ANALYSIS OF EFFECTS OF PROPOSED MILWAUKEE COUNTY GROUNDS DETENTION BASINS ON FLOODING CONDITIONS ALONG THE MENOMONEE RIVER AND UNDERWOOD CREEK

Prepared for

Milwaukee County

by the

Southeastern Wisconsin Regional Planning Commission

February 12, 2003

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
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February 12, 2003

Mr. Robert R. Dennik
Executive Assistant
Milwaukee County Courthouse
901 N. Ninth Street, Room 306
Milwaukee, WI 53233

Dear Mr. Dennik:

As outlined in our September 30, 2002, letter to you, the Regional Planning Commission staff has completed the needed analyses and the evaluation of the potential effects on flooding and flood control projects of the detention basin which the Milwaukee Metropolitan Sewerage District (MMSD) proposes to construct on the Milwaukee County Grounds. Specifically, the project would be located in the vicinity of the confluence of the Menomonee River and Underwood Creek near Swan Boulevard and Underwood Creek Parkway in the northeast and southeast one-quarters of U.S. Public Land Survey Section 20 and the northwest and southwest one-quarters of Section 21, Township 7 North, Range 21 East, City of Wauwatosa.

In our September 30, 2002, letter it was envisioned that the work to be conducted by the Commission staff would be directed toward answering two questions:

1. Under an assumption that the proposed County Grounds Detention Basin would not be constructed, what would be the effects upon:

    a. Menomonee River flood control projects already completed by the MMSD?

    b. Menomonee River flood control projects that are presently under design by the MMSD and scheduled for implementation in the relatively near future?

    c. Any residual areas impacted by overland flooding or related problems downstream of the diversion structure attendant to the County Grounds Basin?

2. What alternatives remain to the construction of the proposed County Grounds Detention Basin that would address any residual flooding or complications that are identified in the answers to question No. 1 above?

It was envisioned that the report addressing the first question would be developed and reviewed with you prior to determining the need for, and content of, any work effort to address the second question. Thus, this letter and the attached memorandum address the first question noted above and provide options for further consideration of this matter.

The enclosed SEWRPC Staff Memorandum, dated February 12, 2003, documents the study results. In preparing the memorandum, we obtained hydrologic and hydraulic data and computer models, cost estimating data, digital mapping data, watercourse system plan and Phase 2 watercourse management plan reports, and project construction drawings from the MMSD and their consultants. As you may be aware, the original hydrologic and hydraulic modeling performed for the Menomonee River watershed was done by the Commission staff for the 1976 SEWRPC *Comprehensive Plan for the Menomonee River Watershed*. Since that time, the models developed under that study have been updated and refined by both

the Commission staff and MMSD and its consultants. The model and related data have been updated and refined for use in preparing this report.

As background, you will recall that the MMSD-proposed Menomonee River floodland management plan consists of a number of interrelated projects designed to function as a system. Those projects are designed to eliminate damages due to direct flooding of buildings during floods on the Menomonee River with recurrence intervals up to, and including 100 years. The mandatory requirement to purchase Federal flood insurance when acquiring buildings with Federally-backed mortgages is intended, upon implementation of the entire plan, to be eliminated for all but four buildings. Those four buildings, consisting of three recreational buildings at Hart Park and one commercial building near the intersection of Harwood Avenue and W. State Street, would be floodproofed.

The proposed MMSD Menomonee River flood control project consists of the following major components, listed from upstream to downstream. The Valley Park project has been constructed and the acquisition and removal of buildings in the floodplain east of Hart Park has been substantially completed. The others are in varying stages of design.

- The Milwaukee County Grounds Detention Basin with a storage capacity of about 800 acre-feet. The basin would store floodwater from Underwood Creek and would be located near the confluence of the Creek and the Menomonee River.

- The Lower Wauwatosa/Hart Park project, consisting of building acquisition and removal, floodproofing, levee/floodwall construction, interior stormwater drainage facilities, and floodplain lowering through excavation in the overbanks.

- The Western Milwaukee project, consisting of building acquisition and removal, levee/floodwall construction, interior stormwater drainage facilities, bridge removal, and floodplain lowering through excavation in the overbanks.

- The Valley Park Neighborhood consisting of building acquisition and removal, combined levee/floodwall construction, and interior stormwater drainage facilities.

- The Falk Floodwall Raising project under which the existing levee/floodwall/closure system of flood protection at the Falk Corporation property in the Menomonee River Valley near the 27th Street viaduct would be improved.

It should be noted that these are not stand-alone projects. They are intended to function together as a system, and there is a high degree of interrelation between them. Therefore, it should come as no surprise that the system will not function as intended if a component is eliminated.

The MMSD watercourse planning program did not explicitly address floodplain issues on the currently undeveloped CMC/Heartland Partners site between the east Miller Park parking lot and the Falk Corporation property. It was assumed that those issues would be resolved through the site design process and would in no way impact upon upstream areas.

The findings of the SEWRPC analyses are summarized below. General findings are presented, followed by findings related specifically to Questions 1a through c as listed above.

GENERAL FINDINGS

- As indicated in Table 1 of the attached memorandum, the Milwaukee County Grounds Detention Basin would reduce 100-year flood flows (volume or amount of flow) and stages (flood elevations) throughout the entire reach of the Menomonee River downstream of the Basin.

- Relative to existing conditions, implementation of the complete proposed MMSD project, including the County Grounds Detention Basin, would reduce the peak 100-year flood flows along Underwood Creek by about 60 percent in the reach downstream of the connection to the County Grounds Basin, and along the Menomonee River by from 2 to 18 percent in the 6.6-mile reach downstream from the County Grounds Basin to the Menomonee River estuary area at about 26th Street, with the greatest decreases occurring in significant flood damage reaches.

- Relative to existing conditions, implementation of the proposed MMSD project without the County Grounds Detention Basin, would reduce peak 100-year flood flows along the Menomonee River by from 1 to 4 percent in the reach between Hart Park and the estuary. Flood flows would be unchanged upstream of Hart Park and along Underwood Creek.

- Relative to existing conditions, implementation of the complete proposed MMSD project, including the County Grounds Detention Basin would reduce the 100-year flood stages along the lower 0.8 mile of Underwood Creek from 0.8 to 3.9 feet and along the lower 8.4 miles of the Menomonee River by up to 7.2 feet. Along much of the Menomonee River the reduction would be in the one- to three-foot range.

- Relative to existing conditions, implementation of the proposed MMSD project without the County Grounds Detention Basin would not reduce the 100-year flood stage along the lower 0.8 mile of Underwood Creek. Implementation would reduce the 100-year stage along the lower 6.6 miles of the Menomonee River by up to 6.6 feet in one, localized reach, but there are locations where stages would increase by up to 1.8 feet. Along much of the Menomonee River the reduction would be in the 0.5- to 1.5-foot range. As set forth in Table 2 of the attached SEWRPC Staff memorandum, stage reductions are always less than they would be with the County Grounds Basin in place.

- Implementation of the complete proposed MMSD project, including the County Grounds Detention Basin, would result in 175 buildings in the Cities of Milwaukee and Wauwatosa no longer being in the 100-year floodplain. Those buildings would also no longer have a Federal flood insurance requirement and they would no longer be regulated as floodplain buildings for local zoning purposes.

- Implementation of the proposed MMSD project without the County Grounds Detention Basin would result in 157 buildings in the Cities of Milwaukee and Wauwatosa no longer being flooded during the 100-year event, but 101 of those buildings would still have a Federal flood insurance requirement and be regulated as floodplain properties for local zoning purposes because the levees/floodwalls intended to protect them would not have adequate freeboard to meet regulatory requirements established by the Federal Emergency Management Agency and the Wisconsin Department of Natural Resources. Freeboard is defined as the difference in elevation between the peak 100-year flood stage and the top of a protective structure, such as a levee or floodwall. Freeboard requirements are intended to provide a margin of safety to enable the levees and/or

floodwalls to provide flood protection in situations where flood stages are increased due to debris blockages or other unforeseen conditions.

- The lack of adequate freeboard increases the likelihood of failure of the levees/floodwalls to perform as intended since they would be more susceptible to overtopping resulting from debris blockages or other unforeseen conditions that could elevate flood stages.

FINDINGS RELATED TO QUESTION 1a: Under an assumption that the proposed County Grounds Detention Basin would not be constructed, what would be the effects upon Menomonee River flood control projects already completed by the MMSD?

- The Valley Park combination levee/floodwall will have inadequate freeboard at one localized segment and additional measures may be needed to officially remove the protected buildings from the floodplain and avoid the requirements for flood insurance placed on homeowners by lending institutions. This finding is based upon the assumption that all of the projects, except the County Grounds Detention Basin, are completed. If the other upstream projects are not constructed, a larger portion of the floodwall/levee would have inadequate freeboard to meet regulatory requirements.

FINDINGS RELATED TO QUESTION 1b: Under an assumption that the proposed County Grounds Detention Basin would not be constructed, what would be the effects upon Menomonee River flood control projects that are presently under design by the MMSD and scheduled for implementation in the relatively near future?

- Proposed levees/floodwalls would have inadequate freeboard as detailed in Table 3 of the attached memorandum, and, as noted above, up to 101 buildings would still have a Federal flood insurance requirement and be regulated as floodplain properties for local zoning purposes.

- The floodproofing cost would be higher at four buildings in Wauwatosa.

- More expensive interior stormwater drainage facilities, including possibly pumping systems, would be required for areas protected by floodwalls and levees because of higher flood stages in the Menomonee River.

FINDINGS RELATED TO QUESTION 1c: Under an assumption that the proposed County Grounds Detention Basin would not be constructed, what would be the effects upon any residual areas impacted by overland flooding or related problems downstream of the diversion structure attendant to the County Grounds Basin?

- During the 100-year event, there will be flood damages estimated at $3.3 million at eight industrial buildings along the Menomonee River in Milwaukee, one industrial building along the Menomonee River in Wauwatosa, and one institutional building and eight single-family houses along Underwood Creek in Wauwatosa.

- Currently occurring indirect, unquantified damages due to temporarily elevated groundwater levels, inadequate stormwater drainage, and sanitary sewer infiltration and inflow would not be reduced in areas near the Underwood Creek floodplain in the vicinity of Fisher Parkway and other areas along the River adjacent to the floodplain.

- The 100-year flood stage would increase relative to existing conditions downstream of N. Hawley Road and downstream of N. 45th Street. In order to ensure compliance with local and State regulations, easements would have to be obtained at nine properties. In addition, easements may have to be obtained at up to 85 properties that are that are in the Cities of Milwaukee and Wauwatosa in the Lower Wauwatosa/Hart Park project area upstream of Hawley Road and that are 1) in the area to be protected by levees or floodwalls, 2) would not be removed from the floodplain for regulatory purposes because of inadequate freeboard for the levees or floodwalls, and 3) are adjacent to those River reaches where 100-year flood stage increases could occur.

- There would be an increased cost for facilities to manage greater overflows from the River that could flow across the CMC site, the proposed W. Canal Street extension, and the Canadian and Pacific Railway tracks, all located east of Miller Park. The cost of those facilities can only be determined through a detailed evaluation accounting for development configurations on the CMC site and possible features of the W. Canal Street extension.

- Although removal of the concrete lining in Underwood Creek is not currently planned by MMSD, it has been studied in the past, and the District may consider it in the future. Construction of the County Grounds Basin may facilitate removal of the lining in the lower 0.8 mile of the Creek because it would significantly reduce peak flood flows, facilitating the construction of a more natural channel without raising flood stages to a level that would threaten existing development. Without the County Grounds Basin, extensive upstream mitigative measures would be required to implement removal of the concrete lining. Such mitigative measures may not be feasible or practical.

Based on the foregoing findings, it is concluded that the MMSD project components would not function to serve their intended purpose of providing relief from floods and officially removing properties from the 100-year floodplain if the County Grounds Basin is not included in the project. This finding is not surprising, since the MMSD projects were designed to function as an integrated system. Furthermore, the residual flooding and related conditions are not considered to be acceptable, given that the recent effort by the MMSD, which included extensive stakeholder and public involvement, identified a relatively complete solution.

Given the foregoing findings and conclusions, there appear to be three options for moving forward with this matter:

1. <u>Proceed with Full Implementation of MMSD Plan</u>
   Rely on the results of the most recent comprehensive floodland management planning effort program—the MMSD watershed management program—involving stakeholder and public involvement and proceed with completing the currently proposed floodland management program, including the County Grounds Detention Basin. This approach would recognize that the effectiveness of the plan relies upon all of the projects acting as an integrated flood abatement system. Under this option, the County, and perhaps a County-sponsored advisory committee, should be an active partner in the design, construction, and operation and maintenance of the basins and related facilities and open space areas in order to ensure that the County's, and to the extent practical, citizen's objectives for the area involved are achieved. It would appear that with such involvement, the area involved could become a community asset, which would be more useable and beneficial, at least to most citizens, than the site is in its current state.

2. Examine Alternative Storage Solutions

Under this alternative, there would be an acceptance as reasonable, sound, and committed of all of the Lower Wauwatosa/Hart Park, Western Milwaukee, Valley Park, and Falk Corporation projects. These projects are either completed or under design. As noted above, these projects will not function as intended, or adequately, without a means of reducing the flood flows upstream of the flood damage centers. Thus, there is an identified need to either construct the County Grounds Detention Basin or develop an alternative which has similar impacts on flood flows. Under this approach, the potential alternative means of providing such storage could be reevaluated. In this regard, we would note that such evaluations have been considered and evaluated on a number of occasions in the past. Based on a review of those previous evaluations, it may be concluded that:

- Alternatives for providing floodwater storage to reduce flood damages in the Menomonee River have been extensively studied as single-feature plans and in combination with other flood mitigation measures;

- Regional, subregional, and local storage alternatives that provide detention storage for areas of existing development and that were developed as essentially complete solutions to the flooding problems in the major damage centers in the Cities of Milwaukee and Wauwatosa would be extremely expensive and would require purchasing more buildings for construction of storage facilities than those facilities would provide with flood protection;

- Of all of the regional and subregional storage locations considered under the MMSD Phase 1 alternatives analysis, the Milwaukee County Grounds site is the only one strategically located near major inputs of runoff and near the Lower Menomonee River flood damage area that would not require acquisition and removal of a substantial number of existing buildings;

- The effects on flood flows of the existing flood storage areas that are recommended to be acquired under the MMSD Conservation Plan have either been explicitly modeled in, or implicitly considered through calibration of, the hydrologic models that were developed for the Phase 1 and Phase 2 MMSD watercourse management plans and that were applied in this evaluation of the County Grounds Basin;

- The flood storage areas identified under the MMSD Conservation Plan are located in headwaters areas where storage enhancement could be beneficial in reducing flood flows and stages along the upper reaches of the Menomonee River, but would not be effective in reducing the flood hazard in the significant damage reaches in Milwaukee and Wauwatosa;

- The provision of the maximum feasible amount of floodwater storage in areas tributary to Underwood Creek upstream of the Milwaukee-Waukesha County line would not reduce flood flows enough to have a significant impact on the size of the proposed Milwaukee County Grounds Basin; and

- The provision of the maximum volume practicable in existing open space in areas tributary to Underwood Creek downstream of the Milwaukee-Waukesha County line (about 400 acre-feet) would require constructing a large retention basin that could only be drained through pumping in the City of Brookfield, overbank lowering along the County's Underwood Creek Parkway, and extensive disturbance of playing fields on the Wauwatosa School District's

Underwood School grounds. The County Grounds Basin would still be necessary to the proper functioning of the flood control plan for the reaches of the Menomonee River downstream of Underwood Creek and the overall volume of the Basin would still be more than 400 acre-feet. The capital and operation and maintenance costs of the overall Underwood Creek storage system would be very likely to increase relative to those for the currently-proposed County Grounds Basin because of loss of economy of scale and decentralization of operation and maintenance.

3. Complete Reevaluation

Under this alternative, a complete reevaluation of the floodland management alternatives, including those projects constructed and under design, for the Menomonee River involving stakeholder and public involvement program. This effort would be a major work effort that would halt the ongoing design process and would involve as much as 18 months of time and substantial cost in order to complete the needed technical work and stakeholder and public involvement. Given that the MMSD is the implementing agency, they should be directly involved.

The only logical, additional alternative that was not evaluated in detail through the MMSD watercourse system planning process would be acquiring and removing all buildings in the 100-year floodplain. Other alternatives that might be considered would be reconfigurations or refinements of alternatives that were already evaluated during the MMSD planning process. Acquisition and removal of all floodplain buildings was considered in a qualitative sense during MMSD plan formulation and it was rejected based on strong opposition from the Cities of Milwaukee and Wauwatosa. As many as 179 single- and two-family residential, commercial, industrial, institutional, and recreational buildings would be acquired and removed under such an approach.

We trust that the foregoing will be helpful to Milwaukee County in considering this important policy matter. We remain available to explain these findings to any interested officials, government staff members, or other interested parties or groups.

Sincerely,

Philip C. Evenson
Executive Director

PCE/MGH/pk
#80200 V1 - MCG DET BASIN EVAL LTR

Enclosure (#79112)

cc: Mr. Kevin L. Shafer, Milwaukee Metropolitan Sewerage District

SEWRPC STAFF MEMORANDUM NO. MCGMNRW-1

HYDROLOGIC AND HYDRAULIC ANALYSES AND EVALUATION OF THE EFFECTS OF THE PROPOSED MILWAUKEE COUNTY GROUNDS DETENTION BASIN ON FLOOD CONDITIONS AND EXISTING AND PROPOSED FLOOD CONTROL PROJECTS ALONG THE MENOMONEE RIVER AND UNDERWOOD CREEK

Prepared for

MILWAUKEE COUNTY

February 12, 2003

INTRODUCTION AND BACKGROUND

In September 2002, the Milwaukee County Executive's office requested that the Southeastern Wisconsin Regional Planning Commission (SEWRPC) perform an analysis to evaluate the potential effects on flooding and flood control projects of the detention basin which the Milwaukee Metropolitan Sewerage District (MMSD) proposes to locate on the Milwaukee County Grounds. Specifically, as shown on Maps 1 and 2A, the basin would be located in the vicinity of the confluence of the Menomonee River and Underwood Creek near Swan Boulevard and Underwood Creek Parkway in the northeast and southeast one-quarters of U.S. Public Land Survey Section 20 and the northwest and southwest one-quarters of Section 21, Township 7 North, Range 21 East, City of Wauwatosa.

The MMSD proposal was developed as part of a two-phase watercourse system management plan.[1] The first phase of the SEWRPC study prepared for the County, which is documented herein, was to develop written, definitive, quantitative, and graphically illustrated answers to the following question:

1. Under an assumption that the proposed County Grounds Detention Basin would not be constructed, what would be the effects upon:

    a. Menomonee River flood control projects already completed by the MMSD?

    b. Menomonee River flood control projects that are presently under design by the MMSD and scheduled for implementation in the relatively near future?

    c. Any residual areas impacted by overland flooding or related problems downstream of the diversion structure attendant to the County Grounds Basin?

An additional question that may be addressed in more detail following the County's consideration of the findings presented here is:

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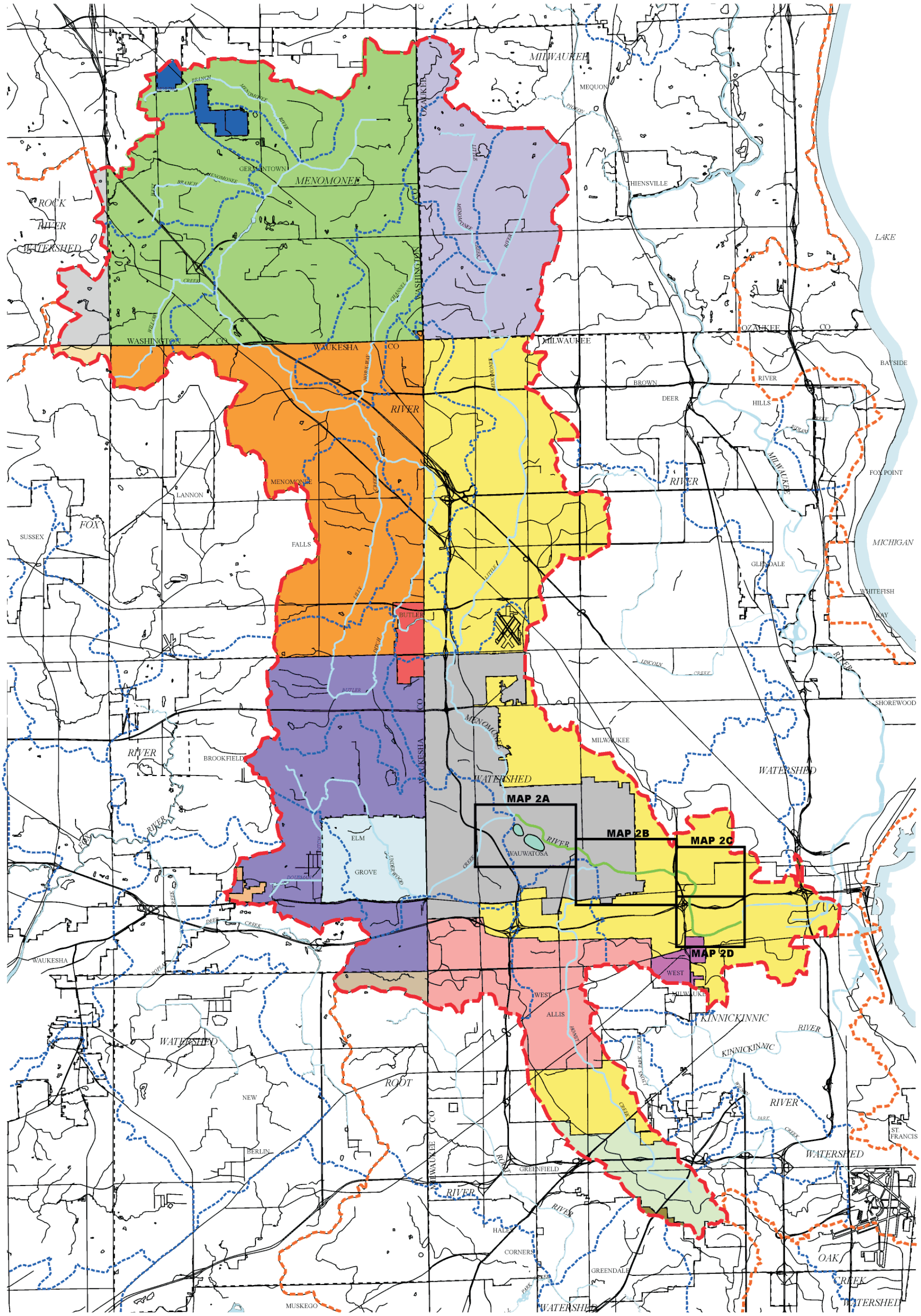
[1] *Milwaukee Metropolitan Sewerage District,* Menomonee River Phase 1 Watercourse System Management Plan*, prepared for by Camp Dresser & McKee, August 2000, and Milwaukee Metropolitan Sewerage District,* Menomonee River Phase 2 Watercourse Management Plan, *Volume I, Project Report; Volume II, Appendix D – Floodplain Maps; and Volume III, Appendix E - Hydrologic/Hydraulic Model Data, Appendix F – Floodplain Profiles, Appendix G – Channel Cross Sections, and Appendix H – Floodplain Tabular Data; prepared by Tetra Tech July 2002.*

