisting of such varieties as rainbow darter, fantail darter, largemouth bass, and grass pickerel. This site was the only sampling site in the watershed that had blackchin shiners, which require clear, clean, weedy waters for survival and are indicative of a very high quality environment. The MDNR has historically conducted fish stocking in this segment although in general, game fish are few in number and too small to provide a good sports fishery. Unfortunately, as indicated earlier, this segment tends to have warm water temperatures due to the many lakes/impoundments and associated surface overflow dams. The temperature problem, in conjunction with the small stream dimensions, results in a low fisheries potential from a management standpoint.

The Upper Segment of the river is largely a conduit between various impoundments and lakes. The lower portion of the Upper Segment is enclosed under the City of Pontiac. Flows are artificially altered due to the controlled lake level impoundments throughout the segment. Substrate tends to be extremely variable ranging from gravel and cobble to silt/sand. The 2001 fish study showed good species diversity in the segment generally dominated by warm water species (creek chubs, bluegill, largemouth bass, and yellow perch). Fish studies done within this segment in the 1970's and 1980's showed similar results as the 2001 study The lakes within the segment generally have good warm water fish communities (bluegill, pumpkinseed, rock bass, and largemouth bass) with some of the lakes also having northern pike, yellow perch, and smallmouth bass. Portions of the Upper Segment have been historically managed for rainbow and brown trout but the warm water temperatures have made these management programs unsuccessful. Although the lakes and river runs within this segment provide an adequate public fishery, the variable flows and warm summer temperatures, coupled with the channelized downstream portion of this segment, make it undesirable from a fisheries management standpoint.

The Middle Segment also has a good gradient and good habitat potential but the flashiness and volume of flow in this segment are a significant issue restricting potential fisheries development. Three stations were sampled in the Middle Segment in 2001. The two upper sites were ranked as acceptable and the lower site was considered to be excellent. The predominant fish species found were white suckers and hog suckers. The Middle Segment was sampled at 12 locations during 1973. Catch rates during the 1973 survey were 14.1 fish/100 feet samples, and 58.5 fish per 100 feet sampled in 2001. The species diversity had also improved in the segment with an increased number of pollution intolerant species. Paint Creek, Stoney Creek, and the West Branch of Stoney Creek all have good substrate and support mottled sculpin, creek chubs, white suckers, brown trout, rainbow trout, rainbow darters, and common shiners. On the other hand, Gallagher Creek has deteriorated significantly since earlier fish surveys as a result of development pressures resulting in increased flows and sediment load and although the cooler water in the Creek can serve as a refuge during hotter summer temperatures in the mainstem of the Middle Segment, the predominant fishery is composed of pollution tolerant species. Various locations in the Middle Segment have been managed by the MDNR for

brown trout, steelhead, and walleye. The steelhead and walleye programs still continues. The trout management program had been discontinued but was reestablished in 2003. Brown trout continue to survive in the segment and appear to be naturally reproducing.

The Lower Segment has a reduced gradient but still has good substrate throughout much of the segment although the downstream portions of the segment tend to have significant sediment deposits that adversely affect the habitat. Additionally, stream flow variability in the segment has a negative impact on the fisheries potential. Three sites were sampled on the Lower Segment in 2002. The predominant species were round gobies (an exotic species), white sucker, rock bass, northern hog sucker, and bluntnose minnows. The nine sites sampled in this segment during 1973 showed a lower species diversity and predominantly pollution tolerant species such as carp, suckers, and shad. The fisheries improvement is likely indicative of a generally improved water quality in the Lower Segment over the last three decades. The Middle Branch of the Clinton River has good quality at the upper end but becomes essentially a degraded drain at the downstream end. The predominant fish species are pollution tolerant. Coon Creek and East Coon Creek are essentially agricultural drains and have generally warmer water temperatures, low base flows, high peak flows, and poor substrate. The Red Run portion of this segment has significantly degraded habitat and is unusable as a fisheries resource in the present condition. A gem among the Lower Segment streams is the North Branch of the Clinton River. The upper portions of the branch tend to have cooler water bordering on being a cold water stream. The headwaters areas of the North Branch have a great cold water fish community including naturally reproducing brook trout. Unfortunately, the stream habitat deteriorates in quality and flows become more flashy as it flows downstream though the more urbanized areas of the watershed and the fish community becomes more pollution tolerant and generally of poorer quality. The Lower Segment has historically been managed for steelhead, walleye, and trout. Steelhead and walleye are still available in the downstream area of the segment primarily as migratory species from Lake St. Clair.

The Mouth Segment has a low gradient, mostly silt/sand substrate, warm temperatures, and flashy flows. The flow is typically slow and very turbid. Pollution tolerant fish species such as carp and gizzard shad were the predominant species located during the 2002 survey of the Clinton River channel. Largemouth bass and golden shiner were also located. The 1973 survey showed even fewer fish species than the 2002 survey and an even higher dominance of carp. The 2002 survey of the Clinton River Cut-Off Canal indicated that the community was dominated by common carp, gizzard shad, largemouth bass, golden shiner, and goldfish. The Mouth Segment of the river is managed for seasonal steelhead and walleye fishery but the predominant fishery influence in this portion of the river is from Lake St. Clair.

3.4 TRENDS IN SEDIMENT CONTAMINATION

As indicated in Table 3-1, contaminated sediment is a key problem in Clinton River Watershed because it directly impacts six out of eight listed BUIs, namely “degraded fish and wildlife populations”, “restrictions on dredging activities”, “degradation of the benthos”, “eutrophication”, “degradation of aesthetics”, and “restrictions on fish and wildlife consumption”. This is because chemicals in the sediments may be toxic to the benthos, and hydrophobic organic chemicals such as PCBs, semivolatile organics, and organic forms of mercury bioaccumulate in higher trophic organisms. The contaminated

sediments that are of concern are those that are in contact with the overlying water such that they can partition between water, air and biota by contaminating the food chain. Contaminated sediments that get sufficiently buried and are not subject to resuspension do not pose a significant risk to organisms. A detailed understanding of sediment resuspension or mobilization in the Clinton Watershed is thus of utmost importance.

In 1994, a detailed watershed-wide sediment survey was undertaken by the U.S. EPA Great Lakes National Program Office, U.S. Army Corps of Engineers, and their consultants. Based upon this study, the headwater regions of the Clinton River did not appear to suffer from serious degradation attributable to toxic contamination. Degraded areas in these reaches were primarily attributable to sedimentation. There were several isolated spots that required follow-up for source identification and control, for metals and some semi-volatile organic compounds. Pesticide contamination did not appear to be a problem in the Clinton River Watershed other than historical levels of organochlorines such as DDTs and chlordanes. However, only a limited number of sampling locations have been studied in the upper reaches of the Clinton River, therefore, more assessment needs to be done and is underway.

In 1994, sediments of the Main Branch (from Pontiac to the confluence with Red Run Drain) were found to be moderately contaminated with metals, petroleum hydrocarbons, a number of semi-volatile organic compounds and nitrogen. It appeared that the contamination was fairly widespread throughout this corridor, relatively serious, and required a follow-up investigation. The 1994 study also found that all samples from Red Run/Plum Brook drainage indicated moderate to heavy contamination of the sediments with metals, petroleum hydrocarbons, and other compounds. The lower reaches of the river including the spillway contained the most contaminated reaches of stream in the watershed. Elevated levels of metals, petroleum hydrocarbons, semi-volatile organic compounds, as well as PCBs, DDT, DDE, and DDD were common in the sediments at levels above sediment quality guidelines.

The 1995 RAP update suggested a follow-up assessment to quantify the extent and severity of the problem, as well as a comprehensive abatement program to minimize the storm water runoff contribution. The 1998 RAP update indicated that some progress had been made for CSO control and separation of combined sewers, but no progress was made in identifying the main sources of the contaminants of concern including PCBs, PAHs, organochlorines, mercury, lead, copper, zinc, and arsenic. Most of the contaminants are thought to be historical (e.g., PCBs) or implied to be from contaminated sites within the watershed. The RAP report identifies 1250 contaminated sites including landfills and leaking underground storage tanks in the watershed including 27 on the National Priorities List and four Superfund sites. An old source of chemicals that makes its way into the river could be considered a new source of contamination to the Clinton River. The 1998 RAP update for the Clinton River recommended to, “identify and track progress at sites of environmental contamination that are contributing to or have the potential to contribute contaminants to the Clinton River” and “determine contaminant loading to groundwater and surface water from abandoned dumps and waste sites”.

