DELISTING TARGETS FOR FISH/WILDLIFE HABITAT & POPULATION BENEFICIAL USE IMPAIRMENTS FOR THE CLINTON RIVER AREA OF CONCERN

Submitted to the Michigan Department of Environmental Quality

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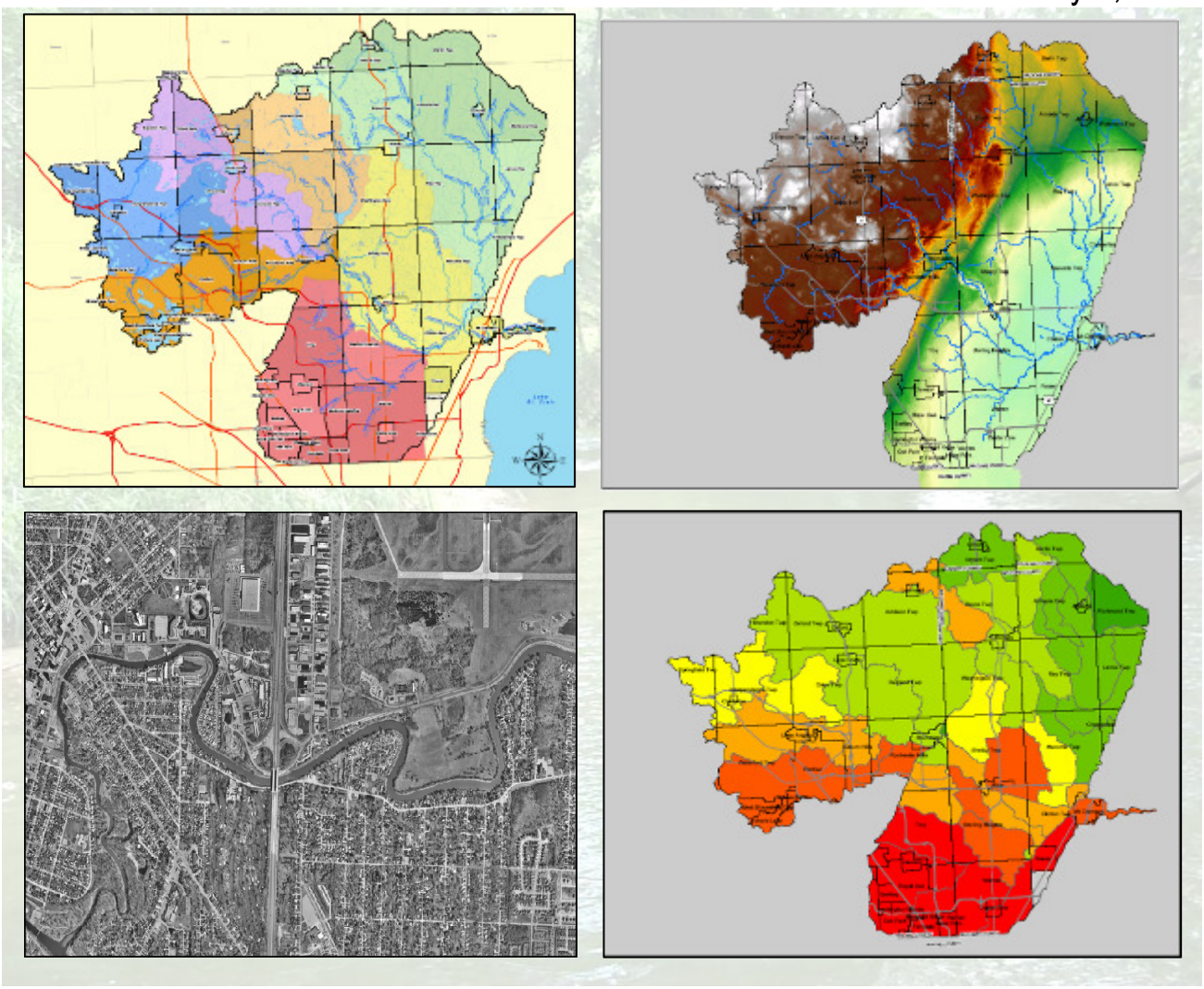

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Many experts contributed their time, efforts, and talent toward the preparation of this report. The Project Team acknowledges the contributions of each of the following members of the Clinton River AOC Delisting Targets Technical Committee, and thanks them for their efforts:

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1.0 EXECUTIVE SUMMARY

The Clinton River Watershed delisting targets 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 delisting targets project was a two phase project. Phase I developed recommended targets for all Beneficial Use Impairments (BUIs) within the AOC. The project interfaced extensively with the Michigan Department of Environmental Quality (MDEQ) who were developing statewide delisting targets concurrently with the development of the Clinton River delisting targets by the Clinton River Remedial Action Plan (RAP) Public Advisory Council (PAC), the Clinton River Watershed Council (CRWC), and the project Technical Committee. Under Phase II, targets for non-habitat and population BUIs were finalized based on comments from MDEQ for Phase I report and are presented in a separate report. In addition, Phase II also developed new habitat related BUI targets based on the finalized guidance developed by the MDEQ. This report presents the delisting targets for habitat and population-related BUIs, and presents a project approach that represents an acceptable approach to the fairly common situation where the RAP documents do not recommend site specific actions and the restoration plans recommended for delisting targets need to be developed relatively independent of the existing RAP.

Current MDEQ guidance for developing BUI delisting targets includes the need to develop local restoration plans for Degraded Fish and Wildlife Populations and Loss of Fish and Wildlife Habitat. The local restoration plans also needed to include the impact associated with degradation of benthos, the third habitat and population related BUI in the Clinton River AOC. The finalized guidance also resulted in a modification to the original Phase I approach to habitat and population related BUI delisting targets. The initial Phase I project targets are preserved in this final report but have been converted to "restoration targets" rather than delisting targets. The finalized approach reflected in the ultimate delisting target recommendations within this report reflect the need to develop the necessary site specific inventory, prioritization, and implementation steps that are part of the local restoration plan needed to actually accomplish the BUI delisting. In the current project, Phase II, these draft plans have been finalized with the assistance of the Technical Committee, the individual sub-watershed advisory groups, and the PAC. The site specific demonstration projects included in the delisting targets represent a cross-section of the types of implementation projects that are necessary accomplish restoration of the habitat-related BUIs throughout the watershed and establish an end-point to achieve delisting of the AOC. Implementation of these projects will be a key step to accomplish delisting and a move toward full restoration thus benefiting the watershed residents and users of the Clinton River as well as Lake Erie and the Detroit River connecting channel.

The *Supporting Guidance for Local Restoration Criteria Development: Loss of Fish and Wildlife Habitat and Degradation of Fish and Wildlife Population* published by MDEQ outlines the process of developing restoration targets for habitat and population BUIs within Michigan's AOCs. The guidance outlines six components and steps that are required for developing a local, site specific restoration plan. Those six components are listed below:

A. Narrative on the historical habitat and population issues in the AOC
B. Description of the impairment(s) and location for each site
C. Locally derived restoration target for each site

D. List of all ongoing related habitat and population planning processes in the AOC
E. Scope of work for each site, including:
    1. Timetable
    2. Funding
    3. Responsible Entities
    4. Indicator & Monitoring
    5. Public Involvement
F. Method for project reporting to MDEQ

Due to the large size of the Clinton River AOC, the EPA and MDEQ agreed that summarization of the habitat and population impairments and selection of priority projects was appropriate for this effort. Therefore, items A through C are addressed in this document. Chapters 1 through 3 of this document detail the information required in parts A and B and the information required in part C is detailed in Chapters 5 and 6.

Finally, although not a specific BUI, it should be noted that flow variations, both low-flow and high peak to low-flow ratios impact all of the BUIs. Attaining restoration targets will be extremely difficult, and in many cases impossible, within the Clinton River watershed unless these flow extremes are addressed and measures implemented to control these variables.

2.0 PROJECT INTRODUCTION AND RATIONALE

2.1 HABITAT & POPULATION BENEFICIAL USE IMPAIRMENTS IN CLINTON RIVER AOC

Two habitat and population-related beneficial uses are considered impaired based on the 2008 Clinton River Remedial Action Plan (RAP) Update. These BUIs are listed in Table 2-1 below:

Table 2-1: Summary of Fish and Wildlife Habitat & Population Related Beneficial Use Impairments in the Clinton River Watershed

USE IMPAIRMENT	EXPLANATION OF IMPAIRMENT	TYPE	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; cool 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	Habitat BUI	Yes
Loss of fish and wildlife habitat	Urban sprawl and inadequate land use planning; erosion, wetland loss, dams, hydrological changes, alteration of riparian habitat	Habitat BUI	Yes

In addition, although the MDEQ guidance for delisting includes Degradation of Benthos as a non-habitat BUI, the Clinton River AOC delisting project has included Degradation of Benthos as part of the Phase II habitat related BUI delisting development.

2.2 PROJECT RATIONALE

The original listing of Areas of Concern (AOCs) within the Great Lakes was based on the presence of beneficial use impairments (BUI). These BUIs were defined by the International Joint Commission (IJC) along with generalized criteria for determining when a BU was impaired (Statewide PAC for Michigan Areas of Concern Program 2004). The first set of guidance for delisting target was put forth in 1991 by the International Joint Commission (IJC). These targets were fairly general, and led to a more specific set of guidance published by the U.S. Environmental Protection Agency (EPA) in 2001.

In 2006, the Michigan Department of Environmental Quality (MDEQ) released their final delisting document applicable to AOCs within the Michigan portion of the Great Lakes (Criteria for Restoration of Beneficial Use Impairments Michigan's Great Lakes Areas of Concern [MDEQ Water Bureau, Inland Lakes and Remedial Action Unit 2006]). The MDEQ guidance is very specific regarding targets for

non-habitat related BUIs and in general, can be applied throughout Michigan with minimal variation. In developing the guidance however it became apparent to the MDEQ that it would be impossible to adopt a single target for habitat/population related BUIs that could be applied throughout Michigan. There are often significant variations within an AOC with respect to the habitat and the ability of the restored habitat to support the same degree of fish and wildlife populations. This observation is magnified if one tries to apply a single target throughout all Michigan AOCs. The guidance for habitat related BUI removal is therefore very general and requires the development and implementation of an AOC specific restoration plan for removing the habitat related BUIs within that specific AOC. The MDEQ guidance can be adopted as published by a local PAC or a PAC can develop its own delisting targets utilizing the MDEQ guidance as a basis. MDEQ will review and approve the final delisting target 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 target for the Clinton River AOC.

The primary goal of developing delisting targets is to create a plan for the delisting/restoration of the AOC. The delisting target develops an endpoint for measuring progress in the remediation of the river and restoration of the BUs that were considered to be impaired within the AOC. In addition to the elimination of the BUIs associated with the AOC, restoration of the AOC may also provide numerous ancillary benefits including:

- A potential increase in property values within the AOC following restoration
- Increased desirability of the AOC for investment and development following elimination of the AOC designation
- Increased public use and enjoyment of the Clinton River associated with increased active recreational uses such as fishing and swimming
- Increased public use and enjoyment of the Clinton River associated with increased non-active recreational uses such as wildlife viewing and the general ability to “connect with nature” as aesthetics improve in the AOC
- Reduction of bacterial and viral organisms within the Clinton River AOC and reduction of exposure related human health impacts
- Providing sub-watershed specific criteria that can be used to evaluate the goals and objectives associated with the updated RAP currently being developed

Ecosystem health is important to humans as well as to the fish and wildlife. Maintaining genetic diversity and healthy populations of fish and wildlife may result in immediate as well as long-term beneficial uses. The development of the habitat related delisting target associated with this Phase II project will provide the tools necessary to move toward implementation of programs and projects to restore the environmental integrity of the fish and wildlife communities within the AOC.

3.0 HISTORICAL HABITAT AND POPULATION ISSUES IN THE AOC: IMPAIRMENT BY WATER QUALITY

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 and the most populated watershed in Michigan. 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 increased impervious area in the watershed, a result of the large population density (more than 1.5 million people) and the resultant increased impervious area in the watershed. The designated 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). 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 (SEMCOG, 1996). This watershed's topography is typical of southeast Michigan plains. 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). Figures 3.4 and 3.5 show trends in land use changes for 1950 and 2000. Less than a fifth of the watershed was urbanized in 1950 whereas a majority of the southern portions of the watershed are completely urban area as of 2000. Booth and Reinelt (1993) found the water quality in a watershed declines substantially once the imperviousness in a watershed increases to 10% 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 have adequate water quality and habitat to support fish and wildlife populations 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 TRENDS IN WATER QUALITY AND QUANTITY

The MDEQ routinely monitors the water quality in the mouths of a number of Great Lakes tributary streams, including the Clinton River. 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 sampled by the MDEQ is located at Shadyside Park on Gratiot Avenue in Mt. Clemens, Macomb County. Among intensely monitored stations throughout the state,

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 River 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 polychlorinated biphenyls (PCBs) 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. In 2004, the MDEQ intensively monitored eleven stations in the 2004 monitoring program. The Clinton River station was the highest among the intensively monitored stations for copper (4.3 ug/l), lead (2.4 ug/l), phosphorus (0.12 mg/l), and chloride (172 mg/l). Mercury analysis ranged from 1.710 ng/l to 40.690 ng/l, all of which exceeded the Rule 57 water quality value of 1.3 ng/l. PCB sampling was done on the North Branch of the Clinton River at Fisher Road in Bruce Township, Macomb County in 2004. Total PCB analyzed at this site was 0.394 ng/l which exceeded the Rule 57 value of 0.026 ng/l.

The Macomb County Health Department (MCHD) has been conducting water quality sampling at several Clinton River watershed locations since 1998. Data from these sample stations are presented in the 2002 Lake St. Clair Water Quality Assessment report. All of the 2002 and 2003 watershed samples collected exceeded the critical value for nitrate (0.3 mg/l) and total phosphorous (0.05 mg/l). The watershed samples also exceeded the wildlife protection value for mercury (1.3 ng/l). One of the notable finding 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 than the wet weather concentrations.

The Water Quality Sampling & Analysis report (June 2007) for the Lake St. Clair Regional Monitoring Project includes data collected at several monitoring locations within the Clinton River AOC during 2004 and 2005 (Figure 3.7). There were a total of eleven monitoring sites established on the Clinton River and its tributaries. In general there were elevated nutrient and aluminum concentrations throughout the watershed and significant increases of total suspended solids during wet weather conditions.

Flow variability within the Clinton River AOC has a significant impact on the aquatic habitat and the habitat based BUIs. 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 has been 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.