Map 1

MENOMONEE RIVER WATERSHED



- MENOMONEE RIVER WATERSHED BOUNDARY
- SUBWATERSHED BOUNDARIES
- OTHER WATERSHED BOUNDARIES IN THE VICINITY OF MENOMONEE RIVER WATERSHED

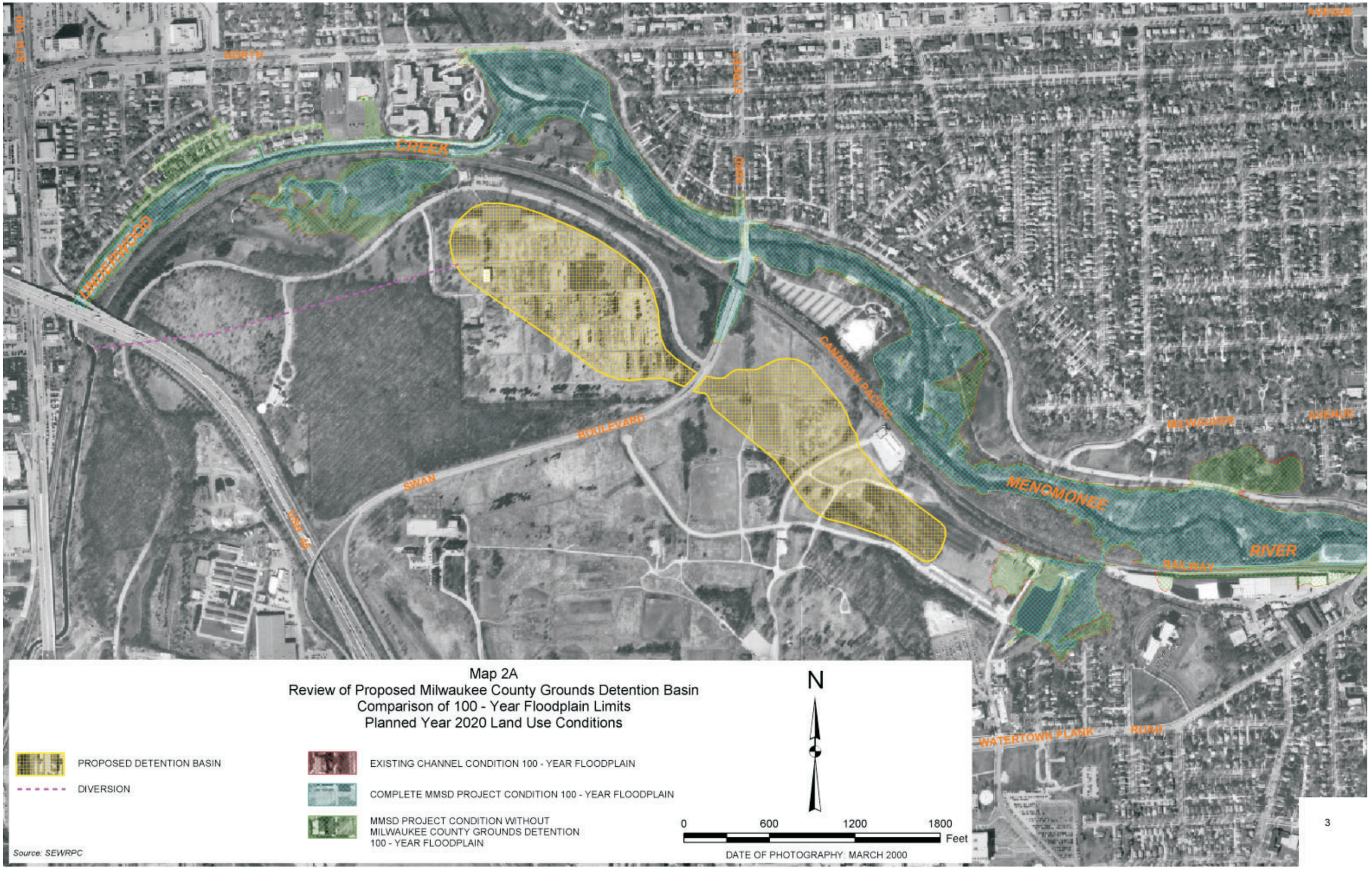
PORTIONS OF MUNICIPALITIES IN THE MENOMONEE RIVER WATERSHED

- CITY OF BROOKFIELD
- CITY OF GREENFIELD
- CITY OF MEQUON
- CITY OF MILWAUKEE
- CITY OF NEW BERLIN
- CITY OF WAUWATOSA
- CITY OF WEST ALLIS
- VILLAGE OF BUTLER
- VILLAGE OF ELM GROVE
- VILLAGE OF GERMANTOWN
- VILLAGE OF GREENDALE
- VILLAGE OF MENOMONEE FALLS
- VILLAGE OF WEST MILWAUKEE
- TOWN OF BROOKFIELD
- TOWN OF GERMANTOWN
- TOWN OF LISBON
- TOWN OF RICHFIELD
- MENOMONEE RIVER STUDY REACH
- PROPOSED MILWAUKEE COUNTY GROUNDS DETENTION BASIN
- SURFACE WATER

N

GRAPHIC SCALE
0 3000 6000 FEET

Source: SEWRPC.



Map 2A
Review of Proposed Milwaukee County Grounds Detention Basin
Comparison of 100 - Year Floodplain Limits
Planned Year 2020 Land Use Conditions

PROPOSED DETENTION BASIN

DIVERSION

EXISTING CHANNEL CONDITION 100 - YEAR FLOODPLAIN

COMPLETE MMSD PROJECT CONDITION 100 - YEAR FLOODPLAIN

MMSD PROJECT CONDITION WITHOUT MILWAUKEE COUNTY GROUNDS DETENTION 100 - YEAR FLOODPLAIN

N

0 600 1200 1800 Feet

DATE OF PHOTOGRAPHY: MARCH 2000

Source: SEWRPC

2. What alternatives remain to the construction of the proposed County Grounds Detention Basin that would address any residual flooding or complications that are identified in the answers to question No. 1 above, and how do any such alternatives compare to the floodwater detention basin alternative in terms of benefits, costs, and implementability?

The following tasks were performed under the study:

- Obtained and reviewed hydrologic and hydraulic data and computer models, cost estimating data, digital mapping data, Phase 1 and 2 watercourse system plan reports, and project construction and/or as-built drawings from the MMSD and their consultants.

- Modified and used the various hydrologic and hydraulic models[2] provided by MMSD to develop consistent, refined models representing the following conditions:

    - Planned year 2020 land use and existing channel and floodplain conditions, including watercourse projects already implemented by MMSD.

    - Planned year 2020 land use and proposed channel and floodplain conditions, including existing and proposed MMSD watercourse projects except for the proposed County Grounds Detention Basin.

    - Planned year 2020 land use and proposed channel and floodplain conditions, including the proposed County Grounds Detention Basin and all other existing and proposed MMSD watercourse projects.

- For the three conditions listed above, delineated the 100-year recurrence interval floodplain boundaries along the lower reach of Underwood Creek downstream of USH 45, and along the reach of the Menomonee River from its confluence with Underwood Creek to the estuary area east of 27th Street. Those floodplain areas are shown on Maps 2A through 2D.

- Evaluated the effects of the proposed County Grounds Detention Basin on: 1) watercourse projects already implemented by MMSD; 2) watercourse projects proposed to be implemented by MMSD; and 3) any areas impacted by overland flooding or related problems downstream of the diversion structure attendant to the detention basin.

DESCRIPTION OF STUDY AREA

As shown on Map 1, the 135.7-square-mile Menomonee River watershed includes portions of the Cities of Brookfield, Greenfield, Mequon, Milwaukee, New Berlin, Wauwatosa, and West Allis, the Villages of Butler, Elm Grove, Germantown, Greendale, Menomonee Falls, West Milwaukee, and the Towns of Brookfield, Germantown, Lannon, and Richfield. Underwood Creek flows into the Menomonee River in the City of Wauwatosa, just downstream from W. North Avenue. The 19.9-square-mile Underwood Creek watershed includes portions of the Cities of Brookfield, New Berlin, Wauwatosa, and West Allis, the Village of Elm Grove, and the Town of Brookfield.

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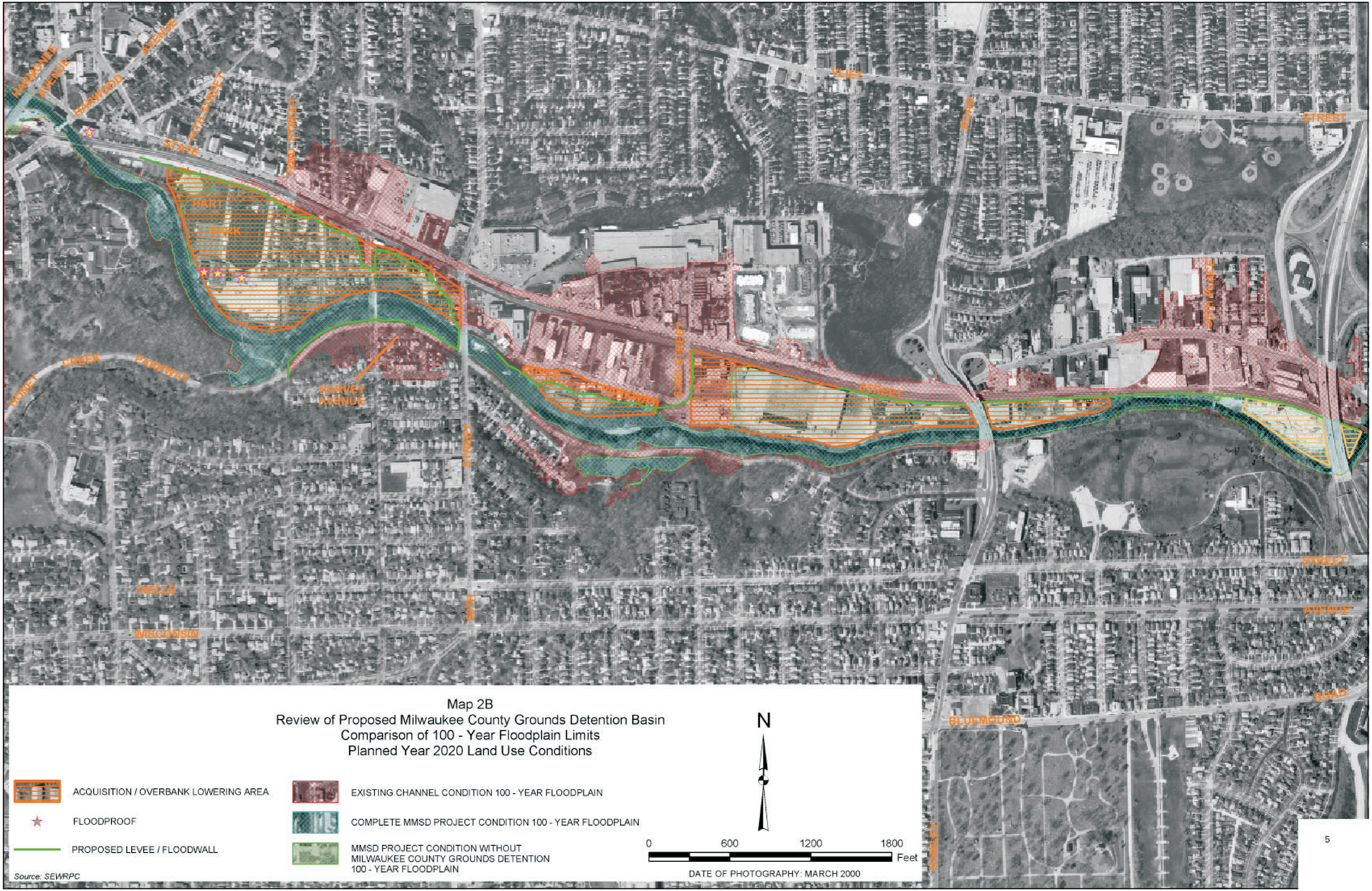
[2] *The hydrologic model is used to develop flood flows corresponding to floods with certain probabilities of occurrence. The event that flood control projects of this nature are typically designed for is the 100-year recurrence interval flood, which has a one percent chance of occurring in any given year. The hydraulic model uses the flood flows, as determined for an event of a given recurrence interval with the hydrologic model, to compute the water surface profile along a stream. That water surface profile can then be used to map the limits of flooding using topographic maps.*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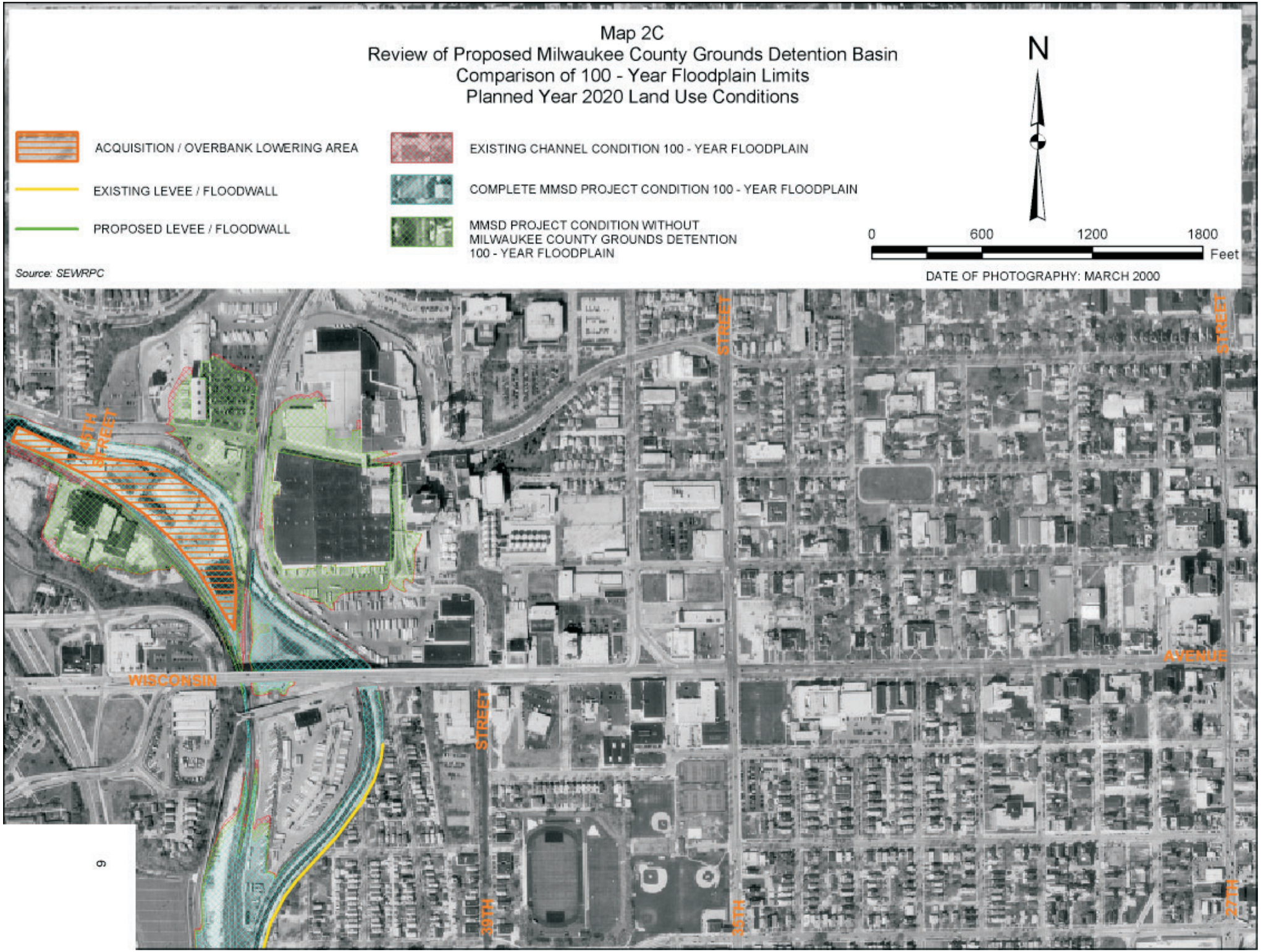
HART
PARK
HARVEY
AVENUE
HONEY
CREEK
PARKWAY
WELLS
WISCONSIN
AVENUE
BLUEMOUND
ROAD
N
0
600
1200
1800
Feet
DATE OF PHOTOGRAPHY: MARCH 2000
ACQUISITION / OVERBANK LOWERING AREA
FLOODPROOF
PROPOSED LEVEE / FLOODWALL
EXISTING CHANNEL CONDITION 100 - YEAR FLOODPLAIN
COMPLETE MMSD PROJECT CONDITION 100 - YEAR FLOODPLAIN
MMSD PROJECT CONDITION WITHOUT
MILWAUKEE COUNTY GROUNDS DETENTION
100 - YEAR FLOODPLAIN
Source: SEWRPC

Map 2B
Review of Proposed Milwaukee County Grounds Detention Basin
Comparison of 100 - Year Floodplain Limits
Planned Year 2020 Land Use Conditions


Map 2C
Review of Proposed Milwaukee County Grounds Detention Basin
Comparison of 100 - Year Floodplain Limits
Planned Year 2020 Land Use Conditions
ACQUISITION / OVERBANK LOWERING AREA
EXISTING LEVEE / FLOODWALL
PROPOSED LEVEE / FLOODWALL
EXISTING CHANNEL CONDITION 100 - YEAR FLOODPLAIN
COMPLETE MMSD PROJECT CONDITION 100 - YEAR FLOODPLAIN
MMSD PROJECT CONDITION WITHOUT
MILWAUKEE COUNTY GROUNDS DETENTION
100 - YEAR FLOODPLAIN
Source: SEWRPC
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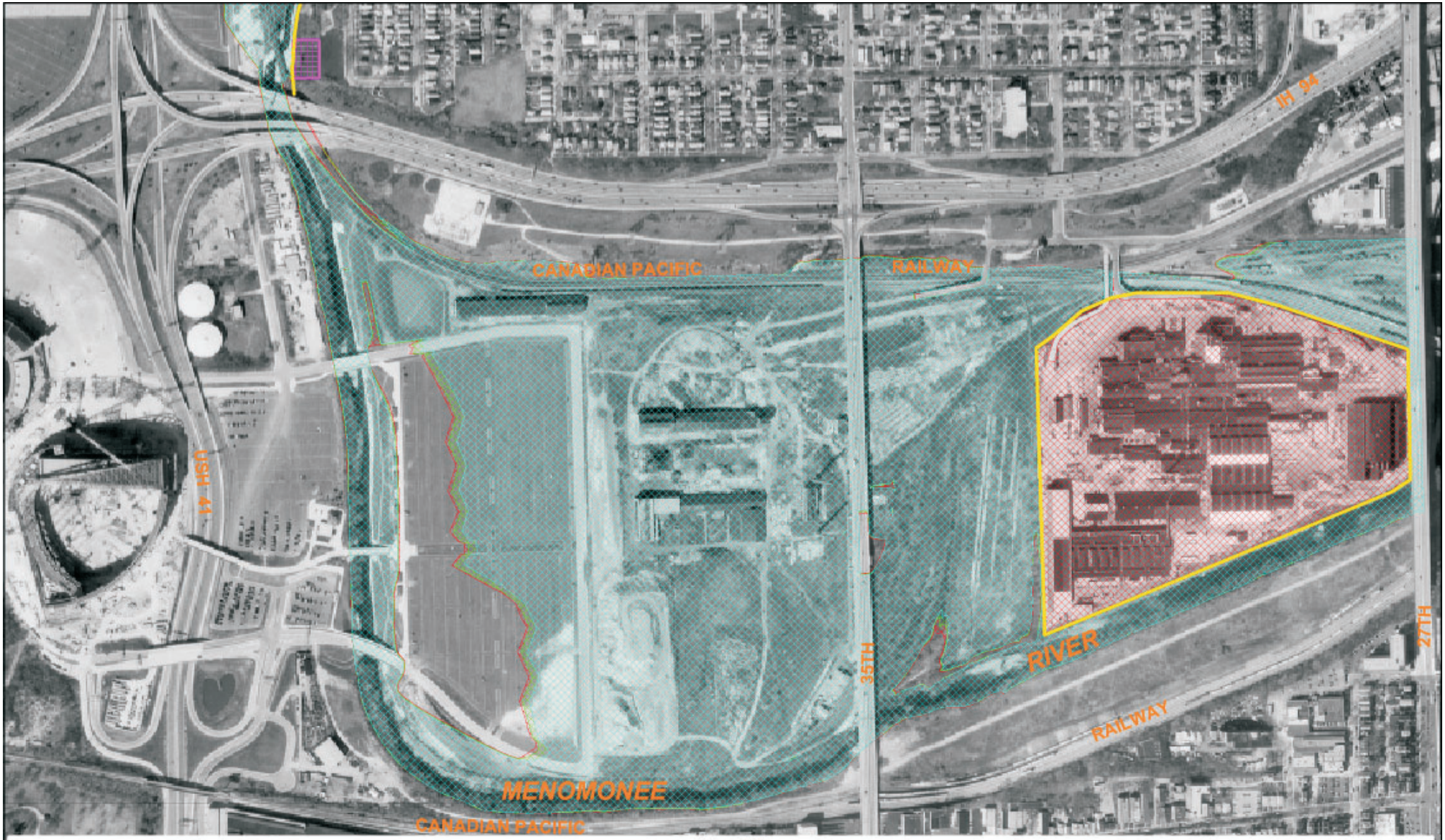

EXISTING STORMWATER PUMP STATION AND STORAGE FACILITY

EXISTING LEVEE / FLOODWALL

Source: SEWRPC

Map 2D

Review of Proposed Milwaukee County Grounds Detention Basin

Comparison of 100 - Year Floodplain Limits

Planned Year 2020 Land Use Conditions

EXISTING CHANNEL CONDITION 100 - YEAR FLOODPLAIN

COMPLETE MMSD PROJECT CONDITION 100 - YEAR FLOODPLAIN

MMSD PROJECT CONDITION WITHOUT MILWAUKEE COUNTY GROUNDS DETENTION 100 - YEAR FLOODPLAIN

N

0 600 1200 1800 Feet

DATE OF PHOTOGRAPHY: MARCH 2000

This study considered the effects of runoff from the entire 135.7-square-mile watershed, but the hydraulic analysis focused on the approximately 6.6-mile-long reach of the Menomonee River from its confluence with Underwood Creek to the reach just downstream of the 27th Street viaduct and upstream of the Lake Michigan estuary.