Caged fish studies were conducted in the Clinton River in 1999-2000 in an effort to locate sites that are contributing to contaminants in fish. The results of the caged fish studies were published in annual reports (MDEQ SWQD 2001, 2002). The results show elevated levels of PCBs in caged fish at the mouth of the main channel from the I-94 to Lake St Clair. However, Harris Lake in Pontiac and several points from Pontiac to the middle branch (Opdyke and Adams Rd in Oakland County, and Ryan and

Cass Roads in Macomb County) all had levels of PCBs from a third to half as concentrated as the caged fish in the lower main channel and mouth of the Clinton River. Note that the concentrations of PCBs range from 0.02 to 0.08 ppm from Pontiac to Lake St Clair in 28 day caged fish studies, which is not a sufficient duration to reach equilibrium (that takes roughly 60 to 90 days). This may indicate widespread low level contamination of PCBs being carried in the water column or existing in the resuspension zone of surficial sediments.

Overall, reports on sediment chemistry and caged fish studies suggest no clear trend in sediment concentrations over time within this watershed. This could be due to several factors: the movement of sediments from sediment resuspension and/or remobilization following storm events, boat activities or bioturbation, new inputs of contaminants, natural attenuation mainly from sediment deposition which buries or dilutes historically contaminated sediments, or a function of the way the sediments were collected and analyzed. A point worth mentioning with respect to trends in sediment contamination is what occurred in a recent storm event in May, 2004. Discharge rates in portions of the Clinton River exceeded 100 year-flood levels, and greatly mobilized sediments down the Clinton River. This also may make historic sediment chemistry data of little value.

In 2003, EPA's Great Lakes National Program Office (GLNPO) started a sediment sampling program in the watershed that is being carried out by Oakland University, Wayne State University and their consultants Environmental Consulting & Technology Inc. This sampling program will determine which factors are significant to understand the mixing and transport of sediments, the stratigraphy or chronology of the sediments, and in identifying potential hotspots and sites for remediation. This study will be completed in March 2005. A summary of the study to-date is as follows: 22 cores of sediments of at least 3 feet in depth have been collected and cut in centimeter or inch increments. These layers are being dated using short-lived radionuclides, ^{7}Be and ^{210}Pb. From this, the extent, mixing and remobilization of contaminants with time will be determined. GLNPO project team is simultaneously collecting water and suspended sediments in various locations within the Clinton River to determine the mobility and bioavailability of contaminants associated with the dissolved and colloidal phases of the water versus the larger particles that settle out. The team will determine if sediments piled up in depositional zones contain sufficient concentrations that can be remediated before another major storm event occurs. The team also found areas where sediments 6-18 inches in depth before the storm have now been swept away, exposing glacial clay and have unearthed old artifacts that had been buried for decades.

3.5 PRE- AND POST-EUROPEAN SETTLEMENT HABITAT/SPECIES EVALUATION

Like almost all regions in the North American continent, European settlement has drastically changed the habitat for flora and fauna, and has impacted almost all native species of plants and wildlife with the Clinton Watershed. In the year 1800, as shown in Figure 3.15, a third of the watershed was covered with Beech-Sugar Maple forest. The other significant types of forests in the watershed were those of Black Oak Barren, Mixed Oak Savanna, and Oak-Hickory Forest. Individual percentages are shown below.

Table 3-2: Summary of vegetation in Year 1800 within Clinton River Watershed

NAME	ACRES	PERCENT OF TOTAL
Beech-Sugar Maple Forest	175,056	35.81%
Black Oak Barren	99,030	20.26
Mixed Hardwood Swamp	57,836	11.83
Mixed Oak Savanna	36,217	7.41
Mixed Oak Forest	29,046	5.94
Oak-Hickory Forest	23,977	4.90
Mixed Conifer Swamp	23,305	4.77
Wet Prairie	16,485	3.37
Lake/River	9,815	2.01
Shrub Swamp/Emergent Marsh	5,859	1.20
Black Ash Swamp	5,019	1.03
Oak/Pine Barrens	3,953	0.81
Muske/Bog	2,127	0.44
Spruce-Fir-Cedar Forest	639	0.13
Cedar Swamp	476	0.10
Total	488,841	100%

As indicated in Figure 3.15, over 20% of the watershed was swamp or wetlands or lakes/rivers. During 1800 through 1975, the population in the area has grown substantially and has resulted in a significant loss of wetlands (see Figure 3.16). The majority of the wetland corridor in the southern portion of the watershed is now gone. Much of this has occurred due to the massive change in land use as evident in Figure 3.3 (1950 land use) and Figure 3.4 (2000 land use). Per SEMCOG (200x), urbanization continues at a strong pace in the watershed underscoring the need for regional storm water ordinances that may help protect the area.

Sporadic botanical investigations have taken place in parts of the drainage over the years. Between 1934 and 1941, Marjorie Bingham conducted a plant survey of Oakland County, and in 1974, Paul Thompson conducted an ecological survey of Oakland Township. Botanists from Cranbrook, Oakland University, the Michigan Natural Areas Council, the University of Michigan, and elsewhere have collected data in the basin over the years. With regard to mammals, Leraas and Hatt studied mammals in the Cranbrook area in the mid-1930's. Bird records have been summarized recently by Kelley (1978) and Detroit Zoo personnel in early 1960's.

A good summary of all of the above studies can be found in the 1981 Michigan Natural Features Inventory report. Based upon the findings in the 1981 this report, and a 2004 updated list of

threatened, endangered, and special concern species, (Table 3-3), a large number of species within the Clinton River watershed have been impacted by the historical and on-going urbanization.

Table 3-3: 2004 List of threatened, endangered, and special concern species within Clinton River watershed

SCIENTIFIC NAME	COMMON NAME	STATE STATUS
Vegetation		
Agalinis gattingeri	Gattinger's Gerardia	E
Castanea dentata	American Chestnut	E
Gentiana puberulenta	Downy Gentian	E
Obovaria subrotunda	Round Hickorynut	E
Plantago cordata	Heart-leaved Plantain	E
Amorpha canescens	Leadplant	SC
Angelica venenosa	Hairy Angelica	SC
Arabis missouriensis var. deamii	Missouri Rock-cress	SC
Carex richardsonii	Richardson's Sedge	SC
Cirsium hillii	Hill's Thistle	SC
Drosera anglica	English Sundew	SC
Gymnocladus dioicus	Kentucky Coffee-tree	SC
Hieracium paniculatum	Panicled Hawkweed	SC
Linum sulcatum	Furrowed Flax	SC
Penstemon pallidus	Pale Beard Tongue	SC
Phaseolus polystachios	Wild Bean	SC
Scirpus clintonii	Clinton's Bulrush	SC
Scleria triglomerata	Tall Nut-rush	SC
Smilax herbacea	Smooth Carrion-flower	SC
Strophostyles helvula	Trailing Wild Bean	SC
Villosa iris	Rainbow	SC
Aristolochia serpentaria	Virginia Snakeroot	T
Armoracia lacustris	Lake Cress	T
Asclepias sullivantii	Sullivant's Milkweed	T
Astragalus canadensis	Canadian Milk-vetch	T
Bouteloua curtipendula	Side-oats Grama Grass	T
Callitriche heterophylla	Large Water-starwort	T
Carex lupuliformis	False Hop Sedge	T
Cypripedium candidum	White Lady-slipper	T
Fuirena squarrosa	Umbrella-grass	T
Galearis spectabilis	Showy Orchis	T
Gentianella quinquefolia	Stiff Gentian	T
Hydrastis canadensis	Goldenseal	T
Linum virginianum	Virginia Flax	T

