State of Wisconsin
Department of Natural Resources

Environmental Impact Statement for the Stream Channel Modifications to the Pike River System

TO THE READER

You are invited to ask questions and to voice your concerns or comments on this Environmental Impact Statement (EIS). Your participation is vital to ensure the EIS on the Pike River channel modification proposal adequately addresses critical public issues. The review schedule for the EIS is as follows:

Release for Review:	*September 19, 1995*
Public Hearing:	*October 19, 1995*
EIS Comment Deadline:	*November 6, 1995*

The Public Hearing will be held at:
University of Wisconsin-Parkside
Student Union Bldg (Rm 104-106)
900 Wood Rd. (30th Ave or CTH G)
Somers, WI
Hours: 1- 4 p.m. and 6-9 p.m.

Readers with comments or questions on the EIS or EIS review procedures should contact:

Jeff Schimpff
Bureau of Environmental Analysis & Review
Department of Natural Resources
P.O. Box 7921, Madison, WI 53707
Telephone: (608) 267-7853

or

George Albright (same address)
Telephone: (608) 266-6437

Readers seeking additional information about the channel modification proposal or the Pike River Comprehensive Watershed Plan should contact:

Bob Biebel, Chief Environmental Engineer
Southeastern Wis. Regional Planning Commission
P.O. Box 1607
Old Courthouse
916 N. East Avenue
Waukesha, WI 53187-1607
Telephone: (414) 547-6721

ENVIRONMENTAL IMPACT STATEMENT PROCESS

The environmental impact statement process under the Wisconsin Environmental Policy Act (s. 1.11, Wis. Stats.) is a process of disclosure. It is intended to relay factual judgements regarding the proposed project, including whether the channel enlargements may or may not comply with state water resources law and the general policies and goals of the Department. Specifically, it is intended to assist decision makers identify potential adverse impacts and seek means of reducing or eliminating them. Impact statements address issues in a broad sense and a review of detailed consultant submittals or background files is often necessary to understand how the proposal is anticipated to comply with a particular, and often complicated, set of environmental standards or policies.

Whether the Department can approve this project depends upon whether it satisfies the legally adopted standards and criteria (especially including water quality and wetland protection standards) applied to all such proposals, whether sponsored by private or public entities. Since human activity typically causes measurable changes in the environment, the channel enlargement will be judged on whether the anticipated impacts are within acceptable bounds as set out in the published standards. If the Department's review of this proposal indicates the channel enlargement can be expected to comply with published standards, the agency will grant permits to implement the project.

BEFORE THE
DEPARTMENT OF NATURAL RESOURCES
ANNOUNCEMENT OF EIS RELEASE AND AVAILABILITY

NOTICE OF PUBLIC INFORMATIONAL HEARING
ON THE
STREAM CHANNEL MODIFICATIONS TO THE PIKE RIVER SYSTEM
ENVIRONMENTAL IMPACT STATEMENT (EIS)

NOTICE IS HEREBY GIVEN that the Department of Natural Resources has prepared an Environmental Impact Statement (EIS) on a stream channel modification project for the Pike River and Pike Creek in Kenosha and Racine counties. During the proposed first phase, the flood channel bottom would be widened to between 10 and 42 feet and deepened by 1 to 11 feet, for a combined distance of approximately 11.5 miles. Subsequent phases would focus on construction of a meandered habitat channel, and revegetation of upland bank areas, as well as placement of instream habitat materials. Accommodation of the future acquisition of a narrow corridor for establishment of a public parkway, recreation trail, and angler access is also proposed. The enlarged channel would minimize damages from flooding under existing development levels, as well as accommodate stormwater runoff from future development, through at least the year 2010. Habitat mitigation measures are intended to partially offset anticipated environmental consequences of the channel enlargement. Copies of the EIS are available from the following Department of Natural Resources offices:

Bureau of Environmental Analysis & Review
Department of Natural Resources
Box 7921
Madison, WI 53707-7921
(608) 267-7853

Southeast District DNR Office
2300 N. Dr. Martin Luther King Jr. Dr.
P.O. Box 12436
Milwaukee, WI 53212
(414) 263-8525

Copies of the EIS are also available for public review at public libraries in Racine, Kenosha, and Sturtevant, at the Reference Desk of the libraries at the University of Wisconsin-Parkside, and Carthage College; and at the town halls in Mount Pleasant and Somers.

NOTICE IS HEREBY FURTHER GIVEN that pursuant to section 1.11, Stats., and section NR 150.23, Wis. Adm. Code, the Department of Natural Resources will hold a public informational hearing on the EIS. The hearing will be held on:

<u>October 19, 1995, (Thursday) from 1-4 p.m. and 6-9 p.m.</u>

University of Wisconsin-Parkside
Student Union Bldg, Room 102-104
900 Wood Road (CTH G, or 30th Ave.)
Somers, Wisconsin

[Parking permits will not be required during the hearing]

In deciding whether to approve the project, to require further changes, or to disapprove the project altogether, the Department considers agency and public comments and information presented in the EIS. If the Department approves the proposal, required state permits will be issued. Federal and local permits would still be required.

DNR and U.S. Army Corps of Engineers approval or denial of the proposed project will be given after the EIS hearing is held.

Interested persons or their representatives will be given an opportunity to comment on and present their views regarding the project, the EIS and the environmental review process under s. 1.11, Stats., the Wisconsin Environmental Policy Act (WEPA), at the hearing. Oral presentations may be limited if it appears the length of the hearing will be unduly lengthened by repetition.

Written comments may be submitted to the Bureau of Environmental Analysis and Review, Department of Natural Resources, P.O. Box 7921, Madison, WI 53707, no later than November 6, 1995.

NOTICE IS HEREBY FURTHER GIVEN that pursuant to s. NR 2.085(4), Wis. Adm. Code, any person may petition for the opportunity to cross examine the person or persons responsible for a specific portion of the environmental impact statement or to present witnesses or evidence at the public informational hearing. The opportunity to cross examine or present witnesses or evidence, will follow the general public comment portion of the hearing of a petition has been properly filed.

A petition to cross examine or present evidence shall include a statement of position on the action or proposal and specific statements and issues on which the person wishes to cross-examine or present evidence or witnesses. Petitions for opportunity to cross examine shall be filed within 20 days after the date on which this notice is published. Failure to file a petition under s. NR 2.085(4), Wis. Adm. Code, shall preclude the opportunity to cross examine.

Dated at Madison, Wisconsin this 19th day of September, 1995.

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

by George Albright

George Albright, Chief
EIS Development Section
Bureau of Environmental Analysis & Review

TABLE OF CONTENTS

NOTICE OF PUBLIC INFORMATIONAL HEARING i

EXECUTIVE SUMMARY v

1.0 INTRODUCTION 1
CONSIDERATION OF ALTERNATIVES (4)

2.0 EXISTING ENVIRONMENT 5
WETLANDS (5)
UPLAND HABITAT AND WILDLIFE COMMUNITY (7)
STREAM HABITAT CHARACTERISTICS (10)
ENVIRONMENTAL INDICES (14)
WATER CHEMISTRY (32)
LAND USE AND FLOODPLAIN DEVELOPMENT (35)
RECREATIONAL USE (39)

3.0 REGULATORY ENVIRONMENT 41
STATE (DNR) AND FEDERAL (COE) APPROVALS AND PERMITS, AND APPLICABLE STATUTES (41)

4.0 DESCRIPTION OF THE PROPOSED PROJECT 47
FLOODLAND MANAGEMENT AND THE PROPOSED PROJECT (47)
RECOMMENDED NON-STRUCTURAL MEASURES OF THE PROPOSED PROJECT (53)

5.0 ALTERNATIVES TO THE PROPOSED PROJECT 55
CONSIDERATIONS IN DEVELOPING THE ALTERNATIVES (55)
ALTERNATIVE 1: NON-STRUCTURAL FLOOD HAZARD MITIGATION (56)
ALTERNATIVE 2: FLOOD HAZARD MITIGATION WITH STORMWATER MANAGEMENT (57)

6.0 IMPACT ANALYSIS OF THE PROPOSED PROJECT 61
LAND USE AND FLOODPLAIN BOUNDARY (62)
FLOODING, DRAINAGE AND SAFETY HAZARDS (62)
STREAM FLOW, EROSION AND SEDIMENTATION (63)
WATER QUALITY (68)
SEDIMENT QUALITY AND MANAGEMENT (73)
FISH AND AQUATIC LIFE (74)
GROUNDWATER (78)
WETLANDS (79)
WILDLIFE (81)
OTHER POTENTIAL OR PROBABLE EFFECTS OF THE PROPOSED PROJECT (85)
COSTS AND FUNDING (89)
FLOOD RISK REDUCTION BENEFITS (90)
SUMMARY FOR THE PROPOSED PROJECT (91)

7.0 IMPACT ANALYSIS OF ALTERNATIVE 1 95
LAND USE AND FLOODPLAIN BOUNDARY (95)
FLOODING, DRAINAGE AND SAFETY HAZARDS (96)
STREAM FLOW, EROSION, AND SEDIMENTATION (96)
WATER QUALITY (97)
SEDIMENT QUALITY AND MANAGEMENT (98)
FISH AND AQUATIC LIFE (98)
GROUNDWATER (98)
WETLANDS (98)
WILDLIFE (99)
OTHER POTENTIAL AND PROBABLE EFFECTS OF THE PROPOSED PROJECT (99)
COSTS (101)
FLOOD RISK REDUCTION BENEFITS (101)
FUNDING ASSISTANCE FOR FLOOD RISK REDUCTION (101)
SUMMARY FOR ALTERNATIVE 1 (101)

8.0 IMPACT ANALYSIS OF ALTERNATIVE 2 105
LAND USE AND FLOODPLAIN BOUNDARY (105)
FLOODING, DRAINAGE AND SAFETY HAZARDS (106)
STREAM FLOW, EROSION AND SEDIMENTATION (107)
WATER QUALITY (108)
SEDIMENT QUALITY AND MANAGEMENT (110)
FISH AND AQUATIC LIFE (110)
GROUNDWATER (111)
WETLANDS (112)
WILDLIFE (112)
OTHER POTENTIAL AND PROBABLE EFFECTS (113)
FLOOD RISK REDUCTION BENEFIT (116)

SUMMARY FOR ALTERNATIVE 2 116

9.0 IMPACT ANALYSIS OF ALTERNATIVE 3: NO ACTION ALTERNATIVE 119
LAND USE AND FLOODPLAIN BOUNDARY (119)
FLOODING, DRAINAGE AND SAFETY HAZARDS (119)
STREAM FLOW, EROSION, AND SEDIMENTATION (119)
WATER QUALITY (120)
SEDIMENT QUALITY AND MANAGEMENT (120)
FISH AND AQUATIC LIFE (121)
GROUNDWATER (121)
WETLAND (121)
WILDLIFE (121)
OTHER POTENTIAL AND PROBABLE EFFECTS (122)
COSTS AND FUNDING (122)
FLOOD RISK REDUCTION BENEFITS (122)
SUMMARY OF ALTERNATIVE 3 (122)

10.0 REFERENCES 125

11.0 LIST OF CONTRIBUTORS 141

EXECUTIVE SUMMARY

In response to frequent flooding, coupled with numerous water quality problems, the Racine and Kenosha county boards contracted with the Southeastern Wisconsin Regional Planning Commission (SEWRPC) in 1975 to write a comprehensive watershed management plan for the Pike River Watershed (A Comprehensive Plan for the Pike River Watershed, Planning Report 35, 1983). In 1993, SEWRPC refined the floodland management element of the plan to revise channel specifications in response to watershed changes, and to include measures suggested by DNR staff to mitigate habitat losses resulting from the construction of the proposed project, and to improve the physical habitat in some reaches.

The Proposed Project

The floodland management element of Planning Report 35 calls for widening and deepening of approximately 11.5 miles of the existing stream channel along the upper Pike River, Pike Creek, the Airport Branch of Pike Creek and the tributary to the Airport Branch to eliminate both existing and anticipated flood hazards. These reaches already have been channelized as a result of agricultural practices. The flood channel would be designed to convey flows anticipated under 2010 land use conditions. The proposed project also would involve:

- the replacement or removal of 22 bridges;
- construction of a 500 ft. dike along Bartlett Branch;
- construction of 3.25 miles of dike along the lower Pike River;
- construction of two jetties at the mouth of the Pike River;
- debrushing and clearing; and
- habitat mitigation and improvement.

Habitat mitigation and improvement measures would include planting grasses within the new channel, constructing a meandered low-flow channel, and replacing aquatic habitat, as described in the 1993 refinements.

The capital cost for implementing the Proposed Project is $10,179,220. With an average annual cost of $684,396 over 17 years and including long-term operation and management costs, over a 50-year lifetime the total project costs would be $12,385,400, and yield a flood control Benefit/Cost Ratio of .43.

Alternatives to the Proposed Project

Concerned with the cumulative impacts of implementing the flood control element of PR 35, the Wisconsin Department of Natural Resources began evaluating the effects of the proposal, which is the subject of this environmental impact statement. Additionally, as part of the EIS process, the Department developed and studied three alternatives to the proposed project. These alternatives are:

Alternative 1: Flood Hazard Mitigation
This alternative would require acquisition, floodproofing, or elevation of as many as 113 existing structures, based on the projected 2010 flood elevation.

Alternative 1 assumes the floodplain would be defined by flood elevations predicted under projected Year 2010 land use conditions in concert with existing channel conditions.

As local options, stormwater management measures could be included to relieve localized flooding. A variety of habitat improvement measures could also be compatible with Alternative 1.

The capital cost for implementing Alternative 1 would be $2,037,486. With an average annual cost of $134,845 over 17 years and no long-term operation and management costs, over a 50-year lifetime the total project costs would be $2,413,358, and yield a flood control Benefit/Cost Ratio of 2.16.

Alternative 2: Flood Hazard Mitigation with Stormwater Management
This alternative would require acquisition, floodproofing, or elevation of 55 existing structures, based on existing flood elevations. As with the Proposed Project, jetties would be constructed at the Pike River's confluence with Lake Michigan.

To maintain the existing floodplain—defined by present runoff rates and volumes, and existing channel conditions—while allowing future development, municipalities within the Pike River Watershed would be required to implement a system-wide stormwater management program. Selective and limited channel enlargement above the two-year recurring discharge stage would be considered in areas where system-wide stormwater management would not be entirely effective in reducing flood hazards. In areas of major blockages to flood flows selective and limited channel clearing and debrushing could be completed.

Habitat improvement measures could be included in Alternative 2, at the option of local governments.

The capital cost for implementing Alternative 2 would be $8,136,085. With an average annual cost of $621,510 over 17 years, and including long-term operation and management costs, over a 50-year lifetime the total project costs would be $15,623,552, and yield a flood control Benefit/Cost Ratio of .47.

Alternative 3: No Action
Under this alternative, the 55 presently affected structures would continue to be subject to flooding. Fifty eight other structures in the 2010 floodplain would be threatened by flooding hazards, as well. Future development would be guided according to current floodplain regulations. Following this alternative, no habitat improvements would be undertaken, and no bridges replaced.

No capital costs or long-term operation and management costs are associated with this alternative.

Environmental Impact Statement
The purpose of this environmental impact statement is to evaluate the effects of the proposed project and the identified alternatives in mitigating flood hazards and providing other benefits in the Pike River Watershed.

PIKE RIVER E.I.S. - COST ESTIMATE COMPARISONS

(All amounts are 1994 dollars. All outcomes are intended to be equivalent in terms of flood control, but not ecological function over a 20-year period. Cost estimates based on PR-35 (SEWRPC, 1983).)

Comparison Factor	**Proposed Project** (Dredging, bridges, on-line storage, jetties, floodproof/elevate 15 bldgs, hab. mit., dike)	**Alternative 1** (Floodproof/elevate 113 structures, jetties, 2010 floodplain as storage, no habitat mitigation need)[1]	**Alternative 2** (Overbank widen, jetties, floodproof/elevate 55 homes, detention storage, 1990 FP, habit. mitig.)	**Alternative 3** (No Action, no reduction in average annual flood risk)
Capital Cost	$10,179,220[2]	$2,037,486[3]	$8,136,085[4]	$0
O & M: Annual **50-Year**	22,747 1,137,350	2,408 120,400	92,664 4,633,200	0 0
Total 50-Year Cost	12,385,400	2,413,358	15,623,552	0
Avg. Annual Cost Cap/17 yrs + Ann. O&M	684,396	134,845	621,510	0
Avg. Ann. Flood Risk Eliminated	291,540	291,540	291,540	0
Benefit/Cost Ratio B/C (Structures)	**.43**	**2.16**	**.47**	**0.0**

PK_COST.CMP 2/7/95 (Rev. 9/12/95)

[1] It is envisioned that no bridges would need to be replaced for flood control purposes under either alternatives 1 or 2, because SEWRPC floodplain and hydraulic analyses has delineated the Year 2010 floodplain based upon the backwater effects of the existing bridges. It is assumed that predicted flood flows over the existing channel would not damage the bridges or their approaches. In the event that bridges wold need to be replaced, that cost has been included in the bridge replacement option line.

[2] This amount is from the refinement to PR-35, with the additional cost from PR-35 of floodproofing three structures along the lower Pike River, the Barlett Branch dike, and the jetties at the river's mouth.

[3] This amount includes $6,708 per floodproofed structure, and $36,120 per elevated structure, derived from SEWRPC estimates. In the absence of a detailed engineering analysis, the proportion of structures requiring floodproofing vs those that require elevating is assumed to be the same as under the proposed project.

[4] It is assumed that, coupled with regional stormwater detention (to serve a watershed population of 40,000 and attendant development), the removal of under 300,000 cubic yards of material from the overbank area (less than one quarter the volume proposed to be removed from the stream bed and banks under the proposed project) would be sufficient to store and pass flows generated by 2010 land use conditions, with no increase in the existing (1990) flood elevation. The cost of the overbank excavation is assumed to be one quarter that of the channel enlargement included under the proposed project. Stormwater detention costs include costs for construction of a system of ponds and restoration of a network of wetlands designed to provide both control of flood peaks and improvements in the quality of stormwater released to the Pike River. Though less than one quarter of the material would be removed from the overbank area under this alternative as would be removed from the channel under the proposed project, it is assumed that overbank habitat mitigation would cost $200,000, or more than one quarter of the mitigation total budgeted for the proposed project.

1.0 INTRODUCTION

Watershed History

As is common throughout Wisconsin, and even more so in the populous southeast, the original post-glacial land cover has been radically altered. The natural, biological diversity in the watershed's environment has largely been lost through conversion of land to agricultural, residential, industrial and commercial uses. The results of these changes can be experienced by watershed residents and visitors in the deteriorated water quality, marked increases in stormwater runoff, a general decline in air quality, a scarcity of opportunities for human interaction with intact ecosystems, and a general sense of aesthetic degradation. Whereas before mechanized agriculture the watershed was characterized primarily by prairies, wetlands, oak savannah, and oak forest, only tiny remnants of these communities remain.

Encompassing approximately 51.5 square miles, the Pike River Watershed drains much of southeast Racine County and northeast Kenosha County into Lake Michigan. Within this land area, the Pike River and its tributaries comprise over 39 miles of perennial streams, as shown in Figure 1 (SEWRPC, 1983).

The Purpose and Need for the Project

"Serious flooding and drainage problems" in the 1960s prompted local governments in the watershed to seek a regional solution. The Pike River Watershed Committee, formed in 1978 of the Southeastern Wisconsin Regional Planning Commission (SEWRPC) staff, local elected officials, professional natural resource managers, and local citizens identified the following four "serious resource-related problems" that needed to be resolved within the watershed (SEWRPC, 1983):

1. Flooding, stormwater drainage, and attendant damages;

2. Water pollution;

3. Changing land use, as related to flooding and stormwater drainage and to water pollution; and

4. Deterioration and destruction of the natural resource base, particularly the loss of important natural areas and wildlife habitat.

A Watershed Comprehensive Plan

In 1983, SEWRPC completed A Comprehensive Plan for the Pike River Watershed (hereafter referred to as "PR 35"). To address the above problems, PR 35 recommends a number of actions for local governments to initiate. These are grouped under three major plan elements. These plan elements are:

1. Land Use (overall land use, urban development, agricultural and other open land use, and park and open space management);

2. Floodland Management (structural measures, including channel widening and deepening, floodland regulations, channel maintenance, flood insurance, lending institution and realtor policies, and community utility policies and emergency programs); and

3. Water Quality Management (elimination of sanitary sewer flow relief devices, abatement of pollution from industrial waste discharges, abatement of pollution from municipal and private sewage treatment plants, control of pollution from diffuse sources, and development of a water quality monitoring program).

After completion of the plan, in 1984 the Department approved the land use and water quality management elements of the plan, but withheld approval of the floodland management element. A Department administrator wrote SEWRPC that the "aquatic life and water use potential" of the Pike River required more in-depth study, and until that study was completed, no decisions could be made regarding the potential impacts of the floodland management element upon the health of the stream (Wible, 1984).

Several refinements to the plan were developed and presented in the SEWRPC Staff Memorandum entitled *Report on Refinements to the Pike River Watershed Plan in Conjunction with the Environmental Impact Statement Process* (1993). These refinements include measures suggested by DNR staff to mitigate habitat losses resulting from the construction of the floodland management elements of the watershed plan, and to improve the physical habitat in some reaches. Other refinements adjusted the general channel size and form in response to hydraulic and hydrological changes in the watershed. During this time, the necessary stream survey was completed by DNR staff.

The Proposed Project - The Floodland Management Element of the Comprehensive Plan

An extensive summary of the proposed project is in Chapter 4 - "Description of the Proposed Project." The proposed project evaluated in this EIS is the floodland management element of A Comprehensive Plan for the Pike River Watershed.

Briefly, the proposed project recommends the following flood damage risk reduction measures:

1. Widen and deepen approximately 11.5 miles of the channels of the upper Pike River, Pike Creek, the Airport Branch of Pike Creek, and the Tributary to Airport Branch. Channel bottom widths would be increased from the existing 4 feet to 16 feet, to bottom widths of 5 feet to 46 feet. Side slopes of 1:3 and 1:4 would increase channel top widths from the existing 14 feet to 26 feet, to as much as 106 feet (for a reach with an existing channel depth of 6 feet and top width of 34 feet). Existing channels would be deepened on average by an additional 6 feet, up to a maximum of 11 feet deeper than at present.

2. Replace or remove approximately 22 bridges (15 would be replaced solely to accommodate the enlarged channel,and six others due to deterioration; one bridge would be removed.

3. Remove woody vegetation from the reach of Pike Creek from Petrifying Springs County Park upstream to Somers Branch.

4. Mitigate the instream and upland habitat lost during channel construction, and improve certain existing reaches of poor habitat value, with a variety of measures, including construction of a meandered habitat or "low-flow" channel with a series of riffle and run reaches, and planting a variety of grasses and herbaceous wetland vegetation.

5. Create two on-line stormwater dry detention areas designed to prevent increases in flood flows and elevations downstream.

6. Elevate or floodproof 16 houses, where floodplain shrinkage is determined not be a useful means of removing the structures from potential flood damage.

7. Construct a pair of jetties at the mouth of the river, into Lake Michigan, to inhibit the formation of a sand and gravel berm that often forms as a result of storm-driven wave action. The jetties would reduce the frequency of backwater effects and attendant flood hazard.

8. Construct a 500 ft. dike along the Bartlett Branch and 3.25 miles of agricultural dikes along the Lower Pike River, at the option of individual landowners.

The Need for an Environmental Impact Statement

The Town of Mount Pleasant applied for permits to implement the proposed project in late 1990. The permits were requested to implement the channel alteration elements of the plan in stages. Several questions arose regarding potential impacts that needed to be addressed before any decision to issue the permits could be made. Department staff wanted to address, at a minimum, the potential impacts on the existing fish populations and other aquatic resources; the potential to achieve fish population improvements; floodplain and other wetlands, upland habitat and wildlife; dry weather flows and water quality.

The Department concluded that, taken as a whole, the project could potentially have a significant impact on the quality of the natural environment. Documentation related to other channel enlargement projects revealed that channelization could create severe and long-lasting decreases in biological productivity, loss of adjacent wetlands, decreases in average stream flows, and sedimentation problems.

Because of this concern, the Department concluded that an EIS was necessary to meet the requirements of the Wisconsin Environmental Policy Act (WEPA). DNR notified the primary applicant, the Mount Pleasant Stormwater Drainage District 1, of this determination by letter, dated January 2, 1992.

This Environmental Impact Statement (EIS) is intended to provide information to staff evaluating the permit applications that describes the likely environmental impacts of the proposed project, and whether any actions could be taken to avoid or minimize the expected impacts. It analyzes the impacts of not only the SEWRPC plan, but also of two alternatives intended to provide a comparable degree of relief from flood hazard risk throughout the floodplain of this steadily-urbanizing river system, while avoiding the risk of negative impacts to aquatic and wetland species and upland wildlife. The third alternative reviewed in this EIS is the "No Action" alternative.

CONSIDERATION OF ALTERNATIVES

The three alternatives to the proposed project were developed in consideration of whether the alternative provides relief from existing flooding and stormwater drainage problems, contributes to improved water quality, addresses ongoing and anticipated changes in land use, and contributes to restoration of the natural resource base.

The three alternatives to the proposed project discussed in this EIS are:

Alternative 1: Flood Hazard Mitigation

This alternative would require acquisition, floodproofing, or elevation of as many as 113 existing structures, based on the projected 2010 floodplain elevation. Alternative 1 assumes development will continue throughout the watershed following year 2010 land use predictions. Stormwater management measures are not proposed as part of Alternative 1, but could be used to maintain existing runoff rates and volumes. A variety of habitat improvement would also be compatible with Alternative 1.

Alternative 2: Flood Hazard Mitigation with Stormwater Management

This alternative would require acquisition, floodproofing, or elevation of 55 existing structures, based on present (1995) flood elevations.

To maintain the existing (1995) floodplain — defined by present runoff rates, volumes and existing channel conditions— while allowing future development, municipalities within the Pike River Watershed would be required to implement a system-wide stormwater management program. Selective and limited channel widening above the two-year recurring discharge stage would be considered in areas where system-wide stormwater management would not be entirely effective in reducing flood hazards. In areas of major blockages to flood flows selective and limited channel clearing and debrushing could be completed.

Alternative 2 also recommends jetties at the Pike River confluence with Lake Michigan to protect agricultural areas and structures along the Lower Pike River.

Habitat mitigation to repair damage caused by any selective channel widening is included. A variety of additional habitat improvement measures would also be compatible with Alternative 2.

Alternative 3: No Action

Under this alternative, the limits of the floodplain would be defined by 2010 land use conditions and existing channel conditions. No steps would be taken to remove the 55 presently affected structures from flood damage risk. Moreover, with increasing development throughout the watershed, 58 other existing structures would be at risk of flooding. Future development would continue to be guided according to current floodplain regulations.

2.0 EXISTING ENVIRONMENT

The Pike River Watershed is comprised of the upper Pike River, Pike Creek and lower Pike River subwatersheds. (See Map 2.1). The Pike River Watershed encompasses approximately 51.5 square miles of southeastern Racine County and northeastern Kenosha County.

The headwaters of the upper the Pike River are located in the upper Pike River subwatershed near CTH C, Racine County, at T3N, R22E, Sec.11, SW, NW. From there, the river flows southerly to Petrifying Springs County Park in the Town of Somers, Kenosha County, where it is joined by Pike Creek, also known as the South Branch. The upper branch of the Pike River—sometimes referred to as the North Branch— drains an area of approximately 17 square miles. A small tributary, the Bartlett Branch, has its confluence with the upper Pike River at T3N, R22E, Sec.11, SW, NW.

Pike Creek is a second order stream located in the Pike Creek subwatershed in eastern Kenosha County, Wisconsin. From its source in the Town of Somers the stream flows northward for approximately 5 miles before its confluence with the upper and lower Pike River at T2N, R22E, Sec.2, SW, SW. The stream drains an area of approximately 19 square miles. The major flow component to Pike Creek is derived from agricultural runoff entering via numerous drainage tile systems (Ruff, 1976).

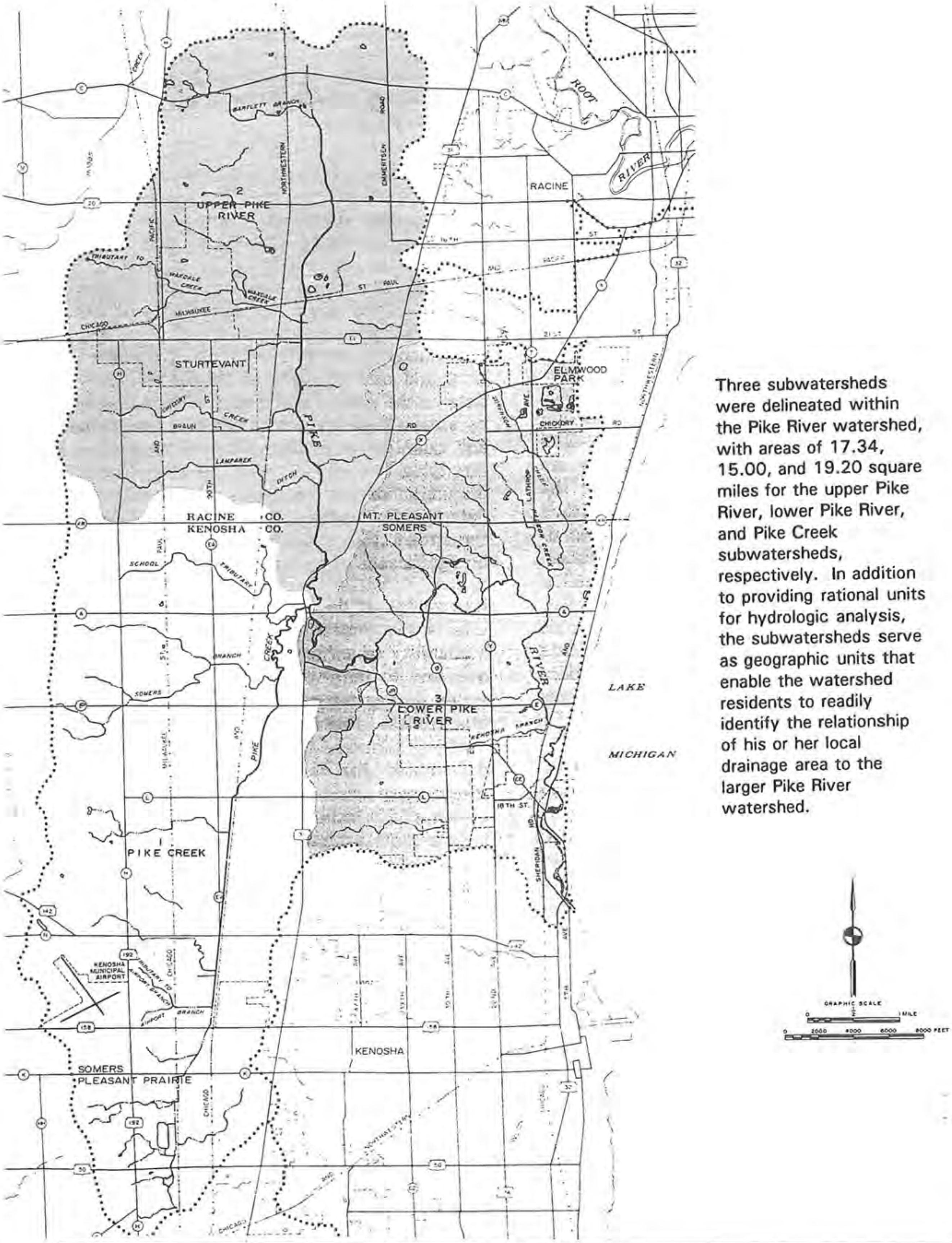
The Hebron-Montgomery-Aztalan is the dominant soil association along the immediate stream corridor. This association is characterized by well-drained to poorly drained soils that have a loam to silty clay subsoil. Erosion is a hazard on the Hebron soils, and improved drainage is needed on the Montgomery and Aztalan soils. The Varna-Elliot-Ashkum is the dominant soil association in the surrounding subwatershed. This association is characterized by well-drained to poorly drained soils that have a silty clay loam to clay subsoil (Link and Demo, 1970). The presence of poorly drained soils in each of these associations has encouraged channelization and the tiling of fields to improve agricultural land drainage. The upper Pike River and its Bartlett Branch tributary, as well as Pike Creek and its Airport Tributary, have been extensively modified in the past to promote agricultural drainage.

WETLANDS

Much of what is now the upper Pike River and Pike Creek was apparently an extensive system of interconnected wetlands. Beginning in the early 1900s, major mechanized land drainage projects created the existing stream channels in the upper reaches of the watershed, and altered the existing stream channel (as evidenced by the former meander channel along the upper Pike River, between CTH KR and CTH A). Drainage of wetlands for conversion into croplands and for other uses proceeded for several decades. The number of acres of wetlands in the Pike River Watershed previously converted to other uses is not known with any degree of certainty.

Two methods were used to estimate the historical extent of wetlands within the Pike River Watershed. In 1960, the Wisconsin Conservation Department (WCD, 1960) estimated that, based on the extent of hydric soils, there were approximately 45,000 acres of wetlands within Kenosha County before the

MAP 2.1
SUBWATERSHEDS OF THE PIKE RIVER WATERSHED



Three subwatersheds were delineated within the Pike River watershed, with areas of 17.34, 15.00, and 19.20 square miles for the upper Pike River, lower Pike River, and Pike Creek subwatersheds, respectively. In addition to providing rational units for hydrologic analysis, the subwatersheds serve as geographic units that enable the watershed residents to readily identify the relationship of his or her local drainage area to the larger Pike River watershed.

Source: SEWRPC.

onset of agricultural drainage. This is approximately 25 percent of the total area of the county. Based upon the untested assumption that the Pike River Watershed contained the same relative percentage of wetlands as Kenosha County as a whole, there would have been approximately 8,200 acres of wetlands in the Pike River Watershed prior to European settlement.

Another estimation of the extent of wetlands historically present was done by examining the extent of hydric and potentially hydric soils within the Pike River Watershed. Rough calculations were made primarily from USDA-SCS soil maps (1970) and supplemented with information from the SCS soil book for areas not covered by the soil maps. This yielded an estimate of 7,600 acres from the soil maps and approximately 2,000 more acres identified in the SCS soil book, for a total of 9,600 acres of potential wetlands. Allowing for a margin of error, both methods indicate that there may have been nearly 8,000 acres of wetlands in the Pike River Watershed before the onset of agricultural drainage.

Present Wetland Inventory

Approximately 455 acres of wetlands remain in the upper Pike River and Pike Creek subwatersheds as estimated from the SEWRPC (1989) aerial-rectified-photography map of the Pike River Watershed. About 67 acres (15%) are located within the proposed project area. Approximately 138 more acres of wetlands exist with direct drainage to the proposed project area, including the tributary streams entering Pike Creek and the upper Pike River within or upstream of the proposed project. This yields an estimate of 205 acres of wetlands from the headwaters of each subwatershed to the downstream end of the proposed project area (Table 2.1). The subwatersheds include 107 acres of wetlands which do not have direct drainage to Pike Creek or the upper Pike River. Also, there are approximately 143 acres of wetlands along the tributary streams with confluence to Pike Creek or the upper Pike River downstream of the proposed project on each stream. The entire Pike River Watershed was estimated to have 655 acres of remnant wetlands in 1975 (SEWRPC, 1983), which is a loss of about 90 percent of the wetlands historically in the watershed.

Based on field assessment of seven representative areas, functions of the remaining wetlands in the project area are generally limited. Exceptions include two wetland complexes that provide good water quality protection and wildlife habitat. See the Summary of Wetland Functional Values in Appendix A.

UPLAND HABITAT AND WILDLIFE COMMUNITY

SEWRPC/DNR wildlife habitat maps were used to determine the amount of wildlife habitat adjacent to the Pike River. Habitat types were grouped and measured using a digital planimeter to determine the acreage of each type within 200 feet of each bank of the river. The stream corridors of the Upper Pike River and Pike Creek watersheds, totaling about 14 miles of streambank were planimetered. This is about 34 percent of the 41 miles of perennial streams present throughout the watershed.

Table 2.1 Wetland Remnants in the Upper Pike River and Pike Creek Subwatersheds (as estimated from the SEWRPC (1989) aerial-rectified-photography map of the Pike River Watershed.)

Stream Reach	Wetlands (acres)		
	Upper Pike River Sub-Watershed	Pike Creek Sub-Watershed	Total
Within Proposed Project Area	19	48	67
Upstream of Proposed Project Area	16	61	77
Located on Tributary Streams adjacent or upstream of project area	52	9	61
Total estimated acreage of wetlands upstream and within project area			205
Without direct drainage to stream reaches	66	41	107
Downstream of Proposed Project including tributaries	25	118	143
Total estimated acreage of wetlands in Upper Pike River and Pike Creek subwatersheds			455

Table 2.2 lists the major habitat types present along the river, based upon 1985 data. Habitats were grouped into five divisions: agricultural, wooded, grass/shrub, wetland, and urban. Additional wildlife habitat exists along other stretches of the Pike River, but this isolated strip cover immediately adjacent to the river was not plotted on the SEWRPC/DNR wildlife habitat maps. This strip cover, acreage undetermined, nevertheless serves as wildlife habitat and is usually used by local wildlife as loafing, feeding, and nesting areas. It also serves an important function by providing travel lanes between isolated parcels of wildlife habitat.

Of the 837 acres planimetered in the corridor, 363 acres (43.4%) provide wildlife habitat. This habitat included woodlands, grassy or shrub covered fields, and wetlands within the corridor. Agricultural lands provide value to wildlife as feeding areas, and serve as nesting cover when left as unmowed set-aside. However, most agricultural lands are fall-plowed, leaving little or no value as wildlife habitat. Urban land use adjacent to the river may provide wildlife habitat. Ornamental trees and shrubs undoubtedly provide shelter for wildlife along stretches of the Pike River corridor. Back yard trees and shrubs provide effective cover, as well as linkages to existing stands of wooded habitat. Wetland cover is significantly lacking along the Pike River corridor. Only 3.5 percent of existing cover in the corridor consisted of non-wooded wetlands, i.e., cattail marshes or sedge meadows.

Table 2.2 Habitat Types and Land Uses (acres) Adjacent[1] to the Pike River, Kenosha and Racine counties.

Habitat Type	North Branch	Pike Creek	Main stem	Total (%)
Agricultural	130	43	48	221 (26.4)
Wooded	39	48	107	194 (23.2)
Grass / Shrub	43	9	88	140 (16.7)
Wetland	5	9	15	29 (3.5)
Urban	137	1	115	253 (30.2)
TOTAL	354	110	373	837
% Wildlife cover	24.6	60.0	56.3	43.4

[1] Land uses out to 200' on each side of the river channels were planimetered from DNR/SEWRPC wildlife habitat maps (1985 edition).

Wildlife Inventories

An inventory of wildlife resources, principally the mammals, amphibians, and reptiles, was prepared by review of published historical records. No wildlife field surveys were conducted for this assessment. Many wildlife species exhibit a wide latitude of habitat preferences, changing seasonally or as the amount of each type varies. For example, ring-necked pheasants require large blocks of undisturbed grasslands as nesting and brood rearing cover in the spring and summer. Yet, in the fall and winter, pheasant survival is highly correlated to the amount and distribution of winter cover, principally cattail wetlands or lowland areas with willow and dogwood shrubs (Gates and Hale, 1974).

Shallow wetlands provide critical breeding territories and brood rearing habitat for waterfowl and shorebirds. Shallow water areas also provide readily available sources of protein for migratory waterfowl and for duck broods in the form of aquatic invertebrates. Non-game birds use the stream banks in proportion to the amount and quality of vegetative cover present. Use of grassy banks is common for the ground nesting birds, such as waterfowl, pheasant, and grassland sparrows. Trees and shrubs provide additional habitat. A greater number and diversity of bird species utilize stream banks within tree and shrub habitat. Lists of the wildlife expected to be found in the Pike River Watershed have been tabulated.

Table 3 lists bird species expected to occur within the Pike River Watershed as derived from bird observations by local members of the Wisconsin Society for Ornithology. Only species that occurred on 5 percent or more of the checklists were used for this analysis. The bird observations reflect those species present throughout Kenosha and Racine counties; however, the listed species are known to use available and suitable habitats within the Pike River Watershed. Additional information on wildlife species expected within the watershed are provided in SEWRPC's Planning Report No. 35 (1983).

Common mammals of the Pike River Watershed are listed in Appendix B. Large mammals, such as the whitetail deer, red fox, and coyote, use the stream banks for hunting territories, travel lanes, burrowing sites, or as loafing areas. The abundance of medium-sized and small-sized mammals is directly related to the amount of ground cover and diversity of habitats within the corridor.

Common reptiles and amphibians expected to occur within the Pike River corridor are also listed in Appendix B. Reptile and amphibian species diversity is greatest, in general, along natural stream reaches and portions of the river that have partially recovered from habitat losses caused by earlier dredging. Areas of the stream where submerged branches, slack water, and adjacent lowland moist soils are present usually contain the greatest diversity and numbers of reptiles and amphibians. Frogs and toads require temporary wetlands for breeding and tadpole development.

STREAM HABITAT CHARACTERISTICS

Habitat characteristics of the Pike River Watershed were recently evaluated by Kanehl and Lyons (1990), Kanehl (1993), and Wessels and Kahehl (1994). The survey results are summarized in Wessels and Lyons (1994). The authors used a set of procedures to evaluate stream system characteristics developed by Lyons (1992) and Simonson et. al. (1994, *unpublished at time of use*). The stream attributes evaluated were bank stability, maximum thalweg depth, riffle/bend ratio, substrate, and cover for fish. Stream habitat was evaluated along channelized and unchannelized.

Burzynski (1993) also evaluated the habitat characteristics of the Pike River Watershed using a habitat rating system developed by Ball (1982) for establishing stream use classifications. This system includes an evaluation of watershed erosion, watershed nonpoint sources, bank erosion, bank vegetative protection, lower bank channel capacity, lower bank deposition, substrate, riffle/run/bend characteristics, and natural scenic beauty. Stream surveys were conducted in reaches that have been historically channelized sections in the upper Pike River and Pike Creek. A survey was also conducted on the natural channel of the Pike River downstream of the confluence of the two branches in the lower Pike River subwatershed.

According to Kanehl and Lyons (1990), Kanehl (1993), Burzynski (1993), and Wessels and Kanehl (1994) unchannelized streams in the Pike River Watershed are comprised of a mix of three habitat types; pools, runs and riffle; while historically channelized sections (Upper Pike River and Pike Creek) are predominately runs. Wessels and Kanehl (1994) also observed some distinct differences in habitat quality between channelized and unchannelized stations. All eight of the channelized stations consisted of homogeneous habitat associated with run type reaches; whereas the unchannelized stations consisted of two or more habitat types including riffles and runs or riffles, runs, and pools. Channel widths were smaller and water depths shallower in channelized reaches. Sand, silt and gravel were the predominant substrate types observed in the upper Pike River. The predominant substrate type in the headwaters of Pike Creek were silt, sand and clay, which shifted to predominately sand and gravel further downstream on Pike Creek.

Lack of rocky substrate and cover were more site specific than related to channelized or unchannelized sections. Bank stability percentages were generally higher in channelized reaches than unchannelized reaches. Lower bank stability in the unchannelized stream reaches may be a consequence of higher stream velocities and runoff rates generated in upstream channelized reaches. Bend-to-bend ratios were excellent in unchannelized reaches, while ratios were very poor in channelized reaches. Adult fish cover along channelized and unchannelized stream reaches included overhanging vegetation, woody debris, submergent vegetation and boulders. Wessels and Kanehl (1994) concluded that the problems in the Pike River Watershed are typical of streams that have been channelized, in that channelization not only affects the area that is channelized, but also areas upstream and downstream.

A summary of the warm water fish habitat ratings for the Pike River Watershed is provided below.

Table 2.3 Summary of Warm Water Fish Habitat Ratings for the Pike R., Upper Pike River, and Pike Cr. for Channelized versus Unchannelized Reaches [1)]

Stream and Station Number	Habitat Rating 1990	Habitat Rating 1993	Habitat Rating 1994
Upper Pike R.			
# 1 Upstream of STH 31 (unchannelized)	Good	Good	Fair
# 2 Upstream of CTH KR (channelized)	--	Fair to Good	Fair
# 3 Upstream of Braun Rd (channelized)	Fair	Fair	Fair
# 4 Downstream of STH 11 (channelized)	--	Fair to Good	Fair
# 5 Upstream of STH 11 (channelized)	Fair	Fair	Fair
# 6 Upstream of STH 20 (channelized)	--	Fair	Fair
Pike R. (mainstem)			
# 1 Downstream of CTH E (unchannelized)	Fair	--	--
# 2 Upstream of CTH Y (unchannelized)	Fair	--	--
# 3 Upstream of SE corner of Petrifying Springs Park Rd. (unchannelized)	Good	Good	Fair
Southbranch Pike R. (Pike Cr.)			
# 1 Upstream of STH 31 (unchannelized)	Fair to Good	Fair to Good	Fair
# 2 Upstream of CTH E (channelized)	Poor to Fair	Fair to Good	Poor
# 3 Upstream of CTH S (channelized)	--	Poor to Fair	Poor

[1)] Wessels and Kanehl (1994)

FISH COMMUNITIES

A historical report noted that northern pike were last commonly caught in the lower Pike River in the 1920s, when the length of the estuary was popular for boating and fishing (SCS, 1966). Northern pike have not been recorded in any fish population surveys since then. Fish assemblage surveys in the early 1900s indicate that Pike Creek and the upper Pike River at one time supported a diverse forage and sport fish community (SEWRPC, 1983). Fish species present in the Pike River Watershed in the early 1900s but not collected since 1975 include the least darter (State Species of Special Concern status), redfin shiner (State Threatened Species status), striped shiner (State Endangered Species status), horneyhead chub and northern redbelly dace, largescale stoneroller (Intolerant Forage Fishes), johnny darter and northern hog sucker (Tolerant Forage Fishes), and rock bass (Warm Water Sport Fish).

The Pike River, and especially the Waxdale Tributary and the upper reaches of the upper Pike River, have experienced fish kills which generally have been attributed to spills. Besides spills, other factors responsible for the decline of fish and aquatic life throughout the Pike River Watershed include historical stream channelization, improperly treated discharges from municipally operated wastewater treatment plants (since abandoned), and nonpoint sources of pollution.

A total of twenty-five fish species and one hybrid cross have been collected from the Pike River and it's tributaries (Fago, 1984; Kanehl and Lyons, 1990; Kanehl, 1993; Burzynski, 1993; Wessels and Kanehl, 1994). Species are represented by migratory cold water sport fish (trout) from Lake Michigan, resident warm water sport fish (sunfish and bullhead species) and a variety of warm water forage fish including species considered intolerant (southern rebelly dace, blacknose shiner and blacknose dace), tolerant and very tolerant of degraded habitat conditions (See Map 2).

A total of twenty-two species and one hybrid cross have been collected at six different sites on the upper Pike River and the Bartlett Branch since 1975 (Fago, 1984; Kanehl and Lyons, 1990; Kanehl, 1993; Burzynski, 1993; Wessels and Kanehl, 1994). The upper Pike River and the Bartlett Branch support fish communities of primarily tolerant (to pollution) to very tolerant forage fish species. Resident sport fish are currently dominated by green sunfish and yellow perch and lesser numbers of pumpkinseed, bluegill, and an occasional black crappie, largemouth and smallmouth bass, and black bullhead. Anadromous brook trout (7) and rainbow trout (4) from Lake Michigan stockings were collected since 1993.

