

Appendix B

Literature Review and Bibliography

A. Groundwater Reports

Washington County 2003-2013 Ground Water Plan

Contents: This Plan provides a County-wide framework for the protection and conservation of groundwater resources. Its implementation is the responsibility of the communities, watershed organizations and state agencies. Goals, policies and implementation actions are meant to act as a model for groundwater planning and protection throughout the County.

The Plan is structured to accomplish three objectives:

1. Provide structure, direction and timing to the parties charged with implementing the Groundwater Plan.
2. Concisely outline the physical nature of the groundwater resources and potential impacts.
3. Adequately state the goals, rationale and Implementation Actions to address specific groundwater issues.

Relevance: This document provides a reference for the SWWD to use in developing its Plan update. The SWWD is expected to attempt to set forth goals, policies and implementation strategies which incorporate or dovetail with those in the County Groundwater Plan studies.

Washington County Groundwater Plan, 2005 Work Plan

Contents: Includes a summary of the County's previous year's activities and accomplishments, the implementation tasks to be completed within that year, a detailed schedule of activities, and a detailed budget. It is intended to be a working document that will be updated yearly.

Relevance: The annual Work Plans provide the SWWD with information on potential opportunities for collaboration on implementation activities.

Cottage Grove Area Nitrate Study Report. Barr Engineering. October, 2005.

Contents: This study was conducted for Washington County for the purposes of: (1) determining the general location and types of sources responsible for the

nitrate detected in groundwater and (2) identifying zones of denitrification to determine if there are areas in the Jordan Sandstone in the Cottage Grove vicinity that are more suitable for water supply than others. This study is a more detailed follow-up to a more regional 1999 MPCA study, which found nitrate concentrations in water samples from several wells which exceeded the 10 mg/l drinking water standard (MPCA 2000). A groundwater flow model was calibrated and used to perform particle tracking to identify sources of nitrate in groundwater and delineate recharge areas for portions of the aquifers within the project area. A number of identified north-south trending faults were incorporated into the groundwater model to evaluate their effects, which were found to be significant. A map of favorable areas for high capacity wells is provided, and recommendations were developed for ways to better understand the groundwater nitrate contamination in the area. The study focused on the major geologic units that provide potable groundwater in southern Washington County – the Prairie du Chien Group and the Jordan Sandstone.

Relevance: This report provides a basis for developing an infiltration suitability map and associated design criteria. The results of this study can be used as a reference in identifying critical recharge areas for preservation as well as selecting locations for new water supply wells.

Integrating Groundwater & Surface Water Management - Southern Washington County. Barr Engineering. August, 2005.

Contents: This project was commissioned to develop tools for planners and water-resources managers that will assist them in making decisions to balance land-use needs with the protection of groundwater and surface-water resources. Its primary focus is the protection of the groundwater contribution to surface waters. One management tool developed in this study is a detailed map of typical infiltration rates across southern Washington County. An Excel-based spreadsheet program was also developed that allows managers to readily estimate how much total loss of infiltration will be produced by a development of a given size in a given area. Maps were developed of groundwatersheds (areas of contribution) for key surface-water features that depend on groundwater. Another spreadsheet-based program allows managers to estimate the effect of a pumping well on groundwater levels in nearby wells (or other observation points). This tool should provide some assistance in evaluating the effects of groundwater withdrawals from proposed developments or other land uses.

Relevance: The spreadsheets and maps developed in this project can be used to guide design criteria and performance standards for infiltration. The District can utilize the approach for mapping key surface water features which are dependent on groundwater.

Intercommunity Groundwater Protection: 'Sustaining Growth and Natural Resources in the Woodbury/Afton Area', Report on Development of a Groundwater Flow Model of Southern Washington County, Minnesota. Barr Engineering. June, 2005

Contents: This report summarizes the construction and use of hydrologic models of southern Washington County, Minnesota, developed through a collective effort of local watershed districts, cities, state agencies, and Washington County. The primary purpose of the project was to develop a predictive tool that can be used to evaluate the "sustainability" of groundwater withdrawals in the Woodbury- Afton area of Washington County. The overall product of this project was a calibrated computer MODFLOW groundwater flow model of the major aquifers in southern Washington County to be used to predict the effects of proposed groundwater withdrawals in the City of Woodbury on (1) groundwater levels and pressures; (2) water levels in existing wells; and (3) base flows into Valley Creek. Additional products of this project include: GIS files of model parameters and results; a web site with interim products, meeting minutes, and presentations; model input and output files; and this report.