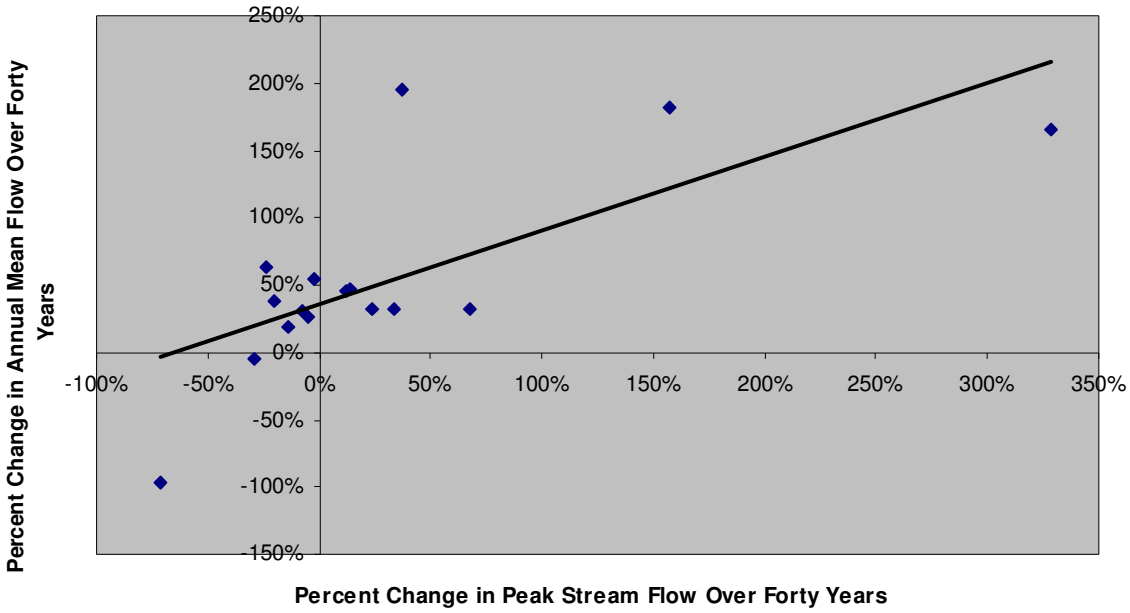

Figure 3.10: Change in Peak Stream Flow Versus Change in Mean Annual Flows Within Clinton River Watershed

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 and 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. Systematic increase in one is expected to lead to an increase in the other. Conversely, it is also 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.

3.2 THE BIOLOGICAL COMMUNITY 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 the following summary of the data that is available:

> "The upper and middle mainstem, being warmed by lakes and cooled by groundwater, contained a cool water 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 Stony 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 (MDNR) Fisheries Division recently completed the Clinton River Assessment (Francis and Haas, 2006). 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 tend to have a significant negative impact on the existing and potential fisheries within the watershed.

Reports and studies cited in the remainder of section 3.2 are cited in the Clinton River Assessment and can be found in the reference listing for the assessment.

The Headwaters Segment is in good condition from a fisheries perspective in that it has a good gradient and substrate and a large population of cool 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 headwaters segment was sampled for invertebrates in 1973 and again in 1999. Although the 1973 sampling results indicated very good water quality existed in this segment, the 1999 sampling indicated a decrease in abundance and alteration of the dominant species mix indicative of declining water quality since 1973.

In general, game fish are few in number and too small to provide a good sports fishery. Small stream dimensions result 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 and sand. The 2001 fish study showed good species diversity in the segment generally dominated by cool 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 cool water fish communities (bluegill, pumpkinseed, rock bass, and largemouth bass) with some of the lakes also having northern pike, yellow perch, and smallmouth bass.

Invertebrate sampling from 1972 to 1982 indicated good water quality in the upper half of this segment, moderate water quality in the middle segment upstream of Pontiac, and a severely degraded community below Pontiac. The upper portion of the segment was again sampled in 1999 and the results indicated that the water quality within the upper portion had declined since the 1972-1982 sampling period.

Portions of the Upper Segment have been historically managed for rainbow and brown trout but the warm water temperatures due to many lakes and impoundments 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 make the river undesirable from a fisheries management standpoint. Maceday, Lotus, Cass, and Orchard lakes have historically been, and continue to be, fishery managed lakes within the Clinton River AOC.

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, Stony Creek, and the West Branch of Stony 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, Galloway Creek has deteriorated significantly since earlier fish surveys due to development pressures and corresponding increased flows and sediment load. 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.

Invertebrate community sampling within the Middle Segment indicates a severely degraded community historically below Pontiac and Rochester with recovering communities between Pontiac and Rochester and again downstream of Rochester. Various locations in the Middle Segment have been managed by

the MDNR for brown trout, steelhead, northern pike, smallmouth bass, and walleye through stocking. The trout program in the middle part of the segment was unsuccessful largely due to water temperatures but the steelhead program has been very successful. The steelhead stocking and walleye regulatory programs still continue. The trout management program had been discontinued but was reestablished in 2003.

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 generally have 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 flashier as it flows downstream through the more urbanized areas of the watershed. As a result, the fish community becomes more pollution tolerant and generally of poorer quality.

Invertebrate community studies in 1973 above Red Run Drain confluence indicated increased stability in the macroinvertebrate community in comparison to the Middle Segment. A 1979 study indicated that the water quality was improved compared to 1973, but a limited study in 1999 showed a decline in stream water quality. All studies in the Middle Segment from Red Run Drain to the confluence with the North Branch have shown relatively poor stream quality. North Branch studies have shown a relatively good stream quality with the exception of the area downstream of Almont and near its confluence with the Clinton River mainstem.

The Lower Segment has historically been managed for steelhead, walleye, and trout. Steelhead and walleye are still present in the downstream area of the segment primarily as migratory species from Lake St. Clair. The Red Run Drain is degraded to the point that it does not have any fisheries management potential at this time. The middle section of the North Branch continues to support a good population of smallmouth bass, again apparently migrating 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 dominant species captured during the 2002 survey of the Clinton River channel. Largemouth bass and golden shiner were also present in the catch. 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 fish community was dominated by common carp, gizzard shad, largemouth bass, golden shiner, and goldfish. Invertebrate community studies have continuously indicated low species diversity and a community dominated by facultative or pollutant tolerant organisms. The Mouth Segment of the river is managed for seasonal steelhead and walleye but the dominant fishery influence in this portion of the river is from Lake St. Clair.

Mussel populations and distribution have been impacted by development within the Clinton River watershed. An excellent summary is provided by Francis and Haas (2006) in the Clinton River Assessment:

> "The earliest records of mussel collections in the Clinton River consist of a series of unpublished collections housed in the University of Michigan, Museum of Zoology. These include scattered collections from 1870 to 1925, as well as a rather thorough collection of 31 species from 11 sites in 1933. In 1977 and 1978, Strayer (1980) did a comprehensive survey of mussels in the Clinton River system and found 26 species. This is the second highest level of species diversity found in the Great Lakes drainage. However, he reported that five species (purple wartyback, round hickorynut, black sandshell, eastern pondmussel, and northern riffleshell) that were collected in earlier sampling, were likely extinct from the Clinton system. These five species were most abundant in the lower mainstem and were probably eliminated due to pollution after 1933 (Strayer 1980). The wavy-rayed lampmussel is threatened, the snuffbox, purple lilliput, and rayed bean are endangered, and the elktoe, slippershell mussel, round pigtoe, and rainbow are listed as species of special concern. Although there was good diversity in the watershed, species distribution was not consistent throughout. Based on Strayer's (1980) work in 1977 and 1978, the Clinton River above Pontiac supported 14 species, including 4 on the state list. A small population of purple lilliput is the only known location of this species in the state, however recent surveys indicate its density is declining due to the proximity of a lake-level control structure. The upper Clinton River also supports what is likely the only population of rayed bean living in Michigan's streams (Strayer 1980). The Clinton River mainstem below Pontiac was extremely degraded. Six stations were sampled and there was no evidence of live mussels. It once supported at least 26 species, including 5 on the state list (Strayer 1980). Mussel populations in Paint Creek were largely destroyed since surveys in 1933. Only four species were found remaining in tributaries and in Paint Creek (Strayer 1980). A healthy mussel community was found in Stony Creek. Although only 10 species were found, population densities were quite high (3 adults/ m2) (Strayer 1980). The North Branch and its tributaries contained a very diverse mussel fauna (22 species) and densities were high (>1 adult/m2) in several locations. Only one listed species (wavy-rayed lampmussel) was found in the North Branch. Strayer concluded that many species found in the Clinton River have been extirpated from their range in eastern Michigan, and the North Branch, as of 1978, contained the finest remaining example of a large river mussel fauna in eastern Michigan (Strayer 1980). More recent sampling for mussels has occurred in the upper Clinton River mainstem, above Pontiac, in the mid-1990s (Hunter et al. 1994, Hunter et al. 1996, Hunter et al. 1997). Hunter et al. (1994) found that species present were very similar to those found by Strayer in 1977 and 1978, although relative abundance varied. In addition, two exotic species, the Asian clam and zebra mussel, were both found in this most recent survey. These species are thought to have colonized the watershed in the early 1990s. Zebra mussels are a

threat to native unionids, because they attach to native mussels and disrupt feeding, locomotion, and reproduction causing death in 2–3 years. Zebra mussels have been implicated in the severe decline in diversity and abundance of mussel populations in inland lakes and the Great Lakes. On the Clinton River, zebra mussels are present as far upstream as Loon Lake (Hunter et al. 1994). However, densities are far less in the upper Clinton River than in the connected lakes. Thus, Hunter suggested that at most river sites, zebra mussel loads on mussels posed no immediate threat to the health and survival of unionids (Hunter et al. 1998), although long-term predictions are still unclear. A more recent (2004) survey duplicating Strayer's sites and methods indicated that overall species richness had declined further, from 26 in 1978 to 14 in 2004 and this had occurred in all seven major tributaries of the river (R. D. Hunter, Department of Biological Sciences, Oakland University, personal communication; Morowski 2004). All regions also declined in mussel density ranging from 63% lower than in 1978 in the North Branch, to 100% lower in the Middle Branch. According to the investigators, this recent decline is likely due to extremes in flow instability. Flashiness results in bottom scouring and mussel displacement during high water events as well as flow stoppage during low water periods. The latter is especially severe below lake-level control structures. The most crucial location is at Dawson's Mill Pond outlet where the unique population of the endangered purple lilliput is especially imperiled due to frequent shutoff of all flow during drought periods (Sweet 2002). Unfortunately, growth in human population and development of the watershed will likely continue to promote flashy hydrodynamics that are detrimental to the freshwater mussel community."

3.3 TRENDS IN SEDIMENT CONTAMINATION

Contaminated sediment is a key problem in the 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 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 are sufficiently buried and 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 of, 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 assessments need to be done and are 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 were 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. 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 show 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 was completed in March 2005. A summary of the study 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. The 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.

3.4 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 River watershed. In the year 1800, as shown in Figure 3.15, one 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 in Table 3.1.

These pre-European settlement vegetation types were derived from the Government Land Office (GLO) surveys of the early 1800s. The GLO surveyors surveyed and mapped the current Township Range Section (TRS) system. While surveying the square mile section lines, the surveyors recorded vegetation characteristics and landforms along the section lines and recorded tree species at section line intersections. Michigan Natural Features Inventory (MNFI) transcribed the surveyor notes to create the dataset. These data are intended to show the types and patterns of the natural community types present prior to European settlement. (Comer, P. J. et al. 1995)

Table 3-1: 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

NAME	ACRES	PERCENT OF TOTAL
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 wetlands or lakes/rivers. From 1800 to 1975, the population in the area grew substantially, resulting 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 loss 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 (2003), 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 the early 1960's.

A good summary of all of the above studies can be found in a 1981 Michigan Natural Features Inventory report. (Master, 1981) Based upon the findings in this report, and the most current list of list of threatened, endangered, and special concern species from MNFI, (Table 3-2), a large number of species within the Clinton River watershed have been impacted by the historical and on-going urbanization. The species listed in Table 3-2 are from the most current version of the MNFI natural heritage database of rare species and high quality natural communities. This database is the most comprehensive compilation of rare species and natural communities in Michigan.

Table 3-2: 2007 List of Threatened, Endangered, and Special Concern Species and High Quality Natural Communities within Clinton River Watershed (MNFI, 2007)

SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS	STATE STATUS
Animals			
Accipiter cooperii	Cooper's Hawk		SC
Acris crepitans blanchardi	Blanchard's Cricket Frog		SC
Alasmidonta marginata	Elktoe		SC
Alasmidonta viridis	Slippershell Mussel		SC
Ammodramus savannarum	Grasshopper Sparrow		SC
Asio otus	Long-eared Owl		T
Botaurus lentiginosus	American Bittern		SC
Buteo lineatus	Red-shouldered Hawk		T
Calephelis mutica	Swamp Metalmark		SC
Chlidonias niger	Black Tern		SC
Circus cyaneus	Northern Harrier		SC
Clemmys guttata	Spotted Turtle		T
Coregonus artedi	Cisco or Lake Herring		T
Cyclonaias tuberculata	Purple Wartyback		SC
Emydoidea blandingii	Blanding's Turtle		SC
Epioblasma torulosa rangiana	Northern Riffleshell	LE	E
Epioblasma triquetra	Snuffbox		E
Erynnis baptisiae	Wild Indigo Duskywing		SC
Gavia immer	Common Loon		T
Lampsilis fasciola	Wavy-rayed Lampmussel		T
Nicrophorus americanus	American Burying Beetle	LE	E
Notropis anogenus	Pugnose Shiner		SC
Noturus miurus	Brindled Madtom		SC
Nycticorax nycticorax	Black-crowned Night-heron		SC
Obovaria subrotunda	Round Hickorynut		E
Oecanthus laricis	Tamarack Tree Cricket		SC
Oecanthus pini	Pinetree Cricket		SC
Pantherophis gloydi	Eastern Fox Snake		T
Pleurobema coccineum	Round Pigtoe		SC
Prosapia ignipectus	Red-legged Spittlebug		SC
Protonotaria citrea	Prothonotary Warbler		SC
Sistrurus catenatus catenatus	Eastern Massasauga	C	SC
Speyeria idalia	Regal Fritillary		E
Toxolasma lividus	Purple Lilliput		E
Villosa fabalis	Rayed Bean	C	E

SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS	STATE STATUS
Villosa iris	Rainbow		SC
Plants			
Agalinis gattingeri	Gattinger's Gerardia		E
Amorpha canescens	Leadplant		SC
Angelica venenosa	Hairy Angelica		SC
Arabis missouriensis var. deamii	Missouri Rock-cress		SC
Armoracia lacustris	Lake Cress		T
Asclepias sullivantii	Sullivant's Milkweed		T
Astragalus canadensis	Canadian Milk-vetch		T
Bouteloua curtipendula	Side-oats Grama Grass		T
Carex davisii	Davis's Sedge		SC
Carex lupuliformis	False Hop Sedge		T
Carex richardsonii	Richardson's Sedge		SC
Castanea dentata	American Chestnut		E
Cirsium hillii	Hill's Thistle		SC
Cyperus acuminatus	Nut-grass		X
Cypripedium candidum	White Lady-slipper		T
Drosera anglica	English Sundew		SC
Euonymus atropurpurea	Wahoo		SC
Fraxinus profunda	Pumpkin Ash		T
Fuirena squarrosa	Umbrella-grass		T
Galearis spectabilis	Showy Orchis		T
Gentiana puberulenta	Downy Gentian		E
Gentianella quinquefolia	Stiff Gentian		T
Gymnocladus dioicus	Kentucky Coffee-tree		SC
Hibiscus moscheutos	Swamp Rose-mallow		SC
Hieracium paniculatum	Panicled Hawkweed		SC
Hydrastis canadensis	Goldenseal		T
Liatris squarrosa	Blazing-star		X
Linum sulcatum	Furrowed Flax		SC
Linum virginianum	Virginia Flax		T
Liparis liliifolia	Purple Twayblade		SC
Ludwigia alternifolia	Seedbox		SC
Monarda didyma	Oswego Tea		X
Muhlenbergia richardsonis	Mat Muhly		T
Panax quinquefolius	Ginseng		T
Penstemon pallidus	Pale Beard Tongue		SC
Plantago cordata	Heart-leaved Plantain		E
Platanthera ciliaris	Orange or Yellow Fringed Orchid		T
Poa paludigena	Bog Bluegrass		T

SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS	STATE STATUS
Polemonium reptans	Jacob's Ladder or Greek-valerian		T
Psilocarya scirpoides	Bald-rush		T
Quercus shumardii	Shumard's oak		SC
Scirpus clintonii	Clinton's Bulrush		SC
Scleria triglomerata	Tall Nut-rush		SC
Silphium integrifolium	Rosinweed		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
Natural communities			
Bog			
Coastal plain marsh	Infertile Pond/marsh, Great Lakes Type		
Dry-mesic southern forest			
Emergent marsh			
Floodplain forest			
Great Lakes marsh			
Hardwood-conifer swamp			
Mesic southern forest	Rich Forest, Central Midwest Type		
Poor conifer swamp			
Prairie fen	Alkaline Shrub/herb Fen, Midwest Type		
Rich tamarack swamp	Forested Bog, Central Midwest Type		
Southern hardwood swamp			
Southern wet meadow	Wet Meadow, Central Midwest Type		
Submergent marsh			
Wet-mesic flatwoods			
Other			
Great Blue Heron Rookery	Great Blue Heron Rookery		

Federal status
C = candidate for federal listing
LE = Endangered

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

3.5 NATURAL RESOURCE VALUES AND IMPORTANT AOC FEATURES

The Clinton River watershed has many animals and natural resources that are highly valued by the local residents and visitors recreating in the watershed including the following (note that is this not an exhaustive list):

- Mink
- Muskrat
- Beaver
- Heron and king fishers
- Freshwater clams/mussels
- High quality cool 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 3-3: 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 3-4: 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 3-5: 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 (Figures 3.15 through 3.17), 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, but not limited to:

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

4.0 DELISTING TARGETS FOR FISH/WILDLIFE HABITAT/POPULATION BENEFICIAL USE IMPAIRMENTS

4.1 PREVIOUSLY PROPOSED RESTORATION CRITERIA

While this project was originally designed to develop "delisting targets" for the habitat related BUIs in the Clinton AOC, the overwhelming view of the Clinton River RAP PAC, the CRWC representatives, and the Technical Committee was that this project should define "restoration targets" for the Clinton AOC in addition to possible delisting targets. Restoration targets are likely to go beyond delisting targets with respect to addressing additional projects and concerns within the AOC. This section outlines the restoration target for habitat BUIs proposed in October 2005 (ECT Report to CRWC and CPAC, 2005). Delisting targets are further addressed in Section 5 and 6 of this report.

4.1.1 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 Target

- 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, achieve no net loss of wetlands 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 target – 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 target trends.

4.1.2 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 impacts from zebra mussels. In addition, the cool 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 water temperatures, impervious surfaces and runoff and altered 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 Target

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 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 identify trends for wildlife populations in the riparian corridor.
- Develop uniform wildlife evaluation procedures for volunteer monitoring groups and have the procedures approved by the MDEQ/MDNR/USFWA as appropriate.

4.2 MDEQ'S COMMENTS ON PREVIOUSLY PROPOSED CRITERIA FOR LOSS OF FISH AND WILDLIFE HABITAT/POPULATION

On July 21st, 2006, MDEQ sent the following comments related to habitat BUIs:

it is MDEQ's understanding that the PAC is in the process of developing/refining the targets included in the Phase I – Final Report for these two BUIs. The criteria for these two BUIs in the state's final Guidance document are a process for developing locally-derived restoration plans for habitat and populations. As resources allow, MDEQ plans to participate in the Clinton River AOC technical committee for this effort and provide technical input where appropriate.

4.3 UPDATES TO PREVIOUSLY PROPOSED DELISTING TARGETS

The final overarching delisting targets and locally-derived restoration projects are presented in Chapter 6 of this document.

5.0 SELECTING DEMONSTRATION SITES FOR HABITAT BUIs RESTORATION

5.1 PROCESS ADOPTED TO SELECT SITES

On January 5, 2007, a Memo requesting restoration recommendations was emailed to nearly a thousand stakeholders by the Executive Director of the Clinton River Watershed Council. In addition, copies of the Memo were provided to attendees of subwatershed management groups within Clinton River watershed.

5.1.1 Key Parameters

The Memo requested that recipients recommend a list of restoration projects at **specific sites** that will greatly benefit the fish and wildlife related BUIs within Clinton River AOC, and noted that one or more of the following parameters needed to be addressed by a proposed restoration project targeted at delisting the AOC:

- In-stream sedimentation
- Changes in hydrology
- Opening fish and wildlife habitats (e.g., fish passage at impoundments)
- Wetland loss
- Alteration of riparian habitat
- Contaminated sediments affecting benthos

5.1.2 Key Project Types

The Memo further identified that the sources of restoration projects/sites could be the following:

- The sites identified as needing restoration in each subwatershed planning effort within the Clinton River Watershed that carried out critical area/monitoring analyses
- Wetland restoration sites as identified by Michigan Department of Environmental Quality
- Projects identified by Michigan Department of Natural Resources
- Anecdotal evidence and experience
- Any other source

And that the typical projects included the following types:

- Riparian vegetation restoration
- In-stream habitat improvement
- Streambank stabilization
- Wetland restoration
- Dam removal
- Fish ladder/Fish Passage
- Daylighting

5.1.3 Adopted Procedure

Two meetings of the AOC Technical Committee were held to discuss the suggestions received from the stakeholders. These meetings further narrowed down the list of projects identified as high-potential demonstration projects that needed to be carried out in the AOC. It was agreed that:

- Implementation projects would be prioritized within each of the seven subwatersheds within Clinton River AOC, and no cross-the-board prioritization would be done.
- Projects were prioritized under "High Priority" and "Low Priority" categories. High priority recommendations are tabulated below. In determining if a project was high or low priority, consideration was given to scientific merit of the project, potential habitat/population impact and project visibility. Additionally, it was important that the selected projects represent a variety of approaches, address different impairment causes and include projects in Macomb and Oakland County and within each of the subwatersheds. The recommendations not tabulated in the report are all considered to be low priority recommendations.
- Barriers to success of an implementation project were important to keep in mind, but did not exclude any project from being listed as a high priority recommendation.

5.2 IDENTIFYING BROAD RESTORATION CATEGORIES TO DELIST THE AOC

The Clinton River Wildlife Habitat and Populations BUIs can be delisted when the targets identified below are met. Due to the large size of the AOC, it is impossible to identify a comprehensive list of projects that once completed would result in full restoration of the AOC. Therefore, priority projects for each delisting target have been identified and are summarized below. It is recognized that additional work may be required prior to ultimate restoration of the AOC.

5.2.1 Delisting Project Category 1: Streambank stabilization

Areas of extreme stream bank erosion exist within the AOC that cause increased sedimentation downstream. Sediment deposition and stream bank erosion have been recognized as impacting in-stream habitat and degrading wildlife populations. Erosion introduces significant amounts of sediment into the stream where it eliminates habitat for insects, fish and other organisms. Erosion can cause loss of trees and other streambank vegetation. The 1995 RAP update attributed degraded native mussel populations to in-stream sedimentation and cool water fishery impairments to sedimentation among a few other factors. Additionally, erosion was identified as a contributor to loss of wildlife habitat. For both BUIs, control of erosion was identified as a necessary control.

5.2.2 Delisting Project Category 2: In-stream habitat improvement

Degraded in-stream habitat for insects, fish and other organisms is prevalent within the AOC. The Clinton Main experiences high peak flows that create large, damaging log jams. The log jams create obstructions in the river and cause erosion and subsequent sedimentation, thus negatively impacting habitat and wildlife populations. However, it is important to recognize that some woody debris is desirable as it provides a diverse habitat for fish, reptiles, amphibians and macroinvertebrates. The Summary Table of Recommendations from the 1995 RAP update identified restoration and recruitment of woody debris as an action that would address the degradation of wildlife habitat and loss of wildlife population BUIs. An additional recommended action item to address these two BUIs was development of a basin-wide log and debris jam master plan. Removing damaging log jams and maintaining and/or

improving beneficial debris that acts as habitat or positively stabilized slopes is one way to improve in-stream habitat.

Additionally, the Summary Table of Recommended Actions included in the 1995 RAP update listed restoration of in-stream habitat for sustainable fish communities as an action that would address the degradation of wildlife habitat and loss of wildlife population BUIs. Activities to restore in-stream habitat may include in-stream structures such as boulder clusters, covered logs, tree cover, cross logs and others. These types of structures function as riffles and create pools within the stream that provide additional and improved in-stream habitat.

5.2.3 Delisting Project Category 3: Riparian vegetation restoration

Removal of vegetation, grading and other maintenance activities in the riparian corridor limit the available habitat. Restoration of riparian corridor vegetation would enhance terrestrial habitat.

5.2.4 Delisting Project Category 4: Dam removal and/or improvements

Dams impair fish passage to critical high-gradient habitat. Dams cause fragmentation of rivers and inhibit critical high gradient habitat. Removal of these dams will open up additional waterway access to critical high-gradient habitat and improve fish and mussel populations. The Summary Table of Recommended Actions included in the 1995 RAP update listed restoration of fish migration ability and spawning habitat through dam removal and/or modification as an action that would address the degradation of wildlife habitat and loss of wildlife population BUIs. Dam removal or construction of fish passages provides a mechanism for fish migration.

Additionally, dams are often detrimental to cool and cold water stream habitat. In warm summer months, water warmed at the surface of the lake is discharged over the dam and results in increased temperatures downstream. The increased water temperature is especially detrimental to sensitive species that cannot tolerate warm water such as trout. Only a few cold water streams exist in Southeast Michigan and Paint Creek is considered to be the highest quality of these. The 1995 RAP update identified stormwater control and habitat protection as the two most critical needs in this basin. Specifically, the cold water habitat should be protected. Additionally, the Summary Table of Recommended Actions included in the 1995 RAP update listed restoration of in-stream habitat for sustainable fish communities as an action that would address the degradation of wildlife habitat and loss of wildlife population BUIs. Dam removal or use of a bottom draw provides reduced downstream water temperatures that are preferred by cold water species.

In the 1990's, the Fisheries Division of MDNR performed a trout population estimate and follow-up survey in Paint Creek from the headwaters at Lake Orion to the confluence with the Clinton River. These surveys were designed to document the effect of the bottom-draw structure constructed at the outlet of Lake Orion. Both surveys showed good survival of trout throughout the stream indicating a positive impact to the cold water habitat (1995 RAP update).

5.2.5 Delisting Project Category 5: Wetland restoration

Loss of wetlands has contributed to an altered hydrologic flow of the Clinton River, resulting in higher peak flows and lower base flows. Higher peak flows create increased erosion that results in sedimentation and loss of fish habitat. The higher peak flows can also widen the stream channel.

Combined with lower base flow, the wider stream also results in loss of fish habitat. In 1995, as noted in the RAP update, wetland losses within the watershed were estimated to be at least 75% and increasing and wetland loss was identified as one contributor to loss of wildlife habitat. Loss of wetlands results in altered hydrology which was identified as a contributor to degraded fish and wildlife populations. Additionally, the Summary Table of Recommended Actions from the 1995 RAP updated included restoration of summer base flows as an action that would address the degradation of wildlife habitat and loss of wildlife population BUIs.

Restoration of areas believed to represent pre-settlement wetlands to wetlands will help to restore the desired hydrologic flow of the river.

5.2.6 Delisting Project Category 6: Sediment removal

Increased sediment deposition has been observed within the AOC. Increased sediment eliminates habitat for insects, fish and other organisms. The 1995 RAP update attributed degraded native mussel populations to in-stream sedimentation and cool water fishery impairments to sedimentation among a few other factors.

Sediment contamination has been recognized as negatively impacting wildlife populations. The 1995 RAP update attributed degraded native mussel populations to in-stream sedimentation and cool water fishery impairments to sedimentation among a few other factors. Additional improvements should be considered in areas of sediment removal activities prevent further sedimentation and long term maintenance plans may be considered to ensure continued sediment removal if necessary.

5.2.7 Delisting Project Category 7: Repair of seriously eroded road/stream crossings

Road/stream crossings, especially for gravel roads with roadside ditches are significant contributors of sediment to the Clinton River and its tributaries. Roadside ditches provide little sediment removal due to their steep slopes adjacent to the waterways. Sediment deposition has been recognized as impacting in-stream habitat and degrading wildlife populations. Erosion introduces significant amounts of sediment into the stream where it eliminates habitat for insects, fish and other organisms. In the 1995 RAP update, erosion and hydrologic changes were identified as two contributors to loss of wildlife habitat. For both BUIs, control of runoff and erosion were identified as necessary controls.

The Paint Creek is a cold water stream and provides valuable trout habitat. Habitat quality is critical to maintaining a healthy trout population. Only a few cold water streams exist in Southeast Michigan and Paint Creek is considered to be the highest quality of these. The 1995 RAP update identified stormwater control and habitat protection as the two most critical needs in this basin. Specifically, the cold water habitat should be protected. Additionally, the Summary Table of Recommended Actions included in the 1995 RAP update listed restoration of in-stream habitat for sustainable fish communities as an action that would address the degradation of wildlife habitat and loss of wildlife population BUIs.

5.2.8 Delisting Project Category 8: Control of runoff

Urban development within the watershed has resulted in increased stormwater peak flows and volumes. Flooding and high peak flows are common in many areas within the AOC and cause erosion of the stream banks and sediment deposition. High peak flows and the resulting stream bank erosion and sedimentation have been recognized as impacting in-stream habitat and degrading wildlife

populations. Erosion introduces significant amounts of sediment into the stream where it eliminates habitat for insects, fish and other organisms. Erosion can cause loss of trees and other streambank vegetation. The 1995 RAP update attributed degraded native mussel populations to in-stream sedimentation and cool water fishery impairments to sedimentation and changes in hydrology among a few other factors. Additionally, erosion and hydrologic changes were identified as two contributors to loss of wildlife habitat. For both BUIs, control of runoff and erosion were identified as necessary controls.