Eighteen fish species and one hybrid cross have been collected at six different sites on Pike Creek and the Airport Tributary since 1975 (Fago, 1984; Kanehl and Lyons, 1990; Kanehl, 1993; Burzynski, 1993; Wessels and Kanehl, 1994). Similar to the upper Pike River, the Pike Creek and Airport Tributary support fish sport and forage fish communities intolerant to very tolerant of degraded habitat conditions. Resident sport fish are dominated by green sunfish and black bullhead, and lesser numbers of yellow bullhead, pumkinseed, bluegill, black crappies and largemouth bass. Three rainbow trout, residents of Lake Michigan, have been collected from Pike Creek since 1993.

A summary of the fish species collected from streams in the Pike River Watershed since 1990 is provided below.

Table 2.4 Relative Abundance and Classification of Fish in the Pike River Watershed - Pike River, Upper Pike River, and Pike Creek 1990-1994

Fish Species (common name)	Classification as Sport or Forage, and Tolerance to Degraded Habitat[1)]	Pike River[2)]	South Br. Pike R. (Pike Cr.) (including Airport Br.)[2 & 3]	Upper Pike R. (including the Bartlett Br.)[2 & 3]
Brook trout	Intolerant Cold Water Sport Fish	66	--	7
Brown trout	Intolerant Cold Water Sport Fish	16	--	--
Rainbow trout	Intolerant Cold Water Sport Fish	58	3	4
Central mudminnow	Very Tolerant Forage Fish	--	--	1
Goldfish	Very Tolerant Forage Fish	1	--	1
Common carp	Very Tolerant Forage Fish	10	5	
Blacknose shiner	Intolerant Forage Fish	--	--	4
Common shiner	Tolerant Forage Fish	28	2	8
Golden shiner	Tolerant Forage Fish	--	9	3
Fathead minnow	Very Tolerant Forage Fish	8	160	76
Bigmouth shiner	--	114	398	2
Blacknose dace	Intolerant Forage Fish	442	1832	19
Southern Redbelly dace	Intolerant Forage Fish	117	581	135
Creek chub	Tolerant Forage Fish	1001	3619	2098
Common White sucker	Tolerant Forage Fish	380	575	610
Black bullhead	Warm Water Sport Fish	40	108	20
Yellow bullhead	Warm Water Sport Fish	2	3	--
Brook stickleback	Tolerant Forage Fish	--	89	66
Green sunfish (excluding hybrids)	Warm Water Sport Fish	513	436	108
Pumpkinseed	Warm Water Sport Fish	52	16	5

Fish Species (common name)	Classification as Sport or Forage, and Tolerance to Degraded Habitat[1)]	Pike River[2)]	South Br. Pike R. (Pike Cr.) (including Airport Br.)[2 & 3]	Upper Pike R. (including the Bartlett Br.)[2 & 3]
Bluegill	Warm Water Sport Fish	179	28	27
Black crappie	Warm Water Sport Fish	2	3	3
Smallmouth bass	Warm Water Sport Fish	2	--	1
Largemouth bass	Warm Water Sport Fish	1	7	4
Yellow perch	Warm Water Sport Fish	43	29	44
Summary				
Total No. Species	25	21	18	22
Cold Water Sport	3	3	1	2
Warm Water Sport	9	9	8	8
Intolerant Forage	3	2	2	3
Tolerant Forage	5	3	5	5
V. Tolerant Forage	4	3	2	3
Unclassified	1	1	1	1

[1)] Ball (1982); [2)] Wessels and Kanehl (1994); [3)] Burzynski (1993)

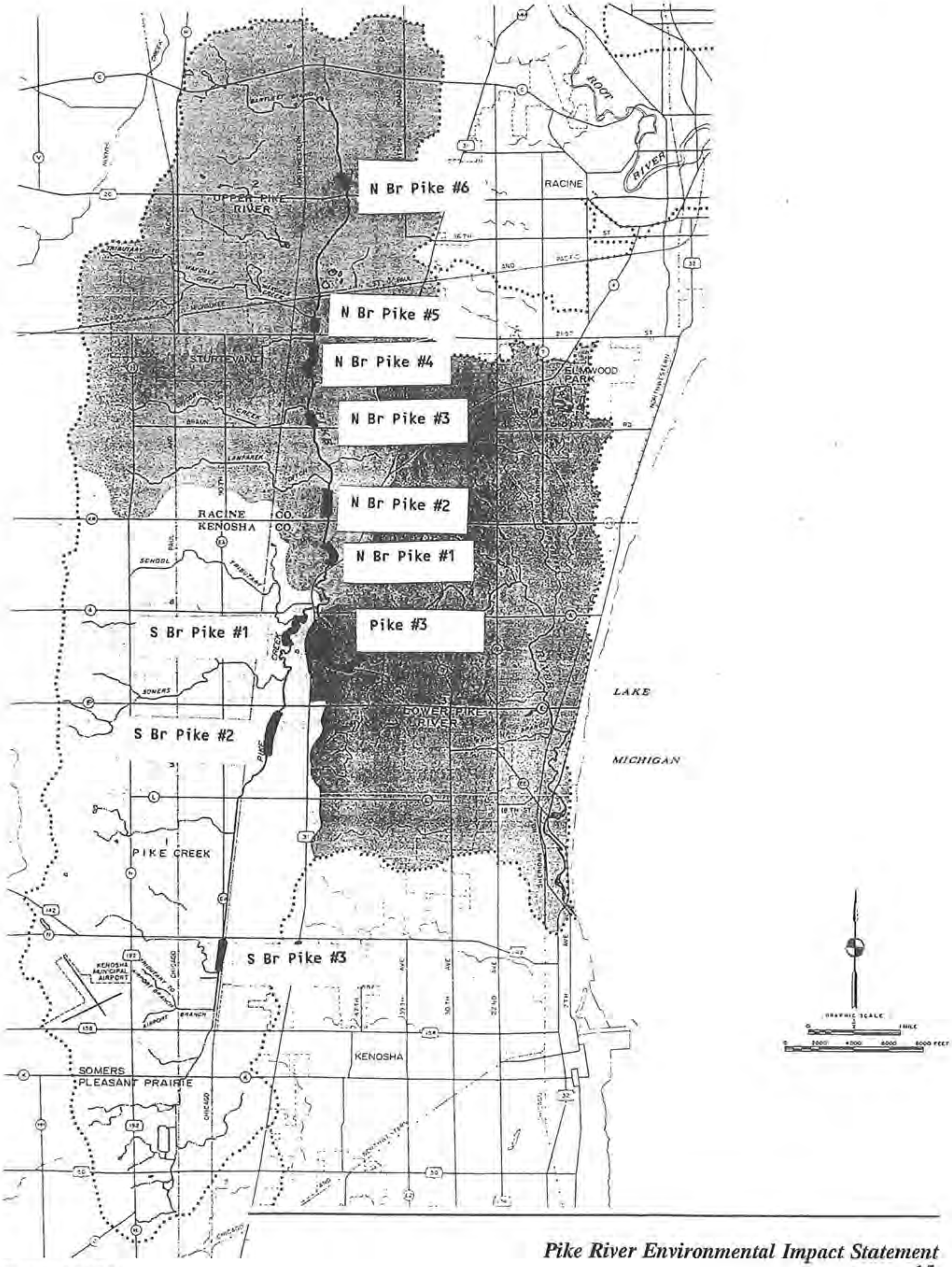
ENVIRONMENTAL INDICES

Biological monitoring is used as a sensitive indicator of environmental conditions and stresses on the entire aquatic ecosystem (Fausch *et. al.*, 1990). Kanehl and Lyons (1990), Kanehl (1993), Burzynski (1993) and Wessels and Kanehl (1994) used the Index of Biotic Integrity for Wisconsin Streams (IBI) (Lyons, 1992) to summarize fish data and to indicate the overall biotic and environmental quality of the Pike River Watershed.

Based on the IBI, the overall biological and environmental integrity of the Pike River, upper Pike River and Pike Creek ranged from very poor to fair. A total of twenty-eight fish assemblage samples were obtained from twelve sites between 1990-1994 (see Map 2). Eight samples were rated as having very poor biological and environmental integrity; fourteen samples were of poor biological and environmental integrity; and six samples were of fair biological and environmental integrity. On a watershed-wide basis, there was a *smaller percentage of very poor and poor* IBI sites, and a *larger percentage of fair* IBI sites in unchannelized stream reaches than in channelized reaches.

MAP 2

SAMPLING SITES: PIKE RIVER HABITAT AND FISH COMMUNITY SURVEY, 1993



Source: SEWRPC.

and relocation), draining of wetlands, and sedimentation from nonpoint sources of pollution. A summary of the stream classifications in the Pike River Watershed are presented below:

Table 2.7
Stream Classifications in the Pike River Watershed.

Stream Name	Stream Use Classification[1]
Pike River Subwatershed	
Kenosha Branch	Warm Water Forage Fish Community
Sorenson Creek	Warm Water Forage Fish Community
Upper Pike River Subwatershed	
Upper Pike River	Warm Water Sport Fish Community (from confluence with the mainstem upstream to STH 20, Racine County)
	Warm Water Sport Fish Community (from STH 20, Racine County, upstream to the headwaters)
Bartlett Branch	Limited Forage Fish Community
Waxdale Creek	Limited Forage Fish Community
Waxdale Tributary	Limited Forage Fish Community
Pike Creek Subwatershed	
Pike Creek	Warm Water Sport Fish Community (from confluence with mainstem upstream to STH 142, Kenosha County)
	Warm Water Forage Fish Community (upstream of STH 142, Kenosha County to the headwaters)
Airport Tributary	Warm Water Forage Fish Community
Somers Tributary	Warm Water Forage Fish Community

[1] Burzynski, T. 1993. Pike River Watershed Stream Classifications: Volumes 1 and 2. Wisconsin Department of Natural Resources. Water Resource Management, Milwaukee, WI.

ENDANGERED, THREATENED AND "SPECIAL CONCERN" SPECIES

Table 2.8 lists species within the Pike River corridor[1] having endangered, threatened or "special concern" status in the State of Wisconsin. There are twelve species of ***plants*** that are either rare, endangered, or of special concern. Several of these species prefer wet or wet-mesic prairie conditions, like those found in the remnant wetlands and areas of moist soils along the stream course. Prairie white-fringed orchid, white lady's slipper, marsh blazing star, waxy meadow rue, and black haw are potential residents in the Pike River floodplain. It is very possible that individuals or small populations of these species exist within the boundaries of the project area. A more detailed field survey may be necessary to determine the precise locations of these species, to assess the impact of any stream alteration on their survival.

One threatened species of ***fish***, the redfin shiner, was present in the Pike River in 1906, but there are no records of its occurrence since then. A species of special concern, the least darter, was recorded in 1924 and 1980. The surveys of 1990, 1993 and 1994 did not record any least darters probably due to the decline in water quality and habitat quality. However, high, turbid water during part of that survey may have allowed darters or other species to evade collection by sampling crews.

Ten other species of endangered, threatened or "special concern" fish have been recorded in adjacent watersheds, but none of these has been recorded in the Pike River.

One ***bird*** of special concern, the black-crowned night heron, has been observed in the northern half of the watershed, where there are a number of wetland remnants that could provide habitat for a population of these and other wetland birds.

As noted in the 1983 SEWRPC plan, one endangered ***amphibian***, the spotted salamander, and one endangered ***reptile***, the blanding's turtle, inhabit the watershed. [Note: Neither of these species is currently listed in the NHI as occurring within a mile of the floodplain, but an ongoing endangered resource inventory is expected to update the records in the National Heritage Inventory (NHI).] The table indicates the status (endangered, threatened, or special concern) of the species, its habitat preferences, and other pertinent comments such as its relative abundance in the state. Status is defined as follows:

Endangered: A species whose continued existence as a viable component of the state's native fauna or flora is in danger, and without help may become extirpated. (Officially protected by Wisconsin's Endangered Species Law.)

[1] For purposes of checking the NHI database, the Pike River "corridor" encompasses every section (areas of one square mile) through or along which the main stem of the Pike River or Pike Creek flows.

Threatened: A species which appears likely, within the foreseeable future, to become endangered. (Officially protected by Wisconsin's Endangered Species Law.)

Special Concern: A species which is suspected, but not proven to be, declining, and may become endangered or threatened if protective steps are not taken. (Not officially protected by Wisconsin's Endangered Species Law. However, they may be protected by some other law or rule such as the Migratory Bird Act, fishing regulations, etc.)

Comprehensive endangered resource surveys have not been completed for the Pike River Watershed. NHI data files contain the following rare species and natural community information for the watershed located in Kenosha and Racine Counties. Information regarding the species' preferred habitats, the optimal observation (survey) dates, and other information useful in planning protection measures is also included. If the described habitat types occur in the project's impact areas, then these species may be present.

Table 2.8:
THREATENED, ENDANGERED AND "SPECIAL CONCERN" SPECIES OF THE PIKE RIVER WATERSHED

Common and Scientific Names	Organism Type	State Status	Habitat in Pike River Watershed	Comments
Purple Milkweed Asclepias purpurascens	plant	END	Dry fields and thickets	Blooming occurs from June through August
Prairie Milkweed Asclepias sullivantii	plant	THR	mesic prairies	Blooming occurs from June through July. Presence is in doubt.
Cooper's Milk Vetch Astragulus neglectus	plant	END		
Great Indian Plantain Cacalia muhlenbergii	plant	SC	Southern woodlands and sometimes disturbed habitats such as old pastures	Blooming occurs from late June through August. Presence is in doubt.
Hop-like Sedge Carix lupuliformis	plant	END		
White Lady's Slipper Cypripedium candidum	plant	THR	Moist, calcareous soils of wet or mesic prairies, or open fens	Blooming occurs from late June through August
Pale Purple Coneflower Echinacea pallida	plant	THR	Dry prairies and other dry open places	Blooming occurs from June through July. Presence would be due to human introduction.
Golden Seal Hydrastis canadensis	plant	SC		
Twinleaf Jeffersonia diphylla	plant	SC		

Table 2.8:
THREATENED, ENDANGERED AND "SPECIAL CONCERN" SPECIES OF THE PIKE RIVER WATERSHED

Common and Scientific Names	Organism Type	State Status	Habitat in Pike River Watershed	Comments
Marsh Blazing Star Liatris spicata	plant	SC	Wet to wet-mesic prairies	This species reaches the limit of its natural range in southeastern Wisconsin. Blooming occurs from July through August
One-Flowered Broom-Rape Orobanche uniflora	plant	SC		
Wild Quinine Parthenium integrifolium	plant	THR	Deep-soil mesic prairies	Blooming occurs from June through September
Prairie White-Fringed Orchid Platanthera leucophaea	plant	END	Wet prairies; wet meadows; bogs; and other open, grassy places	Blooming occurs during June through July. Habitat reportedly destroyed since 1982
Waxy Meadow Rue Thalictrum revolutum	plant	SC	wet and wet-mesic prairies and sedge meadows	Fruiting occurs from June to September
Red Trillium Trillium recurvatum	plant	SC		
Black Haw Viburnum prunifolium	plant	SC	wet and wet-mesic prairies and sedge meadows	Fruiting occurs from June to September

Table 2.8:
THREATENED, ENDANGERED AND "SPECIAL CONCERN" SPECIES OF THE PIKE RIVER WATERSHED

Common and Scientific Names	Organism Type	State Status	Habitat in Pike River Watershed	Comments
Redfin Shiner <u>Lythrurus umbratilis</u>	fish	THR	turbid waters of pools in low-gradient streams over substrates of silt, gravel, or rubble	Spawning occurs from early June through mid-August in sunfish nests and they coexist with the sunfish in the nesting territory
Least Darter <u>Etheostoma microperca</u>	fish	SC	clear, warm, quiet waters of small streams, ponds, pools and lakes over substrates of gravel, silt, or sand	Spawning occurs from mid-April through early July
Blanding's Turtle <u>Emydoidea blandingii</u>	reptile	THR	Sedge meadows, southern wet and southern wet-mesic forest, wet and wet-mesic prairie, open-water marshes, backwater sloughs, prairie potholes, large ponds, slow-moving rivers and shallow lakes	The breeding season occurs from April through September
Black-crowned Night-Heron <u>Nycticorax</u>	bird	SC	freshwater wetlands dominated by bulrush and cattail with small groves of alder, willow, or other brush	Their breeding season occurs from mid-April through mid-September

In conjunction with the Wisconsin Department of Natural Resources (DNR), through its Bureau of Endangered Resources, SEWRPC recently completed a two-year endangered resource inventory primarily targeting terrestrial natural areas (including wetlands). Information from this survey is included in the table above. New occurrence records include Cooper's milk vetch, hop-like sedge, golden seal, twinleaf, one-flowered broom-rape, and red trillium.

Stream Sediment

The most intensive qualitative sediment quality data for the Pike River Watershed is limited to samples collected and analyzed (beginning in 1987) for a number of compounds in Waxdale Creek, as an initial step in an ongoing Corrective Action Program under the federal Resource Conservation and Recovery Act (RCRA). Other sampling for selected pesticides and polychlorinated biphenyls (PCBs) was conducted in 1980 and 1983 to gather data for fish kill studies. Samples were collected from the lower Pike River near Lake Michigan and in Petrifying Springs Park, and along the upper Pike River and Waxdale Creek in Mount Pleasant.

Pesticide, polynuclear aromatic hydrocarbon (PAH), PCB and other contaminant sediment concentrations were measured. At several sites concentrations exceeded sediment quality standards (see tables 2.3 and 2.4 for a summary of the results of the RCRA survey). These elevated concentrations indicate a historical or continuing source of these contaminants.

Sediment quality samples were generally more contaminated from Waxdale Creek than other sample sites in the watershed. This observation may be influenced by the limited amount of sediment data collected throughout the Pike River Watershed versus the greater number of samples collected from Waxdale Creek.

The 1983 survey revealed that throughout the Pike River Watershed, the highest concentrations of pesticides were noted from Waxdale Creek sediments. Pesticide concentrations in Waxdale Creek were often orders of magnitude greater than other watershed sediment concentrations. Maximum concentrations of PCBs were similar between Waxdale Creek and Pike River sediments. Depth segregated core sample results generally indicated higher pesticide concentrations from middle core segments (0.33 ft. to 0.42 ft. from surface) and lower core segments (0.66 ft. to 0.84 ft. from surface).

When detected, chlordane concentrations from Waxdale Creek sediment samples ranged from 0.039 to 13.30 mg/kg and averaged 3.21 mg/kg (sd 4.62 mg/kg; n = 11), dieldrin concentrations ranged from 0.015 to 5.67 mg/kg and averaged 0.55 mg/kg (sd 1.54 mg/kg; n = 13). When detected, Waxdale Creek sediment DDT concentrations ranged from 0.011 to 2.58 mg/kg and averaged 0.22 mg/kg (n=14; sd 0.68 g/kg). The chlordane and dieldrin concentrations in Waxdale Creek sediments are some of the highest concentrations observed in the State of Wisconsin to date.

One of four core samples collected from the Pike River had concentrations of chlordane, dieldrin and aldrin also exceeded background sediment concentrations for southeastern Wisconsin rural or urban streams. A core sample collected from the Pike River at Willow Rd. had chlordane concentrations of 1.18 and 2.36 mg/kg, dieldrin 0.856 and 1.80 mg/kg, and aldrin 0.9 and 0.166.

Similar to pesticide concentrations in sediment, sediment PCB concentrations were generally more elevated along Waxdale Creek than the Pike River. Concentrations of PCBs in most Waxdale Creek sediments, and two of eight samples collected from the Pike River exceeded background levels for southeastern Wisconsin. Detectable concentrations of PCBs in Waxdale Creek ranged from 0.07 to 18.40 mg/kg and averaged 2.90 mg/kg (n=13; sd 6.03 mg/kg). Three of eleven Pike River sediment samples had detectable concentrations of PCB ranging from 0.287 to 9.20 mg/kg.

Due to their bioaccumulative and toxic nature the high dieldrin, chlordane and PCB concentrations present the greatest risk to biota and may present special requirements for safe disposal of dredge spoils. A PCB and pesticide fish consumption advisory is in effect for carp on the lower Pike River near Lake Michigan. The numerous toxic or hazardous compounds in Waxdale Creek sediments pose a potentially serious concern, due to the "long-term potential for future off-site migration of contaminants" (CH^2MHill, 1993). DNR and SC Johnson are currently evaluating the advisability of and best method for removing some of these contaminants from two landfills and a pond on the SC Johnson property. However, for the forseeable future there would be no attempt to remove or treat contaminated sediments in Waxdale Creek.

Overall, there is very little sediment sampling data available from stream reaches recommended to be deepened and widened along the Proposed Project corridor. The presence of elevated pesticide and PCB sediment concentrations at the headwater and lowest reaches of the Pike River may indicate that these contaminants may be present along other river reaches of the Proposed Project. Other potentially toxic compounds that may be present but were not analyzed for include heavy metals and polynuclear aromatic hydrocarbons (PAHs). These compounds would be expected to be present in streams that drain urban land uses (Masterson, 1994). Observations by DNR crews collecting fish and fish habitat data indicated that large areas of soft-textured and organically enriched anaerobic sediments are found along the Pike River and Pike Creek. When disturbed, these sediments were noted as releasing methane and hydrogen sulfide gases. These observations also indicate that ammonia-nitrogen, and potentially toxic un-ionized ammonia, may also be present. Sediment quality data is also lacking for more conventional types of pollutants, most notably phosphorus and nitrogen, which are very likely present in sediment throughout the Proposed Project area.

Table 2.9. Summary of Sediment Chemical Analysis for the Waxdale Creek and Upper Pike River - 1983 (mg/kg dry weight basis)

Sample Number Identification and Sample Location	Core Sample Depth (feet)	Aldrin	Chlordane	DDE	DDD	DDT	Diel-drin	PCB[1]
Waxdale Creek Samples S #1 Leechate area north embankment	upper 0.5 lower 0.5	* *	* *	0.037 0.047	0.046 0.054	0.037 0.036	* *	0.069 0.051
S #2 Upstream of SC Johnson (control)	upper 0.42 lower 0.42	* *	* *	0.022 0.014	0.017 0.014	0.012 0.007	* *	* *
S #3 Upstream of outfall along southwest bank	upper 0.42 middle 0.42 lower 0.42	* * *	* * *	0.034 0.022 0.014	0.067 0.030 0.060	0.068 0.011 *	* * *	* * *
S #4 downstream of outfall along southwest bank	upper 0.33 middle 0.33 lower 0.33	* * *	0.039 0.070 2.760	0.034 0.022 0.042	0.052 0.027 0.060	0.029 0.020 0.032	* * 0.131	* 0.070 (1254)
S #5 Immediately downstream of landfill runoff area	upper 0.33 lower 0.33	* *	0.201 *	0.010 0.056	* *	* 0.074	0.029 0.027	0.445 0.432
S #6 50 ft. downstream from sample S #1 & S #2 above	upper 0.33 middle 0.33 lower 0.33	* * *	0.315 0.307 1.660	0.071 0.055 0.124	* * 1.220	* * *	0.083 0.071 0.301	2.110 0.194 0.521

Table 2.9. Summary of Sediment Chemical Analysis for the Waxdale Creek and Upper Pike River - 1983 (mg/kg dry weight basis)

Sample Number Identification and Sample Location	Core Sample Depth (feet)	Aldrin	Chlordane	DDE	DDD	DDT	Diel-drin	PCB[1]
S #7 Downstream of SC Johnson outfall 003	upper 0.42 middle 0.42 lower 0.42	* * *	0.637 10.30 5.760	0.066 0.140 0.222	0.125 < 0.20 < 0.10	0.057 0.133 2.580	0.160 0.104 5.670	0.513 0.314 14.20
S #8 Downstream of SC Johnson outfall 002	upper 0.33 lower 0.33	* *	13.30 *	0.550 < 0.30	< 0.06 < 0.40	< 0.03 < 0.70	0.275 0.277	0.317 18.40
S #9 Downstream of SC Johnson outfall 001	upper 0.25 lower 0.25	0.010 *	* *	* *	0.013 *	0.013 *	0.019 0.015	* *
Pike River Samples S #10 at STH 11	0.33 composite	0.012	*	*	*	*	*	*
S #11 Upstream of confluence with Waxdale Cr.	upper 0.50 (sand) lower 0.25 (clay)	* *	0.100 *	0.011 *	0.010 *	0.009 *	0.082 *	* *
S #12 Downstream of Waxdale Cr. approx. 50 ft.	upper 0.33 lower 0.33	* *	* *	* *	0.014 *	0.012 *	* *	* *

Table 2.9. Summary of Sediment Chemical Analysis for the Waxdale Creek and Upper Pike River - 1983 (mg/kg dry weight basis)

Sample Number Identification and Sample Location	Core Sample Depth (feet)	Aldrin	Chlordane	DDE	DDD	DDT	Diel-drin	PCB[1]
S #13 "Pool" downstream of Willow Rd.	upper 0.33 lower 0.33	0.166 0.090	2.360 1.180	0.198 0.115	< 0.09 < 0.04	0.064 < 0.05	1.800 0.856	0.287 0.428

[1] PCB as Arachlor 1260 unless otherwise noted.
* Less than laboratory detection limits. Detection limits not provided in report.

Table 2.10. Summary of Sediment Chemical Analysis[1] for the Pike River Watershed (mg/kg dry weight basis)

Sample Number Identification and Sample Location	PP, DDT	PP, DDD	PP, DDE	Dieldrin	Total PCB
S #1 Near confluence with Lake Michigan adjacent to St. Georges Cemetery	0.06	0.06	0.19	< 0.01	9.20
S #2 at Berryville Rd.	0.05	0.03	0.06	< 0.01	< 0.05
S #3 at Petrifying Springs County Park	0.04	0.04	0.10	0.02	< 0.05
S #4 CTH 11	< 0.01	0.01	0.02	0.09	0.06

[1] All samples collected with Eckman dredge to approximate depth of 0.4 ft. Other parameters analyzed but not detected include OP, DDD, OP, DDE, and OP,DDT, Heptachlor

[1] All samples collected with Eckman dredge to approximate depth of 0.4 ft. Other parameters analyzed but not detected include OP, DDD, OP, DDE, and OP, DDT, Heptachlor

Table 2.11
Hazard Quotients of Final Chemicals of Concern (FCOCs)
Waxdale Creek Study Area - SC Johnson Wax, Waxdale Facility

FCOC	Concentration (EPC)	Criteria[a]		Hazard Quotient Index[b]	
		Acute	Chronic	Acute	Chronic
Surface Water					
Metals					
Chlorine	722 µg/L	*18.4 µg/L	*7.06 µg/L	39.2	102.3
Chromium**	0.024 µg/L	1.7 µg/L	0.21 µg/L	0.014	102.3
Organic Compounds					
4,4'-DDT	0.034 µg/L	*0.43 µg/L	0.001 µg/L	0.08	34
Aldrin	0.031 µg/L	*2.16 µg/L	?	0.01	?
bromodichloromethane	5.9 µg/L	11,000 µg/L	?	0.0005	?
dibromochloromethane	2.7 µg/L	11,000 µg/L	?	0.0002	?
trichlorofluoromethane	4.1 µg/L	11,000 µg/L	?	0.0003	?

FCOC	Concentration (EPC)	Derived Sediment Quality Criteria	Hazard Quotient Index	
			Acute	Chronic
Sediment				
Metals				
Cadium	1.5 mg/kg	1 mg/kg		1.5
Copper	76.5 mg/kg	70 mg/kg		1.09
Lead	66.6 mg/kg	35 mg/kg		1.9
Mercury	038 mg/kg	0.1 mg/kg		3.8
Zinc	485 mg/kg	100 mg/kg		4.85
Organic Compounds				
4,4-DDT	0.037 µg/g	0.01 µg/g		3.7
Aldrin	2.8 µg/g	0.01 µg/g		280
Dieldrin	4 µg/g	0.01 µg/g		400
Endrin	0.096 µg/g	0.02 µg/g		4.8
Chlordane	0.19 µg/g	0.01 µg/g		19
anthracene	5.3 µg/g	430µg/g		0.01
benso(a) anthracene	20µg/g	0.4 µg/g		50
2,4'-D	0.13µg/g	?		?
Methoxychlor	0.042µg/g	?		?
Acetophenone	0.84µg/g	?		?
Benzo(b) flouranthene	37 µg/g	?		?
Benzo(g,h,i) perylene	20 µg/g	?		?
Benzo(k) flouranthene	18 µg/g	?		?
Butly benzyl phthalate	0.088 µg/g	?		?
Ideno (1,2,3-cd)pyrne	22 µg/g	?		?
bis (2-Ethylhexyl) phthalate	6.4µg/g	?		?
Styrene	0.03 µg/g	?		?

[a] Federal or State of Wisconsin WQC, whichever was lower.
[b] Hazard Quotient = [Observed contaminant concentration or derived exposure dose]/[Effective Concentration or Surrogate]
[c] Derived criteria based on Wisconsin Criteria or NOAA/ER-L.
* Based on aquatic life use designation subcategory for Waxdale Creek--All other fish and aquatic life.
** Form of chromium is assumed to be hexavalent and is probably an overly conservative assumption.

PKELS.WXI
Source: CH2M Hill, 1995

Table 2.12
Hazard Quotients of Final Chemicals of Concern (FCOCs)
Waxdale Landfill Surface Soil - SC Johnson Wax, Waxdale Facility

FCOC	Exposure Point Concentration (EPC) (mg/kg)[a,b]	Adjusted Toxicity Value (mg/kg/BW/d)[b]	Adjusted Toxic Soil Concentrations (mg/kg)[b,c]	Hazard Quotient[d,e]
VOCs				
Ethylbenzene	2,500.00	2.9 (rat)	300.0	8.0
Xylenes (total)	1,5000.00	18.0 (rat)	1,900.0	8.0
SVOCs				
Dibenzofuran	0.059	NA	NA	NA
Pesticides/PCBs				
Aldrin	21.0	0.067 (rat)	6.9	3.0
Dieldrin	21.0	0.047 (rat)	4.8	4.0
Dioxin/Furan Parameters				
Furans (total)	0.00013	NA	NA	NA
			Total	67.2

[a] Exposure point concentration (EPC) = maximum concentration
[b] Rounded off to two significant figures

[c] Adjusted toxic soil concentration $(ATSC) = \frac{(ATV)(BW)}{(SIR)}$

SIR = Soil ingestion rate
ATV = Adjusted toxicity value
BW = Body weight
[d] Hazard quotient $= \frac{EPC}{ATSC}$
[e] Rounded off to one significant figure

PKELS.WX2
Source: CH2M Hill, 1992

WATER CHEMISTRY

A summary of water quality data gathered from 1968 through 1975 (SEWRPC, PR 35) showed that in general, water quality was much better during periods of dry weather than during periods with stormwater runoff. The total phosphorous standard of 0.1 mg/l was met 80 percent of the time in dry weather, but violated nearly all the time in wet weather. Also, the transport loading of chloride increased by 200 percent to 400 percent during wet periods. Two municipal wastewater treatment plants, which were operating at the time, also contributed to high chloride concentrations. The ammonia nitrogen standard of 0.02 mg/l of unionized ammonia was not exceeded from 1972 through 1975, except (for 10 percent of the time) along an unspecified distance downstream of the Sturtevant wastewater treatment plant. The municipal wastewater treatment facilities have been abandoned and no longer discharge to the Pike River or its tributaries.

The temperature standard in effect at the time, 89° F, was met all the time under all conditions. Dissolved oxygen concentrations were below the standard (5 mg/l) about 20 percent of the time from 1968 through 1975 under both wet and dry conditions (SEWRPC, PR 35). Fecal coliform exceeded the standard of 400 MFFCC/100 ml about 56 percent of the time, under both wet and dry conditions. The maximum value recorded was 12,000 MFFCC/100 ml. High fecal coliform values in general were attributed to poorly treated sewage.

Water temperatures and dissolved oxygen were measured during the 1993 stream classification surveys (Burzynski, 1993). All values were within seasonal limits. However, the presence of rather dense filamentous algae and aquatic macrophytes may lead to oxygen deficit during the summer months. Measurement of the dissolved oxygen revealed super-saturated levels at some sites, indicating high biological productivity. High respiration rates could thus be expected, which might prove limiting to biological communities in the stream.

Table 2.13

CHARACTERISTICS OF STREAMS IN SUBWATERSHEDS WITHIN THE PIKE RIVER WATERSHED

SUBWATERSHED Stream Reach	Perennial Stream Length (miles)	Fish Population and Diversity	Recurring NPS-caused Fish Kills	Water Quality Problems						Biotic Index Rating	Streambed Sedimentation	Physical Modifications to Channel
				DO	NH_3	NO_3	Total P	Fecal Coliform	Toxics			
Pike River upstream Pike Creek	16.5	Poor	Yes	No	No	Yes	No	No	Yes	Very poor	High (silt, muck, gravel)	Major
Pike River downstream Pike Creek	12.0	Poor	Yes	No	No	No	No	Yes	Yes	Poor to very poor	High (silt, muck, gravel, rocks)	Moderate
Pike Creek	8.4	Poor	No	Yes	No	Yes	No	Yes	Yes	Fair to poor	High (silt, muck, gravel)	Major

Source: Wisconsin Department of Natural Resources

PK_WQUAL.TAB

Table 2.14

CHARACTERISTICS OF OTHER KNOWN POINT SOURCES OF WATER POLLUTION IN THE PIKE RIVER WATERSHED: 1990

Facility Name	County	Permit Type	Permit No.	Expiration Date	Standard Industrial Classification Code	Industrial Activity	Receiving Water	Treatment System[1]
Pike River Watershed								
Eaton Corporation - Elec. Drives Div.	Kenosha	General	0044938-3	NA	3566	Speed changers, drives & gears	Pike River via storm sewer	NA
Ken-Crete Products Co., Inc.	Kenosha	General	0046507-2	NA	3721/3273	Concrete block, brick & ready-mix	Absorption pit	NA
Metal-lab Inc.	Kenosha	General	0044938-3	NA	3398	Metal heat treating	Pike River via unnamed trib.	NA
Racine Fluid Power	Kenosha	General	0044938-3	NA	3561	Pumps & equip., valves & pipe fit.	Pike River	NA
Racine School Dist.: J.I. Case H.S.	Kenosha	General	0046523-1	NA	3494	Secondary school	Pike River via drainage ditch	NA
Spencer Residence	Kenosha	General	HEAT PUMP	NA	8811	Private residence	Pike River via storm sewer	NA
UW Parkside Pool	Kenosha	General	0046523-2	NA	8221	College or university	Pike River via drainage ditch	NA
J.I. Case Co. - Transmission Plant	Racine	Specific	0039691		3523	Farm machinery & equipment	Lake Michigan via storm sewer	None
Land Reclamation Co.	Racine	Specific	0045420		4953	Refuse systems	Pike river via drainage ditch	1, 2
S.C. Johnson & Son, Inc. - Waxdale	Racine	Specific	0027758		2842	Polishes & sanitation goods	Pike River via unnamed trib.	None

PK_PTS.TAB

[1] The number code refers to the following treatment systems:
- a. Gravity sedimentation
- b. Holding pond

NOTE: NA indicates "not applicable or "not available".

SOURCE: Wisconsin Department of Natural Resources and SEWRPC.

LAND USE AND FLOODPLAIN DEVELOPMENT

Significant residential, commercial and industrial development is forecast within the watershed (see Map 3 and Table 9). Some of this development is intended for the existing floodplain, especially along the upper reaches of the Pike River and Pike Creek. Elimination of the floodplain would make this property fully developable.

A 1990 SEWRPC study revealed that during the 10 years from 1975 to 1985, the watershed lost more than 5 percent of its remaining agricultural land, while commercial development expanded by 75 percent. Overall urban land uses increased by over 12 percent. And, over the 25-year period between 1985 to 2010, another 11 percent to 17 percent of the agricultural lands in the watershed are predicted to be lost (see table 2.9). Urban uses are expected to expand by about 50 percent from 1985 levels.

Development projects anticipated in the Pike River Watershed include construction of industrial facilities at the Kenosha Auto Transfer site, and the expansion of the Kenosha municipal airport. Under the proposed project, increased channel capacity on Pike Creek would convey the added stormwater runoff contributed from this development. At a Pike River Watershed Committee meeting early in the EIS process, and in subsequent correspondence, SEWRPC staff and local officials noted that a stormwater drainage system was needed for developing parts of the watershed in the foreseeable future. The stormwater generated by this and other new development will, if not managed in some way, cause increases in flood elevation and increased flood damage risk to existing structures that are not currently in the floodplain.

Each type of land use contributes a mix of nonpoint pollutants, ranging from leaves, pet waste and lawn pesticides, to oil and grease, toxic compounds, sediment, and salt. Four existing stormwater drainage systems covering about five square miles of the watershed (about 10 percent) convey some of these pollutants directly into the Pike River and its tributaries.

Existing Floodplain

No information has been tabulated on the effect that development subsequent to 1980 may be having

MAP 3:
YEAR 2010 PLANNED LAND USE IN THE PIKE RIVER WATERSHED

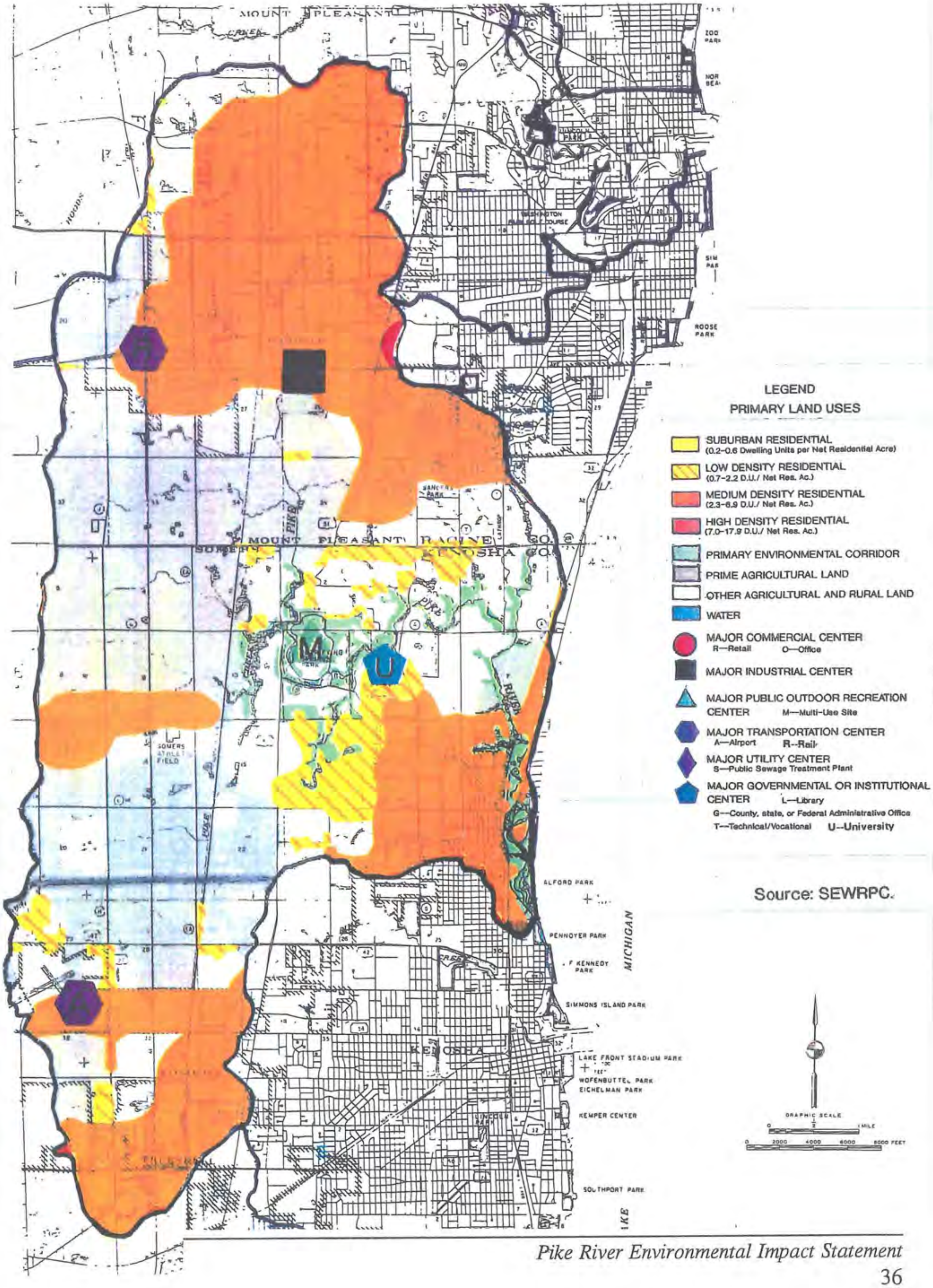


Table 2.15

EXISTING AND PLANNED LAND USE IN THE PIKE RIVER WATERSHED: ACTUAL 1985 AND PLANNED 2010[a]

Land Use Category	Existing 1985		Year 2010 Intermediate Growth				Year 1020 High Growth			
			2010		Change 1985-2010		2010		Change 1985-2010	
	Acres	Percen t	Acres	Percen t	Acres	Percent	Acres	Percen t	Acres	Percen t
Urban										
Residential	4,232	12.86	5,912	17.96	+1,680	+39.70	6,759	20.54	+2,527	+59.71
Commercial	214	0.65	283	0.86	+69	+32.24	316	0.96	+102	+47.66
Industrial	496	1.51	757	2.30	+261	+52.62	942	2.86	+446	+89.92
Transportation, Communication and Utilities[b]	2,795	8.46	3,581	10.88	+786	+28.12	3,939	11.97	+1,144	+40.93
Governmental and Institutional	699	2.12	754	2.29	+55	+7.87	783	2.38	+84	+12.02
Recreational	675	2.05	842	2.56	+167	+24.74	893	2.71	+218	+32.30
Subtotal	9,111	27.68	12,129	36.85	+3,018	+3312	13,632	41.42	+4,521	+49.62
Rural										
Agricultural and Related	20,022	60.84	17,843	54.22	-2,179	-10.88	16,558	50.31	-3,464	-17.30
Lakes, Rivers, Streams and			894	2.72	0	0				
Wetlands	894	2.72	905	2.75	-4	-0.44	894	2.72	0	0
Woodlands[c]	909	2.76	1,140	3.46	-835	-42.32	882	2.68	-27	-2.97
Open Lands	1,973	6.00					943	2.87	-1,030	-52.20
Subtotal	23,798	7232	20,780	63.15	-3,018	-12.68	19,277	58.58	-4,521	-19.00
Total	32,909	100.00	32,909	100.00	0	—	32,909	100.00	0	---

[a] As approximated by whole U.S. Public Land Survey one-quarter sections.
[b] Includes all off-street parking.
[c] Includes landfills, dumps, and extractive.

Source: SEWRPC.

on the existing flood elevations. Any increase due to development since then has not been determined or documented.

SEWRPC maps in Appendix C (Exhibits I and J) show the floodplain, or flood elevation, as it would be under the development conditions forecast for the year 2010. In 1980, according to PR 35, future development was expected to raise peak flood elevations by less than one foot above the then-current 1 percent chance-of-occurrence flood elevation.

Review of the current (1983-1993) floodplain maps provided by SEWRPC reveals that the existing floodplain is in most places nearly as extensive as the projected Year 2010 floodplain. The increase in flood elevation from 1980 to 2010 would range from "less than one foot" (SEWRPC, 1994) to about four feet. This increase is sufficient to cause numerous existing additional homes, including many recently built, to be included in the 2010 floodplain. Appendix D is a tabulation of the location and number of structures currently in the floodplain, existing structures that later will be in the floodplain under predicted Year 2010 development conditions and existing channel conditions.

Flooding

Whether floodplain development or flood elevation concerns were widespread or publicized as development proceeded during the first half of this century has not been documented. At times the opposite problem, very low flows, were reported and attributed to withdrawing water for crop irrigation.

By the 1960s, watershed water quality problems prompted the local SCS staff to recommend that local governments and landowners work together to establish a 300 foot-wide conservancy strip of permanent vegetative cover. News reports in 1969 note that there were an increasing number of complaints by landowners regarding the perceived increase in flooding downstream from development in Racine County (SCS, 1966).

In 1972, then-State Representative George Molinaro predicted that, in the absence of appropriate controls, runoff from Racine County land developments in the vicinity of STH 11 were going to create serious stormwater runoff problems downstream. Meanwhile, part of the lower Pike River floodplain was filled to accommodate construction on the Carthage College Campus, eliminating a significant area of floodwater storage above the mouth of the river.

From 1960 through 1978, nine "major flood events" (floods that have caused relatively heavy and widespread flood damage, significant damage to property, and disruption of normal community activities) occurred in the Pike River Watershed. Although actual damage amounts were not recorded for these floods, the most costly of these floods is believed to be one that peaked in June 1969. The SEWRPC flood economics sub-model produced an estimated damage amount of $820,000 (1980 dollars), for a flood whose recurrence interval was estimated at between once in 26 years to 29 years.

The average annual flood damage in the Pike River Watershed has been estimated to be between $215,000 (PR 35, p. 582) and $421,400 (PR 35, p. 159).[1] About 25 percent of this estimated damage amount, or $53,750 to $105,436, is for agricultural damages. $244,928 of the larger

[1] Estimates were adjusted to 1994 dollars. Original estimates calculated using 1980 economy.

estimated annual loss amount (nearly 60 percent) is for residential structure and contents damage. The flood damage risk for a "100-year" flood has been more recently estimated to be $291,540 (1994 dollars) (SEWRPC, 1994).

More recently, PR 35 noted that a number of homes and parts of an industrial site are within the regulatory floodplain (see Appendix D for a tabulation of houses in the existing floodplain). Some areas of farmland are subject to spring flooding. Likewise, residential yards often accumulate standing water; and water occasionally seeps into house basements.

A significant portion of the complaints from property owners about basement flooding, in particular, are reportedly caused by stormwater runoff, not flooding from the Pike River or its tributaries washing over their banks. Stormwater inundation results when stormwater runoff drains to low-lying areas before emptying to stream channels. The results are significant yard and basement flooding.

The proposed project is not intended to address directly this type of local drainage problem. Local grading changes and stormwater conveyance systems would be needed to do that, and the Mount Pleasant Stormwater Drainage District intends to pursue those problems once they know what the stream bottom elevation will be. The proposed channel enlargement is designed to provide the stream channel capacity necessary to safely convey the stormwater after it is discharged into the stream.[1]

RECREATIONAL USE

Recreational opportunities within the proposed project area along the upper Pike River and Pike Creek are little documented. The most probable reasons for this are the lack of public access, and the multiple effects of previous channelization and drainage. Within the project area, the only publicly-owned land consists of the playing fields of J.I. Case High School, and the lands purchased for development by Kenosha County (the Kenosha Auto Transport site), along upper Pike Creek.

Along the upper Pike River, there is some use of the bank as a dirt bike trail and thoroughfare along private land. A few road crossings offer pleasant visual relief from the appearance of intensive agricultural and industrial land uses. Along Pike Creek, a few road crossings provide views of the river's remaining natural scenic beauty, and a private nature center offers walking paths to the stream, as well as the visual interest of a floodplain forest that can also be viewed from STH 31. The areas possessing better habitat along both branches support the limited populations of sport fish and forage fish described in the DNR resource assessment. In places, both branches are either crossed or paralleled by large electrical transmission lines that detract from the natural scenic beauty of the stream corridor.

In the lower Pike River, angling opportunities have improved over the past 20 years. Though in the lower Pike River, this is due primarily to an intensified stocking program. Further expansion of angling opportunities is limited by restrictions on access to the water and degraded habitat.