SCIENTIFIC NAME	COMMON NAME	STATE STATUS
Panax quinquefolius	Ginseng	T
Platanthera ciliaris	Orange or Yellow Fringed Orchid	T
Psilocarya scirpoides	Bald-rush	T
Trichostema dichotomum	Bastard Pennyroyal	T
Trillium recurvatum	Prairie Trillium	T
Trillium sessile	Toadshade	T
Valeriana edulis var. ciliata	Edible Valerian	T
Viola pedatifida	Prairie Birdfoot Violet	T
Zizania aquatica var. aquatica	Wild-rice	T
Cyperus acuminatus	Nut-grass	X
Liatris squarrosa	Blazing-star	X
Monarda didyma	Oswego Tea	X
Sisyrinchium hastile	Blue-eyed-grass	X
	Wildlife	
Epioblasma triquetra	Snuffbox	E
Nicrophorus americanus	American Burying Beetle	E
Toxolasma lividus	Purple Lilliput	E
Villosa fabalis	Rayed Bean	E
Accipiter cooperii	Cooper's Hawk	SC
Acris crepitans blanchardi	Blanchard's Cricket Frog	SC
Calephelis mutica	Swamp Metalmark	SC
Circus cyaneus	Northern Harrier	SC
Emys blandingii	Blanding's Turtle	SC
Erynnis baptisiae	Wild Indigo Duskywing	SC
Macrhybopsis storeriana	Silver Chub	SC
Microtus pinetorum	Woodland Vole	SC
Notropis anogenus	Pugnose Shiner	SC
Nycticorax nycticorax	Black-crowned Night-heron	SC
Oecanthus laricis	Tamarack Tree Cricket	SC
Oecanthus pini	Pinetree Cricket	SC
Pleurobema coccineum	Round Pigtoe	SC
Sistrurus catenatus catenatus	Eastern Massasauga	SC
Asio otus	Long-eared Owl	T
Buteo lineatus	Red-shouldered Hawk	T
Clemmys guttata	Spotted Turtle	T
Elaphe vulpina gloydi	Eastern Fox Snake	T
Gavia immer	Common Loon	T
Lampsilis fasciola	Wavy-rayed Lampmussel	T
	Communities	
Bog		
Coastal plain marsh	Infertile Pond/marsh, Great Lakes Type	

SCIENTIFIC NAME	COMMON NAME	STATE STATUS
Delta	Geographical Feature	
Dry-mesic southern forest		
Emergent marsh		
Great blue heron rookery	Great Blue Heron Rookery	
Great lakes marsh		
Hardwood-conifer swamp		
Kame	Geographical Feature	
Landscape complex		
Mesic southern forest	Rich Forest, Central Midwest Type	
Outwash	Geographical Feature	
Prairie fen	Alkaline Shrub/herb Fen, Midwest Type	
Relict conifer swamp	Forested Bog, Central Midwest Type	
Southern floodplain forest		
Southern swamp		
Southern wet meadow	Wet Meadow, Central Midwest Type	
Submergent marsh		

E= Endangered
SC = Special concern
T = Threatened
X = Possibly extirpated

3.6 NATURAL RESOURCE VALUES AND IMPORTANT AOC FEATURES

The Clinton River watershed has many natural resources that are highly valued by the local residents and visitors recreating in the watershed including:

- Mink
- Muskrat
- Beaver
- Heron and king fishers
- freshwater clams/mussels
- high quality warm water and cold water fisheries
- cedar bogs
- wetlands that abound with wild flowers and assorted wildlife

The natural beauty of the undeveloped upstream areas is highly valued for the pure enjoyment of nature at its finest. These areas are high priority preservation areas for the local residents for wildlife

viewing, recreation, and fishing. Surveys within the upper watershed areas indicate that the local people value the uniqueness of the area, the landscape diversity and environmental features (the "view"), the beauty of the riparian corridor, the wildlife, the passive recreation/nature observation aspects, and the wetland areas.

The Michigan Natural Features Inventory has completed an extensive analysis in Oakland County which contains the upper portions of the Clinton River watershed. A variety of threatened, endangered, special concern, and high quality natural communities were identified in the study.

Table 3-4: Threatened, Endangered and Special Concern Plants in the Upper Clinton Sub-watershed

SCIENTIFIC NAME	COMMON NAME	STATE STATUS*
Carex richardsonii	Richardson's Sedge	SC
Cypripedium candidum	White Lady-slipper	T
Drosera anglica	English Sundew	SC
Linum virginianum	Virginia Flax	T
Platanthera ciliaris	Orange or Yellow Fringed Orchid	T
Trichostema dichotomum	Bastard Pennyroyal	T

* (E=Endangered, T=Threatened, SC=State Special Concern)

Table 3-5: Threatened, Endangered and Special Concern Animals in the Upper Clinton Sub-watershed

SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS*	STATE STATUS*
Buteo lineatus	Red-shouldered Hawk		T
Erynnis baptisiae	Wild Indigo Duskywing		SC
Oecanthus laricis	Tamarack Tree Cricket		SC
Oecanthus pini	Pinetree Cricket		SC
Sistrurus catenatus catenatus	Eastern Massasauga	C	SC
Villosa fabalis	Rayed bean mussel		E
Epioblasma triquetra	Snuffbox mussel		E
Lampsilis fasciola	Wavy-rayed lamp-mussel		T
Pleurobema sintoxia	Round pigtoe mussel		SC
Villosa iris	Rainbow mussel		SC

* (FE=Federal endangered, C=Federal concern, E=State endangered, T=State threatened, SC=State special concern)

Table 3-6: High Quality Natural Communities and Unique Geographical Features in the Upper Clinton Sub-watershed

NAME	TYPE/DESCRIPTION
Emergent Marsh	Community Type
Great Blue Heron Rookery	Habitat Type
Hardwood-conifer Swamp	Community Type
Mesic Southern Forest	Rich Forest, Central Midwest Type
Outwash	Geographical Feature
Prairie Fen	Alkaline Shrub/Herb Fen, Midwest Type
Relict Conifer Swamp	Forested Bog, Central Midwest Type
Southern Wet Meadow	Wet Meadow, Central Midwest Type
Submergent Marsh	Community Type

Although the natural habitat has been seriously degraded in the lower portions of the watershed, there are still valuable resource areas, such as the wetland areas bordering the lower segment of the natural channel, that need to be reclaimed and reestablished as functional wetlands. These wetland areas are important to improving the water quality of these lower watershed reaches including such benefits as:

- Flood and storm water storage
- Storm water treatment
- Plant diversity and wildlife habitat
- Fish, reptile, and amphibian habitat

4.0 RESTORATION CRITERIA—WHERE WE WANT TO BE

4.1 APPLICABILITY OF STATE WATER QUALITY STANADARDS TO RESTORATION CRITERIA

The Clinton River AOC shall be considered restored when there are no significant impairments to the beneficial uses of the area which have been caused by human activities. The relationship of Clinton BUIs and Michigan designated uses is presented in Table 4-1.

Table 4-1: Clinton River Watershed BUIs and Michigan Designated Uses

USE IMPAIRMENT	MICHIGAN DESIGNATED USE
Degraded fish and wildlife populations	• Warm water and cold water fishery • Other indigenous aquatic life and wildlife
Beach closings and other "full body contact" restrictions	• Partial and total body contact recreation
Loss of fish and wildlife habitat	• Warm water and cold water fishery • Other indigenous aquatic life and wildlife
Restrictions on fish and wildlife consumption	• Warm water and cold water fishery • Other indigenous aquatic life and wildlife
Eutrophication or undesirable algae	
Degradation of benthos	• Warm water and cold water fishery • Other indigenous aquatic life and wildlife
Degradation of aesthetics	
Restrictions on dredging activities	

The State of Michigan has adopted Water Quality Standards (WQSs) that are applicable to all surface water bodies in the State of Michigan. These WQSs are promulgated as Part 4 of the General Rules adopted under the provisions of The Natural Resources and Environmental Protection Act of 1994, as amended. Although the BUIs are technically based on the IJC criteria established in Annex 2 of the 1987 Amendment to the Great Lakes Water Quality Agreement that established the Area of Concern program, many also have a basis under the Michigan WQSs and/or the fish contaminant criteria adopted by the Michigan Department of Community Health.

The type and density of fish and wildlife that can be supported within a watershed are related to the water quantity and quality within the watershed as well as the local land uses, sediment quality, habitat

and food availability, as well as other factors. Although there are guidelines available from the Michigan Department of Natural Resources that can be used to determine how these various factors impact the fish and wildlife populations and the optimum range for the contributing factors for best management of the fish and wildlife resources, there are no promulgated standards to compare Degraded Fish and Wildlife Populations against.

Rule 323.1062 of the Michigan Water Quality Standards (MWQSs) establishes the maximum concentration of *E. coli* bacteria that are acceptable for waters of the state to meet total and partial body contact recreational uses. These standards are used to evaluate the Beach closings and other "full body contact" restrictions impairment.

Loss of fish and wildlife habitat is not measured by a MWQS. It can be evaluated and comparatively ranked by guidance developed by the MDNR and directly results from poor land use planning, failure to protect wetland areas, erosion, high stream flows and low base flows.