5.3 CHOSEN SITES

The twenty-five high priority recommendations are summarized below and are presented in Figure 5.1.

- In-stream habitat improvement and/or streambank stabilization &/or riparian vegetation restoration:
  - Oakland County Complex Mainland Drain Project
  - Extend Rochester Hills Woody Debris Management Plan
  - McBride Drain Restoration
  - Hart Drain Restoration
  - Ferry Drain and Renshaw Drain Stabilization
  - Stream Bank Restoration near Riverside Park
  - Deer Creek Restoration
  - Sterling Relief Spillway Naturalization

- Wetland restoration:
  - Wetland Restoration/Connectivity in Harrison Township
  - Potential Wetland Restoration Site in Springfield Township
  - Potential Wetland Restoration Site in Independence Township
  - Potential Wetland Restoration Site in Oakland Township
  - Two Potential Wetland Restoration Sites in Bruce Township
  - Potential Wetland Restoration Site in Ray Township
  - Potential Wetland Restoration Site in Washington Township

- Dam removal and/or development of underflow &/or fish passage:
  - Crystal Lake Dam Cold Water Bottom Draw
  - Cascade Dam Removal
  - Wolcott Park Dam Removal
  - Paint Creek Dam Removal
  - Fish Passage Modification to the Oakland/Woodhull Lake Level Structure

- Seriously eroded road-stream crossings to prevent sedimentation etc:
  - Clarkston/Kern Road Crossing Improvements
  - Silver Bell Road and Dutton Road Crossings Improvements

- Sediment removal:
  - Shadyside Park Sediment Removal
  - PCB Contaminated Sediment Removal

6.0 FINAL DELISTING TARGETS FOR SELECTED RESTORATION SITES

6.1 OVERARCHING DELISTING TARGETS

The overarching delisting targets developed for the AOC are measurable targets to be used in identifying when one of the two Fish and Wildlife BUIs can officially be delisted. Due to the complexity of the Fish and Wildlife BUIs, multiple targets are identified for each BUI. Each of the listed targets for any given BUI would need to be obtained prior to delisting that BUI. Table 6.1 details the overarching targets for each of the BUIs.

Table 6-1: Overarching Delisting Targets

BENEFICIAL USE IMPAIRMENT	DELISTING TARGET
Degradation of Fish and Wildlife Populations BUI	1. A healthy fish population is determined by the relevant resource management agency(ies) to exist within the AOC at selected sites (to be determined cooperatively by the CRPAC, MDEQ and MDNR).
	2. Relevant inventories, sightings, and observations made at selected sites (to be determined cooperatively by the CRPAC, MDEQ and MDNR) lead to the determination: • That a diverse wildlife population exists with the AOC, and • That species that should be at those sites actually are at those sites.
Loss of Fish and Wildlife Habitat BUI	1. Degradation of Benthos BUI is delisted.
	2. No waterbodies within the AOC are included on the list of non-attaining waters due to low DO in the most recent Clean Water Act Water Quality and Pollution Control in Michigan Section 303(d) and 305(b) Integrated Report (Integrated Report)
	3. The CRPAC, MDEQ, and MDNR will cooperatively assess large woody debris within the Clinton River watershed to determine whether habitat-destructive large woody debris (defined as large woody debris which contributes to the destruction of more habitat than it creates) forms in the watershed, and if so, to specifically identify key sites where it typically forms. If habitat destructive large woody debris is indeed determined to form within the watershed, criteria will be developed to address it at the sites identified during the assessment.
	4. At selected sites (to be determined cooperatively by the CRPAC, MDEQ, and MDNR) programs are in place to establish minimum subwatershed 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%) areas.
	5. Wetlands are created/restored such that there is a net increase in area which is equivalent to replacing a minimum of 1% to 5% of the wetlands that were "lost" since presettlement as indicated in the report entitled "Clinton River AOC: Wetland Status and Trends Presettlement to 1978" (as updated to 2005) (Robert Zbiciak, MDEQ).
	6. Degradation of Fish and Wildlife Populations BUI is delisted.

It was the intention of the Technical Committee that the targets be challenging yet not unrealistically attainable. It is recommended that the overarching targets be periodically reviewed and modified if it is determined that any of them are deemed impossible to reach.

6.2 IDENTIFIED RESTORATION PROJECTS

This list is of high priority demonstration projects that the Technical Committee identified when the report was being written. Lack of resources prevented any detailed feasibility study of the projects presented below. Future, detailed feasibility study may result in a change in the list of specific projects.

Completion of these projects or suitable replacement projects will progress the AOC toward delisting. The local stakeholders will need to periodically evaluate the conditions within the AOC with respect to the overarching delisting targets to determine if additional restoration projects are required.

Demonstration Project 1 – Oakland County Complex Mainland Drain Project

Description of Impairment and Proposed Improvements

Urban development within the watershed has resulted in increased stormwater peak flows and volumes. Areas of flooding and high peak flows along the Mainland Drain located at the Oakland County Campus have been a concern of the Oakland County Drain Commissioner (OCDC). Sediment deposition and stream bank erosion were observed within the drain.

Land uses adjacent to the stream are a significant source of sediment loading to the drain. Storm water management facilities are proposed, in addition to the demonstration project, to address the peak flows and sediment loading to the drain. Constructed wetlands and stormwater detention facilities are proposed to reduce peak flows and increase base flows. Sediment forebays are proposed to reduce sediment loading to the drain.

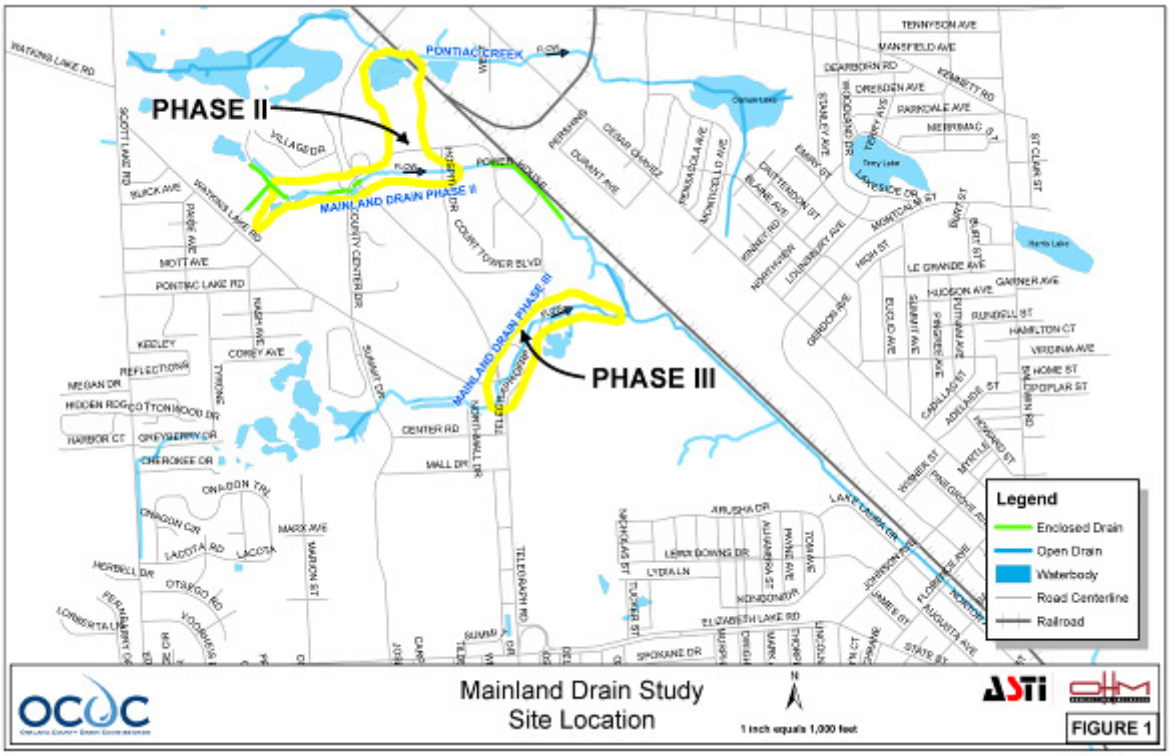

Figure 6.1. Mainland Drain within Oakland County Campus

The demonstration project consists of cleaning, stabilizing and re-grading this portion of the drain to prevent the sediment from entering the drain. Other causes of sedimentation within the Mainland Drain include an old culvert and a multiple culvert crossing. It appears that the old culvert is unnecessary and could be removed. The multiple culvert crossing impedes flow resulting in increased downstream velocities that increase the potential for erosion problems. Upstream pooling can also result in increased sedimentation. Replacement of the multiple culverts with a box culvert would allow for reduced downstream velocities and reduce the sedimentation in this area. Additional re-grading, reshaping and stabilization will occur at areas where significant stream bank erosion and sedimentation were observed.

This drain may be a good candidate for fish habitat restoration and will likely encourage spawning activities of fish species, including pike and suckers that prefer small tributaries. Restoration of this drain to a more traditional stream environment would provide additional and diverse wildlife habitat and promote enhanced wildlife populations. Improvements may include in-stream structures such as boulder clusters, covered logs, tree cover, cross logs and others. These types of structures function as riffles and create pools within the stream. Additional improvements could include restoration of riparian corridor vegetation that would enhance terrestrial habitat.

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 1: Streambank Stabilization
- Delisting Project Category 2: In-stream Habitat Improvement

- Delisting Project Category 3: Riparian Vegetation Restoration
- Delisting Project Category 8: Control of Runoff

Demonstration Project 2 - Extend Rochester Hills Woody Debris Management Plan

Description of Impairment and Proposed Improvements

A portion of the Clinton Main is located within Rochester Hills. The Clinton Main experiences high peak flows that create large, damaging log jams. The log jams create obstructions in the river and cause erosion and subsequent sedimentation, thus negatively impacting habitat and wildlife populations. However, it is important to recognize that some woody debris is desirable as it provides a diverse habitat for fish, reptiles, amphibians and macroinvertebrates. A woody debris management plan should be coordinated with stream bank stabilization and improvement considerations so that woody and other debris acting as habitat or positively stabilizing slopes will be modified to benefit habitat as well as flow.

The City of Rochester Hills has completed an inventory of the woody debris in the Clinton Main within the City. The next step is to create a stream bank stabilization management plan that would identify the debris that should be maintained and/or augmented for habitat enhancement. The management plan would include a long term maintenance plan. A similar inventory and management plan will be completed for downstream communities, resulting in a unified woody debris management plan for the Main Branch of the Clinton River. Additionally, similar plans will be completed for the North Branch and Middle Branch portions of the Clinton River.

Delisting Project Category(ies) Addressed

Completion of the Woody Debris Management plan, removal of the undesirable large woody debris and implementation of a long term maintenance plan will address the following delisting project categories:

- Delisting Project Category 2: In-stream Habitat Improvement

Demonstration Project 3 –McBride Drain Restoration

Description of Impairment and Proposed Improvements

The McBride Drain is a traditionally maintained drain that is tributary to the North Branch of the Clinton River. Maintenance has focused on conveyance rather than ecological considerations. Removal of vegetation, grading and other maintenance activities limit the available habitat. Limited wildlife exists in this drain. Restoration of this drain to a more traditional stream environment will provide additional and diverse wildlife habitat and promote enhanced wildlife populations. Improvements may include in-stream structures such as boulder clusters, covered logs, tree cover, cross logs and others. These types of structures function as riffles and create pools within the stream. Additional improvements could include restoration of riparian corridor vegetation that would enhance terrestrial habitat.

This drain is considered to be a good candidate for fish habitat restoration and will likely encourage spawning activities of fish species, including pike and suckers that prefer small tributaries.

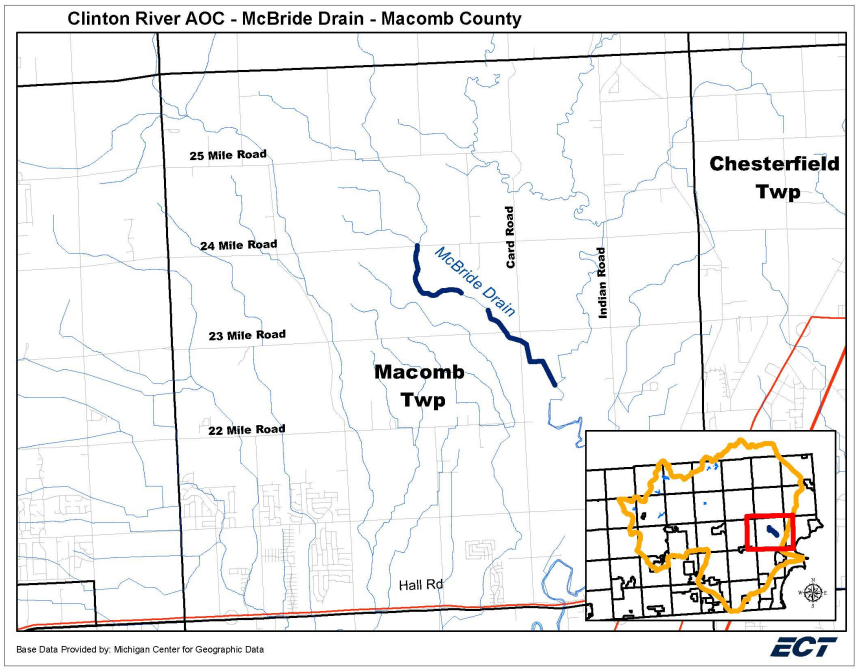

Figure 6.2. McBride Drain

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 2: In-stream Habitat Improvement
- Delisting Project Category 3: Riparian Vegetation Restoration

Demonstration Project 4 – Hart Drain Restoration

Description of Impairment and Proposed Improvements

The Hart Drain is tributary to the North Branch of the Clinton River. Maintenance has traditionally focused on conveyance rather than ecological considerations. Removal of vegetation, grading and other maintenance activities limit the available habitat. Limited wildlife exists in this drain. Restoration of this drain to a more traditional stream environment will provide additional and diverse wildlife habitat and promote enhanced wildlife populations. Improvements may include in-stream structures such as boulder clusters, covered logs, tree cover, cross logs and others. These types of structures function as riffles and create pools within the stream. Additional improvements could include restoration of riparian corridor vegetation that would enhance terrestrial habitat.

This drain is considered to be a good candidate for fish habitat restoration and will likely encourage spawning activities of fish species, including pike and suckers that prefer small tributaries.