Relevance: The District may utilize the approach and methods employed in this project to develop triggers or thresholds for water levels in existing wells to manage groundwater consumption.

Comparative Review of Watershed District Rules and Recommendations for Standardization, Washington County Water Consortium. Spring, 2003.

Contents: The Washington County Water Consortium researched the feasibility of developing common countywide standards for use in watershed district rules and regulations. The main objective of the rule review process was to identify those portions of the rules that could be standardized across organizations. This report identifies a number of common issues that could be addressed in a similar manner. Although the Consortium concluded that standardization would be difficult, it has recommendations and suggestions which would make the rules for water management more understandable and predictable, including using a standard rule format and similar language. The report also contains a proposed structure of Watershed District Rules

Relevance: This document would be relevant if and when the District updates its rules based on the Plan Update. This document may serve as a reference if broad changes to the rules are sought.

Washington County Water Consortium, Minnesota, Incorporating Groundwater Protection into Watershed District Rules. EOR. December, 2004

Contents: The Washington County Water Consortium developed model groundwater rules for future adoption by the watershed districts located

within the County, which address a number of the policies identified in the Washington County Groundwater Plan 2005 Work Plan. The WD/WMO's are encouraged to adopt those standards which are applicable to their specific management goals.

Relevance: This document would be relevant if and when the District updates its rules based on the Plan Update. This document may serve as a reference if broad changes to the groundwater rules are sought.

B. Hydrologic/Hydraulic Reports

SWWD Central Draw Overflow Project; Minor Plan Amendment Report. HDR. Jan., 2001.

Contents: This Minor Plan Amendment Report summarizes engineering and technical activities related to the Central Draw Overflow Project. The project objective is to develop stormwater conveyance routing to the Mississippi River. The report provides a basis for the SWWD Board to amend the 1997 Plan in order to conduct additional planning studies and implement projects related to the Central Draw Overflow Project.

Hydrologic and hydraulic modeling was used to assess existing and future conditions of the watershed's stormwater system. The report recommends that the amendment allow for the following four projects:

1. Upper Watershed Flooding
2. Bailey Lake Outlet
3. Central Draw Overflow
4. Risk Reduction and Emergency Response Plan

Relevance: This study sets the District's framework for stormwater conveyance and storage under fully developed conditions within the Central Draw.

Engineer's Report - Central Draw Project and Flood Storage Area Maps – Final. HDR. June, 2002

Contents: The purpose of this report was to present a project to correct existing flooding conditions and identify associated flood storage areas in the communities upstream of Bailey Lake. Hydrologic and hydraulic modeling was used to assess existing conditions of the stormwater system. The proposed Project provides a principle outlet capable of managing the excess runoff associated with a 100-year 24-hour event under existing conditions. The design is intended to provide principal and emergency outlet capacity for this landlocked area up through completion of Woodbury's Phase I AUAR development area. The report also noted that Woodbury intended to apply for a permit to alter the rate, volume and location of stormwater discharge from the Bailey Lake Pump Station. The permit, at the time of the study, limited flow rate to 75 cfs and water can not discharge beyond CD-P86 North lobe. The Project is designed to accommodate flows up to 150 cfs and discharge stormwater to CD-

P86 South Lobe and Gables Lake. HDR prepared preliminary design drawings depicting a 150 cfs design in Appendix A of the report.

Relevance: The information generated from this report will be used for project implementation. Future development activities in the project study area will need to conform with the content of this report.

Flood Damage Reduction Report Wilmes Lake Subdistrict. HDR. October, 2003

Contents: The purpose of this study of the Wilmes Lake Subwatershed was to quantify the flood risk and identify potential solutions to minimize flood damage potential.