HYDROLOGIC AND HYDRAULIC ANALYSIS METHODS

Hydrologic Analyses

The original hydrologic analyses of the Menomonee River watershed were performed by the SEWRPC staff under the Menomonee River watershed study.[3] Those analyses were made using the Hydrocomp continuous simulation hydrologic model.[4] The Hydrocomp model for the Menomonee River watershed was revised and updated under a 1990 stormwater drainage and flood control plan prepared for MMSD.[5] Planned condition flood flows determined for the 1976 and 1990 SEWRPC studies were based on year 2000 conditions as determined under the Commission's regional land use plan. The hydrologic analysis documented in the 2000 MMSD *Menomonee River Phase I Watercourse System Management Plan* used the U.S. Environmental Protection Agency Hydrological Simulation Program-Fortran (HSPF) continuous simulation model. The HSPF model is a successor to the Hydrocomp model. The Menomonee River watershed HSPF model developed by CDM generally used the same subbasins determined under the previous Commission planning efforts and it also utilized planned year 2020 land use data developed by the Commission under the updated regional land use plan.[6] The 1976 and 1990 SEWRPC models and the 2000 MMSD model were all calibrated to match known flood events, using observed rainfall information from gauges in, or near, the watershed and observed flood hydrographs at the U.S. Geological Survey (USGS) continuous recording streamflow gauge on the Menomonee River at N. 70th Street in the City of Wauwatosa. The 1990 SEWRPC and 2000 CDM/MMSD models also were calibrated using an additional, upstream USGS gauge at Pilgrim Road in the Village of Menomonee Falls. The model parameters were calibrated to reproduce representative flood events for given combinations of land cover, stormwater drainage conditions, and stream hydraulic conditions. Such calibration provides a "reality check" that the model adequately represents the hydrologic processes of the watershed. Calibration also enables the model to be applied to estimate existing and potential future land cover, stormwater drainage, and stream hydraulic conditions.

Following completion of the 2000 MMSD watercourse system plan, MMSD initiated the next step in flood control project implementation as documented in the Phase 2 watercourse management plan report for the Menomonee River watershed. The Phase 2 analyses used the calibrated Phase 1 HSPF hydrologic model. The base model for the hydrologic analyses performed for Milwaukee County by the SEWRPC staff was the USEPA HSPF continuous simulation model as developed by MMSD and its consultants through the completion of the Phase 2 study. That model was reviewed and modified by the SEWRPC staff under the planning effort documented herein. The Regional Planning Commission is in the process of updating flood hazard maps for all of Milwaukee County and those portions of the MMSD service area in Ozaukee, Washington, and Waukesha Counties under a program funded by the Milwaukee County Automated Mapping and Land Information System (MCAMLIS) Steering Committee, MMSD, and SEWRPC. The maps will be based on planned year 2020 land use

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[3] *SEWRPC Planning Report No. 26,* A Comprehensive Plan for the Menomonee River Watershed*, Volume 1, Inventory Findings and Forecast, and Volume 2 Alternative Plans and Recommended Plan, October 1976.*

[4] *Hydrocomp, Inc.,* Hydrocomp Simulation Programming Operations Manual, *4th edition, January 1976.*

[5] *SEWRPC Community Assistance Planning Report No. 152,* A Stormwater Drainage and Flood Control System Plan for the Milwaukee Metropolitan Sewerage District*, December 1990.*

[6] *SEWRPC Planning Report No. 45,* A Regional Land Use Plan for Southeastern Wisconsin: 2020, *December 1997.*

and current channel and floodplain conditions. Following review by the affected municipalities, those updated maps are expected to be submitted by the municipalities to the Wisconsin Department of Natural Resources (WDNR) and the Federal Emergency Management Agency (FEMA) for review and approval, adopted by the municipalities for local zoning purposes, and published by FEMA for Federal flood insurance purposes. Thus, the following hydrologic model modifications made by the Commission staff were made with consideration of the evaluation of the Milwaukee County Grounds Detention Basin as well as the additional model application for local zoning and Federal flood insurance:

- The flood routing component of the model was carefully reviewed and modified to eliminate consideration of overbank floodwater storage on the Miller Park East parking lot and the CMC site between the parking lot and the Falk Corporation. Although that area is currently mapped as floodplain because the existing dikes and floodwalls along the bank of the River do not meet FEMA standards for that area to be excluded from the floodplain, the overbank area would not be flooded to same flood stage elevation as would exist in the River. In the rare event that flood stages in the River exceeded the top elevations of the protective dikes, overflow from the River would occur to the north and east, but that overflow would be conveyed across the CMC site and the railroad right-of-way north of the Falk Corporation, the flood stages through that area would be less than in the river channel, and the amount of floodwater storage on the site would be expected to be relatively minor given the amount of overflow relative to the volume of runoff in the flood hydrograph. As was done for the Phase 1 and 2 models, the existing City of Milwaukee regulatory floodway[7] limits as defined at the top of the left (north) riverbank were applied from the Falk Corporation upstream past the CMC site.

- East of the 27th Street viaduct and the Falk Corporation property, there is the possibility for flow over the low east river bank during large floods. The complicated flow splits resulting from that situation were first modeled by the SEWRPC staff under a study made for the City of Milwaukee in 1999 using the U.S. Army Corps of Engineers (USCOE) HEC-2 water surface profiles hydraulic model.[8] That model was converted to the USCOE HEC-RAS Version 2.2 river analysis systems model, refined, and incorporated in the MMSD Phase 1 and 2 study models. For the current SEWRPC study, the HEC-RAS Version 2.2 model was converted to Version 3.0, which allowed direct computation of the various flow splits, while Version 2.2 did not. The volume-discharge relationships used in the HSPF model for routing floods were revised to reflect the results obtained with HEC-RAS Version 3.0.

- The HSPF model used for the MMSD Phase 1 and Phase 2 studies determined flood flows based on continuous simulation of the meteorological record as recorded from January 1, 1940 through September 30, 1997 at the National Weather Service station at Mitchell International Airport.[9] The most intense rains that occurred during the extreme rainfall event on August 6, 1986 were recorded at Mitchell Field. The assumption in the use of data from a single meteorological gauge, as was done under the Phase 1 and 2

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[7]*The 100-year floodplain is defined as the area inundated during a 100-year flood. The floodway is that portion of the flow area in which flood flows are conveyed and flood flow velocities are relatively large. The remainder of the floodplain area between the floodway and the outer boundary of the floodplain is the flood fringe area in which floodwaters are stored, but in which there is no significant conveyance of floods. Velocities of flow in the flood fringe are negligibly small.*

[8]*SEWRPC Water Resources Simulation Project No. 305,* Hydraulic Analysis of Lower Menomonee River from its Mouth to IH 94 for Preparation of Floodway/Floodplain Maps for the City of Milwaukee, *March 1999.*

[9]*The annual peak flood flows as simulated with the calibrated HSPF model were analyzed using the USCOE HEC-FFA flood frequency analysis computer program to develop flood flows of various recurrence intervals (e.g. 10-. 50-, and 100-years) throughout the watershed.*

studies, is that the rainfalls at that gauge occur uniformly over the entire watershed. The August 6, 1986 point rainfall was omitted from the Phase 1 and 2 analyses because it was of such an intensity that it would be highly unlikely to occur over a 135.9-square-mile watershed and it was identified as a "high outlier," or a very extreme event, according to the statistical procedures applied by the HEC-FFA model.

Hydraulic Analyses

As stated above, the hydraulic analyses for the MMSD Phase 1 and 2 studies were performed using the U.S. Army Corps of Engineers HEC-RAS Version 2.2 river analysis systems model. The base model for the Menomonee River that was used to develop those HEC-RAS models was the USCOE HEC-2 model initially developed by the Commission staff under the 1976 Menomonee River watershed study, refined by the Commission staff under the 1990 stormwater drainage and flood control system plan for the MMSD, and again refined under various SEWRPC Water Resource Simulation Projects.[10] The Phase 2 HEC-RAS model was updated by MMSD's consultants to reflect new bridges and bridge and channel and overbank cross section field survey data collected by MMSD consultants at numerous locations along the 8.4-mile-long reach downstream from W. North Avenue.

During preparation of the 2000 MMSD watercourse system plan the District began a preliminary engineering and design process which led to the removal of the drop structure in the Menomonee River at N. 45th Street in the City of Milwaukee and the construction of a more-natural stream channel upstream and downstream of that structure, including the removal of about 1,100 lineal feet of concrete lining from the channel. That process was documented in two reports and the HEC-RAS model developed for that study was incorporated into the overall Menomonee River model developed for the Phase 2 hydraulic analysis.[11] MMSD provided the SEWRPC staff with the construction drawings for that project and those drawings were consulted in reviewing and modifying the Phase 2 HEC-RAS model.[12]

In order to provide relief from flooding to the residents of the Valley Park neighborhood in an area of the City of Milwaukee approximately bounded by W. Wisconsin Avenue on the north, IH 94 on the south, the Menomonee River on the west, and N. 39th Street on the east, MMSD funded and constructed a levee/floodwall/interior drainage project that was recommended under the Phase 1 study.[13] Subsequent to the construction of that project, MMSD prepared documentation to be submitted to FEMA in support of a Letter of Map Revision (LOMR) to remove the Federal flood insurance requirement for the properties protected by the Valley Park flood control

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[10]*SEWRPC Water Resources Simulation Project No. 282,* Hydraulic Analysis of Proposed N. Emmber Lane Replacement Bascule Over the Menomonee River, *March 1997 and* op. cit. *SEWRPC Water Resources Simulation Project No. 305.*

[11]*Inter-Fluve, Inc.,* Menomonee River Drop Structure Removal Project Pre-Design Memorandum, *prepared for the MMSD, January 1998 and* Menomonee River Drop Structure Removal Project Revised Flood Plain Analysis Technical Memorandum, *prepared for the MMSD, February 10, 1999* .

[12]*Milwaukee Metropolitan Sewerage District,* Menomonee River Drop Structure Removal, *prepared by Inter-Fluve, Inc. in association with Camp Dresser & McKee, Inc., EMCS Design Group, and J.C. Zimmerman Engineering , June 1999.*

[13]*Milwaukee Metropolitan Sewerage District,* Valley Park Levee/Floodwall and Interior Drainage Contract Documents, C*ontracts WO23GX010 and WO23GX030, prepared Hey and Associates, Inc. in association with K. Singh & Associates, Inc, TN & Associates, Inc, and Donohue & Associates, May 2000.*

project.[14] Construction of the combination levee/floodwall affects floodplain hydraulics, thus, the Phase 2 hydraulic model reflects that structure.

Development of Hydrologic and Hydraulic Models by SEWRPC Staff
Because the modeling for the Phase 2 planning process and the Valley Park LOMR application were conducted by different MMSD consultants with some overlap in time, the SEWRPC staff carefully reviewed both hydraulic models and combined the most appropriate stream reaches from each model to develop the HEC-RAS that served as the starting point for this study of the effects of the proposed Milwaukee County Grounds detention basin. As noted above, planned year 2020 land use hydrologic and hydraulic models were developed to represent:

- **Existing Condition:** Existing channel and floodplain conditions, including watercourse projects already implemented by MMSD.

- **Proposed Project Condition Without the Milwaukee County Grounds Detention Basin:** Proposed channel and floodplain conditions, including existing and proposed MMSD projects except for the County Grounds basin.

- **Proposed Complete Project Condition:** Proposed channel and floodplain conditions, including the proposed County Grounds basin and all other existing and proposed MMSD projects.

Only the third of these three conditions was explicitly represented in the hydrologic and hydraulic models developed under the overall MMSD watercourse planning and design program. Thus, the Commission staff made appropriate modifications to the Proposed Complete Project Condition model in order to develop the models representing Existing Conditions and Proposed Project Conditions Without the Milwaukee County Grounds Detention Basin. This process ensured complete consistency between the three models in that each model represents those features that are the same for all three conditions in the same way. Existing topographic conditions as represented in the hydraulic model were determined using:

- Large-scale digital topographic surveys recently obtained by MMSD for design purposes at a one-foot elevation contour interval and a scale of one inch equals 100 feet for the 1.9-mile-long reach extending from the Harmonee Avenue bridge in the City of Wauwatosa downstream to a location about 0.2 mile upstream of USH 41, and

- Large-scale digital topographic maps from the Milwaukee County Automated Mapping and Land Information System program, prepared over the period from 1985 through 1997 at a two-foot elevation contour interval and a scale of one inch equals 100 feet.

DESCRIPTIONS OF THE THREE CONDITIONS ANALYZED

The components of the MMSD flood control project in the reach from the County Grounds Basin site downstream to 27th Street were designed to function as a system. Thus, as noted above, the hydrologic and hydraulic analysis conducted by MMSD and it consultants was only developed for the complete system. If one of the system components were eliminated (such as the County Grounds Basin), the other components of the system would have to be modified, or additional components might be required. Analysis of the three conditions described below will lead to the general identification of the necessary plan modifications if the Basin were not constructed.

[14] *Milwaukee Metropolitan Sewerage District,* Request for Letter of Map Revision – Federal Emergency Management Agency for Valley Park Neighborhood Flood Management, *prepared by Hey and Associates, May 2002.*

Existing Condition
This condition represents existing channel and floodplain conditions, including watercourse projects already implemented by MMSD which would have an impact on flood flows and stages in the 6.6-mile long study reach from W. North Avenue through 27th Street. Those projects include:

- A project consisting of a combined levee/floodwall with interior drainage to provide relief from flooding to the residents of the Valley Park neighborhood in an area of the City of Milwaukee approximately bounded by W. Wisconsin Avenue on the north, IH 94 on the south, the Menomonee River on the west, and N. 39th Street on the east. As shown on Map 2C, the civil works associated with the project included an approximately 1,800-foot-long earthen levee topped by a concrete floodwall and an interior drainage system and stormwater pumping station to convey, store, and pump local runoff from the landward side of the levee/floodwall. In addition, eight houses were acquired and demolished for construction of the floodwall.[15]

- A project to remove the N. 45th Street drop structure and about 1,100 lineal feet of concrete lining in the channel downstream from the former drop structure. The streambed dropped about five feet vertically at that structure, presenting an impediment to fish migration and navigation on the River. The concrete channel lining was removed downstream of the drop structure to improve the opportunities for fish migration by reducing flow velocities and providing a more natural channel.

- A combined City of Wauwatosa and MMSD program to purchase and demolish 69 single- and two-family residential or commercial buildings and six vacant lots in the area bounded by the Canadian Pacific Railway on the north, Hart Park on the west, the Menomonee River on the south and N. 68th Street on the east.

In 2001, MMSD completed construction of a 58 acre-foot dry detention basin for Grantosa Creek at Milwaukee County's Timmerman Airport in the City of Milwaukee. That detention basin was designed to eliminate overland flooding to buildings immediately south of W. Hampton Avenue in the City of Wauwatosa and to reduce surcharging along the Grantosa Creek channel enclosure along N. 100th Street and W. Grantosa Avenue. The detention basin is located about 1.8 miles upstream of the mouth of Grantosa Creek at its confluence with the Menomonee River and the mouth of Grantosa Creek is located about 2.1 miles upstream of W. North Avenue. The Timmerman detention basin is intended to address local flooding problems along Grantosa Creek.

Based on alternatives analyzed for the Concordia Avenue area under the Phase 2 study, MMSD is currently considering either a levee/floodwall project or structure acquisition at 17 single-family houses. The project area is located along the Menomonee River over one mile upstream of W. North Avenue and upstream of the study reach for the analysis described herein.

Proposed Project Condition With the Milwaukee County Grounds Detention Basin
The hydrologic and hydraulic models developed to represent this condition explicitly included all pertinent existing or proposed MMSD flood control projects that would affect flood flows and stages along the reach of the Menomonee River that was studied. From upstream to downstream, those projects include:

- Milwaukee County Grounds Detention Basin

- Lower Wauwatosa/Hart Park

- Western Milwaukee

[15] *The owners of those houses were either compensated by MMSD or replacement houses were constructed.*

- Valley Park Neighborhood

- Falk Floodwall Raising

Milwaukee County Grounds Detention Basin
As shown on Maps 1 and 2A, the Milwaukee County Grounds Detention Basin is proposed to be located on either side of Swan Boulevard just upstream of the confluence of Underwood Creek and the Menomonee River. The site is south of Underwood Creek, northeast of USH 45, and southwest of the Canadian Pacific Railway that runs parallel to the Menomonee River.

MMSD has proposed to divert flow from Underwood Creek immediately upstream of the Canadian Pacific Railway bridge that is located west of USH 45 and to convey that flow into the County Grounds Basin. Flow would only be diverted during floods with peak flows in excess of about 2,600 cubic feet per second, or during events with recurrence intervals of about two years or greater. Because flow in Underwood Creek contributes significantly to the downstream peak in the Menomonee River, detaining peak and near-peak runoff from Underwood Creek is very effective in reducing downstream flood flows as shown in Table 1.

Based on the most recent design details available from MMSD, the basin site would cover about 90 acres and the basin would have a floodwater storage capacity of about 800 acre-feet. The west and east cells of the basin would be connected with a large culvert under Swan Boulevard. Water impounded at the higher elevations would drain to the Menomonee River through gravity flow and water in the lower portion of the basin would be pumped into the River.

Lower Wauwatosa/Hart Park Project
This project area extends from the western boundary of Hart Park around N. 74th street extended to N. 63rd Street. The project involves a combination of 1) building and lot acquisition and removal, 2) modifications to the floodplain and the streambank, and 3) construction of a levee/floodwall system with associated interior drainage facilities to handle local stormwater runoff from the landward side of the levee/floodwall.[16] The acquisition and demolition of 69 buildings and the purchase of six vacant lots all in the area east of Hart Park, as mentioned above, are components of this project that have already been implemented.

The additional flood control project components are listed below.

- One single-family, one two-family, and one commercial building in the vicinity of N. 68th Street and River Parkway have been acquired and are scheduled to be demolished.

- Six commercial and two industrial buildings located on N. 63rd Street and in the 6300 through 6600 block of River Parkway are proposed to be acquired and demolished either to eliminate a flood hazard or to accommodate the proposed River Parkway Levee located between N. 63rd and N. 68th Streets.

- One building along Harvey Avenue is proposed to be acquired for construction of the Harvey Avenue Levee/Floodwall.

- The Muellner building, the concessions/locker room building, and a storage building at Hart Park and a commercial building near the intersection of W. State Street and Harwood Avenue[17] are to be floodproofed.

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[16] *The floodwall is located on the west side of the N. 68th Street bridge.*

[17] *The commercial building is just upstream of the project boundary as defined in the Phase 2 report.*

Table 1

REVIEW OF PROPOSED MILWAUKEE COUNTY GROUNDS DETENTION BASIN

FLOOD DISCHARGE COMPARISON
100-YEAR RECURRENCE INTERVAL FLOOD EVENT
PLANNED YEAR 2020 AND LAND USE CONDITIONS

MENOMONEE RIVER

Description	River Miles	Existing Channel Conditions (cfs)	Complete MMSD Project (cfs)	Percent Change in Peak Flow with Complete Project (relative to existing conditions)	MMSD Project without Milwaukee County Grounds (MCG) Detention (cfs)	Percent Change in Peak Flow for MMSD Project without MCG (relative to existing conditions)	Percent Change in Peak Flow for MMSD Project without MCG (relative to complete project conditions)
Estuary	0.00-0.92	22,000	21,500	-2	21,800	-1	+1
Falk Corporation	0.92-2.51	17,600	16,600	-6	17,200	-2	+4
Valley Park/CMC Property	2.51-4.24	16,600	15,100	-9	16,000	-4	+6
Hart Park/Western Milwaukee	4.24-6.11	14,500	12,400	-14	14,100	-3	+14
Upstream of Honey Creek	6.11-8.37	10,500	8,600	-18	10,400	-1	+21
Upstream of Underwood Creek	8.37-9.66	6,050	6,050	0	6,050	0	0

- The approximately 3,100-foot-long Hart Park Levee/Floodwall which would be located south of the Canadian Pacific Railway (along W. State Street) and would consist of a 1) 1,230-foot-long concrete floodwall, extending from a point near the intersection of Blanchard and W. State Streets eastward to N. 72nd Street and 2) a 1,770-foot-long earthen levee extending from N. 72nd Street eastward to N. 68th Street.

- The approximately 2,000-foot-long River Parkway Levee along the south side of River Parkway between N. 68th and N. 63rd Streets, which will tie in to high ground at the railway just east of N. 63rd Street.[18]

- The approximately 1,720-foot-long Harvey Avenue Levee/Floodwall which would be located south of the Menomonee River along Honey Creek Parkway. The levee portion would be comprised of public streets that would have their grades raised. The levee/floodwall would consist of 1) a 1,350-foot-long levee from N. 72nd Street extended to a point about 370 feet west of N. 68th Street and 2) a 370-foot-long concrete floodwall from the end of the levee to N. 68th Street. Roadway grades would be raised at N. 72nd and N. 70th Streets and at Harvey Avenue near N. 70th Street.

- A concrete floodwall would be constructed on the west side of the N. 68th Street bridge, connecting segments of the Hart Park and Harvey Avenue Levees/Floodwalls and providing adequate freeboard.[19]

- The Hart Park, River Parkway, and Harvey Avenue Levees/Floodwall systems would function to protect a total of 43 single- and two-family residential, commercial, industrial, and governmental buildings.

- Modifications to the storm sewer systems draining the areas landward of the Hart Park, River Parkway, and Harvey Avenue Levees/Floodwalls.

- Excavating to lower the floodplain overbank area by one to two feet in the area bounded by the Canadian Pacific Railway on the north, Hart Park on the west, the Menomonee River on the south and N. 63rd Street on the east.

Western Milwaukee Project

This project area extends from N. 63rd Street to the first Canadian Pacific Railway bridge downstream of N. 45th Street. The project involves a combination of 1) building and lot acquisition and removal, 2) modifications to the floodplain and the streambank, and 3) construction of a levee/floodwall system with associated interior drainage facilities to handle local stormwater runoff from the landward side of the levee/floodwall.

The flood control project components are listed below.

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[18]*The Phase 2 plan called for a stormwater pumping station to be located near the east end of the levee/floodwall just west of N. 63rd Street. As of the date of this memorandum, it is the understanding of the Commission staff that, based on the ongoing interior drainage design by consultants to MMSD, interior drainage may be accomplished through gravity flow, thereby eliminating the need for the pump station.*

[19]*Freeboard is defined as the difference in elevation between the peak 100-year flood stage and the top of a protective structure, such as a levee or floodwall. Freeboard requirements are established by the Federal Emergency Management Agency and the Wisconsin Department of Natural Resources and they are intended to provide a margin of safety to enable the levees and/or floodwalls to provide flood protection in situations where flood stages are increased due to debris blockages or other unforeseen conditions.*

- Sixteen commercial and industrial buildings and one single-family residence located between the River and the Canadian Pacific Railway are proposed to be acquired and demolished either to eliminate a flood hazard or to accommodate the proposed Western Milwaukee Levee/Floodwall.