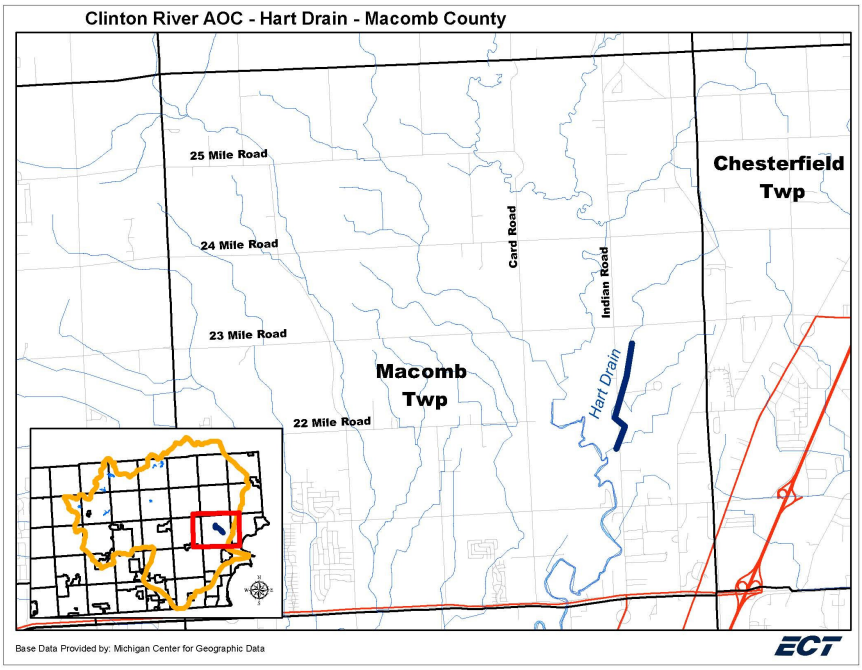

Figure 6.3. Hart Drain

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 2: In-stream Habitat Improvement
- Delisting Project Category 3: Riparian Vegetation Restoration

<u>Demonstration Project 5 –Ferry Drain and Renshaw Drain Stabilization</u>

Description of Impairment and Proposed Improvements

The portion of the Ferry Drain and Renshaw Drain between South Boulevard and Rochester Road (past Square Lake Road) in the City of Troy has significant quantities of sediment depositions that impair the stream flow. Additionally, bank erosion is prevalent, resulting from residential lawns maintained to the edge of the steam bank.

Vegetative and/or structural stabilization will assist in dissipating flow energy within the channel; improve water quality by controlling erosion and dissipation and improve riparian terrestrial and aquatic habitat. Stream bank restoration and sediment removal will improve wildlife habitat and promote enhanced wildlife populations.

This drain is considered to be a good candidate for fish habitat restoration and will likely encourage spawning activities of fish species, including pike and suckers that prefer small tributaries.

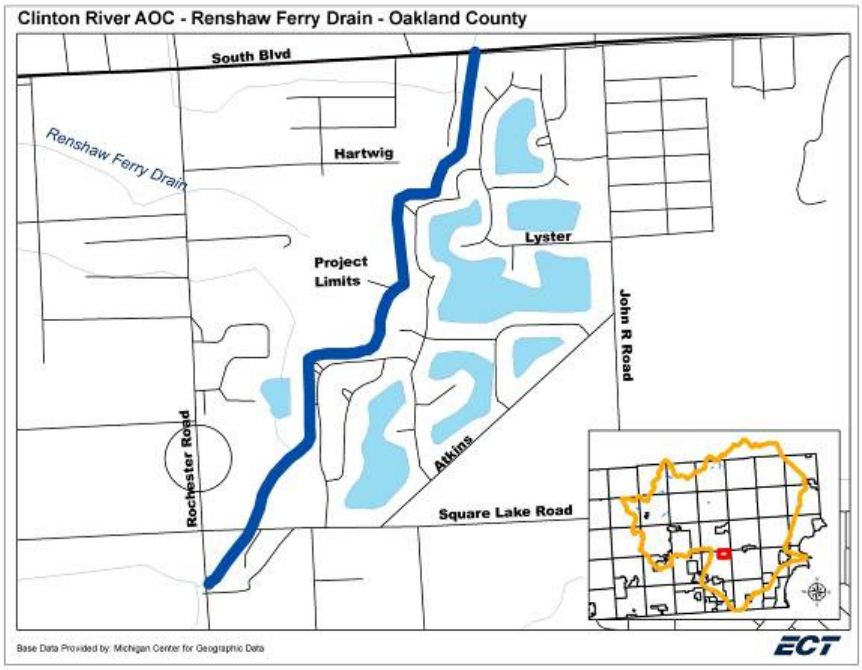

Figure 6.4. Ferry Drain and Renshaw Drain

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 1: Streambank Stabilization
- Delisting Project Category 2: In-stream Habitat Improvement
- Delisting Project Category 3: Riparian Vegetation Restoration
- Delisting Project Category 6: Sediment Removal

<u>Demonstration Project 6 – Crystal Lake Dam Cold Water Bottom Draw</u>

Description of Impairment and Proposed Improvements

The Crystal Lake Dam is located in the Upper Segment of the Clinton Main in the City of Pontiac. The segment of the river downstream of the dam within Rochester Hills and Auburn Hills supports a trout population and creation of a trout fishery in this area is desirable. Use of a bottom draw provides reduced downstream water temperatures that are preferred by cold water species. The dam at Crystal Lake is not a candidate for removal as it maintains a legal lake level and controls flooding in the City of Pontiac, but creation of a bottom draw is appropriate. This will provide for a hydraulic connection between the lower, cooler parts of the lake and the downstream river.

Described very generally, construction of an underflow to create a bottom draw would include installation of a pipe between the dam structure and the deep part of the lake. Water discharged from the dam could be entirely from the cool portion of the lake or a combination of cool water and warm water overflowing the dam. The underflow can be designed to provide easy adjustments for flow regulation. Active monitoring of the dam and downstream temperature conditions will be necessary.

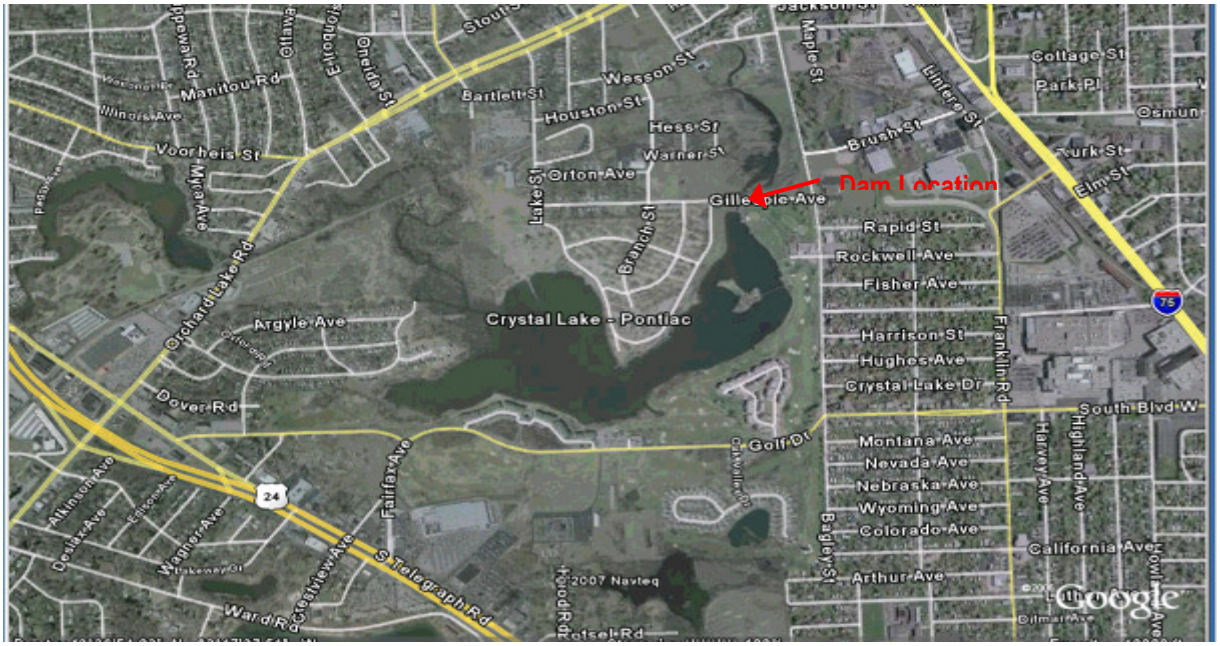

Figure 6.5 Crystal Lake Dam

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 4: Dam Removal and/or Improvements

Demonstration Project 7 – Cascade Dam Removal

Description of Impairment and Proposed Improvements

The Cascade Dam is located in the North Branch of the Clinton River on Romeo Plank Road between 31 and 32 Mile Roads. Some of the highest quality habitat in the watershed, including a designated trout stream, is located upstream of the dam. The Cascade Dam is a good candidate for removal. Removal of this existing low-head dam will benefit the entire fish and aquatic community by providing access to the upstream high quality habitat.

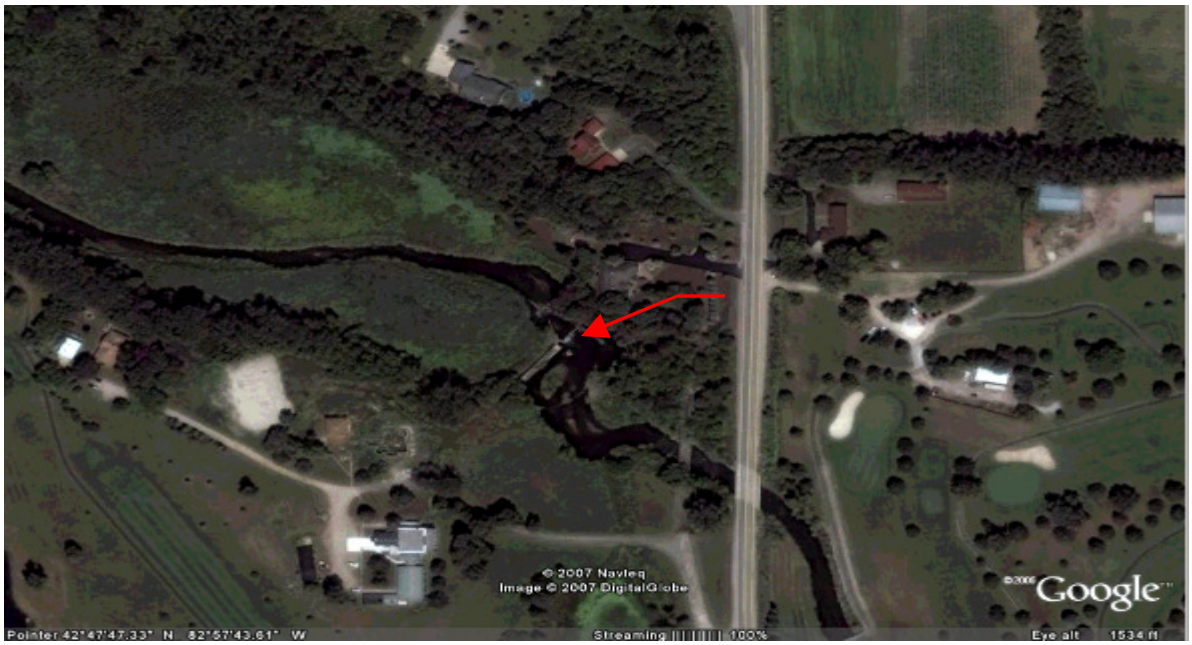

Figure 6.6. Cascade Dam

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 4: Dam Removal and/or Improvements

Demonstration Project 8 – Wolcott Park Dam Removal

Description of Impairment and Proposed Improvements

The Wolcott Park dam is a small low-head dam located in the North Branch of the Clinton River, approximately three miles downstream of the Cascade dam in Ray Township. The Wolcott Park dam is a good candidate for removal. Removal of the Wolcott Dam in combination with removal of the Cascade dam will result in full fish passage along the entire length of the North Branch providing access to some of the highest quality habitat in the watershed.

Figure 6.7. Wolcott Park Dam

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 4: Dam Removal and/or Improvements

Demonstration Project 9 - Fish Passage Modification to the Oakland/Woodhull Lake Level Structure

Description of Impairment and Proposed Improvements

The lake level control structure between Oakland and Woodhull lakes is not a candidate for removal, but creation of a fish passage is appropriate. Structural improvements to the dam will be required and creation of a fish passage would be appropriate at that time. The fish passage would provide cool water species including Pike and Walleye access to desirable upstream habitat.

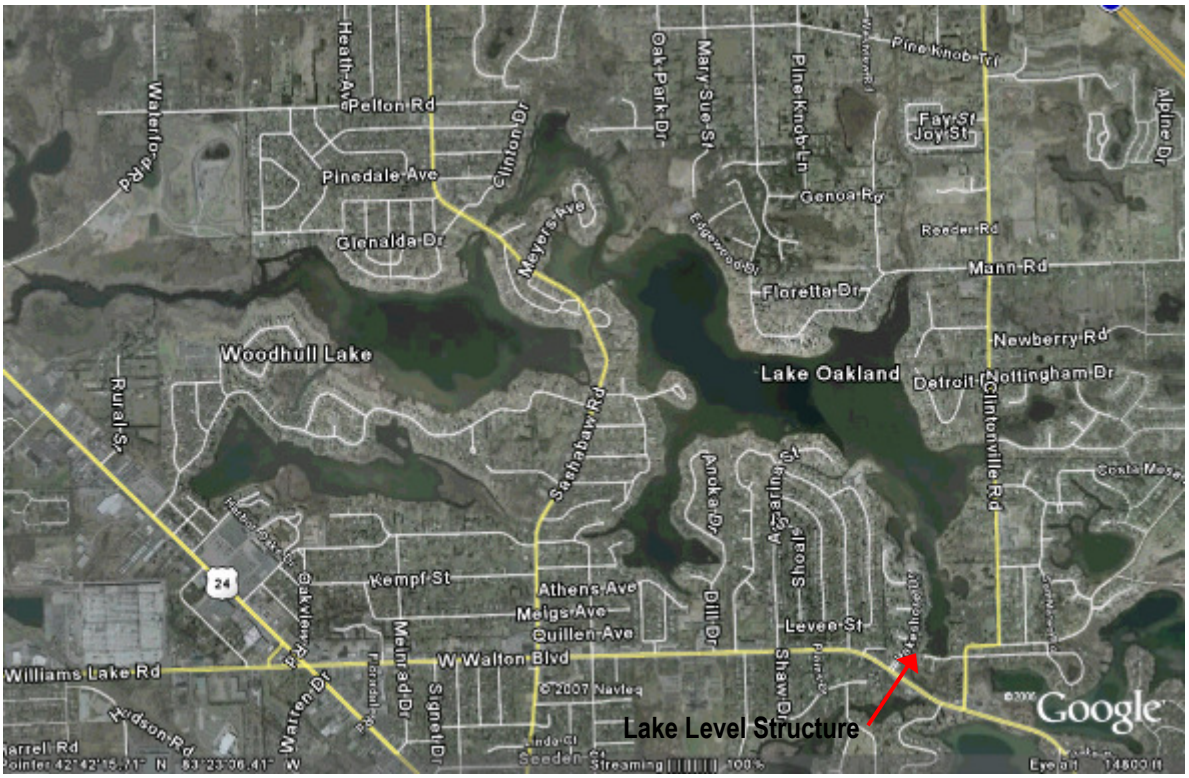

Figure 6.8. Oakland/Woodhull Lake Level Structure

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 4: Dam Removal and/or Improvements

Demonstration Project 10 – Paint Creek Dam Removal

Description of Impairment and Proposed Improvements

The Paint Creek dam, located near the midpoint of Paint Creek near the intersection of Gunn Road and Orion Road is a small low-head dam. Only a few cold water streams exist in Southeast Michigan and Paint Creek is considered to be the highest quality of these. Dam removal in this area will provide access to the upstream high-quality cold water habitat.