Unacceptable contaminant levels in fish and wildlife are established by the Michigan Department of Community Health. These contaminant levels are used in conjunction with measured contaminant levels from the Michigan Fish Contaminant Monitoring Program (FCMP) to establish fish consumption advisories that result in the Restrictions on fish and wildlife consumption BUI. Elevated contaminant levels can be caused by "food chain biomagnification", water column contamination, or sediment contamination.

While Eutrophication or undesirable algae is not directly evaluated by application of a MWQS, interference with "designated uses" established under Rule 323.1100 and unacceptably depressed dissolved oxygen concentrations compared to Rule 323.1064 can be used to determine if undesirable algae growths are evident in the watershed. The presence of specific algal species is also indicative of a BUI. This BUI results from excessive nutrient discharges associated with storm water runoff (both point and non point sources), point source discharges from WWTPs, nutrient release from contaminated sediments, and low base flows resulting in extended detention times in the watershed.

Degradation of benthos is another BUI that is measured by guidance used by the Michigan DNR but is not directly related to established MWQSs. The BUI is normally a result of excessive and/or contaminated sediment within the watershed and/or deteriorated water quality which can be evaluated through the use of MWQSs but is more a cause-effect relationship than a direct standards comparison.

Rule 323.1050 establishes narrative criteria to evaluate the BUI Degradation of aesthetics coupled with the watershed designated uses established in Rule 323. 1100. The criteria used in the evaluation is if any of the "unnatural physical properties" associated with aesthetics interferes with the designated use of the watershed. Degraded aesthetics can be caused by point and non-point source storm water runoff, littering, and poorly operated wastewater treatment systems.

Specific determinations on handling of dredge spoils are made by the U.S. Army Corps of Engineers and the MDEQ at the time of dredging. When the dredge spoils must be handled in a special manner or disposed of at a confined disposal facility due to the level of contaminants in the sediment then the Restrictions on dredging activities is considered to be a BUI.

4.2 SUMMARY OF RESTORATION CRITERIA ADOPTED IN OTHER AREAS OF CONCERNS AND THEIR RELEVANCE TO CLINTON AOC

Restoration criteria developed and/or proposed in other AOCs were reviewed for relevance to the Clinton River AOC during development of the recommended restoration/delisting criteria for the Clinton River watershed. These criteria from other AOCs are summarized in this section of the report. Progress toward delisting has been made in the following AOCs:

- In the United States:
  - Presque Isle Bay AOC is in recovery stage.
  - Oswega AOC and Saginaw AOC have developed delisting criteria/targets and/or milestones.
  - Torch Lake AOC has a well-defined restoration design with appropriate goals, indicators, and a long-term monitoring strategy.
  - Kalamazoo AOC is close to finalizing their delisting criteria and have established baseline inventories of habitat and wildlife, but needs to develop a long-term monitoring plan
  - The U. S. side of the Detroit is progressing toward finalization of delisting criteria
- In Canada:
  - Collingwood Harbour AOC and Severn Sound AOC, have been delisted.
  - Waukegon Harbor AOC may be close to being delisted and fish advisories have been removed.
  - Spanish Harbour AOC is in recovery
  - Detroit River AOC on the Canadian side has developed delisting criteria that has been approved by the Canadian side PAC.

Torch Lake AOC is a Superfund Site and somewhat irrelevant to the Clinton River AOC because it is a single issue AOC focusing specifically on mine tailing waste. Kalamazoo AOC is also a superfund site focusing primarily on PCB contaminated sediment remediation.

The Detroit River on the Canadian side developed delisting criteria that have been reviewed by their PAC as of May 2005, who have endorsed the report as Canadian delisting criteria for the Detroit River until bi-national delisting criteria can be developed. This is a multiple BUI and multiple parameter AOC and may be useful in evaluating and developing Clinton AOC restoration criteria.

Presque Isle Bay in Pennsylvania, the only US AOC in recovery stage, was listed as an AOC on the basis of 14 BUIs with the most severely impacted being fish tumors and restrictions on dredging. Sources of contaminants have been addressed, including a $100 million sewage treatment expansion, and pollution prevention and monitoring plans with restoration criteria are being finalized. Sediments were found to be not as contaminated as initially believed in 1991 when it was listed, and natural attenuation appears to be working as a recovery process for contaminated sediments. While the Clinton River AOC does not list fish tumor incidences as a BUI, the dredging restrictions consideration in the Presque Isle Bay AOC may be relevant to development of Clinton River AOC criteria with respect to this BUI, particularly with respect to consideration of natural attenuation/monitoring as an implementation strategy.

Although the St. Clair River AOC developed and adopted "yardstick" measurements of success early in the RAP process, they have not as yet developed approved delisting criteria for the nine BUI in the AOC. The AOC has made significant remediation progress with respect to contaminated sediments utilizing these "yardsticks", which may be relevant to the Clinton River with respect to the dredging restrictions BUI criteria. Of specific interest also are the contaminated sediment related studies that have been conducted to assist in developing sediment related delisting guidelines. These studies have been conducted to evaluate surficial sediments that may impair benthos and that may help determine the feasibility of remediation.

Further details of information gathered from other AOCs and their relevance to specific BUIs within Clinton River AOC is discussed below:

4.2.1 Restrictions on fish and wildlife consumption

IJC Recommended that this BUI is restored "When contaminant levels in fish and wildlife populations do not exceed current standards, objectives or guidelines and no public health advisories are in effect for human consumption of fish and wildlife. Contaminant levels in fish and wildlife must not be due to contaminant input from the watershed". The IJC delisting criteria are more stringent than the MDEQ guidelines but while the IJC criteria may constitute a good goal, it may not be immediately feasible to eliminate all fish consumption advisories because contaminants in other sites can be transported to the AOC by atmospheric deposition, and thus will stay in the food chain. A more rational approach is reflected in the Ohio delisting guidance draft document (2005) that bases this delisting target on no fish and wildlife consumption advisories attributed to sources within the AOC. Additionally, the proposed milestones include not only tracking changes in fish tissues and advisories, but also set limits for PCBs (50 ppb), mercury (50 ppb) and lead (86 ppb).

The Four Agency Framework (FAF) recommends basing delisting criteria for this BUI on appropriate assessment programs and reporting for a suite of most at risk chemicals and consumption guidelines (on the most current and restrictive guidelines).

For the Canadian side of the Detroit River contaminant levels in sport fish declining below the strictest action level for all jurisdictions issuing fish consumption advisories for a minimum of 3 years, with levels demonstrating a downward trend is the criteria for delisting this BUI.. Contaminant levels in fish that are a result of pollutants originating outside the AOC are not to be a barrier to delisting. Contaminant burdens in relatively non-migratory fish species must decline below action levels for jurisdictions that issue fish consumption advisories for a minimum of three years, with levels declining. No public health advisories are to be in effect for human consumption of wildlife for a minimum of three years.

In the Saginaw AOC; fish contaminant criteria were based on comparison of contaminant levels in other areas of Great Lakes that are not listed as AOCs and, on indications from caged fish studies that PCBs and dioxin sources have been controlled. Comparison to a reference site is relevant to the Clinton River, but one must be careful to not choose a reference site simply because it is not listed as an AOC because even non-AOCs may have this same BUI (e.g., Lake St Clair). Thus, reference sites have to be carefully chosen and agreed upon by the MDEQ, EPA and stakeholders. One alternative

approach could be that fish tissues taken in the uncontaminated upper headwaters of the Clinton River could serve as a reference site(s).
A progressive decline in caged fish tissues may indicate a control on sources, and/or that natural attenuation is taking place. A caveat is that old historic sediments can be mobilized during rare extreme storm events. A remediation assessment currently being undertaken by Oakland and Wayne State Universities with ECT and the Clinton River Watershed Council may ferret out the potential for future PCB transport of buried sediments into the water column and possible reference sites within the watershed.

In the Oswega AOC, the delisting milestone is in removing fish consumption advisories or reducing them to "the maximum extent possible". This endeavor requires long-term monitoring of fish tissues. This approach is a realistic compromise to requiring complete removal of fish consumption advisories, although it may be difficult to determine when the "maximum extent" has been achieved. Again, it implies a comparison to a reference site.

4.2.2 Restrictions on Dredging Activities

The MDEQ guidance (2005, draft) indicates that delisting criteria is achieved when sediment contaminant data from the commercial or recreational navigational channel (at the time of proposed dredging) in the AOC indicates that contaminant levels are not significantly different from other comparable, non-AOC commercial or recreational navigation channels. Restoration of the BUI will be achieved when there is no special handling or use of a confined disposal facility required for dredge spoils due to chemical contamination.