Along the lower Pike River, the river supports canoeing in the estuary, summertime beach use at the mouth of the river and seasonal-to-year-'round use by waterfowl. The river and estuary also provide

[1] To underscore the link between channelization and stormwater management, SEWRPC staff have stated that the channel enlargement was needed in order to provide a "proper stormwater drainage system" to accommodate new development in the watershed (PRWC, 2/93).

visual enjoyment at several road crossings and a bicycle trail crossing. The banks of the lower Pike River provide a restricted thoroughfare along private property and a major pathway along the reach of the Pike River within Petrifying Springs Park, and on the University of Wisconsin-Parkside campus. A major road crossing near the mouth of the Pike River provides a view of the estuary, as well as a visual linkage between the stream and Lake Michigan.

Potential or existing recreational uses for the upper Pike River and Bartlett Branch and their corridors include wading, fishing, bait fish collection, trapping, hiking, enjoyment of natural scenic beauty, nature study, and others.

The Pike River corridor holds an appreciable scenic value when compared to the surrounding crop land and other landscapes. Along most reaches in the project area, minimally-sloping cropland stretches off to the horizon, with very little in the way of discernable fence rows, other elements of wildlife habitat or visual relief from monocultural crop fields, housing developments, industrial sites, and electric power transmission and distribution lines.

3.0 REGULATORY ENVIRONMENT

STATE (DNR) AND FEDERAL (COE) APPROVALS AND PERMITS, AND APPLICABLE STATUTES

Overall statutory authority for DNR involvement in the protection and management of navigable waters rests in Chapter 30 and Sec. 144.26, Wis. Stats., the navigable waters protection laws. Other, and more specific, authorities rest in a number of statutes and related administrative rules.

Most applicable state statutes authorize waterway alterations provided that "the department finds that the project will not injure public rights or interest, ...that the project will not cause environmental pollution... , ...and that no material injury to the rights of any riparian owners on any body of water will result..." Public interests can include all forms of navigation and related uses such as hunting, fishing, swimming, enjoyment of natural scenic beauty, relief from flooding and protection of water quality.

The types of proposed activities and the state statutes that govern these activities include:

State authorities:

- Dredging a navigable waterway requires a DNR permit, pursuant to Section 30.20, Wis. Stats.
- Grading in excess of 10,000 square feet requires a DNR permit under Section 30.19(1)(a), Wis. Stats.
- Relocating the channel of a navigable stream requires a DNR permit, pursuant to Section 30.195, Wis. Stats.
- Diverting the waters of a navigable stream requires a DNR permit, pursuant to Section 30.18, Wis. Stats.
- Any activity that affects water quality in wetlands must meet the standards in NR 103, Wis. Admin. Code.
- Culvert replacement or addition to convey navigable waters requires a DNR permit, pursuant to Section 30.18, Wis. Stats. (although these are most often addressed under a Memorandum of Understanding between DNR and the Wisconsin Department of Transportation).
- Enlargement of the channel of a navigable waterway requires a DNR permit, pursuant to Section 30.19, Wis. Stats.
- A connected enlargement of a navigable waterway requires a DNR permit, pursuant to 30.19(1)(b), Wis. Stats.
- Bridge replacement requires a DNR permit, pursuant to Sections 30.12 and 30.123, Wis. Stats., or concurrence under the DNR-DOT cooperative agreement [30.12(4)] and under Trans 207, Wisconsin Administrative Code.

- Placing riprap in a navigable waterway requires a DNR permit, pursuant to Section 30.12, Wis. Stats.

Local authorities:

- Construction within floodplains requires a permit from local zoning authorities under local floodplain zoning ordinances adopted pursuant to Section 87.30, Wis. Stats.

- Alteration of shorelands of navigable waters within the unincorporated areas of counties requires a zoning permit under a county administered ordinance, pursuant to Section 59.971, Wis. Stats.

- Alteration of shorelands of navigable waters within cities requires a zoning permit under a city administered ordinance, pursuant to Section 59.971, Wis. Stats.

- Some counties allow construction in unincorporated areas only upon issuance of a construction site erosion control and stormwater management permit, issued in compliance with an ordinance developed pursuant to Section 59.974, Wis. Stats.

- Some cities allow construction within their incorporated areas or extraterritorial areas only upon issuance of a construction site erosion control and stormwater management permit, issued in compliance with an ordinance developed pursuant to Section 62.234, Wis. Stats.

- Some villages allow construction within their incorporated areas or extraterritorial areas only upon issuance of a construction site erosion control and stormwater management permit, issued in compliance with an ordinance developed pursuant to Section 61.351, Wis. Stats.

- Any activity that alters a wetland that lies within a shoreland within a city requires a permit under a city administered ordinance, pursuant to Section 62.231, Wis. Stats.

Federal authorities:

- Any activity that alters in any way a wetland existing outside of a shoreland requires a permit under either a locally-administered shoreland/wetland zoning ordinance, or the U.S. EPA Section 404 wetland program administered by the U.S. Army Corps of Engineers, Waterways Section.

- Any activity that places fill or structures on the bed of a navigable interstate waterway requires a permit from the U.S. Army Corps of Engineers, Waterways Section.

Table 3.1:
Permits Required to Implement the Proposed Project

WATERWAY	PERMITTED ACTION	REQUIRED PERMIT
Bartlett Branch	Floodproofing Dike and structure floodproofing Culvert replacement	• No Chapter 30 permit is likely to be required. • Chapter 30.19 permit for grading in excess of 10,000 sq. ft. • 30.123 permit for replacement of culvert with bridges.
Waxdale Creek and Tributary to Waxdale Creek	No stream modifications proposed. (Pike River channel enlargement would eliminate the floodplain upstream to the Line Railway embankment.)	• No permits required.
Chickory Creek	No stream modifications proposed. (Pike River channel enlargement would eliminate the floodplain upstream to within .2 miles below the SOO Line Railway embankment.)	• No permits required.
Lamparek Ditch	No stream modifications proposed. (Pike River channel enlargement would eliminate the floodplain upstream to within .3 miles above the SOO Line Railway embankment.)	• No permits required.
Somers Branch	Structure elevation and floodproofing. (Pike River channel enlargement would not affect the present floodplain.)	• No Chapter 30 permit is likely required.

Table 3.1:
Permits Required to Implement the Proposed Project

WATERWAY	PERMITTED ACTION	REQUIRED PERMIT
Airport Branch and Tributary to Airport Branch[1]	Replacement of CP Rail System bridge, major channelization (0.9 miles),[2] and construction of a diversion channel from the vicinity of the Kenosha airport.	• 30.19 permit for airport diversion channel • 30.123/DOT/Trans 207 approval for bridge replacement.
Nelson Creek	No stream modifications proposed. (Pike River channel enlargement would not affect the present floodplain.)	• 30.19 permit for channel enlargement • No permits required.
Sorenson Creek[3]	Possible structure floodproofing and elevation at CTH KR upstream to abandoned North Shore Line ROW. Possible structure floodproofing & elevation, possible culvert replacement[4] at Chickory Rd. upstream to Pleasant Lane.	• No Chapter 30 permit is likely required. • 30.123 permit for culvert and bridge replacement.
Kenosha Branch	No stream modifications proposed.	• No permits required.

[1] The tributary to Airport Branch was moved without the statutorily-required permit, allegedly to accommodate proposed airport expansion. DNR staff performed an initial site investigation in the summer of 1994 and concluded not to take further action.

[2] Channel enlargement is proposed to accommodate stormwater runoff from a proposed major industrial park expansion and from the proposed diversion channel from the vicinity of the Kenosha airport.

[3] Bank stabilization work was completed in 1992. Flood flows and elevations were not affected.

[4] Culvert replacement is expected to remove the floodplain from all homes along Sorenson Creek, upstream of Chickory Road.

Table 3.1:
Permits Required to Implement the Proposed Project

WATERWAY	PERMITTED ACTION	REQUIRED PERMIT
Pike Creek	Major channelization from CTH E upstream to 1/2 mile north of ST 50.	• 30.19 permit for channel enlargement. • 30.123 permit for bridge replacement. Some may be owned by DOT.
	Detention storage reservoir and channel debrushing.	• Chapter 31 approval for water control (berm). • Z-1 Kenosha County shoreland zoning approval for channel debrushing[1].
	Replacement of five culverts with a clear-span structure, or maintenance of existing structure. (Bridge over Pike Creek near Somers solid waste transfer station).	• 30.123/DOT/Trans 207 approval for five bridge replacements. • 30.123 permit for bridge construction.
Upper Pike River	Major channelization.	• 30.19 permit for channel enlargement. • 30.195 permit for channel relocation. • 30.12 or 30.123 DOT/Trans 207 approval for replacement of 10 bridges.
	Detention storage, structure floodproofing and elevation.	• Possible 30.19 permit for detention basin within 500 feet of streambank. • 30.19 permits for grading > 10,000 sq. ft • Chapter 31 approval for four water control structures (dams). • Z-2 Racine County Shoreland Zoning variance and debrushing banks. • 30.19 permits for grading > 10,000 sq. ft. for dike construction • 30.12 or 30.123 DOT/Trans 207 approval for replacement of ten bridges.

[1] Debrushing has already been done once in the early 1990s.

Table 3.1:
Permits Required to Implement the Proposed Project

WATERWAY	PERMITTED ACTION	REQUIRED PERMIT
Lower Pike River	Bridge replacement. Possible Structure floodproofing and elevation. Diking (possible 3.25 miles of dikes, at landowner discretion)[1]	• 30.12 or 30.123 DOT/Trans 207 approval for replacement of bridges. • No permits required. • 30.19 permits for grading > 10,000 sq. ft. for dike construction.
Pike River Estuary	Jetty construction (steel pile jetties).	• 30.12 permit for jetty construction. • 30.20 permit for periodic dredging.

[1] The dikes were proposed in PR 35 to minimize agricultural losses from flood events up to and including the 10-year recurrence interval flood. PR 35 noted that the area affected was likely to be converted to urban uses in the foreseeable future, and that the present floodplain would then be held in open space uses to eliminate the possibility of future flood damages. Construction of dikes would not be sponsored by local governments, but would be an option for the owners of agricultural floodplain land.

4.0 DESCRIPTION OF THE PROPOSED PROJECT

The term "Proposed Project" as used in this EIS refers to those proposed actions in the floodland management discussion in PR 35. The proposed project relates to the measures that would physically alter the hydrology and hydraulic characteristics of the Pike River Watershed. The proposed project does not address water quality improvements, acquisition or development of upland parks and wildlife areas, or general land use that are also a part of the SEWRPC plan. However, it is important to note the proposed project affects and, in turn, is affected by the water quality and land use elements described in PR 35.

In summary, the proposed project recommends the following actions:

- Widening and deepening approximately 11.5 miles of the channels of the Upper Pike River, Pike Creek, the Airport Branch of Pike Creek, and the Tributary to Airport Branch;
- Construction of 500 ft. of flood control dikes and the option for constructing 3.25 miles of additional dikes;
- Channel cleaning and debrushing activities;
- Elevating or floodproofing 19 residential, commercial or institutional structures, where floodplain reduction through channel modifications is ineffective in removing the structures from potential flood damage;
- Replacement of 16 bridges to accommodate channel modifications and increased runoff and flows, and five bridges due in part to deterioration. One bridge would be removed;
- Mitigating to varying degrees the instream and upland habitat lost during construction of channel and other environmental corridor modifications;
- Creating two instream or on-line stormwater detention areas designed to limit increases in flood elevations caused by upstream channel modifications along the Pike River and Pike Creek;
- The construction of two parallel jetties and the periodic dredging of the channel bottom between the jetties to maintain channel flow capacity at the mouth of the Pike River, and to abate the flooding problems caused by the formation of a sandbar across the mouth of the Pike River.

FLOODLAND MANAGEMENT AND THE PROPOSED PROJECT

The proposed project calls for abating flood damages to roughly 800 acres of agricultural land and 44 structures in the existing floodplain. Under the proposed project, future flood damages, resultant of increased runoff from urban development, would be resolved, as well. So, the proposed project would mitigate flood damage in the 2010 floodplain to a total of 850[1] acres of agricultural land and 50

[1] Approximately 800 acres of the existing floodplain are employed in agricultural land uses. In the 2010 floodplain, 50 additional acres of agricultural land would be affected.

an average height of about four feet, and a maximum height of about six feet. Water impounded behind the dike from local drainage would be permitted to be dissipated slowly through infiltration into the groundwater reservoir.

Lower Pike River Subwatershed

- The option to construct a series of low level dikes along 3.25 miles of the main stem of the Lower Pike River, both upstream and downstream of the Kenosha Country Club in order to abate agricultural crop damages.

[**NOTE:** The plan does not specifically recommend that these dike systems be constructed because of a long-term commitment to convert the affected floodlands from rural to urban use. However, such a long-term commitment to urban land use development should not be construed to prohibit farmers along these stream reaches from individually or collectively undertaking the construction of low level dikes to abate agricultural flood damage problems so long as the land continues to be farmed. Such a system of dikes could be designed to prevent flooding from up to and including the 10-year recurrence interval flood. In the long term, however, the plan envisions that the entire 100-year recurrence interval floodplain be maintained in essentially natural, open uses as the lands adjacent to the lower Pike River become urbanized over the next several decades. In some cases, the nature of the floodplain is such that wetlands will be reestablished along the stream system and the primary environmental corridor along the Lower Pike River will be consequently enriched. Whether or not to construct the low level dikes in the interim for agricultural land protection would be a decision to be made by the farmers involved either individually or collectively. SEWRPC, 1983.]

3. **Channel cleaning and debrushing activities.**

Pike Creek Subwatershed

- The Proposed Project recommends that channel cleaning and debrushing extending 1.8 miles from the confluence with the Pike River in Petrifying Springs County Park upstream to the confluence with Somers Branch. Although this activity has already been completed, routine cleaning and debrushing will be required to abate flooding.

4. **Elevate or floodproof 19 residential, commercial or institutional structures, where floodplain reduction through channel modifications is ineffective in removing the structures from potential flood damage.**

Pike Creek Watershed

- The floodproofing[1] of three structures and the elevation of two additional structures along the Somers Branch upstream of the Chicago, Milwaukee, St. Paul & Pacific railroad crossing.

Upper Pike River Watershed

- The floodproofing of seven structures and the elevation of four additional structures along the Bartlett Branch downstream of Spring Street.

[1] Methods of floodproofing structures are outlined in Floodproofing Regulations, U.S. Army Corps of Engineers, Washington, DC (March 31, 1992).

Lower Pike River Subwatershed

- The floodproofing of the Carthage College Field House (completed) and the former Valley Restaurant and Supper Club and the elevation of one residence located just upstream of CTH G.

5. **Replacement or removal of 22 bridges. (Fifteen bridges would be replaced to accommodate channel modifications and increased runoff and flows; six bridges would be replaced because of deterioration and one bridge removed.)**

Pike Creek Subwatershed

- The Proposed Project channel modifications for Pike Creek would require the replacement of nine existing bridges across the Pike Creek: STH 142; STH 158; CTH E; CTH K; the Chicago, Milwaukee, St. Paul & Pacific railroad bridge downstream of CTH K; the Town of Somers solid waste transfer station bridge upstream of CTH L; and three farm bridges upstream of STH 142.

- The Proposed Project channel modifications for the Airport Branch would require replacement of the Chicago, Milwaukee, St. Paul & Pacific railroad crossing of the Airport Branch.

Upper Pike River Subwatershed

- The Proposed Project would require the replacement or modification of eleven existing bridges across the Upper Pike River: STH 11, STH 20, STH 31, CTH KR, Oakes Road, Spring Street, Braun Road, two private bridges upstream of STH 20, a farm bridge downstream of STH 11, and a farm bridge downstream of the confluence with Lamparek Ditch. In addition, the abandoned Chicago, Milwaukee, St. Paul & Pacific railroad crossing upstream of STH 11 would be removed.[1]

Lower Pike River Subwatershed

- The Proposed Project would require the replacement of the existing Chicory Road crossing of Sorenson Creek with a new clear span bridge having an opening of about 30 feet. The new bridge would eliminate the backwater effects of the existing hydraulically inadequate crossing and thereby resolve upstream structure flooding problems.

6. **Mitigate or improve to varying degrees the instream and upland habitat lost during construction of channel and other environmental corridor modifications.**

Pike Creek Subwatershed

- Habitat mitigation and improvement measures in Pike Creek include the incorporation of a low-flow channel with pool and riffle areas constructed within the flood control channel downstream of STH 50 to CTH E, and the preservation of the existing channel downstream from CTH E to the confluence with the Pike River.

[**NOTE:** In addition to the channel refinements, a preliminary delineation has been made of a Pike Creek parkway and recreation trail. This trail would connect Petrifying Springs County Park

[1] As of spring, 1994, this abandoned railroad right-of-way was being well used for motorized trail biking, of-road bicycling, and walking. The Town of Mount Pleasant may want to investigate the advisability and means of maintaining or upgrading this stream crossing.

with a proposed community park located in the Village of Pleasant Prairie. In general, this parkway incorporates the proposed Pike River channel along with an adjacent 50- to 200-foot-wide buffer. Selected natural resource restoration areas would be incorporated into the proposed parkway. Some of these areas are located adjacent to the channel and have been identified as having hydric soils and/or residual floodplain. These areas would be restored to wetland or native upland grasslands.

<u>**Upper Pike River Subwatershed**</u>

- For the Upper Pike River, these refinements include the incorporation of a low-flow channel within the flood control channel, the addition of pool and riffle areas within that low-flow channel, and the preservation of existing channel meanders along that reach between the confluence with Pike Creek and CTH KR.

[**NOTE:** Included with the channel refinements is a preliminary delineation of a Pike River parkway corridor similar to that called for under the park and open space plan for the Town of Mt. Pleasant. In general, this parkway incorporates the proposed Pike River channel along with an adjacent 50- to 100-foot-wide buffer for recreational trail purposes. Natural resource restoration areas have also been incorporated into the proposed parkway. These areas are located adjacent to the channel and have been identified as having hydric soils and/or residual floodplain. These areas would be restored to wetland or native upland grasslands.]

<u>**Lower Pike River Subwatershed**</u>

- There are no proposed river channel or environmental corridor restoration practices proposed for the Lower Pike River subwatershed.

7. **Create two instream or on-line stormwater detention areas designed to limit increases in downstream flood elevations caused by upstream channel modifications along the Pike River and Pike Creek.**

<u>**Pike Creek Subwatershed**</u>

- Construct an on-line floodwater storage basin along Pike Creek about 1,100 feet upstream (south) of CTH E. The basin would serve to limit downstream flood discharges and attendant stages to existing channel conditions and existing development levels. The basin would need to store an estimated 460 acre-feet of water. This basin would contain a low-flow channel as described above along the alignment of the existing Pike Creek channel. As with the flood control channel, wetland vegetation would be established along the bottom and lower side slopes of the basin, with medium growing grasses and forbs planted along the upper slopes.

<u>**Upper Pike River Subwatershed**</u>

- Construct an on-line, floodwater storage area by enlarging the flood control channel along an approximately 2,350 foot long reach of the Pike River beginning 250 feet upstream of CTH KR. This storage facility would extend through the site of a proposed community park, to be located at the confluence with Lamparek Ditch. The added storage provided would limit downstream flood discharges and attendant stages to Year 2000[1] planned land use and existing

[1] SEWRPC staff have stated that since actual, current growth rates have fallen short of those predicted in 1980 for the present, the planned channel capacity would be of sufficient capacity to convey the predicted Year 2010 level-of-development flood flows.

channel condition levels. A total storage volume of about 400 acre-feet would be required at this location during a 1% chance-of-occurrence flood.

8. **The construction of two parallel jetties and the periodic dredging of the channel bottom between the jetties to maintain channel flow capacity at the mouth of the Pike River on the Lake Michigan shoreline.**

These measures would abate the flooding problems that are caused by the formation of a sandbar across the mouth of the Pike River.

The pair of jetties proposed to be constructed along the bed of Lake Michigan would cover approximately 3,200 square feet of Lake Michigan bottom. This assumes that each jetty is approximately 2 feet wide, with inner walls lined with rip-rap covering an area of 30 feet by 50 feet out from the shoreline.

RECOMMENDED NON-STRUCTURAL MEASURES OF THE PROPOSED PROJECT

Recommended non-structural measures include recommended standards relative to bridge replacement to ensure that major streets and highways remain operable during flood events. Non-structural measures also include several supplemental measures intended to minimize the monetary losses associated with flooding, including participation in the Federal Flood Insurance Program and continuation of desirable lending institution and realtor policies concerning the sale of riverine properties. Maintenance of a basic cooperative stream gaging program is also recommended.

Finally, the plan recommends that each of the units of government in the watershed carefully review their floodland zoning regulations to ensure that such regulations complement the recommended watershed land use plan element and are coordinated with the structural flood control measures recommended in the plan. In general, those floodlands lying within the 100-year recurrence interval flood hazard lines under year 2000 planned land use conditions that are presently neither developed for urban use nor committed to such development by the recordation of land subdivision plats and the installation of municipal improvements should be zoned so as to prohibit incompatible future urban development.[1] Those existing urban land uses in the floodlands scheduled to be floodproofed, elevated, or protected through future structural flood control measures should be placed in a flood hazard district until implementation of the recommended flood control measures, at which time the lands should be appropriately rezoned.

[1] This residual floodplain area would comprise approximately 20% of the existing floodplain, once the channel was deepened and widened.

5.0 ALTERNATIVES TO THE PROPOSED PROJECT

Three Alternatives were developed based on recommendations prepared by WDNR resource management, water quality, and water regulatory staff. The Department resource management recommendations were presented in the WDNR 1994 report entitled *A Resource Assessment for the Pike River Watershed, with a Set of Management Recommendations* and WDNR 1994 *Stream Classification Report* for the Pike River Watershed.

The development of alternatives to the proposed project also considered public comments expressed at a Department sponsored EIS Open House in July 1992. Out of 62 individual comments recorded at the Open House, 25 called for abating sources of pollution, halting additional loss of wetlands or stream restoration. Eleven comments favored flood control alternatives which do not involve channel enlargement, eight felt that either the channel alterations or Lake Michigan jetties were necessary, while seven specifically opposed channel alterations or Lake Michigan jetties.

To the greatest extent possible, the alternatives were also developed to be consistent with park and open space plans developed by the SEWRPC for communities in the Pike River Watershed. These plans included the Community Assistance Planning Report 199 entitled *A Park and Open Space Plan for the Town of Mt. Pleasant, Racine County, Wisconsin* as adopted by the Town Board of Supervisors of Mount Pleasant in 1991, and SEWRPC Community Assistance Planning Report 131 entitled *A Park and Open Space Plan for Kenosha County, Kenosha County, Wisconsin.*

CONSIDERATIONS IN DEVELOPING THE ALTERNATIVES

With the above considerations, Department staff developed the guidelines below. Specifically, a viable alternative to the proposed project should:

1. To the greatest extent possible, accomplish the same level of flood damage risk reduction for planned land use conditions as the Proposed Project, recognizing that some land use, development and storm water management plans may need to be adjusted to meet the needs of natural resource protection.

   Alternative floodland management measures are based upon the experience-supported premise that river and floodland management should be practiced through sound land use management. Beside preventing flood hazard damage to structures, there are other environmental reasons for avoiding urban development in floodplains and environmental corridors. According to SEWRPC (1992), "The exclusion of urban development from these corridors will also help to prevent the creation of serious problems as air and water pollution, wet and flooded basements, building and pavement foundation failures, and excessive infiltration and inflow of clear water into sanitary sewerage systems." These areas, while not well suited for urban development, are prime locations for park and environmental corridor areas. Brookes (1988) and Nunnally (1978) state that massive channelization projects may not be necessary when flood magnitude and frequency can be abated through engineered reduction in runoff volumes and exclusion of urban development from floodplains.

2. Avoid or minimize the use of structural flood control practices, including widening and deepening of the channel, to the fullest extent possible. Both environmental impacts and uncertainty of flood protection by structures requiring maintenance have led to a state policy of using structural flood controls only in the absence of alternatives (Executive Order 132, January 1992; DNR Secretary's Guidance Memo, November 23, 1987).

Guideline 2 was included because extensive research has concluded that stream channelization or rechannelization can result in a variety of negative environmental impacts to streams and their riparian corridors (Shields and Sander, 1986; Brookes, 1988). In addition, this guideline also recognizes that projects which rely on structural modifications to the stream channel, bank and floodplain have the potential to fail, and in the long term may create or worsen other flooding and environmental problems. These problems have, in some instances, resulted in additional long-term flood control maintenance and environmental mitigation costs (Keller, 1975 and 1978; Wilson, 1968).

Additionally, one of the recommendations stemming from *A Resource Assessment for the Pike River Watershed, with a Set of Management Recommendations* (WDNR, 1994) and the *Stream Classification Report for the Pike River Watershed* (DNR, 1994) is that the Pike River and its tributary channels not be further channelized because of the risk of long-term negative environmental impacts associated with large-scale stream channelization projects.

Recent examples of flood hazard mitigation projects, current or on-going, that do not use or greatly limit the amount of structural modifications to the stream channel, stream banks or floodplain include such places as Camp and Center lakes (Kenosha County), Darlington, and Eau Claire, Jefferson and Pierce Counties, Wisconsin; Beatrice, Nebraska; Austin, Minnesota; and elsewhere in the United States (IFMRC, 1994).

3. Include opportunities to abate the negative physical, chemical and biological impacts of urban nonpoint sources of pollution, including stormwater.

   Guideline 3 was developed in recognition that new urban development may result in additional nonpoint sources of pollution being discharged to the Pike River Watershed and Lake Michigan if a full range of urban stormwater management practices are not implemented. Urban nonpoint source pollutants of concern include conventional pollutants (i.e. sediment and bacteria) and toxic pollutants (i.e. heavy metals and polynuclear aromatic hydrocarbons).

4. Alternatives should not exclude opportunities to improve fish and wildlife habitat in the Pike River Watershed.

5. Alternatives should be consistent with other local or regional recreation and open space plans.

ALTERNATIVE 1: NON-STRUCTURAL FLOOD HAZARD MITIGATION

This alternative would require acquisition, floodproofing, or elevation of as many as 113 existing structures, based on the Year 2010 floodplain. Development in the floodplain would be regulated to the Year 2010 flood elevation. Alternative 1 assumes the elevation and spatial extent of the 2010 floodplain will be defined by SEWRPC's projected Year 2010 land use patterns and the existing stream channel.

A more detailed description of Alternative 1 floodland management measures is presented below:

1. Regulate development in the floodplain to the anticipated Year 2010 flood elevation. For planning purposes, the Year 2010 floodplain is assumed to be the floodplain estimated by SEWRPC under their projected Year 2010 land use conditions and existing channel conditions.

The regulated floodplain should apply to the Pike River as well to all its navigable tributaries. Future flood hazard mitigation would be accomplished by adopting the map of the Year 2010 floodplain, and enforcing local floodplain zoning ordinances.

2. To the fullest extent possible, a local government-property owner partnership would acquire, floodproof, or elevate structures within the Year 2010 floodplain. Depending upon the actual amount of development that occurs in the watershed, up to 113 homes would be acquired, floodproofed or elevated. Two of the structures are located in the lower Pike River subwatershed; 39 are located in the upper Pike River subwatershed; 51 structures are located in the Bartlett Branch subwatershed; and 21 structures are located in the Pike Creek subwatershed.

3. As a local government option, stormwater management measures could be included to relieve flooding and reduce nonpoint sources of pollution from new urban developments. The number of homes to be floodproofed, elevated or moved could be significantly reduced by this option.

4. Habitat improvement measures could be included in this alternative. For example, some flood lands could be planted to a diverse mix of native floodplain species. Some wetland areas could be restored. The existing channel could be improved through the use of a variety of instream devices, substrate materials, and bank stabilization techniques.

Alternative 1 is compatible with a number of other management activities, which if implemented, would improve the natural resource base in the Pike River Watershed. At the option of local governments, implementing a comprehensive stormwater management plan would minimize the predicted increase in floodplain area and improve stormwater quality. This alternative would not exclude the incorporation of "buffer strips" along urban and rural stream reaches to abate polluted stormwater runoff and improve surface water quality. Fish and aquatic life, and wildlife habitat improvement measures could be included, as well as an option to acquire and develop land for park and recreational uses.

ALTERNATIVE 2: FLOOD HAZARD MITIGATION WITH STORMWATER MANAGEMENT

This alternative would require the acquisition, floodproofing or elevation of 55 existing structures, based upon their presence in the existing floodplain. To protect water quality from new sources of polluted urban runoff, and to maintain the existing flood elevation (defined by present runoff rates and volumes, and existing channel conditions) while allowing future development, municipalities within the Pike River Watershed would be required to implement system-wide stormwater management. Selective and limited enlargements to the upper bank may be considered if stormwater management is shown to be ineffective in abating structural flooding hazards. Habitat and wetland mitigation would be required along all enlarged upper bank reaches. Additionally, selective and limited channel clearing and debrushing could be completed to remove major blockages to flood flows.

A more detailed description of Alternative 2 floodland management measures is presented below.

1. Complete and implement a comprehensive watershed-wide stormwater management plan which includes stormwater quantity and quality elements for *all new development* based upon anticipated Year 2010 land use conditions.

- The water quantity element would maximize upland stormwater storage capacity and infiltration for all proposed (1995-2010) development to prevent or greatly limit any increase in the existing (determined by Year 1995 land use and runoff, and existing channel conditions) floodplain elevations using centralized storage facilities and stormwater conveyance,[1] with limited on-site stormwater detention. Detention sites would be designed to prevent or minimize potential problems with weed growth, sedimentation, bank erosion, and algae growth.

- The water quality element would abate contaminated urban runoff by implementing urban stormwater runoff best management practices for all new development. Methods would include combinations of engineered and non-engineered measures for planned urban developments. Existing development may be retrofitted as an on-going option, where good results can be achieved at a reasonable cost.

2. Regulate anticipated Year 2010 land use to existing (1995) floodplain conditions. This should apply to the Pike River and all its navigable tributaries. Mitigation of future flood hazards would be accomplished by adopting the map of the existing floodplain, and enforcing local floodplain zoning ordinances.

3. Review the current land use plan for the Pike River Watershed and identify opportunities to guide land uses in ways that would maintain or reduce the volume and pollutant load of stormwater generated by new development. To the extent they may not already have done so, local governments could implement controls for all future development. Examples of these controls may include:

   - Require all new or planned development to maintain runoff rates and volumes equal to those of existing land use conditions.

   - For all planned developments, require the incorporation of site designs that minimize impervious road surfaces and storm water runoff, and maximize open space. Examples include "cluster housing" or other developments that require greater housing densities, narrower streets, more open space, and greater self-sufficiency in design and character in new neighborhoods;

   - Improved implementation of local erosion control ordinances and other nonpoint source pollution controls, especially regarding lawn care, yard wastes and other compostables, road salt, pet wastes, parking lot and industrial site runoff, street sweeping and storm sewer catch basin cleaning.

[1] This would differ somewhat from the per-parcel detention policy supported by the Kenosha County Land Conservation Committee, in that one common detention site could serve several parcels of land zoned for development, a concept that should provide both more developable land per parcel, and slightly larger areas of contiguous open space.

- Cooperation with state and federal programs that help control agricultural and other rural nonpoint sources of pollution.[1]

4. To the fullest extent possible, acquire, floodproof, or elevate up to 55 structures within the existing floodplain.

5. Provide an option for additional flood storage capacity and conveyance using minimal floodway overbank enlargement utilizing a conventional two-stage flood channel. This option is offered in case the regulation and management of storm water runoff rates and volumes is shown not to be entirely effective in reducing flood damage risks.

   This option is similar to the Proposed Project, but differing in one significant way. Alternative 2 only considers widening the floodplain above the 2-year flood elevation (hereafter referred to as the upper bank). No excavation of the existing channel sideslopes below the 2-year flood elevation (hereafter referred to as the lower bank) or of channel bottom is proposed. Enlargement along one bank is preferred to minimize erosion and habitat disturbance. To the greatest extent practicable, enlargements bordering wetlands should be avoided. This approach has been offered as an alternative to channel realignment (deepening and widening) flood control projects by Dobbie et al., 1971; Nunnally, 1978; Hinge and Hollis, 1980; Jewel, 1981; Wojcik, 1981; Paynting, 1982; Weeks, 1982; and Brookes, 1988. Selective channel enlargement limits the impacts to wildlife, and fish and aquatic life resources generally associated with channel realignment through deepening and widening (Soil Conservation Service, 1977).

6. Mitigate habitat disturbed as a result of constructing enlarged upper banks.

7. Selective and limited channel cleaning and debrushing activities as needed to resolve major drainage problems are proposed along the Pike River or its tributaries.

   Guidelines have been developed which allow for improved channel hydraulic conveyance, while at the same time preserving sufficient amounts of bankside vegetation for bank stability, and fish and wildlife habitat (Gregory and Stoke, 1980; Shields and Nunnally, 1984; and AFS, 1992).

8. Construct two parallel jetties and periodically dredge the channel bottom between the jetties to maintain channel flow capacity at the mouth of the Pike River on the Lake Michigan shoreline. These measures would abate the flooding problems that are caused by the formation of a sandbar across the mouth of the Pike River.

Consistent with the recommendation included in the Proposed Project, Alternative 2 could include the option for constructing a 500 ft. dike along the Bartlett Branch if additional floodplain analysis indicates that the dike is a cost effective means of reducing flood damages. Based on existing Year 1995 land use conditions and floodplain elevations, there may be between 3 and 51 structures which could be protected from the 100-year flood event by constructing the 500 ft. dike. The actual number of affected structures would be dependent on the amount of development and resulting increase in runoff and flood elevation which has occurred since 1980. According to SEWRPC, dike construction

[1] In 1991, the Pike River received a very high rating using eligibility criteria under the Nonpoint Source Pollution Abatement Program.

would protect 3 structures based on Year 1980 land use and flood elevations, and 51 structures would be protected from flooding under Year 2010 land conditions use and flood elevations.

Alternative 2 is compatible with a number of other management activities, which if implemented, would improve the natural resource base in the Pike River Watershed. At the option of local governments and land owners, "buffer strips" or "filter strips" could be established along urban and rural stream reaches to abate polluted stormwater runoff and improve surface water quality. In addition, fish and aquatic life, and wildlife habitat improvement measures could be included, as well as an option to acquire and develop land for park and recreational uses.

Alternative 3: No Action

A "no-action" alternative was also selected for review. Chapter NR 150, Wis. Adm. Code requires that the no action alternative be considered in any analysis of impacts.

Hereafter, the no-action alternative as used in this EIS assumes that none of the recommended structural elements of the Proposed Project would be implemented to resolve the existing or anticipated land use flooding problems in the Pike River Watershed. As detailed under the "No-Action" alternative below, it does not preclude voluntary landowner activities that could be accomplished without permits, technical assistance, or financial participation of any unit of government.

The "No-Action" alternative assumes that:

1. None of the 11.5 miles of the of the channels of the Upper Pike River, Pike Creek, the Airport Branch of Pike Creek, and the Tributary to Airport Branch would be deepened or widened.
2. None of the 500 ft. of flood control dikes proposed for Bartlett Branch or the 3.25 miles of optional dike proposed for the lower Pike River would be constructed.
3. No maintenance channel cleaning and debrushing activities would be conducted.
4. None of the 113 residential, commercial or institutional structures anticipated to be present in the Year 2010 floodplain would be floodproofed or elevated.
5. None of the 16 hydraulically significant bridges would need to be replaced for purposes of flood abatement.
6. None of the proposed mitigation of fish, aquatic life or wildlife habitat would be constructed or required. The option for habitat improvement measures is not included under this alternative.
7. Neither of the two instream or on-line flood water detention areas along the Pike River and Pike Creek would be constructed.
8. The two parallel jetties proposed to be constructed at the mouth of the Pike River would not be constructed and no periodic dredging would take place.

6.0 IMPACT ANALYSIS OF THE PROPOSED PROJECT

This chapter will discuss the probable environmental and other impacts of implementing the Proposed Project. In review, the Proposed Project recommends:

- widening and deepening approximately 11.5 miles of the channels of the Upper Pike River, Pike Creek, the Airport Branch of Pike Creek, and the Tributary to Airport Branch;

- construction of 500 ft. of flood control dikes and the option for constructing 3.25 miles of additional dikes;

- channel cleaning and debrushing activities;

- elevating or floodproofing up to 12 residential, commercial or institutional structures, where floodplain reduction through channel modifications is ineffective in removing the structures from potential flood damage.

- replacement of 16 bridges to accommodate channel modifications and increased runoff and flows, and five bridges due in part to deterioration. One bridge would be removed;

- mitigate or improve the instream and upland habitat lost during construction of channel and other environmental corridor modifications;

- creating two instream or on-line stormwater detention areas designed to limit increases in flood elevations caused by upstream channel modifications along the Pike River and Pike Creek;

- the construction of two parallel jetties and the periodic dredging of the channel bottom between the jetties to maintain channel flow capacity at the mouth of the Pike River, and to abate the flooding problems caused by the formation of a sandbar across the mouth of the Pike River.

The Proposed Project does not exclude the option of implementing a more comprehensive stormwater management program which could provide water quality improvements.

The 11.5 miles of Pike Creek and the upper Pike River proposed to be deepened, widened and relocated, have historically been channelized. As a result, many of the most severe impacts of stream channelization have already occurred, or continue to impact, those streams. Although the impacts of channelization on natural streams is documented in the literature (including impacts to the Pike River Watershed), there is little information available on the negative impacts of rechannelizing already historically channelized river systems. Despite the limited information on the impacts of stream rechannelization, the Proposed Project may have, to varying degrees, impacts similar to channelization due to the nature of the activity (i.e. construction and erosion) (Brookes, 1988).

The Proposed Project includes a refinement to the Floodland Management element of the Pike River watershed plan (PR 35). This refinement identifies actions to mitigate the effects of the Proposed Project, or provide for improvements, over existing stream and upland habitat conditions. The mitigation plan emphasizes partial replacement of the fish and aquatic life physical cover destroyed through channelization of the upper Pike River, Pike Creek and Airport Branch. The mitigation plan includes the construction of a meandering low-flow or pilot channel within the much larger flood channel; construction of pools and riffles; installation of fish habitat structures; and re-vegetating stream channels with wetland plant species. An option for a constructing open space buffer strips also is included.

The refinement also includes a preliminary delineation of a parkway along the upper Pike River and Pike Creek. Although the parkway may not be considered integral to implementing the major actions of the floodland management, it does provide additional opportunities to restore park and open space, and wildlife amenities to the Pike River Watershed. Therefore, a separate assessment of the conceptual parkway's environmental effects is provided.

LAND USE AND FLOODPLAIN BOUNDARY

The Proposed Project is based upon a floodplain initially defined by anticipated Year 2010 watershed land use and existing channel conditions. Defined by these conditions, the 2010 floodplain would include 2,370 acres. The Proposed Project recommends channelizing 11.5 miles of stream channel as a means of reducing both flood elevations and the area in the floodplain. Channelization, in concert with other floodland measures, would reduce the 2,370 acre floodplain by approximately 1,187 acres or 50 percent.

Of the approximately 1,187 acres which would be removed from the floodplain, approximately 680 acres (57%) is proposed to be developed in urban land uses. Specifically, 530 acres would be converted to residential uses and 150 acres to commercial or industrial land uses. Approximately 197 acres (16%) of floodplain is proposed to remain or be managed as open space, wetland or other environmental corridor land uses. This is a net increase of 149 acres over existing floodplain open space, wetland or environmental corridor land use conditions. Approximately 995 acres (54%) would remain in agricultural land uses, or a net decrease of 849 acres over existing floodplain land use conditions. Approximately 360 acres are considered "prime" agricultural lands. The net increase of 149 acres of land devoted to open space land uses will provide additional wildlife habitat in the Pike River Watershed.

Effects of Buffer Strips

Open space buffer strips would provide an increase in the amount of open space between the stream and lands that are presently agricultural uses. It is not apparent if buffer strips are proposed to be included along all of the urban developed areas, most notably the reach located in Mount Pleasant. It is assumed that the buffer strip acreage is included in the 149 acre net increase in open space land uses identified above.

Effects of Mitigation Measures

The proposed mitigation actions would not substantially affect floodplain land use conditions.

FLOODING, DRAINAGE AND SAFETY HAZARDS

Following the Proposed Project, structural flood damages and related monetary and social costs would be reduced for 113 structures located in the Year 2010 floodplain. In summary, 39 of these structures are located in the upper Pike River subwatershed; 2 structures in the lower Pike subwatershed; 21

structures in the Pike Creek subwatershed; and 51 in the Bartlett Branch subwatershed. Channelization and bridge replacement would remove 50 of the 113 structures from primary flooding, and 12 of the 113 structures would be floodproofed or elevated. The 500 ft. dike along the Bartlett Branch would remove 51 of the 113 structures from primary flooding. The project would reduce, but not eliminate, flood damages related to local drainage problems. Along the lower Pike River, the optional 3.25 miles of dike would provide flood relief to low-lying agricultural and open space floodlands (a golf course) at the 10-year recurring flood interval[1].

Channelization, and consequent bridge replacements, are also expected to have the affect of decreasing the frequency and magnitude of flood flows and stages. Thus, flooding along bridges in the project area is expected to occur less often. During the design flood (floods having a 1% chance of occurring in any year), the Proposed Project channel conditions would allow for safer vehicular passage than existing conditions.

The Proposed Project's flood control measures (primarily as a result of channelization and bridge replacement) will increase flood flows along the upper Pike River, Pike Creek and the Airport Branch upstream of the two proposed on-line flood detention ponds. These increases are expected to occur independent of proposed land use changes and increases in stormwater runoff (Table 11). Compared to existing channel conditions, the proposed flood control measures will increase 100-year flood flows in the upper Pike River from 2,020 cfs to 2,260 cfs or 11 percent. The increases in flood flows are more substantial in Pike Creek and the Airport Branch. Compared to existing channel conditions, the proposed flood control measures will increase 100-year flood flows in Pike Creek from 1,250 cfs to 2,370 cfs or 90 percent, and from 355 cfs to 1,485 cfs or 318 percent in the Airport Branch. Peak flood flows and water elevations in the Pike River (down stream of the proposed detention ponds) will be mitigated through construction of the flood detention ponds on the upper Pike River and Pike Creek. The ponds may extend the duration of flood flows in the Pike River downstream of the confluence with Pike Creek and the upper Pike River.

Despite these increases in 100-year flood discharges, the potential flood and safety hazards to recreational users of the Pike River, Pike Creek and the upper Pike River would be similar to existing conditions. PR 35 notes that under existing development and channel conditions, flood elevations can rise rapidly and flood velocities in the deep, steep-sided channel tend to be "high, and therefore potentially dangerous."

Effects of Mitigation Measures

The proposed habitat mitigation actions are not expected to affect the present flood and drainage hazards.

STREAM FLOW, EROSION AND SEDIMENTATION

Impacts of Channelization

Approximately 11.5 miles of channel of the upper Pike River and Pike Creek would be realigned through channel widening and deepening. On average, the Pike River would be deepened about 6

[1] It is important to note that if the dikes are overtopped during larger events (> 10-year flood), then the damage experienced on agricultural floodlands may be greater than anticipated without the dikes.

feet. The bottom width would range from 20 feet to 46 feet. The top width of the channel, assuming 3:1 slopes, would range from 42 feet to 112 feet.

Table 6.1 Estimated flood flows ("100-year") for the Pike River, Pike Creek, and Airport Branch under existing and planned land use conditions and proposed project conditions.

Stream	Discharge (cfs) Existing year-1995 land use w/existing channel conditions	Discharge (cfs) Planned Year 2010 land use w/ existing channel conditions	Discharge (cfs) Planned Year 2010 land use w/ proposed channel conditions	Discharge (cfs) Attendant to Proposed Project floodland management plan
Upper Pike R. @ Braun Rd.	2,020	2,680 (32% increase)	2,920 (45% increase)	2,260 (12% increase)
Pike Cr. @ CTH L	1,250	1,530 (22% increase)	2,650 (112% increase)	2,370 (90% increase)
Airport Br. near Pike Cr.	335	440 (24% increase)	1,570 (342% increase)	1,485 (318% increase)

Pike Creek would be deepened by as much as 11 feet and have an average bottom width of 20 feet to 42 feet. Assuming side slopes of 3:1, top channel widths would range from 60 feet to 126 feet. The Airport Branch would have its bottom width increased to widths of 15 feet to 25 feet. Top channel widths would range from 50 feet to 70 feet, assuming a depth of 6 feet to 8 feet. Approximately 1,230,000 cubic yards of earth and sediment would be removed.

The rechannelization of the Pike River and its tributaries will significantly increase erosion rates in the Pike River Watershed especially during construction. The erosion may be grouped according to short-term and long-term sources and impacts. Short-term erosion sources and impacts may be viewed as extending throughout the active construction phase of the Proposed Project. Principal sources of erosion during the short-term would be removal of stream bank vegetation, and disturbance of stream bank and channel soils during channel realignment (relocation, deepening and widening). Long-term erosion sources and impacts may extend beyond the construction phase of the project, which includes the period in which the stream channel adjusts toward a state of equilibrium. Sources of erosion during the long-term include stream bed and bank aggradation and degradation. The effects of increased levels of soil and channel erosion on the physical, chemical and biological resources of the Pike River Watershed will be discussed in this assessment.

Short-term Channel Stability and Erosion

Widening of the Pike River and its tributaries will remove vegetation along both stream banks. These disturbed stream banks would be exposed to a wide range of stream flows and water elevations.

Erosion rates would increase proportional to increases in discharge, stage and velocities during construction. Once vegetation is reestablished after construction, active bank erosion in the project area would be expected to decrease. The removal of woody vegetation (trees and shrubs) and replacement with grasses and forbs will not optimize bank erosion control. Diverse forms of vegetation, including grasses, forbs and woody-types provide better bank protection against flowing water (Karr and Schlosser, 1977; Schueler, 1991).

Preliminary plans indicate that the proposed channelized stream reaches will approximate the existing channel alignment and construction will occur in actively flowing channels. As a result, erosion will occur during most phases of construction.

At present, there are no proven technologies which can mitigate, to levels protective of water quality and aquatic habitat, the amount of erosion and sedimentation which will occur during construction in a hydrologically active stream. The impacts of erosion could be reduced to more acceptable levels if a new channel were constructed outside the existing channel floodway, and stabilized before conveying flow.

Long-Term Channel Stability and Erosion

A review of the existing literature on stream channelization suggests that predicting and designing non-eroding post-constructed channels is difficult and requires fairly extensive analysis of the functional relationships which shape streams. According to Nunnally (1985) these related factors include sediment discharge; suspended sediment concentration; median particle size and bedload discharge; water discharge; velocity and surface slope; flow depth and width; channel sinuosity and valley slope. Failure to account for these fluvial functional relationships in channelization projects result in long-term channel instability and erosion. These problems would be expected to occur regardless of the project taking place as initial channelization or rechannelization. This analysis will need to be completed as part of the design phase of project.

There are a number of case studies which identify the process by which channelized stream adjust their alignment. These processes have been documented occurring within, upstream and downstream of channelized reaches (Daniels, 1960; Emerson, 1971; Yearke, 1971; Campbell et al., 1972; Parker and Andres, 1976; Barnard, 1977; Piest et al., 1977; Simon and Senturk, 1977; Brice, 1981; Schumm et al., 1984; Brookes, 1987 and 1988). Each of the studies observed similar responses to channelization including bank slumping (erosion); sedimentation (aggradation); bed erosion (degradation); headcutting along unchannelized tributaries; wider channels and shallower water depths; and channel braiding.