The report includes a GIS based hydrologic/hydraulic model of the Wilmes Lake Subwatershed, identification of subwatersheds that have a significant impact on Wilmes Lake, and identification of locations where flooding poses a hazard to homes and property. The baseline modeling demonstrated that the greatest potential adverse impact on Wilmes Lake is due to the constructed detention basins located throughout the subwatershed releasing runoff volume to Wilmes Lake within the same timeframe. Four structures/locations were identified, modeled, and evaluated as conceptual flood hazard mitigation solutions to modify the timing of the runoff volume to Wilmes Lake and reduce flood conditions. Evaluation of the proposed modifications to the structures include evaluation of gate operations, environmental change analysis, hydrograph development, cost estimate, and updated DSS Database. In addition to immediately implementing development ponding, a second priority is adding gated structures at Armstrong Lake, Margravs Lake and the Evergreen Wetland. The third priority is to modify the structure at Hudson Road.

Relevance: This report provides proposed projects which would address Wilmes Lake levels. The projects should be considered when developing Section 2 of the SWWD Plan Update, Implementation & Work Plans.

DRAFT Flood Mitigation Plan and Emergency Response Evaluation. South Washington Watershed District. HDR. January, 2004.

Contents: This Draft Plan was intended to serve as the foundation for flood mitigation activities and actions within the SWWD. A model was constructed to evaluate flooding and flood damages for the areas surrounding Bailey, Wilmes, and Powers Lake and for the City of Cottage Grove. Maps are provided showing the delineated at-risk flood areas based on the nearest 2-foot contour to the predicted water surface elevation, as well as the estimated flood damage for various flood depths above estimated walkout elevations. The document discusses watershed plan solutions, including:

- Inventory, Acquisition, and Relocation of Repetitive Loss Structures;
- Flood proofing and retrofitting of structures; and
- Additional Drainage Infrastructure (Flood Damage Mitigation Program to

utilize storage, infiltration and routing to provide an overflow to the Mississippi River in extreme flooding events).

This Draft Plan describes the components and steps to prepare an Emergency Preparedness Plan, which the report notes will be required by the SWWD as a future action item. The document also provides an Emergency Action Plan for the cities of Woodbury and Cottage Grove (which the SWWD is to help facilitate) in the form of Public Service Announcements which explain what to do in conditions of a flood Watch, flood Warning, and after the event.

Relevance: The estimated flood depths resulting from the modeling may be useful to the District in developing its Emergency Preparedness Plan, as well as plan for and/or implement flood hazard mitigation projects.

Cottage Grove East Ravine Alternative Urban Areawide Review (AUAR) and Mitigation Plan - Draft for Public Comment. Hoisington Koegler Group. etc. July 18, 2005.

Contents: The City of Cottage Grove East Ravine AUAR identifies the 4000-acre eastern portion of the community as a future phase for development. Two scenarios were evaluated: a base scenario using the current comprehensive plan (generally a low density residential land use pattern with limited commercial areas along T.H. 10/ T.H. 61); and the East Ravine Pre-design Master Plan (large areas of single family residences interspersed with medium and higher density residences and two commercial areas). The focus of this AUAR's evaluation is on the second scenario. It is the City's intent to update the Comprehensive Plan as part of the East Ravine Pre-Design Project.

The development of the AUAR project area could have impacts on the environment and existing development. The Mitigation Plan identifies existing tools and policies that the City has in place, as well as additional methods to mitigate potential impacts. Infiltration and ponding will be incorporated to protect downstream resources. However, the Plan seemingly makes contradictory statements regarding the suitability of infiltration in the area.

Relevance: This AUAR and associated future development must coordinate with plans for the Central Draw Overflow. Contradictory statements regarding infiltration suitability support the need for design criteria. This AUAR and future urbanization will cooperate with development and implementation of TMDL strategies for the East Ravine.

Stormwater Modeling Report, West Draw Subwatershed, Draft – HDR. July, 2005.

Contents: The SWWD initiated this study to quantify the flood risk and identify potential solutions to minimize flood damage potential. The West Draw Subwatershed is undergoing active suburban development. The purpose of the study is to establish the existing drainage patterns and evaluate the inter-community flow values based upon the as-built condition and

currently planned projects. Of particular importance to the communities is inter-community flow between Woodbury and Cottage Grove, required storage volumes to achieve the desired flow, and the downstream drainage concerns at Hamlet Park Pond and Highway 61.