- The approximately 3,800-foot-long Western Milwaukee Levee/Floodwall located south of the Canadian Pacific Railway (along W. State Street) and extending from N. 60th Street eastward to N. 47th Street. Fifty-eight single- and two-family residential, commercial, and industrial buildings would be afforded flood protection by this levee/floodwall

- Excavating to lower the north floodplain overbank area by up to about four feet[20] from just downstream of N. 63rd Street to midway between N. Hawley Road and USH 41, except for a 700-foot-long reach just east of N. 50th Place where there is inadequate room in the overbank.

- Excavating to lower the south floodplain overbank area by up to about four feet from just downstream of the Canadian Pacific Railway bridge east of USH 41 to the Canadian Pacific Railway bridge at the east end of the project area.

- Removing the driveway bridge just upstream of N. Hawley Road.

Valley Park Neighborhood Project
This project is described above in the "Existing Conditions" subsection.

Falk Floodwall Raising
The Falk Corporation industrial complex is located north and west of the River just west of the 27th Street viaduct. The entire complex is protected by an existing system of sheet pile and concrete floodwalls, levees, flood closures, and an interior drainage system. MMSD proposes to modify the protection system to increase the height of the levees and floodwalls by up to five feet to provide protection during a 100-year flood with a level of freeboard adequate to meet State and Federal standards for the plant to be regulated as being outside the 100-year floodplain.

Proposed Project Condition Without the Milwaukee County Grounds Detention Basin
The hydrologic and hydraulic models developed to represent this condition explicitly included all pertinent existing or proposed MMSD flood control projects that would affect flood flows and stages along the reach of the Menomonee River that was studied, except for the proposed detention basin on the Milwaukee County Grounds site. From upstream to downstream, those projects include:

- Lower Wauwatosa/Hart Park

- Western Milwaukee

- Valley Park Neighborhood

- Falk Floodwall Raising

All of the projects listed above are described in the preceding section of this memorandum.

[20] *The actual extent of excavation will depend on whether contaminated soils that cannot be readily removed are discovered during the preliminary engineering design phase. Any changes that would significantly alter the amount of overbank floodwater storage would have to be evaluated regarding their effect on the overall project.*

DESCRIPTION OF FLOODING CONDITIONS UNDER THREE CONDITIONS ANALYZED

A comparison of peak 100-year flood flows under the three conditions is set forth in Table 1, a detailed comparison of peak flood stages is provided in Table 2, and a graphical comparison of 100-year flood profiles is given on Figures 1 and 2.

Existing Condition

Under existing conditions, there are 92 structures in the 100-year floodplain of the Menomonee River in the City of Wauwatosa downstream of the proposed County Grounds Basin. Those structures include single- and two-family houses, commercial, industrial, and recreational structures. During a 100-year flood, the estimated total direct and indirect flood damages to those buildings and their contents is $7.1 million. Most of the flooding of residential buildings would be basement flooding due to direct overflow from the River, but several structures could experience first floor flooding. The potential flooding of commercial, industrial, and recreational structures would be first floor flooding generally ranging in depth from about one to six feet. In addition there are eight houses located on Fisher Parkway and one institutional building along W. North Avenue along Underwood Creek downstream of the proposed diversion from Underwood Creek to the County Grounds Basin that are in danger of being flooding during a 100-year event. During a 100-year flood, the estimated total direct and indirect flood damages to those buildings and their contents is $130,000.

As shown on Map 2B, the flooded structures in Wauwatosa (the area west of N. 60th Street) are primarily located north of the River including areas north of W. State Street. However, there are two concentrations of residential areas with potential direct flood damages that are located south of the River: 1) the area around Harvey and Auburn Avenues between W. 68th and W. 70th Streets and 2) along Hillside Lane west of Jacobus Park.

There are 78 structures in the 100-year floodplain of the Menomonee River in the City of Milwaukee in the reach from N. 60th Street to N. 35th Street. Those structures include single- and two-family houses, commercial, industrial, and institutional structures. During a 100-year flood, the estimated total direct and indirect flood damages to those buildings and their contents is $6.5 million.

As shown on Map 2B, the flooded structures in Milwaukee in the area from N. 60th Street to N. 45th Street are located north of the River including areas north of W. State Street. Between N. 45th Street and W. Wisconsin Avenue, there are several significant industrial building within the floodplain, both north and south of the River. From W. Wisconsin Avenue downstream to N. 27th Street, the only flood hazard to structures is at the Falk Corporation site. Downstream of 27th Street, buildings south of the River could be flooded due to overflow of the east River bank in the reach that parallels 27th Street.[21]

In addition to the quantified flood damages noted above, there are unquantified damages in the vicinity of Fisher Parkway and along the Menomonee River in Wauwatosa from N. 76th Street to N. 60th Street and in Milwaukee from N. 60th Street to W. Wisconsin Avenue. Those damages are the result of a combination of temporary high groundwater levels, stormwater drainage problems, and sanitary sewer infiltration and inflow, all of which are impacted by River levels. These indirect flooding problems are a consideration in the evaluation of the impacts of future improvements.

Chapter NR 116 of the *Wisconsin Administrative Code* and Section 65.10 of the Code of Federal Regulations (pertaining to the National Flood Insurance Program administered by the Federal Emergency Management Agency) both include freeboard requirements for levees and floodwalls intended to provide protection from floods. A minimum freeboard of three feet above the 100-year flood stage is required. Within 100 feet upstream

[21] *MMSD jurisdiction for flood control projects does not extend downstream of N. 27th Street.*

Table 2

REVIEW OF PROPOSED MILWAUKEE COUNTY GROUNDS DETENTION BASIN

FLOOD STAGE COMPARISON
100-YEAR RECURRENCE INTERVAL FLOOD EVENT
PLANNED YEAR 2020 LAND USE CONDITIONS

MENOMONEE RIVER

River Mile	Location	Existing Channel Conditions (feet above NGVD29)	Complete MMSD Project (feet above NGVD29)	Difference in Elevation Between Complete Project Conditions and Existing Conditions (feet)	MMSD Project without Milwaukee County Grounds Detention (feet above NGVD29)	Difference in Elevation Between Project without County Grounds Detention and Existing Conditions (feet)	Difference in Elevation Between Project without County Grounds Detention and Complete Project Conditions (feet)
0.01	Mouth	580.10	580.10	0.00	580.10	0.00	0.00
0.025		580.02	580.02	0.00	580.02	0.00	0.00
0.05		579.82	579.83	0.01	579.83	0.01	0.00
0.055		579.84	579.85	0.01	579.85	0.01	0.00
0.1		581.45	581.39	-0.06	581.42	-0.03	0.03
0.15		581.54	581.48	-0.06	581.51	-0.03	0.03
0.23		581.19	581.13	-0.06	581.17	-0.02	0.04
0.28		581.37	581.31	-0.06	581.35	-0.02	0.04
0.35		580.91	580.86	-0.05	580.89	-0.02	0.03
0.355		580.94	580.89	-0.05	580.92	-0.02	0.03
0.38		582.76	582.66	-0.10	582.72	-0.04	0.06
0.48		582.73	582.63	-0.10	582.69	-0.04	0.06
0.57		582.52	582.42	-0.10	582.48	-0.04	0.06
0.66		582.61	582.52	-0.09	582.57	-0.04	0.05
0.75		582.69	582.60	-0.09	582.65	-0.04	0.05
0.84		582.71	582.61	-0.10	582.67	-0.04	0.06
0.9		582.70	582.60	-0.10	582.66	-0.04	0.06
0.92		582.27	582.18	-0.09	582.23	-0.04	0.05
0.9225	Emmber Lane						
0.925		582.29	582.20	-0.09	582.26	-0.03	0.06
0.97		583.30	583.12	-0.18	583.23	-0.07	0.11
1.03		583.27	583.09	-0.18	583.20	-0.07	0.11
1.11		583.17	583.00	-0.17	583.10	-0.07	0.10
1.115		583.17	583.00	-0.17	583.10	-0.07	0.10
1.13		583.37	583.18	-0.19	583.29	-0.08	0.11
1.22		583.41	583.22	-0.19	583.34	-0.07	0.12
1.32		583.46	583.27	-0.19	583.38	-0.08	0.11
1.41		583.49	583.29	-0.20	583.41	-0.08	0.12
1.51		583.50	583.30	-0.20	583.42	-0.08	0.12
1.6		583.49	583.30	-0.19	583.41	-0.08	0.11
1.71		583.74	583.51	-0.23	583.65	-0.09	0.14
1.74		583.71	583.48	-0.23	583.62	-0.09	0.14
1.75		583.39	583.17	-0.22	583.30	-0.09	0.13
1.76		583.23	583.01	-0.22	583.15	-0.08	0.14
1.77		583.75	583.63	-0.12	583.70	-0.05	0.07
1.86		587.53	587.32	-0.21	587.45	-0.08	0.13
1.87		587.47	587.27	-0.20	587.40	-0.07	0.13
1.8725	CP Rail Bridge						
1.875		589.22	588.98	-0.24	589.12	-0.10	0.14
1.88		589.23	588.99	-0.24	589.13	-0.10	0.14
1.9		589.20	588.96	-0.24	589.10	-0.10	0.14
1.91		589.38	589.14	-0.24	589.28	-0.10	0.14

Table 2 (continued)

River Mile	Location	Existing Channel Conditions (feet above NGVD29)	Complete MMSD Project (feet above NGVD29)	Difference in Elevation Between Complete Project Conditions and Existing Conditions (feet)	MMSD Project without Milwaukee County Grounds Detention (feet above NGVD29)	Difference in Elevation Between Project without County Grounds Detention and Existing Conditions (feet)	Difference in Elevation Between Project without County Grounds Detention and Complete Project Conditions (feet)
1.9125	CP Rail Bridge						
1.915		590.26	590.01	-0.25	590.16	-0.10	0.15
1.92		590.22	589.97	-0.25	590.12	-0.10	0.15
1.94		590.13	589.89	-0.24	590.04	-0.09	0.15
1.95		590.33	590.08	-0.25	590.23	-0.10	0.15
1.9525	CP Rail Bridge						
1.955		591.62	591.42	-0.20	591.55	-0.07	0.13
1.97		591.55	591.35	-0.20	591.47	-0.08	0.12
1.9725	CP Rail Bridge						
1.975		593.45	593.24	-0.21	593.38	-0.07	0.14
1.98		593.44	593.23	-0.21	593.36	-0.08	0.13
2.059		593.32	593.13	-0.19	593.25	-0.07	0.12
2.06		593.32	593.13	-0.19	593.25	-0.07	0.12
2.08		593.34	593.15	-0.19	593.27	-0.07	0.12
2.08475		593.28	593.10	-0.18	593.22	-0.06	0.12
2.0895		593.22	593.04	-0.18	593.15	-0.07	0.11
2.09425		593.13	592.96	-0.17	593.07	-0.06	0.11
2.099		593.02	592.87	-0.15	592.97	-0.05	0.10
2.1		593.00	592.86	-0.14	592.96	-0.04	0.10
2.1025	27th Street Viaduct						
2.105		594.63	594.28	-0.35	594.50	-0.13	0.22
2.11		594.71	594.35	-0.36	594.59	-0.12	0.24
2.14		595.59	595.17	-0.42	595.44	-0.15	0.27
2.21		595.65	595.23	-0.42	595.50	-0.15	0.27
2.22		594.47	594.12	-0.35	594.35	-0.12	0.23
2.225		596.57	596.09	-0.48	596.39	-0.18	0.30
2.28		596.66	596.18	-0.48	596.49	-0.17	0.31
2.38		596.95	596.46	-0.49	596.77	-0.18	0.31
2.48		596.98	596.50	-0.48	596.80	-0.18	0.30
2.49		597.34	596.82	-0.52	597.15	-0.19	0.33
2.51		597.77	597.25	-0.52	597.58	-0.19	0.33
2.58		597.30	596.89	-0.41	597.16	-0.14	0.27
2.61		598.17	597.65	-0.52	597.98	-0.19	0.33
2.631		598.09	597.58	-0.51	597.90	-0.19	0.32
2.634		598.11	597.60	-0.51	597.92	-0.19	0.32
2.641	35th Street Viaduct						
2.65		598.90	598.30	-0.60	598.68	-0.22	0.38
2.651		598.91	598.31	-0.60	598.69	-0.22	0.38
2.71		599.31	598.64	-0.67	599.06	-0.25	0.42
2.78		599.46	598.79	-0.67	599.22	-0.24	0.43
2.84		600.26	599.54	-0.72	600.00	-0.26	0.46
2.91		601.28	600.48	-0.80	600.98	-0.30	0.50
2.94		601.63	600.80	-0.83	601.32	-0.31	0.52
2.97		601.67	600.85	-0.82	601.36	-0.31	0.51
2.99		601.75	600.94	-0.81	601.45	-0.30	0.51
3.03		601.83	601.02	-0.81	601.53	-0.30	0.51
3.09		602.04	601.22	-0.82	601.74	-0.30	0.52
3.11		602.27	601.42	-0.85	601.95	-0.32	0.53
3.13		602.49	601.63	-0.86	602.17	-0.32	0.54
3.15		602.47	601.61	-0.86	602.15	-0.32	0.54
3.16		602.64	601.76	-0.88	602.31	-0.33	0.55
3.165	Parking Lot Access						
3.17		602.74	601.86	-0.88	602.41	-0.33	0.55

Table 2 (continued)

River Mile	Location	Existing Channel Conditions (feet above NGVD29)	Complete MMSD Project (feet above NGVD29)	Difference in Elevation Between Complete Project Conditions and Existing Conditions (feet)	MMSD Project without Milwaukee County Grounds Detention (feet above NGVD29)	Difference in Elevation Between Project without County Grounds Detention and Existing Conditions (feet)	Difference in Elevation Between Project without County Grounds Detention and Complete Project Conditions (feet)
3.18		602.73	601.85	-0.88	602.40	-0.33	0.55
3.24		602.83	601.97	-0.86	602.51	-0.32	0.54
3.245	Footbridge						
3.25		602.94	602.07	-0.87	602.61	-0.33	0.54
3.28		603.18	602.28	-0.90	602.84	-0.34	0.56
3.33		603.31	602.40	-0.91	602.96	-0.35	0.56
3.37		603.43	602.53	-0.90	603.09	-0.34	0.56
3.38		603.50	602.60	-0.90	603.15	-0.35	0.55
3.41		603.63	602.75	-0.88	603.29	-0.34	0.54
3.42		603.60	602.73	-0.87	603.26	-0.34	0.53
3.425	Parking Lot Access						
3.43		603.68	602.80	-0.88	603.34	-0.34	0.54
3.44		603.99	603.07	-0.92	603.63	-0.36	0.56
3.46		604.03	603.12	-0.91	603.68	-0.35	0.56
3.53		603.98	603.11	-0.87	603.64	-0.34	0.53
3.54		603.82	602.96	-0.86	603.49	-0.33	0.53
3.55		604.01	603.15	-0.86	603.67	-0.34	0.52
3.574		604.11	603.26	-0.85	603.78	-0.33	0.52
3.593		604.10	603.23	-0.87	603.76	-0.34	0.53
3.611		603.68	602.88	-0.80	603.37	-0.31	0.49
3.629		603.35	602.54	-0.81	603.04	-0.31	0.50
3.648		603.20	602.44	-0.76	602.91	-0.29	0.47
3.668		604.24	603.37	-0.87	603.90	-0.34	0.53
3.689		604.09	603.21	-0.88	603.75	-0.34	0.54
3.696		603.54	602.78	-0.76	603.25	-0.29	0.47
3.705		605.97	605.01	-0.96	605.60	-0.37	0.59
3.708		606.35	605.38	-0.97	605.97	-0.38	0.59
3.71	CP Rail Bridge						
3.712		609.44	608.50	-0.94	609.09	-0.35	0.59
3.725		608.85	607.96	-0.89	608.52	-0.33	0.56
3.741		608.54	607.68	-0.86	608.22	-0.32	0.54
3.779		608.96	607.99	-0.97	608.60	-0.36	0.61
3.819		608.77	607.80	-0.97	608.41	-0.36	0.61
3.859		608.76	607.86	-0.90	608.42	-0.34	0.56
3.896		608.63	607.77	-0.86	608.32	-0.31	0.55
3.932		608.73	607.87	-0.86	608.41	-0.32	0.54
3.971		608.60	607.75	-0.85	608.29	-0.31	0.54
3.988		608.76	607.91	-0.85	608.44	-0.32	0.53
4.006		608.80	607.95	-0.85	608.48	-0.32	0.53
4.025		608.89	608.04	-0.85	608.58	-0.31	0.54
4.043		609.44	608.54	-0.90	609.10	-0.34	0.56
4.057		609.59	608.69	-0.90	609.25	-0.34	0.56
4.068		610.36	609.31	-1.05	609.96	-0.40	0.65
4.07	Bluemound Road						
4.078		610.44	609.40	-1.04	610.03	-0.41	0.63
4.089		610.15	609.06	-1.09	609.73	-0.42	0.67
4.102		610.13	609.07	-1.06	609.72	-0.41	0.65
4.12		610.19	609.12	-1.07	609.78	-0.41	0.66
4.138		610.41	609.21	-1.20	609.95	-0.46	0.74
4.158		609.97	608.88	-1.09	609.55	-0.42	0.67
4.176		611.47	609.81	-1.66	610.88	-0.59	1.07
4.196		610.71	609.43	-1.28	610.24	-0.47	0.81
4.215		610.55	609.27	-1.28	610.08	-0.47	0.81

Table 2 (continued)

River Mile	Location	Existing Channel Conditions (feet above NGVD29)	Complete MMSD Project (feet above NGVD29)	Difference in Elevation Between Complete Project Conditions and Existing Conditions (feet)	MMSD Project without Milwaukee County Grounds Detention (feet above NGVD29)	Difference in Elevation Between Project without County Grounds Detention and Existing Conditions (feet)	Difference in Elevation Between Project without County Grounds Detention and Complete Project Conditions (feet)
4.239		613.97	612.72	-1.25	613.49	-0.48	0.77
4.24	CP Rail Bridge						
4.249		616.24	614.36	-1.88	615.68	-0.56	1.32
4.259		615.50	613.71	-1.79	614.97	-0.53	1.26
4.273		615.76	614.07	-1.69	615.37	-0.39	1.30
4.275		615.72	614.47	-1.25	615.84	0.12	1.37
4.277		616.08	614.89	-1.19	616.32	0.24	1.43
4.278		615.83	614.90	-0.93	616.33	0.50	1.43
4.28		616.09	614.83	-1.26	616.25	0.16	1.42
4.283		615.97	614.93	-1.04	616.37	0.40	1.44
4.284		615.90	615.03	-0.87	616.48	0.58	1.45
4.295		615.67	615.03	-0.64	616.47	0.80	1.44
4.299		615.65	615.12	-0.53	616.57	0.92	1.45
4.309		616.29	615.18	-1.11	616.63	0.34	1.45
4.314		616.78	615.11	-1.67	616.56	-0.22	1.45
4.332		616.81	615.10	-1.71	616.56	-0.25	1.46
4.336		617.08	615.12	-1.96	616.59	-0.49	1.47
4.345		616.85	615.14	-1.71	616.61	-0.24	1.47
4.351		616.77	615.11	-1.66	616.59	-0.18	1.48
4.369		616.35	615.09	-1.26	616.56	0.21	1.47
4.373		616.35	615.07	-1.28	616.55	0.20	1.48
4.382		616.45	615.11	-1.34	616.59	0.14	1.48
4.387		616.21	614.97	-1.24	616.46	0.25	1.49
4.405		616.33	614.53	-1.80	616.02	-0.31	1.49
4.425		616.41	614.18	-2.23	615.63	-0.78	1.45
4.438		616.13	613.54	-2.59	614.86	-1.27	1.32
4.447		616.05	613.26	-2.79	614.48	-1.57	1.22
4.45	45th Street						
4.456		617.32	614.24	-3.08	615.55	-1.77	1.31
4.461		617.52	614.30	-3.22	615.82	-1.70	1.52
4.468		617.50	614.10	-3.40	615.61	-1.89	1.51
4.472		617.31	614.16	-3.15	615.62	-1.69	1.46
4.48		617.39	614.41	-2.98	615.75	-1.64	1.34
4.481		617.46	614.67	-2.79	615.98	-1.48	1.31
4.486		617.88	615.49	-2.39	616.73	-1.15	1.24
4.49		617.68	615.13	-2.55	616.36	-1.32	1.23
4.5		617.75	615.24	-2.51	616.45	-1.30	1.21
4.505		617.92	615.57	-2.35	616.76	-1.16	1.19
4.515		617.83	615.66	-2.17	616.82	-1.01	1.16
4.519		617.70	615.46	-2.24	616.62	-1.08	1.16
4.537		618.10	616.25	-1.85	617.22	-0.88	0.97
4.558		621.73	619.73	-2.00	621.13	-0.60	1.40
4.559		621.67	619.60	-2.07	621.00	-0.67	1.40
4.56	CP Rail Bridge						
4.566		625.29	622.18	-3.11	624.52	-0.77	2.34
4.572		625.55	622.42	-3.13	624.78	-0.77	2.36
4.581		625.58	622.43	-3.15	624.81	-0.77	2.38
4.597		625.31	622.10	-3.21	624.51	-0.80	2.41
4.62		625.19	621.62	-3.57	624.33	-0.86	2.71
4.622		625.60	621.84	-3.76	624.76	-0.84	2.92
4.623	USH 41 (northbound)						
4.63		625.74	622.11	-3.63	624.93	-0.81	2.82

Table 2 (continued)