Channelized streams, or re-channelized streams such as the upper Pike River and Pike Creek, have been shown to require additional engineering and maintenance dredging to protect eroding banks and channel, to remove aggraded sediment (Keller and Brookes, 1984; Brookes, 1988), or to protect down-cutting tributaries as a result of having caused a lower outlet elevation (Keller, 1976). Tributary down-cutting would contribute additional erosion and sedimentation, and extend the impacts of channelization to non-channelized tributaries. Keller (1976) suggests that channelization be kept to an absolute minimum because the stability of channelized streams are very difficult to predict. Allowing streams to maintain or restore a more natural morphology through meandering and flooding is a feasible management alternative for improving water quality and habitat, especially during low or intermediate flows (Karr and Schlosser, 1977). If required to maintain flood channel capacity over time, maintenance dredging would remove habitat structures installed along the upper Pike River and Pike Creek to mitigate channelization impacts or improve habitat over existing conditions.

In the absence of extensive engineered bank protection measures (i.e. revetments), channelized streams have a tendency to reshape their former or similar sinuosity through accelerated erosion of the bed and banks. Brookes (1987) observed 300 streams whose channels had been straightened and widened. He observed that a channel bottom meander (thalweg) developed to discharge low flows. This sinuous thalweg formed by erosion in higher slope reaches, leaving remnants of the larger channel at higher elevations. At lower slope areas, the larger channel narrowed as a result of deposition. Reaches where this has been occurring have been observed along historically channelized streams in the Pike River Watershed.

The impacts of past channelization of the upper Pike River and Pike Creek is evident, both within and downstream of channelized reaches. Sedimentation and bank erosion, within and downstream of channelized stream reaches, have been identified as important factors limiting the water quality, fish and aquatic life habitat in the Pike River Watershed (Kanehl, 1994; Burzynski, 1993).
According to Wessels and Kanehl (1994) banks along the proposed upper Pike River and Pike Creek are generally stable. In areas where existing bank erosion is a problem, resloping of the channel bank is a viable erosion control practice which would benefit water quality and habitat. Similarly, the Proposed Project intends for the low-flow channel to approximate the stability of a natural meandering channel.

Effect of Bridge Replacements

Replacement of the 22 bridges would have minor environmental effects provided erosion can be minimized by proper installation and maintenance of standard construction site erosion control practices, and by staging construction away from critical fish spawning periods. Failure to prevent erosion will result in sedimentation.

Effect of Channel Diking and Jetties

The optional channel diking described in the Proposed Project for the Lower Pike River would effect stream flow, erosion and sedimentation. Channel diking may result in greater rates of channel and bank erosion because higher flows and velocities are confined and restricted. The amount of erosion would be expected to be most severe along dike-confined and river bend reaches.

The proposed jetties at the mouth of the river on Lake Michigan may result in some erosion of the beach immediately to the south. The northern jetty would block transport of sand in the normal process of "long-shore drift," and most markedly when strong northerly and northeasterly winds blow. Sand would be routed around the ends of the jetties. Some would still block the stream outlet and require periodic dredging. The eddy or current vortex at the tip of the southern jetty would cause sand to accumulate immediately south of and adjacent to the jetty wall.

The local dissipation of wave energy would prevent the steady replacement of beach sand for perhaps several hundred feet, but the effective loss of beach width should not be severe, nor significantly decrease the recreational, biological or aesthetic values of the beach.

Effects of Detention Ponds

Two on-line flood control detention ponds are proposed to be construction to abate the effects of stream channelization on downstream flood flows and flood elevations. One 400 ac/ft flood control facility is proposed to be located along the upper Pike River 250 feet upstream of county highway (CTH) KR. Another 460 ac/ft flood control pond would be constructed along Pike Creek beginning 1,100 feet upstream of CTH E.

The extent to which the two detention ponds may contribute to downstream channel stability and erosion has not been assessed. If modifications or structures are added to the outlet of the ponds, they may affect erosion in ways similar to flood control dams and hydraulically significant structures (i.e. bridges and culverts) which form constricted flow and upstream backwater effects. If constructed, they may reduce velocities, accumulate sediment, and reduce the channel slope upstream of the ponds; and increase velocities, channel degradation or erosion, and channel slope downstream of the ponds.

Effects of Debrushing

Channel clearing (also referred to as "snagging") and debrushing would occur as a result of realigning the bed and bank of the Pike River and Pike Creek. This action would clear the stream corridor of all vegetation during construction of the channel, and would extend for a period after channelization until vegetation was re-established.

Channel clearing and de-brushing was proposed, and has since been completed, along a 1.8 mile reach of the Pike River extending upstream from Petrifying Springs Park to the confluence with Somers Branch. The affects of this past activity have not been studied.

Trees and other woody vegetation have been shown to have a significant effect in retarding bank erosion (Shields and Nunnally, 1984). Fallen trees and large log jams may trigger bank erosion, particularly in small streams (Brookes, 1988). Whole-scale clearing and snagging can reduce bank resistance to erosion resulting in channel widening and downstream sedimentation (Strauser and Long, 1976). Plant species which are native to riparian floodway environments have been shown to provide the greatest level of bank erosion control (Brookes, 1988).

Gregory and Stoke (1980) and Shields and Nunnally (1984) have proposed alternatives to large scale channel clearing and snagging projects which are less detrimental to channel stability and habitat, while still affording the need to improve hydraulic capacity. The authors recommended that clearing and snagging be undertaken on a small localized level as needed. Material not causing blockage or erosion should be maintained. Rooted trees should only be removed if they are overhanging the channel at a 30° or more. In most cases, removal need only be completed along one bank and care should be taken to insure that the most potentially unstable bank be left unchanged. Hand removal using small hand tools is preferred. Debrushing is recommended along one or alternating banks. This may result in acceptable hydraulic improvements while maintaining enough vegetation to maintain bank stability and habitat. The potential impacts of the proposed debrushing may be mitigated by following the above recommended guidelines.

Effects of Habitat Mitigation

Although the Proposed Project does not provide specific details on the types, numbers, and location of structural instream habitat improvement measures (i.e. deflectors), these structures are not expected to cause any significant problems with respect to channel and bank stability provided they are properly designed, constructed, and maintained. When properly design and installed, they should in fact help improve bank stability.

WATER QUALITY

Effects of Channelization

The proposed channelization phase of the project is expected to impact surface water quality, especially during the construction phase of the project. These impacts can be reduced through installation and maintenance of construction site erosion control practices along the upper bank. However, because extensive construction will occur in a hydrologically active stream and along the lower bank, erosion of soils and resuspension of sediments will occur.

Although past studies have documented the water quality impacts of channelizing "natural" streams, the impacts described below would be expected to occur in association with rechannelization activities. These impacts would be expected to occur, to varying degrees, both locally and downstream of the channelization.

Generally, the Proposed Project would be expected to significantly increase discharges of suspended solids (Little, 1973; Hill, 1976; Simmons and Watkins, 1982), and turbidity (Kuenzler et al., 1977; Shields and Sanders, 1986; Brookes, 1988). As a result of channelization, Barton (1977) and Brookes (1988) observed suspended solids concentrations to increase over background by factors of 278 times (maximum 1,390 mg/l) and 40 times (maximum 598 mg/l), respectively. Barton (1977) also observed a sedimentation rate increase by a factor of 10 times, averaging 0.61 g dry wt/cm^2/day.

Other studies have noted increases in other pollutants associated with eroded soil particles and resuspended sediment. Significant increases in phosphorus, nitrate, ammonia have been reported as a result of channelization (Kuenzler et al., 1977; Shields and Sanders, 1986). Eroded soils and resuspended sediment are important sources of phosphorus. Release of phosphorus from bottom sediments and soils would promote increases in primary production (Schrank, 1992). Combs (1994) estimates that on average, Wisconsin soils contain 50 mg/kg of phosphorus. While additional nutrients would tend to increase primary production, higher turbidity levels from eroded soils and resuspended sediment may inhibit the diversity of primary producers (Brookes, 1988). Re-suspension of anoxic stream sediments could increase concentrations and loadings of toxic un-ionized ammonia and hydrogen sulfide. Ammonia and hydrogen sulfide from disturbed bottom sediments would exert a biochemical and chemical oxygen demand adjacent to and downstream of channelized reaches.

Grimes (1975) reported significant increases in fecal coliform bacteria following disturbance and relocation of bottom sediments along the Mississippi River.

Simmons and Watkins (1982) observed an increase in dissolved oxygen as a result of higher stream velocities following removal of accumulated organic substrate in a marshy North Carolina stream. In the short term, removal of anoxic sediment along the upper Pike River and Pike Creek may reduce sediment oxygen demand and improve dissolved oxygen levels along channelized reaches.

Pollutant loadings generated as a result of this project would eventually be discharged to Lake Michigan. These additional pollutants may not be consistent with the Great Lakes Water Quality Initiative (Cohen, 1995).

Post-construction water quality impacts are dependent upon the long-term stability of the new channel and upper banks, and time needed to "flush" newly deposited sediment. The level of impact can be reduced, but not avoided, provided steps are taken to reduce erosion. The Proposed Project may improve existing sediment and water quality by removing sediments known or suspected of containing a variety of hydrophobic organic (pesticides and PCBs) and inorganic (metals) contaminants (see Chapter 2; Sediment Quality).

The Proposed Project will remove canopy vegetation and increase turbidity. These conditions may increase water temperatures (Gebhards, 1973; Corbett et al., 1978; Simpson, 1981; Simmons and Watkins, 1982). Karr and Schlosser (1977) observed maximum summer water temperature increases ranging from 6°C to 9°C following removal of stream bank vegetation along warm water streams. Duvel et al., (1976) observed a 1.7°C increase in mean summer water temperatures. Hansen (1971) observed July water temperature in a channelized reach of stream to fluctuate more widely; maximum temperatures averaged 1.3°C higher, and mean daily water temperatures were 0.3°C warmer compared to unchannelized streams. Warmer water temperatures correlated with higher base-flow turbidity levels in channelized streams.

As water temperature increases, the ability to hold oxygen decreases (Karr and Schlosser, 1977). Slight increases in water temperature above 15°C produce substantial increases in the amount of phosphorus released from sediments.

The impacts of vegetation removal on water temperature may be short-term and would be dependent on the rate and extent that streambank vegetation and canopy are restored. Some reaches of the upper Pike River and Pike Creek do not currently have sufficient amounts of canopy cover. As such, post-channelization restoration of vegetation and canopy may moderate extreme water temperature regimes, or even increase cooling effect, along these reaches.

Effect of Diking

Construction of 3.25 miles of dike along the lower Pike River would constrict flood flows, cause additional stress on the stream banks, and increase bank erosion potential. The effects of these eroded sediment and soil loadings on water quality would be the same as those described for channelization above.

Effects of Urban Nonpoint Sources of Pollution

Unabated stormwater runoff from new development will contribute additional nonpoint sources of pollution to the Pike River, its tributaries and Lake Michigan. The Proposed Project does include voluntary and educational actions needed to reduce urban nonpoint sources of pollution. In addition, implementing the Proposed Project does not exclude more comprehensive nonpoint source pollution abatement practices from being implemented in the future. However, these urban nonpoint source pollution control practices become much more costly and more technically difficult to install after the areas are developed.

Studies have shown that runoff from urban land uses degrade water quality (Pitt and Bozeman, 1982; Field and Pitt, 1990; Bannerman, 1983 and 1993; Marsh, 1993), sediment (Masterson and Bannerman, 1994) and aquatic habitat (Sloane et al., 1981; Schueler, 1991; Weaver and Garman, 1994; Masterson and Bannerman, 1994). Urban runoff contributes heavy metals, pesticides, bacteria, suspended solids, nutrients and polycyclic aromatic hydrocarbons (PAHs) to surface waters and often exceed water quality standards (U.S. EPA, 1983; Bannerman et al., 1983; Bannerman et al., 1993).

Although potential toxins loadings and concentrations to receiving waters increase during runoff events, some toxic pollutants accumulate in bottom sediments and biota over a longer period (Field and Pitt, 1990; Marsh, 1993). Toxins from urban runoff contribute to chronic toxicity rather than just during short-term runoff periods. Masterson and Bannerman (1994) showed that toxins from urban runoff, most notably lead and PAHs, bioaccumulate in crayfish and other biota. Crayfish from an urban watershed bioaccumulated lead at a rate 40 times greater than crayfish collected from a rural reference watershed. Similar trends were noted for chromium. Crayfish from an urban watershed accumulated PAHs at a rate of 92 to 1,079 times the rate observed in crayfish from the rural reference watershed. PAHs are of special concern because they are known carcinogens.

Weaver and Garman (1994) observed that gradual, low-intensity urbanization negatively affects a warm water fish community at levels previously attributed to rapid, high intensity land use disturbances. The authors observed significant decreases in species diversity and abundance for all species and trophic guilds in response to low-intensity urbanization over a 32-year period. Similar results were observed by Taylor and Roff (1986) and Hachmoller et al., (1991) as a result of sedimentation from urban development. Karr et al., (1986) observed significant changes in fish assemblages as a result of altered flow regimes in urban watersheds. McDonnell and Pickett (1990) noted significant differences in fish community structure between rural and urban land use gradients, in part as a result of nutrient sources.

The water quality element contained in PR 35 includes a recommendation to abate urban nonpoint sources of pollution in the Pike River Watershed. The recommendations include a combination of regulatory and educational means to abate urban nonpoint sources of pollution. Recommendations include controlling litter and pet wastes; proper application of pesticides and fertilizers; construction site erosion controls; streambank erosion controls; and proper application of de-icing solutions. Educational and voluntary programs re an important element of a comprehensive nonpoint source pollution abatement program. However, these programs may result in controlling 5% or less of urban nonpoint sources of pollution. On average, properly installed and maintained construction site erosion controls would be expected to control approximately 50% of the suspended solids and particle bound phosphorus from construction sites. None of these practices would be expected to provide needed reductions in toxic types of urban nonpoint sources of pollution, such as heavy metals and PAHs.

Besides the educational and voluntary programs identified above, PR 35 also recommends that communities examine the manner in which municipal services are performed to determine if the amount of dust, dirt and litter that accumulates on the road surfaces and adjacent areas, and is subject to runoff to surface waters, can be reduced by street and storm sewer cleaning and maintenance. Similar to the educational and voluntary measures identified above, street sweeping and storm sewer maintenance would also be expected to reduce some of the land surface pollutants from entering the streams. A summary of the potential pollutant reduction benefits provided by the recommendations in PR 35, and as currently practiced in the urban portion of the Pike River Watershed, is provided below. The effectiveness of detention basins is also provided for comparative purposes.

The nonpoint source pollution abatement practices which currently exist or are proposed to exist for new developments in the Pike River Watershed do not optimize the amount of nonpoint sources of pollution. Additional practices, such as those afforded by detention basins, would provide a greater level of pollution control. Dual purpose detention basins could also be developed to shave peak flows and reduce flood damages. At a Pike River Watershed Committee meeting early in the EIS process, and in subsequent correspondence, SEWRPC staff and local officials noted that a stormwater drainage system was needed in the foreseeable future. Upon reviewing an initial draft of the alternatives to the Proposed Project to be evaluated in the EIS, SEWRPC staff suggested that a stormwater management element could be added to the Proposed Project. Depending upon the design and level of implementation, similar benefits to those demonstrated above could be realized.

Table 6.2 Comparative Effectiveness of Non-Point Pollution Controls

Pollutant	A Nonpoint Source Pollution Abatement Practices in PR 35[1]	B Street Sweeping and Catch Basin Cleaning in PR 35[4]	C Maximum Nonpoint Source Pollutant Reduction Capabilities (A+B)[4]	D Detention Basins as Proposed Under Alternative 1 and 2[4]
Total Suspended Solids	benefit for construction sites only if practiced on daily basis	5-10%[2] 10-25%[3]	5-10%[2] 10-25%[3]	80%
Phosphorus	5%	5%[2] 15%[3]	5%[2] 15%[3]	40%
Heavy Metals	minimal	5-10%[2] 10-25%[3]	5-10%[2] 10-25%[3]	60-70%
Hydrocarbons (PAHs)	minimal	5-10%[2] 10-25%[3]	5-10%[2] 10-25%[3]	60-70%
Pesticides	5% water soluble & application dependent	<5%[2] water soluble & application dependent	<5% water soluble & application dependent	<5% water soluble & application dependent
Chlorides	minimal water soluble & application dependent	none water soluble & application dependent	none water soluble & application dependent	none water soluble & application dependent
Litter	5%	5-10%[2] 10-25%[3]	5-10%[2] 10-25%[3]	>90% of non-floatables; >90% floatables w/ submerged outlet & maintenance
Bacteria	5%	Unknown	5%	60-70%

1) Recommendations in SEWRPC PR 35 including control of litter and pet wastes, proper application of pesticides and fertilizers, construction site erosion controls, streambank erosion controls, and proper application of de-icing solutions.

2) Based on Wisconsin Priority Watershed Stormwater Management Plans and current practices by Town of Mt. Pleasant streets with curb and gutter swept once/month during spring through fall; City of Kenosha all streets swept every 2-3 weeks and catch basins cleaned every 2 years (pers. comm., 1995).

3) Reference Wisconsin Priority Watershed Stormwater Management Plans: Assumes catch basins are designed to maximize trap efficiency; catch basin cleaning twice/year; and street sweeping twice/month.

4) Sources: City of Kenosha and Village of Mount Pleasant; Bruch (pers. comm 1995); Bannerman (pers. comm. 1995); Local Stormwater Management Plan for the City of Sheboygan-Sheboygan River Basin Priority Watershed

The benefits of instream habitat mitigation and improvement measures could, in the long term, be reduced by water quality degradation from new sources of urban storm water runoff.

Effects of Flood Detention Basins

The two detention basins proposed to be constructed during implementation of the Proposed Project would provide some attenuation and assimilation of pollutant discharged from upstream sources. The effectiveness of the basins would depend on a wide range of factors related to their design and construction. These facilities would not provide any reduction of storm water pollutants generated from land surfaces prior to being discharged to surface waters. As a general rule, the pond surface area should equal 1-2% of the upstream watershed in order to achieve an 80 percent reduction of suspended solids for pollutants generated from mixed land uses. Based on a preliminary review, the basins would be undersized and not meet this 80% suspended solids control criteria.

Effects of Buffers

The Proposed Project recommends vegetated open space "buffers" between proposed urban developments and the upper Pike River and Pike Creek to reduce nonpoint sources of pollution. The proposed buffer strips would reduce particulate bound pollutants from entering the stream along relatively small and localized sheet drainage areas. However, most of the anticipated urban stormwater and associated pollutants would be conveyed to the receiving stream's by channelized flow. The incorporation of the vegetated buffer along the stream is typically capable of filtering estimated 5 percent to 20 percent of the eroding soil transported as sheet flow only (Bannerman, 1994). Higher filtration rates, approaching 85%, can be achieved provided sheet flow travel times across the strips reach 20 minutes (USEPA, 1985). The overall effectiveness of these buffers in reducing the impacts of polluted urban and rural sheet runoff would be dependent on type and quantity of pollutant, width of buffer, length and slope of the buffer, soil type, and vegetation type and density (Karr and Schlosser, 1977; Welsch, 1991). The buffer strips will provide some much needed wildlife habitat and aesthetic amenities along the stream corridor.

Unlike buffers, "filter strips" can provide significant reductions (50% to 80%) in particle bound urban and rural nonpoint sources of pollution. Unlike buffer strips, filter strips require larger amounts of land between the land surface and stream, and more thorough design and construction considerations.

SEDIMENT QUALITY AND MANAGEMENT

Effects of Channelization

Disturbance of existing stream sediments by channelization will resuspend pollutants and increase their mobility in the environment. This would occur primarily during the construction phase of the project. Sediment and water quality may improve as contaminated and anoxic sediment is removed by dredging the channel. The long-term benefit of removing these contaminants would depend on the ability to abate active and new sources, especially from urban nonpoint source runoff. For the foreseeable future, increasing volumes of untreated urban stormwater would enter the stream and a portion of these contaminants would accumulate in the stream bottom sediments.

There is no information available on the quality of sediment along Pike Creek. However, there is a limited sediment quality data base available for the upper- and lower-most reaches of the Pike River and Waxdale Creek. These data were collected in 1983 and may be considered outdated (CH2M Hill, 1983; WDNR, 1983). No other information is on file regarding sediment sites that may have been sampled in the Pike River (Talbot, 1993).

These limited data suggest that PCBs, and the pesticides dieldrin, chlordane and DDT exceed background levels for southeastern Wisconsin streams, often by orders of magnitude. Sediment contaminant levels suggest historical or continuing sources in the vicinity of the upper Pike River and the Waxdale Creek tributary.

The presence or absence of other contaminants along the Pike River and tributary sediments is not known. Due largely in part to the urban nature of the upper-most watersheds of the Pike River and Pike Creek, sediment concentrations of PAH compounds and heavy metals may be elevated. Masterson and Bannerman (1994) found that urban storm water contributes to contaminated bottom sediments. Urban stream sediments often exceed EPA heavily and moderately polluted criteria for metals. PAHs in urban stream sediments were shown to exceed PAHs from reference rural watersheds by orders of magnitude. PAHs from urban stream sediments exceeded sediment quality criteria normalized for total organic carbon.

The Proposed Project does not include a sediment management element. Similar projects which have proposed to dredge large quantities of contaminated sediment typically collect and analyze sediment for suspected contaminants. Based on the level of contamination, a sediment or dredge spoil management plan should be developed. Sediments that are found to exceed regulatory levels of contaminants of concern will have to be disposed of in a manner approved by WDNR and/or EPA, and the owners and operators of the disposal sites.

FISH AND AQUATIC LIFE

Effects of Channelization on Fish and Aquatic Life

The upper Pike River and Pike Creek have been channelized in the past. Rechannelization will impact fish and aquatic life resources along some reaches which have partially recovered over time. The degree to which these populations and their habitat have recovered is reach-by-reach specific. Overall, fish habitat in the upper Pike River is currently rated as "Fair" to "Good" (median equal "Fair to Good"), and fish habitat along Pike Creek is rated as "Poor" to "Fair to Good" (median equal "Fair") (Wessels and Kanehl, 1994).

The upper Pike River and Pike Creek have a moderately diverse fishery for a first order stream in southeastern Wisconsin. A total of twenty-five fish species and one hybrid cross have been collected from the Pike River and it's tributaries (Fago, 1984; Kanehl and Lyons, 1990; Kanehl, 1993; Burzynski, 1993; Wessels and Kanehl, 1994) (see Chapter 2).

The proposed mitigation of habitat lost through rechannelization could successfully restore fish and aquatic life habitat. The mitigation may also improve habitat, along some existing reaches, where existing habitat conditions are inadequate. The effectiveness of the proposed habitat mitigation and improvement actions is dependent on their proper design and construction, and long-term channel stability. The habitat mitigation or improvement element of the Proposed Project does not currently include an element to replace indigenous species of fish and aquatic life populations that could be greatly reduced or extirpated as a result of the project.

A review of the impacts to fish and aquatic life resources is provided below. This review is provided to inform the reader that similar short-term or and long-term impacts may occur in the Pike River Watershed, and to also provide documentation on the need to mitigate these impacts.

The effects of channelization on instream biota are quite variable and often depend on the nature of the channel modification, intensity and extent of the modification, and long term adjustment of the stream following channelization (USDA and USFWS, 1977; Brookes, 1988). Channelization has potentially widespread, direct and indirect, physical, chemical and biological effects on fish and aquatic life. These include changes in velocity; loss of spawning and protective cover; changes in substrate composition; loss of food supply; sedimentation and shifting substrates; changes in shading and water temperatures; changes in chemical water quality conditions; and physical removal of organisms. Channelization of natural meandering streams greatly reduces the length of natural alluvial streams. However, the loss of stream length will not occur along the Proposed Project reaches of the upper Pike River and Pike Creek since they have already been channelized.

Previous studies have identified a variety of channelization impacts on macroinvertebrate populations including reductions in standing crop; reductions in the number of taxa and shift to taxa tolerant of disturbed environmental conditions; reduction in abundance, diversity and biomass (Clarke, 1944; Apman and Otis, 1965; Morris et al., 1968; Hansen and Muncy, 1971; Bou, 1977; Griswold et al., 1978; Schmal and Sanders, 1978; Brookes, 1985). Hortle and Lake (1982) observed recovery of macroinvertebrate populations in an Australian stream where there was no change in substrate size and stability.

Considering all of the studies conducted to assess the effects of stream channelization, the effects of channelization on fish are the most extensive. A review of the effects of channelization on fish will focus on studies completed in North America and warm water fisheries similar to those present or potentially managed for in the Pike River Watershed.

Documented impacts of channelization on fish include reduced diversity and number of taxa; reduced abundance; biomass or standing crop; shifts in community trophic structure and to species more tolerant of degraded habitat; extirpation of species; and loss of recreational angling opportunities. The effects of channelization negatively impact all life stages (i.e. eggs, juvenile and adult), and all of the critical life requisites including reproduction, feeding, cover, and water quality. The majority of studies which looked at the effects of stream channelization on fish communities suggest that a reduction or modification in the amount of habitat diversity is most responsible for the negative impacts on fish populations. Changes in substrate; temperature regimes; sedimentation; and cover types are most important (Beland, 1953; Larimore and Smith, 1963; Bayless and Smith, 1967; Irizarry, 1969; Congdon, 1971; Schneberger and Funk, 1971; Tarplee et al., 1971; Huggins and Moss, 1974; Trautman and Gartman, 1974; Duvel et al., 1976; Headrik, 1977; Karr and Schlosser, 1977; Stern and Stern, 1980; Simpson et al., 1982; Edwards et al., 1984; Carline, 1985; Karr et al., 1986; Brookes, 1988; USACOE, 1993; Johnson, 1994).

Effects of Diking on Fish and Aquatic Life

Construction of the 3.25 miles of dikes along the lower Pike River wetland and other undeveloped open space areas may affect fish and aquatic life populations. The construction of dikes in natural floodlands effectively narrows the stream and prevents the formation of seasonal ephemeral pools and backwaters. This practice would reduce habitat diversity, and reduce fish and macroinvertebrate production in former backwater areas (Funk and Robinson, 1974; Groen and Schmulbach, 1978). Macroinvertebrate populations may be affected by increased stream velocities as a result of the channel constriction (Morris et al., 1978).

Effect of Detention Ponds on Fish and Aquatic Life

The effects of constructing the two on-line detention basins on fish and aquatic life populations is not known based on the lack of specific designs. Potential impacts on fish include impediments to migration and entrapment. The degree to which they impede migration may depend on the design of the outlet channel, if present. An outlet channel built at grade may not significantly effect fish and aquatic life migrations. Entrapment of fish may occur as water is drained from the pond. While providing a minimum depth of water may allow fish and aquatic life to sustain themselves during periods of low flow or drought, entrapped fish may suffer acute heat stress or winter freeze-out.

Effects of Debrushing and Clearing on Fish and Aquatic Life

Clearing and snagging along the Pike River will remove important fish and aquatic life habitat. Routine clearing and snagging may limit biological recovery for fish and aquatic life. Riparian vegetation, especially trees and shrubs, provide cover and shading for fish, provide a means to moderate water temperature, and provides food and habitat for fish food organisms including both terrestrial and aquatic insects (Simonson, et al., 1994). Riparian vegetation is an important form of fish cover in the Pike River and Pike Creek (Schimpf et al., 1994; Wessels and Kanehl, 1994).

Effect of Mitigation on Fish and Aquatic Life

The pilot channel is proposed to be from 2 feet to 4 feet wide and have maximum depths ranging from 1 feet to 2 feet. Pools and riffles are also proposed to be constructed in the pilot channel at various intervals. Artificial fish habitat structures (i.e. deflectors) are proposed to be constructed and installed. The bottom and lower side slopes of the flood channel would be revegetated with wetland species, with the remaining side slopes being revegetated with grasses and forbs. The plan also proposes that a 50 to 100 ft. open space buffer be maintained along the upper Pike River, and 50 to 200 ft. open space buffers along Pike Creek. The proposed habitat mitigation may lessen the long-term severity associated with channelization provided the habitat practices are present in sufficient quantity, and are properly designed, installed and maintained. Restoration of habitat may improve existing habitat conditions where it is present in limited quantity and quality.

The economic cost and level of mitigation needed to successfully mitigate fish and aquatic life habitat will be depend on the type and extent of morphological changes made to the stream (Brookes, 1988). The US Soil Conservation Service and US Fish and Wildlife Service (1977) assessed the impacts of various types of channel modification on fish and wildlife resources. The severity of impacts associated with the various types of channel modification are provided in ascending order below:

1. Riprapping as bank protection
2. Selective snagging for removing fallen objects
3. Clearing and snagging on a larger scale
4. Channel widening
5. Channel deepening
6. Channel realignment (deepening, widening and relocation)

7. Channel lining such as a gabion mattress or concrete invert

The flood control plan for the Pike River Watershed proposes to essentially realign the upper Pike River, Pike Creek and the Airport Branch through deepening and widening of the existing channels. The Proposed Project is expected to cause severe impacts to fish and wildlife resources relative to other forms of channel modifications. The Proposed Project will also be more costly and difficult to mitigate compared to other types of channel modifications.

A variety of instream fish habitat devices are capable of replacing some of the lost habitat from channelization (Kanehl, 1993). Brookes (1988) classified these instream devices according to their primary effects: altering the flow; provide direct cover; or increase spawning areas for fish and macroinvertebrate habitat. The Proposed Project recommends devices which alter the flow (i.e. deflectors) and increase spawning areas (i.e. riffles) for fish and habitat for macroinvertebrates. Device which serve as direct cover (i.e. overhanging woody vegetation) are lacking from the mitigation plans because they may conflict with the goal of maximizing flood flow conveyance. Kanehl (1993) and Wessels and Kanehl (1994) observed that woody debris and overhanging vegetation provide important habitat for fish in the Pike River Watershed. Recovery of macroinvertebrate populations in the Pike River Watershed will be very dependent on replacing and maintaining suitable substrate conditions.

The replacement of coarse substrate in riffle areas, construction of pools and instream habitat devices would speed the biological recovery of the channelized stream (Platt et al., 1979; Armstrong, 1984; Brookes, 1988). Where sediment loads are too high, the restoration and maintenance of functional gravel riffle areas, pools and instream habitat devices may be difficult or impossible. Sediment loadings to streams in the Pike River Watershed may increase from two principal sources: construction site erosion from new urban development; and post-channelization bank erosion and stream bed degradation.

The preliminary mitigation and restoration plan does not include a detailed alluvial geomorpholocial analysis. In the absence of this analysis, it can not be ascertained if the proposed low-flow pilot channels and lower bank can be properly designed and constructed to maintain long-term channel and bank stability, while restoring a diverse channel morphology, and creating and/or maintaining "usable" instream habitat structures and water depth. Channelization will cause higher rates of erosion and sedimentation in the short-term (i.e. during construction) and long-term (i.e. bank and channel degradation). These factors may cause fish habitat structures to fail or require frequent maintenance (Keown, 1981; May, 1975 from Brookes, 1988; Harvey and Watson, 1988). Shields (1983) stated that a thorough assessment of stream channel stability and sedimentation is needed to insure that instream mitigation measures will not be lost. The outcome of large-scale projects are more difficult to predict, and because of that, the authors advise that contingencies be included for modifying or replacing habitat mitigation structures for some period of time following construction.

Failure to analyze, design and construct the low flow channel properly, especially in two-stage channels, may make it difficult to maintain vegetation along the bottom of the flood control channel. This would potentially result in more scour and erosion.

The sequence of instream habitat mitigation work relative to channelization has not been determined. Habitat mitigation could be more effective if it were to follow channelization by two to three years, in order to allow the channel to "settle in" to its new alignment. This could minimize the potential for wasted effort and materials that could occur due to channel degradation and aggradation. This may also increase the construction costs for habitat mitigation practices. DNR fishery research staff and/or private consultants may need to identify those specific habitat treatments that should be delayed until the channel is stabilized. It is important to note that some former native fish species collected from the Pike River Watershed in the early 1900's may be extirpated. The disappearance of these species coincides with the original channelization of the upper Pike River and Pike Creek, and other land use changes which have occurred in the watershed. Fish species present in the Pike River Watershed in the early 1900s but not collected since 1975 include the least darter (State Species of Special Concern status), redfin shiner (State Threatened Species status), striped shiner (State Endangered Species status), horneyhead chub and northern redbelly dace, largescale stoneroller (Intolerant Forage Fishes), johnny darter and northern hog sucker (Tolerant Forage Fishes), northern pike and rock bass (Warm Water Sport Fish). If construction activities cause a permanent loss or significant reduction in some existing aquatic life species, these species may need to be reintroduced according to a carefully-designed biotic restoration plan. These potential impacts and need for biotic restoration are not currently included in the Proposed Project mitigation element.

GROUNDWATER

Impacts of Channelization on Groundwater

Previous studies have concluded that channel deepening may cause a lowering of the near-surface water table, especially in the immediate vicinity of the realigned channel, and along reaches were soils are more permeable (Simmons and Watkins, 1982).

The effectiveness of past channelization (in concert with field drain tiles) in reducing groundwater tables and improving drainage in the Pike River Watershed is evident by the extent to which it created more tillable land. The extent to which the groundwater table in the Pike River Watershed will be impacted by channelization has not been determined, and will depend on the depth of channelization and hydraulic conductivity of the adjacent soils. Since many reaches along the proposed new channel are in soils of low permeability, the impacts on the local groundwater table may not extend a significant distance from the channelized stream reach (SEWRPC pers. comm. 1995).

Loss of groundwater flow to the Pike River may be important. Seepage of groundwater from the sand and gravel aquifer accounts for approximately 74 percent of the total dry-weather stream flow in the Pike River (SEWRPC, 1983, p. 121). The loss of dry-weather flow from groundwater sources could be harmful to fish and other aquatic life. No detailed study that could quantify the possible volume of reduced flow, or its significance to aquatic life, has been conducted.

The 500 feet of dike proposed for the Bartlett Branch is not expected to have a significant effect on groundwater quality or quantity. However, the level of impact associated with constructing 3.25 miles of dike along the lower Pike River on groundwater is not known. The frequency which backwater and other floodplain areas were previously flooded by the Pike River Areas will be reduced. The quantity of surface water previously allowed to infiltrate in backwater or floodplain areas may be reduced proportionably.

The two flood detention ponds will maintain or increase the rate of surface water infiltration into the groundwater. The rate will depend on the permeability of soils, the area and depth of water in the ponds, and water retention time.

Watershed urbanization and attendant increase of impervious surfaces will decrease the amount of infiltration to groundwater.

WETLANDS

Impacts of Channelization on Wetlands

According to WDNR estimates, approximately 67 acres of wetland exist in proximity to the proposed channel construction alignment. According to SEWRPC (pers. comm., 1995), approximately 17 of the 67 acres of wetland would be directly impacted by constructing the new channelized sections of stream and the excavation of the detention ponds.

Ten of the 17 acres are proposed to be restored, and 7 acres would be lost. All of these 17 acres of wetlands are located adjacent to the proposed channel realignments, and are located within the existing and Year 2010 floodplains. Based on a recent wetland assessment completed by the DNR, most of the 17 acres of directly disturbed wetlands are of low to medium value with respect to wildlife habitat; fish habitat; flood control; water quality protection; flora diversity; aesthetics, education and recreation; and groundwater benefits.

Channelization and additional lowering of the near-surface water table is not expected to significantly impact existing wetlands located beyond the construction corridor because the water budget for these wetlands are maintained by a perched groundwater table.

The following is an analysis of channelization impacts on wetlands. It is important to note that many of these impacts have already occurred as a consequence of historical channelization which has taken place in the Pike River Watershed. The review reinforces the importance of proper design and construction of wetlands proposed to be created or restored.

Barcly et al., (1982) provided an extensive literature review on the impacts of channelization on wetland vegetation. Direct physical impacts may include lowered species and structural diversity; dieback and sunscald; loss of woody productivity and mast; increased erosion, changes in nutrient cycling; and affects on fertility succession. Indirect impacts associated with draining and de-watering of wetland soils include a shift in species community composition to species more tolerant of dry conditions; increased competition for water tolerant species; loss of productivity by water tolerant species; and increased losses of wetland communities by encouraging land use changes (i.e. urban and agricultural).

Riparian wetlands provide benefits for improved water quality. Loss of additional Pike River Watershed floodplain wetlands through channelization may effect the biological and physical-chemical availability of phosphorus (Rosendahl and Waite, 1978).

Effect of Wetland Mitigation

The Proposed Project will result in an estimated 176 acres of additional wetlands being planted or created. The majority of these wetlands would be created in the two flood control detention ponds proposed to be located on Pike Creek and the upper Pike River; and along the lower bank of the channelized streams. In addition, approximately 10 of the 17 acres of wetland expected to be disturbed along the construction corridor will be restored. Although the ultimate value of the created wetlands can not be determined at this time, the quantity of wetland proposed to be created is expected to benefit wildlife populations and aesthetics. Final design and wetland construction will also determine the value of the created wetlands relative to flood protection; fish habitat; water quality protection; flora diversity; education and recreation; and groundwater benefits. The quality and diversity of wetlands proposed for the flood channel, and other proposed areas, would depend on the selection of wetland species, coverage, and successful establishment rates.

If successfully restored, proposed wetland vegetation areas (primarily in the channel bottom) may help to remove and assimilate water pollutants. The process is similar to that which occurs along buffer strips. Wetlands influence water quality through a variety of physical, chemical and biological processes that sometimes act independently and sometimes act in concert (Kusler, 1989). The efficiency of wetland vegetation in removing particle bound pollutants will be dependent on travel times across the plants. Generally, rigid plants which do not lay down during submergence of flood flows will be effective in removing particulates. This would potentially occur during smaller runoff events. Under moderate to high flow conditions, contact time would be small and plants would have a tendency to lie down and be less effective in reducing settling solids. Under these conditions, most particle bound pollutants would remain suspended in the water column and transported to downstream locations.

The proposed wetland mitigation and creation activities would not negatively impact, and may improve, local or watershed groundwater elevations and groundwater quality. Watershed-wide improvements or maintenance of groundwater quality or elevations by wetland creation may be partially offset by urbanization.

Effects of Diking on Wetlands

The approximately 10 acres of floodplain wetlands located along the 3.25 miles of dike along the lower Pike River would be affected directly and indirectly as a result of dike construction. Wetland vegetation would be directly impacted by depositing and grading soils for dike construction. These wetland communities would be permanently lost. Indirectly, riparian wetlands located along the lower Pike River would be hydrologically removed from seasonal or more frequent flood inundation by the Pike River. Riparian wetlands, especially those whose existence is dependent on the seasonal or more frequent flooding events, are especially vulnerable to diking. Similar to the effects of channelization on wetlands discussed above, some of the direct physical impacts may include lowered species and structural diversity; dieback and sunscald; changes in nutrient cycling; and affects on fertility succession. Indirect impacts associated with diking include a shift in species community composition to species tolerant of dry conditions, increased competition for water tolerant species, loss of productivity by water tolerant species, and increased losses of wetland communities by encouraging land use changes (i.e. urban and agricultural) (Barclay et al., 1982).

Storage provided by floodplain wetlands permits floodwater to filter into the groundwater table to recharge the stream and adjacent wetland areas. The loss of wetland storage may lead to some reduction in dry-weather stream flows. Although no hydrologic analysis has been completed to estimate the possible reduction in base flow through wetland alterations, Demise (1993) estimated that Illinois stream flows would be reduced by about 2.5 percent, due to a projected wetland loss of 95 acres. Further flow reduction would result from loss of groundwater infiltration.

There are no known wetlands which would be impacted by construction of the 500 ft. dike along the Bartlett Branch.

Effects of Debrushing on Wetlands

Clearing of woody shrubs and trees will remove shade along the riparian area. This area may contain wetland plant species which are intolerant of direct sun and heat. Removal of shade vegetation may cause dieback and sunscald to less tolerant wetland vegetation, and a shift to species more tolerant of dry conditions (Barclay et al., 1982).

WILDLIFE

Effects of Channelization on Wildlife

Stream bank corridors and riparian wetlands provide critical wildlife habitat, especially in agricultural and urban landscapes. As such, these corridors need careful management to allow wildlife to prosper, and also to provide local landowners, other local community residents, and visitors the opportunity to enjoy aesthetically pleasing green space and wildlife viewing.

Channelization would contribute toward the removal of approximately 55 acres (or 50%) of the existing woody vegetation along the stream corridor. This woody vegetation cover type would be replaced with grasses in order to improve hydraulic capacity of the new channel. Clustered plantings of woody vegetation along the upper bank could mitigate the loss of woody vegetation while minimizing the negative effects on stream hydraulics.

The effects of removing woody vegetation on wildlife populations may extend to 15 - 30 years. The proposed creation and planting of 176 acres of new wetlands, and restoration of disturbed wetlands would benefit wildlife populations. The short-term and long-term impacts of stream channelization on wildlife populations will ultimately depend on the resiliency of wildlife population, the final design and construction of habitat mitigation features.

The following review describes the effects of stream channelization on wildlife populations. The effects of rechannelization would be expected to be similar, and would vary to the extent that some reaches of historically channelized streams have partially been restored by natural recovery. The review also reinforces the importance of wildlife habitat restoration.

Wildlife populations are most abundant in diverse, shrub and tree stages of plant succession where a variety of habitats are provided. Diverse stream bank vegetation is typical of less recently channelized reaches and natural sections of the Pike River. In many cases, most wildlife that occur in the Pike River Watershed use stream bank cover and riparian wetlands as part of their daily territories or home range. Yet, other species, such as the cottontail rabbit, may live their entire life span in this corridor.

The terrestrial, riparian and wetland wildlife types associated with small rural streams include amphibians and reptiles, game and non-game birds, small mammals and furbearers, and larger animals.

The effects of channelization and wildlife include physical removal of animals. To a large degree, the effects of channelization on vegetation ultimately determines the impacts on wildlife.

Streams provide critical sources of food, cover, and especially reproductive habitat for amphibians and some reptiles. Barclay et al., (1982) summarized the effects of channelization and their impact on herpetofauna. Hydrologic modifications results in a loss of reproductive habitat, nesting and food sources. Vegetation shift from woodlands to grasslands may eliminate or reduce available cover, and the reduction in aquatic vegetation and invertebrates directly impacts their food sources. Benson and Weithman (from Brookes, 1988) reported that channelization and drainage of wetlands in Wisconsin was responsible for decimating amphibians and reptiles in Wisconsin.

Upland areas and riparian areas adjacent to small streams provide nongame birds (i.e. songbirds) and game birds cover, food and water supply. Channelization effects nongame bird populations through widespread habitat changes, especially with respect to the quality and quantity of vegetation. Loss of taller woody species of vegetation reduce cover needed for cavity nesters, reduce canopy nester cover. Barclay et al., (1982) reported that channelized river corridors supported fewer fall and spring songbird migrants. Channelization will reduce the production of invertebrates (i.e. snails and crayfish) and vertebrates (i.e. fish) which directly impacts feeding opportunities for shore birds and fisher bird species.

Possardt and Dodge (1978) observed reductions in the diversity and abundance of song birds and small mammals in a small channelized Vermont stream compared to unchannelized streams. While swallows and sandpipers were more abundant in channelized reaches, thrushes, vireos and particularly warblers were more abundant in unchannelized streams. Similarly, shrews and jumping mice were greatly reduced in channelized streams. The white-footed mouse population was greatly reduced immediately after channelization but recovered rapidly in channelized streams.

Carothers and Johnson (1975) found that breeding bird density, number of breeding species, and total number of species were all lower along channelized stream corridors compared to non-channelized streams corridors. Vandre (1975) observed that channelization impacts were lessened when woody vegetation was allowed to remain in place along the riparian areas.

Table 3 (in the "Existing Conditions") illustrates that wooded/forested habitat with snags, cavities, and understory vegetation that is adjacent to streams provides the highest value of habitat for birds. The loss of this type of habitat will have the greatest impact on bird species diversity.

Channelization will affect small mammals and furbearers through reduced seasonal flooding along the floodplain; loss of cover through destruction or modification of vegetation and den areas; and reduction or loss of food supplies. According to Barclay et al., (1982) channelization will reduce flood frequency and magnitude. This condition will effect small mammal species which have specific mesic habitat requirements. Shrews for example, require near-water vegetation for cover and feeding. Loss of woody vegetation and lower vegetation diversity will reduce woodland mammal diversity. Vegetation composition shifts from mixed woodland and grasses to grasses and forbs will reduce or eliminate cover and food for arboreal species. Vandre (1975) reported larger populations of small mammals but lower diversity in grass-lined channelized streams. Greater diversity of small mammals were noted along channelized reaches dominated by more diverse woody plant species.

Similarly, channelization may affect furbearers by reducing available woody vegetation and root wads needed for cover and foraging. Gray and Arner (1977) noted that channelization reduced the availability of suitable den sites by changing bank soil composition. Channelization will reduce invertebrate and herpetofauna productivity and therefore food resources needed by furbearers.

To help simplify review of the potential impacts of stream channelization and related dredge spoil disposal to the wildlife resources, a matrix was constructed which depicts the three most common habitat types encountered along the Pike River and wildlife species utilizing these habitats (see Tables 3, 4 & 5 in Existing Conditions). The impact of channelization and spoil disposal is dependent on the amount of each habitat disturbed and season of disturbance. Although the seasonal use of various habitats is not discussed, many wildlife species exhibit a wide latitude of habitat preferences, changing seasonally at various life stages or as the amount of available habitat changes. For example, ring-necked pheasant require large blocks of open grasslands as nesting and brood rearing cover in the spring and summer. While in the fall, pheasant survival is highly correlated to the amount and distribution of winter cover, principally cattail wetlands or lowland areas with woody shrubs (i.e. willow and dogwood).

Effects of Wildlife Habitat Mitigation

As previously discussed, the Proposed Project recommends creating 176 acres of additional wetlands. The majority of these wetlands would be created in the two flood control detention ponds proposed to be located on Pike Creek and the upper Pike River; and along the lower bank of the channelized streams. Although the ultimate value of the created wetlands on wildlife populations can not be determined at this time, the quantity of wetland proposed to be created is expected to benefit wildlife populations.

The Proposed Project also recommends constructing 50 - 200 ft. buffer strips along the upper Pike River and Pike Creek. The long-term benefits of these buffer strips on wildlife populations are dependant upon a combination of vegetative succession, habitat restoration, nearness to undisturbed natural plant communities, and wildlife ingress into revegetated stream reaches. In order to maintain the desired hydraulic conveyance in the new channel, woody vegetation, as trees and shrubs and including their root systems, would be discouraged from the channel. Mitigation proposes to replace woody vegetation with grasses and forbs along the entire flood channel. The reduction in woody vegetation would shift wildlife use of the corridor in favor of those species that use grassy cover types such as mice, voles, grassland snakes, grassland birds, etc., but detrimental to tree squirrels, perching birds, deer, and other species. Species such as squirrels, raccoons and tree cavity-dwelling birds would continue to be effected and their near-future populations would be significantly reduced. Bank-dwelling species dependent on dens or other habitats encompassing bank tree root systems would be lost, because in order to maintain hydraulic efficiency, woody habitat would not be replaced along the stream bank (Halverson, 1994). Natural succession of the plant community from grasses to a mixture of grasses and woody vegetation may take as long as 30-years provided maintenance clearing and de-brushing are discontinued.

Unless preventive measures are taken, undesirable invasive plant species could colonize the constructed stream channel immediately following disturbance. The revegetation plan may need to be amended to include measures specifically to minimize problems with undesirable species.

Effects of Dikes on Wildlife

The maintenance of stable dike systems requires the removal of woody and deep rooting vegetation, and exclusive use of grasses. Monotypic types of grass or forb vegetation do not provide the same value of wildlife habitat as woody vegetation (Karr and Schlosser, 1977).

The effects of dike construction and maintenance on wildlife populations is primarily related to the degree and frequency of disturbance to the vegetation. Vegetation structure (height and width), density, and patchiness (horizontal structural diversity) determines the available cover for wildlife (Barclay et al., 1982).