Figure 6.9. Paint Creek Dam

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 4: Dam Removal and/or Improvements

Demonstration Project 11 – Clarkston/Kern Road Crossing Improvements

Description of Impairment and Proposed Improvements

Clarkston and Kern Roads are gravel roads with roadside ditches that drain to Paint Creek. The ditches provide little sediment removal due to their steep slopes adjacent to the creek. A significant amount of sediment is discharged to the Paint Creek in this location. The Paint Creek is a cold water stream and provides valuable trout habitat. Only a few cold water streams exist in Southeast Michigan and Paint Creek is considered to be the highest quality of these. Habitat quality is critical to maintaining a healthy trout population. These road crossings are at the upstream end of the managed trout area so improvements will benefit the entire managed area.

Improvements to Clarkston and Kern roads, including a potential conversion of the gravel surface to asphalt would reduce the sediment loading to Paint Creek. Installation of and/or modification to stormwater conveyance facilities would eliminate the high-velocity discharges that carry sediment and increase bank erosion. A sedimentation pond or alternative BMPs could further reduce discharge velocities and allow for additional sediment removal.

Figure 6.10. Clarkston & Kern Crossing on Paint Creek

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 7: Repair of Seriously Eroded Road/Stream Crossings
- Delisting Project Category 8: Control of Runoff

Demonstration Project 12 – Silver Bell Road and Dutton Road Crossing Improvements

Description of Impairment and Proposed Improvements

Silver Bell and Dutton roads are gravel roads with roadside ditches that drain to Paint Creek. The ditches provide little sediment removal due to their steep slopes adjacent to the creek. A significant amount of sediment is discharged to the Paint Creek in this location. The Paint Creek is a cold water stream and provides valuable trout habitat. Habitat quality is critical to maintaining a healthy trout population. Only a few cold water streams exist in Southeast Michigan and Paint Creek is considered to be the highest quality of these.

Improvements to Silver Bell and Dutton roads, including a potential conversion of the gravel surface to asphalt would reduce the sediment loading to Paint Creek. Installation of and/or modification to stormwater conveyance facilities would eliminate the high-velocity discharges that carry sediment and increase bank erosion. A sedimentation pond or alternative BMP could further reduce discharge velocities and allow for additional sediment removal.

Figure 6.11. Silver Bell & Dutton Roads Crossing at Paint Creek

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 7: Repair of Seriously Eroded Road/Stream Crossings
- Delisting Project Category 8: Control of Runoff

Demonstration Project 13 –Stream Bank Restoration near Riverside Park

Description of Impairment and Location

Areas of extreme stream bank erosion exist within the Riverside Park in Auburn Hills, near the USGS stream gauges that are causing increased sedimentation downstream. This portion of the river is located within a public park. Approximately 400-500 feet of bank is available for public fishing. Removal of the sediment and additional stream bank restoration and subsequent improvement to the wildlife habitat and population is very desirable.

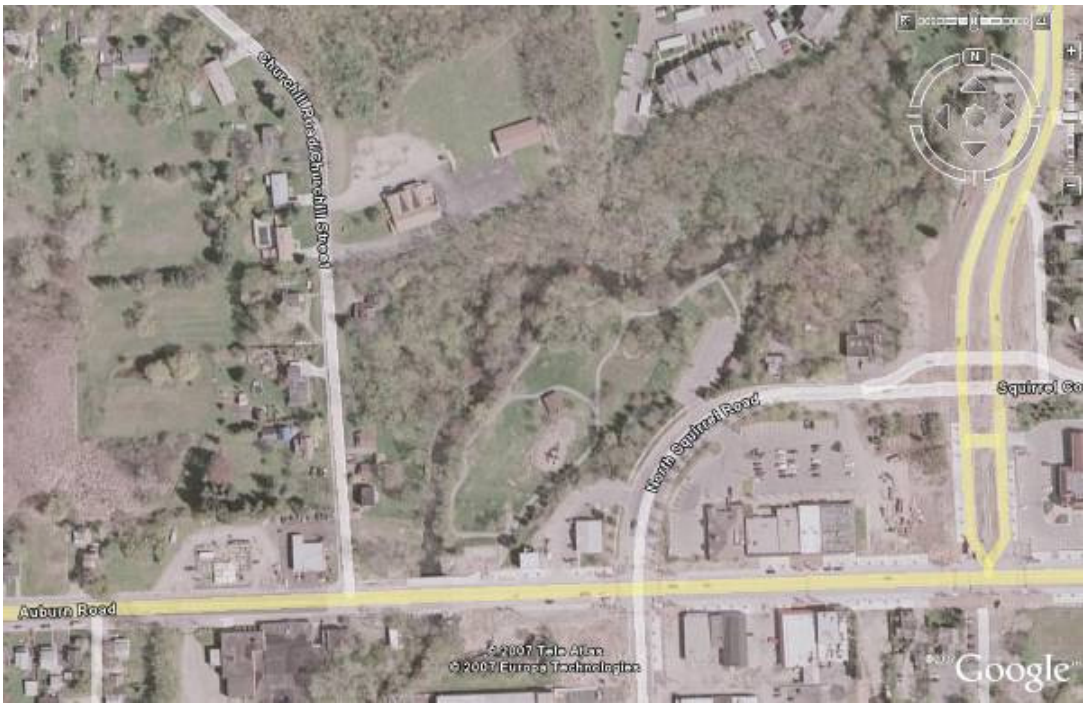

Figure 6.12. Riverside Park in Auburn Hills

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 1: Streambank Stabilization
- Delisting Project Category 6: Sediment Removal

Demonstration Project 14 – Shadyside Park Sediment Removal

Description of Impairment and Proposed Improvements

The Shadyside Park area has been identified as one of the most contaminated sites in the watershed due to the large amount of contaminated sediment. Removal of the contaminated sediment from the riverbed and shoreline and supplemental in-stream habitat restoration will allow for two BUIs to be addressed. In addition to the previously deposited contaminant sediment, a sharp bend in the river and in-stream weir contribute to continued sedimentation in this location. Additional improvements should be considered in this area to prevent future sedimentation. Alternatively, a long term maintenance plan to ensure for continued sediment removal should be provided.

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 2: In-stream Habitat Improvement
- Delisting Project Category 6: Sediment Removal

Figure 6.13. Location of Contaminated Sediment near Shadyside Park

Demonstration Project 15 – Wetland Restoration/Connectivity in Harrison Township

Description of Impairment and Proposed Improvements

Loss and degradation of coastal wetlands along the Great Lakes shoreline has resulted in significant impacts to fish and wildlife habitats, and loss of water quality functions that these wetlands provide. Because of these losses, Michigan Natural Features Inventory has identified Great Lakes Coastal Marshes as unique and rare natural communities in the State of Michigan, including the wetlands that have formed at the delta of the Clinton River and along the Shoreline of Lake St. Clair.

The coastal wetlands at the delta of the Clinton River are located in Harrison Township at Metropolitan Beach Metropark. The Park is located 5 miles southeast of Mt. Clemens and 22 miles northeast of Detroit. This 770-acre park first opened in 1950 and boasts approximately 1.4 million visitations annually. The wetlands at the park are locally known as Point Rosa Marsh and North Metro Marsh and consist of emergent, scrub shrub and forested wetland systems. North Metro Marsh is approximately 250 acres of open water and emergent wetland and the southern portion, Pointe Rosa Marsh, is approximately 120 acres of emergent wetland, scrub shrub and forested wetland. Both marshes have experienced severe hydrologic disturbance over the decades due to development. Plant communities within the marshes were once diverse but are now strongly dominated by aggressive non-native vegetation, primarily giant reed grass (*Phragmites australis*), and more recently European Frogbit (Hydrocharis morsusranaae). Their ability to support a diversity of native plants and animal species has become highly diminished.

Wetland hydrology has been significantly altered by residential development, road construction, ditching, and dredging within the wetland and adjacent areas. Low water levels over the past several years have also impacted the flow of water into the wetlands which has also reduced the quality of the

wetlands. The proposed project would restore these wetland systems through improving the hydrological connection to Lake St. Clair and installing a water level management system infrastructure to the South Marsh. The project would also look to eradicate and control invasive plants in both the North and South Marsh to allow native vegetation to recover, greatly enhancing the breeding and migration habitat for wetland dependant fish and wildlife. A long term monitoring and treatment program is also part of this project. In addition to restoration of the marshes, there are three adjacent properties that provide an opportunity to expand and protect the unique wetland communities. Acquisition and restoration activities for the parcels are described below.

Harrison Township recently purchased a 155-acre wetland located southwest of Metro Beach. Two parcels separate the Harrison Township and Metro Beach wetlands. Acquisition of the two parcels and/or an execution of a conservation easement in all or a portion of the parcels would allow for creation and protection of a hydrologic and ecological connection between the two wetlands. Restoration efforts, including invasive species management and hydrologic improvements are obviously required.

The third property, approximately 80 acres in size, is located adjacent to the north marsh at the Metropark and is a good candidate for expanding the Great Lakes Marsh wetland. A portion of the wetlands were illegally filled in the 1970's and a lawsuit from the US Army Corps of Engineer resulted in a restoration order for the property. However, it is highly unlikely that the restoration will ever be completed. Acquisition of this property would ensure future restoration of the wetland and expansion of the valuable Great Lakes Marsh ecosystem.

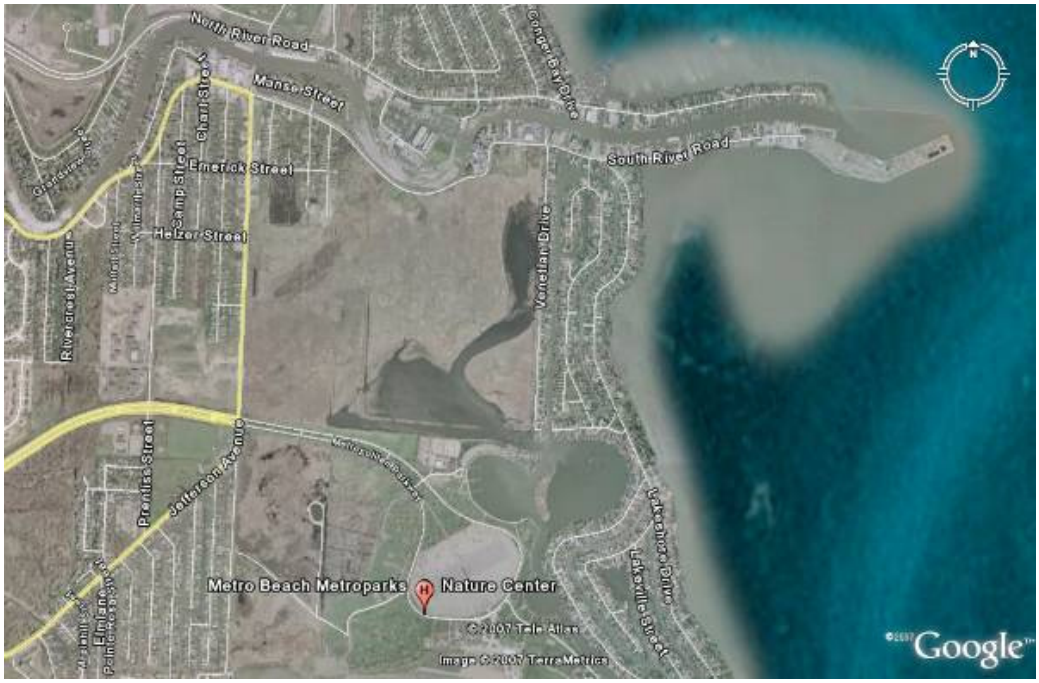

Figure 6.14. Metro Beach Metro Park

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 5: Wetland Restoration

Demonstration Project 16 – Deer Creek Restoration

Description of Impairment and Proposed Improvements

Deer Creek is a tributary to the North Branch of the Clinton River. Removal of vegetation, grading and other maintenance activities limit the available habitat. Limited wildlife exists in this drain. Restoration of this drain to a more traditional stream environment will provide additional and diverse wildlife habitat and promote enhanced wildlife populations. Improvements may include in-stream structures such as boulder clusters, covered logs, tree cover, cross logs and others. These types of structures function as riffles and create pools within the stream. Additional improvements could include restoration of riparian corridor vegetation that would enhance terrestrial habitat.

This drain is considered to be a good candidate for restoration and will likely encourage spawning activities of fish species, including pike and suckers that prefer small tributaries.

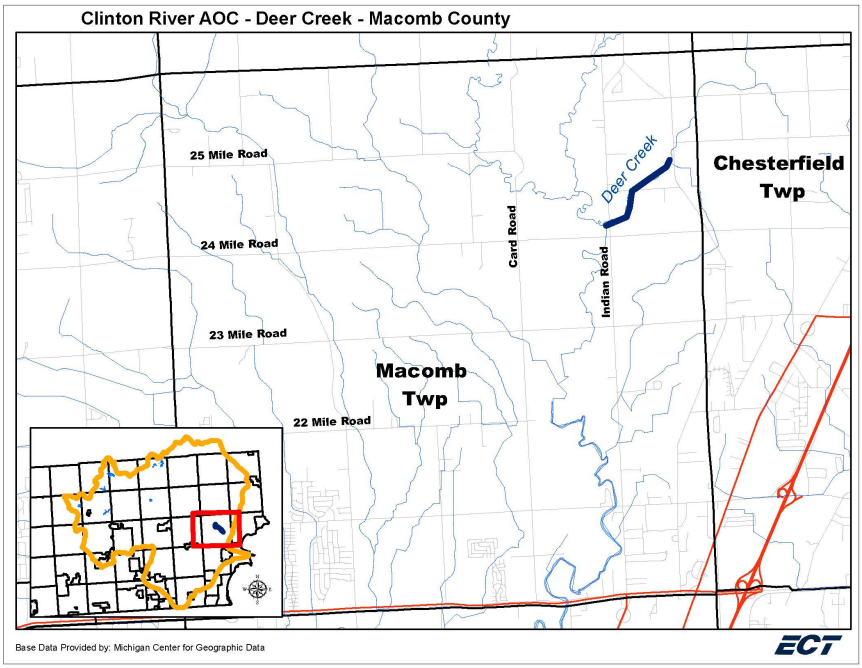

Figure 6.15. Deer Creek

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 2: Instream Habitat Improvement
- Delisting Project Category 3: Riparian Vegetation Restoration

Demonstration Project 17 – PCB Contaminated Sediment Removal

Description of Impairment and Proposed Improvements

Portions of the Clinton River from the confluence of the River with Lake St. Clair upstream to Yates Park Dam, just downstream of Utica are contaminated with PCBs. This area is currently listed as an impaired waterway in Section 303(d) of the Clean Water Act. Development of a TMDL for PCBs in this area is scheduled for 2010. Following completion of the TMDL, sediment contaminated with PCBs will be removed in accordance with the TMDL guidance. Removal of the contaminated sediment from the riverbed and shoreline and supplemental in-stream habitat restoration will allow for two BUIs to be addressed.