The State of Ohio's draft delisting criteria document (2005) has a delisting target of, "no restrictions on navigational dredging or disposal activities due to contaminants in sediments". Ohio's delisting document (2005) describes milestones that must be met in Ohio AOCs. The ones that are relevant to the Clinton River AOC include:

- Identify ongoing sources of sediment contaminants
- Remediate and/or eliminate ongoing sources, track changes in pollutant loadings to ensure control on known sources
- Document efforts in place to ensure that no sources within the AOC will re-contaminate sediments, such as by runoff, landfills, spills, etc.
- Compare concentrations of sediments to sediment guidance levels
- Sediments meet the criteria for beneficial upland reuse
- Sediments meet criteria for open waters disposal
- There are no restrictions on dredging or disposal activities due to contaminated sediments.

The Canadian Detroit River AOC delisting criteria are based on contaminants in sediments not exceeding applicable standards, criteria, or guidelines. As such, there would be no restrictions on dredging or disposal activities.

The Presque Isle Bay needs no further remedial action and is undergoing monitoring for the next 10 years. They have formed a task force for pollution prevention. This AOC has the advantage of natural attenuation working in its favor. Natural attenuation should be taken advantage of for delisting of BUIs

related to contaminated sediments wherever sediments are in depositional zones that are relatively undisturbed. However, this may necessitate temporary restrictions on dredging which would prevent delisting of this BUI. In other words, using natural attenuation could be an argument for delisting restrictions on fish and wildlife consumption, degradation of fish and wildlife populations, and degradation of benthos, but it may work against the delisting of restrictions on dredging although sub-watersheds could be targeted for delisting.

4.2.3 Beach Closings

The Ohio (2005) draft guidance document has delisting targets as follows:

No more than 10 posted advisory days due to elevated bacteria counts per year for five consecutive years; *Or* for primary contact recreation, the 75th percentile of all samples collected in one year does not exceed 1000 per 100 ml fecal coliform, or the 90th percentile does not exceed 2000 per 100 ml; *Or*, for E.*coli*, the 75th percentile does not exceed 126 per 100 ml or the 90th percentile does not exceed 298/100 ml. This standard must be met for 5 years. OR, for secondary contact, the 90th percentile for 5 years does not exceed 5000/100 ml or 576/100 ml *E. coli* AND, no contact advisories exist related to chemical contamination (the guidance recommends no contact for PCB and PAH-contaminated sites).

The Canadian side of the Detroit River based its delisting criteria generically that total or partial body contact standards, guidelines and objectives not be exceeded, and that there are no beach closures as a result of water quality problems for two years.

The Four Agency Framework states water should be safe for full body contact (bacteria) by the most restrictive standards.

Criteria based on numeric evaluations need to consider that studies have shown that human enteric bacteria can survive and reproduce in sediments, perhaps seasons or years after they were initially discharged. Therefore, even if all sources of sewage discharges were eliminated, bacteria counts in shallow water can exceed water quality standards if bacteria in beach sediments increase during summer months. Final criteria should evaluate the potential restoration status if the source of elevated bacteria densities is contaminated sediment rather than water column contamination.

4.2.4 Degradation of Aesthetics

The IJC guidance specifies that restoration constitutes elimination of unnatural oily sheens, turbidity, color and odor. The Four Agency Framework bases criteria on the river/shore being devoid of objectionable deposits such as no visible oil sheen. Milestones are set at eliminating combined sewer overflows (CSOs) and separating all sewers. A decline in the number of spills and complaints must be reported. The Ohio delisting is similar, but more specific to Ohio regulations.

On the Canadian side of the Detroit River, delisting criteria are generic except worth noting is that monitoring could be done to track historical changes and monitoring could focus also on complaints and spills.

In the St. Louis River AOC, the restoration goal is to have no sightings of oil slicks, spills, or other unnatural phenomenon. with a milestone of no sightings in five consecutive years which includes a public awareness campaign, zoning regulations, and spill response plans.

In other AOCs, water quality standards relating to aesthetics cover part of the restoration goals.

4.2.5 Eutrophication

The Ohio (2005) draft guidance bases delisting on meeting the minimum dissolved oxygen (DO) criteria and no nuisance growth of algae or blue-green algae or aquatic weeds that may hinder recreational use or contact with the body.

The Saginaw AOC based its criteria on average concentration of total phosphorus being 15 ug/L or less. A similar criteria could be applied to the Clinton River AOC based on nutrient data within the watershed (MSU Extension 2005).

Severn Sound based their delisting criteria on specific water quality criteria for phosphorus, DO, chlorophyll, water clarity and on demonstrating an increase in rooted plants. The details are spelled out in the Stage 3 RAP (Environment Canada and OMOE 2002).

The Canadian Detroit River delisting criteria for eutrophication are based on: no persistent water quality problems (no depletion of DO in bottom waters, nuisance algal blooms or accumulations, decreased clarity of the water) attributable to cultural eutrophication. Algal blooms in Lake Erie should not be attributable to Detroit River water quality impairments. Similar criteria could be utilized in the Clinton River AOC. based on meeting both DO and P criteria, and on the absence of nuisance algal growth.

4.2.6 Degradation of Benthos

The MDEQ guidance (2005) sates that this BUI deals with only the surficial layer of sediments where organisms live, typically less than 6 inches. In order to demonstrate restoration, the AOC must demonstrate:

- Sources of contaminants that degrade benthos in the AOC must be controlled
- All remedial actions must be completed and monitored according to the approved monitoring plan for the site
- All known sites of severely degraded benthos identified in the most recent RAP or by results of MDEQ monitoring that are not currently under regulatory authority must be brought under the appropriate authority and remedial actions completed as per step 2
- A list of regulatory programs in an AOC available to address future discoveries of severe contamination causing degraded benthos must be prepared and incorporated into the RAP.

The guidance makes clear that low-level widespread contamination is exempt; only sites that are severely impacted apply.

Four Agency Framework recommends delisting based on no more benthos than observed in unimpaired areas elsewhere in the Great Lakes basin, or upon comparison with upstream/downstream

populations. This approach may have applicability in the Clinton River AOC since the upstream headwaters of the Clinton River are cleaner than downstream and could be used as reference sites.

The IJC delisting criteria suggests when environmental conditions support healthy, self-sustaining communities of desired fish and wildlife at predetermined levels of abundance, restoration is complete. In the Canadian side of the Detroit River, delisting criteria reflects that the benthic community must contain none of the attributes that characterize a degraded community for 4 years, and toxicity of sediments from test sites should not be significantly higher than controls. The Canadian RAP specifies the criteria for evaluating if the benthic community is degraded .

In the Saginaw AOC, the delisting was based on mayfly nymphs because mayfly nymphs are important to fisheries and because their populations have been severely impacted since early 1950s. This may have relevance at the mouth of the Clinton River.

Since the Clinton River has several BUIs related to contaminated sediments, the first priority is to identify sources of contaminants, and eliminate them and evaluate the potential for remediation. Sites with known impaired benthos are already being evaluated for contaminants in sediments, and should be evaluated for water quality impacts such as storm water runoff.

4.2.7 Loss of fish and wildlife habitat

The MDEQ guidance for this BUI is similar to guidance for restoration of Degradation of Fish and Wildlife Populations. Water quality standards must be met, and if not, sources of water quality contamination be controlled. Then, a restoration plan must be developed and implemented which includes (A) a short narrative on the historical fish and wildlife population loss and degradation in the AOC, including how habitat has been impaired by water quality. (B) a description of the impairment and location for at least one critical habitat site or for multiple sites where determined appropriate at the local level, (C) a locally derived restoration goal/target for each habitat site. Restoration goals can be based on those for population BUI #3 (D), a list of all other ongoing habitat restoration planning processes in the AOC, and a description of their relationship to the restoration projects proposed in the plan, and (E) a work plan including:

- Specific habitat restoration actions(s) to be completed
- Timetable
- Funding
- Responsible entities
- Indicators and monitoring
- Public involvement

A specific plan for reporting on habitat restoration implementation actions(s) to the MDEQ must be included. Fish and wildlife populations need not be fully restored before delisting.

The Ohio (2005) delisting targets are as follows:

- Forested buffers exist on 50% of residential tributaries and 25% of urban tributaries, and

- For headwater streams, HHEI habitat quality shall average a score of 30 for warm water streams and 70 for cold water streams, or
- For headwater streams and wetlands, State Aquatic Life Water Quality standards are met, or
- Wildlife officials do not identify loss of or poor quality habitat as cause for non-attainment with wildlife goals.