Recommended Parkway Acquisition and Development

The refinement to the Floodland Management element of the Pike River Watershed Plan (PR 35) includes a preliminary delineation of a parkway along the Pike River and Pike Creek. Although the parkway may not be considered integral to implementing the major actions of the floodland management, it does provide additional opportunities to restore park and open space, and wildlife amenities to the Pike River Watershed. Therefore, a general assessment of the conceptual parkway's environmental effects is provided below.

Recreational Access and Use

If the proposed parkway is publicly acquired, recreational access in the stream corridor would increase. The proposed bicycle/pedestrian trail would allow walk-up access to most of the stream bank. There could be opportunities to develop several public access points on the upper Pike River and along Pike Creek. Currently, the only access along these reaches is at road crossings, but there is no suitable public parking. Several small off-road parking sites could accommodate the needs of parkway users. One of these could be located at a proposed neighborhood park within the parkway. Other access options include providing connecting trails from existing and new residential and commercial developments. With access to the trail from their homes via a connecting trail, local residents should have little need for parking when they use the parkway for angling, trail use or general enjoyment.

As long as stream corridor acquisition takes place as proposed, the value of the stream corridor as a movement and dispersal route would be increased. If developed, the proposed parkway could provide good wildlife habitat, but for a different mix of species than presently occurs. Along those reaches that are already confined by industrial and other development, there may be a net loss of wildlife habitat, due to the expanded width of the stream bottom and corresponding top width of the channel. A well-planned and successful bank revegetation could help ensure that no net loss of habitat area would occur.

Upland habitat improvements along the conceptual parkway would provide an increase in wildlife viewing opportunities for grassland species. Nothing in this parkway proposal would intentionally affect canoeing, angling, other recreational pursuits, or aesthetics on the lower Pike River.

Local recreation advocates have expressed a concern that if a provision is not made to obtain desired parkway lands before channel realignment is permitted to reduce the extent of the floodplain, then the market-driven cost of developable land in the former floodplain would increase beyond the ability of any local government or non-governmental organization to purchase it.

Some riparian landowners may be resistant to selling or providing an easement for a narrow strip of their property for a recreation corridor. These landowners often express concerns that a few people may be attracted to the trail who would vandalize their property or commit other offenses. There are several recreation corridors in urban or urbanizing areas around the U.S. that demonstrate that these fears are largely unwarranted. For example, along the Highline Canal in Denver, Colorado, not only have acts of vandalism or decreases in property values failed to materialize, but some of Denver's most valuable homes front the heavily-used canal trail. Many other examples are available from around the country (NPS, 1992).

Aesthetics

Overall, the provision of a parkway with a variety of vegetation would enhance the aesthetics of the river corridor, even though there would still be prominent views of adjacent row crop fields, near and distant industrial, residential, and possibly commercial development, and high voltage transmission lines.

OTHER POTENTIAL OR PROBABLE EFFECTS OF THE PROPOSED PROJECT

Endangered Resources Rare, endangered or threatened species, if present along the stream construction corridor, would be impacted by this alternative. However, a review of the DNR's Natural Heritage Inventory (NHI) did not identify the presence of any rare, threatened or endangered species that could be impacted as a result of the Proposed Project.

The DNR Bureau of Endangered Resources (BER) has noted that with improvement in surface water quality in the watershed, it may be possible to attempt the reintroduction of rare fish species, and possibly other aquatic and terrestrial organisms in the watershed. As an example, historic fish surveys reported collecting redfin shiners (state "threatened") and least darters (state "special concern"). Their reintroduction into the Pike River system might be possible if water quality conditions and other habitat requirements are improved. However, based upon existing resource information and the present lack of any stormwater quality improvement program, it is not clear that habitat and future water quality changes would be amenable to the return of any rare fish or amphibian species. The proposed open space buffer may present an opportunity to return or restore rare prairie species to the watershed, though no such measures are currently proposed.

Natural Areas There is no activity which will impact state natural areas. There is no proposal to designate any state natural areas, or to improve any site to natural area quality, nor should the Proposed Project negatively impact the existing local natural sites at Hawthorne Hollow and Petrifying Springs County Park.

Aesthetics The removal of man-made debris during channelization would improve the aesthetics along debris-lined reaches. Creation of buffer strips, wetlands, and parkway vegetation plantings would improve the scenic quality of other reaches.

The floodway channel itself may appear less scenic than it is now along certain reaches, due to the removal of existing trees and their replacement with tall grasses.

There are also a few reaches that are currently confined by existing development and a narrow ribbon of pioneer trees and shrubs. These areas may be viewed as less appealing once they are altered by vegetation removal and construction.

Cultural and Historic Sites There are no known significant historic structures along the reaches of the Pike River that would be affected by channel construction. There is one known significant cultural site (Ra-60) that could potentially be affected by construction. At least two structures (inventory numbers 83 and 86) could potentially be affected by an increase in flood elevation. At least five archeological sites (Kn-22, Kn-29, Kn 139, Kn-146 and Kn-224) could potentially be affected by an increase in flood elevation.

A more thorough review may be necessary to determine whether any of the sites on the upper Pike River and Pike Creek would be affected by channelization, or by dike construction along the lower Pike River. The State Historical Society, Division on Historic Preservation, will review this EIS and their inventory of historically significant structures and archeological sites in the watershed, and propose necessary mitigation measures, if any, to avoid disturbance of those sites.

Relation to Adopted Watershed and Land Use Plans There is no intent to modify any current, approved land use and infrastructure plans. The local units of government sponsoring the Proposed Project have been mindful of ensuring consistency between the watershed comprehensive plan and approved land use or infrastructure plan.

The Proposed Project does feature a slight modification or refinement of the floodplain management element of *"A Comprehensive Plan for the Pike River Watershed"* (PR-35), adopted in 1983. The effect on the floodplain is nearly the same, with the proposed plan leaving more remnant floodplain than the previously adopted plan. The major differences involve channel design modifications whereby the channel bottom is less deep along some reaches, but wider along most reaches; avoiding direct disturbance of any of the environmental corridor near the confluence of the upper Pike River and Pike Creek; adding two on-line stormwater detention basins; adding a meandered dry-weather low-flow pilot channel; and constructing habitat mitigation features including riffle and pools, and other habitat improvement structures.

The net effect of the Proposed Project on areas designated for urban development would remain the same. The existing and planned floodplain would be physically removed from these areas through a combination of channelization, bridge replacement, diking, and flood proofing or elevating structures. These actions will remove floodplain zoning constraints from land development planning and design.

Proposals for related development activities do exist, and communication related to them underscores the potential vulnerability of structures built on certain soils common in the watershed, including a large area of the headwaters of Pike Creek. A major industrial development is planned for that area.
Farmland Preservation The Proposed Project has not been coordinated with any current farmland preservation program. Some cropland would be taken out of production for channel construction and parkway development, but most of that land is located in the planned Year 2010 floodplain, and may not be as consistently productive as land located outside the floodplain.

Regional Economic Development The Proposed Project is integral to regional economic development goals. Increasing the channel capacity would facilitate local and regional economic growth, through the removal of floodplain restrictions on several hundred acres. Increased channel capacity would also enable the channel to convey stormwater runoff from the level of land development through approximately the year 2010, without the expense of developing centralized and on-site stormwater management facilities.

Transportation The Proposed Project acknowledges regional transportation goals. Planned bridge replacements and highway expansions would accommodate the wider constructed floodway at stream crossings. The impact would include the added cost of replacing 16 bridges that would not otherwise need replacement at this time. (Six other bridges in the watershed are scheduled for replacement due to transportation needs).

Public Health If in-place contaminated sediments are present and migrating into the food chain, removal of contaminated sediments may reduce contaminant levels in resident fish and aquatic life, and wildlife. Reductions in fish and wildlife tissue contaminants would be beneficial to the people who eat them. The benefit to fish that are migrants from Lake Michigan would probably be very small, because most of their tissue accumulation of harmful substances would be due to Lake Michigan sources. In the absence of urban stormwater management practices, bioaccumulative contaminants from urban nonpoint sources would continue to be discharged to streams and bottom sediments.

If construction releases contaminants back into the water column, then contaminant levels can be expected to increase slightly in fish and aquatic life, and wildlife.

Use of the trail for commuting, general recreation, or fitness could provide a significant health benefit to most trail users.

Recreational Access and Use Acquisition of additional lands necessary to accommodate widening the channel presents an opportunity for developing public access to the upper Pike River and Pike Creek. It does provide an opportunity to develop a public recreational corridor, through acquisition of flood easements along remanent floodplain lands. Replacement of bridges would also provide an opportunity to develop a more limited form of public access.

In the process of developing the refinements for the flood channel design, SEWRPC staff also mapped out a proposed parkway boundary and recreation trail alignment, similar to the concept proposed in the Park and Recreation Plan for the Town of Mount Pleasant (SEWRPC, 1991).

Other benefits, more difficult to estimate, could be realized from the proposed public parkway. One study done in 1983 on the Lower Wisconsin River estimated that the average visitor spent $10.30 in local communities. Using a total business activity multiplier, the value of each visitor-day was estimated at $22.11 toward the local economy (Boyle and Bishop, 1984). Any food service establishments near the parkway, and sporting goods retailers would probably be the prime beneficiaries. Along the relatively new '400' Trail in southwest Wisconsin, businesses that had turned their unkempt backs on the former railway corridor have recently renovated their back entrances, in a successful attempt to draw customers from among the trail users. Most forms of recreation likely to occur along the upper Pike and Pike Creek would produce less of economic return to local communities, because most parkway users would probably not be traveling far from home, and because the overall quality of the resource and experience would differ greatly from a visit to the near-totally rural Lower Wisconsin River valley.

Local recreation advocates have expressed a concern that if desired parkway lands are not obtained before channel enlargement is permitted to reduce the extent of the floodplain, then the market-driven cost of developable land in the former floodplain would increase beyond the ability of any local government or non-governmental organization to purchase it.

The Proposed Project does not exclude establishing an anadromous cold water sport fishery via Lake Michigan to the upper Pike River and Pike Creek. However, the ability to further develop and maintain this type of recreational fishery will be dependent on the ability to abate existing and future rural, and especially urban nonpoint sources of pollution, the success of habitat mitigation or improvement activities, and the removal of fish migration barriers.

If the fish barrier on the golf course grounds were removed, it would help alleviate existing trespass problems on the Kenosha Country Club grounds by spreading fishing opportunities upstream of the golf course. Public access sites with parking along the proposed public parkway should prevent trespass problems in these upstream areas. Removal of the drop structure within Petrifying Springs County Park would allow anadromous and resident fish to migrate upstream to more easily make use of the proposed habitat improvements in the upper Pike River and Pike Creek, as well as to further ease crowding by diffusing angling opportunities.

A number of sources estimate an average value of each angler-day in pursuit of steelhead and similar species to be worth approximately $51.50 (USDI-NPS 1992). Currently, there are approximately 15,000 angler-hours (or 5,000 angler-days' use, assuming an average daily participation of three hours per angler) annually on the Pike River, worth as much as $257,000 to the regional economy.

<u>Real Estate Value</u> Experience in numerous communities has shown that public greenways (or parkways) are a valued amenity that generally have a positive effects on overall property values. For example, residential property values in Boulder, Colorado, Salem, Oregon, Amherst and Concord Massachusetts, and Philadelphia, Pennsylvania were all significantly higher for properties adjacent to a greenway than for homes located only 1000 feet away. Clustered housing with open space appreciates at a faster rate than conventionally-designed subdivisions, by 2 1/2 absolute percentage points per year in one case (USDI-NPS, 1992).

Future sales prices of existing homes may increase slightly more for greenway property than for residences away from the greenway. Initial sales prices, and therefore assessments, of newly-constructed homes would probably be higher for homes along the greenway than for comparable new homes at a distance from the greenway. Some communities view the resulting increase in tax revenues as one means to offset the cost of the greenway. Depending upon circumstances, the property tax revenues lost in converting privately-owned, undeveloped land to a greenway are more often recaptured by the added value the greenway would provide to nearby homes (and in some cases, businesses).

Owners of formerly undevelopable floodplain lands may realize a substantial increase in selling price. As noted earlier, value of this land may be expected to double, from approximately $2,000 per acre to about $4,000 or 5,000 per acre (1990 dollars). Real estate values of properties abutting some reaches of the channel may increase, while others may not, depending upon zoning changes.

Irretrievable Commitment of Fossil Energy and Non-Renewable Minerals in Construction An unknown amount of refined petroleum fuels would be used in the construction phase of this project. The amount would probably be more than several thousand gallons.

An uncomputed amount of gravel, rock, boulders and rough lumber would be committed to mitigate or improve existing instream and upland habitat destroyed by channelization. Construction of gabions and other types of bank protection revetments would require additional tons of rock and rolls of heavy mesh wire. Bridge replacement will require the use of several score yards of concrete, and many dozen tons of structural steel and steel railings. Elevating structures would require a few dozen yards of concrete and minor quantities of other structural materials.

COSTS AND FUNDING

The total estimated annual cost of channel alterations, floodproofing, habitat mitigation and related bridge replacements is approximately $684,396 (in 1994 dollars[1] - see Appendix E). The approximate annual cost of parkway acquisition and trail development is $104,000[2] (in 1990 dollars). The breakdown in responsibility for channel alteration and parkway development costs among civil divisions would need to be calculated and agreed upon before any costs per resident could be calculated within each municipality.

Proposed Project construction, design and engineering, project management, and contingency costs which may need to be included or increased are: acquisition of stream corridor land necessary to construct the channel; ponds and buffer strips; sediment testing and management; erosion control practices; monitoring and maintenance of instream habitat mitigation or improvement practices; wetland and upland creation and planting; and biological restoration in the project area. The proposed method for assigning costs among responsible units of government or property owners is not yet available.

Costs for acquisition of stream corridor land necessary to construct the channel have not been included in cost estimate. Even if there were no parkway land acquisition, access through easement or outright purchase would be needed to implement the proposed channel modifications, habitat mitigation, flood pond facilities, and buffer strips. This land would extend from approximately 60 to 120 feet along each side of the center of the stream channel (approximately 130 acres), in addition to approximately 200 acres for the two proposed stormwater detention sites. The added cost for this land at $5,000 per acre could be up to $1.65 million, which would add another $91,600 to the average annual cost of the project.

The cost of securing a performance bond for erosion control and habitat mitigation is a potential added cost which has not been included. The amount of the bond and its cost to the project applicants would be determined upon review of updated project design and application information.

[1] Inflation and interest rates were in the 12% to 18% range for the period immediately following the estimation of cost, so present-dollar cost would be much higher.

[2] Obtained by doubling the cost estimate for the Mount Pleasant segment alone (to factor-in a cost estimate for the Somers segment), and dividing by 18 to account for interest over a 20-year implementation period.

When considering only annual flood damage risk reduction ($291,540), the estimated 50-year cost of the Proposed Project ($12,385,000) would be $1,650,000 more than the cost of a public buy-out of floodplain homes ($10,735,000). This is according to the results of a WDNR floodplain management "Community Assistance Visit" conducted prior to March, 1993.

For many years, the Mount Pleasant Stormwater Utility District (which includes most of the Town of Mount Pleasant) has been assessing District property owners for the actual or anticipated cost of drainage projects. The annual assessment has been 1.3 mills, or $1.30 per $1000 assessed value. As of May, 1994, the District had approximately $750,000 to pay its portion of the cost of the Proposed Project. This leaves the need to raise additional funds, through continuation of the current assessment structure, borrowing, or other means.

The Town of Somers also has some funds for this project, but as with Mount Pleasant, future assessments and/or borrowing may be necessary.

With no outside funding in the form of grants or cost-sharing, project costs for acquisition and development would amount to approximately $9.50 per person, per year, for 20 years, assuming costs were shared proportionate to population throughout the watershed.

Responsibility for funding the replacement of bridges and other stream crossing structures for motor vehicles would be apportioned among the State of Wisconsin (paid for by the Wisconsin Department of Transportation through a combination of fuel taxes and state general revenues), Racine County, (funded by property tax revenues), Kenosha County (funded by property tax revenues), Town of Mount Pleasant (funded by property tax revenues), Town of Somers (funded by property tax revenues), and the U. S. Department of Transportation (paid for through a combination of fuel taxes and federal general revenues).

Once the project is completed, owners of land presently in the floodplain that is removed from the floodplain by project construction, who are not interested in selling their land, or who cannot readily find buyers, may be required to pay increased property taxes according to possible zoning changes and reassessment of their land. The Proposed Project would affect approximately 1100 acres in this way. According to land value estimates used in the Mount Pleasant Park and Open Space Plan, valuations, and consequently tax assessments, could increase on some of these lands.

FLOOD RISK REDUCTION BENEFITS

Many of the flood damages, estimated at an average annual cost of $291,540 would be largely eliminated. These costs have been born for decades in part by residential property owners, local governments, and to the extent federal or private flood insurance or crop insurance payments were made to cover losses, by premium payers into those programs, as well as general taxpayers, who subsidize public flood insurance fund shortfalls and fund disaster relief.

Regional economic development would benefit to a substantial degree, by virtue of converting several hundred acres of the current regulatory floodplain and other open space into commercial, industrial and residential zones. No new jobs would be created that could be attributed solely to the Proposed Project, beyond the short-term jobs during actual channel construction. Because several hundred acres of current floodplain could be developed for a variety of uses, and this land can be obtained at a lower cost than land currently outside the floodplain, total development costs would be slightly lower than they would be under present floodplain conditions. Another benefit is that the additional stormwater that would be generated by the ongoing City of Kenosha airport expansion, and pending adjacent development, would be conveyed off-site. This would eliminate the need to deal with the stormwater by some other, potentially more problematic, means.

SUMMARY FOR THE PROPOSED PROJECT

The Proposed Project addresses the problem of flooding using a combination of structural and non-structural measures including 11.5 miles of channelization along the Pike River, Pike Creek and the Airport Branch; construction of a 500 ft. dike along Bartlett Branch and the option to construct an additional 3.25 miles of dike along the lower Pike River; channel debrushing and clearing along 1.8 miles of the upper Pike River; removal or replacement of 17 bridges; floodproofing or elevating 12 floodprone structures; construction of two on-line flood detention ponds; construction of jetties and dredging at the mouth of the Pike River; and enforcement of the local floodplain ordinances under planned Year 2010 land use conditions. Approximately 176 acres of wetland would be created and 10 of 17 acres disturbed by construction would be restored. The remaining 7 acres of wetland would be permanently lost.

Flood control measures would remove approximately 1,187 acres of the 2,370 acres contained in the Year 2010 floodplain. Of the 1,187 acres approximately 470 acres are in existing urban land uses, 48 acres are in open space and 669 acres are in agricultural uses. An additional 680 acres of former floodplain could be developed as urban land uses.

The Proposed Project would reduce or eliminate existing or anticipated flood hazards to 113 structures. Following these measures, up to 12 structures would have to be elevated or floodproofed. Diking would protect 51 structures already developed in the Bartlett Branch floodplain. It would also allow new urban development at elevations that are below the level of the existing floodplain. This raises the potential that a future flood, of a magnitude greater than a 1%-chance-of -occurrence ("100-Year") flood, or dike failure, could cause damages in excess of what the same flood could cause under existing floodplain development conditions. There would also be some relief from problems caused by localized stormwater ponding in low areas or storm sewers with inadequate outlets elevations.

The Proposed Project will result in greater discharge volumes. This is due to the increases in runoff as forecast land use changes occur. These conditions, however, are not expected to increase human safety concerns beyond those which currently exist along historically channelized reaches of the upper Pike River and Pike Creek. The proposed flood control measures will decrease the frequency with which bridges and approaches are inundated. This will enable safer vehicular passage during design flood conditions.

In general, channelization and the option to construct 3.25 miles of dike afford the greatest probable or potential short-term and long-term environmental impact in the Pike River Watershed. Construction of the 500 ft. dike along Bartlett Branch, bridge replacement, floodproofing or elevation of floodprone structures, construction of jetties and dredging at the mouth of the Pike River, and enforcement of local floodplain regulations are expected to have minimal or no negative environmental impacts.

Long-term water quality and sediment quality in the Pike River Watershed is expected to decrease as a result of unabated urban nonpoint sources of pollution from new developments. Most notably, potentially toxic pollutant loadings of heavy metals and PAHs will increase. As a result of urban construction, suspended solids and other particle bound pollutants such as phosphorus, will increase. Suspended solids and phosphorus may decrease over time as rural sources of soil are "paved over". Implementation of the Proposed Project does not exclude the incorporation of a comprehensive stormwater management program which could abate urban nonpoint sources of pollution from new development.

Channel realignment will likely cause an increase in short-term, and potentially long-term, erosion and sedimentation rates in the Pike River Watershed. In the short-term, erosion and sedimentation will be caused by excavation of the channels bed and bank, and removal of riparian vegetation. These impacts are unavoidable since the channel realignment will take place in a hydrologically active stream. In the long-term, erosion and sedimentation may occur upstream, within, and downstream of channelized segments as the effected channels equilibrate to changes in slope, discharge, and sediment transport. Optional construction of an additional 3.25 miles of dike along the lower Pike River will, if adequate control measures are not employed, result in bank and channel instability and increase erosion and sedimentation potential. Diking along the lower Pike River may impact channel stability by constricting flows during flood events.

Eroded channel bed and bank material will contribute to degraded water quality. Increased loadings of sediment, and other particle bound pollutants, will occur. Erosion would result in sedimentation, increased levels of turbidity and other soil particle bound pollutants such as phosphorus, and increases in water temperature. This conditions will result in direct and indirect impacts to fish and aquatic life, primary producers, and wildlife populations. Excavation and resuspension of anoxic sediment will release ammonia and sulfide, increase oxygen demand and may be toxic to fish and aquatic life. Removal of overhanging vegetation and higher levels of turbidity will increase water temperatures until such time that vegetation is restored.

If present, sediments contaminated by heavy metals, pesticides and PAHs will be removed by channel dredging. A lesser amount of these contaminants, will be resuspended and transported downstream during construction. Removal of contaminated sediments would benefit fish and aquatic life, wildlife, and human health. Removal of anoxic sediment may reduce sediment oxygen demand and improve dissolved oxygen levels.

Although the upper Pike River and Pike Creek have been historically channelized, the rechannelization activity would have direct and indirect negative impacts on fish and other aquatic life. Deepening and widening of the existing channel will remove sessile organisms such as macroinvertebrates and mussels. Other short-term or long-term impacts will include loss of instream and riparian cover; loss of fish spawning and nursery habitat; loss of food supplies through excavation and sedimentation; reduce canopy shading; increased water temperatures; release of nutrients and potentially toxic sulfide and un-ionized ammonia. Routine maintenance of the channel through large scale debrushing and clearing of woody vegetation would remove overbank cover for fish and other aquatic life.

Instream habitat mitigation, as proposed under the refinements to Pike River Watershed Plan, would lessen the severity of the Proposed Project by replacing some of the instream fish and aquatic life habitat lost through channelization, clearing and debrushing. Habitat may be improved along some reaches where existing habitat conditions are limited. If the amount of habitat mitigation is sufficient, and they are properly designed, constructed and maintained, the long-term severity associated with channelization will be reduced. No biological restoration element is presently proposed for species whose populations may become extirpated or greatly reduced as a consequence of channelization.

Recovery of macroinvertebrate populations in the Pike River Watershed will be dependent on replacing and maintaining suitable substrate conditions, and immigration from undisturbed stream reaches in the watershed.

Construction of the new channel will result in the disturbance of 17 of the existing 67 acres of wetlands along the project corridor. Ten of the 17 acres will be restored and 7 acres will be permanently lost. An additional 176 acres of additional wetlands are proposed to be created and planted. The majority of these wetlands would be created in the two flood control detention ponds proposed to be located on Pike Creek and the upper Pike River; and along the lower bank of the channelized streams. The quantity of wetland proposed to be created is expected to benefit wildlife populations and aesthetics. Final design and wetland construction will also determine the value of the created wetlands relative to flood protection; fish habitat; water quality protection; flora diversity; education and recreation; and groundwater benefits. The quality and diversity of wetlands proposed for the flood channel, and other proposed areas, would depend on the selection of wetland species, coverage, and successful establishment rates.

Up to 10 acres of wetland could be impacted as a consequence of constructing (excavation, grading and filling) dikes along 3.25 miles of the lower Pike River. No wetland, wildlife or fish and aquatic life habitat mitigation was proposed for this element of the Proposed Project.

Wildlife populations are most abundant along the stream corridor having a diverse community of woody vegetation (shrubs and trees). Rechannelization would remove approximately 55 acres along the project area. Proper design, construction and maintenance of the wetlands proposed to be mitigated and created, revegetation of the channel corridor, addition of buffer strips, and acquisition and redevelopment of the proposed parkway would provide long-term benefits for wildlife, and improve the corridors scenic quality.

Channel deepening is not expected to negatively impact the groundwater quality or groundwater table outside the vicinity of the new channel. New urban development will decrease the rate of infiltration to groundwater in localized areas. Construction of the optional 3.25 mile of dike along the lower Pike River may impact groundwater infiltration rates as the frequency of seasonal backwater flooding by the Pike River is reduced.

The total estimated annual cost of channel alterations, floodproofing, habitat mitigation and related bridge replacements is approximately $12,385,400 (in 1994 dollars). The approximate annual cost of parkway acquisition and trail development is $104,000 (in 1990 dollars). The breakdown in responsibility for channel alteration and parkway development costs among civil divisions would need to be calculated and agreed upon before any costs per resident could be calculated within each municipality. Using the average annual flood risk benefit of $291,540 yields a benefit-to-cost ratio of 0.43. Flood damages, estimated at an average annual cost of $291,540, would be largely eliminated. Some of the Proposed Project's construction, design and engineering, project management, and contingencies costs which may not yet be included. They include acquisition of stream corridor land necessary to construct the channel; buffer strips; sediment testing and management; erosion control practices; monitoring and maintenance of instream habitat mitigation or improvement practices; wetland and upland planting; and biological restoration in the project area. These cost estimates will need to be updated.

Regional economic development would benefit by virtue of converting several hundred acres of the current regulatory floodplain and other open space into commercial, industrial and residential zones.

Recovery of macroinvertebrate populations in the Pike River Watershed will be dependent on replacing and maintaining suitable substrate conditions, and immigration from undisturbed stream reaches in the watershed.

Construction of the new channel will result in the disturbance of 17 of the existing 67 acres of wetlands along the project corridor. Ten of the 17 acres will be restored and 7 acres will be permanently lost. An additional 176 acres of additional wetlands are proposed to be created and planted. The majority of these wetlands would be created in the two flood control detention ponds proposed to be located on Pike Creek and the upper Pike River; and along the lower bank of the channelized streams. The quantity of wetland proposed to be created is expected to benefit wildlife populations and aesthetics. Final design and wetland construction will also determine the value of the created wetlands relative to flood protection; fish habitat; water quality protection; flora diversity; education and recreation; and groundwater benefits. The quality and diversity of wetlands proposed for the flood channel, and other proposed areas, would depend on the selection of wetland species, coverage, and successful establishment rates.

Up to 10 acres of wetland could be impacted as a consequence of constructing (excavation, grading and filling) dikes along 3.25 miles of the lower Pike River. No wetland, wildlife or fish and aquatic life habitat mitigation was proposed for this element of the Proposed Project.

Wildlife populations are most abundant along the stream corridor having a diverse community of woody vegetation (shrubs and trees). Rechannelization would remove approximately 55 acres along the project area. Proper design, construction and maintenance of the wetlands proposed to be mitigated and created, revegetation of the channel corridor, addition of buffer strips, and acquisition and redevelopment of the proposed parkway would provide long-term benefits for wildlife, and improve the corridors scenic quality.

Channel deepening is not expected to negatively impact the groundwater quality or groundwater table outside the vicinity of the new channel. New urban development will decrease the rate of infiltration to groundwater in localized areas. Construction of the optional 3.25 mile of dike along the lower Pike River may impact groundwater infiltration rates as the frequency of seasonal backwater flooding by the Pike River is reduced.

The total estimated annual cost of channel alterations, floodproofing, habitat mitigation and related bridge replacements is approximately $12,385,400 (in 1994 dollars). The approximate annual cost of parkway acquisition and trail development is $104,000 (in 1990 dollars). The breakdown in responsibility for channel alteration and parkway development costs among civil divisions would need to be calculated and agreed upon before any costs per resident could be calculated within each municipality. Using the average annual flood risk benefit of $291,540 yields a benefit-to-cost ratio of 0.43. Flood damages, estimated at an average annual cost of $291,540, would be largely eliminated. Some of the Proposed Project's construction, design and engineering, project management, and contingencies costs which may not yet be included. They include acquisition of stream corridor land necessary to construct the channel; buffer strips; sediment testing and management; erosion control practices; monitoring and maintenance of instream habitat mitigation or improvement practices; wetland and upland planting; and biological restoration in the project area. These cost estimates will need to be updated.

Regional economic development would benefit by virtue of converting several hundred acres of the current regulatory floodplain and other open space into commercial, industrial and residential zones.

7.0 IMPACT ANALYSIS OF ALTERNATIVE 1

Alternative 1 involves the least floodplain management, compared with the Proposed Project and Alternative 2. Following this alternative, the floodplain is allowed to expand, unchecked, as a result of increased development and runoff. Similarly, Alternative 1 does not manipulate the floodplain boundary through modifications to the stream channel.

Briefly, this alternative assumes the limits of the year-2010 floodplain. Following Alternative 1, the floodplain would be more extensive than both the floodplains that now exists and is assumed to result from the Proposed Project. The chief flood mitigation measure Alternative 1 recommends is floodproofing, elevating, or acquisition of 113 flood prone structures located along the upper and lower Pike River (41), Bartlett Branch (51), and Pike Creek (21).

Alternative 1 does not exclude the implementation of a more comprehensive and voluntary stormwater management program which could provide added flood mitigation and water quality improvements; a voluntary option for improving upland and instream habitat; land acquisition and development for park and recreational uses; or incorporation of "buffer strips" along the stream to improve stormwater runoff quality.

LAND USE AND FLOODPLAIN BOUNDARY

The year 2010 floodplain, as estimated by SEWRPC (1992) under their projected Year 2010 land use conditions, is the assumed floodplain for the Alternative 1 evaluation. Defined by these conditions, the 2010 floodplain would include 2,370 acres. The floodplain would be larger than the floodplain that now exists.

As a result of the expanded floodplain, up to 113 structures would need to be acquired, floodproofed, or elevated to the extent possible. Structures which were not floodproofed, elevated or acquired would continue to be subject to flooding. The same flood hazards would exist for new development.

Following any of the alternatives or the Proposed Project, there would be no relief from problems caused by localized stormwater ponding in low areas or areas of insufficient conveyance. Although, local governments could require future development in low-lying areas to include floodproofing measures.

Consistent with the Proposed Project, further development in the floodplain would be discouraged, but not uniformly prohibited. Present regulation does allow for some floodplain area along the Pike River to be filled. All new development in the floodplain would be regulated to the year 2010 floodplain. The regulated floodplain should apply to the Pike River as well as to all navigable tributaries, including Pike Creek, Bartlett Branch, Waxdale Creek, Chicory Creek, Lamparek Ditch, School Tributary, Somers Branch, Airport Branch, the Tributary to Airport Branch, Nelson Creek and Sorenson Creek. For the short-term, floodplain storage capacity would remain as it is now. The floodplain elevation and capacity would gradually increase, however, as development proceeded in the watershed.

Alternative 1 does not directly call for the development of additional park and open space within the project area. Still, Alternative 1 does not prevent acquisition and development of park and other open space land. Recreational access and use would remain as it is now, with the opportunity that some enhancements could be made. Additional lands could become available for park and other open space land uses as presently flood-prone agricultural lands and other areas planned for development would continue to be subject to flooding and as a result were placed into park and other open space uses.

FLOODING, DRAINAGE AND SAFETY HAZARDS

As many as 113 of the remaining structures in the 2010 floodplain would require elevation, floodproofing or acquisition. Structural flood damages and related monetary and social costs would be reduced. Similar to the Proposed Project, Alternative 1 would reduce, but not eliminate, flood damages related to local drainage problems.

Alternative 1 would not relieve flood damages related to local drainage problems. These problems may include flooded streets, flooded drainage swale and yards, wet basements and wet areas on croplands outside the floodplain.

Discharge volumes and velocities in the Pike River and Pike Creek will be greater than existing conditions as a result of increased runoff from developing areas. Discharge volumes in the Upper Pike River and Pike Creek would be similar to discharges estimated for the Proposed Project (Table 11). Discharges in the Lower Pike River under the 100-year flood frequency and year-2010 land use would increase over existing conditions and those estimated for the Proposed Project. Overall, the potential flood and safety hazards to recreational users of the Pike River, Pike Creek and the Upper Pike River would be similar to existing conditions because the proposed channelized stream reaches have already been channelized. PR 35 notes that under existing development and channel conditions, flood elevations can rise rapidly and flood velocities in the deep, steep-sided channel tend to be "high, and therefore potentially dangerous."

STREAM FLOW, EROSION, AND SEDIMENTATION

In the absence of watershed-wide stormwater management practices for all new developments (as proposed in Alternative 2), or the two flood detention ponds (as identified in the Proposed Project), peak flow volumes and velocities downstream of the project area would increase from existing conditions. Throughout the watershed, the potential for additional problems of channel and stream bank erosion would increase due to additional urban development and associated stormwater runoff.

No channel realignment is proposed under Alternative 1. Furthermore, no debrushing or channel clearing is proposed. Existing streambank erosion barriers — shrubs, trees, and root mass — would remain and, thus, less erosion, sedimentation and other water quality problems related to channel realignment projects are expected. Deadfalls may contribute to localized erosion problems if they are not removed.

In the absence of watershed-wide agricultural and construction site erosion control practices, sediment and other soil related pollutant (i.e., phosphorus) loadings to watershed surface waters and Lake Michigan will increase. In agricultural and open space portions of the floodplain proposed to be developed, the amount of erosion and sedimentation will depend, in part, upon the type and location of development that occurs and how construction site erosion is managed. In the long-term, construction site erosion and sedimentation will decrease as the watershed becomes fully developed.

This alternative does not include recommendations to abate existing problems with soil eroding from stream banks, croplands or other developing land surfaces. These problems could be independently addressed with either voluntary or mandatory best management practices.

Effects of Optional Habitat Improvements

This alternative does not include specific details on the types, numbers, and location of optional structural instream habitat improvement measures (i.e. deflectors). If installed, these structures are not expected to cause any significant problems with respect to channel stability or erosion provided they are properly designed, constructed, and maintained.

WATER QUALITY

Alternative 1 does not recommend modifications to the stream channel or banks. Therefore, the erosion, sedimentation and other related water quality problems (i.e., temperature) otherwise associated with channel realignment projects, would not occur. Water quality would be expected to follow conditions characteristic throughout the watershed. Water quality problems associated with existing stream bank erosion would not be abated.

Effects of Urban Nonpoint Sources of Pollution

In the absence of watershed-wide stormwater management practices for all new developments, stormwater runoff from new development will contribute additional nonpoint sources of pollution to the Pike River, its tributaries and Lake Michigan. Implementing this alternative does not exclude more comprehensive nonpoint source pollution abatement practices from being implemented in the future. However, these urban nonpoint source pollution control practices become more costly and technically difficult to install after the areas are developed.

Stormwater runoff from agricultural sources contain elevated suspended solids and phosphorus along with other nutrients and pollutants sorbed to particles (Noel *et al.* 1992; Mace *et al.* 1984). As development occurs in the watershed, the characteristics of stormwater runoff will change. If the agricultural lands currently in the floodplain are converted to parks or nature areas, then the levels of suspended solids and phosphorus from these lands would decrease from current conditions. If these lands are converted to urban uses, there will be an initial increase in suspended solids and phosphorus during construction. Generally, once the watershed is developed, urban sources of suspended solids and phosphorus may decrease. In the long-term, urban stormwater runoff will result in significant increases in heavy metals, polycyclic aromatic hydrocarbons (PAHs) and bacteria (Bannerman *et al.*, 1993). As with the Proposed Project, no stormwater management practices are proposed under this alternative; hence, the water quality problems associated with urban stormwater runoff that are currently observed will continue and worsen.

With the exception of voluntary controls to abate urban nonpoint sources of pollution, there are no measures proposed to improve the quality and reduce the quantity of stormwater generated by planned development. This alternative does not advance the Great Lakes Water Quality Initiative and other programs aimed at improving water quality and quantity in Lake Michigan.

Implementing Alternative 1 does not exclude the incorporation of buffer strips or filter strips along urban and rural stream reaches to abate polluted stormwater runoff and improve surface water quality.

SEDIMENT QUALITY AND MANAGEMENT

No dredging of the stream channel is proposed for this alternative. Existing levels and quantities of contaminated sediment, if present, would not be removed or resuspended as would be expected to occur under the Proposed Project. No bottom sediments would be dredged, so there would be no potential costs associated with sediment management, including laboratory testing, and the costs and potential liability of disposal. However, unlike the Proposed Project, the potential water quality and biological benefits afforded the removal of contaminated sediments, if present, would not exist under this alternative.

Future sediment quality will follow conditions characteristic of watershed conditions. In the absence of urban stormwater management practices, sediment quality will decrease as the watershed is developed in urban land uses. The sediment quality problems associated with existing runoff will continue and increase relational to the type of urban development that occurs in the watershed.

Although there are no recommendations to treat existing sediment quality problems with soil eroding from croplands or other developed land surfaces, these problems could be independently addressed with either voluntary or mandatory stormwater best management practices.

Anoxic sediment, and if present contaminated sediment, are not proposed to be removed under this alternative.

FISH AND AQUATIC LIFE

Alternative 1 does not recommend modifications to the stream channel. In the absence of additional disturbance, fish and aquatic communities would be expected to slowly recover from past channelization projects. Fish habitat in the upper Pike River is currently rated as "Fair" to "Good" (median equal "Fair to Good"), and fish habitat along Pike Creek is rated as "Poor" to "Fair to Good" (median equal "Fair") (Wessels and Kanehl, 1994). However, water quality would continue to degrade as a result of increased urban development and stormwater runoff (Bannerman *et al.*, 1993). Degraded water quality will offset existing and future improvements in fish and aquatic life habitat.

Implementing Alternative 1 does not exclude installation of additional fish habitat structure. Compared to the Proposed Project, the costs attendant to installing habitat would be less under Alternative 1. Alternative 1 would require the addition of fewer "units" of habitat structure than the Proposed Project since habitat structures would be added only to supplement habitat which already exists.

GROUNDWATER

In the absence of channel deepening on the Pike River and Pike Creek local groundwater elevations should not be affected. Groundwater recharge rates and quality may be reduced as imperviousness increases with urban development.

WETLANDS

No channel deepening or widening, large scale dike construction, clearing or debrushing of river banks is proposed which might affect wetlands in the watershed. Therefore, the existing 67 acres of wetlands located in the project area will not be affected. The amount of wetlands may increase as the floodplain increases in size, the ability to farm becomes more difficult, and land development is restricted.

WILDLIFE

Current riparian and wildlife habitat conditions are expected to remain the same or improve. Without further disturbance caused by channelization, diking, clearing and debrushing, riparian and wildlife habitat may experience some long-term recovery from the impacts of historical channelization. In the absence of abandonment of farming or other uses, this recovery is expected to be limited primarily to maturation of existing trees and potentially a modest increase in plant diversity.

As development is further restricted within the floodplain, consistent with local ordinances, habitat would improve if development occurs as open spaces for parks or nature areas. However, if conversion of remaining agricultural lands within the floodplain is for urban development, the local wildlife populations will need to increasingly rely on the riparian cover of the Pike River for food and shelter (Halvorsen, 1994).

Alternative 1 does not exclude a voluntary option for improving upland wildlife habitat.

OTHER POTENTIAL AND PROBABLE EFFECTS OF THE PROPOSED PROJECT

Endangered Resources Rare, endangered or threatened species, if present along the stream corridor, would not be impacted by this alternative. A review of the WDNR's Natural Heritage Inventory (NHI) did not identify the presence of any rare, threatened or endangered species along the stream corridor.

Similar to the Proposed Project, based upon existing resource information and the present lack of any stormwater quality improvement program, it is not clear that existing habitat and future water quality changes would be amenable to the return of any rare fish or amphibian species.

Natural areas As with the Proposed Project, there is no proposal to designate any state natural areas, or to improve any site to natural area quality, nor should this alternative negatively impact the existing local natural sites at Hawthorne Hollow and Petrifying Springs County Park.

Aesthetics Aesthetics along the corridor will likely remain as presently exists along the stream corridor and floodplain. Some improvements could occur if flood-prone agricultural lands and other areas planned for urban development are placed into park and other open space uses by acquisition or easement. If these lands are acquired for park and open space uses, continued inundation by flood events could promote wetlands along the stream corridor. Flood easements may be required and this may provide an opportunity to create a visually-pleasing riparian corridor than currently exists (Smardon, 1989).

Cultural and Historic Sites With no construction along the stream, there should be no impact to *known* cultural and historic sites.

Relation to Adopted Watershed and Land Use Plans This alterative represents a modification of the existing floodplain management element of the adopted watershed plan. The floodplain would become more extensive than at present (expanding by about 350 acres). In some areas, the amount of developable floodplain land would be less than under the Proposed Project.

Implementation of this alternative would entail a modification of the land use and infrastructure element of the approved watershed comprehensive plan. There would be fewer floodplain acres available for development, especially in the area proposed for development in the headwaters of Pike Creek and Upper Pike River. There would need to be changes in county and local zoning codes and land use plans in response to the added floodplain area.

Farmland Preservation No farmland would be taken out of production within the stream corridor as a direct result of implementing this alternative. An additional 350 acres of farmland and other open rural land would be at risk during major floods, if development proceeds to predicted year-2010 levels. The increased frequency and duration of flooding on existing floodplain farm land may increase as a result of additional runoff from development in the watershed. The profitability of farming both existing floodplain land and the added 350 acres of farmland within the expanded floodplain, would probably decrease.

Regional Economic Development This alternative can be linked to regional economic goals. This would require a deviation in the means to achieve those goals, namely in the need to use adjacent farmland or other open space land to site an increment of planned industrial development that would not be placed within the floodplain.

Transportation This alternative acknowledges regional transportation goals. Unlike the Proposed Project, this alternative does not require the replacement of 16 bridges to accommodate a wider constructed channel. (Six other bridges in the watershed are scheduled for replacement due to transportation needs).

Public Health This alternative does not propose to remove any contaminated river sediments. Contaminated sediments, if present, could impact resident fish and aquatic life, wildlife and human health. The effect on fish migrants from Lake Michigan (i.e. trout) would probably be very small, because most of their tissue accumulation of harmful substances would be due to Lake Michigan sources. In the absence of urban storm water management practices, bioaccumulative contaminants from urban nonpoint sources would continue to be discharged to streams and bottom sediments.

Recreational Access and Use Alternative 1 does not exclude the acquisition and development of public park and open space. This alternative provides an opportunity to develop a public recreational corridor through acquisition of flood easements. Floodplains are well suited for park and open space land uses.

Irretrievable Commitment of Fossil Energy and Non-Renewable Minerals in Construction Elevating and floodproofing up to 113 homes would require concrete and other materials. No significant use of fossil fuels is expected. If at some future time bridge replacement would be necessary to accommodate higher flood flows, then steel, concrete, and other materials would be required. Though costly, these materials are not currently in short supply.

COSTS

Capital costs for the flood risk reduction measures of Alternative 1 would be approximately $2,037,846, for an annual average capital cost over 17 years of $134,845. There would be no annual operation and maintenance cost, so the total average annual cost would also be $134,845. Using the average annual flood risk benefit of $291,540 yields a benefit-to-cost ratio of 2.16.

Costs for the optional buy out of floodplain residences, for the 113 homes in the year-2010 floodplain, would be approximately $9,000,000 to $10,735,000[1] (1995 dollars, assuming an average value of $95,000 per residence).

In order to realize the wages, profits and state and local tax revenues mentioned or implied in Chapters 5 and 6, there would probably be a need to purchase more existing non-floodplain acres than under the Proposed Project. Filling part of the existing floodplain could be a substitute to purchasing this more expensive land. This additional expense for land and/or fill would represent only a small portion of total development costs.

FLOOD RISK REDUCTION BENEFITS

This alternative assumes that the average annual flood damage risk would be reduced by the full average annual flood damage risk amount of $169,500. This reduced cost would stem from a program of structural floodproofing, elevation and acquisition and stricter adherence to local floodplain zoning ordinances.

FUNDING ASSISTANCE FOR FLOOD RISK REDUCTION

Local communities in the watershed, as represented by the Pike River Watershed Committee, could apply for a federal Flood Hazard Mitigation Grant. Grant funds can be used to floodproof, elevate, relocate, or purchase for demolition residential structures. If no funding assistance is available, then either individual property owners would be responsible for protecting their property at their own expense, or communities in the watershed could provide public assistance, via borrowing or property assessments.

SUMMARY FOR ALTERNATIVE 1

Alternative 1 addresses the problem of flooding through floodproofing, acquisition, or elevation of 113 structures located in the planned year-2010 floodplain. This alternative was developed to provide the same level of flood damage reduction and economic development as the Proposed Project. Alternative 1 does provide existing structures relief from flood hazards. Existing floodplain areas proposed for development may be restricted from this use according to local floodplain zoning ordinances. Despite these restrictions, this alternative can be linked to regional economic goals. This would require a deviation in the means to achieve those goals, namely in the need to use adjacent farmland or other open space land to site an increment of planned industrial development that would not be placed within the floodplain.

[1] For comparison, the 50-year cost in 1994 dollars of the Proposed Project is $12,385,000.

Flood damages would be eliminated to the same extent as under the Proposed Project and Alternative 2. The major difference is that up to 89 additional structures would have to be elevated, floodproofed or acquired than under the Proposed Project. This is due to the increase in flood elevations as forecast land use changes occur and generate additional stormwater volume. Overall, public costs would be much less than under either the Proposed Project, or Alternative 2. Since this alternative involves no increase in channel size or requires replacing bridges for a new channel alignment, construction costs would be reduced to those required for floodproofing and elevation.

Localized flooding due to stormwater runoff and surcharging in storm sewers are not resolved with this alternative. Agricultural areas which are currently in the floodplain and being inundated will continue to be subjected to flooding. The degree to which flooding will increase by year-2010 will be determined by the level of development and runoff which occurs in the watershed. Future developments that result in large impervious surfaces will result in increased stormwater runoff and flooding to downstream reaches.

Alternative 1 will result in greater discharge volumes and velocities. This is due to the increase in flood elevations as forecast land use changes occur and generate additional stormwater volume. These conditions, however, are not expected to increase human safety concerns beyond those which currently exist along historically channelized reaches of the Upper Pike River and Pike Creek. The proposed flood control measures will not decrease the frequency with which bridges and approaches are inundated. This will not increase safer vehicular passage during flood conditions.

There are no alterations to the stream channel, by channelization or diking, which would negatively affect erosion and sedimentation rates, water quality, wetlands, and habitat for fish, aquatic life and wildlife. Future fish and aquatic life, and wildlife habitat is expected to be similar to existing conditions. This alternative does not exclude the option for improving upland and instream habitat.

No stormwater management is proposed for existing or future urban developments. Therefore, water quality and sediment quality is not expected to improve under this alternative and will decline proportional to the increases in urban stormwater runoff. Most notably, potentially toxic pollutant loadings of heavy metals and PAHs will increase. As a result of urban construction, suspended solids and other particle bound pollutants such as phosphorus, will increase. Suspended solids and phosphorus may decrease over time as rural sources of soil are "paved over". Alternative 1 does not exclude the implementation of a more comprehensive and voluntary stormwater management program which could provide added flood mitigation and water quality improvements.

Unlike the Proposed Project, contaminated sediment, if present, will not be removed from the stream. If contaminated sediments are present and not removed, fish and aquatic life, and wildlife populations would not benefit.