River Mile	Location	Existing Channel Conditions (feet above NGVD29)	Complete MMSD Project (feet above NGVD29)	Difference in Elevation Between Complete Project Conditions and Existing Conditions (feet)	MMSD Project without Milwaukee County Grounds Detention (feet above NGVD29)	Difference in Elevation Between Project without County Grounds Detention and Existing Conditions (feet)	Difference in Elevation Between Project without County Grounds Detention and Complete Project Conditions (feet)
4.639	USH 41 (southbound)						
4.652		625.78	622.30	-3.48	624.98	-0.80	2.68
4.653		625.22	621.86	-3.36	624.41	-0.81	2.55
4.672		625.12	621.95	-3.17	624.44	-0.68	2.49
4.692		624.76	621.58	-3.18	624.06	-0.70	2.48
4.711		625.01	622.10	-2.91	624.36	-0.65	2.26
4.729		625.99	622.42	-3.57	625.25	-0.74	2.83
4.748		625.55	622.29	-3.26	625.12	-0.43	2.83
4.766		625.73	622.68	-3.05	625.09	-0.64	2.41
4.785		625.98	622.67	-3.31	625.12	-0.86	2.45
4.805		626.50	623.42	-3.08	625.73	-0.77	2.31
4.828		626.38	623.03	-3.35	625.19	-1.19	2.16
4.83		626.01	623.20	-2.81	625.20	-0.81	2.00
4.831	Footbridge						
4.849		627.10	623.30	-3.80	626.55	-0.55	3.25
4.866		627.84	624.10	-3.74	627.41	-0.43	3.31
4.93		626.95	624.10	-2.85	627.12	0.17	3.02
5.03		627.77	627.72	-0.05	629.57	1.80	1.85
5.13		630.24	628.72	-1.52	630.36	0.12	1.64
5.1525	Old Hawley Road Bridge						
5.17		635.92	629.65	-6.27	630.93	-4.99	1.28
5.25		636.52	630.13	-6.39	631.38	-5.14	1.25
5.36		637.16	631.36	-5.80	632.46	-4.70	1.10
5.48		637.52	631.96	-5.56	632.94	-4.58	0.98
5.57		639.16	631.96	-7.20	632.59	-6.57	0.63
5.69		640.12	635.00	-5.12	635.72	-4.40	0.72
5.82		639.47	635.43	-4.04	636.01	-3.46	0.58
5.894		640.55	638.12	-2.43	638.61	-1.94	0.49
5.94		641.63	640.02	-1.61	640.84	-0.79	0.82
5.96		641.78	640.22	-1.56	641.03	-0.75	0.81
5.9625	68th Street						
5.965		643.68	642.27	-1.41	644.02	0.34	1.75
5.97		643.72	642.23	-1.49	643.98	0.26	1.75
6.03		644.41	643.02	-1.39	644.80	0.39	1.78
6.09		644.67	643.19	-1.48	644.91	0.24	1.72
6.1		644.65	643.37	-1.28	645.08	0.43	1.71
6.1025	70th Street						
6.105		645.60	645.62	0.02	646.62	1.02	1.00
6.11		646.27	645.86	-0.41	646.94	0.67	1.08
6.181		646.90	646.50	-0.40	647.46	0.56	0.96
6.22		647.30	646.79	-0.51	647.71	0.41	0.92
6.24		647.61	646.96	-0.65	647.85	0.24	0.89
6.312		647.86	647.00	-0.86	647.90	0.04	0.90
6.3135	Bike Trail Bridge						
6.315		648.00	646.90	-1.10	647.82	-0.18	0.92
6.33		649.37	647.35	-2.02	648.05	-1.32	0.70
6.4		649.28	646.99	-2.29	647.75	-1.53	0.76
6.43		649.38	647.44	-1.94	648.10	-1.28	0.66
6.47		649.71	648.29	-1.42	648.93	-0.78	0.64
6.59		650.30	649.20	-1.10	649.82	-0.48	0.62
6.69		651.89	650.95	-0.94	651.72	-0.17	0.77
6.7		653.79	652.52	-1.27	653.72	-0.07	1.20

Table 2 (continued)

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6.7025	CP Rail Bridge						
6.705		655.04	652.80	-2.24	654.91	-0.13	2.11
6.721		656.34	654.08	-2.26	655.92	-0.42	1.84
6.7215	Harwood Footbridge						
6.722		657.29	654.91	-2.38	656.87	-0.42	1.96
6.723		657.18	654.80	-2.38	656.75	-0.43	1.95
6.724		656.93	654.55	-2.38	656.49	-0.44	1.94
6.725		656.97	654.60	-2.37	656.53	-0.44	1.93
6.726		656.81	654.43	-2.38	656.37	-0.44	1.94
6.73		656.66	654.26	-2.40	656.20	-0.46	1.94
6.731		657.87	655.60	-2.27	657.52	-0.35	1.92
6.7712		658.37	656.11	-2.26	658.03	-0.34	1.92
6.774		658.86	656.45	-2.41	658.54	-0.32	2.09
6.78	Harmonee Avenue						
6.79		659.54	657.20	-2.34	659.25	-0.29	2.05
6.799		659.90	657.63	-2.27	659.63	-0.27	2.00
6.88		660.35	658.17	-2.18	660.12	-0.23	1.95
6.885		660.34	658.15	-2.19	660.11	-0.23	1.96
6.888		660.30	658.12	-2.18	660.08	-0.22	1.96
6.8895	Bike Trail Bridge						
6.89		660.43	658.26	-2.17	660.22	-0.21	1.96
6.891		660.39	658.24	-2.15	660.20	-0.19	1.96
6.96		660.80	658.70	-2.10	660.55	-0.25	1.85
7.08		661.18	659.26	-1.92	660.96	-0.22	1.70
7.15		661.33	659.52	-1.81	661.12	-0.21	1.60
7.23		661.63	660.08	-1.55	661.45	-0.18	1.37
7.34		662.11	661.18	-0.93	662.01	-0.10	0.83
7.47		664.51	663.46	-1.05	664.46	-0.05	1.00
7.58		667.15	665.48	-1.67	667.06	-0.09	1.58
7.67		668.10	667.45	-0.65	668.06	-0.04	0.61
7.68		668.24	667.62	-0.62	668.21	-0.03	0.59
7.6805	Footbridge						
7.681		669.22	668.23	-0.99	669.14	-0.08	0.91
7.69		669.47	668.52	-0.95	669.41	-0.06	0.89
7.82		670.00	669.42	-0.58	670.00	0.00	0.58
7.98		673.11	671.93	-1.18	673.05	-0.06	1.12
7.995		673.73	672.48	-1.25	673.66	-0.07	1.18
8		674.17	672.84	-1.33	674.10	-0.07	1.26
8.002501	Swan Boulevard						
8.005		676.09	674.55	-1.54	676.02	-0.07	1.47
8.02		676.23	674.66	-1.57	676.16	-0.07	1.50
8.1		676.16	674.76	-1.40	676.10	-0.06	1.34
8.19		676.70	675.28	-1.42	676.63	-0.07	1.35
8.29		678.14	676.60	-1.54	678.06	-0.08	1.46
8.31		678.08	676.54	-1.54	678.01	-0.07	1.47
8.3133		678.12	676.58	-1.54	678.04	-0.08	1.46
8.314	Golf Course Bridge						
8.3158		678.20	676.65	-1.55	678.13	-0.07	1.48
8.325		678.20	676.65	-1.55	678.13	-0.07	1.48
8.37		678.46	676.93	-1.53	678.39	-0.07	1.46
8.5		679.02	677.56	-1.46	678.96	-0.06	1.40
8.501		678.87	677.28	-1.59	678.79	-0.08	1.51

Table 2 (continued)

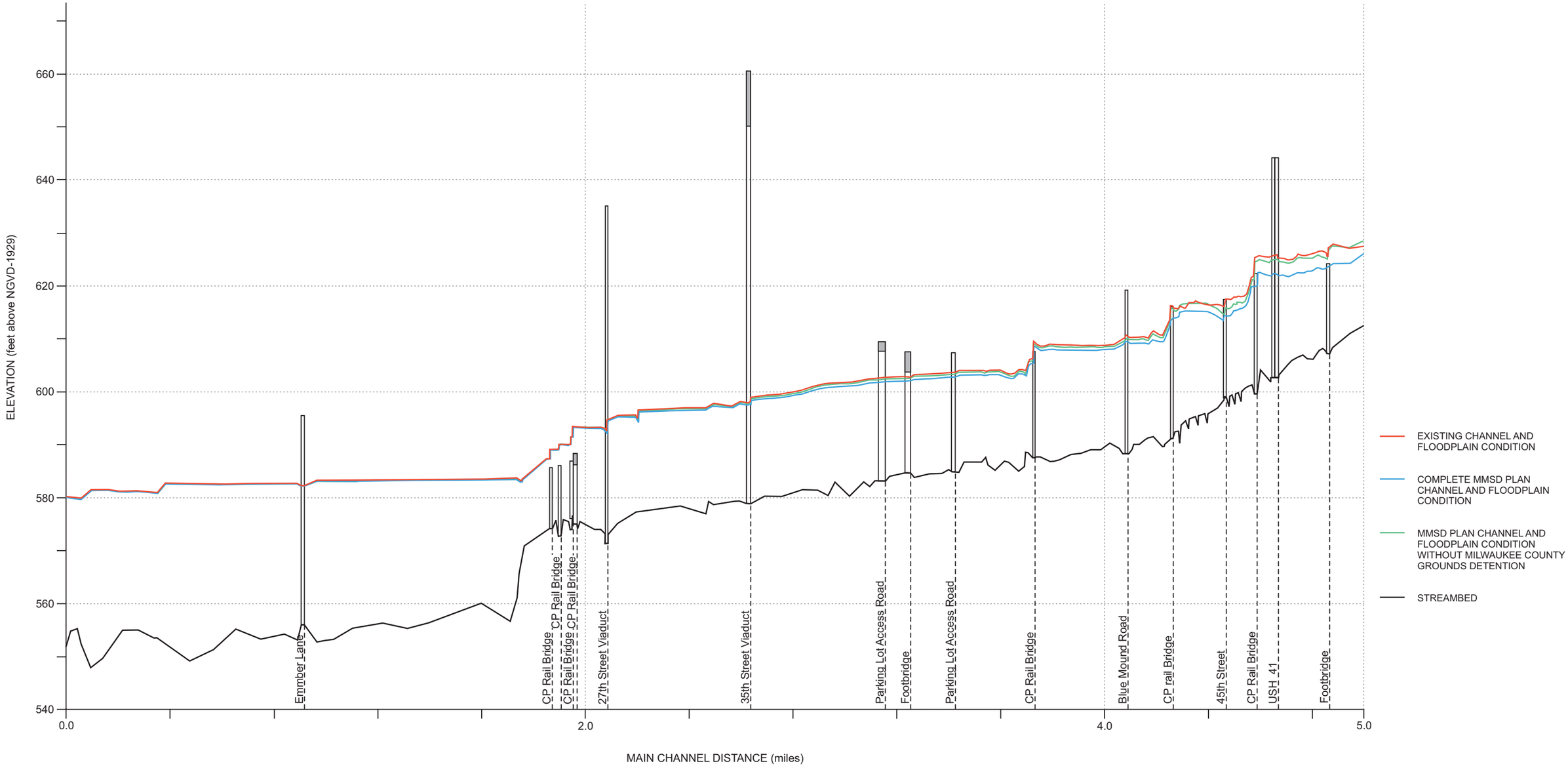
River Mile	Location	Existing Channel Conditions (feet above NGVD29)	Complete MMSD Project (feet above NGVD29)	Difference in Elevation Between Complete Project Conditions and Existing Conditions (feet)	MMSD Project without Milwaukee County Grounds Detention (feet above NGVD29)	Difference in Elevation Between Project without County Grounds Detention and Existing Conditions (feet)	Difference in Elevation Between Project without County Grounds Detention and Complete Project Conditions (feet)
8.5015	North Avenue						
8.505		679.98	678.59	-1.39	679.92	-0.06	1.33
8.52		680.04	678.68	-1.36	679.99	-0.05	1.31
8.62		680.62	679.63	-0.99	680.58	-0.04	0.95
8.7		681.09	680.26	-0.83	681.05	-0.04	0.79
8.78		681.56	680.90	-0.66	681.53	-0.03	0.63
8.88		681.86	681.28	-0.58	681.84	-0.02	0.56
8.99		682.22	681.72	-0.50	682.19	-0.03	0.47
9.19		683.17	682.86	-0.31	683.15	-0.02	0.29
9.32		683.92	683.70	-0.22	683.91	-0.01	0.21
9.47		684.63	684.47	-0.16	684.62	-0.01	0.15
9.66		686.40	686.32	-0.08	686.40	0.00	0.08
9.68		686.43	686.36	-0.07	686.43	0.00	0.07
9.6805	Burleigh Street (eastbound)						
9.681		686.80	686.72	-0.08	686.80	0.00	0.08
9.682		686.83	686.75	-0.08	686.82	-0.01	0.07
9.6835	Burleigh Street (westbound)						
9.685		687.21	687.13	-0.08	687.21	0.00	0.08
9.7		687.19	687.11	-0.08	687.19	0.00	0.08
9.75		687.58	687.51	-0.07	687.58	0.00	0.07

UNDERWOOD CREEK

River Mile	Location	Existing Condition	MMSD Project	Difference (feet)	MMSD Project without Milwaukee County Grounds Detention	Difference (feet)
0.06		678.46	676.93	-1.53	678.39	-0.07
0.11		678.56	677.01	-1.55	678.50	-0.06
0.22		679.04	677.27	-1.77	679.00	-0.04
0.225		679.64	677.00	-2.64	679.64	0.00
0.23		680.91	677.62	-3.29	680.91	0.00
0.33		683.22	679.78	-3.44	683.22	0.00
0.42		683.74	680.39	-3.35	683.74	0.00
0.46		684.06	680.64	-3.42	684.06	0.00
0.468		685.21	681.49	-3.72	685.21	0.00
0.475		685.71	681.87	-3.84	685.71	0.00
0.49		686.06	682.18	-3.88	686.06	0.00
0.491		685.99	682.09	-3.90	685.99	0.00
0.495		686.02	682.08	-3.94	686.02	0.00
0.52		686.10	682.19	-3.91	686.10	0.00
0.63		686.14	682.39	-3.75	686.14	0.00
0.635		685.19	681.43	-3.76	685.19	0.00
0.67		686.14	682.71	-3.43	686.14	0.00
0.675		688.00	685.65	-2.35	688.00	0.00
0.72		690.28	687.36	-2.92	690.28	0.00
0.725		690.28	687.36	-2.92	690.28	0.00
0.73		689.69	686.82	-2.87	689.69	0.00
0.74		691.38	688.06	-3.32	691.38	0.00
0.76		691.46	688.19	-3.27	691.46	0.00
0.8		692.16	688.69	-3.47	692.16	0.00
0.805		693.50	691.52	-1.98	693.50	0.00
0.81		695.18	693.06	-2.12	695.18	0.00
0.8125	CP Rail Bridge					
0.815		698.36	697.57	-0.79	698.36	0.00
0.82		699.48	698.56	-0.92	699.48	0.00
0.83		699.58	698.35	-1.23	699.58	0.00

Figure 1

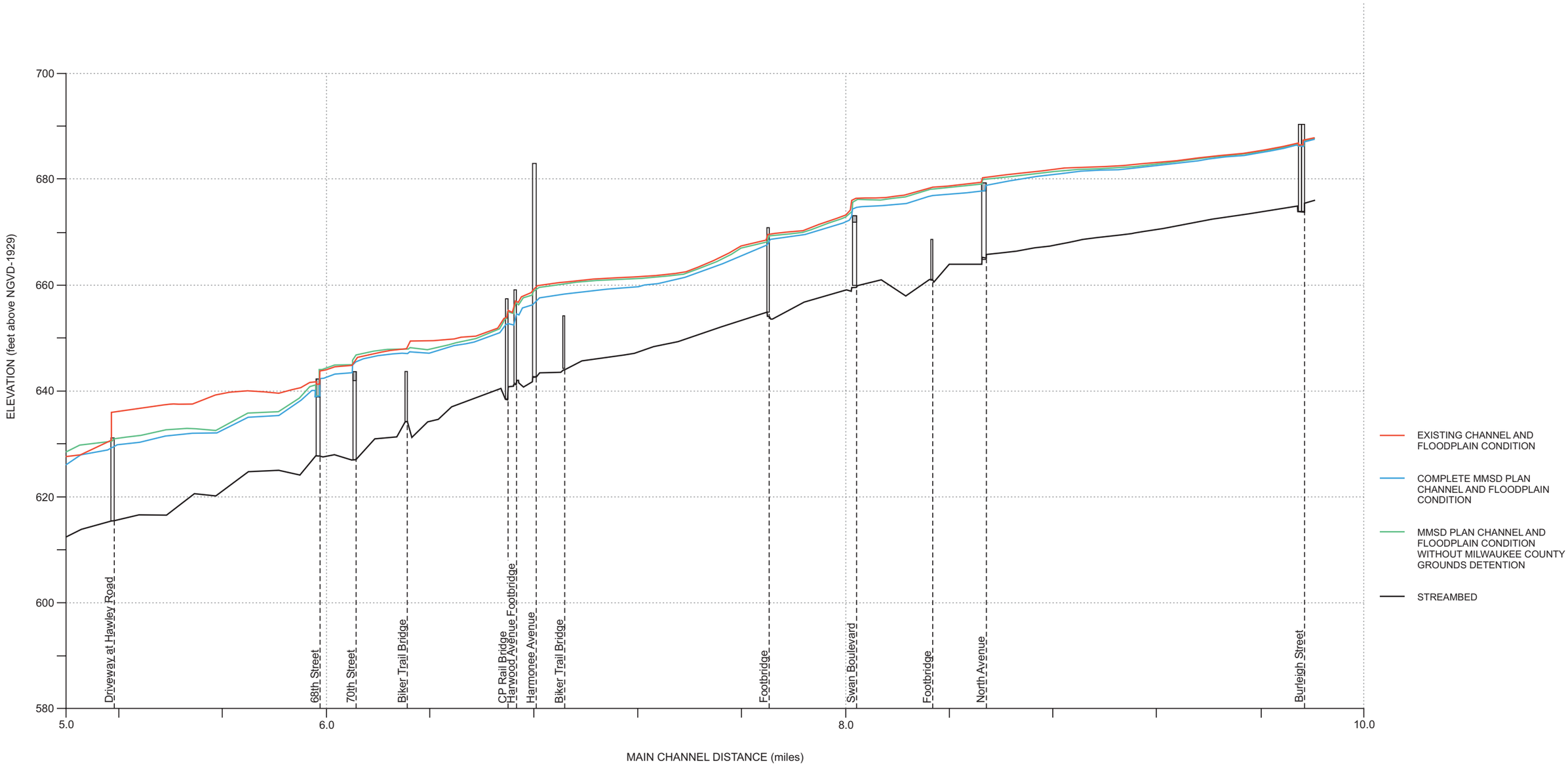
MENOMONEE RIVER
FLOOD STAGE AND STREAMBED PROFILES
100-YEAR RECURRENCE INTERVAL FLOOD EVENT - YEAR 2020 PLANNED LAND USE



Source: SEWRPC.

Figure 1 (Continued)

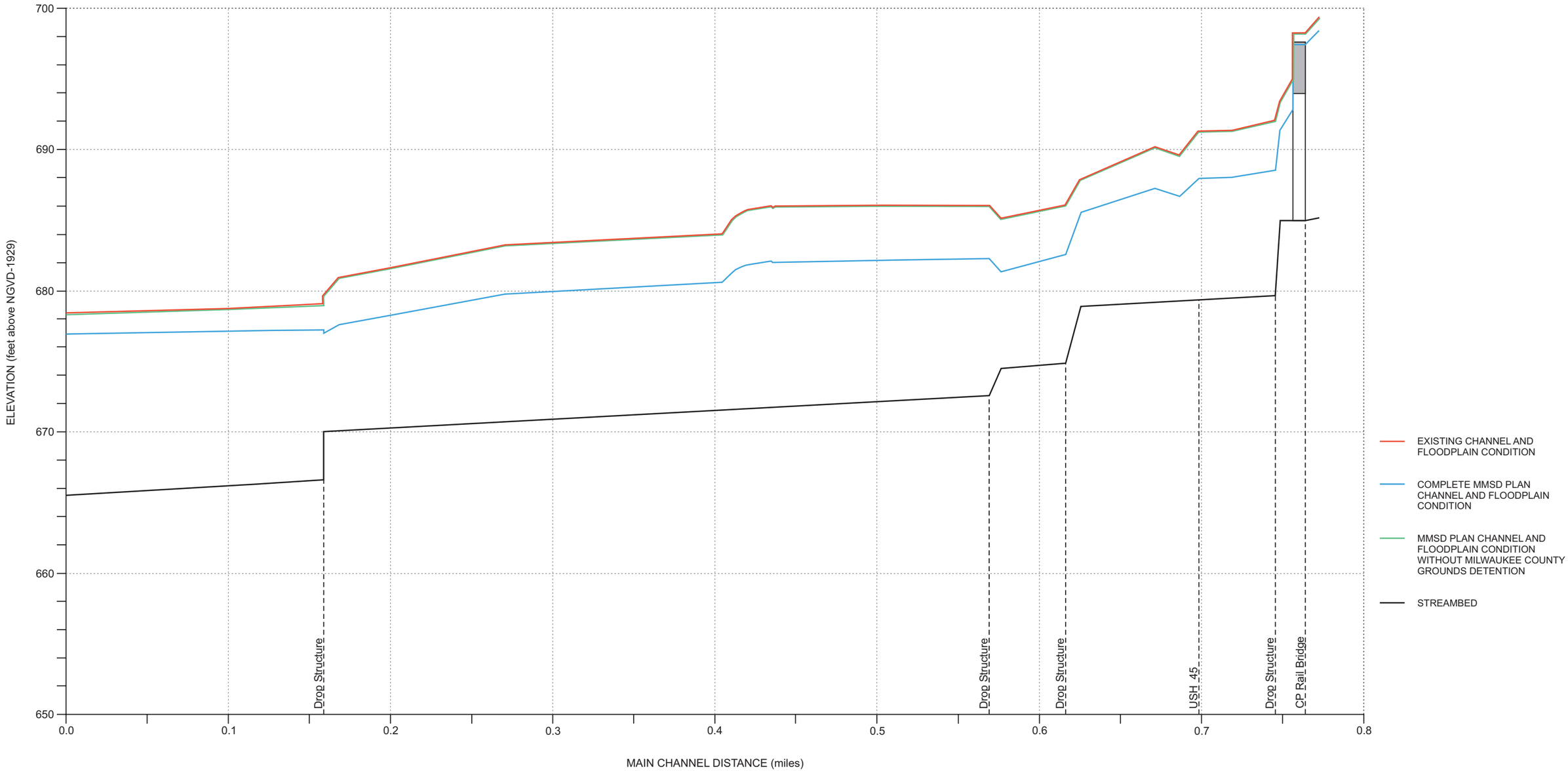
MENOMONEE RIVER
FLOOD STAGE AND STREAMBED PROFILES
100-YEAR RECURRENCE INTERVAL FLOOD EVENT - YEAR 2020 PLANNED LAND USE



Source: SEWRPC.

Figure 2

UNDERWOOD CREEK
FLOOD STAGE AND STREAMBED PROFILES
100-YEAR RECURRENCE INTERVAL FLOOD EVENT - YEAR 2020 PLANNED LAND USE



Source: SEWRPC.

and downstream of structures such as bridges, four feet of freeboard is required and 3.5 feet of freeboard are required at the upstream end of a levee or floodwall. These freeboard levels must be met in order for local floodplain zoning and Federal flood insurance requirements to be lifted.