The philosophy expressed in the Ohio delisting milestones can be applied to the Clinton River AOC, but have to be critically reviewed rather than just directly applied.. The Ohio milestones include:

- Buffers, conservation easements, riparian setback ordinances or other protective mechanisms are in place on more than 80% of the streams and tributaries
- over 10% of major watershed and over 6% of sub-watershed is high quality wetland habitat
- over 75% of the stream length is naturally vegetated
- less than 15% of watershed is impervious
- over 30% of the watershed is in forest cover
- track Headwater Habitat Evaluation Scores; percentage of forested riparian buffers along streams in residential and urban areas; management goal attainment
- habitat is sufficient to support wildlife goals for the AOC.

The Detroit River on the Canadian side set the following delisting criteria:

- The amount and quality of physical, chemical and biological habitat required to meet fish and wildlife management goals has been achieved and protected
- loss of productive fish and wildlife habitat in the DR AOC has ceased, and is protected by local bylaws, ordinances, and/or statutes
- A net gain of restored and protected habitats has occurred in accordance with local fish and wildlife management plans for the conservation and restoration of the DR habitat – in particular the Biodiversity Conservation Strategy for the Canadian portion of the AOC and is protected in perpetuity through local bylaws, ordinances, and statutes.
- At a minimum, twelve percent of the AOC watershed should be comprised of quality natural cover and a buffer of natural riparian vegetation should border 75% of all First-to-Third Order streams and virtually all wetlands.

It also recommends a moratorium on development in critical areas of the watershed.

The Saginaw AOC developed the following delisting criteria for this BUI:

- Dissolved oxygen criteria: 5 mg/L during summer
- Protection of coastal marsh
- Targeted restoration: documentation of natural reproduction of Lake Sturgeon in Saginaw River, abundance measures for Yellow Perch and Walleye.

EPA guidance recommends no further loss of habitat. Ideally, no further loss would greatly help the Clinton River which suffers from too much development as the reason for loss of habitat. Additionally,

many of the criteria concepts in the other AOCs listed above have relevance to the Clinton River AOC restoration criteria.

4.2.8 Degradation of Fish and Wildlife Populations

The MDEQ guidance (2005) states that the one universal criterion for delisting this BUI, if water quality criteria are not met, is that sources of water quality contamination be controlled before fish and wildlife remediation is conducted. Following remediation, a restoration plan must be developed and implemented as described in MDEQ (2005). Since the restoration goals may take a long time to achieve, the guidance states that fish and wildlife populations need not be fully restored before delisting. The MDEQ guidance was derived, in part, from the IJC recommendation that delisting criteria be based on historic data of fish and wildlife populations, or in the absence of such data, toxicity bioassays to show no significant toxicity from water column or sediment contaminants.

Ohio guidance (2005) sets delisting targets for fish on biological indices for lakes and nearshore; and for wildlife, healthy reproducing populations of sentinel species. In addition, restoration goals and management objectives must be met. The process, which could be applied in the Clinton River AOC, would include selecting sentinel species and tracking changes in populations of wildlife and tracking fish community surveys, achieving water quality standards and meeting ecoregional biocriteria.

The Canadian side of the Detroit River AOC has set delisting criteria based on the following:

- Environmental conditions should sustain healthy and genetically diverse communities of most sensitive indicator species at levels of abundance and biodiversity that would be expected from the amount and quality of suitable physical, chemical and biological habitat present. The objective should be consistent with the Great Lakes ecosystem objectives and Great Lakes Fishery Commission's fish community goals for adjoining waters and the conservation vision for the lower Detroit River.
- Scientifically defensible fish and wildlife bioassays must confirm that there is no significant toxicity from water column or sediment contaminants.
- As much as possible for connecting channels, programs should be in place to discourage further proliferation of existing non-native species and prevention of future introductions.

Note that in the Detroit AOC, the number of bald eagles was low, but lake sturgeon and river otters are returning and could therefore be used as indicator species for the Detroit River. A similar assessment and approach could be used for the Clinton River in determining sentinel species.

Oswega AOC had an issue of a dam that prevented stream flow. This is somewhat relevant to the Clinton River since fish populations are affected by water levels, and water levels are an issue that needs to be addressed for restoration of the AOC.

At Collingwood AOC, sediment monitoring in 1995 by Environment Canada found that benthic species were different from those in reference sites due to the assemblage of organisms present which were reflective of nutrient conditions and not due to the presence of contaminants. Recommendations for further actions included repeating sediment toxicity tests and resampling of sites to determine if the benthic community was returning to reference conditions. This may be relevant to the Clinton River,

which exceeds water quality standards in some instances for nitrogen and phosphorus. Rather than focus on expensive toxicity tests, though, restoration criteria for the Clinton River should focus on meeting water and sediment quality criteria which need to be met for several BUIs. In the Clinton River, it may not be practical to return to historic population levels of all species due to widespread urbanization of the watershed. Protection and restoration of existing habitat should remain a high priority.

4.3 DEVELOPING RESTORATION CRITERIA FOR EACH BUI

4.3.1 Restrictions on fish and wildlife consumption

Significance to Clinton River Watershed Area of Concern

Fish and wildlife consumption advisories in Michigan are determined by the Michigan Department of Community Health, and are based upon the levels of contaminant concentrations in fish or wildlife tissues. Within the Clinton AOC, the consumption advisory is specific for PCB contamination in Carp, and the current sources of PCB are contaminated sediment and potentially Nonpoint sources. This specific BUI is applicable only to the western near-shore of Lake St Clair, so the impact is localized to the watershed.

Restoration Criteria

Per MDEQ guidelines, the restoration of the fish consumption advisory is based on contaminants in fish tissue and a comparison to other locations, and not on the number of advisories. Restoration of this BUI will be determined by the following steps and criteria:

- Sources of pollutants: Identify and control the sources of PCB contamination and other appropriate pollutants by an evaluation that includes site-specific monitoring of remedial actions or other monitoring.
- Determination of advisories: If the advisories in the AOC are the same or less restrictive than the associated Great Lakes or appropriate control site, then the BUI has been restored, unless the advisory is for no consumption.
- Comparison studies for contaminants causing advisories:
    - If there is no statistically significant difference in fish tissue concentrations of contaminants causing advisories in the AOC compared to a control site, then the BUI has been restored. This will be demonstrated by studies designed to compare contaminant concentrations in fish from the AOC to a suitable control site. The studies will be designed to control variables known to influence contaminant concentrations such as species, size, age, sample type, lipids, and collection dates. The control site must be agreed to by the MDEQ, and will be chosen based on physical, chemical, and biological similarity to the AOC. The two sites need to be within the same ecoregion. .
    - If there is a significant difference between AOC and the control site in the comparison study, then impairment exists.

Actions

- Establish a baseline of data on the levels of contaminants currently found in Carp in the Clinton watershed that can be compared with contaminant levels found for similar species from at least two sites within the Clinton River ecoregion on a periodic basis.
- Implement sediment monitoring in Clinton River to provide a comprehensive baseline for PCBs.
- Establish appropriate control sites within the AOC or similar watershed for evaluating restoration criteria

4.3.2 Restrictions on dredging activities

Significance to Clinton River Watershed Area of Concern

Within the Clinton AOC, guidelines for open water disposal of sediments from navigational channels are exceeded in the lower Clinton River for PCBs, oil, grease, and metals. Confined disposal of sediments is required. This BUI has a localized impact and has no Great Lakes wide impact.

Restoration Criteria

This BUI will be considered restored when there have been no restrictions on routine navigational dredging done by the U.S. Army Corps of Engineers, based on the two most recent dredging events, such that special handling or use of a confined disposal facility is required for dredge spoils due to chemical contamination originating from controllable sources within the AOC.

Actions

- Track dredge spoil disposal requirements for projects within the AOC to determine when criteria is being met
- Determine the degree of contamination in the lower river sediments and track trends in the level of contamination as remediation efforts precede throughout the watershed.

4.3.3 Beach closings and other "full body contact" restrictions

Significance to Clinton River Watershed Area of Concern

This BUI applies only to public beaches in the AOC because the state and local agencies have no authority over private beach assessments and operations. While the BUI refers specifically to public beaches, it is recommended that the delisting criteria reflect the need for the entire watershed to meet the established *E.* coli limitations to assure adequate public protection for total body contact recreation at other than public beach locations. The Clinton River AOC is a highly urbanized watershed. Combined Sewer Overflows (CSOs), urban and rural storm water runoff, failing septic systems, animal waste, and illegal connections to storm sewers contribute to elevated fecal bacteria levels in many locations throughout the watershed.