This alternative will not directly impact the groundwater quality or groundwater table. Similar to the Proposed Project, new urban development will decrease the rate of infiltration to groundwater in localized areas.

This alternative does not propose to recommend the acquisition and development of park and other open space land uses. But at the same time, it does not exclude an opportunity to develop a public recreational corridor through acquisition of flood easements.

Capital costs for the flood risk reduction measures of Alternative 1 would be approximately $2,037,486, for an annual average capital cost over 17 years of $134,845. There would be no annual operation and maintenance cost, so the total average annual cost would also be $ 134,845. Using the average annual flood risk benefit of $169,500 yields a benefit-to-cost ratio of 2.7

Costs for the optional buy out of floodplain residences, for the 113 homes in the year-2010 floodplain, would be approximately $9,000,000 to $10,735,000[1] (1995 dollars, assuming an average value of $95,000 per residence).

Local communities in the watershed, as represented by the Pike River Watershed Committee, could apply for a federal Flood Hazard Mitigation Grant. Grant funds can be used to floodproof, elevate, relocate, or purchase for demolition residential structures. If no funding assistance is available, then either individual property owners would be responsible for protecting their property at their own expense, or communities in the watershed could provide public assistance, via borrowing or property assessments.

This alternative assumes that the average annual flood damage risk would be reduced by the full average annual flood damage risk amount of $291,540. This reduced cost would stem from a program of structural floodproofing, elevation and acquisition and stricter adherence to local floodplain zoning ordinances.

[1] For comparison, the cost in 1994 dollars of the Proposed Project is $9,197,000.

8.0 IMPACT ANALYSIS OF ALTERNATIVE 2

Alternative 2 maintains the elevation and spatial extent of the existing floodplain (defined by 1995 land use and channel conditions), using an integrated floodplain management approach that includes structural and non-structural measures. The principle flood control measure Alternative 2 recommends is a system-wide stormwater management for all new development, where stormwater management is a combination of conveyance, on-site and centralized detention and infiltration.

Added flood hazard relief would be achieved through:

- elevation, floodproofing or acquisition of as many as 55 structures.
- construction of two parallel jetties and periodic maintenance dredging of the channel between the jetties
- selective enlargements to the floodplain at or above the upper stream bank
- habitat mitigation or improvement of enlarged floodplain areas
- selective and limited channel clearing and debrushing

Similar to Alternative 1, this alternative does not exclude an option for improving upland and instream habitat; land acquisition and development for park and recreational uses; or incorporation of "buffer strips" along the stream to improve stormwater runoff quality.

Consistent with the recommendation included in the Proposed Project, Alternative 2 could include the option for constructing a 500 ft. dike along the Bartlett Branch if additional floodplain analysis indicates that the dike is a cost effective means of reducing flood damages. Based on existing Year 1995 land use conditions and floodplain elevations, there may be between 3 and 51 structures which could be protected from the 100-year flood event by constructing the 500 ft. dike. The impacts of dike construction have been described under the Proposed Project. Overall, construction of the 500 ft. dike along the Bartlett Branch would not have any significant environmental impacts.

Most of the 11.5 miles of upper banks along Pike Creek and the upper Pike River have been disturbed as a consequence of past channelization. As a result, many of the most severe environmental impacts have already occurred, or continue to impact, wildlife habitat along those streams. The impacts of channelization and upper bank disturbances on natural streams are documented in the literature (including the Pike River Watershed). Although there is less documentation on the negative effects of repeating upper bank modifications, the impacts would be similar to the original channelization because of the nature of the activity (i.e. removal of vegetation and erosion). Additional disturbances to the upper bank would cause a setback to the progress made toward partial restoration of wildlife habitat recognizing that some upper banks have not been disturbed for decades.

LAND USE AND FLOODPLAIN BOUNDARY

According to SEWRPC land use projections, approximately 3,000 acres now employed in agricultural and open land uses in the Pike River Watershed would be converted to urban areas. Under this alternative, new development in the watershed would be required to implement stormwater management to maintain or reduce runoff rates and volumes under existing land use conditions. In implementing system-wide stormwater management, local governments would need to review county and local zoning codes and land use plans which are based on the Proposed Project floodplan element and Year 2010 land uses. Additionally, local government could designate parkways and other conservancy greenways as well as require compact land uses (subdivisions and office parks).

Selective enlargements to the upper bank would be considered along reaches where flood hazards were not completely mitigated through watershed-wide stormwater management. In combination with these structural flood mitigation measures, the enlarged upper banks would provide additional flood storage and conveyance capabilities.

This alternative assumes the limits of the existing (1995) floodplain. The approximately 2,370 acres that presently lie within the floodplain would remain. (Of this total, 478 acres are employed in urban land uses, 48 acres in protected open space, wetland or environmental corridor and 1844 acres in agricultural land uses). Land uses within the floodplain could be regulated to emphasize open space and other land use compatible with the existing local floodplain ordinances. Implementation of Alternative 2 would entail some change from the land use and infrastructure element of the approved watershed plan. There could be fewer acres available for development—especially in the area along the headwater's of Pike Creek and the Upper Pike River.

Consistent with the Proposed Project, further development in the floodplain would be discouraged, but not uniformly prohibited. Present regulation does allow for some floodplain area along the Pike River to be filled. All new development in the floodplain would be regulated to the existing 1995 floodplain. The regulated floodplain should apply to the Pike River as well as to all navigable tributaries, including Pike Creek, Bartlett Branch, Waxdale Creek, Chicory Creek, Lamparek Ditch, School Tributary, Somers Branch, Airport Branch, the Tributary to Airport Branch, Nelson Creek and Sorenson Creek. The floodplain elevation and capacity would remain similar to existing land use conditions with the implementation of stormwater management practices for new developments.

Alternative 2 does not directly call for the development of additional park and open space within the project area. Still, Alternative 2 does not prevent implementation of existing park and open space plans. Recreational access and use would remain as it is now, with the opportunity that some enhancements could be made. Additional lands could potentially become available for park and other open space land uses as presently flood-prone agricultural lands and other areas planned for development were placed into park and other open space uses.

Effect of Jetties

The proposed jetties would be effective in providing flood hazard relief for the areas intended, as described in the Proposed Project.

FLOODING, DRAINAGE AND SAFETY HAZARDS

Alternative 2 recommends floodproofing, elevating or acquiring 55 flood prone structures. In following the Proposed Project, structural flood damages and related monetary and social costs would be reduced. Similar to the Proposed Project, Alternative 2 would reduce, but not eliminate, flood damages related to local drainage problems. These problems may include flooded streets, flooded drainage swale and yards, wet basements and wet areas on croplands outside the floodplain.

Alternative 2 flood control measures would maintain flood flows along the upper Pike River, Pike Creek and the Airport Branch at current levels (see Chapter 6, Table 11). Frequency of flooding along bridges in the project area is expected to occur at existing levels. Under design flood (100-year recurrence interval) conditions, channel conditions may not increase the level of safety for vehicular passage beyond that which currently exists.

Overall, the potential flood and safety hazards to recreational users of the Pike River, Pike Creek and the upper Pike River would be similar to existing conditions. PR 35 notes that under existing development and channel conditions, flood elevations can rise rapidly and flood velocities in the deep, steep-sided channel tend to be "high, and therefore potentially dangerous."

STREAM FLOW, EROSION AND SEDIMENTATION

In following Alternative 2, the stream channel in the project area would be characterized by flow volumes and velocities less than yielded under the Proposed Project and Alternative 1. Through use of detention basins and other stormwater measures, peak stream flow volumes and velocities should approximate existing conditions.

Effect of Upper Bank Enlargement

Alternative 2 provides an option to selectively enlarge the floodway above the upper bank (above the 2-year recurring stream flow). Vegetation would be initially removed, and later restored along enlarged upper bank reaches.

Since the enlarged upper banks will be constructed in the existing floodway, some erosion and sedimentation is unavoidable, especially under larger flood events. Construction site erosion control practices can minimize, but not entirely avoid, erosion and sedimentation. Some short-term erosion and sedimentation will occur until the upper banks are stabilized in permanent vegetation. Short-term construction erosion under Alternative 2 will be less than that which would occur under the Proposed Project because Alternative 2 does not recommend any deepening of the existing hydrologically active stream channel and lower bank.

Alternative 2 will also result in more stable long-term channel compared to the Proposed Project. Alternative 2 does not result in any major changes in stream sediment discharge or concentration; median particle size and bedload discharge; water discharge; changes in stream velocity, surface water slope and depth; channel width, sinuosity and valley slope. According to Nunnally (1985), avoiding changes in these fluvial geomorphological factors will maintain a more stable stream channel.

Alternative 1 does not provide for any channel modifications. Therefore, there is less potential for short-term or long-term erosion and sedimentation.

Effects of Selective Clearing and Debrushing

Trees and other woody vegetation have been shown to have a significant effect in retarding bank erosion (Shields and Nunnally, 1984). Large fallen trees and large log jams may also trigger bank erosion, particularly in small streams (Brookes, 1988). Whole-scale clearing and snagging can reduce bank resistance to erosion resulting in channel widening and downstream sedimentation (Strauser and Long, 1976). Plant species which are native to riparian floodway environments have been shown to provide the greatest level of bank erosion control (Brookes, 1988).

Limited and selective channel clearing and debrushing should not cause significant amounts of bank erosion and sedimentation provided certain construction guidelines were followed. In following these guidelines, channel conveyance of flood flows would improve while maintaining bank stability. Gregory and Stoke (1980) and Shields and Nunnlly (1984) recommend alternatives to large scale channel clearing and snagging projects which are less detrimental to channel stability and habitat. Clearing and snagging should be undertaken on small and localized areas, on an as needed basis. Material not causing blockage or erosion should be maintained and rooted trees should only be removed if they are overhanging the channel at a 30° or more. Tree removal should be considered only along one bank and care should be taken to insure that the most potentially unstable bank be left unchanged. Hand removal using small hand tools is preferred. Debrushing is recommended along one or alternating banks. Natural debris should be removed only where it is a significant impediment to stream flow or when it is causing bank stability problems.

Following these guidelines, Alternative 2 is not expected to significantly impact stream bank stability and erosion. Although the Proposed Project's large-scale debrushing and clearing would provide more efficient conveyance of flood flows, the Proposed Project would result in greater potential for bank erosion problems.

Effect of Jetties

As previously described under the Proposed Project, the construction of several jetties are not expected to result in significant erosional related impacts to the environment.

WATER QUALITY

Effect of Upper Bank Enlargement

Constructing enlarged upper banks may impact water quality as a result of construction site erosion. If construction site erosion control practices are not installed and maintained, the impacts of excessive erosion on water quality would be similar to those described for the Proposed Project (see Chapter 6). Excessive amounts of erosion would increase suspended solids and other particle bound pollutants, such as phosphorus; increase turbidity; water temperature; and primary productivity. As with the Proposed Project, these impacts would occur during the construction phase of the project and until such time that the area is protected with vegetation. Post-construction water quality impacts are dependent upon the long-term stability of the upper banks, and time needed to "flush" newly deposited sediment. The level of impacts can be reduced, but not entirely avoided, provided steps are taken to reduce construction site erosion.

Overall, the amount of erosion and resulting water quality impacts associated with Alternative 2 would be less than the Proposed Project because no deepening of the hydrologically active stream channel or lower bank will occur. Compared with Alternative 1, Alternative 2 will result in more erosion and related water quality impacts.

Effects of Urban Nonpoint Sources of Pollution

As previously discussed in Chapter 6, studies have shown that runoff from urban land uses degrade water quality (Pitt and Bozeman, 1982; Field and Pitt, 1990; Bannerman, 1983 and 1993; Marsh, 1993), sediment (Masterson and Bannerman, 1994) and aquatic habitat (Sloane et al., 1981; Schueler, 1991; Weaver and Garman, 1994; Masterson and Bannerman, 1994). Urban runoff contributes heavy metals, pesticides, bacteria, suspended solids, nutrients and polycyclic aromatic hydrocarbons (PAHs) to surface waters and often exceed water quality standards (U.S. EPA, 1983; Bannerman et al., 1983; Bannerman et al., 1993).

Alternative 2 includes actions needed to reduce urban nonpoint sources of pollution from new developments. Approximately 22.5 acres of detention ponds are proposed to abate nonpoint sources of pollution from new urban developments, using a 75% reduction goal for suspended solids. Increasing the detention basin acreage to 45 acres and modifying the outlet control structure would provide flood storage benefits. Additional flood control benefits may be realized by using practices centralized and on-site stormwater management practices which encourage infiltration of runoff (i.e. grassed waterways). Additional hydraulic analysis would be required.

Due to existing limits on pollution prevention technologies, urban stormwater pollutant loadings from new development would still increase under Alternative 2, but at significantly lower levels compared to the Proposed Project and Alternative 1.

The effectiveness of stormwater management practices for new developments as recommended by Alternative 2, Alternative 1 and the Proposed Project is provided for comparative purposes.

Pollutant	Proposed Project[1)]	Alternative 1[2)]	Alternative 2[3)]
Total Suspended Solids	10-25%	none	>80%
Phosphorus	5-10%	none	>40%
Heavy Metals	10-25%	none	>60-70%
Hydrocarbons (PAHs)	10-25%	none	>60-70%
Pesticides	5% water soluble & application dependent	none	<5% water soluble & application dependent
Chlorides	minimal water soluble & application dependent	none water soluble & application dependent	none water soluble & application dependent
Litter	10-25%	none	>90% of non-floatables; >90% floatables w/ submerged outlet & maintenance
Bacteria	5%	none	5%

1) Assumes recommendations in SEWRPC PR 35 including control of litter and pet wastes, proper application of pesticides and fertilizers, construction site erosion controls, streambank erosion controls, and proper application of de-icing solutions, catch basins designed to maximize trap efficiency, and excellerated street sweeping to twice/month and catch basin cleaning twice per year by Town of Mt. Pleasant and City of Kenosha.

2) Assumes no educational, voluntary, structural and non-structural practices. Alternative 1 does not exclude nonpoint sources pollution control practices identified in footnote 1 above.

3) Assumes combination of nonpoint source pollution control practices identified in footnote 1 above plus multiple purpose detention ponds for flood control and water quality. Total of 22.5 acres of centralized wet detention basins for new development.

Sources: City of Kenosha and Village of Mount Pleasant; Bruch (pers. comm 1995); Bannerman (pers. comm. 1995); Local Stormwater Management Plan for the City of Sheboygan-Sheboygan River Basin Priority Watershed

Overall, net reductions in watershed urban nonpoint sources of pollution can only be achieved by extending structural, non-structural, voluntary and educational control measures into existing developments. While implementing either the Proposed Project or Alternative 1 does not exclude incorporation of multiple purpose detention pond facilities recommended in Alternative 2, this practice becomes more costly and technically difficult to install after the areas are developed.

Implementing Alternative 2 does not exclude the incorporation of buffer strips or filter strips along urban and rural stream reaches to abate polluted stormwater runoff and improve surface water quality.

Effects of Selective Clearing and Debrushing

Selective channel clearing and debrushing may cause some bank erosion and sedimentation, and other attendant water quality problems. Water temperatures may lead to increases in ambient water temperatures. Overall, the effects of selective clearing and debrushing may be less than those which could occur under the Proposed Project's larger-scale clearing and debrushing element.

SEDIMENT QUALITY AND MANAGEMENT

No deepening of the existing stream bed, or enlargement of the channel below the 2-year recurring stream flow, is proposed for this alternative. Existing levels and quantities of contaminated sediment, if present, would not be removed or resuspended as would be expected to occur under the Proposed Project. No bottom sediments would be dredged, so there would be no potential costs associated with sediment management, including laboratory testing, and the costs and potential liability of sediment disposal. However, unlike the Proposed Project, the potential water quality and biological benefits afforded by the removal of contaminated sediments, if present, would not exist under this alternative.

Along with water quality, stream sediment quality in the project area is expected to remain at present levels as watershed-wide stormwater management practices are implemented for all new development.

The detention basins will require a program of periodic maintenance, in order to remove potentially contaminated sediments. The frequency and costs are dictated by the effectiveness of other practices tributary to the ponds such as construction site erosion control practices and street sweeping. Overall pond maintenance costs may be less than the economic, social and environmental costs attendant to removing contaminated sediments deposited onto the stream from urban nonpoint sources of pollution.

Effect of Jetties

The sediment quality in Lake Michigan is not expected to be significantly affected by the construction of jetties or maintenance dredging at the mouth.

FISH AND AQUATIC LIFE

Similar to Alternative 1, this alternative does not recommend modifications to the stream channel below the 2-year recurring stream discharge elevation. The cover provided by existing instream structures and riparian vegetation would not be disturbed, and in the absence of additional channelization, habitat, fish and aquatic communities would continue to improve over existing conditions. Fish habitat in the upper Pike River is currently rated as "Fair" to "Good", and fish habitat along Pike Creek is rated as "Poor" to "Fair to Good" (Wessels and Kanehl, 1994).

The option exists for enlarging the upper bank to improve flood flow conveyance. Erosion from constructing the enlarged upper bank can be minimized, but not entirely avoided, using standard construction erosion control practices. Excessive amounts of erosion and resulting instream sedimentation will negatively impact fish and aquatic life communities. Overall, the potential for erosion and sedimentation would be less under Alternative 2 compared to the Proposed Project because no dredging of the stream channel and lower banks will occur. Erosion and sedimentation potential will be greater than Alternative 1.

Implementing Alternative 2 does not exclude installation of additional fish habitat structure. Compared to the Proposed Project, the costs attendant to installing habitat would be less under Alternative 2 and Alternative 1. Alternative 1 and 2 would require the addition of fewer "units" of habitat structure than the Proposed Project since habitat structures would be added to supplement habitat which already exists.

Effects of Selective Clearing and Debrushing

Overhanging vegetation provides important cover for fish in the upper Pike River and Pike Creek (Wessels and Kanehl, 1994). Under Alternative 2, selective clearing and debrushing will reduce the amount of cover available to fish and aquatic life. The level of removed cover and resulting impacts to fish and aquatic life would be less than would be expected to occur as a result of implementing the Proposed Project's large-scale debrushing and clearing element.

Selection of areas to be managed could follow guidelines suggested by Gregory and Stoke (1980) and Shields and Nunnlly (1984). These authors recommend alternatives to large scale channel clearing and snagging projects which are less detrimental to channel stability and habitat, while still allowing for improved hydraulic capacity. Clearing and snagging would be undertaken on small and localized areas, on an as needed basis. Material not causing blockage or erosion should be maintained. Rooted trees should only be removed if they are overhanging the channel at a 30° or more. Removal should be considered only along one bank and care should be taken to insure that the most potentially unstable bank be left unchanged. Hand removal using small hand tools is preferred. Debrushing is recommended along one or alternating banks. This may provide an improvement in hydraulic conveyance while providing enough vegetation to maintain bank stability and habitat.

Effect of Jetties

Similar to the Proposed Project and Alternative 1, Lake Michigan habitat is not expected to be appreciably impacted by the jetties. Periodic maintenance dredging should have limited adverse ecological impact, because there are abundant aquatic organism recruitment areas from surrounding lake-bed and upstream undredged river reaches.

GROUNDWATER

Groundwater quality will not be adversely affected as a result of implementing Alternative 2. No channel deepening is proposed. Therefore, there should be no effect on the local groundwater table beyond the enlarged upper bank areas. Retention of the existing floodplain will minimize disruption of groundwater recharge, and help protect groundwater quality. Detention basins should be designed and located in suitable soils to prevent contamination of groundwater.

Effect of Jetties

Groundwater interaction with the surface waters of the Pike River are not expected to change from current conditions as a result of the proposed jetties in Lake Michigan.

WETLANDS

Alternative 2 will impact wetlands located along stream reaches where upper bank channel enlargements are constructed. To the greatest extent possible, upper bank enlargement should avoid stream reaches with riparian wetlands. Similar to the Proposed Projects, up to 17 acres of wetlands could be disturbed if upper bank channel enlargements are constructed along all 11.5 miles of the upper Pike River and Pike Creek. All disturbed wetlands would require restoration.

Wetlands located upgradient of the upper bank enlargement areas are not expected to be impacted by changes in the local groundwater table, or modification of surface water drainage. These wetlands are maintained by perched water tables.

Effects of Selective Clearing and Debrushing

Clearing of woody shrubs and trees will remove shade along the riparian area. This area may contain wetland plant species which are intolerant of direct sun and heat. Removal of shade vegetation may cause dieback and sunscald to less tolerant wetland vegetation, and a shift to species more tolerant of dry conditions (Barclay et al., 1982). Overall, selective clearing and debrushing as proposed under Alternative 2 would have less of an impact than the Proposed Project.

Effect of Jetties

The impacts on wetlands by the construction of jetties into Lake Michigan is expected to be minimal. The wetlands near the mouth of the Pike River are affected by lake water levels.

WILDLIFE

Stream corridors and riparian wetlands provide critical wildlife habitat, especially in more developed (agricultural and urban) landscapes. Alternative 2 would result in disturbing existing wildlife communities and their habitat by constructing upper bank enlargements. If all 11.5 miles of upper bank along the upper Pike River and Pike Creek were to be enlarged, the amount of disturbed vegetation and wildlife cover would be similar to the approximately 55 acres that would be disturbed under the Proposed Project. Wildlife and wildlife cover would not be disturbed under Alternative 1. Similar to the Proposed Project, most woody vegetative cover would be replaced with grasses in order to improve hydraulic conveyance along the enlarged upper bank. Clustered plantings of woody vegetation along the upper bank could mitigate the loss of woody vegetation while minimizing the negative effects on stream hydraulics. The effects of removing woody vegetation on wildlife populations may extend to 15 - 30 years.

Channel enlargement areas would have to be restored to meet or exceed the quality and quantity of wildlife habitat which previously existed. The short-term and long-term impacts of upper bank enlargement on wildlife populations will depend on the resiliency of wildlife population, the final design and construction of habitat mitigation features.

Unless preventive measures are taken, undesirable invasive plant species could colonize the constructed stream channel immediately following disturbance. A revegetation plan would need to be developed to include measures specifically to minimize problems with undesirable species.

Effects of Selective Clearing and Debrushing

Similar to the Proposed Project, selective clearing and debrushing of vegetation and debris along the 11.5 miles of stream channel would impact wildlife populations. The scale of impact associated with Alternative 2 would be less than under the Proposed Project.

Implementation of this alternative would not exclude measures to improve existing wildlife habitat.

OTHER POTENTIAL AND PROBABLE EFFECTS

Endangered Resources Rare, endangered or threatened species, if present along the stream construction corridor, would be impacted by this alternative. However, a review of the WDNR's Natural Heritage Inventory (NHI) did not identify the presence of any rare, threatened or endangered species that could be impacted as a result of the Proposed Project.

The WDNR Bureau of Endangered Resources (BER) has noted that with improvement in surface water quality in the watershed, it may be possible to attempt the reintroduction of rare fish species, and possibly other aquatic and terrestrial organisms in the watershed. As an example, historic fish surveys reported collecting redfin shiners (state "threatened") and least darters (state "special concern"). Their reintroduction into the Pike River system might be possible if water quality conditions and other habitat requirements are improved through implementation of the alternatives recommended stormwater management plan.

Natural Areas: There is no activity which will impact state natural areas. There is no proposal to designate any state natural areas, or to improve any site to natural area quality, nor should the Proposed Project negatively impact the existing local natural sites at Hawthorne Hollow and Petrifying Springs County Park.

Aesthetics The enlarged floodway channel itself may appear less scenic than it is now along certain reaches, due to the removal of existing trees and their replacement with tall grasses. There are also a few reaches that are currently confined by existing development and a narrow ribbon of pioneer trees and shrubs. These areas may be viewed as less appealing once they are altered by vegetation removal and construction. Improvements in existing aesthetics could be made by varying the dimensions of the enlarged upper bank and replanting and landscaping the upper banks with a diverse mixture of plants.

Cultural and Historic Sites The impact on *known* cultural and historic sites would be similar to that of the Proposed Project. Further review of the proposed location of detention ponds and floodway enlargement construction by State Historical Society staff would be necessary before construction could begin. Adjustments in locating detention ponds and floodway enlargement may be necessary.

Relation to Adopted Watershed and Land Use Plans Alternative 2 presents a modification of the floodplain management element of the adopted watershed plan. The floodplain would remain similar to existing conditions. Upon completion of the project, the residual floodplain would be more extensive than under the Proposed Project.

Some areas that lie within the existing and planned year-2010 floodplain could not be developed due to residual flood hazards. However, some of this land could still be filled for development, as it can under existing floodplain regulations.

There would also need to be some changes in county and local zoning codes, and land use plans. These would be necessary to make formal designations of stormwater detention and treatment areas, and to consider more compact land use in subdivision, office and industrial development, as well as to provide the most energy-efficient modes of transportation possible to new development. The configuration of streets and home sites would be more compact than in contemporary residential developments. This would make more land area available for both small and large greenways that would help control the effects of additional stormwater and provide water quality improvements.

There would be no significant increase in the existing frequency or magnitude of flood hazards or damage to agricultural land due to implementing this alternative. Future damages may be expected to be similar to existing conditions, or reduced, depending on the benefits provided by stormwater management and upper bank channel enlargement.

<u>Farmland Preservation</u> This alternative has not been coordinated with any current farmland preservation program. Some cropland may be taken out of production for floodway widening, stormwater detention, industrial development, and other uses, but much of that land is presently in the floodplain, and may not be as consistently productive as land above the regional flood elevation. Detention sites would have to be located in a manner that takes up the least amount of prime agricultural land, such as locating these facilities in former wetland sites.

This alternative will not cause any increase in future flood damages to agricultural lands.

<u>Regional Economic Development</u> Just as is the Proposed Project and Alternative 1, this alternative is linked to regional economic goals. This would require a deviation in the means to achieve those goals, namely in the possible need to use adjacent farmland or other open space land to site an increment of planned industrial development that would not be placed within the Pike Creek headwaters floodplain.

<u>Transportation</u> The Proposed Project acknowledges regional transportation goals. Planned future bridge replacements and highway expansions may have to accommodate the wider constructed floodway at stream crossings. The extent to which bridge crossings are effected would require further stream flood analysis. Independent of this alternative, six other bridges in the watershed are scheduled for replacement due to transportation needs.

<u>Public Health</u> To the extent that some features of this alternative contribute to better water quality, public health benefits would be increased, but because the Pike River contributes only a small fraction of the total contaminant load of Lake Michigan, the benefits to those who eat fish, waterfowl, etc. from the lake would not be noticeably different than under the Proposed Project.

If present, sediment contaminated by bioaccumulative substances would not be removed under this alternative. If fish, waterfowl, etc. continue to be exposed to these contaminants, human health may be jeopardized by excess consumption of contaminated fish and wildlife tissue.

Recreational Access and Use There would be no direct improvement in benefits in comparison to the Proposed Project. Further improvements in water quality could improve sport fish stocks and angling opportunities.

This alternative would be compatible with the proposed parkway trail located within the floodplain. Use of the trail would be interrupted during larger flood events.

If the fish barrier on the golf course grounds were removed, it would help alleviate existing trespass problems on the Kenosha Country Club grounds by spreading fishing opportunities upstream of the golf course. Public access sites with parking along the proposed public parkway should prevent trespass problems in these upstream areas. Removal of the drop structure within Petrifying Springs County Park would allow anadromous and resident fish to migrate upstream and make use of the upper Pike River and Pike Creek, as well as to further ease crowding by diffusing angling opportunities.

Irretrievable Commitment of Fossil Energy and Non-Renewable Minerals in Construction

The amount of fossil energy (mostly diesel fuel) required to implement this alternative would be roughly one-quarter the amount required by the Proposed Project. The amount of concrete and other materials needed to floodproof or elevate structures would be more than for the Proposed Project but less than for Alternative 1.

The amount of steel required for the jetties is the same as under the Proposed Project, and some of this may be salvageable for future needs.

Costs and Funding

Capital costs for the flood risk reduction measures of Alternative 2 would be approximately $8,136,085. The annual average cost over 17 years would be $621,510, including operation and management. Using the average annual flood risk benefit of $291,540 yields a benefit-to-cost ratio of 0.47. Maintenance costs increase the 50-year cost to $15,623,552.

Costs for the optional buy out of floodplain residences, for the 55 homes in the Year 2010 floodplain, would be approximately $5.5 million (1995 dollars, assuming an average value of $ 100,000 per residence.)

Land use controls can reduce the costs to area property tax payers. Assuming this plan would be implemented over a number of years, conservation easements can be acquired through required dedication at the time riparian property is (sold or) rezoned. Another means is to initiate a "*Transfer of Development Rights*" (TDR) program within the watershed or within the counties that contain the watershed. Under a TDR program, buyers of designated riparian land would be prohibited from developing a certain number of acres of that land, but would be able to sell at market value a set amount of "development rights" that could be used by others in designated development zones. Under this scenario, the breakdown of costs for parkway acquisition and development is as follows:

More acres of farmland would be taken out of production than under the Proposed Project. An approximate number would require an in-depth analysis of stormwater detention needs. This could result in the loss of several agriculture-related jobs.

The impact on property values and local taxes would be very similar to that under the Proposed Project. Assessments of residential properties along the tributaries that are designated for modest wetland restorations would probably not increase, because there would be no publicly designated greenway. If conservation land dedications or easements are not required as a means of obtaining additional lands of funds needed for the proposed parkway and to maintain a substantial increment of floodplain storage, then an increase in the drainage district levy may be necessary to raise the required funds.

This alternative brings with it a program of local zoning changes that may include smaller lot sizes, and overall more compact land use. This would allow for easier choices in designating open space, and would help to ensure that the higher selling prices and attendant property tax benefits expected of new homes adjacent to the greenway would accrue.

The land conversion/development windfall phenomenon mentioned under the analysis of the Proposed Project would be largely offset by a Transfer of Development Rights (TDR) program, and by the proposal to enact a development impact fee.

FLOOD RISK REDUCTION BENEFIT

Flood control and land development benefits would be similar to those in the Proposed Project and the previous alternative. Alternative 2 would be effective in relieving future drainage problems related to new development.

SUMMARY FOR ALTERNATIVE 2

Similar to the Proposed Project, Alternative 2 achieves flood damage and hazard abatement within the project area while allowing development to proceed throughout the watershed. However, some existing floodplain lands may not be developable.

Alternative 2 maintains the elevation and spatial extent of the existing floodplain (defined by 1995 land use and channel conditions), using an integrated floodplain management approach that includes structural and non-structural measures. The principle flood control measure Alternative 2 recommends is a system-wide stormwater management for all new development, where stormwater management is a combination of conveyance, on-site and centralized detention and infiltration. Floodproofing, elevation or acquisition is recommended for 55 structures located in the existing and Year-2010 floodplain. Enlargements to the channel upper bank may be considered when stormwater management is shown not to be entirely effective in reducing flooding hazards to existing structures. Limited and selective clearing and debrushing may be included to eliminate major blockages during flood flows.

This alternative assumes the limits of the existing (1995) floodplain, therefore, the approximately 2,370 acres that presently lie within the floodplain would remain. Of this total, 478 acres are employed in urban land uses, 48 acres in protected open space, wetland or environmental corridor and 1844 acres in agricultural land uses. There could be fewer acres available for urban development — especially in the area along the headwater's of Pike Creek and the Upper Pike River. These remaining floodplain lands could be developed for land uses consistent with existing local floodplain ordinances. Implementation of Alternative 2 would entail some change from the land use and infrastructure element of the approved watershed plan.

This alternative will not result in greater stream peak discharge volumes and velocities. These conditions, however, are not expected to increase human safety concerns beyond those which currently exist along historically channelized reaches of the upper Pike River and Pike Creek. The proposed flood control measures will not decrease the frequency with which bridges and approaches are currently inundated.

Alternative 2 reduces the negative impacts associated with urban nonpoint sources of pollution from new development. Discharges of urban nonpoint sources of pollution will increase, but at levels less than would be expected to occur under the Proposed Project and Alternative 1. Overall decreases in existing urban nonpoint sources of pollution can be reduced by extending urban nonpoint sources pollution control practices (structural and/or non-structural) to existing developments. Control of nonpoint sources of pollution will benefit stream and Lake Michigan water quality, sediment quality, fish and aquatic life, wildlife and human health.

Alternative 2 does not recommend modifications to the lower bank or bottom channel. Therefore, the existing fish and aquatic life habitat provided by instream and riparian vegetation will remain in tact. Other consequences common to channelization or rechannelization projects—increased water temperature; increased turbidity; loss of bankside canopy cover; increased pollutant loadings; increased bed and bank erosion within, upstream and downstream of channelized reaches; increased downstream flooding and sedimentation—will be reduced.

Similar to Alternative 1, this alternative does not exclude an option for improving upland and instream habitat; land acquisition and development for park and recreational uses; or incorporation of "buffer strips" along the stream to improve stormwater runoff quality. Additional flood prone lands could become available for park and other open space land uses as development is steered away from floodplains.

The chief environmental consequences to implementing Alternative 2 are related to upper bank channel enlargement, and to a lesser degree, selective and limited channel clearing and debrushing. These actions are proposed to provide improved flood flow conveyance and flood storage benefits. As a result of upper bank channel enlargement, short-term increases in streambank erosion and sedimentation will occur. Use of construction site erosion control practices can minimize, but not entirely eliminates all erosion. Erosion potential would be greatest during the construction phase of the project, especially during larger rainfall and stream flow events. Failure to control erosion would result in sedimentation, increased levels of turbidity and other soil particle bound pollutants such as phosphorus, and increases in water temperature. This conditions will result in direct and indirect impacts to fish and aquatic life, primary producers, and wildlife populations. Removal of overhanging vegetation, through channel enlargement and debrushing, will increase water temperatures until such time that vegetation is restored.

Wildlife populations are most abundant along the upland stream corridor and wetlands. This alternative will disturb up to 17 acres of wetlands and up to 55 acres of wildlife habitat along the upper banks. All disturbed wildlife habitat and wetlands would need to be restored. Final design and wetland construction will determine the value of the restored wetlands relative to flood protection; fish and wildlife habitat; water quality protection; flora diversity; education and recreation; and groundwater benefits. The quality and diversity of restored wetlands and upland habitats would depend on the selection of plant species, coverage, and successful establishment rates.

Upper bank enlargement is not expected to negatively impact the groundwater quality or groundwater table outside the vicinity of the construction area. Overall, new urban development will decrease the rate of infiltration to groundwater in localized areas. Implementation of certain storm water management practices may partially reduce these impacts.

Capital costs for the flood risk reduction measures of Alternative 2 would be approximately $8,136,085. The annual average cost over 17 years would be $621,510, including operation and management. Using the average annual flood risk benefit of $291,540 yields a benefit-to-cost ratio of 0.47. Costs for the optional buy out of floodplain residences, for the 55 homes in the Year 2010 floodplain, would be approximately $5.5 million (1995 dollars, assuming an average value of $100,000 per residence.)

Flood control and land development benefits would be similar to those in the Proposed Project and Alternative 1. Alternative 2 would be partially effective in relieving future drainage problems related to new development, since the stormwater system could be designed to help solve these problems, in conjunction with good site design for new development.

9.0 IMPACT ANALYSIS OF ALTERNATIVE 3: NO ACTION ALTERNATIVE

The Proposed Project, Alternative 1 and Alternative 2, all involve some level of floodplain management. Following the No Action alternative, the floodplain is allowed to expand, unchecked, as a result of increased development and no attempt is made to address flooding. The existing local floodplain ordinances would continue to direct development in the floodplain. No stream modifications, floodproofing of existing structures, construction of dikes and jetties, nor water quality measures would be implemented in the Pike River Watershed.

Briefly, this alternative assumes the limits of the 2010 floodplain. The floodplain would be more extensive than both the floodplains that now exists and is assumed to result from the Proposed Project.

LAND USE AND FLOODPLAIN BOUNDARY

The year 2010 floodplain, as estimated by SEWRPC (1992) under their projected Year 2010 land use conditions, is the assumed floodplain for the No Action alternative. As a result of the expanded floodplain, up to 113 structures would be subjected to flooding by Year 2010. The same flood hazards would exist for new development in the floodplain. Present regulation does allow for some floodplain area along the Pike River to be filled. The floodplain elevation and capacity would gradually increase, however, as development proceeded in the watershed.

As with any of the alternatives or the Proposed Project, all of the problems caused by localized stormwater ponding in low areas or areas of insufficient conveyance, would not be resolved.

The No Action alternative would be less conducive to implementing existing park and open space plans because of increased flooding and further degraded water quality. Recreational access and use would remain as it is now.

FLOODING, DRAINAGE AND SAFETY HAZARDS

The No Action alternative would not relieve flood damages related to local drainage problems and increased stormwater runoff as new development occurs in the watershed. These problems may include damage to structures within the floodplain, flooded streets, flooded drainage swale and yards, wet basements and wet areas on croplands outside the floodplain. Transportation bridges subject to flooding potentially could affect emergency vehicle routes.

Discharge volumes and velocities in the Pike River and Pike Creek will be greater than existing conditions during stormwater runoff events as a result of increased runoff from developing areas. The channel would not be deepened nor would the existing woody vegetation be removed from the stream banks. However, safety hazards would likely increase as more area is subject to floodplain floods. Bankside woody vegetation, such as shrubs or overhanging trees, might allow a person caught in a fast current to more easily remove themselves from the stream.

STREAM FLOW, EROSION, AND SEDIMENTATION

No channel realignment is proposed under the No Action alternative. Furthermore, no debrushing or channel clearing is proposed. Existing streambank erosion barriers— shrubs, trees, and root mass— would remain and, thus, less erosion, sedimentation and other water quality problems related to stream dredging projects are expected.

Under the No Action alternative, no system-wide stormwater management practices (as proposed in Alternative 2), nor detention ponds (as identified in the Proposed Project) are called for; hence, peak flow volumes and velocities downstream of the project area would increase from existing conditions.

Throughout the watershed, the potential for additional problems of channel and stream bank erosion would increase due to additional development and urban storm water runoff in absence of any stormwater management.

There are no recommendations to treat existing problems with soil eroding from croplands or other developed land surfaces. In the absence of watershed-wide agricultural and construction site erosion control practices, sediment and other soil related pollutants (i.e. phosphorus) loadings to watershed surface waters and Lake Michigan will increase. In the agricultural and open space portions of the floodplain, the amount of erosion and sedimentation will depend, in part, upon the type and location of development that occurs and how construction site erosion is managed.

Periodic storm driven blockage of the outlet of the Pike River into Lake Michigan will continue. During maintenance dredging there will be a resuspension of sediment into the lake.

WATER QUALITY

The No Action alternative does not recommend modifications to the stream channel or banks. Therefore, the erosion, sedimentation and other related water quality problems (e.g., temperature) otherwise associated with channel realignment projects, would not occur. Water quality would be expected to follow conditions characteristic throughout the watershed.

As with the Proposed Project and Alternative 1, no stormwater management practices would occur under the No Action alternative. Therefore, the water quality problems associated with stormwater runoff that are currently observed will continue and worsen in relation to the type of development in the watershed.

Stormwater runoff from agricultural sources contain elevated suspended solids and phosphorus along with other nutrients and particles sorbed to particles (Noel *et al.* 1992; Mace *et al.* 1984). As lands are converted to urban uses there will be an increase in stormwater runoff with numerous contaminants. Urban stormwater pollutants consist of heavy metals, polycyclic aromatic hydrocarbons (PAHs), bacteria, suspended solids, and pesticides at levels which often exceed federal water quality regulations (Bannerman *et al.*, 1993).

The No Action alternative does not advance the Great Lakes Water Quality Initiative and other programs aimed at improving water quality and quantity in Lake Michigan. There would be no measures proposed to improve the quality and reduce the quantity of stormwater generated by present and future development.

SEDIMENT QUALITY AND MANAGEMENT

Dredging of the stream channel would not occur under the No Action alternative. Existing levels and quantities of contaminated sediment, if present, would not be removed or resuspended as would be expected to occur under the Proposed Project.

Future sediment quality will follow conditions characteristic of watershed conditions. In the absence of agricultural erosion control practices and urban stormwater management practices, sediment quality will decrease because of the increase of urban pollutants as the watershed is converted to urban land uses. The sediment quality problems associated with existing runoff will continue and increase relational to the type of urban development that occurs in the watershed.

There are no recommendations to treat existing, nor future, sediment quality problems associated with soil eroding from croplands or other developed land surfaces.

Hazardous substance spill concerns would continue under the No Action alternative as well as for the Proposed Project and all alternatives.

FISH AND AQUATIC LIFE

Under the No Action alternative there would be no modifications to the stream channel. Consequently, in the absence of additional disturbance, fish and aquatic communities could be expected to recover from past channelization projects; however, water quality would continue to degrade as a result of increased stormwater runoff from urban development inhibiting aquatic life recovery.

Fish migration will not be improved and seasonal blockage of the river outlet into Lake Michigan will continue to occur.

GROUNDWATER

In the absence of channel deepening on the Pike River and Pike Creek, groundwater elevations should not be affected. Throughout the watershed, groundwater recharge rates and quality may be reduced as imperviousness increases with development.

WETLAND

No channel deepening or widening, large scale dike construction, bridge replacement, clearing or debrushing of river banks would occur under the No Action alternative. Therefore, the existing 186 acres of wetlands (as estimated from the SEWRPC, 1989, aerial-rectified-photography map of the Pike River Watershed) will not be affected. The amount of wetlands may increase as the floodplain increases in size, resulting in a decrease of acreage suitable for agricultural uses.

WILDLIFE

Under the No Action alternative the current riparian and wildlife habitat conditions are expected to remain the same or improve. Without further disturbance caused by channelization, diking, clearing and debrushing, riparian and wildlife habitat should recover from past channelization.

As development is further restricted within the floodplain, consistent with local ordinances, habitat would improve if development occurs as open spaces for parks or nature areas. However, if conversion of remaining agricultural lands within the floodplain is for urban development, the local wildlife populations will need to increasingly rely on the riparian cover of the Pike River for food and shelter (Halvorsen, 1994).

Under the No Action alternative there are no proposals to designate any state natural areas, or to improve any site to natural area quality, should the existing local natural sites at Hawthorne Hollow and Petrifying Springs County Park become degraded due to increased flows and lower water quality as a result of future development. These environmental corridors will likely be adversely affected under the No Action alternative as development occurs in the watershed resulting in higher flows during runoff events with associated increased erosion, sedimentation, and declining water quality.

OTHER POTENTIAL AND PROBABLE EFFECTS

Aesthetics

Aesthetics along the corridor could improve if presently flood-prone agricultural lands and other areas planned for urban development would continue to be subject to flooding and as a result were placed into park and other open space uses. The No Action alternative does not call for the development of additional park and open space; however, the No Action alternative does not prevent implementation of existing park and open space plans. Recreational access and use would remain as it is now.

Farmland Preservation

No farmland would specifically be taken out of production within the stream corridor in implementing this alternative. Farmland, and other open space land uses would continue to be flooded on a recurring basis and the frequency may increase as a result of additional runoff from development in the watershed.

COSTS AND FUNDING

No costs result directly from the No Action alternative. As a consequence of taking no actions to address flooding, there would be costs related to flood damage. Cost associated with flood damage (i.e., up to 113 structures in the Year 2010 floodplain, flood insurance, and crop damage), result in an average annual flood risk of $169,500.

Local communities in the watershed, as represented by the Pike River Watershed Committee, could apply for a federal Flood Hazard Mitigation Grant. Grant funds can be used to floodproof, elevate, relocate, or purchase for demolition residential structures. If no funding assistance is available, then either individual property owners would be responsible for protecting their property at their own expense, or communities in the watershed could provide public assistance, via borrowing or property assessments.

FLOOD RISK REDUCTION BENEFITS

This alternative assumes no alleviation of the average annual flood damage risk amount of $169,500.

SUMMARY OF ALTERNATIVE 3

The No Action alternative is a necessary component to all Environmental Impact Statements. As such, this alternative does not address existing nor future flooding. Due to the increase in flood elevations as predicted land use changes occur, up to 113 structures will be subject to flooding within the Year 2010 floodplain. Structures currently subject to flooding will continue to be flooded.

In absence of any flood relief, the No Action alternative does not support the planned watershed land use. Existing floodplain areas proposed for development may be restricted from this use according to local floodplain zoning ordinances.

There are no alterations to the stream channel or riparian habitat which might otherwise negatively affect water quality, wetlands, and habitat for fish, aquatic life and wildlife. Lake Michigan storm-driven lake-bed sand and gravel which periodically blocks the Pike River outlet would not be alleviated under this alternative.

Localized flooding due to stormwater runoff and surcharging in storm sewers are not resolved with this alternative. Agricultural areas which are currently in the floodplain and being inundated will continue to be subjected to flooding. The degree to which flooding will increase by year 2010 will be determined by the land use decisions made in the watershed. Future developments that result in large impervious surfaces will result in increased stormwater runoff and flooding to downstream reaches. Furthermore, any future decrease in the limited amount of existing wetlands will exacerbate flooding.

As with the Proposed Project and Alternative 1, the No Action alternative does not propose stormwater management for existing or future urban developments. Therefore, water quality will decline proportional to the increases in urban stormwater runoff. Lower water quality affects the fish and other aquatic organisms. Higher stormwater flows will cause more flooding, affect more structures and impact the environmental corridors.

10.0 REFERENCES

American Society of Civil Engineers. 1993. Double Rock Park stream restoration project. Proceedings of the 20th Anniversary Conference on Water Management in the '90s. ASCE, New York, N.Y.

Anderson, S.O., J.G. Eugster, and R. Diamont. 1995. Using economics as a river conservation tool. River Voices, 6(1):2-5.

Apman, R.P., M.B. Otis. (1965) Sedimentation and stream improvements. New York Fish and Game Journal, 12, 117-126.

Army Engineer Institute for Water Resources. 1973. Analyzing the environmental impacts of water projects. IWR report 73-3, Alexandria, VA. 432 pp.

Arner, D.H., H.R. Robinette, J.E. Fasier, and E. Gray. 1976. Effects of channelization of the Luxapalila River on fish, aquatic invertebrates, water quality, and furbearers. Department of Wildlife and Fisheries, Mississippi State University, No. 14-16-0008-739.

Bachant, J. 1991. Backyard streams. Missouri Conservationist 52(5):18.

Baird, Kathryn. 1988. High quality restoration of riparian ecosystems. Restoration and Management Notes 7(2).

Baldwin, Susan L. (Milwaukee County Parks Department). 1994. Letter and position statement to Ralph Hollmon (Milwaukee Metropolitan Sewerage District). February 21.

Ball, J. 1982. Stream classification guidelines for Wisconsin. Technical Bulletin. Wisconsin Department of Natural Resources, Madison, Wisconsin.

Bannerman, R.T., et al. 1983. Evaluation of urban nonpoint source pollution management in Milwaukee County, Wisconsin, volume I. U.S.EPA, Water Planning Division, PB84-114164.

Bannerman, R.T., D W. Owens, R.B. Dodds and N.J. Hornewer. 1993. Sources of pollutants in Wisconsin stormwater. Water Science and Technology 28:(3-5)241-259. Great Britain.

Bannerman, R.T. 1994. Personal correspondence.

Barclay, J.S. (1980). Impact of Stream Alterations on Riparian Communities in South Central Oklahoma. Report No. FWS/OBS-80/17, Office of Biological Services,Fish and Wildlife Service, US Department of the Interior, Washington, D.C.

Barnard, R.S. 1977. Morphology and morphometry of a channelized stream: the case history of the Big Pine Creek Ditch, Benton County, Indiana. Studies in Fluvial Geomorphology, Technical Report No. 9, Water Research Center, Purdue University, West Lafayette, IN.

Bartel, R.L. and A.E. Maristany. 1989. Wetlands and stormwater management: a case study of Lake Munson. In: Wetlands: Concerns and Successes. Proceedings of a symposium held September 17-22. American Water Resources Association, Bethesda, MD.