Table 3 sets forth an evaluation of the ability of the project condition without the County Grounds Basin and the project condition with the County Grounds Basin to meet State and Federal freeboard requirements. It also evaluates whether the existing Valley Park combination levee/floodwall meets freeboard requirements under existing conditions, without the other components of the proposed MMSD project in place. The data in Table 3 indicate that, under existing conditions, the Valley Park levee/floodwall would have from 2.5 to 5.2 feet of freeboard during a 100-year flood, providing protection to the neighborhood, but along most of its length, it would have freeboard slightly below the State and Federal requirement for removal from the floodplain. The shortfall in freeboard is 0.5 foot or less. Thus, the area currently protected by the levee would still have to be regulated as floodplain. Property owners would continue to be required to purchase flood insurance in order to secure Federally-backed financing.

Proposed Project Condition Without the Milwaukee County Grounds Detention Basin

Description of Flooding Conditions

Under this condition, 87 of the 92 buildings along the Menomonee River in Wauwatosa that would be expected to flood during a 100-year event under existing conditions would no longer be flooded. Of those 87 buildings, 23 buildings would no longer be flooded because of improvements to the storm sewer system called for under the proposed project.[22] Of the remaining 64 buildings, 43 would continue to be considered as floodplain buildings by the WDNR and FEMA because the levees intended to protect them would have inadequate freeboard. Of the five buildings that would be expected to be flooded, three recreational buildings at Hart Park and one commercial building would be floodproofed, but the remaining industrial building is not intended to be floodproofed under the MMSD plan because implementation of the complete plan would remove the building from the floodplain by sufficiently lowering flood stages. That is, construction of the County Grounds Basin would lower the 100-year flood stage enough to remove that building from the floodplain. During a 100-year flood, the estimated total direct and indirect flood damages to that building and its contents is $785,000. In addition, the flooding potential would be unchanged from existing conditions at the eight houses located on Fisher Parkway and the one institutional building along W. North Avenue along Underwood Creek downstream of USH 45. During a 100-year flood, the estimated total direct and indirect flood damages to those buildings and their contents is $130,000.

The measures needed to floodproof the four buildings would be more extensive and costly under this condition than under the complete project condition because the flood stages at those buildings would be higher than under complete project conditions. At the three buildings in Hart Park, the 100-year flood stage would be 0.7 to 0.8 foot higher than under complete project conditions. At the commercial building near the intersection of W. State Street and Harwood Avenue, the flood stage would be about two feet higher.

Under this condition, 70 of the 78 buildings in Milwaukee that would be expected to flood during a 100-year event under existing conditions would no longer be flooded. Of those 70 buildings, 58 would continue to be considered as floodplain buildings by the WDNR and FEMA because the levees intended to protect them would have inadequate freeboard. During a 100-year flood under these project conditions, the estimated total direct and indirect flood damages to those eight buildings and their contents is $2.4 million.

[22] *As noted below, that interior stormwater drainage system would have to be modified and might have to include stormwater pumping.*

Table 3

REVIEW OF PROPOSED MILWAUKEE COUNTY GROUNDS DETENTION BASIN

COMPARISON OF FLOOD STAGES WITH TOP OF LEVEE ELEVATIONS
100-YEAR RECURRENCE INTERVAL FLOOD EVENT
PLANNED YEAR 2020 LAND USE CONDITIONS

MENOMONEE RIVER

Valley Park Combination Levee/Floodwall											
	Combination Levee/ Floodwall Elevation (feet above NGVD 29)	Required Freeboard (feet)	Existing Channel Conditions			Complete MMSD Project			MMSD Project without Milwaukee County Grounds Detention		
River Mile			Flood Stage (feet above NGVD 29)	Freeboard (feet)	Freeboard Requirement Met?	Flood Stage (feet above NGVD 29)	Freeboard (feet)	Freeboard Requirement Met?	Flood Stage (feet above NGVD 29)	Freeboard (feet)	Freeboard Requirement Met?
CP Rail Bridge											
3.712	613.1	4.0	609.44	3.66	No	608.50	4.60	Yes	609.09	4.01	Yes
3.725	614.0	4.0	608.85	5.15	Yes	607.96	6.04	Yes	608.52	5.48	Yes
3.741	611.5	3.0	608.54	2.96	No	607.68	3.82	Yes	608.22	3.28	Yes
3.779	611.5	3.0	608.96	2.54	No	607.99	3.51	Yes	608.60	2.90	No
3.819	611.5	3.0	608.77	2.73	No	607.80	3.70	Yes	608.41	3.09	Yes
3.859	611.5	3.0	608.76	2.74	No	607.86	3.64	Yes	608.42	3.08	Yes
3.896	611.5	3.0	608.63	2.87	No	607.77	3.73	Yes	608.32	3.18	Yes
3.932	611.5	3.0	608.73	2.77	No	607.87	3.63	Yes	608.41	3.09	Yes
3.971	611.5	3.0	608.60	2.90	No	607.75	3.75	Yes	608.29	3.21	Yes
3.988	611.5	3.0	608.76	2.74	No	607.91	3.59	Yes	608.44	3.06	Yes
4.006	611.5	3.0	608.80	2.70	No	607.95	3.55	Yes	608.48	3.02	Yes
4.025	612.1	3.5	608.89	3.21	No	608.04	4.06	Yes	608.58	3.52	Yes
End of Floodwall											
4.043	- -	- -	609.44	- -	- -	608.54	- -	- -	609.10	- -	- -
4.057	- -	- -	609.59	- -	- -	608.69	- -	- -	609.25	- -	- -
4.068	- -	- -	610.36	- -	- -	609.31	- -	- -	609.96	- -	- -
Bluemound Road											

Western Milwaukee Levee/Floodwall								
	Levee/Floodwall Elevation (feet above NGVD 29)	Required Freeboard (feet)	Complete MMSD Project			MMSD Project without Milwaukee County Grounds Detention		
River Mile			Flood Stage (feet above NGVD 29)	Freeboard (feet)	Freeboard Requirement Met?	Flood Stage (feet above NGVD 29)	Freeboard (feet)	Freeboard Requirement Met?
4.566	627.0	4.0	622.18	4.82	Yes	624.52	2.48	No
4.572	627.0	4.0	622.42	4.58	Yes	624.78	2.22	No
4.581	627.0	4.0	622.43	4.57	Yes	624.81	2.19	No
4.597	627.0	3.0	622.10	4.90	Yes	624.51	2.49	No
4.62	627.0	4.0	621.62	5.38	Yes	624.33	2.67	No
4.622	627.0	4.0	621.84	5.16	Yes	624.76	2.24	No
USH 41 (northbound)								
4.63	627.0	4.0	622.11	4.89	Yes	624.93	2.07	No
USH 41 (southbound)								
4.652	627.0	4.0	622.30	4.70	Yes	624.98	2.02	No
4.653	627.0	4.0	621.86	5.14	Yes	624.41	2.59	No
4.672	627.0	3.0	621.95	5.05	Yes	624.44	2.56	No
4.692	627.0	3.0	621.58	5.42	Yes	624.06	2.94	No
4.711	627.0	3.0	622.10	4.90	Yes	624.36	2.64	No
4.729	627.5	3.0	622.42	5.08	Yes	625.25	2.25	No
4.748	627.5	3.0	622.29	5.21	Yes	625.12	2.38	No
4.766	627.5	3.0	622.68	4.82	Yes	625.09	2.41	No
4.785	627.5	3.0	622.67	4.83	Yes	625.12	2.38	No
4.805	628.0	3.0	623.42	4.58	Yes	625.73	2.27	No
4.828	628.0	4.0	623.03	4.97	Yes	625.19	2.81	No
4.83	628.0	4.0	623.20	4.80	Yes	625.20	2.80	No
Footbridge								
4.849	628.0	4.0	623.30	4.70	Yes	626.55	1.45	No
4.866	628.5	4.0	624.10	4.40	Yes	627.41	1.09	No
4.93	628.5	3.0	624.10	4.40	Yes	627.12	1.38	No
5.03	631.5	3.0	627.72	3.78	Yes	629.57	1.93	No

Table 3 (continued)

River Parkway Levee								
			Complete MMSD Project			MMSD Project without Milwaukee County Grounds Detention		
River Mile	Levee Elevation (feet above NGVD 29)	Required Freeboard (feet)	Flood Stage (feet above NGVD 29)	Freeboard (feet)	Freeboard Requirement Met?	Flood Stage (feet above NGVD 29)	Freeboard (feet)	Freeboard Requirement Met?
5.57	639	3.0	631.96	7.04	Yes	632.59	6.41	Yes
5.69	640	3.0	635.00	5.00	Yes	635.72	4.28	Yes
5.82	640	3.0	635.43	4.57	Yes	636.01	3.99	Yes
5.894	642	3.5	638.12	3.88	Yes	638.61	3.39	No

Hart Park Levee/Floodwall								
			Complete MMSD Project			MMSD Project without Milwaukee County Grounds Detention		
River Mile	Levee/Floodwall Elevation (feet above NGVD 29)	Required Freeboard (feet)	Flood Stage (feet above NGVD 29)	Freeboard (feet)	Freeboard Requirement Met?	Flood Stage (feet above NGVD 29)	Freeboard (feet)	Freeboard Requirement Met?
5.965	646.5	4.0	642.27	4.23	Yes	644.02	2.48	No
5.97	646.5	4.0	642.23	4.27	Yes	643.98	2.52	No
6.02	647.0	3.0	642.89	4.11	Yes	644.66	2.34	No
6.04	647.0	3.0	643.05	3.95	Yes	644.82	2.18	No
6.06	647.0	3.0	643.11	3.89	Yes	644.86	2.14	No
6.09	648.5	4.0	643.19	5.31	Yes	644.91	3.59	No
6.1	648.5	4.0	643.37	5.13	Yes	645.08	3.42	No
N. 70th Street								
6.105	651.0	4.0	645.62	5.38	Yes	646.62	4.38	Yes
6.11	651.0	4.0	645.86	5.14	Yes	646.94	4.06	Yes
6.181	651.0	3.0	646.5	4.50	Yes	647.46	3.54	Yes
6.22	651.0	3.0	646.79	4.21	Yes	647.71	3.29	Yes
6.24	651.0	3.0	646.96	4.04	Yes	647.85	3.15	Yes
6.312	651.0	4.0	647.00	4.00	Yes	647.90	3.10	No
Bike Trail Bridge								
6.315	651.1	4.0	646.90	4.20	Yes	647.82	3.28	No
6.33	651.3	4.0	647.35	3.95	No	648.05	3.25	No
6.4	652.3	3.0	646.99	5.31	Yes	647.75	4.55	Yes
6.43	652.8	3.0	647.44	5.36	Yes	648.10	4.70	Yes
6.47	653.3	3.0	648.29	5.01	Yes	648.93	4.37	Yes
6.59	655.0	3.5	649.20	5.80	Yes	649.82	5.18	Yes

Harvey Avenue Levee/Floodwall								
			Complete MMSD Project			MMSD Project without Milwaukee County Grounds Detention		
River Mile	Levee/Floodwall Elevation (feet above NGVD 29)	Required Freeboard (feet)	Flood Stage (feet above NGVD 29)	Freeboard (feet)	Freeboard Requirement Met?	Flood Stage (feet above NGVD 29)	Freeboard (feet)	Freeboard Requirement Met?
5.965	646.5	4.0	642.27	4.23	Yes	644.02	2.48	No
5.97	646.5	4.0	642.23	4.27	Yes	643.98	2.52	No
6.02	646.5	3.0	642.89	3.61	Yes	644.66	1.84	No
6.04	648.0	3.0	643.05	4.95	Yes	644.82	3.18	Yes
6.06	649.0	3.0	643.11	5.89	Yes	644.86	4.14	Yes
6.09	649.0	4.0	643.19	5.81	Yes	644.91	4.09	Yes
6.1	650.0	4.0	643.37	6.63	Yes	645.08	4.92	Yes
N. 70th Street								
6.105	651.0	4.0	645.62	5.38	Yes	646.62	4.38	Yes
6.11	651.0	4.0	645.86	5.14	Yes	646.94	4.06	Yes
6.181	651.0	3.0	646.50	4.50	Yes	647.46	3.54	Yes
6.22	651.0	3.5	646.79	4.21	Yes	647.71	3.29	No

Interior Drainage Considerations
As currently envisioned under the full MMSD project, the proposed interior stormwater drainage systems in Wauwatosa and Milwaukee are designed to function through gravity flow, eliminating the need for more expensive stormwater pumping. The increases in flood stages resulting from elimination of the County Grounds Basin would adversely affect the interior stormwater drainage systems and might make stormwater pumping necessary.

Indirect, Unquantified Damages
The indirect, unquantified damages in the vicinity of Fisher Parkway which could result from a combination of temporary high groundwater levels, stormwater drainage problems, and sanitary sewer infiltration and inflow in areas near the floodplain would not be mitigated at all under this project condition. The portion of the indirect, unquantified damages along the Menomonee River in Wauwatosa from N. 76th Street to N. 60th Street and in Milwaukee from N. 60th Street to W. Wisconsin Avenue that can be attributed to high River stages during floods with recurrence intervals up to, and including, 100 years would be reduced relative to existing conditions, but they would be greater than the damages if the County Grounds Basin were constructed. As noted above, the reduction that would be achieved would require a more expensive interior drainage system than for the project with the County Grounds Basin. The indirect, unquantified damages upstream of Harmonee Avenue would be expected to remain similar to the existing condition situation since no significant changes in flood stages would be expected in that upstream reach.

Adequacy of Levees/Floodwalls as Currently Designed
According to State and Federal floodplain regulations, if one section of a continuous levee/floodwall does not met the freeboard requirement, the entire levee/floodwall is considered to be noncompliant. Table 3 indicates that, along one localized section of the Valley Park combination levee/floodwall the freeboard requirement would not be met under this project condition.[23] That table also shows that, in general, the freeboard requirement would not be met for the Western Milwaukee levee/floodwall under this project condition, although the elevation of the top of the levee/floodwall would be above the 100-year flood stage. The River Parkway levee would generally meet the freeboard requirements, except at its upstream end where it would fall about 0.1 foot below the required elevation.

The Hart Park levee/floodwall would not meet the freeboard requirement over about 35 percent of its length. The Harvey Avenue levee would not meet the freeboard requirement over about 30 percent of its length.

Regulatory Effects of Possible 100-Year Flood Stage Increases
The City of Milwaukee floodplain zoning ordinance and Chapter NR 116, "Wisconsin's Floodplain Management Program," of the *Wisconsin Administrative Code* prohibit any activity in the floodplain that would increase the 100-year flood stage by 0.01 foot or more unless appropriate legal arrangements are made with all affected property owners and municipalities. Under the condition analyzed here, the 100-year flood stage increase relative to existing conditions would exceed 0.01 foot in a short reach just downstream of N. Hawley Road, affecting five properties, including a narrow strip of land along the River in Milwaukee County's Doyne Park, and in a short reach east of N. 45th Street, affecting four properties (including the Canadian Pacific Railway) that MMSD does not propose to purchase. Thus, under this condition, eight easements for the flood stage increase would have to be obtained from private owners and one from Milwaukee County. In addition, easements may have to be obtained at up to 85 properties in the Cities of Milwaukee and Wauwatosa that are located in the Lower Wauwatosa/Hart Park project area upstream of Hawley Road and that are 1) located in the area to be protected by levees or

[23] *The with-project condition flood profile is computed based on the existing regulatory floodway from IH 94 to 27th Street. Modifications to that floodway as part of the W. Canal Street extension or the CMC property development project could alter that floodway, possibly lowering the 100-year flood stage.*

floodwalls, 2) would not be removed from the floodplain for regulatory purposes because of inadequate freeboard for the levees or floodwalls, and 3) are adjacent to those River reaches where 100-year flood stage increases could occur. The cost of any necessary easements would be subject to negotiation, thus no estimate of that cost is made.

Potential Impacts in the Area Between IH 94 and the 27th Street Viaduct

This reach includes the proposed W. Canal Street extension; the Canadian Pacific Railway, including the existing Amtrak line and a possible future high-speed rail line;[24] the east Miller Park parking lot; the CMC/Heartland Partners property for which several development proposals and plans have been put forth; and the Falk Corporation. During large floods, under existing and with-project conditions there is the potential for flow to leave the Menomonee River just downstream from IH 94 and flow across the Miller Park detention basin, along the Canadian Pacific Railway tracks north of the CMC site and north of the Falk Corporation property, and across the extreme northern portions of the CMC and Falk properties. Flow could also leave the River in the vicinity of the 35th Street viaduct and flow from south to north across the CMC site, joining the northern overflow along the railroad tracks before reentering the River near the railroad bridges located east of the Falk property. Under this specific project condition, the SEWRPC staff estimates that, relative to existing conditions 1) the peak flow leaving the River just downstream from IH 94 could be about 29 percent less, 2) the peak flow leaving the River near the 35th Street viaduct could be about 16 percent less, and 3) the total peak rate of overflow from both sources could be about 20 percent less. Under this condition, relative to proposed complete MMSD project conditions, 1) the peak flow leaving the River just downstream from IH 94 could be about double, 2) the peak flow leaving the River near the 35th Street viaduct could be about 33 percent greater, and 3) the total peak rate of overflow from both sources could be about 45 percent greater.

Increases in the peak rates of overflow relative to the project conditions with the County Grounds Basin will increase the size and cost of facilities to manage that overflow as it is conveyed across the CMC site, the proposed W. Canal Street extension, and the railway. The cost of those facilities can only be determined through a detailed evaluation accounting for development configurations on the CMC site and possible features of the W. Canal Street extension.

Along the Falk Corporation levee/floodwall, 100-year flood stages under this condition could be 0.1 to 0.2 foot less than under existing conditions and 0.2 to 0.3 foot higher than under complete project conditions. Those higher stages would necessitate increasing the height of the raised levee/floodwall system based on the complete project condition by the amount of the stage increase.

Estimated Cost

The consultants for MMSD prepared engineer's opinions of the cost of the Falk, Western Milwaukee, Lower Wauwatosa/Hart Park, and Milwaukee County Grounds Detention Basin elements of the overall Menomonee River watershed flood control project. Those estimates were reviewed by the SEWRPC staff. Based on those estimates, the estimated total cost of those project elements, excluding the County Grounds Basin is about $70 million.[25] If stormwater pumping were required, a rough estimate of the additional cost for interior drainage is about $5 million.

Proposed Complete Project Condition (with the Milwaukee County Grounds Detention Basin)

Description of Flooding Conditions

Under this condition, 88 of the 92 buildings along the Menomonee River in Wauwatosa that would be expected to flood during a 100-year event under existing conditions would no longer be flooded and they all would be

[24] *The Wisconsin Department of Transportation has identified this railway line to be considered for high-speed rail service when such service is evaluated in the future.*

[25] *The project elements are still being designed and the cost estimate is subject to revision as that design proceeds.*

considered to no longer be in the floodplain by the WDNR and FEMA because their protective levees and floodwalls would have adequate freeboard.[26] Of those 88 buildings, 23 buildings would no longer be flooded because of improvements to the storm sewer system called for under the proposed project. Of the four remaining buildings that would be expected to be flooded, three recreational buildings at Hart Park and one commercial building would be floodproofed. The eight houses located on Fisher Parkway and the one institutional building along W. North Avenue along Underwood Creek downstream of USH 45 would not be expected to be flooded during a 100-year flood. The peak flood flow in the reach where those buildings are located would be significantly reduced because of the diversion of floodwaters into the County Grounds Basin.[27]

The measures needed to floodproof the four buildings would be less extensive and costly under this condition than under the project condition without the County Grounds Basin because the flood stages at those buildings would be lower under this condition. At the three buildings in Hart Park, the 100-year flood stage would be 0.7 to 0.8 foot lower than under project conditions without the detention basin. At the commercial building near the intersection of W. State Street and Harwood Avenue, the flood stage would be about two feet lower.

Under this condition, all of the 78 buildings in Milwaukee that would be expected to flood during a 100-year event under existing conditions would no longer be flooded and, for regulatory and flood insurance purposes, they all would be considered to no longer be in the floodplain by the WDNR and FEMA because their protective levees and floodwalls would have adequate freeboard.

Interior Drainage Considerations

As currently envisioned under the full MMSD project, the proposed interior stormwater drainage systems in Wauwatosa and Milwaukee are designed to function through gravity flow, eliminating the need for more expensive stormwater pumping.

Indirect, Unquantified Damages

That portion of the indirect, unquantified damages in the vicinity of Fisher Parkway that would be attributed to the impact of high stages in Underwood Creek on temporary high groundwater levels, stormwater drainage problems, and sanitary sewer infiltration and inflow would be mitigated to the greatest degree practicable under this project condition. The portion of the indirect, unquantified damages along the Menomonee River in Wauwatosa from N. 76th Street to N. 60th Street and in Milwaukee from N. 60th Street to W. Wisconsin Avenue that can be attributed to high River stages during floods with recurrence intervals up to, and including, 100 years would be reduced to the highest degree practicable, and they would be expected to be considerably less than if the County

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[26] *There are several other requirements stated in section NR 116.17 of the* Wisconsin Administrative Code *for the levees/floodwalls to be considered adequate. These include preparation of an approved emergency action plan for the protected area, local notification to all those receiving construction permits in the protected area that the area is subject to flooding if the levee/floodwall were to overtop, and that the levee/floodwall is annually inspected by a registered professional engineer and certified to meet applicable standards. It is assumed that these conditions will be met. NR 116.17 also requires that any increase in the 100-year flood stage due to levee or floodwall construction be addressed according to the requirements of NR 116. The MMSD project is designed to meet that requirement.*

[27] *A possible additional benefit of those reductions in peak flood flow would be that, in the reach from the Canadian Pacific Railway bridge located upstream of USH 45 to the mouth of Underwood Creek, it might be possible to remove the concrete channel lining without creating flooding problems at buildings. The subwatershedwide measures necessary to make such a concrete removal project feasible would have to be investigated. In the past, MMSD has considered options to enable removal of the concrete channel lining, thereby improving aquatic habitat.*

Grounds Basin were not constructed. In addition, the indirect, unquantified damages upstream of Harmonee Avenue would be expected to be significantly alleviated since relatively large reductions in flood stages would be expected in that upstream reach.

Adequacy of Levees/Floodwalls as Currently Designed
As indicated in Table 3, the Valley Park, Western Milwaukee, River Parkway, Hart Park, and Harvey Avenue levees and or floodwalls would meet the freeboard requirement under this project condition.

Regulatory Effects of Possible 100-Year Flood Stage Increases
With one minor exception, 100-year recurrence interval flood stages would decrease relative to existing conditions as a result of implementation of the complete project. Under the condition analyzed here, there would be a localized 100-year flood stage increase of 0.02 foot immediately upstream of N. 70th Street. The increase would only affect land owned by the City of Wauwatosa and Milwaukee County, so obtaining easements for this minor change should not be problematic. Thus, there are no major negative regulatory issues regarding flood stages.