Restoration Criteria

This BUI will be considered restored when public beaches within the AOC and representative watershed locations monitored for a period of four years over the 16-week total body contact recreation period (generally memorial day to labor day), using methods adopted in Rule 323.1062 of the Michigan WQS, meet the following standards:

- *E. coli* concentrations are below a 30-day geometric mean of 130 counts per 100 milliliters (ml); and
- At least 90% of sample results are below the daily geometric mean limits of 300 counts *E. coli* per 100 ml; and
- No more than 1 of the sample results exceed the partial-body contact water quality standard of 1,000 counts *E. coli* per 100 ml based on a daily geometric mean.

Contaminants originating from outside the AOC shall not prohibit delisting.

Actions

Actions currently underway in the AOC are generally sufficient to determine when this restoration criteria is being met. The existing monitoring locations should be reviewed to assure that they provide sufficient coverage of the AOC to establish baseline and trend information. Additional monitoring locations should be added if necessary. The existing actions within the AOC include:

- Local health departments with public access sites monitor *E. coli* at bathing beach sites from April through October.
- Annual summary reports are developed containing the sampling results from the river, beaches, and wastewater discharge points.

Additional future actions

- Through the cooperative efforts of MDEQ, local wastewater treatment plant operators, and local health officials, review existing sample locations and establish additional appropriate sampling protocols (including sampling frequency) and locations to monitor bacteria levels.
- Conduct annual review of the data collected to determine if sample numbers and/or location should be increased or decreased.

4.3.4 Degradation of aesthetics

Significance to Clinton River Watershed Area of Concern

Within the Clinton River AOC, this BUI is attributed to widespread erosion and in-stream sedimentation, localized algal blooms, habitat degradation, litter, and severe log jams. Evaluation of aesthetic impairments can be subjective, with people having different perceptions about what constitutes a nuisance or impairment. Natural physical features which occur in normal ecological cycles (e.g. logjams/woody debris, rooted aquatic plants) are not considered impairments, and in fact serve a valuable role in providing fish and wildlife habitat. However, when log jams far exceeded natural occurrence rates or size, which they have in many areas of the Clinton River AOC, they become classified as "severe log jams". Many of these jams end up collecting an enormous amount of litter and become one of the most serious aesthetic problems in parks along the river. The Clinton River Watershed Council currently receives more complaints about logjams than any other aesthetic or habitat impairment.

Many AOCs have developed and used numeric indices as a means of evaluating the aesthetic quality of a water-body (e.g., Rouge River in Michigan, and Grand Calumet River in Indiana). These indices are based upon qualitative descriptors that are assigned numeric values. Similar approach could also be used within Clinton AOC.

Restoration Criteria

This BUI will be considered restored when monitoring data and/or surveys for any 2 of 3 years indicates that water bodies in the AOC do not exhibit persistent, high levels of the following "unnatural physical properties" (as defined by Rule 323.1050 of the Michigan Water Quality Standards) in quantities which interfere with the state's designated uses for surface waters:

- Turbidity
- Color
- Oil films
- Floating solids
- Foams
- Settleable solids
- Suspended solids
- Deposits
- Severe log jams defined by size and/or frequency of occurrence

For the purposes of this criteria, these eight properties impair aesthetic values if they are unnatural -- meaning those that are manmade (e.g., garbage, sewage), or natural properties which are exacerbated by human-induced activities (e.g. excessive algae growth from high nutrient loading, log jams due to high storm water runoff volumes). Persistent, high levels is defined as long enough or high enough to be injurious to any designated use listed under Rule 323.1100 of the Michigan WQS.

Actions

- Review numeric indices developed in other AOCs for potential use in the Clinton River AOC
- Establish a baseline of data within the Clinton River watershed to determine the degree of degradation, trends in aesthetic improvements, and when the delisting criteria have been met

4.3.5 Eutrophication or undesirable algae

Significance to Clinton River Watershed Area of Concern

Within the Clinton River AOC, excessive algal growth has occurred in the lower Clinton River and a number of inland lakes and is attributed primarily to the high nutrients from storm water runoff, low flows, and direct discharge from riparian lawns.

Restoration Criteria

An AOC water body will be considered restored for the eutrophication impairment if monitoring nutrients, chlorophyll, dissolved oxygen, and secchi depth using the protocols of Michigan's Cooperative Lakes Monitoring Program in any 2 of 3 years indicates that:

- There are no growths of undesirable algae in quantities which interfere with a water body's designated uses as defined in Rule 323.1100 of the Michigan Water Quality Standards (e.g., inhibits swimming due to the physical presence of algal mats and/or associated odor; inhibits the growth and production of warm water fisheries and/or indigenous aquatic life and wildlife). Undesirable algae species which may indicate impairment include toxic-producing cyanobacteria (e.g., Microsystis), noxious bloom-forming phytoplankton (e.g., Aphanizomenon), or bethic algae (e.g. Cladophora); and
- The water body meets the minimum D.O. standards listed in Rule 323.1064 in the Michigan WQS; and
- Any deviation from Rule 323.1064 is a direct result of vegetation; and
- The waterbody is no longer listed as impaired due to nutrients on the Clean Water Act Section 303(d) list for the state.

MDEQ is currently in the process of developing nutrient criteria for the surface waters of the state which will be adopted into the Michigan WQS. BUI restoration will be expanded to include adherence to this nutrient criteria when it is officially adopted.

Actions

- Expand existing monitoring programs to include routine analysis for nutrients and dissolved oxygen, as necessary, to establish baseline and trend data
- Utilize volunteer monitoring programs to visually evaluate indicators of nuisance algal blooms in the watershed

4.3.6 Degradation of Benthos

Significance to Clinton River Watershed Area of Concern

Benthic communities are impaired throughout the watershed because of sedimentation, and at specific locations due to contaminated sediments. This BUI has a watershed-wide impact, but no Great Lakes wide impact.

Restoration Criteria

- Samples of indicator species (e.g. mayfly, stonefly, caddisfly nymphs) collected in the watershed exceed a certain percentage of total individuals collected. Indicator species, a certain percent increase in species, and diversity should be chosen based on habitat present and habitat restoration that can reasonably be expected within the area of the watershed under consideration.
- Suggested restoration criteria based on volunteer macroinvertebrate data: Macroinvertebrate assessments conducted by volunteers at sites across the watershed meet or exceed the "good" ranking as established by the Izaak Walton League of America's Water Quality Index.
- Pore space water in the sediment is non-toxic to appropriate indicator species

Actions

- Support funding for annual monitoring and reporting for the abundance of macroinvertebrates indicative of good water quality.
- Expand volunteer monitoring programs and report results annually….supplement with professional data as available.

4.3.7 Loss of fish and wildlife habitat

Significance to Clinton River Watershed Area of Concern

The Clinton AOC is one of the most urbanized watersheds in Michigan. Urban sprawl and inadequate land use planning have led to erosion, wetland destruction, and significant hydrologic changes that have resulted in loss of fish and wildlife habitat. This BUI has a Great Lakes wide impact.

Restoration Criteria

- DO levels in the river meet or exceed the minimum Michigan's Water Quality Standards.
- Aquatic and riparian zone habitat are considered to be good to excellent at appropriate locations within the AOC as evaluated by MDEQ GLEAS Procedure 51 and other appropriate guidelines and procedures. Appropriate locations are those areas within the watershed where habitat should be protected or habitat improvement can reasonably be achieved.
- Programs are in place within the AOC to establish minimum sub watershed specific forest cover within the riparian corridor for suburban/forested (e.g., 60%), suburban/agricultural (e.g., 40%), urban/suburban (e.g., 25%), and urban (e.g., 15%)
- Impervious surface coverage is at or below an equivalent of 15% average throughout the watershed. Equivalent imperviousness is a combination of actual imperviousness within the watershed and apparent imperviousness due to the installation of appropriate BMPs.
    - Undeveloped areas remain at less than 10% imperviousness
    - Agricultural land use targeted at less than 50% of the undeveloped watershed area
    - No increase in areas presently greater than 30% impervious
- Programs are in place within the AOC to preserve existing wetland areas (no net loss) and restore/increase wetland area within the watershed by 1% to 5% over the next ten years
- Programs are in place within the AOC to acquire and preserve a minimum of 5% of the priority conservation areas within the AOC annually
- River hydrology and temperature fluctuations do not impact indicator fish and wildlife species
- Toxic pollutants in the sediment and water column do not impact indicator fish and wildlife species