Barton, B.A. 1977. Short-term effects of highway construction on the limnology of a small stream in southern Ontario. Freshwater Biology 7:99-108.

Bayless, J. and W.B. Smith. 1967. The effects of channelization upon the fish population of lotic waters in eastern North Carolina. Proceedings of the Annual Conference of the Southeast Association Game and Fish Commission, 18, 230-238.

Beland, R.D. 1953. The effect of channelization on the fishery of the lower Colorado River. California Fish and Game, 39, 137-139.

Benson, N.C. and A.S. Weithman. 1980. A summary of seven U.S. fish and wildlife stream channelization studies. Kearneysville, WV. US Fish and Wildlife Service, 54 pp.

Besadny, C.D. 1987. Guidance on department regulation of stream channelization projects for urban flood control. Wisconsin Department of Natural Resources memo to division administrators and district directors.

Bonn, P.J., et al. 1992. River Conservation and Management. John Riley & Sons, New York.

Born, S.M. and R.D. Margerum. 1993. "Integrated environmental management: improving the practice in Wisconsin." University of Wisconsin, Department of Urban and Regional Planning, Madison.

Bou, C. 1977. Consequences ecologiques de l'extraction des alluvions recentes dans le cours moyen du Tarn. Bulletin Ecologiques 8:435-444 (from Brookes, 1988).

Boyle, K.J. and R. Bishop. 1984. Economic benefits associated with boating and canoeing on the lower Wisconsin River. Economic Issues, No. 84. University of Wisconsin - Madison, Department of Agricultural Economics, College of Agricultural and Life Sciences.

Brice, J.C. 1981. Stability of relocated stream channels. Technical Report No. FHWA/RD-80/158, Federal Highways Administration, U.S. Department of Transportation, Washington D.C.

Brinson, M.M. 1988. Strategies for assessing the cumulative effects of wetland alteration on water quality. Environmental Management 12(5):655-662.

Brooker, M.P. 1985. The ecological effects of channelization. Geographical Journal 151, 63-69.

Brookes, A. 1987. River channel adjustments downstream from channelization works in England and Wales. Earth Surface Process and Landforms 12:337-351.

Brookes, A. 1988. Channelized Rivers: Perspectives for Environmental Management. John Wiley & Sons. New York, New York.

Brookes, A. 1989. Alternative channelization procedures. In: J.A. Gore and G.E. Petts, eds. Alternatives in Regulated River Management. CRC Press, Boca Raton, FL. pp 139-162.

Brooker, M.P. 1991. Impacts of river channelization; IV - the ecological effects of channelization. (Wales) Geographic Journal 151(1):63-69.

Brown, J. et al. 1991. Pike River watershed assessment and multiple use management plan. Departments of Biological Sciences and Urban Planning, University of Wisconsin - Milwaukee.

Brown, R.G. 1985. Effects of wetlands on water quality of runoff entering lakes in the Twin Cities metropolitan area. USGS, Denver, Water Resources Investigations Report 85-4170.

Burzynski, T. 1993. Water quality standards review and stream classification for the north branch of the Pike River, Pike River watershed. Wisconsin Department of Natural Resources, Southeast District, Milwaukee, Wisconsin. Unpub. report.

Burzynski, T. 1994. Stream Classifications and Standards Review for the Pike River Watershed. Wisconsin Department of Natural Resources, Milwaukee, WI.

CH_2M Hill, Inc. 1983. Investigation of fish mortality on Waxdale Creek and the Pike River, August 23, 1983. Unpublished report.

CH_2M Hill, Inc. 1993. RCRA Facility Investigation Report - SC Johnson Wax Waxdale Facility (W.I.D. 006-091-425), Volume 1 of 3. Prepared for SC Johnson Wax, Racine, WI.

CH_2M Hill, Inc. 1995. Ecological Assessment Report - SC Johnson Wax Waxdale Facility (W.I.D. 006-091-425). Prepared for SC Johnson Wax, Racine, WI.

Cairns, J. Jr. et al. 1992. Restoration of Aquatic Ecosystems. National Academy Press, Washington, D.C.

Cairns, J. Jr. 1991. Developing a strategy for protecting and repairing self-maintaining ecosystems. Journal of Clean Technology and Environmental Science.

Campbell, K.L., S. Kamur and H.P. Johnson. 1972. Stream straightening effects on flood runoff characteristics. Transcripts of the American Society of Agricultural Engineers 15(1):94-98.

Canter, L.W. 1977. An assessment of problems associated with evaluating the physical, chemical and biological impacts of discharging fill material. Army Engineer Waterways Experiment Station, Vicksburg, MS, Technical Report D-77-29.

Carline, R.F. and S. Klosiewski. 1985. Responses of fish populations to mitigation structures in two small channelized streams in Ohio. No. Am. J. Fisheries Management 5:1-11.

Carothers, S.W. and R.R. Johnson. 1975. The effects of stream channel modifications on birds in the southwestern United States. Symposium on Stream Channel Modification, Harrisburg, VA. pp. 60-70.

Chescheir, G.M., et. al. 1987. Hydrology and pollutant removal effectiveness of wetland buffer areas receiving pumped agricultural drainage water. North Carolina Water Resources Research Institute, Raleigh, Report No. 231.

Clark, C.C. 1944. The freshwater naiades of Auglaize County, OH. Ohio Journal of Science 54: 167-176.

Cohen, K.J. 1995. EPA, Great Lakes states reach pact to limit chemical pollutants levels. Milwaukee Sentinel, March 14.

Combs, S.M. 1995. Changes in Wisconsin soil test levels - phosphorus and potassium 1990 - 1994 summary. University of Wisconsin Extension, Madison, Wisconsin.

Congdon, J.C. 1971. Fish populations of channelized and unchannelized sections of the Chariton River, Missouri. Stream Channelization (eds. Schneberger, E. and J.L. Funk). North Central Division, American Fish Society, Special Publication No. 2, Bethesda, MD. pp. 52-83.

Corbett, E.S., J.A. Lynch, and W.E. Sopper. 1978. Timber harvest practices and water quality in the Eastern United States. Journal of Forestry 76:484-488.

Daniels, R.B. 1960. Entrenchment of the Willow Creek Drainage, Harrison County, Iowa. American Journal of Science 258:161-176.

Delaney, R. L. 1994. Program notes on flood pulse restoration. River Almanac, USDI - National Biological Survey, Environmental Monitoring Technical Center, Onalaska, WI. September.

Demissie, M. and A. Khan. 1993. Influence of wetlands on streamflow in Illinois. Illinois State Water Survey, Hydrology Division. Champaign, IL.

Dobbie, C.H., T.M. Prus-Chacinski, and H.C. Bowen. 1971. Flood alleviation works. Civil Engineering and Public Works Review, 383-390.

Dugan, P.J. 1991. Wetlands, regional planning and the development assistance community. Landscape and Urban Planning 20(1/3):211.

Duvel, W.A. Jr., R.D. Volkmar, W.L. Specht and F.W. Johnson. 1976. Environmental impact of stream channelization. Water Resources Bulletin 12:799-812.

Edwards, C.J. et al. 1984. Mitigating Effects of artificial riffles and pools on the fauna of a channelized warmwater stream. No. Am. J. Fisheries Mgmt 4:194-203.

Emerson, J.W. 1971. Channelization: A case study. Science 173:325-326.

Environmental Defense Fund, Inc. v Hoffman (adequacy of environmental impact statement challenged). 566 Ft.2d: 1060-1073 (1977).

Environmental Defense Fund, Inc. v Hoffman (adequacy of environmental impact statements as a basis for congressional decisions). 421 F. Supp.:1083-89 (E.D. Ark. 1976).

Erickson, R.E., R.L. Linder and K.W. Harmon. 1979. Stream channelization (P.L. 83-566) increased wetland losses in the Dakotas. Wildlife Society Bulletin 7(2):71-78.

Eronen, T.K. and P. Shemeikka. 1985. Restoration of the River Vaikkojoki, Finland. In: Proceedings of the European Fisheries Advisory Commission, Aarhus, Sweden; May 23-25. Butterworths, London, England. p 109-115.

Fago, Donald. 1984. Distribution and relative abundance of fishes in Wisconsin. Number IV. Root, Milwaukee, Des Plaines,and Fox River Basins. Technical Bulletin No. 147. Wisconsin Department of Natural Resources, Madison, Wisconsin.

Fausch, K. D., J. Lyons, J. R. Karr, and P. L. Angermeier. 1990. Fish communities as indicators of environmental degradation. American Fisheries Society Symposium 8:123-144.

Field, R. and R.E. Pitt. 1990. Urban storm induced discharge impacts. Water Environment and Technology. 3(6)47-49.

Foeckler, F. et. al. 1991. Water mollusc communities and bioindication of lower Salzach [Germany] floodplain waters. Regulated Rivers Research and Management 6(4):301-312.

Funk, J.L. and J.W. Robinson. 1974. Changes in the channel of the lower Missouri River and effects on fish and wildlife. Aquatic Series II, Missouri Department of Conservation, Jefferson City, MO.

Gates, J. M. and J. B. Hale. 1974. Seasonal movement, winter habitat use and population distribution of an east central Wisconsin pheasant population. Technical Bulletin No. 76. WDNR, Madison, WI. 56 pp.

Gebhards, S. 1973. Effects of channelization on fish. Panel on Stream Channelization and Trout Fisheries (ed White R.J.), Trout Magazine 14:23-24.

Goettle, A. 1992. Natural design and maintenance of rivers and streams: targets, features and conclusions. Water Science and Technology 26(9-11):2625-2634.

Gore, J.A. and G.E. Petts, eds. 1989. Alternatives in Regulated River Management. CRS Press, Inc., Boca Raton, FL.

Gray, M.H. and D.H. Arner. 1977. The effects of channelization on furbearers and furbearer habitat. Proceedings of the Annual Conference Southeastern Association of Fish and Wildlife Agencies. 31:259-265 (from Barclay et al., 1988).

Gregory, J.D. and J.L. Stokoe. 1980. Streambank management. Proceedings of the Symposium on Fisheries Aspects of Warmwater Streams. American Fisheries Society, pp. 276-281.

Grimes, D.J. 1975. Release of sediment bound fecal coliforms by dredging. Applied Microbiology, 29:109-111.

Griswold, B.L., et al. 1978. Some effects of stream channelization on fish populations, macroinvertebrates and fishing in Ohio and Indiana. Report No. FWS/OBS-77/46, Office of Biological Services, Fish and Wildlife Service, US Department of the Interior, Washington, DC.

Groen, C.L. and J.C. Schmulbach. 1978. The sport fishery of the unchannelized Middle Missouri River. Transactions of the American Fisheries Society 107:412-418.

Gruber, Bonnie. 1993. Personal communication, December 29.

Hachmoller, B., R.A. Mathews, and D.F. Brakke. 1991. Effects of riparian community structure, sediment size and water quality on the macroinvertebrate communities in a small, suburban stream. Northwest Science 65:125-132.

Halvorsen, H. 1993. Pike River Environmental Impact Statement, Wildlife Resources Assessment. Wisconsin Department of Natural Resources. pp. 1-18. Bong Rec. Area, Kansasville, WI.

Hammer, Donald A. 1989. Protecting water quality with wetlands in river corridors. In: Wetlands and River Corridor Management, Proceedings of the International Wetland Symposium of the Association of Wetland Managers, Charleston, S.C. AWM, Berne, NY.

Hansen, D.R. 1971. Stream channelization effects on fishes and bottom fauna in the Little Sioux River, Iowa. E. Schneberger and J.L Funk (eds.) Stream Channelization: A Symposium. Special Publ. No. 2. North Central Division, American Fisheries Society, Omaha, Nebraska.

Hansen, D.R. and R.J. Muncy. 1971. Effects of Stream Channelization on Fish and Bottom Fauna in the Little Sioux River, Iowa State Water Resources Research Institute, Ames, IA.

Hanson, K. and U. Lemanski. 1995. Hard-earned lesson from the Midwest floods - Floodplain open space makes economic sense. River Voices 6(1):3-5.

Harvey, M.D. and C.C. Watson. 1986. Fluvial processes and morphological thresholds in incised channel restoration. Water Resources Bulletin 22(3):359-368.

Hayek, Michael A. 1993. Letter to Ron Kazmierczak, Wisconsin DNR, March 30.

Headrick, M.R. 1976. Effects of stream channelization on the fish populations in the Buena Vista Marsh, Portage County, Wisconsin. Unpublished MS Thesis, University of Wisconsin - Stevens Point, WI.

Herson-Jones, Lorraine. 1994. Bridging troubled waters: citizen-government cooperation for urban stream conservation. Proceedings: Community Stewardship for North Carolina's Urban Streams and Forests. Water Resources Research Institute of the University of North Carolina, Raleigh, NC.

Hey, D.L. 1988. Wetlands: A future nonpoint pollution control technology. Wetlands: Concerns and Successes. Proceedings of a symposium held September 17-22. American Water Resources Association, Bethesda, MD.

Hey, D.L. 1982. Creation of wetland habitats in northeastern Illinois. Illinois Department of Energy and Natural Resources Document No. 82/09.

Hill, A.R. 1976. The environmental impacts of land drainage. Journal of Environmental Management 4:251-274.

Hinge, D.C. and G.E. Hollis. 1980. Land Drainage, Rivers, Riparian Areas and Conservation. Discussion papers in Conservation No. 37, University College London, London. (from Brookes, 1988).

Hiney, W.D., R.J. Seidler, and P.C. Kingman. 1984. Riparian Zone Systems, Uses and Management. Oregon State University Water Resources Research Institute. Corvallis, OR. 69 pp.

Hortle, K.G. and P.S. Lake. 1982. Macroinvertebrate assemblages in channelized and unchannelized sections of the Bunyip River, Victoria. Australian Journal of Marine and Freshwater Research 35:1071-1082.

Huggins, D.G. and R.E. Moss. 1974. Fish population structure in altered and unaltered areas of a small Kansas stream. Transactions of the Kansas Academy of Science 77:18-30.

Hunt, C.E. and V. Huser. 1988. Down by the River: The Impact of Federal Water Projects and Policies on Biological Diversity. Island Press, Washington, D.C., 260 pp.

Interagency Floodplain Management Review Committee (IAFMRC). 1994. Sharing the Challenge: Floodplain Management into the 21st Century. USGPO, Washington, D.C.

Irizarry, R. 1969. The effects of stream alterations in Idaho. Project Report No. F-55-R-2. Idaho Fish and Game Department, Boise, ID.

Jahn, L.R. 1979. Values of riparian habitats to natural ecosystems. In: Strategies for Protection and Management of Floodplain Wetlands and Oter Riparian Ecosystems. USDA-Forest Service, Washsington, D.C. Technical Report WO-12.

Jewel, L. 1981. Construction: alternatives to channelization. Landscape Architecture, July 1981.

Johnson, C. 1995. Stormwater ponds: an effective way to control urban runoff. University of Wisconsin - Extension, pub. GWQ 017. 6 pp.

Johnson, C. 1992. Urban runoff: how polluted is it? University of Wisconsin - Extension. 8 pp.

Johnson, R. 1994. Stream dynamics. In: A Gathering for the Rivers (conference proceedings), University of Wisconsin - Extension, Madison.

Johnston, C.A. 1989. Human impacts to Minnesota wetlands. Journal of the Minnesota Academy of Science 55(1):120-124.

Kanehl, P. and J. Lyons. 1990. Sampling of the north branch of the Pike River, the Pike River, and the south branch of the Pike River, Racine County and Kenosha County, by fish research personnel during June, 1990. Unpublished manuscript. Wisconsin Department of Natural Resources - Bureau of Research, Madison, WI, October 29.

Kanehl, P. 1993. Sampling of the north branch of the Pike River, the Pike River, the south branch of the Pike River, and the west branch of the Root River Canal, Racine and Kenosha Counties, by fisheries management, water resources and fish research personnel during June, 1993. Unpublished manuscript. Wisconsin Department of Natural Resources - Bureau of Research, Madison, WI, December 22.

Karr, J.R. and I.J. Schlosser. 1977. Impact of nearstream vegetation and stream morphology on water quality and stream biota. U.S. EPA-600/2-77-097.

Karr, J.R., et al. 1986. Assessing the biological integrity in running waters, a method and its rationale. Illinois Natural History Survey Special Publication No. 5.

Keddy, P.A. 1989. Freshwater wetlands human-induced changes: indirect effects must also be considered. Environmental Management 7(4):299-302.

Keller, E.A. 1976. Channelization: environmental, geomorphic and engineering aspects. In D.R. Coates (ed.). Geomorphology and Engineering. Dowden, Hutchinson & Ross, Inc. Stroundsburg, PA. pp 115-139.

Keller, E.A. 1978. Pools, rifles and channelization. Environmental Geology 2(2):119-127.

Keller, E.A. and A. Brookes. 1984. Consideration of meandering in channelization projects: selected observations and judgements. In River Meandering, Proceedings of Conference River '83. American Society of Civil Engineers, Vicksburg, MS, pp. 384-398.

Kenosha County Growth Management Task Force. 1994. Growth management. Planning and design Institute, Inc., Milwaukee, WI. 52 pp.

Keown, M.P. 1981. Field investigation of Fisher River channel realignment project near Libby, Montana. Inspection Report No. 11, Section 32 Program, US Army Corps of Engineers Waterway Experimental Station, Vicksburg, Mississippi.

Kohnke, R.E. and A.K. Boller. 1989. Soil bioengineering for streambank protection. Journal of Soil and Water Conservation 44(4):286.

Kuenzler, E.J., et al. 1977. Water quality in North Carolina streams and effects of channelization. Water Resources Research Institute of University of North Carolina and North Carolina State, Raleigh, NC. 160 pp.

Kusler, J.A. and M.E. Kentula. 1990. Wetland creation and restoration: the status of the science. Island Press, Covelo, CA. 594 pp.

Lagerway, P. and B. Punchochar. 1988. Evaluation of the Burke-Gilman trail's effect on property values and crime. Transportation and Research Record 1168. Washington, DC.

Landers, J.C. and B.A. Knuth. 1993. Use of wetlands for water quality improvement under the USEPA Region V clean lakes program. New York Sea Grant Institute, Ithaca, NY.

Larimore, R.W. and P.W. Smith. 1963. The fishes of Champaign County, Illinois as effected by 60-years of stream changes. Bulletin Illinois State Natural History Survey, 28, 299-382.

Lindon, T.J. and M.P. Gergen. 1985. Interagency disputes over dry fields or clean water: a case study of the conflict between agricultural drainage programs and the Chesapeake Bay cleanup. Virginia Journal of Natural Resources Law 4(2):219-262.

Link, E. G. and O. R. Demo. 1970. Soil survey of Racine and Kenosha counties, Wisconsin. U. S. Department of Agriculture, Soil Conservation Service.

Little, A.D. 1973. Channel modification: an environmental, economic and financial assessment. Report to the Council on Environmental Quality, Executive Office of the President, Washington, DC.

Louks, O.L. 1992. Restoration of the pulse control function of wetlands and its relationship to water quality objectives. Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, CA.

Lowe, E.F. 1992. Particulate phosphorous removal via wetland filtration: an examination of potential for hypertrophic lake restoration. Environment Management 16(1):67-74.

Lowell, T.L. 1988. Changes in floodplain management philosophy and policy resulting from the Trinity River regional environmental impact statement. In Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, Boulder, CO.

Lyons, J. 1992. Using the index of biotic integrity (IBI) to measure environmental quality in warmwater streams of Wisconsin. Gen. Tech. Rep. NC-1149. U. S. Department of Agriculture, Forest Service, North Central Forest Experiment Station, St. Paul, MN. 51 p.

Lyons, J. and C.C. Courtney. 1990. Review of fisheries habitat improvement projects in warmwater streams, with recommendations for Wisconsin. Wisconsin Department of Natural Resources Technical Bulletin No. 169, 34 pp.

Mace, S. E., Sorge, P., and T. Lowry, 1984. Impacts of Phosphorus on Streams. Wisconsin Department of Natural Resources, Madison, WI. pp. 1-92.

Maddock, T. Jr. 1976. A primer on floodplain dynamics. Journal of Soil and Water Conservation, 31:44-47.

Marsh, J.M. 1993. Assessment of nonpoint source pollution in stormwater runoff in Louisville, (Jefferson County), Kentucky, USA. Archives of Environmental Contamination and Toxicology, 24:446-445.

Marsh, L. 1989. Development and wetlands/wildlife conservation:ways to reconcile development and conservation. Urban Land 48(7):22.

Masterson, J.P. and R.T. Bannerman. 1994. Impacts of stormwater runoff on urban streams in Milwaukee County, Wisconsin. National Symposium on Water Quality. American Water Resources Association. 11:123-133.

McConnell, C., et al. 1983. Stream obstruction removal guidelines. American Fisheries Society, 9 pp.

McDonnell, M.J. and S.T.A. Pickett. 1990. Ecosystem structure and function along urban-rural gradients: an unexploited opportunity for ecology. Ecology 71:1232-1237.

Migliore, M. 1977. Legislative and judicial attention to stream modification: channelization, its effects and alternatives. Cumberland Law Review 8(1):21-75.

Montgomery v Ellis (action seeking to enjoin stream channelization). 364 F. Supp. 517-535 (N.D. Ala. 1973).

Moore, I.D. and C.L. Larson. 1976. Effects of drainage projects on surface runoff from wetland topography of the North Central states. Paper No. NCR 76-203 presented at the 1976 Annual Meeting of North Central region, American Society of Agricultural Engineers, OWRT-B-122-MINN (3), 14-31-000106092.

Morris, , L.A., et al. 1968. Effects of mainstem impoundments and channelization upon the limnology of the Missouri River, Nebraska. Transactions of the American Fisheries Society 97: 380-388.

National Research Council. 1992. Restoration of aquatic ecosystems: science, technology and public policy. National Academy Press, Washington, D.C.

The Nature Conservancy. 1994. The conservation of biological diversity in the great lakes ecosystem: issues and opportunities. The Nature Conservancy Great Lakes Program. Chicago, IL.

Noel, J., Dennis, J., Dennis, M. E., and C. Kuhns, 1992. Phosphorus control in lake watersheds, a technical guide to evaluating new development. Maine Department of Environmental Protection. pp. 1-111. Bridgton, ME.

North Carolina University, Raleigh. 1994. Community Stewardship for North Carolina's Urban Streams and Forests; Proceedings. Water Resources Research Institute, Earth Day Conference, April 21-22. 59 pp.

Nunnally, N. 1985. Application of Fluvial Relationships to Planning and Design of Channel Modifications. Environmental Management, 9(5):417-426.

Odum, E.P. 1978. Ecological importance of riparian zones. In: Johnson, R.R. and J.R. McCormic, technical coordinators. Strategies for Protection and Management of Floodplain Wetlands and other Riparian Ecosystems, Symposium Proceedings, U.S. Forest Service, USDA. GTR-WO-12.

Parker, G. and D. Andres. 1976. Detrimental effects of stream channelization. Proceedings of Conference Rivers '76, American Society of Civil Engineers, pp. 1248-1266.

Paynting, T. 1982. Flood scheme reconciles conservation and alleviation. Surveyor, 14-16.

Peterson, M.R. et al. 1991. Development of a computer-aided decision process for channel rehabilitation and watershed enhancement techniques. In: Hydraulic Engineering - Proceedings of the 1990 National Conference. ASCE - Boston Society of Civil Engineers. Boston, MA. pp. 580-585.

Peterson, R.C., L.B. Peterson, and J.LaCoursiere. 1992. A building-block model for stream restoration. In: P.J. Boon, P. Calow, and G.E. Petts, eds. River Conservation and Management. John Wiley and Sons, Ltd. pp. 293-309.

Piening, R. 1982. Surface water resources of Kenosha County. Lake and Stream Classification Project (2nd ed.). Wisconsin Department of Natural Resources, Madison, Wisconsin.

Piest, R.F., L.S. Elliot and R.G. Spooner. 1977. Erosion of the Tarkio drainage system, 1845-1976. Transactions of the American Society of Agricultural Engineers, 20:458-488.

Pike River Watershed Committee. EIS work group subcommittee meeting notes. September 26, 1993.

Pitt, R. and M. Bozeman. 1982. Sources of urban runoff pollution and its effects on an urban creek. EPA-600/52-82-090, U.S. Environmental Protection Agency, Cincinnati, OH.

Possardt, E.E. and W.F. Dodge. 1978. Stream channelization impacts on songbirds and small mammals in Vermont. Department of Forestry, Massachusetts University, Amherst.

Reimold, R.J. 1989. Mitigation or litigation: the scientific reasonableness of wetlands restoration vs. preservation. In: Wetlands: Concerns and Successes. Proceedings of a symposium held September 17-22. American Water Resources Association, Bethesda, MD.

Rosendahl, P.C. and T.D. Waite. 1978. Transport characteristics of phosphorus in channelized and meandering streams. Water Resources Bulletin, 14(5):1227-1238.

Ruff, Jim. 1976. Southeast Wisconsin river basins - a drainage basin report. November, 1976. Wisconsin Department of Natural Resources, Div. of Environmental Standards, Madison, Wisconsin.

St. Amant, J., Pariso, M.E., T. Sheffy. 1983. Final report on the toxic substance survey of Lake Michigan, Lake Superior, and tributaries. Wisconsin Department of Natural Resources, Madison, Wisconsin.

Sandler, M.J. Turning a ditch back into a creek. In: Floodplain Harmony. The Natural Hazards Research and Applications Information Center; Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO.

Shields, F.D. and R.R. Copeland. 1990. Environmental design of channels - can it be done? Hydraulic Engineering: Proceedings of the 1990 National Conference. American Society of Civil Engineers. New York.

Shields, F.D. 1983. Design of habitat structures in open channels. Journal of Water Resources Planning and Management, American Society of Civil Engineers 109:331-344.

Shields, F.D. and N.R. Nunnally. 1984. Environmental aspects of clearing and snagging. Journal of Environmental Engineering, American Society of Civil Engineers 110:152-165.

Shields, F.D. and T.G. Sanders. 1986. Water quality effects of excavation and diversion. Journal of Environmental Engineering, American Society of Civil Engineers, 112:211-228.

Schimpff, J., P. Kanehl and H. Halverson. 1994. A Resource Assessment for the Pike River Watershed. Wisconsin Department of Natural Resources, Madison, WI, 105 pp.

Schlosser, I.J. 1991. Stream fish ecology: a landscape perspective. BioScience 41:704-712.

Schmal, R.N. and D.F. Sanders. 1978. Effects of stream channelization on macroinvertebrates, Buena Vista Marsh, Portage County, Wisconsin Report No. FWS/OBS-78-92, Office of Biological Services, Fish and Wildlife Service, US Department of the Interior, Washington, D.C.

Schneberger, E. and J.L. Funk. 1971. Stream Channelization: a symposium. Presented at 33rd Midwest Fish and Wildlife Conference. North Central Division American Fisheries Society Publication No. 2.

Schueler, T.R. 1991. Watershed restoration handbook: collected papers at the conference; "Restoring Our Home River: Water Quality and Habitat in the Anacostia. Metropolitan Washington Council of Governments, Washington, D.C.

Schumm, S.A., M.D. Harvey, M.D., and C.C. Watson. 1984. Incised channels: morphology, dynamics and control. Water Resources Publications, Littleton, CO.

Schwecke, T., et al. 1988. A look at visitors on Wisconsin's Elroy-Sparta bike trail. Recreation Resources Center, Cooperative Extension Service, University of Wisconsin - Extension, Madison.

Simon, B. D., et al. 1991. Evaluating wetlands for flood storage. Unpublished field methodology. Wisconsin DNR, Madison, WI.

Simons, D.B., and F. Senturk. 1977. Sediment Transport Technology. Water Resources Publications, Fort Collins, CO.

Simons, C.E. and S.A. Watkins. 1982. Effects of channel excavation on water quality characteristics of the Black River and on the groundwater levels near Dunn, North Carolina. US Geological Survey, Report No. 82-4083.

Simonson, T. D., J. Lyons, and P. Kanehl. 1991. Guidelines for evaluating fish habitat in wisconsin streams. General Technical Report No. NC-164, .U.S. Forest Service, North Central Forest Experiment Station, St. Paul, MN.

Simpson, P.W., et al. 1981. Manual of channelization impacts on fish and wildlife. Publication No. 14-16-0009-80-066, Office of Biological Services, Fish and Wildlife Service, US Department of the Interior, Washington, D.C.

Simpson, P.W., et al. 1982. Manual of stream alteration impacts on fish and wildlife. Environmental Science Engineering, Inc. U.S. Fish and Wildlife Service. FWS/OBS-82/24, 166 pp.

Sloane-Riley, J., P.A. Perkins, and K.W. Malueg. 1981. The effects of urbanization and stormwater runoff on the food quality in two salmonid streams. Verh. International Limnology. 21:812-818.

Solution File: Stormwater pond is wetlands mitigation amenity. Urban Land 49(12):28.

Southeastern Wisconsin Regional Planning Commission (SEWRPC). 1983. A comprehensive plan for the Pike River watershed. Planning Report No. 35. SEWRPC, Waukesha, WI.

Southeastern Wisconsin Regional Planning Commission (SEWRPC). 1991. Assessment and ranking of watersheds for nonpoint source management purposes in southeastern Wisconsin." Staff memorandum.

Stern, D.H. and M.S. Stern. 1980. Effect of bank stabilization on the physical and chemical characteristics of streams and small rivers: an annotated bibliography. US Fish and Wildlife Service, Washington, D.C. FWS/OBS-80/12.

Strauser, C.N. and N. Long. 1976. Discussion of man-induced changes of the middle Mississippi River. Journal of the Waterways, Harbors, and Coastal Engineering Division, American Society of Civil Engineers 102:281.

Swales, S. 1988. Fish populations of a small lowland channelized river in England subject to long-term river maintenance and management works. Regulated Rivers Research and Management 2(4): 493-506.

Swales, S. 1982. Environmental effects of river channel works used in land drainage improvements. Journal of Environmental Management 14(2):103-126.

Tarplee, W.H., D.E. Louder, and A.J. Weber. 1971. Evaluation of the effects of channelization on the fish populations in North Carolina coastal streams. North Carolina Wildlife Resources Commission, Raleigh, NC.

Task Committee. 1978. Environmental effects of hydraulic structures. Journal of the Hydraulic Division of the American Society of Civil Engineers, XXIV, 62-103, from Brookes, 1988.

Taylor, B.R. and J.C. Roff. 1986. Long-term effects of highway construction on the ecology of a southern Ontario stream. Environmental Pollution Series A 40:317-344.

Taylor, G.G. 1981. Stream alterations: an introduction. U.S Fish and Wildlife Service, Kearneysville, WV.

Thackston, E.L. and R.B. Sneed. 1982. Review of environmental consequences of waterway design and construction practices as of 1979. Technical Report E-82-4, Army Engineer Waterways Experiment Station, Vicksburg, MS.

Thrasher, M.H. 1984. Highway impacts on wetlands: assessment, mitigation and enhancement measures. Transportation Research Record 948:17-20.

Trautman, M.B. and D.K. Gartman. 1974. Re-evaluation of the effects of manmade modifications on Gordon Creek between 1887-1938. Ohio Journal of Science, 39, 275-288.

Turner, R.K. 1983. Valuation of the environmental impact of wetland flood protection and drainage schemes. Environment and Planning A (UK), 15(7):871-888.

U.S. Army Corps of Engineers (USA-COE). 1993. Easily constructed light trap helps scientists collect larval fishes in wetlands. The Wetlands Research Program Bulletin 3(4):3-4, December. USA-COE Waterways Experiment Station, Vicksburg, MS.

U.S. Department of Agriculture - Soil Conservation Service. 1970. Soil Survey of Kenosha and Racine Counties, Wisconsin.

U.S.D.A. - Soil Conservation Service. 1977. Compliance with the national Environmental Policy Act, 1969; Use of channel modifications as a means of water management; and guide for environmental assessment. Federal Register, 42, 40119-40122.

U.S. Department of the Interior. 1974. Stream Channel Alteration Guidelines, Washington, D.C.

U.S.D.I. - Fish and Wildlife Service. 1990. Locating and Identifying Drained Wetlands for Restoration.

U.S.D.I. - Fish and Wildlife Service. 1980. Riparian Ecosystems: a Preliminary Assessment of Their Importance, Status, and Needs. EWastern Energy and Land Use Team, National Water Resource Analysis Group, USFWLS. Kearneysville, WV. 13 pp.

U.S. Department of the Interior - National Park Service. 1992. Economic Impacts of Protecting Rivers, Trails and Greenway Corridors, 3rd edition. Washington, D.C.

U.S.D.I. - National Park Service. 1991. A Casebook in Managing Rivers for Multiple Uses. NPS Recreation Resources Assistance Division, Washington, D.C.

U.S. Department of Transportation. 1991. National Bicycling & Walking Study - Interim Report. Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1983. Results of the National Urban Runoff Program, Volume I: Final Report. Water Planning Division. NTIS PB 84-185552.

U.S. Geological Survey. 1992. Low-flow characteristics of streams in the Lake Michigan basin, Wisconsin. USGS, Madison, Wisconsin.

Vandre, W.G. 1975. Effects of stream channelization on wildlife and wildlife habitat of Buena Vista Marsh, Portage County, Wisconsin. University of Wisconsin - Stevens Point, Master Thesis, 76 pp.

Watson, C.C. et al. 1988. Geotechnical and hydraulic stability numbers for channel rehabilitation: Part I - the approach. Hydraulic Engineering: Proceedings of the 1988 National Conference on Hydraulic Engineering, Colorado Springs, CO. ASCE, New York, NY.

Watson, C.C. et al. 1988. Geotechnical and hydraulic stability numbers for channel rehabilitation: Part II - application. Hydraulic Engineering: Proceedings of the 1988 National Conference on Hydraulic Engineering, Colorado Springs, CO. ASCE, New York, NY.

Way, C.M. 1991. Structure and function of stream ecosystems. Techniques for Evaluating Aquatic habitats in Rivers, Streams, and Reservoirs: Proceedings of a Workshop. Army Corps of Engineers Miscellaneous Paper W-91-2, p. 29-31.

Weaver, L.A. and G.C. Garman. 1994. Urbanization of a watershed and historical changes in a stream fish assemblage. Transactions of the American Fisheries Society 123:162-172.

Weeks, K.G. 1982. Conservation aspects of two river improvement schemes in the River Thames catchment. Journal of the Institute of Water Engineers and Scientists 36:447-458.

Welsch, D.J. 1991. Riparian forests buffers: function and design for protection and enhancement of water resources. U.S. Department of Agriculture. Forest Service Pub. NA-PR-07-91.

Wessels, M. and P. Kanehl. 1995. Sampling of the north branch of the Pike River, the Pike River, the south branch of the Pike River, and the west branch of the Root River Canal, Racine County and Kenosha County, by fisheries management, water resources and research personnel during June, 1994. Unpublished manuscript. Wisconsin DNR - Bureau of Research, Madison, WI.

Whitlock, P. K. and M. Warner. 1990. Rehabilitation of rapidly urbanizing streams. Water Resources Infrastructure: Needs, Economics, and Financing. American Society of Civil Engineers, Boston, MA.

Whittlesey, K. 1994. Preventing urban stormwater pollution: citizen-government cooperation for public education. Proceedings: Community Stewardship for North Carolina's Urban Streams and Forests. Water Resources Research Institute of the University of North Carolina, Raleigh, NC.

Wible, L. G. 1984. Letter to Alfred G. Raetz, April 17.

Wilcock, D.N and C.I. Essery. 1991. Environmental impacts on the River Main, County Antrim, Northern Ireland. Journal of Environmental Management 32(2):127-143.

Willard, D.E. 1990. Wetland dynamics: considerations for restored and created wetlands. In: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, CA.

Williams, P.B. 1994. Rethinking flood-control channel design. Flood Management News. Arizona Department of Water Resources. Winter.

Winter, T.C. 1988. Conceptual framework for assessing cumulative impacts on the hydrology of non-tidal wetlands. Environmental Management 12(5):605-620.

Wisconsin Department of Natural Resources. 1994. Stream classifications for the Pike River watershed. Unpublished manuscript. Southeast District, Milwaukee.

Wojcik, D.K. 1981. Flood alleviation, conservation and fisheries: an experimental scheme on the River Roding. Unpublished MS Thesis, Department of Civil Engineering, City University, London (from Brookes, 1988).

Yearke, L.W. 1971. River erosion due to channel relocation. Civil Engineering 41:39-40.

Zemaitis, W.R. and G. Fleming. 1990. Mitigation of wetland impacts. Water Pollution Control Association of Pennsylvania Magazine. 23(3):29-33, May-June.

11.0 LIST OF CONTRIBUTORS

Department of Natural Resources Employee	Job Title or Area of Expertise	*Madison Bureau* or Office Location
Jeffrey Schimpff	Environmental Analyst	*Environmental Analysis & Review*
George Albright	Section Chief	*Environmental Analysis & Review*
Jim Morrissey	Environmental Impact Coordinator	Milwaukee
Steve Mace	Environmental Analyst	Milwaukee
Paul Kanehl	Warmwater Research Ecologist	Research
Harvey Halvorson	Private Lands Specialist	Bong RA
Mike Keniry	Lake Michigan Fisheries Biologist	Milwaukee
Tom Burzynski	Lake Michigan Fisheries Biologist	Milwaukee
Frank Dallam	Floodplain Engineer	*Water Regulation & Zoning*
Sharon Gayan	Water Resources Supervisor	Milwaukee
Steve Galarneau	Water Quality Planner	Milwaukee
William Wawrzyn	Water Quality Planner	Milwaukee
Kim Murphy	Water Quality Planner	Milwaukee
John Pfender	Planning Analyst	*Water Resources Management*
Mary E. Vollbrecht	Water Regulation Supervisor	Milwaukee
Bob Watson	Floodplain Engineer	*Water Regulation & Zoning*
Lynn Torgerson	Floodplain Specialist	Milwaukee
Sue Schumacher	Floodplain Specialist	Milwaukee

Summary of Representative Wetland Functional Values
Proposed Project Corridor - Upper Pike River and Pike Creek

WETLAND FUNCTION	SIGNIFICANCE TALLY (Number of wetland sites, out of seven surveyed, with the following level of significance:)					Points	AGGREGATE FUNCTIONAL SIGNIFICANCE (Pts. ÷ 7) rounded to nearest whole)
	Low (1 pt.)	Medium (2 pts.)	High (3 pts.)	Exceptional (4 pts.)	N/A (0 pts.)		
Floral Diversity	6		1			9	Low (1.29)
Wildlife Habitat	3	2	2			13	Medium (1.86)
Flood/Stormwater Attenuation	4	3				10	Low (1.43)
Water Quality Protection	4	2	1			11	Medium (1.57)
Shoreline Protection	2	1			4	4	Low (0.57)
Groundwater	6	1				8	Low (1.14)
Scenic Beauty/ Recreation/ Education	5	2				9	Low (1.29)

Appendix B
Wildlife of the Pike River Watershed

Table B.1 Birds expected to occur[1] in the Pike River Watershed, Kenosha and Racine counties.

Species	% of Occurrence on Checklists	Grassland Park land	Riparian / Stream	Wooded Shrubland
Ring-necked pheasant	21.7	X	X	X
Sandhill crane	21.9	X	X	X
Great blue heron	38.7		X	X
Green-backed heron	18.7		X	X
Canada goose	58.0	X	X	
Wood duck	9.5		X	X
Mallard	58.2	X	X	X
Blue-winged teal	13.6	X	X	
Red-tailed hawk	52.2	X	X	X
American kestrel	52.2	X	X	X
Northern harrier	8.5	X	X	X
Killdeer	50.8	X	X	
Ring-billed gull	5.9	X	X	
Herring gull	26.8	X	X	
Rock dove	64.2	X	X	X
Mourning dove	84.9	X	X	X
Great horned owl	8.0	X	X	X
Common nighthawk	12.1	X	X	X
Chimney swift	24.8	X	X	X
Belted kingfisher	15.7		X	X
Red-headed woodpecker	14.0			X
Red-bellied woodpecker	6.9			X
Downy woodpecker	45.1			X
Northern flicker	43.2	X	X	X
Great-crested flycatcher	6.0	X	X	X
Eastern kingbird	24.5	X	X	X

Appendix B
Wildlife of the Pike River Watershed

Table B.1 Birds expected to occur[1] in the Pike River Watershed, Kenosha and Racine counties.

Species	% of Occurrence on Checklists	Grassland Park land	Riparian / Stream	Wooded Shrubland
Purple martin	26.2	X	X	X
Tree swallow	34.3	X	X	X
Horned lark	18.5	X		
Barn swallow	34.6	X	X	X
Blue jay	71.4		X	X
American crow	82.2	X	X	X
Black-capped chickadee	77.6		X	X
Red-breasted nuthatch	10.3		X	X
White-breasted nuthatch	42.2		X	X
Eastern bluebird	15.6	X	X	
House wren	12.1	X	X	X
Wood thrush	6.8		X	X
American robin	65.4	X	X	X
Gray catbird	17.3	X	X	X
Brown thrasher	11.5	X	X	X
Cedar waxwing	25.1	X	X	X
European starling	75.6	X	X	X
Yellow warbler	8.8		X	X
Yellow-rumped warbler	5.7		X	X
Common yellowthroat	13.3		X	X
Northern cardinal	76.9	X	X	X
Rose-breasted grosbeak	6.1		X	X
Indigo bunting	15.7	X	X	X
Rufous-sided towhee	5.9		X	X
American tree sparrow	15.0	X	X	X
Chipping sparrow	36.3	X	X	X

Appendix B
Wildlife of the Pike River Watershed

Table B.1 Birds expected to occur[1] in the Pike River Watershed, Kenosha and Racine counties.

Species	% of Occurrence on Checklists	Grassland Park land	Riparian / Stream	Wooded Shrubland
Field sparrow	10.0	X	X	
Savannah sparrow	8.7	X	X	
Song sparrow	36.4	X	X	X
Swamp sparrow	8.4		X	X
White-throated sparrow	6.6		X	X
Dark-eyed junco	48.5	X	X	X
Red-winged blackbird	60.3	X	X	X
Eastern meadowlark	33.8	X	X	
Common grackle	54.6	X	X	X
Brewer's blackbird	9.0	X	X	X
Brown-headed cowbird	37.0	X	X	X
Bobolink	10.5	X		
Yellow-headed blackbird	7.2		X	
Northern oriole	15.6		X	X
Purple finch	7.3		X	X
Pine siskin	10.1	X	X	X
American goldfinch	74.1	X	X	X
House finch	41.3	X	X	X
House sparrow	86.9	X	X	X

[1] Compiled from 998 Wisconsin Society for Ornithology checklists for Kenosha and Racine counties between 1983 and 1993.

Table B.2 Common mammals expected to occur[1] in the Pike River Watershed, Kenosha and Racine counties.

Species	Grassland / Parkland	Riparian / Stream-side	Wooded / Shrub land
Opossum	X	X	X
Masked shrew	X	X	X
Shorttail shrew	X	X	X
Deer mouse	X	X	X
White-footed mouse	X	X	X
Meadow vole	X	X	X
Norway rat	X	X	X
House mouse	X	X	X
Little brown bat	X	X	X
Silver-haired bat	X	X	X
Big brown bat	X	X	X
Eastern chipmunk			X
Woodchuck	X	X	X
Eastern gray squirrel			X
Eastern fox squirrel			X
Southern flying squirrel			X
Muskrat		X	
Eastern cottontail	X	X	X
Raccoon	X	X	X
Longtail weasel	X	X	X
Mink		X	X
Striped skunk	X	X	X
Red fox	X	X	X
coyote	X	X	X
Whitetail deer	X	X	X

[1]Adapted from Burt, W. H. (1977). Mammals of the Great Lakes Region. Ann Harbor Press, MI 246pp.

Table B.3 Reptile and amphibian species expected to occur[1] in the Pike River Watershed, Kenosha and Racine counties.

Species	Grassland / Park land	Riparian / Stream-side	Wooded / Shrub land
Amphibians			
Eastern American toad	X	X	X
Western chorus frog		X	X
Green frog		X	
Northern leopard frog	X	X	
Blue-spotted salamander			
Eastern tiger salamander		X	X
Reptiles			
Common snapping turtle	X	X	
Blandings turtle			
Painted turtle	X	X	
Eastern milk snake	X	X	X
Western fox snake			
Northern red-bellied snake			
Brown snake			
Northern water snake			
Eastern garter snake	X	X	X

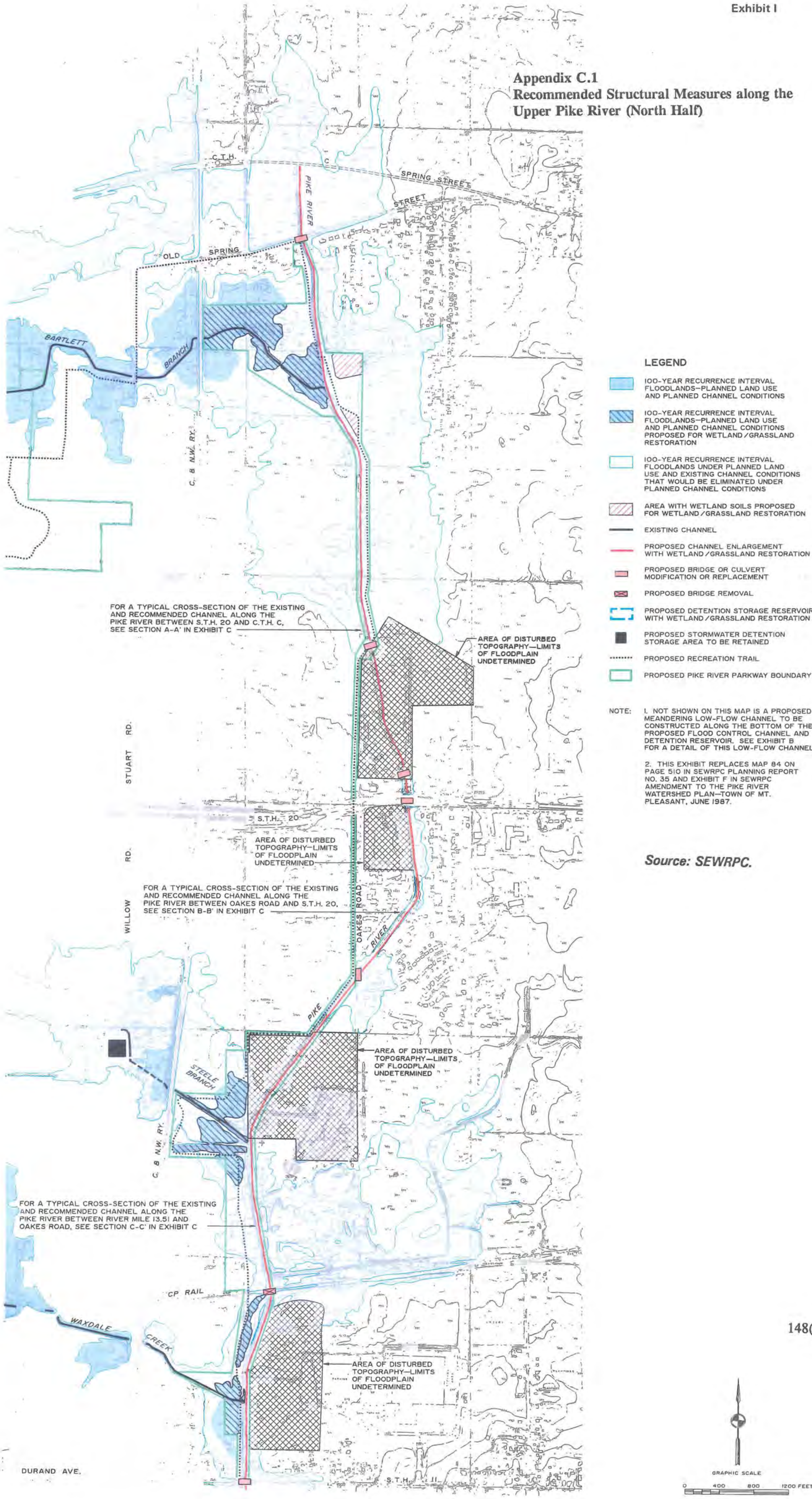
[1] Adapted from Vogt, R. C. 1981. Natural History of Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum. Milwaukee, WI 205pp. Updated from the Wisconsin Herptile Atlas Project.