Potential Impacts in the Area Between IH 94 and the 27th Street Viaduct
As mentioned above, this reach includes the proposed W. Canal Street extension; the Canadian Pacific Railway, including the existing Amtrak line and a possible future high-speed rail line; the east Miller Park parking lot; the CMC/Heartland Partners property; and the Falk Corporation. During large floods, under existing and with-project conditions there is the potential for flow to leave the Menomonee River and flow across the area east and north of the River before reentering the River. Under this specific project condition, the SEWRPC staff estimates that, relative to existing conditions 1) the peak flow leaving the River just downstream from IH 94 could be about 64 percent less, 2) the peak flow leaving the River near the 35th Street viaduct could be about 37 percent less, and 3) the total peak rate of overflow from both sources could be about 45 percent less. Under this condition, relative to project conditions without the County Grounds Basin, 1) the peak flow leaving the River just downstream from IH 94 could be about 50 percent less; 2) the peak flow leaving the River near the 35th Street viaduct could be about 25 percent less, and 3) the total peak rate of overflow from both sources could be about 45 percent less.

Decreases in the peak rates of overflow will decrease the size and cost of facilities to manage that overflow as it is conveyed across the CMC site, the proposed W. Canal Street extension, and the railway. The cost of those facilities can only be determined through a detailed evaluation accounting for development configurations on the CMC site and possible features of the W. Canal Street extension.

Along the Falk Corporation levee/floodwall, 100-year flood stages under this condition could be 0.3 to 0.5 foot less than under existing conditions and 0.2 to 0.3 foot lower than under project conditions without the County Grounds Basin. Those decreases would result in a lower, slightly less costly raised levee/floodwall system than would be required based on the project condition without the proposed County Grounds Basin.

Estimated Cost
Based on the MMSD consultants engineer's opinions of the cost of the Falk, Western Milwaukee, Lower Wauwatosa/Hart Park, and Milwaukee County Grounds Detention Basin elements of the overall Menomonee River watershed flood control project, the estimated total cost of those project elements, including the County Grounds Basin is about $134 million.[28]

[28] *The project elements are still being designed and the cost estimate is subject to revision as that design proceeds.*

SUMMARY AND CONCLUSION

Comparison of Two Project Conditions

A point-by-point comparison of the two flood control projects (with and without the County Grounds Basin) is set forth in Table 4.

Findings of the SEWRPC Study

The findings of the SEWRPC analyses are summarized below. General findings are presented, followed by findings related specifically to Questions 1 a through c as listed near the beginning of this memorandum.

General Findings

- As indicated in Table 1, the Milwaukee County Grounds Detention Basin would reduce 100-year flood flows (volume or amount of flow) and stages (flood elevations) throughout the entire reach of the Menomonee River downstream of the Basin.

- Relative to existing conditions, implementation of the complete proposed MMSD project, including the County Grounds Detention Basin, would reduce the peak 100-year flood flow along Underwood Creek by about 60 percent in the reach downstream of the connection to the County Grounds Basin, and along the Menomonee River by from 2 to 18 percent in the 6.6-mile reach downstream from the County Grounds Basin to the Menomonee River estuary area at about 26th Street, with the greatest decreases occurring in significant flood damage reaches.

- Relative to existing conditions, implementation of the proposed MMSD project without the County Grounds Detention Basin, would reduce peak 100-year flood flows along the Menomonee River by from 1 to 4 percent in the reach between Hart Park and the estuary. Flood flows would be unchanged upstream of Hart Park and along Underwood Creek.

- Relative to existing conditions, implementation of the complete proposed MMSD project, including the County Grounds Detention Basin, would reduce the 100-year flood stages along the lower 0.8 mile of Underwood Creek from 0.8 to 3.9 feet and along the lower 8.4 miles of the Menomonee River by up to 7.2 feet. Along much of the Menomonee River the reduction would be in the one- to three-foot range.

- Relative to existing conditions, implementation of the proposed MMSD project without the County Grounds Detention Basin, would not reduce the 100-year flood stage along the lower 0.8 mile of Underwood Creek. Implementation would reduce the 100-year stage along the lower 8.4 miles of the Menomonee River by up to 6.6 feet in one, localized reach, but there are locations where stages would increase by up to 1.8 feet. Along much of the Menomonee River the reduction would be in the 0.5- to 1.5-foot range. As set forth in Table 2, stage reductions are always less than they would be with the County Grounds Basin in place.

- Implementation of the complete proposed MMSD project, including the County Grounds Detention Basin, would result in 175 buildings in the Cities of Milwaukee and Wauwatosa no longer being in the 100-year floodplain. Those buildings would also no longer have a Federal flood insurance requirement and they would no longer be regulated as floodplain buildings for local zoning purposes.

- Implementation of the proposed MMSD project without the County Grounds Detention Basin, would result in 157 buildings in the Cities of Milwaukee and Wauwatosa no longer being flooded during a the 100-year event, but 101 of those buildings would still have a Federal flood insurance requirement and be regulated as floodplain properties for local zoning purposes because the levees/floodwalls intended to protect them would not have adequate freeboard to meet regulatory requirements established by the Federal Emergency Management Agency and the Wisconsin Department of Natural Resources. Freeboard is defined as the

Table 4

REVIEW OF PROPOSED MILWAUKEE COUNTY GROUNDS DETENTION BASIN

COMPARISON OF CONDITIONS FOLLOWING IMPLEMENTATION OF THE PROPOSED MMSD MENOMONEE RIVER FLOOD CONTROL PROJECT WITH AND WITHOUT THE MILWAUKEE COUNTY GROUNDS DETENTION BASIN

Proposed Project Condition without the Milwaukee County Grounds Detention Basin	Proposed Complete Project Condition (with the Milwaukee County Grounds Detention Basin)
• 87 of the 92 buildings in Wauwatosa that would be expected to flood during a 100-year event under existing conditions would no longer be flooded	• 88 of the 92 buildings in Wauwatosa that would be expected to flood during a 100-year event under existing conditions would no longer be flooded
• Of those 87 buildings, 22 buildings would no longer be flooded because of improvements to the storm sewer system called for under the proposed project	• Of those 88 buildings, 22 buildings would no longer be flooded because of improvements to the storm sewer system called for under the proposed project
• Of the remaining 65 buildings, 43 would continue to be considered as floodplain buildings by the WDNR and FEMA because the levees intended to protect them would have inadequate freeboard	• All 88 buildings would be considered to no longer be in the floodplain by the WDNR and FEMA because their protective levees and floodwalls would have adequate freeboard or because of reductions in the extent of the 100-year floodplain
• Of the remaining five buildings that would be expected to be flooded, three recreational buildings at Hart Park and one commercial building would be floodproofed	• Of the remaining four buildings that would be expected to be flooded, three governmental buildings at Hart Park and one commercial building would be floodproofed
• The measures needed to floodproof the four buildings would be more extensive and costly under this condition than under the complete project condition because flood stages would be higher	• The measures needed to floodproof the four buildings would be less extensive and costly under this condition than under the project condition without the County Grounds basin because the flood stages would be lower
• The remaining industrial building is not intended to be floodproofed under the MMSD plan because implementation of the complete plan would remove the building from the floodplain by sufficiently lowering flood stages. During a 100-year flood, the estimated total direct and indirect flood damages to that building and its contents is $785,000	- -
• Eight houses located on Fisher Parkway and one institutional building along W. North Avenue along Underwood Creek downstream of the proposed diversion from Underwood Creek to the County Grounds basin would be in danger of being flooded during a 100-year event. During a 100-year flood, the estimated total direct and indirect flood damages to those buildings and their contents is $130,000	• The eight houses located on Fisher Parkway and one institutional building along W. North Avenue along Underwood Creek downstream of USH 45 would not be expected to be flooded during a 100-year flood
• Under this condition, 70 of the 78 buildings in Milwaukee that would be expected to flood during a 100-year event under existing conditions would no longer be flooded	• All of the 78 buildings in Milwaukee that would be expected to flood during a 100-year event under existing conditions would no longer be flooded
• Of those 70 buildings, 58 would continue to be considered as floodplain buildings by the WDNR and FEMA because the levees intended to protect them would have inadequate freeboard	• For regulatory and flood insurance purposes, all 78 buildings would be considered to no longer be in the floodplain by the WDNR and FEMA because their protective levees and floodwalls would have adequate freeboard or because of reductions in the extent of the 100-year floodplain

Table 4 (continued)

Proposed Project Condition without the Milwaukee County Grounds Detention Basin	Proposed Complete Project Condition (with the Milwaukee County Grounds Detention Basin)
• During a 100-year flood, the estimated total direct and indirect flood damages to the remaining eight buildings in Milwaukee that would be expected to flood and to their contents is $2.4 million	- -
• The increases in flood stages resulting from elimination of the County Grounds basin would adversely affect the interior stormwater drainage systems and might make stormwater pumping necessary	• The proposed interior stormwater drainage systems in Wauwatosa and Milwaukee are designed to function through gravity flow, eliminating the need for more expensive stormwater pumping
• Indirect, unquantified damages along the Menomonee River in Wauwatosa from N. 76th Street to N. 60th Street and in Milwaukee from N. 60th Street to W. Wisconsin Avenue that can be attributed to a combination of temporary high groundwater levels, stormwater drainage problems, and sanitary sewer infiltration and inflow, all influenced by high River stages during floods with recurrence intervals up to, and including, 100 years would be reduced relative to existing conditions, but they would be greater than the damages if the County Grounds Basin were constructed	• Indirect, unquantified damages along the Menomonee River in Wauwatosa from N. 76th Street to N. 60th Street and in Milwaukee from N. 60th Street to W. Wisconsin Avenue that can be attributed to high River stages during floods would be reduced to the highest degree practicable, and they would be expected to be considerably less than if the County Grounds Basin were not constructed.
• Indirect, unquantified damages upstream of Harmonee Avenue would be expected to remain similar to the existing condition situation	• Indirect, unquantified damages upstream of Harmonee Avenue would be expected to be significantly alleviated since relatively large reductions in flood stages would be expected in that upstream reach
• Indirect, unquantified damages in the vicinity of Fisher Parkway would not be mitigated at all under this project condition.	• Indirect, unquantified damages in the vicinity of Fisher Parkway would be mitigated to the greatest degree practicable
• Along one localized section of the Valley Park combination Levee/Floodwall, the freeboard requirement would not be met, potentially making the entire levee/floodwall noncompliant • The freeboard requirement would not be met for the Western Milwaukee levee/floodwall • The River Parkway levee would generally meet the freeboard requirements, except at its upstream end where it would fall about 0.1 foot below the required elevation, potentially making the entire levee/floodwall noncompliant • The Hart Park levee/floodwall would not meet the freeboard requirement over about 35 percent of its length, making the entire levee/floodwall noncompliant • The Harvey Avenue levee would not meet the freeboard requirement over about 30 percent of its length, making the entire levee/floodwall noncompliant	• The Valley Park, Western Milwaukee, River Parkway, Hart Park, and Harvey Avenue levees and/or floodwalls would meet the freeboard requirement

Table 4 (continued)

Proposed Project Condition without the Milwaukee County Grounds Detention Basin	Proposed Complete Project Condition (with the Milwaukee County Grounds Detention Basin)
• The height of the Hart Park levee/floodwall would range from 1.8 to eight feet. Within that range, relative to the complete project condition, the levee/floodwall height would increase by a maximum of 1.5 feet	• The height of the Hart Park levee/floodwall would range from 1.8 to eight feet
• The height of the Harvey Avenue levee/floodwall would range from three to eight feet. Within that range, relative to the complete project condition, the levee/ floodwall height would increase by a maximum of 1.5 feet at the extreme eastern and western ends of the levee/floodwall	• The height of the Harvey Avenue levee/floodwall would range from three to eight feet under either project condition
• The height of the Western Milwaukee levee/floodwall would range from three to ten feet. The height would be about six feet or less along about 60 percent of the length of the levee/floodwall	• The height of the Western Milwaukee levee/floodwall would range from 0.6 to eight feet under proposed MMSD complete project conditions. The height would be about six feet or less along about 75 percent of the length of the levee/floodwall
• The height of the River Parkway levee/floodwall would range from 3.6 to six feet	• The height of the River Parkway levee/floodwall would range from 3.5 to six feet
• The higher floodwall required along the west side of the N. 68th Street bridge over the Menomonee River could present design challenges to enable adequate traffic sight lines near the intersection of N. 68th Street and Honey Creek Parkway	- -
• The 100-year flood stage increase relative to existing conditions would exceed 0.01 foot in a short reach just downstream of N. Hawley Road, affecting five properties, and in a short reach east of N. 45th Street, affecting four properties (including the Canadian Pacific Railway) that MMSD does not propose to purchase. Eight easements for the flood stage increase would have to be obtained from private owners and one from Milwaukee County. • In addition, easements may have to be obtained at up to 85 properties that are in the Cities of Milwaukee and Wauwatosa in the Lower Wauwatosa/Hart Park project area upstream of Hawley Road and that are 1) in the area to be protected by levees or floodwalls, 2) would not be removed from the floodplain for regulatory purposes because of inadequate freeboard for the levees or floodwalls, and 3) are adjacent to those River reaches where 100-year flood stage increases could occur.	• With one minor exception, 100-year recurrence interval flood stages would decrease relative to existing conditions as a result of implementation of the complete project. There would be a localized 100-year flood stage increase of 0.02 foot immediately upstream of N. 70th Street. The increase would only affect land owned by the City of Wauwatosa and Milwaukee County, so obtaining easements for this minor change should not be problematic. Thus, there are no major negative regulatory issues regarding flood stages.

Table 4 (continued)

Proposed Project Condition without the Milwaukee County Grounds Detention Basin	Proposed Complete Project Condition (with the Milwaukee County Grounds Detention Basin)
• Relative to existing conditions 1) the peak flow leaving the River just downstream from IH 94 could be about 29 percent less, 2) the peak flow leaving the River near the 35th Street viaduct could be about 16 percent less, and 3) the total peak rate of overflow from both sources could be about 20 percent less. Relative to proposed complete MMSD project conditions, 1) the peak flow leaving the River just downstream from IH 94 could be about double, 2) the peak flow leaving the River near the 35th Street viaduct could be about 33 percent greater, and 3) the total peak rate of overflow from both sources could be about 45 percent greater	• Relative to existing conditions 1) the peak flow leaving the River just downstream from IH 94 could be about 64 percent less, 2) the peak flow leaving the River near the 35th Street viaduct could be about 37 percent less, and 3) the total peak rate of overflow from both sources could be about 45 percent less. Relative to project conditions without the County Grounds basin, 1) the peak flow leaving the River just downstream from IH 94 could be about 50 percent less; 2) the peak flow leaving the River near the 35th Street viaduct could be about 25 percent less, and 3) the total peak rate of overflow from both sources could be about 45 percent less
• Increases in the peak rates of overflow relative to the project condition with the County Grounds Basin will increase the size and cost of facilities to manage that overflow as it is conveyed across the CMC site, the proposed W. Canal Street extension, and the railway	• Decreases in the peak rates of overflow will decrease the size and cost of facilities to manage that overflow as it is conveyed across the CMC site, the proposed W. Canal Street extension, and the railway
• Along the Falk Corporation levee/floodwall, 100-year flood stages under this condition could be 0.1 to 0.2 foot less than under existing conditions and 0.2 to 0.3 foot higher than under complete project conditions. Those higher stages would necessitate increasing the height of the raised levee/floodwall system based on the complete project condition by the amount of the stage increase	• Along the Falk Corporation levee/floodwall, 100-year flood stages under this condition could be 0.3 to 0.5 foot less than under existing conditions and 0.2 to 0.3 foot lower than under project conditions without the County Grounds basin. Those decreases would result in a lower, slightly less costly raised levee/floodwall system than would be required based on the project condition without the proposed County Grounds basin
• The estimated total cost of the project elements, excluding the County Grounds basin is about $70 million. If stormwater pumping were required, a rough estimate of the additional cost for interior drainage is about $5.0 million	• The estimated cost of the complete MMSD project is about $134 million

difference in elevation between the peak 100-year flood stage and the top of a protective structure, such as a levee or floodwall. Freeboard requirements are intended to provide a margin of safety to enable the levees and/or floodwalls to provide flood protection in situations where flood stages are increased due to debris blockages or other unforeseen conditions.

- The lack of adequate freeboard increases the likelihood of failure of the levees/floodwalls to perform as intended since they would be more susceptible to overtopping resulting from debris blockages or other unforeseen conditions that could elevate flood stages.

FINDINGS RELATED TO QUESTION 1a: Under an assumption that the proposed County Grounds Detention Basin would not be constructed, what would be the effects upon Menomonee River flood control projects already completed by the MMSD?

- The Valley Park combination levee/floodwall will have inadequate freeboard at one localized segment and additional measures may be needed to officially remove the protected buildings from the floodplain and avoid the requirements for flood insurance placed on homeowners by lending institutions. This finding is based upon the assumption that all of the projects, except the County Grounds Detention Basin, are completed. If the other upstream projects are not constructed, a larger portion of the floodwall/levee would have inadequate freeboard to meet regulatory requirements.

FINDINGS RELATED TO QUESTION 1b: Under an assumption that the proposed County Grounds Detention Basin would not be constructed, what would be the effects upon Menomonee River flood control projects that are presently under design by the MMSD and scheduled for implementation in the relatively near future?

- Proposed levees/floodwalls would have inadequate freeboard as detailed in Table 3 of the attached memorandum, and, as noted above, up to 101 buildings would still have a Federal flood insurance requirement and be regulated as floodplain properties for local zoning purposes.

- The floodproofing cost would be higher at four buildings in Wauwatosa.

- More expensive interior stormwater drainage facilities, including possibly pumping systems, would be required for areas protected by floodwalls and levees because of higher flood stages in the Menomonee River.

FINDINGS RELATED TO QUESTION 1c: Under an assumption that the proposed County Grounds Detention Basin would not be constructed, what would be the effects upon any residual areas impacted by overland flooding or related problems downstream of the diversion structure attendant to the County Grounds Basin?

- During a 100-year flood, there will be flood damages estimated at $3.3 million at eight industrial buildings along the Menomonee River in Milwaukee, one industrial building along the Menomonee River in Wauwatosa, and one institutional building and eight single-family houses along Underwood Creek in Wauwatosa.

- Currently occurring indirect, unquantified damages due to temporarily elevated groundwater levels, inadequate stormwater drainage, and sanitary sewer infiltration and inflow would not be reduced in areas near the Underwood Creek floodplain in the vicinity of Fisher Parkway and other areas along the River adjacent to the floodplain.

- The 100-year flood stage would increase relative to existing conditions downstream of N. Hawley Road and downstream of N. 45th Street. In order to ensure compliance with local and State regulations, easements

would have to be obtained at nine properties. In addition, easements may have to be obtained at up to 85 properties that are located in the Cities of Milwaukee and Wauwatosa in the Lower Wauwatosa/Hart Park project area upstream of Hawley Road and that are 1) in the area to be protected by levees or floodwalls, 2) would not be removed from the floodplain for regulatory purposes because of inadequate freeboard for the levees or floodwalls, and 3) are adjacent to those River reaches where 100-year flood stage increases could occur.

- There would be an increased cost for facilities to manage greater overflows from the River that could flow across the CMC site, the proposed W. Canal Street extension, and the Canadian and Pacific Railway tracks, all located east of Miller Park. The cost of those facilities can only be determined through a detailed evaluation accounting for development configurations on the CMC site and possible features of the W. Canal Street extension.

- Although removal of the concrete lining in Underwood Creek is not currently planned by MMSD, it has been studied in the past, and the District may consider it in the future. Construction of the County Grounds Basin could greatly facilitate removal of the lining in the lower 0.8 mile of the Creek because it would significantly reduce peak flood flows, facilitating the construction of a more natural channel without raising flood stages to a level that would threaten existing development. Without the County Grounds Basin, extensive upstream mitigative measures would be required to implement removal of the concrete lining. Such mitigative measures may not be feasible or practical.

Options for Further Consideration

Based on the foregoing findings, it is concluded that the MMSD project components would not function to serve their intended purpose of providing relief from floods and officially removing properties from the 100-year floodplain if the County Grounds Basin is not included in the project. This finding is not surprising, since the MMSD projects were designed to function as an integrated system. Furthermore, the residual flooding and related conditions are not considered to be acceptable, given that the recent effort by the MMSD, which included extensive stakeholder and public involvement, identified a relatively complete solution.

Given the foregoing findings and conclusions, there appear to be three options for moving forward with this matter:

1. <u>Proceed with Full Implementation of MMSD Plan</u>

   Rely on the results of the most recent comprehensive floodland management planning effort program—the MMSD watershed management program—involving stakeholder and public involvement and proceed with completing the currently proposed floodland management program, including the County Grounds Detention Basin. This approach would recognize that the effectiveness of the plan relies upon all of the projects acting as an integrated flood abatement system. Under this option, the County, and perhaps a County-sponsored advisory committee, should be an active partner in the design, construction, and operation and maintenance of the basins and related facilities and open space areas in order to ensure that the County's, and to the extent practical, citizen's objectives for the area involved are achieved. It would appear that with such involvement, the area involved could become a community asset, which would be more useable and beneficial, at least to most citizens, than the site is in its current state.

2. <u>Examine Alternative Storage Solutions</u>

   Under this alternative, there would be an acceptance as reasonable, sound, and committed of all of the Lower Wauwatosa/Hart Park, Western Milwaukee, Valley Park, and Falk Corporation projects. These projects are either completed or under design. As noted above, these projects will not function as intended, or adequately, without a means of reducing the flood flows upstream of the flood damage centers. Thus, there is an identified need to either construct the County Grounds Detention Basin or develop an alternative which has similar impacts on flood flows. Under this approach, the potential alternative means of providing such storage could be reevaluated. In this regard, we would note that such evaluations have been considered

and evaluated on a number of occasions in the past. Based on a review of those previous evaluations, it may be concluded that:

- Alternatives for providing floodwater storage to reduce flood damages in the Menomonee River have been extensively studied as single-feature plans and in combination with other flood mitigation measures;

- Regional, subregional, and local storage alternatives that provide detention storage for areas of existing development and that were developed as essentially complete solutions to the flooding problems in the major damage centers in the Cities of Milwaukee and Wauwatosa would be extremely expensive and would require purchasing more buildings for construction of storage facilities than those facilities would provide with flood protection;

- Of all of the regional and subregional storage locations considered under the MMSD Phase 1 alternatives analysis, the Milwaukee County Grounds site is the only one strategically located near major inputs of runoff and near the Lower Menomonee River flood damage area that would not require acquisition and removal of a substantial number of existing buildings;

- The effects on flood flows of the existing flood storage areas that are recommended to be acquired under the MMSD Conservation Plan have either been explicitly modeled in, or implicitly considered through calibration of, the hydrologic models that were developed for the Phase 1 and Phase 2 MMSD watercourse management plans and that were applied in this evaluation of the County Grounds Basin;

- The flood storage areas identified under the MMSD Conservation Plan are located in headwaters areas where storage enhancement could be beneficial in reducing flood flows and stages along the upper reaches of the Menomonee River, but would not be effective in reducing the flood hazard in the significant damage reaches in Milwaukee and Wauwatosa;

- The provision of the maximum feasible amount of floodwater storage in areas tributary to Underwood Creek upstream of the Milwaukee-Waukesha County line would not reduce flood flows enough to have a significant impact on the size of the proposed Milwaukee County Grounds Basin; and

- The provision of the maximum volume practicable in existing open space in areas tributary to Underwood Creek downstream of the Milwaukee-Waukesha County line (about 400 acre-feet) would require constructing a large retention basin that could only be drained through pumping in the City of Brookfield, overbank lowering along the County's Underwood Creek Parkway, and extensive disturbance of playing fields on the Wauwatosa School District's Underwood School grounds. The County Grounds Basin would still be necessary to the proper functioning of the flood control plan for the reaches of the Menomonee River downstream of Underwood Creek and the overall volume of the Basin would still be more than 400 acre-feet. The capital and operation and maintenance costs of the overall Underwood Creek storage system would be very likely to increase relative to those for the currently-proposed County Grounds Basin because of loss of economy of scale and decentralization of operation and maintenance.