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 2: In-stream Habitat Improvement
- Delisting Project Category 6: Sediment Removal

Demonstration Project 18 – Sterling Relief Spillway Naturalization

Description of Impairment and Proposed Improvements

The Sterling Relief Spillway, tributary to the Red Run Drain is a traditionally maintained drain. Maintenance has focused on conveyance rather than ecological considerations. Removal of vegetation, grading and other maintenance activities limit the available habitat. Limited wildlife exists in this drain. Restoration of this drain to a more traditional stream environment will provide additional and diverse wildlife habitat and promote enhanced wildlife populations. The Red Run Drain is a degraded ecosystem and improvements to the Sterling Relief Spillway will provide much needed habitat that will benefit fish and wildlife in the Red Run Drain. Improvements may include in-stream structures such as boulder clusters, covered logs, tree cover, cross logs and others. These types of structures function as riffles and create pools within the stream. Additional improvements could include restoration of riparian corridor vegetation that would enhance terrestrial habitat.

This drain is considered to be a good candidate for restoration. The Red Run Drain is a degraded stream and improvements to the Sterling Relief Spillway will provide refuge for a diverse population of aquatic species that is desperately needed in this area.

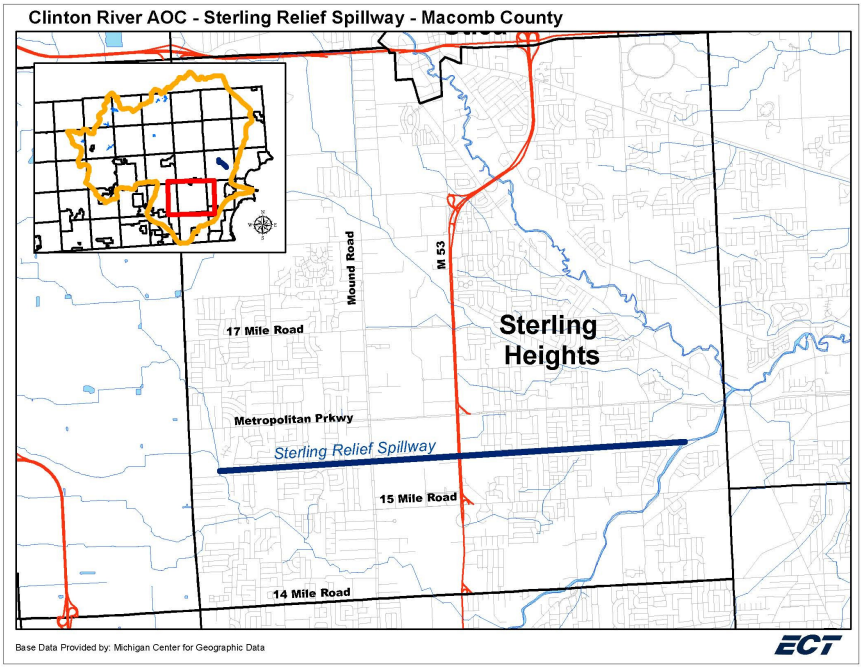

Figure 6.16. Sterling Relief Spillway

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 2: In-stream Habitat Improvement
- Delisting Project Category 3: Riparian Vegetation Restoration

Demonstration Projects 19 through 25 Wetland Restoration Sites

Description of Impairment and Proposed Improvements

Restoration of areas believed to represent pre-settlement wetlands to wetlands will help to restore the desired hydrologic flow of the river and provide valuable habitat within the AOC. With the assistance of MDEQ and MNFI, potential restoration sites were identified based on analysis of hydric soils, circa 1800 wetlands, proximity to existing wetlands or waterway, landscape context, proximity to protected areas, existing wetland easements, headwater areas, development threats and significant biological features. A detailed summary of the wetland restoration site analysis can be found in the *Methodology Report for the Clinton River Area of Concern Wetland Restoration Prioritization Project* prepared by Ed Schools with the Michigan Natural Features Inventory. Three sites were selected in Oakland County and three sites were selected in Macomb County.

Delisting Project Category(ies) Addressed

Completion of these projects will address the following delisting project categories:

- Delisting Project Category 5: Wetland Restoration

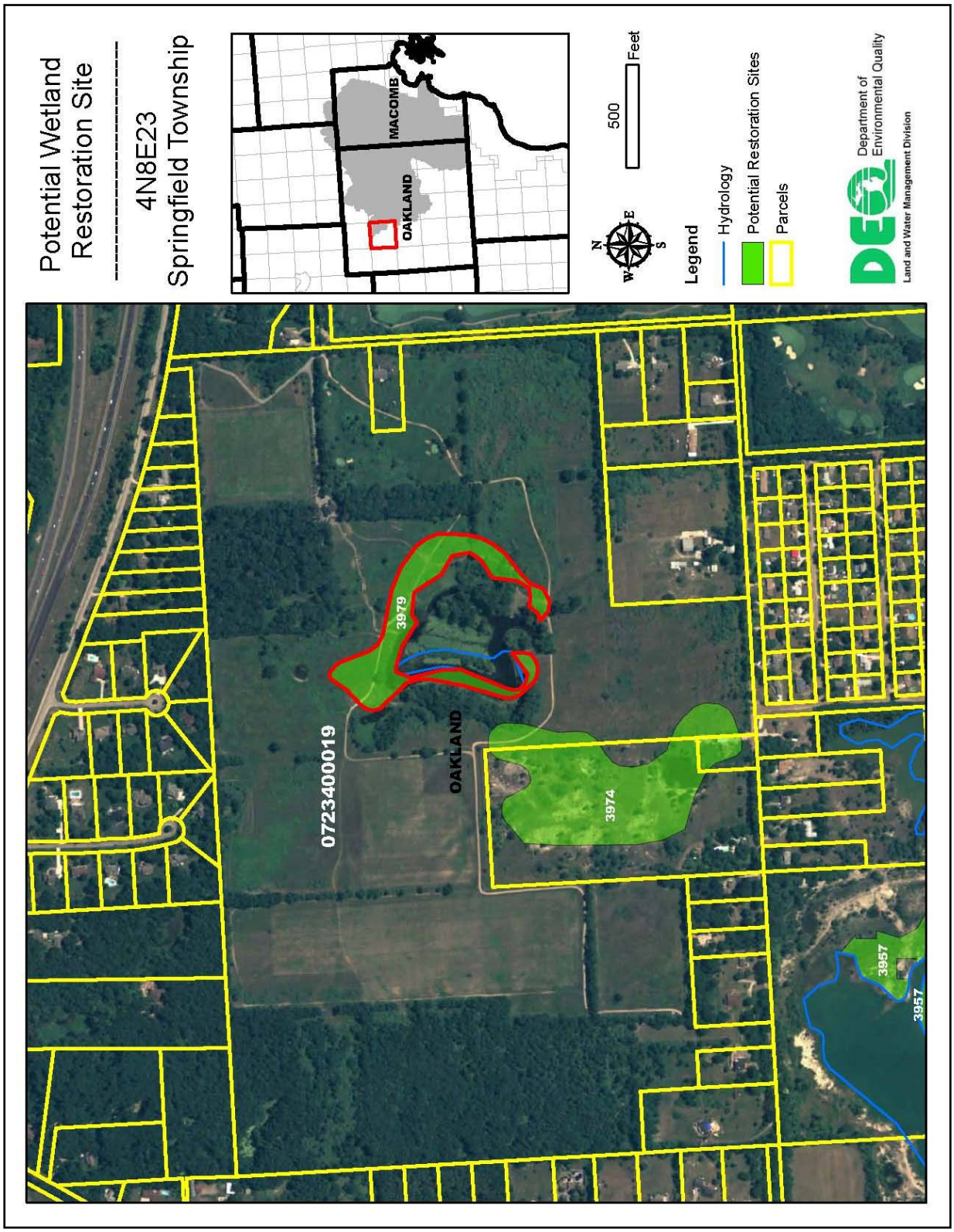

Figure 6.17 –Potential Wetland Restoration Site in Springfield Township

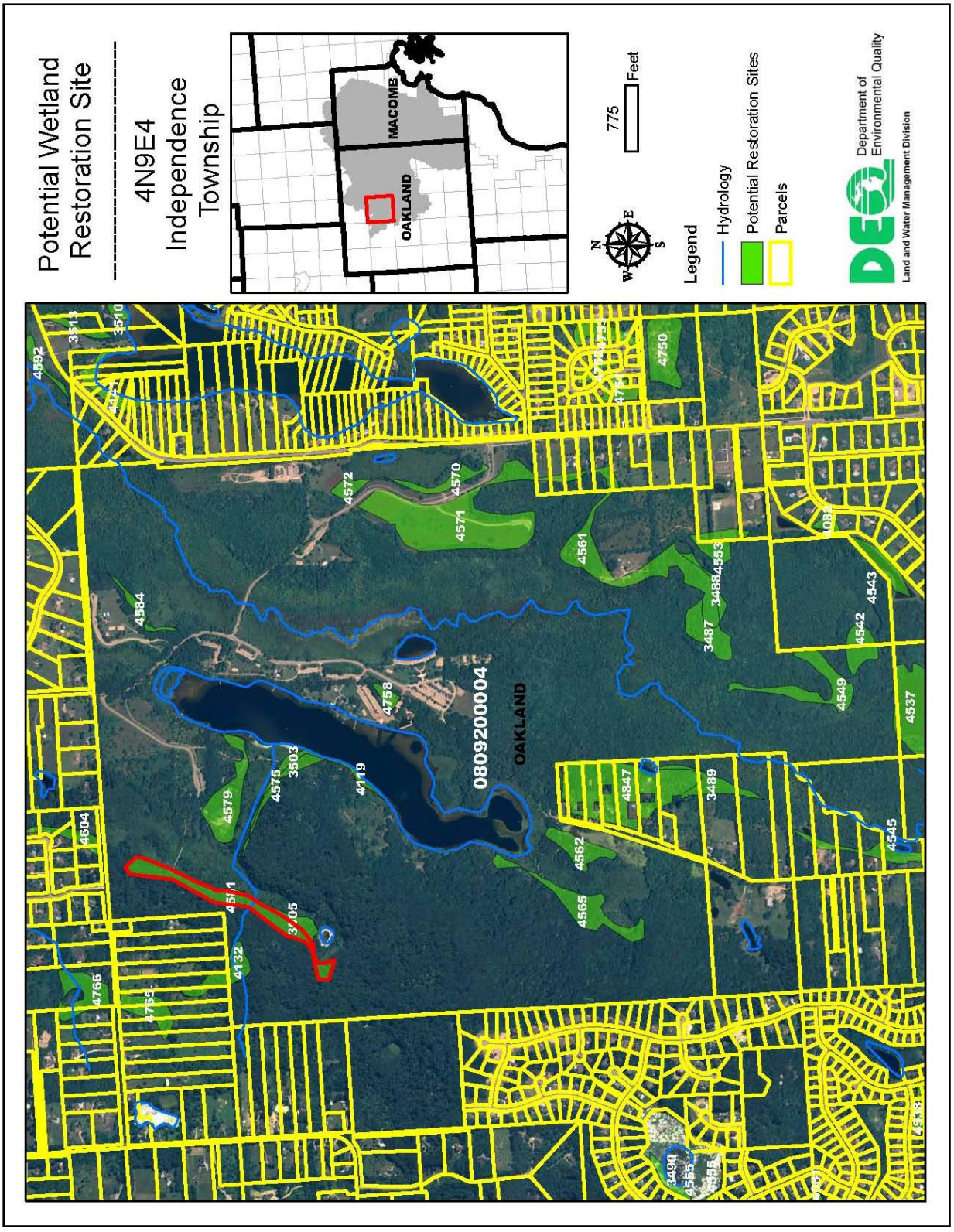

Figure 6.18 – Potential Wetland Restoration site in Independence Township

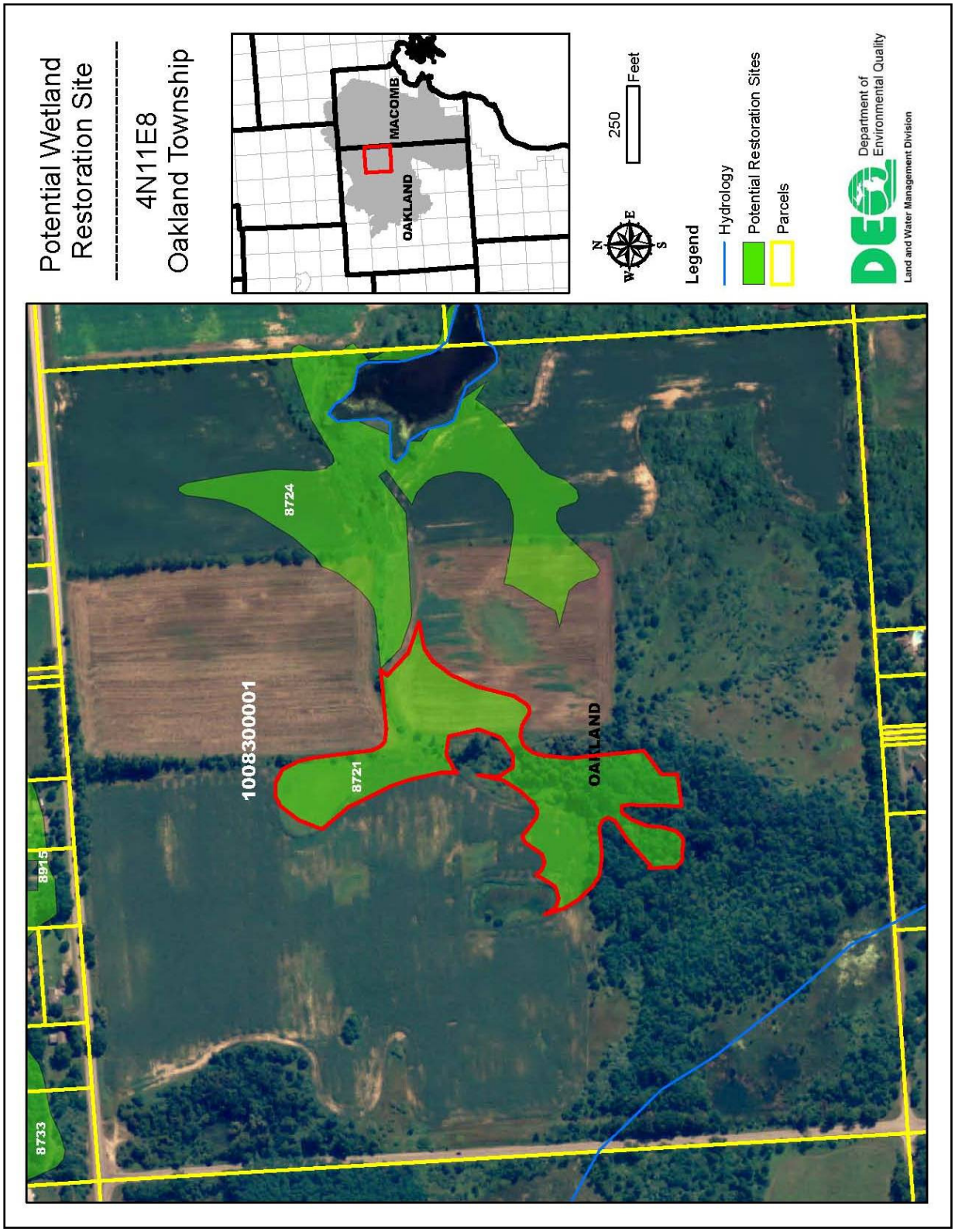

Figure 6.19 – Potential Wetland Restoration site in Oakland Township

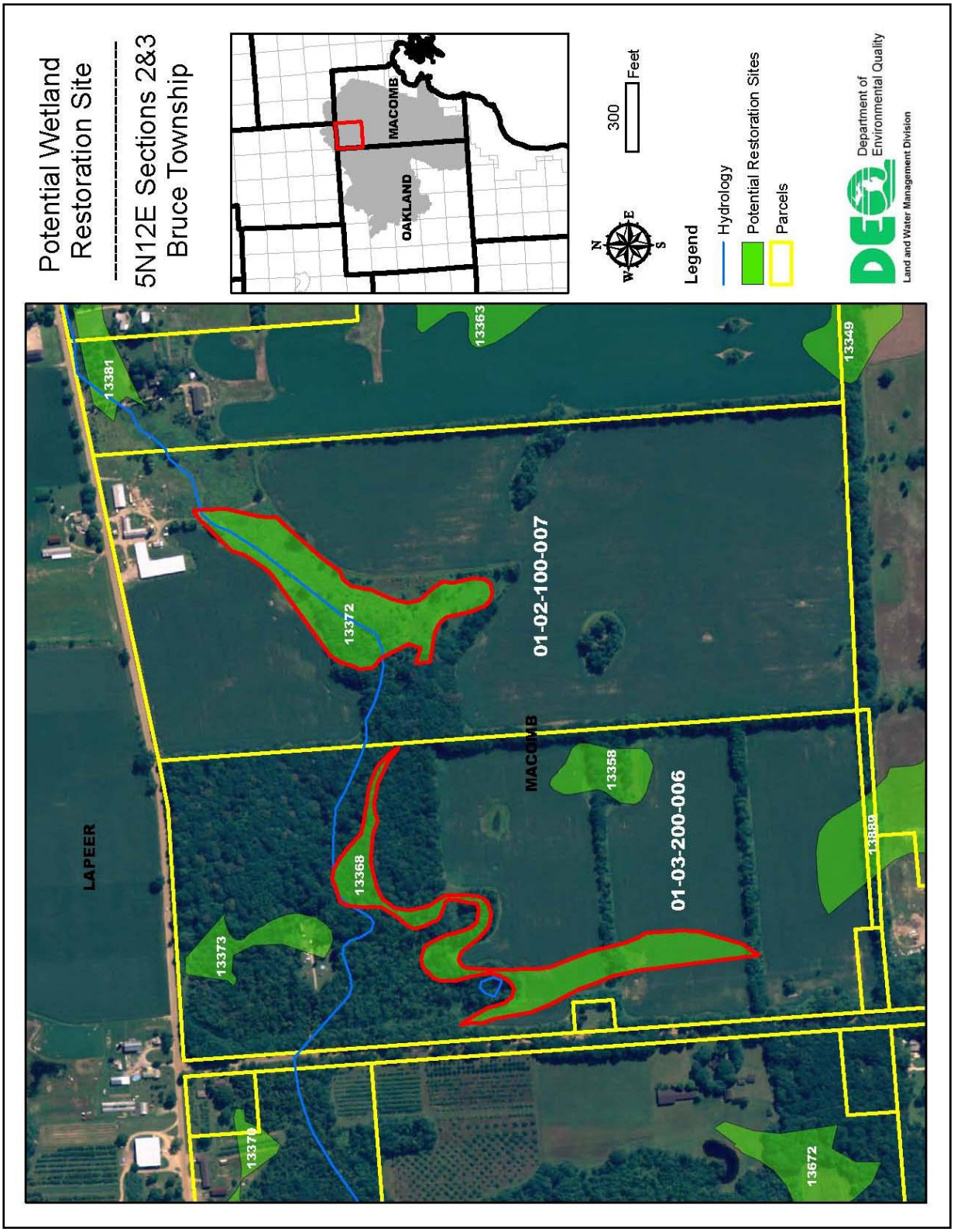

Figure 6.20 – Two Potential Wetland Restoration Sites in Bruce Township

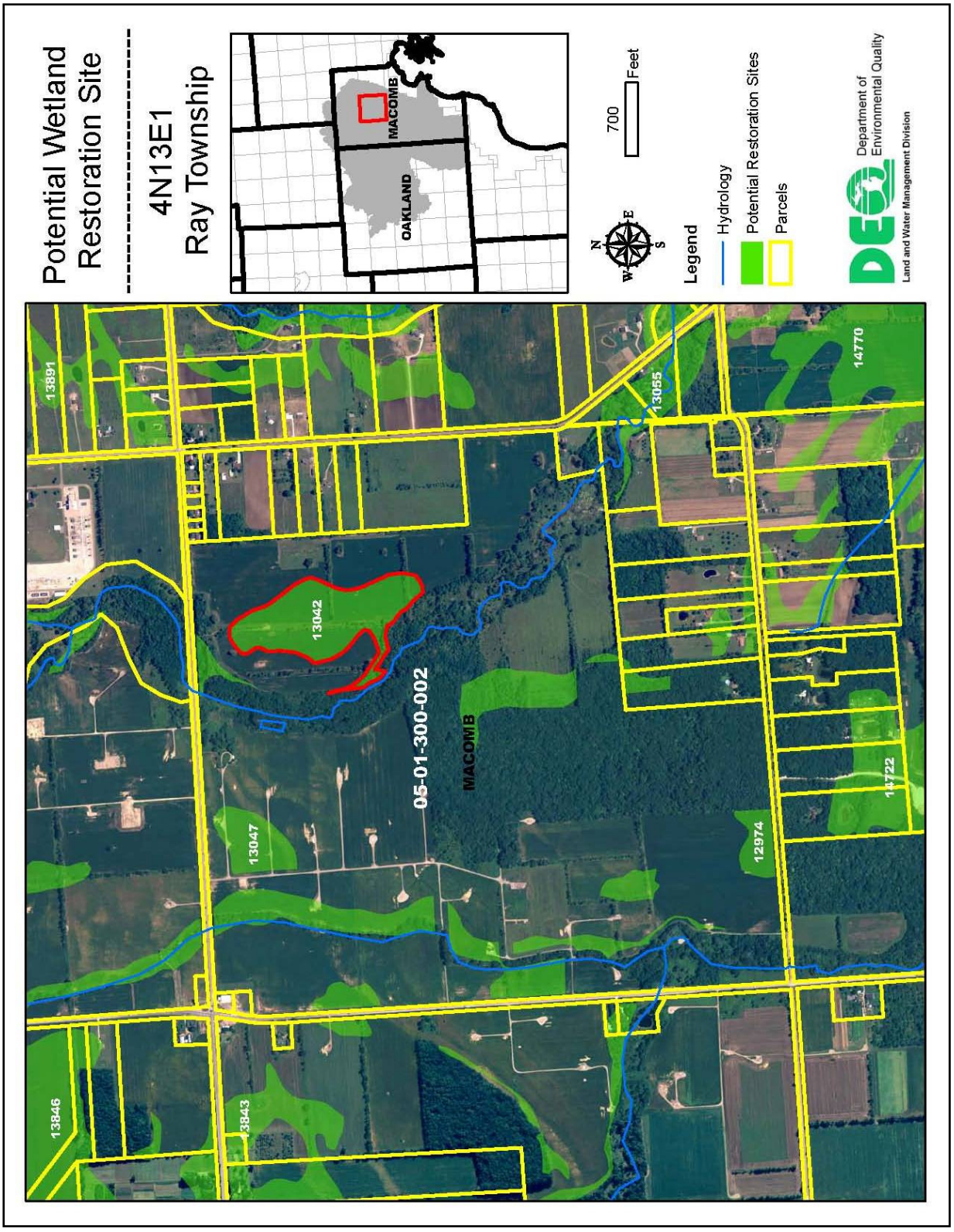

Figure 6.21 – Potential Wetland Restoration Site in Ray Township

Figure 6.22 – Potential Wetland Restoration Site in Washington Township

Demonstration Project 26 – North Branch Floodplain Restoration, Conservation Easement and Nicholson Center

Description of Impairment and Proposed Improvements

Macomb County recently executed a conservation easement covering 33 acres and extending one linear mile along the North Branch of the Clinton River. This county owned parcel has been put into a floodplain conservation easement with the Six Rivers Regional Land Conservancy. As part of a county-wide Green Infrastructure Program, this site is in the heavily populated community of Clinton Township. By holding off recent commercial use speculation on the parcel, the designation will provide a template for other floodplain land conservation efforts throughout Midwest. At the downstream end of the watershed, this area is frequently inundated with flood waters that have devastated the stream banks, and altered tree growth. The county plans to improve the conditions of wildlife and fish habitat by restoring 250 linear feet of streambank as well as a three acre vernal wooded wetland; conduct a large woody debris low-impact control program; provide an outdoor classroom for stewardship programming and water sampling; and use the site as a major connector in the countywide trailway plan. The management or removal of the log jams will be completed to allow for safe recreational navigation along the North Branch of the Clinton River, to mitigate flash flood releases, to reduce the number of sediment load releases associated with log jam breaks, and to reduce the impact to fish migration.

Delisting Project Category(ies) Addressed

Completion of this project will address the following delisting project categories:

- Delisting Project Category 1: Streambank stabilization
- Delisting Project Category 2: In-stream habitat improvement
- Delisting Project Category 3: Riparian vegetation restoration
- Delisting Project Category 5: Wetland restoration
- Delisting Project Category 8: Control of runoff

7.0 CONCLUSIONS AND RECOMMENDATIONS

This project was designed to establish delisting targets for the habitat-based BUIs in the Clinton River AOC and was an outgrowth of the initial delisting target project addressing the non-habitat BUIs. It was determined during initial discussions with the Clinton RAP PAC, the CRWC project personnel, and the Technical Committee that the consensus was that the desired endpoint in the AOC was restoration and not just delisting. Additionally, review of the various RAP documents developed for the AOC historically showed that although there were several wide "area causes" described within the documents there were no site specific recommendations for restoration projects within the AOC. It was therefore not possible to develop restoration actions within the AOC that would address the RAP recommendations as stipulated in the MDEQ guidance for development of habitat related BUIs. The project did however solicit stakeholder input on recommended restoration sites that could be used both as demonstration sites leading to further restoration within the AOC and also establish an endpoint that would allow for future delisting application to the MDEQ.

Suggested projects were screened and prioritized by the Technical Committee based on the criteria listed below:

- Implementation projects would be prioritized within each of the seven subwatersheds within the Clinton River AOC, and no cross-the-board prioritization would be done.
- In determining if a project was high or low priority, consideration was given to scientific merit of the project, potential habitat/population impact and project visibility. Additionally, it was important that the selected projects represent a variety of approaches, address different impairment causes and include projects in Macomb and Oakland County and within each of the subwatersheds.
- Barriers to success of an implementation project were important to keep in mind, but did not exclude any project from being listed as a high priority recommendation.

The recommended projects are included in Chapter 6 of the project report and include:

- In-stream habitat improvement and/or streambank stabilization &/or riparian vegetation restoration:
  - Oakland County Complex Mainland Drain Project
  - Extend Rochester Hills Woody Debris Management Plan
  - McBride Drain Restoration
  - Hart Drain Restoration
  - Ferry Drain and Renshaw Drain Stabilization
  - Stream Bank Restoration near Riverside Park
  - Deer Creek Restoration
  - Sterling Relief Spillway Naturalization

- Wetland restoration:
  - Wetland Restoration/Connectivity in Harrison Township
  - Potential Wetland Restoration Site in Springfield Township
  - Potential Wetland Restoration Site in Independence Township

- Potential Wetland Restoration Site in Oakland Township
- Two Potential Wetland Restoration Sites in Bruce Township
- Potential Wetland Restoration Site in Ray Township
- Potential Wetland Restoration Site in Washington Township

- Dam removal and/or development of underflow &/or fish passage:
  - Crystal Lake Dam Cold Water Bottom Draw
  - Cascade Dam Removal
  - Wolcott Park Dam Removal
  - Paint Creek Dam Removal
  - Fish Passage Modification to the Oakland/Woodhull Lake Level Structure

- Seriously eroded road-stream crossings to prevent sedimentation etc:
  - Clarkston/Kern Road Crossing Improvements
  - Silver Bell Road and Dutton Road Crossings Improvements

- Sediment removal:
  - Shadyside Park Sediment Removal
  - PCB Contaminated Sediment Removal

The site specific demonstration projects included in the delisting targets represent a cross-section of the types of implementation projects that are necessary accomplish restoration of the habitat related BUIs throughout the watershed and establish an end-point to achieve delisting of the AOC. Completion of each of the projects listed in Chapter 6 will move toward restoration of the AOC and will result in the ability to delist the Clinton River AOC for habitat related BUIs. Implementation of these projects will accomplish delisting and move toward full restoration thus benefiting the watershed residents and users of the Clinton River as well as Lake Erie and the Detroit River connecting channel.

As the Clinton River AOC moves closer toward restoration of the habitat BUIs where a request can be made to delist the habitat BUIs, a more detailed restoration blueprint should be developed for each project. As the demonstration projects are implemented, additional projects may need to be considered based on the findings of post-implementation monitoring. It is also important to consider that although not a specific BUI, flow variations, both low-flow and high peak to low-flow ratios, impact all the BUIs. Attaining restoration target will be extremely difficult, and in many cases impossible, 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