- Local Green Infrastructure Plans are being implemented within the AOC
- Habitat restoration goals have been established within the AOC and are being implemented

Actions

- Reestablish effective DO monitoring in the watershed during critical low-flow summer periods to determine whether the WQS is being achieved.
- Track riparian forest cover in partnership with county planning departments
- Track wetland cover
- Track impervious surface coverage
- Utilize MNFI inventories to identify priority conservation areas.
- Utilize Adopt-A-Stream volunteer habitat assessment data to measure progress in achieving the restoration criteria – report annually on the data and trends
- Utilize frog and toad surveys as partial wildlife assessment indicators
- Utilize county level GIS resources to assist in tracking restoration criteria trends

4.3.8 Degraded fish and wildlife populations

Significance to Clinton River Watershed Area of Concern

Within the Clinton River AOC, degraded native mussel populations is attributable to in-stream sedimentation and zebra mussel presence. In addition, warm water fishery is impaired by sedimentation, impoundment, and changes in hydrology. The designated cold water fishery areas are threatened by increased development in the watershed leading to increased impervious surfaces and resultant runoff affecting the watershed hydrology and geomorphology. The impoundments in the watershed also contribute to excessive low flows and increased temperatures. There is inadequate data available to determine trends and impacts on amphibians, waterfowl and other birds, and small mammals that use riparian corridor, but the extensive development within many areas of the AOC would imply that these populations are impaired. This BUI has a Great Lakes wide impact.

Restoration Criteria

This beneficial use will be considered to be restored when the population and diversity of indicator fish and wildlife species within the applicable portions of the AOC are consistent with guidance developed by the MDNR and the USFWS over two consecutive monitoring seasons. Assessment of the fish and wildlife populations will be done in accordance with procedures established by, or approved by, the MDNR, MDEQ, and USFWS.

Actions

- Continue to monitor annual harvest of specific fish species, and conduct annual netting surveys to determine whether a) targeted restoration conditions are being met and/or maintained, and b) natural reproduction of specific fish species continue to provide evidence of improved habitat conditions.
- Utilize existing Marsh Monitoring Program, park and nature center observations (Bald Mountain, Stony Creek Metropark, Wolcott Mill Metropark, Oakland County parks, Metro Beach Metropark, etc.), MNFI inventories, and volunteer sighting reports to establish a baseline and trends for wildlife populations in the riparian corridor

- o Develop uniform wildlife evaluation procedures for volunteer monitoring groups and have the procedures approved by the MDEQ/MDNR/USFWA as appropriate

4.4 APPLICABILITY OF BUIs TO SUBWATERSHEDS

The Clinton River Watershed, as explained in Section 3.0, is diverse and with regions where each of the eight BUIs apply with varying degrees of relevance. The following matrix was developed to attempt to quantitatively present this relevance in a concise format.

Table 4-2: Relevance of BUIs to Each of the Seven Sub-watersheds Within Clinton River AOC (per Opfer 2005)

BENEFICIAL USE IMPAIRMENT	SUBWATERSHED						
	Stony Creek	Paint Creek	Upper Clinton	North Branch	Clinton Main	Clinton East	Red Run
Degraded fish and wildlife populations	◔	◔	◒	◒	◕	◕	◕
Beach closings and other "full body contact" restrictions	◔	◒	◔	◕	◕	◕	◕
Loss of fish and wildlife habitat	◔	◔	◒	◒	◒	◕	◕
Restrictions on fish and wildlife consumption	○	○	○	○	◒	◒	◒
Eutrophication or undesirable algae	◔	◒	◒	◕	◒	◕	◕
Degradation of benthos	◔	○	◔	○	◔	◕	◕
Degradation of aesthetics	◔	◔	◔	◒	◒	◕	◕
Restrictions on dredging activities	○	○	○	○	○	◕	◕

Key: Relevance ranking: ○ = Low or Not Applicable; ◔ = Low-Medium; ◒ = Medium; ◕ = Medium-High; ● = High.

5.0 PATHWAY TO RESTORATION—HOW DO WE GET THERE?

5.1 BASIC IMPLEMENTATION CONCEPTS

Setting Restoration Goals
This project is a first step towards establishing restoration targets that are locally derived and measurable and, meet the criteria for the frequency and longevity of monitoring that is consistent with federal and state regulations & GLWQA Annex 2. These goals should focus both on the overall watershed and the individual sub watershed areas as appropriate.

Evaluate Delisting on the Basis of Outside or Natural Factors
BUIs should be evaluated for factors outside the watershed. If restoration of a BUI is not possible because of factors outside the AOC or is typical of lake-wide or region-wide conditions, recommend delisting on this basis and refer BUI to Lakewide Management Plan (LaMP). If the BUI is due to natural causes, not human sources, recommend delisting on this basis.

Implementing Restoration Goals
The vehicle for ultimate implementation of the delisting/restoration efforts within the AOC focused at achieving the restoration criteria is the RAP. An updated RAP report will be completed for the Clinton River AOC in the near future. This next generation RAP, and subsequent iterations, will help identify and prioritize BUIs that can be most easily delisted and identify the steps necessary to work towards implementing restoration for all BUIs. The restoration work plan must include:

- Establishing a realistic restoration budget
- Selection of reference sites where needed.
- Establishment of a timeline for implementation including such major milestones as:
    - contaminant removal
    - point source pollution monitoring and prevention
    - non-point source BMP implementation
    - habitat restoration
- Development of long term funding sources and agreements
- Establishment of necessary monitoring networks to create baseline data and measure progress in achieving delisting/restoration criteria
- Establishment of implementation alternatives such as evaluation of low level, wide-spread contamination for feasibility of natural attenuation as a restoration alternative.

Once it has been established that restoration criteria have been met or that progress is moving extensively towards delisting goals, the BUI or sub-watershed can be recommended for delisting or placement in the "recovery" stage. A RAP implementation committee, working in consultation with the public and stakeholders, would then submit a recommendation to delist the AOC, or portions thereof, and complete a Draft Final RAP Stage 3 Report to EPA and MDEQ. The recommendation spells out the roles and responsibilities for implementation of the RAP.

Formal request to have AOC delisted

Long-term monitoring plan must be written. Restoration must be completed or well underway and meeting restoration goals at all sites before an AOC can be delisted. Resources are needed for long-term monitoring and protection must be in place to prevent future degradation from occurring.

5.2 TIMELINE OF THE IMPLEMENTATION

1. Adopt proposed delisting/restoration criteria for the Clinton River watershed and all sub-watersheds by December 31, 2005.
2. Complete RAP Update by June 30, 2007
3. Develop baseline monitoring network by June 30, 2006
4. Begin implementation of all BUIs restoration programs within the AOC and sub-watersheds by 2010
5. Achieve delisting/restoration status of at least one BUI annually starting in 2008

6.0 CONCLUSION AND RECOMMENDATIONS

Restoration criteria have been developed to address the eight BUIs within the Clinton River watershed. The criteria were reviewed and adopted by the Clinton River RAP PAC at their September 15, 2005 meeting. These criteria are generally applicable throughout the watershed however each of the seven sub-watershed areas were reviewed with the appropriate Sub-watershed Advisory Group (SWAG) to obtain their input relative to the appropriateness of the BUI and respective criteria within that specific sub-watershed.

Recommendations:

1. The restoration/delisting criteria need to be incorporated into the process of goal setting in the next iteration of the sub-watershed plans.
2. The criteria for the fish and wildlife habitat and benthos related BUIs need to be further refined including evaluation of the existing and anticipated future habitat within the individual sub-watershed areas. The final criteria should reflect the variation in what can be attained relative to habitat and benthic quality. The lower reaches of the watershed that are highly urbanized can not be restored to the same benthic and habitat quality that can be protected and restored in the rural/undeveloped areas. However, reasonable efforts should be implemented to improve the habitat/benthic quality in these lower reaches.
3. The RAP update that will be initiated shortly needs to utilize the restoration criteria in developing the overall goals and action plans for the watershed.
4. The RAP PAC should periodically review the status of restoration efforts within the watershed and determine the degree of progress toward attainment of the restoration criteria.
5. Although not a specific BUI, it should be noted that all the BUIs are impacted by flow variations, both low-flow and high peak to low-flow ratios. Attaining restoration criteria will be extremely difficult within the Clinton River watershed unless these flow extremes are addressed and measures implemented to control these variables.

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APPENDIX A: FIGURES