3. Complete Reevaluation

Under this alternative, a complete reevaluation of the floodland management alternatives, including those projects constructed and under design, for the Menomonee River involving stakeholder and public involvement program. This effort would be a major work effort that would halt the ongoing design process and would involve as much as 18 months of time and substantial cost in order to complete the needed technical work and stakeholder and public involvement. Given that the MMSD is the implementing agency, they should be directly involved.

The only logical, additional alternative that was not evaluated in detail through the MMSD watercourse system planning process would be acquiring and removing all buildings in the 100-year floodplain. Other alternatives that might be considered would be reconfigurations or refinements of alternatives that were already evaluated during the MMSD planning process. Acquisition and removal of all floodplain buildings was considered in a qualitative sense during MMSD plan formulation and it was rejected based on strong opposition from the Cities of Milwaukee and Wauwatosa. As many as 179 single- and two-family residential, commercial, industrial, institutional, and recreational buildings would be acquired and removed under such an approach.

Evaluation Of Alternatives for the Provision of Floodwater/Runoff Storage

To assist the County in considering Option 2 for proceeding, the SEWRPC staff evaluated the feasibility of providing alternative storage of floodwater/runoff as a means of reducing the size of the Milwaukee County Grounds Detention Basin, or eliminating the basin. That evaluation considered several existing studies that relate directly to options for providing floodwater/runoff storage within the Menomonee River watershed. Those studies include:

- The 2000 MMSD Phase 1 watercourse system plan (Phase 1 plan),
- The 2001 MMSD Conservation Plan,[29]
- A May 16, 2001 Tetra Tech Memorandum to MMSD staff presenting an "Underwood Creek Floodplain Storage Evaluation" (Tetra Tech memo),
- The 2000 study of alternatives for removing the concrete lining in Underwood Creek prepared for MMSD by SEWRPC[30] (SEWRPC Underwood Creek concrete lining study),
- The 2000 SEWRPC stormwater and floodland management plan for the Dousman Ditch and Underwood Creek subwatersheds (CAPR No. 236) and a subsequent SEWRPC Staff Memorandum that further refined the recommendations of CAPR No. 236 (collectively referred to herein as the SEWRPC Underwood Creek floodland plan),[31] and
- The 1990 stormwater drainage and flood control system plan prepared for MMSD by SEWRPC (CAPR No. 152).

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[29]*Milwaukee Metropolitan Sewerage District,* Conservation Plan *and* Conservation Plan Technical Report, *prepared by the Conservation Fund; Applied Ecological Services, Inc.; Resources Data, Inc.; Heart Lake Conservation Associates; Velasco & Associates; and K. Singh & Associates, October 3*

[30]*SEWRPC Memorandum Report No. 141,* Analysis of Alternative Plans for Removal of the Concrete Lining in Underwood Creek in the City of Wauwatosa, *November 2000.*

[31]*SEWRPC Community Assistance Planning Report No. 236,* A Stormwater and Floodland Management Plan for the Dousman Ditch and Underwood Creek Subwatersheds in the City of Brookfield and the Village of Elm Grove, *February 2000, and SEWRPC Staff Memorandum,* Alternative Refinements to the Recommended Floodland Management plan for Underwood Creek, *February 5, 2001.*

Types of Floodwater/Runoff Storage

Storage can take several forms, including 1) natural or enhanced floodwater storage in riverine areas, 2) detention or retention of runoff from the land surface prior to collection in major streams,[32] and 3) detention or retention of floodwaters diverted from streams. Storage can be provided in:

- The "natural" floodplain,
- Natural depressions which are located outside of riparian areas and which collect and retain runoff from the land surface,
- Constructed detention basins that collect and slowly release runoff and are generally intended to reduce peak rates of runoff from developed areas, and
- Constructed retention basins that collect and hold runoff and are also generally intended to reduce peak rates of runoff from developed areas. (Water stored in these basins may infiltrate into the groundwater system and is often pumped out of the basin following a flood.)

In the context of controlling runoff during large events, such as those considered for flood control projects, the main feature of each of these facilities is their ability to store runoff, which is a function of the basin's volume. For large events, detention storage facilities generally have little effect on the total volume of water that ultimately reaches the stream system. Retention facilities that drain through infiltration and evaporation do reduce runoff volume, but, for the soil types present in the Menomonee River watershed, widespread use if such facilities is impractical for handling runoff from large events. The County Grounds Basin would drain by gravity and pumping, thus, it has characteristics of both a detention and retention facility.

When considering large floods in the Menomonee River watershed, such as those for which flood control projects are designed, the effects of the volume of floodwater/runoff storage predominates over other factors such as infiltration capacity and nature of the vegetation in the storage area. The preservation and restoration of wetlands can serve many valuable purposes related to groundwater recharge, habitat preservation or enhancement, and enhanced storage of runoff during small events. However, in the context of large floods whether an area is a wetland or of another pervious land cover has little effect on peak rates of runoff.

It should be noted that the MMSD Phase 1 and 2 plans and this study prepared for Milwaukee County were developed under the assumption that existing wetland and floodplain storage in the watershed would be maintained in areas upstream of the existing flood damage concentrations in the Cities of Milwaukee and Wauwatosa.

Watershedwide Evaluations of Storage

Background

The Phase 1 plan and CAPR No. 152 and , to a lesser degree, the Conservation Plan, provide watershedwide evaluations of storage. As noted previously, the hydrologic analyses for both the Phase 1 plan and CAPR No. 152 were based on calibrated, continuous simulation models of the entire watershed. Such models enable evaluation of the impacts of various measures, such as the provision of storage, on flood flows throughout the watershed. They also enable direct assessment of the effectiveness of a storage facility at one location on reducing flooding at a downstream location. The identification of potential storage sites under the Conservation Plan was not based on explicit modeling of the interconnected hydrologic processes that occur throughout a watershed, but the process

[32] *Detention of runoff generally refers to storing and gradually releasing runoff during a flood. Retention refers to storing runoff for release after the flood has passed or for storing runoff and relying on infiltration and evaporation to empty the retention basin.*

did provide more weight to sites that were judged to possibly effect flood flows on receiving streams. That determination was made on the basis of whether a particular storage area was tributary to a stream reach that was identified under the Phase 1 plan as having the potential to experience significant increases in peak flood flows due to development between 1995 and 2020. Similar criteria were applied in selecting possible storage sites for the Phase 1 plan and CAPR No. 152; however, once selected those sites were then subjected to analysis in the hydrologic model of the entire watershed. Such analysis was not a part of the Conservation Plan.

There are two very important considerations in evaluating where floodwater/runoff storage will be effective in reducing flood flows and stages in the major Menomonee River damage areas. Those are:

- The effects of providing detention storage diminish with increasing distance downstream from the storage feature and

- The detention of runoff from new development will have very little impact on flood flows and stages in the major damage areas in the Cities of Milwaukee and Wauwatosa downstream of Harmonee Avenue. The hydrologic modeling for the MMSD Phase 1 study demonstrated that under existing channel conditions, the peak 100-year flood flow under 1995 land use conditions would only increase by about 1.4 percent under year 2020 planned land use conditions, even if no detention were provided for runoff from new development.

The storage evaluations for the Phase 1 plan and CAPR No. 152 verified that the effects of providing detention storage diminish with increasing distance downstream from the storage feature. That situation was also recognized in the ranking process adopted under the Conservation Plan, but was not explicitly modeled under that study.

SEWRPC CAPR No. 152
This plan reviewed storage options considered under the 1976 SEWRPC Menomonee River watershed study. The watershed study presented a comprehensive evaluation of various storage options within the watershed that could address the flooding problems along the lower reach of the Menomonee River. An initial inventory conducted under the 1976 watershed study identified 25 potential detention or retention sites throughout the watershed. The potential for each site to produce a significant reduction in downstream flood damages was evaluated by considering the drainage area tributary to each site, the available storage volume at each site, and the proximity of each site to downstream flood-prone areas, among other considerations. After that screening, the number of potential sites was reduced to eleven. The eleven sites were scattered throughout Milwaukee, Ozaukee, Washington , and Waukesha Counties.[33] One of the eleven sites was adjacent to Underwood Creek about 1.35 miles upstream of its mouth and upstream of the proposed County Grounds Basin. The watershed study concluded that 1) the storage reduction in peak 100-year flood flows in the flood damage reach from N. 70th Street downstream to N. Hawley Road would not be sufficient to completely alleviate flooding problems and that 2) the most cost-effective and environmentally sensitive approach was to maintain existing natural storage in the watershed. That conclusion, which was reiterated under CAPR No. 152, is consistent with the approach being taken by MMSD under their Conservation Plan.

MMSD Phase 1 Plan
The Phase 1 plan presented a comprehensive evaluation of various storage options within the watershed that could address the flooding problems along the lower reach of the Menomonee River. The storage locations put forth under CAPR No. 152 were considered under this plan. These Phase 1 plan options include:

[33]*Four of those eleven sites have been filled since the 1976 watershed study.*

- Regional storage strategically located at six sites, including the Milwaukee County Grounds. These sites could provide an estimated 6,220 acre-feet of storage and could essentially eliminate flood damages along the Lower Menomonee River. However, the construction of the basins would require purchasing about 320 buildings (more than are expected to be flooded during a 100-year event), and it was estimated to cost about $421 million.

- Local storage on 100 small sites scattered throughout the watershed. These sites could provide an estimated 13,400 acre-feet of storage and could essentially eliminate flood damages along the Lower Menomonee River. However, the construction of the basins would require purchasing about 5,040 buildings (many more than are expected to be flooded during a 100-year event), and the alternative was estimated to cost about $1.9 billion.

- Subregional storage at nine sites, including the six sites identified for the regional storage alternative.[34] These sites could provide an estimated 7,695 acre-feet of storage and could address the majority of the flood damages along the Lower Menomonee River. However, the construction of the basins would require purchasing about 320 buildings (more than are expected to be flooded during a 100-year event), and the alternative was estimated to cost about $321 million.

- Regional storage at five sites, including the Milwaukee County Grounds, plus storage for runoff from new development that would be planned to occur between 1995 and 2020. These sites could provide an estimated 5,750 acre-feet of storage, about 10 percent of which would serve new development. In order to eliminate damages along the Lower Menomonee River, it was found that the Valley Park levee/floodwall would be needed. The construction of the basins would require purchasing about 320 buildings (more than are expected to be flooded during a 100-year event), and it was estimated to cost about $264 million.

Of all of the regional and subregional storage locations considered under the Phase 1 alternatives analysis, the Milwaukee County Grounds site is the only one strategically located near major inputs of runoff and near the Lower Menomonee River flood damage area that would not require acquisition and removal of a substantial number of existing buildings.

MMSD Conservation Plan

The Conservation Plan identified potential runoff storage sites as those open lands with hydric soils and areas of 25 acres or more. Those sites were then ranked according to size with the largest sites receiving the greatest weight. It was determined that, if water could be stored to a depth of two feet on each site for a 100-year, 24-hour storm, sites with tributary drainage areas that are seven times the storage site area would be the most effective in storing runoff.[35] Sites with smaller area ratios would have excess, unused storage capacity, and sites with larger ratios would not have sufficient capacity. The watershed to site area ratios were estimated and a weight was assigned to each site based on its ratio. A "Storage Effectiveness" value for each site was determined as the product of the Site Area score and the Tributary Area/Site Area Ratio score. Based on the "Storage Effectiveness" value, 27 sites covering about 5,000 acres of land in the Menomonee River watershed were identified as having the greatest potential to store floodwater. Those sites are primarily located in the headwaters in the City of Mequon and the Village of Germantown. There are also sites identified along Lilly Creek and Butler Ditch in the Village of Menomonee Falls and Underwood Creek and Dousman Ditch in the City of Brookfield. Much of the area covered by the sites in the City of Mequon and the Village of Germantown, and all of the area in the City of Brookfield and the Village of Menomonee Falls, is located in existing floodplains. The effect on flood flows of

[34] *The volumes of the six basins also included under the regional storage alternative would be changed under this alternative to optimize their performance in conjunction with the added basins.*

[35] *Assuming residential development in the tributary area.*

the storage in those floodplains is already explicitly accounted for in the analyses made under the MMSD Phase 1 and 2 plans and the current study.

As noted above, the Conservation Plan process did assign more weight to sites that were judged to possibly effect flood flows on receiving streams and the general concept behind that assignment is consistent with the criteria that were applied in selecting possible storage sites for CAPR No. 152 and the Phase 1 plan.

The Conservation Plan also examined the effect of impounding more water on the selected sites than would be stored under current natural conditions. The inventory of existing storage on the sites identified under the Conservation Plan[36] shows that no significant existing depressional storage was quantified on any of the sites under existing conditions. Thus, the generalized analysis of the Conservation Plan looked at constructing berms ranging from two- to six feet-high to impound more water on the sites. No detailed modeling was done to quantify the hydrologic and hydraulic functions of such modifications, considering outflow from the sites, if any, or the variation in water levels in the impoundments between storms. The construction of such facilities in floodplains present practical and regulatory problems, including 1) placement of fill in wetlands when acceptable alternative storage sites (the Milwaukee County Grounds Basin) are available, 2) net losses in floodwater storage volume due to the placement of fill in floodplains, and 3) the long-term impoundment of runoff which could actually displace existing storage volume and increase downstream flows. Furthermore, the locations of the potential storage areas considered in the Conservation Plan are such that if they were to be used for new, created storage there would be a need to provide storage volumes which are far greater than would be needed at the County Grounds site. It is our understanding that MMSD is pursuing acquisition of lands prioritized under the Conservation Plan with the intent of preserving those sites without augmenting storage. That approach is consistent with the recommendations of the Menomonee River watershed study, CAPR No. 152, and the MMSD Phase 1 study and it will provide benefits of 1) preserving existing floodplain storage and 2) preserving or enhancing habitat.

Subwatershed-Specific Evaluations of Storage

Specific evaluations of the provision of flood storage in the Underwood Creek subwatershed, with or without the Milwaukee County Grounds Basin are provided in the MMSD Phase 1 plan, the Tetra Tech memo on Underwood Creek floodplain storage, the SEWRPC Underwood Creek floodland plan, and the SEWRPC Underwood Creek concrete lining study, all of which are referenced at the beginning of this memorandum section.

SEWRPC Underwood Creek Floodland Plan

The SEWRPC Underwood Creek floodland plan presents an exhaustive analysis of storage options in those portions of the watershed tributary to Underwood Creek at the Milwaukee-Waukesha County line. Those analyses indicate that the provision of the maximum feasible amount of floodwater storage in those areas, which would be part of an overall plan that is being implemented to provide significant flood relief in the City of Brookfield and the Village of Elm Grove, could reduce peak 100-year flood flows along Underwood Creek in the City of Wauwatosa by three to five percent. Such decreases would have only a small impact on the size of the proposed Milwaukee County Grounds Basin.

Plans That Address Changes in Floodwater Storage in the Context of Removing the Concrete Lining in Underwood Creek

The MMSD Phase 1 plan, the Tetra Tech memo on Underwood Creek floodplain storage, and the SEWRPC Underwood Creek concrete lining study all address changes in floodwater storage in the context of removing the concrete lining in Underwood Creek. The extensive analyses conducted under the SEWRPC Underwood Creek concrete lining study provides a useful framework to review and evaluate the results of the two other studies, but the scope of the SEWRPC study did not include an evaluation of the impacts that augmenting floodwater storage along Underwood Creek would have on the County Grounds Basin project. Thus, it provides no direct

[36] *See Appendices III, IV, and V of the Conservation Plan Technical Report.*

conclusions in that regard. The other two studies do evaluate the impacts that increasing floodwater storage along Underwood Creek would have on the County Grounds project.

The Phase 1 plan and the Tetra Tech memo on Underwood Creek floodplain storage both approach the addition of floodwater storage along Underwood Creek from the standpoint of removing the concrete lining in the channel. Such an action by itself would increase storage because replacement of the existing, relatively smooth concrete channel lining with a natural, rougher channel would increase flood stages and storage. A negative effect of such an action, in the absence of other mitigating measures, would be a potentially significant increase in the flood hazard along Underwood Creek. However, the concept of increasing floodwater storage could be accomplished through other means if the concrete channel were allowed to remain. Such means would involve excavating storage areas in open lands along Underwood Creek. Much of those lands are part of Milwaukee County's Underwood Creek Parkway.

The Phase 1 plan and the Tetra Tech memo conclude that the addition of 200 acre-feet of floodwater storage along Underwood Creek downstream of the Milwaukee-Waukesha County line could enable the volume of the County Grounds Basin to be reduced by 150 acre-feet, from 800 acre-feet to 650 acre-feet, a reduction of about 19 percent. Thus, the provision of a certain volume of floodwater storage along Underwood Creek would not reduce the proposed County Grounds Basin volume by an equal amount.

As noted above, the results of the SEWRPC Underwood Creek floodland plan lead to the conclusion that the provision of the maximum feasible amount of floodwater storage in areas tributary to Underwood Creek upstream of the Milwaukee-Waukesha County line would not reduce flood flows enough to have a significant impact on the size of the proposed Milwaukee County Grounds Basin. The SEWRPC Underwood Creek concrete lining study provides an estimate of the maximum volume of floodwater storage that could be provided in areas that are tributary to Underwood Creek downstream of the County line. It is estimated that the maximum volume that could be provided in existing open space in the Cities of Brookfield and Wauwatosa[37] would be about 400 acre-feet. The provision of this volume would require constructing a large retention basin that could only be drained through pumping in the City of Brookfield, overbank lowering along the County's Underwood Creek Parkway, and extensive disturbance of playing fields on the Wauwatosa School District's Underwood School grounds.[38] Despite all that, the County Grounds Basin would still be necessary to the proper functioning of the flood control plan for the reaches of the Menomonee River downstream of Underwood Creek, the overall volume of the Basin would still be more than 400 acre-feet, and the capital and operation and maintenance costs of the overall

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[37]*The floodwater storage volume in the City of Brookfield would be provided along the South Branch of Underwood Creek, which is tributary to Underwood Creek downstream of the Milwaukee-Waukesha County line.*

[38]*In the past, various interests have raised the possibility of utilizing, or enhancing, storage along the "old" Underwood Creek channel that generally parallels the current channel. The old channel is located 1) north of the Canadian Pacific Railway, and of the current channel, in the reach of Underwood Creek upstream of W. Watertown Plank Road and 2) in Milwaukee County's George Hansen Golf Course south of the Railway, and of the current channel. Those reaches of the old channel are both located in the 100-year floodplain and they both function as floodwater storage areas under existing conditions. The reach of the old channel upstream of W. Watertown Plank Road is located in a wetland. Excavation of that area to provide some additional storage would have negative environmental impacts and would produce a marginal gain in storage. Increasing the storage in that reach by raising the flood stages, rather than excavating, would adversely impact residences along Diane Drive in the City of Wauwatosa. Those residences currently experience basement water problems due to elevated groundwater levels. Those elevated levels would be worsened if more floodwater were stored along the adjacent old channel. The reach of the old channel in Hansen Golf Course is partially located in a wetland. Excavation of that area to provide some additional storage would also have negative environmental impacts, would significantly alter topography and drainage on the Course, and would produce a marginal gain in storage.*

Underwood Creek storage system would be very likely to increase relative to the those for the currently-proposed County Grounds Basin because of loss of economy of scale and decentralization of operation and maintenance.

Conclusions of Floodwater/Runoff Storage Evaluation

Based on the foregoing, it can be concluded that:

- Alternatives for providing floodwater storage to reduce flood damages in the Menomonee River have been extensively studied as single-feature plans and in combination with other flood mitigation measures,

- Regional, subregional, and local storage alternatives that provide detention storage for areas of existing development and that were developed as essentially complete solutions to the flooding problems in the major damage centers in the Cities of Milwaukee and Wauwatosa would be extremely expensive and would require purchasing more buildings for construction of storage facilities than those facilities would provide with flood protection,

- Of all of the regional and subregional storage locations considered under the Phase 1 alternatives analysis, the Milwaukee County Grounds site is the only one strategically located near major inputs of runoff and near the Lower Menomonee River flood damage area that would not require acquisition of a substantial number of existing buildings.

- The effects on flood flows of the existing flood storage areas that are recommended to be acquired under the MMSD Conservation Plan have either been explicitly modeled in, or implicitly considered through calibration of, the hydrologic models that were developed for the Phase 1 and Phase 2 MMSD watercourse management plans and that were applied in this evaluation of the County Grounds Basin,

- The flood storage areas identified under the Conservation Plan are located in headwaters areas where storage enhancement could be beneficial in reducing flood flows and stages along the upper reaches of the Menomonee River, but would not be effective in reducing the flood hazard in the significant damage reaches in Milwaukee and Wauwatosa,

- The provision of the maximum feasible amount of floodwater storage in areas tributary to Underwood Creek upstream of the Milwaukee-Waukesha County line would not reduce flood flows enough to have a significant impact on the size of the proposed Milwaukee County Grounds Basin, and

- The provision of the maximum volume practicable in existing open space in areas tributary to Underwood Creek downstream of the Milwaukee-Waukesha County line (about 400 acre-feet) would require constructing a large retention basin that could only be drained through pumping in the City of Brookfield, overbank lowering along the County's Underwood Creek Parkway, and extensive disturbance of playing fields on the Wauwatosa School District's Underwood School grounds. The County Grounds Basin would still be necessary to the proper functioning of the flood control plan for the reaches of the Menomonee River downstream of Underwood Creek, the overall volume of the Basin would still be more than 400 acre-feet, the capital and operation and maintenance costs of the overall Underwood Creek storage system would be very likely to increase relative to those for the currently-proposed County Grounds Basin because of loss of economy of scale and decentralization of operation and maintenance.

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