APPENDIX C
Floodplain Maps and Channel Cross-Sections of the Proposed Project

The following maps and cross-sections (pp. 148(a) - 148(e) and 149) comprise Exhibits B, C, E, I and J of the revisions to the Pike River Watershed Comprehensive Plan (SEWRPC, 1994; SEWRPC, 1995). While these maps do show the existing floodplain, they do portray the extent of the floodplain as it would be under planned Year 2010 land use conditions, and existing channel conditions (areas in pale blue).

The maps also show the extent of the proposed channel widening and deepening (red line); a suggested parkway boundary (green line) and possible trail alignment (dotted black line); floodplain remnant areas under proposed channel conditions (medium blue); areas within the remnant floodplain proposed for restoration or maintenance of wetland/grassland vegetation (black diagonal lines); and hydric soil areas outside the remnant floodplain proposed for restoration or maintenance of grassland/wetland vegetation (red diagonal lines).

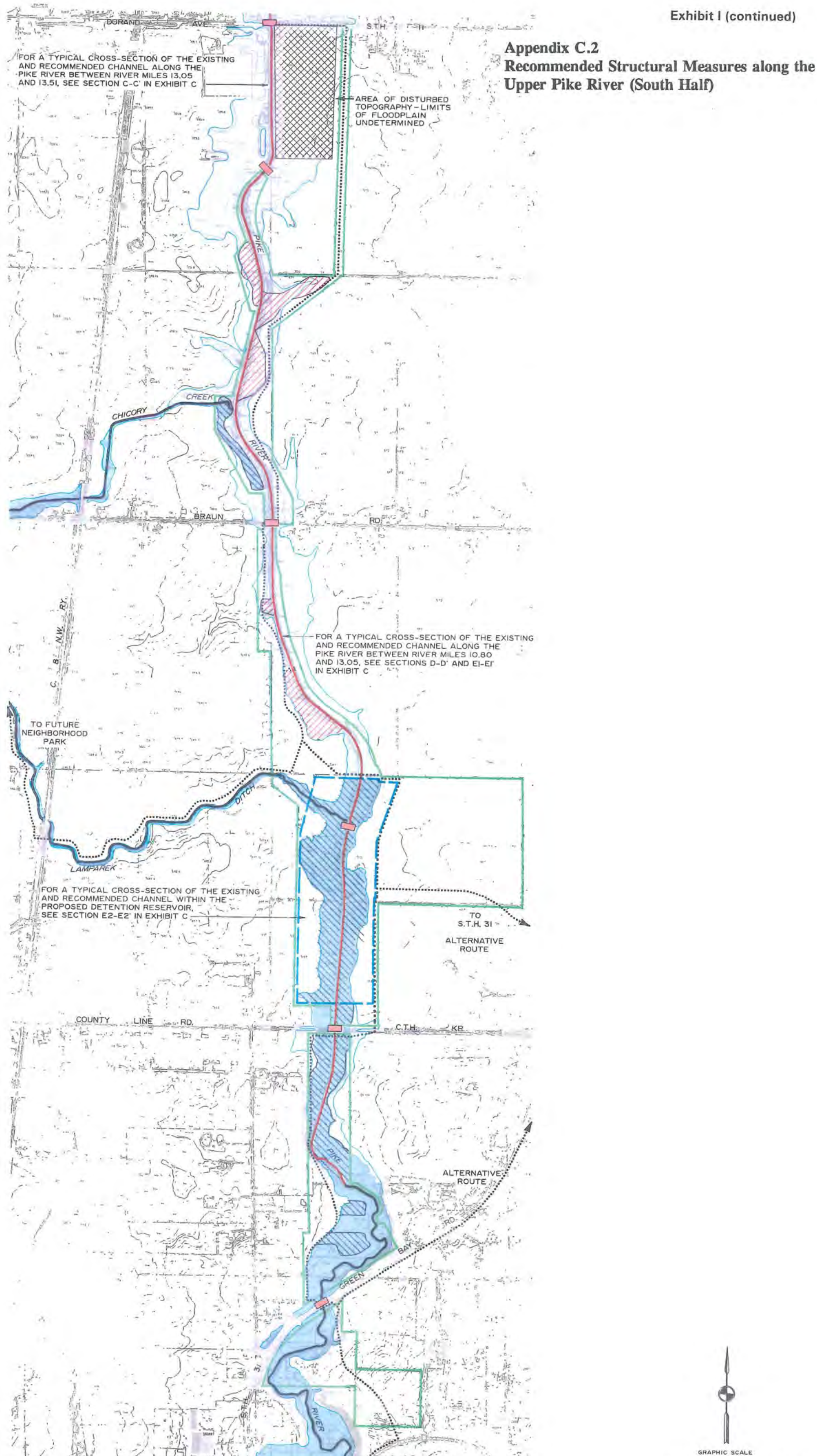
Appendix C.1
Recommended Structural Measures along the Upper Pike River (North Half)



Source: SEWRPC.

Exhibit I (continued)

Appendix C.2
Recommended Structural Measures along the Upper Pike River (South Half)

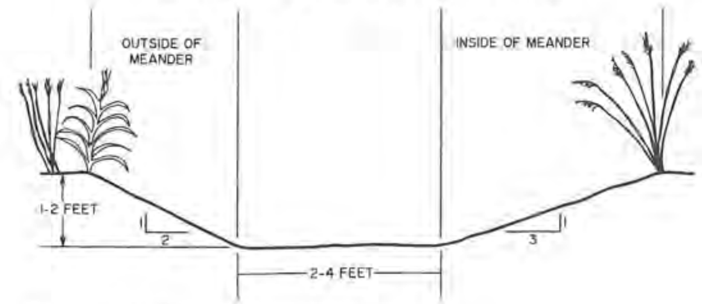


Source: SEWRPC.

Appendix C.3
Typical Low-Flow Channel and Cross-Sections of Existing and Proposed Channel along the Upper Pike River

Exhibit B

TYPICAL CROSS-SECTION OF PROPOSED LOW-FLOW CHANNEL

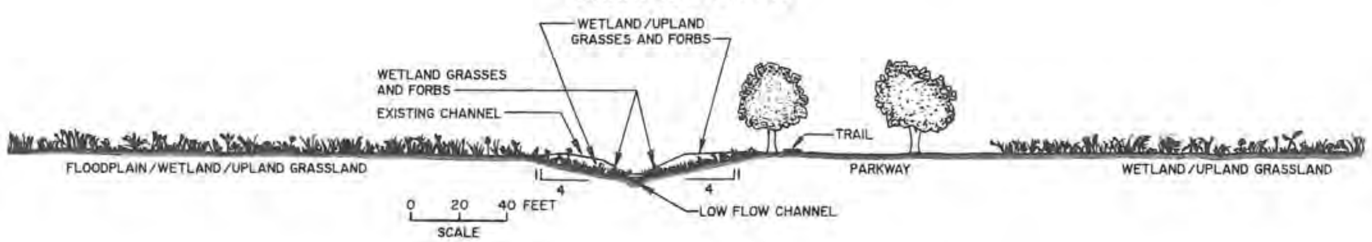


Source: SEWRPC.

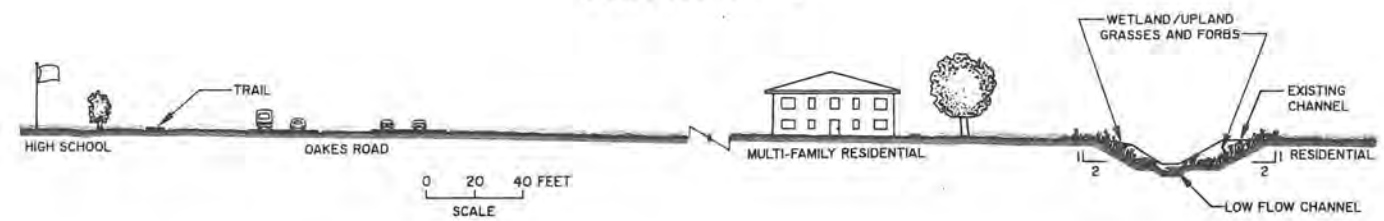
Exhibit C

TYPICAL CROSS-SECTIONS OF EXISTING AND PROPOSED CHANNEL ALONG THE UPPER PIKE RIVER

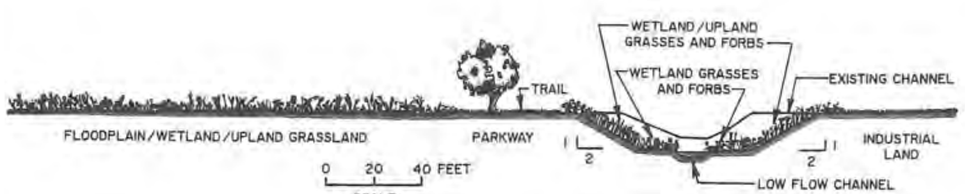
CROSS-SECTION A-A'



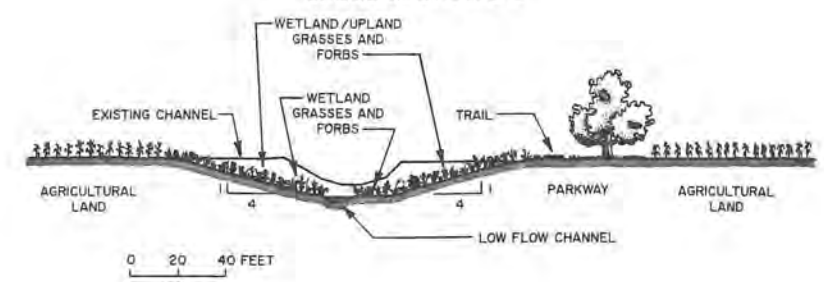
CROSS-SECTION B-B'



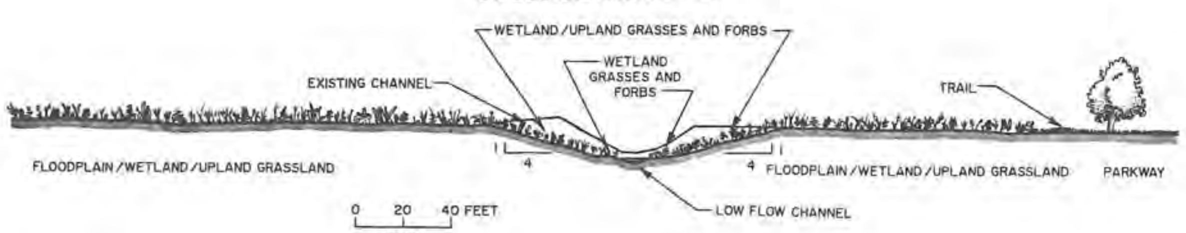
CROSS-SECTION C-C'



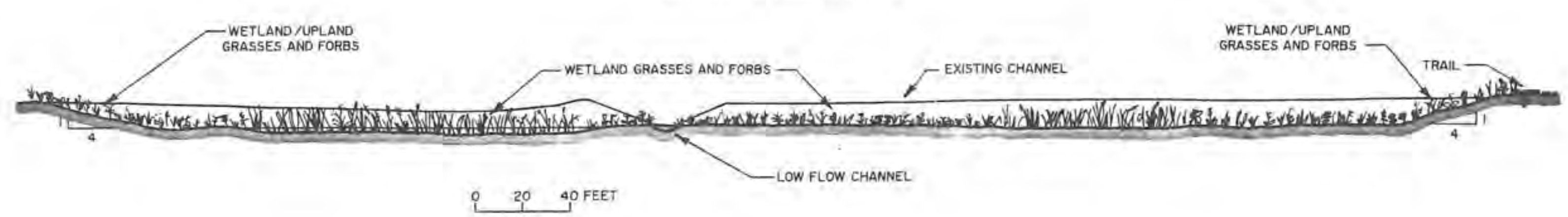
CROSS-SECTION D-D'



CROSS-SECTION E1-E1'



CROSS-SECTION E2-E2'



Source: SEWRPC.

Appendix C.4
Recommended Structural Measures along Pike Creek, Airport Branch and the Tributary to Airport Branch (North Half)

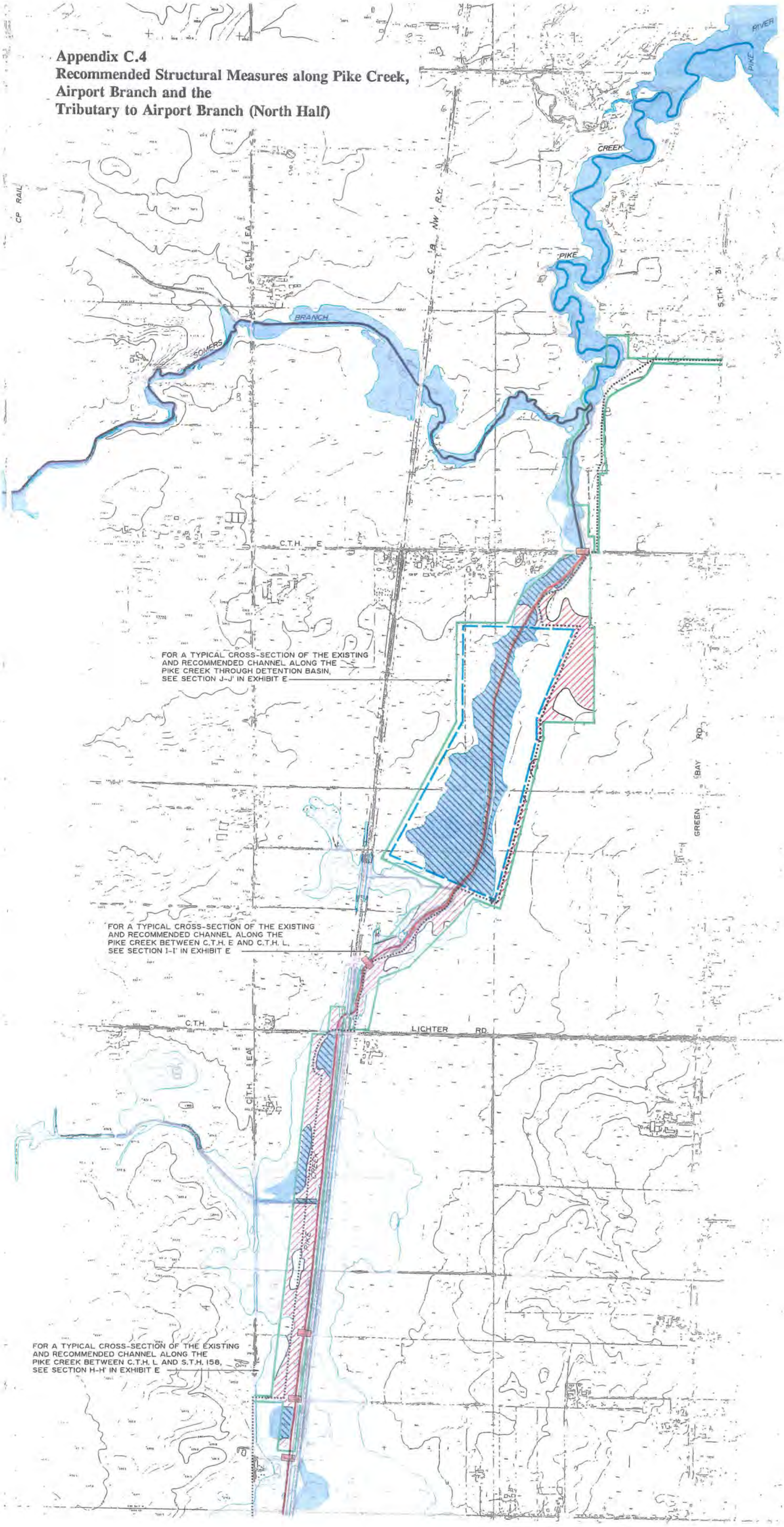


Exhibit J

RECOMMENDED STRUCTURAL FLOODLAND MANAGEMENT MEASURES ALONG THE PIKE CREEK, THE AIRPORT BRANCH, AND THE TRIBUTARY TO AIRPORT BRANCH

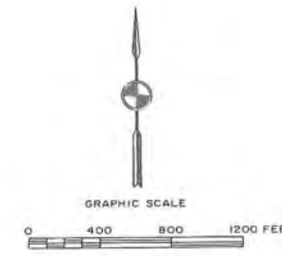
LEGEND

- 100-YEAR RECURRENCE INTERVAL FLOODLANDS—PLANNED LAND USE AND PLANNED CHANNEL CONDITIONS
- 100-YEAR RECURRENCE INTERVAL FLOODLANDS—PLANNED LAND USE AND PLANNED CHANNEL CONDITIONS PROPOSED FOR WETLAND/GRASSLAND RESTORATION
- 100-YEAR RECURRENCE INTERVAL FLOODLANDS UNDER PLANNED LAND USE AND EXISTING CHANNEL CONDITIONS THAT WOULD BE ELIMINATED UNDER PLANNED CHANNEL CONDITIONS
- AREA WITH WETLAND SOILS PROPOSED FOR WETLAND/GRASSLAND RESTORATION
- EXISTING CHANNEL
- EXISTING CULVERT
- PROPOSED CHANNEL ENLARGEMENT WITH WETLAND/GRASSLAND RESTORATION
- PROPOSED MAJOR CHANNELIZATION WITH WETLAND/GRASSLAND RESTORATION
- PROPOSED CHANNEL CLEARING AND DEBRUSHING
- PROPOSED GRASS WATERWAY
- PROPOSED BRIDGE OR CULVERT MODIFICATION OR REPLACEMENT
- PROPOSED DETENTION STORAGE RESERVOIR WITH WETLAND/GRASSLAND RESTORATION
- PROPOSED RECREATION TRAIL
- PROPOSED PIKE CREEK PARKWAY BOUNDARY

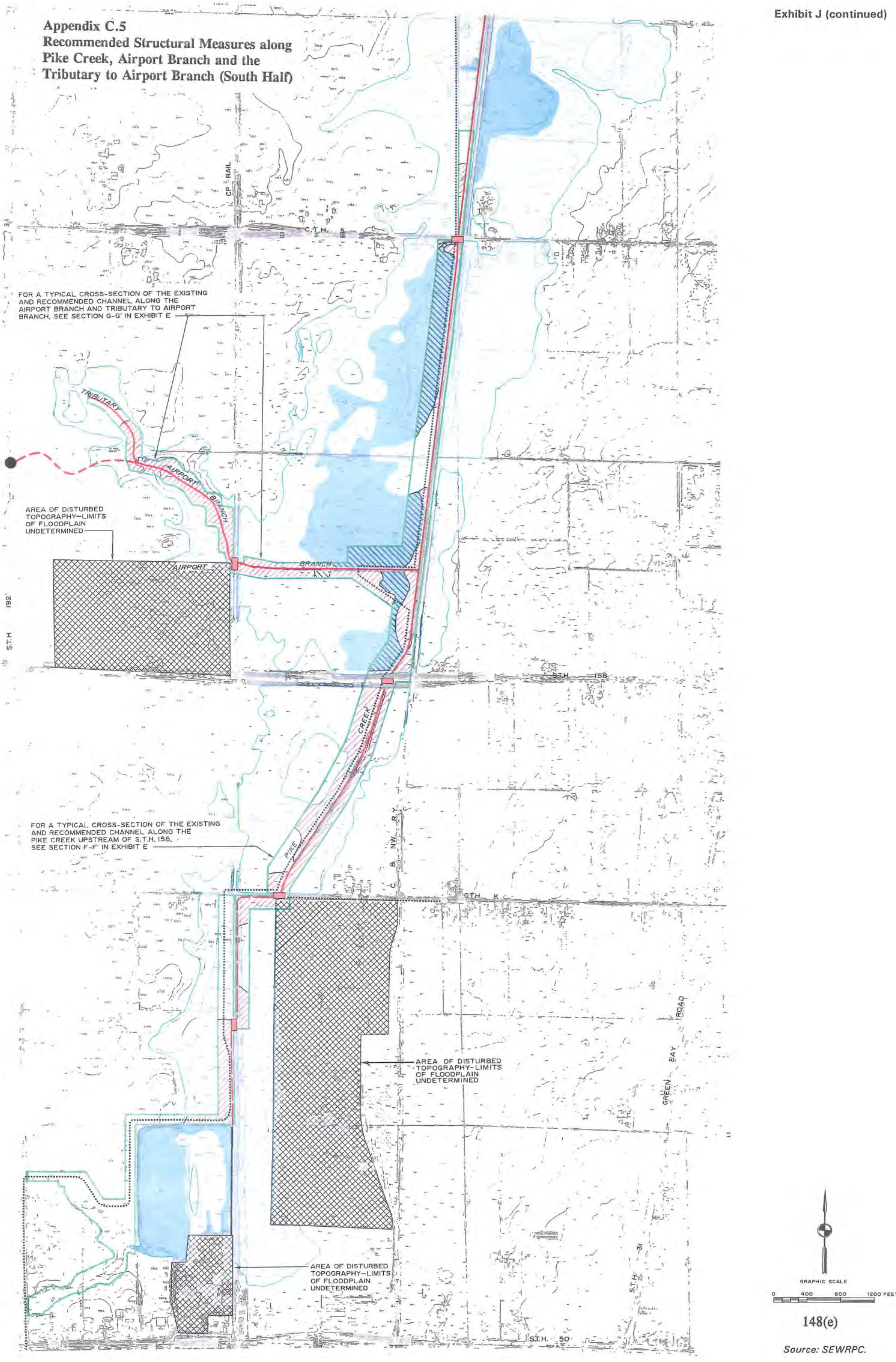
NOTE: 1. NOT SHOWN ON THIS MAP IS A PROPOSED MEANDERING LOW-FLOW CHANNEL TO BE CONSTRUCTED ALONG THE BOTTOM OF THE PROPOSED FLOOD CONTROL CHANNEL AND DETENTION RESERVOIR. SEE EXHIBIT B FOR A DETAIL OF THIS LOW-FLOW CHANNEL.

2. THIS EXHIBIT REPLACES MAP 80 ON PAGES 502 AND 503 AND MAP 82 ON PAGE 505 IN SEWRPC PLANNING REPORT NO. 35.

Source: SEWRPC.



Appendix C.5
Recommended Structural Measures along Pike Creek, Airport Branch and the Tributary to Airport Branch (South Half)



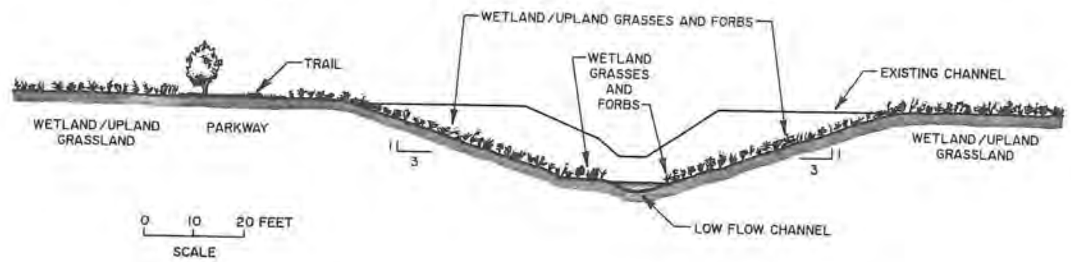
Source: SEWRPC.

Appendix C.6
Typical Cross-Sections of Existing and Proposed Channel along the Upper Pike River

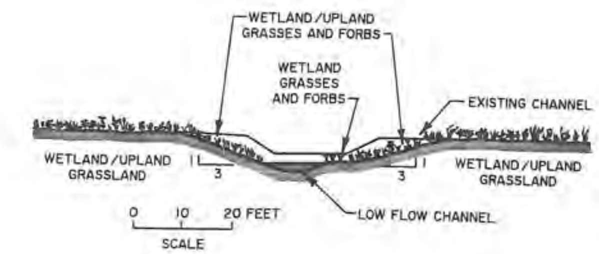
Exhibit E

TYPICAL CROSS-SECTION OF EXISTING AND PROPOSED CHANNEL ALONG PIKE CREEK, AIRPORT BRANCH, AND TRIBUTARY TO AIRPORT BRANCH

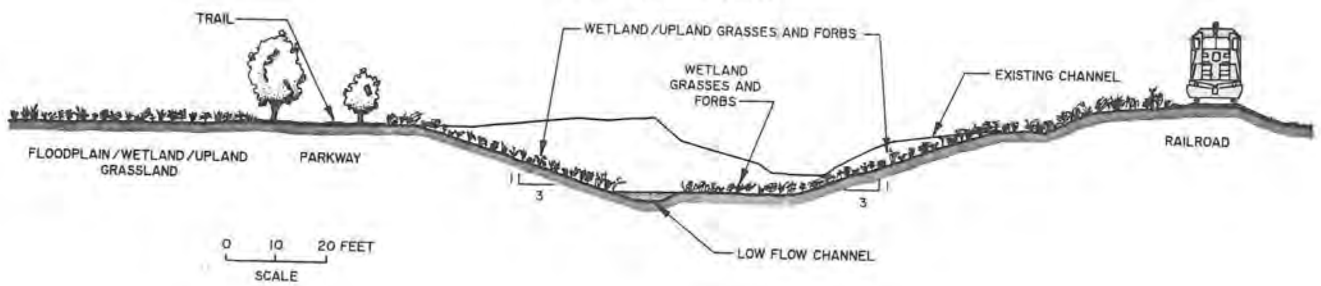
CROSS-SECTION F-F'



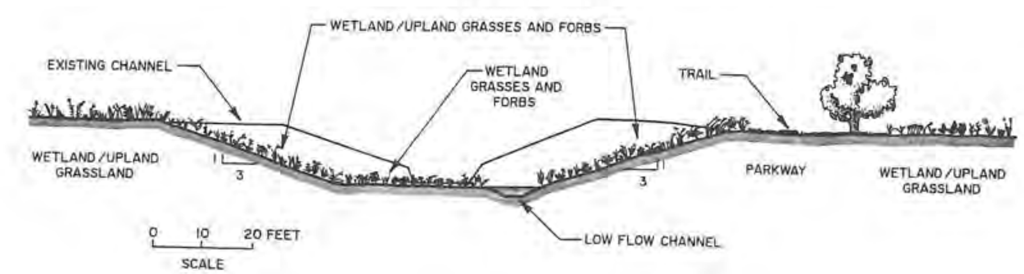
CROSS-SECTION G-G'



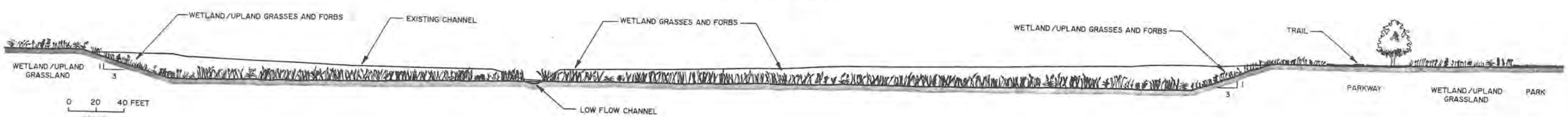
CROSS-SECTION H-H'



CROSS-SECTION I-I'



CROSS-SECTION J-J'



Source: SEWRPC.

APPENDIX D
Existing Visual Conditions and Visual Simulations

Environmental analysis includes assessing the visual impacts of any proposed project and alternatives that would change existing visual conditions. The Proposed Project and the optional elements of Alternative 2 would directly change the appearance of the existing Pike River channel and stream corridor. In order to approximate the visual effects of these actions, visual simulations were prepared through the use of digital image processing.

Photographs of aerial and ground-level views of the upper Pike River at the Braun Road crossing were used as the baseline for these simulations. This stream reach was chosen as being typical of the views existing in the stream corridor. Both a ground view and an aerial view of this site were used to represent existing visual conditions. The scenes were then duplicated in a digital format, and altered to approximate the visual conditions that would exist under both the Proposed Project and major habitat improvement option under Alternative 2. Photographs of a few other scenes in the Pike River Watershed and a nearby watershed were also used to provide vegetation and other visual elements used in constructing these scenes.

It is important to note that the simulations for both the Proposed Project and the Major Habitat improvement option contain elements that are not integral to achieving stated flood damage risk reduction goals. The simulation of the Proposed Project depicts the proposed parkway and trail. The simulation of a Major Habitat Improvement Option includes a full spectrum of habitat improvements and depicts a hypothetical recreation trail alignment. This habitat improvement simulation, while it does not depict the basic flood control elements of Alternative 2, would be compatible with Alternative 2. The overbank element could also be compatible with the Proposed Project. It is included in order to provide a wider spectrum of scenic beauty possibilities.

(The scenes begin on the next page.)

Pike River at Braun Road, Existing Conditions, Ground View Looking South

Pike River at Braun Road, Existing Conditions, Aerial View Looking South

Pike River at Braun Road, Proposed Project Visual Simulation, Ground View Looking South

Pike River at Braun Road, Proposed Project Visual Simulation, Aerial View Looking South

Pike R. at Braun Rd, Habitat Improvement Visual Simulation, Ground View Looking South

Pike R. at Braun Rd, Habitat Improvement Visual Simulation, Aerial View Looking South

PIKE RIVER E.I.S. ALTERNATIVES COST DOCUMENTATION AND SUMMARY

ALTERNATIVE	COMPONENT	ESTIMATED (1994) COST	SOURCE
Proposed Project	Channel enlargement, deepening and realignment on upper Pike River, Pike Creek, and the Airport Branch tributary to Pike Creek. *(Does not include land acquisition to accommodate wider channel.)*	$3,061,600 [O&M: $9,632]	SEWRPC "Report on Refinements to the Pike River Watershed Plan..." (1994). *All component costs are derived from 1980 dollar costs, using a conversion ratio of 1994:1980 Pike Creek flood control element costs ($1,081,000/626,000 = 1.72).*
	On-line stormwater detention. *(Site construction only - Does not include land acquisition.)*	$2,155,160 [O&M: $10,320]	Same as above.
	Land for detention sites (860 acre-feet, or 86 acres, avg. 10 ft. deep, @ $3,000/acre).	$258,000	Volume: SEWRPC to DNR (Mace) 10/13/94. Depth: SEWRPC "Report on Refinements...," Exhibit E.
	Bridges (replace 15, remove 1).	$2,710,720	SEWRPC "Report on Refinements..."
	Construct Bartlett Branch dike to protect 51 houses.	$65,188 [O&M: $516]	Same as above.
	Floodproof (8) and elevate (4) structures on Bartlett Branch.	$198,144	Same as above.
	Floodproof 1 house, 1 field house, and 1 restaurant on lower Pike River.	$145,168	SEWRPC Planning Report 35.
	Instream, side slope and channel bank habitat mitigation of construction damage.	$1,421,840 [O&M: $387]	SEWRPC "Report on Refinements..."
	Jetty construction at mouth of river.	$163,400 [O&M: $1,892]	SEWRPC Planning Report 35.
Cost Summary	Capital: $10,179,220 O&M: $22,747	Avg. Ann.[1]: $684,396	50-Year: 12,385,400[2] B/C: .43[3]

[1] Average annual cost = [capital cost x .065 (Annualized at 6% over 17 years)] + annual O&M.

[2] 50-year cost = [avg. ann. x 17 (# of annual payments)] + [ann. O&M x 50].

[3] B/C ratio assumes that the proposed project and alternatives 1 and 2 achieve a reduction in average annual flood damage risk of $291,540 [1.72 x $169,500 (from SEWRPC, (1994) "Report on Refinements to the Pike River Watershed Plan...")].

ALTERNATIVE	COMPONENT	ESTIMATED (1994) COST	SOURCE
Alternative 1	Floodproof (71) and elevate (42) structures on upper Pike River and Pike Creek. *(Assumed same FP/EL ratio as under proposed project. Count based on SEWRPC 2' contour maps).*	$1,993,308	SEWRPC "Report on Refinements..." *Average 1980 cost to floodproof = 3,900 (1994 = 6,708); average 1980 cost to elevate = 21,000 (1994 = 36,120).*
	Floodproof 1 house, 1 field house, and 1 restaurant on lower Pike River.	$145,168	SEWRPC "Report on Refinements to the Pike River Watershed Plan..." (1994).
Cost Summary[4]	Capital: $2,037,486; Annual O&M: $2,408	Avg. Ann.: $134,845	50-Year: $2,413,358; B/C: 2.16
Alternative 2	Stormwater design, detention and treatment for new development (1995 - 2010), providing a minimal degree of peak flow increase and 80% removal of TSS. *(Cost does not include land that might be needed for siting detention basins.)*	$5,916,925 [O&M: $90,000]	DNR Bureau of Waste Water. *Assumed balance of 1985-2010 development as 60% of projection, or 1811 acres. Estimated need for 22.4 acres of detention at $70,000 per acre capital and $2,000 per acre annual O&M, for treatment only, and 3.5 X that cost to control peaks.*
	Land for stormwater detention ponds (45 acres).	[@ $3,000/A] $135,000	Same as above. Doubled acreage, to 45 A.
	Widen upper area of channel (overbank area), to achieve a maximum increase in flood channel cross-section of 25%, with total amount of material removed of 300,000 cubic yards. *(Cost does not include land needed to accommodate wider channel.)*	$445,000	Estimate is 25% of the amount for full channel enlargement and realignment, under the proposed project, above. Amount of material moved is <25% of the full amount. Cost assumes a small decrease in cost efficiency.
	Habitat mitigation to restore disturbed upland habitat in widened overbank area.	$344,000 [O&M: $172]	Based on replacing grassland and woodland habitat. Mitigation cost-per-mile would be higher than under proposed project, but there would be no aquatic habitat repair costs.
	Floodproof (34) and elevate (21) homes. *(Assumed same EL/FP ratio as under proposed project.)*	$986,592	Used same unit cost amounts as in Alternative 1, above, and 8/31 SEWRPC revised count of 55.

[4] Alternative assumes no bridge approaches would be flooded. Costs to raise approach elevation may be required, pending further analysis.

ALTERNATIVE	COMPONENT	ESTIMATED (1994) COST	SOURCE
	Jetty construction at mouth of river.	$163,400 [O&M: $1,892]	Same as above.
	Floodproof 1 house, 1 field house, and 1 restaurant on lower Pike River.	$145,168	SEWRPC Planning Report 35.
Cost Summary	Capital: $8,136,085; Annual O&M: $92,664	Avg. Ann.: $621,510	50-Year: $15,623,552; B/C: 0.47
Alternative 3	No action	$0	SEWRPC Planning Report 35

PR_CST_C.JST 9/11/95

APPENDIX F

State, Federal and Non-Governmental Programs that Are Potential Funding and Assistance Sources

Grant or Other Assistance Description	Eligibility	Assistance
Urban Green Space (Wisconsin DNR) Purchase land to provide open natural space near or in urban areas for ecological protection, passive recreation and non-commercial urban gardens. *Applications due May 1 (608-266-5891)*	Counties, cities, villages, towns, lake districts, tribal governments, nonprofit conservation organizations	50% matching grants
Urban Rivers (Wisconsin DNR) Purchase land adjacent to urban rivers to improve access and recreation opportunities, assist economic revitalization, preserve or restore natural areas. *Applications due May 1 (608-266-5891)*	Counties, cities, villages, towns, lake districts, tribal governments. (Multi-use projects favored)	Up to 50% matching grants
Bureau of Water Regulation and Zoning (WDNR) Technical assistance on floodplain regulation, floodplain mapping, integration with community planning, dam safety and participation in National Flood Insurance Program. *(608-266-0161)*	Landowners, other state agencies, local governments, tribal governments, non-profit conservation groups	Technical assistance and information on funding
Streambank Protection (Wisconsin DNR) Purchase land for the protection of water quality and aquatic habitat in rivers and streams. *Applications due May 1 (608-266-0161)*	Counties, cities, villages, towns, tribal governments, nonprofit conservation organizations	50% matching grants
Habitat Restoration Areas (Wisconsin DNR) Purchase land for the restoration of wildlife habitat lost to agriculture or development. *Applications due May 1 (608-266-5891)*	Nonprofit conservation organizations	50% matching grants

Aids for the Acquisition and Development of Local Parks (Wisconsin DNR) Assist in purchasing land and developing public outdoor recreation areas. *Applications due May 1 (608-266-5891)*	Counties, cities, villages, towns, lake districts, tribal governments (Comprehensive Outdoor Rec. Plan required); nonprofit conservation organizations (acquisition only)	Up to 50% matching grants
County Conservation Aids (Wisconsin DNR) Assist with management projects to improve fish or wildlife habitat or hunter and angler facilities. *Applications due May 1 (608-266-5891)*	Counties, tribal governments	50% of eligible activities
Rivers, Trails and Conservation Program (USDI -National Park Service) Acts as advisor and facilitator for local river corridor (and other) planning efforts, as well as floodplain mitigation) *(414-297-3617)*		
Federal Aid in Sport Fish Restoration Act Land purchase, habitat restoration, access development, public education. *(Contact the District Fish Manager for details: 414-263-8613)*	Wisconsin DNR (may contract with counties, villages and towns), for projects identified in Fisheries Management Strategic Plan	75% cost share
Land and Water Conservation Fund (LAWCON) Land acquisition, development of public outdoor recreation areas, preservation of water frontage and open space. *Applications due May 1 - Funding uncertain (608-266-5891)*	Counties, cities, villages, towns, school districts, and tribal governments with an approved Comprehensive Outdoor Recreation Plan	50% matching grants
North American Wetlands Conservation Fund Wetland protection projects. Details from: No. American Wetlands Conservation Fund Council Coordinator 4401 N. Farifax Dr., Rm 110 Arlington, VA 22203 [PH: 703-358-1784]	"Any group, agency or individual with a quality project"	50% matching funds

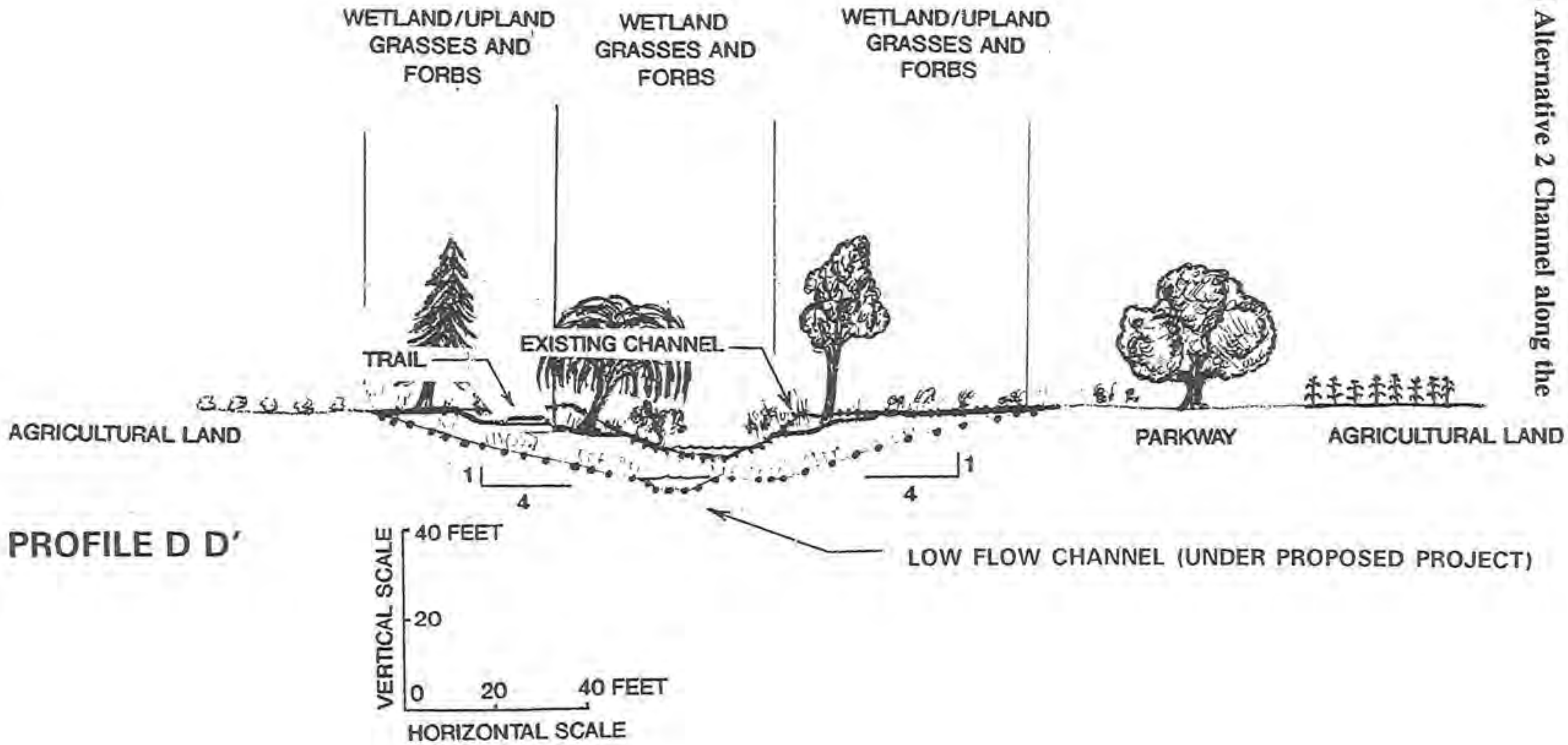
Wisconsin Department of Transportation Wetland mitigation program purchases and restores wetland restoration sites, using highway funds. Flood Damage Aids Program provides funds to repair roadways damaged by floods. *(Contact DOT district office)*	Approved wetland mitigation sites agreed upon by DOT and DNR. Flooded roads must have been closed or impassable. Funds are provided to local gov'ts.	Not specified for wetlands; 75% replacement for roadways
Wisconsin Department of Development Community Development Block Grant (CDBG) Disaster Recovery Funds available to relocate, repair or replace damaged or destroyed housing and government facilities. Priority to urgent housing, health and safety needs. *(608-266-3278)*	Available to local governments	100% coverage of approved costs (no match required)
Wisconsin Department of Administration Division of Housing processes housing portion of CDBG, described above. HOME Program provides housing grants to people meeting income limitations, and who have already applied to FEMA and SBA. *(608-266-1983)*	CDBG available to local governments; HOME grants distributed to individuals.	Not specified
Wisconsin State Historical Society Technical assistance and (limited) funding for restoring or stabilizing flood-damaged property. *(608-264-6508)*	Property owners, including local governments	Total available for structural stabilization is $100,000
Wisconsin State Public Land Trust Fund Short-term low-interest loans *(608-266-0034)*	Local units of government that are awaiting other funding	Loan example: 3.25% for 1 to 10 years
Wisconsin Department of Military Affairs Emergency preparedness and response; Hazard Mitigation Grant Program; 1988 Disaster Law public assistance; and Individual and Family Grant Program. *(608-242-3211)*		
University of Wisconsin - Extension Provides education and training materials on flood recovery measures.	Flood-prone property owners and other flood survivors	Information for practical action

Federal Emergency Management Agency (FEMA) Disaster response and relief; flood insurance study coordination; guidance on enforcement of floodplain management regulations; financial assistance for planning and implementation of flood hazard mitigation programs. *(312-408-5500)*		
Wetland Reserve Program Restoration and protection of farmed wetlands or converted wetlands. *Contact Agricultural Stabilization & Conservation Service (ASCS) or SCS office serving landowner's county.*	Land owners with eligible land who agree to enter into a permanent or long-term easement	Direct payment for conservation easement
Watershed Management and Flood Prevention General and financial assistance for small watershed planning. Can be used to establish buffer zone between agricultural lands and aquatic environment. *Contact state SCS office.*	State agencies, local governments, and certain non-profits with watershed improvement authority	Grants, advisory services, and counseling
Water Quality Incentive Projects Incentive for minimizing the generation, emission, or discharge of nonpoint agricultural pollutants that result from agricultural activity. Can help provide buffers and protect wetlands. *Contact state ASCS or county SCS office.*	Land owners or farm operators whose practices do or could impact water resources	Payment of $25 annually, up to $3500 per person per year
Water Bank Program To improve wetlands and provide migratory waterfowl habitat. Can provide a buffer for riparian habitats. *Contact state ASCS or county SCS office.*	Landowners who agree not to drain, burn, fill or farm wetlands	Direct payments, according to use
Soil and Water Conservation Technical assistance in integrated resource planning to improve water quality, including non-point source reduction. *Contact state and county SCS offices.*	General public, as well as state and local governments	Technical assistance in planning
Emergency Watershed Protection Program Technical and financial assistance in relieving imminent hazards to life and property caused by clogged streams, slumping, etc. *Contact county SCS offices.*	Land owners and local governments	Technical and financial assistance

Emergency Conservation Program Helps landowners replace conservation structures destroyed by natural disasters. *Contact state ASCS office.*	Land owners	Cost sharing
River Basin Surveys and Investigations Planning assistance to solve upstream rural flooding, agricultural water quality problems, and wetland preservation. *Contact state and county SCS offices.*	Federal, state and local agencies	Planning assistance and special services
Agricultural Conservation Program Financial assistance for the control of erosion and soil loss aimed at improving water quality. Can provide buffers for aquatic environments. *Contact ASCS county committee.*	Farmers with land under cultivation during certain time periods	Direct payments for implementing approved practices
Resource Conservation and Development (RC&D) Program To develop programs that "conserve and develop" natural and cultural resources. *Contact state and county SCS offices.*	State and local governments and non-profit groups in areas with approved RC&D programs	Planning and project grants, and advisory services
North American Wetlands Conservation Fund To acquire, enhance and restore a diversity of wetland ecosystems for wetland wildlife, especially migratory birds. *Contact USF&WS regional office: (708-381-2253)*	Preference to non-federal partners, for joint ventures that protect high priority species	Project grants
Migratory Bird Conservation Fund To acquire and preserve quality waterfowl habitat threatened by human activity, through means other than FWS acquisition. *Contact USF&WS regional office.*	(Not identified)	(Not identified)
FmHA Conservation Easement Program Places farmland with conservation values into an easement to protect environmental, wildlife or recreation values.	FmHA borrowers volunteering to provide an easement for 50 years, or in perpetuity	Reduction in principal on FmHA loan
Economic Development Administration Assists flood-prone communities with development and administration of strategies for long-term economic relief. *(715-834-4079]*	Local governments.	80% cost share

EPA-Funded Programs Administered by DNR Wetlands, environmental monitoring, sediment management, hazardous waste and other programs. *(312-353-5791)*	Local governments meeting criteria for program participation	90% or more cost share
U.S. Army - Corps of Engineers Section 205 program provides funds for structural or non-structural flood damage mitigation projects that are economically feasible and environmentally acceptable. *(612-290-5204)*	Local or state governments	75% cost share
U.S. Small Business Administration Low-interest, long-term loans to repair damage after a declared disaster. 20% of the loan may be used for flood hazard mitigation measures. *(1-800-359-2227)*	Homeowners and businesses affected by declared disasters	Low-cost loans
National Weather Service - Flood Warning System Provides technical assistance for developing flood warning systems. *(414-965-2906]*.	Counties and communities	Not specified

APPENDIX G
Typical Cross-Section of Existing and Alternative 2 Channel along the Upper Pike River



Wisconsin Department of Natural Resources
101 South Webster Street
P.O. Box 7921
Madison, WI 53707-7921