Relevance: This report provides information which can be used by the SWWD to assist in establishing requirements for District-wide inter-community flows.

South Washington Watershed District XP-SWMM Model Verification Study, HDR. October, 2005.

Contents: Rainfall and flow data collected from 2000 to 2004 by the South Washington Watershed District (SWWD) and Washington County Conservation District (WCD) were used to test whether the XP-SWMM models (data, assumptions and modeling approach) are reasonable. The report lists the peak flow, seasonal rainfall totals and maximum rainfall intensities observed at the SWWD monitoring sites. The measured rainfall intensities during the data collection years are much less than the intensities given by the design storms using Type II Distributions of 5.9 or 6.3 inches, respectively.

Measured stage versus discharge rating curves at the MS1, MS2 and Tamarack Road monitoring sites were compared to simulated rating curves generated with the XP-SWMM model. The rating curves generally diverge at high flows, with the SWMM model predicting higher discharge than the measured rating curves for a given stage. In addition, the curves only extend to flows and stages well below the peak flows and stages that were observed.

The model predictions (volume, peak flow and stage) at selected sites are mixed in comparison to the observed runoff--some modeled events match quite well and others are quite different. The model generally over predicts the outflow at the comparison sites and tends to under predict runoff volumes in the most developed watersheds.

Relevance: This report asserts a basis for accepting the XP-SWMM model as appropriate for District modeling and planning, and establishing critical flows. The report conclusion of model adequacy for flood routing and planning needs to be carefully considered since none of the modeled historic rainfall events were rare occurrences.

C. Infiltration Reports

South Washington Watershed District Infiltration Management Study Phase II Report. Emmons & Olivier Resources. Nov. 2001.

Contents: This document includes the data collection, monitoring, analysis, and modeling for the purpose of evaluating the importance of infiltration as a stormwater management tool. The data used in this report is from 8 monitoring wells at 5 basins that the SWWD installed in 1998. The City of Woodbury also samples 3 wells in the vicinity of CD-P85 for water quality

and groundwater level. This report examines the effects of stormwater infiltration on groundwater quality, level, and environmental resources.

Relevance: This report discusses the benefits and impacts of stormwater infiltration on groundwater quality and level. This report is useful for reference in developing design criteria for the District.

Infiltration Monitoring Reports, by Emmons & Olivier Resources (EOR):

2000 Infiltration Monitoring Report. EOR. Nov. 2001

2001 Infiltration Monitoring Report. EOR. Nov. 2001

2002 Infiltration Monitoring Report. EOR. March 2003

2003 Infiltration Monitoring Report. EOR. Feb. 2004

2004 Infiltration Monitoring Program Final Report. EOR. Feb. 2005

Contents: The SWWD has been monitoring infiltration as part of the Infiltration Management Study initiated in 1997. These documents contain the methodology and results as well as a summary of infiltration rates and analysis, conclusions and recommendations for the infiltration of groundwater.

Relevance: These documents provide summaries of data for guidance of the infiltration of groundwater. The reports are useful for reference in developing design criteria for the District such as Curve Numbers.

Guidance on Specific Infiltration Techniques. Emmons & Olivier Resources. April 2002.

Contents: This guidance document supplies the SWWD with a number of tools the District can use for the implementation of its volume control standards. It includes six fact sheets containing the definitions of volume control techniques, general design, construction and maintenance criteria diagrams and examples.

Relevance: These documents provide tools for the District to guide future infiltration projects and development of design criteria.

Powers Lake Water Quality Analysis. Bonestroo, Rosene, Anderlik and Associates. January 2003.

Contents: This technical memorandum to the City of Woodbury summarizes analyses of runoff volumes within the Powers Lake drainage area. Three previous technical memoranda by Bonestroo regarding infiltration approaches to mitigate watershed impacts to Powers Lake were summarized in this document. This series of analyses compared different

infiltration scenarios benefiting Powers Lake. In-lake modeling was performed to assess the relative water quality improvement based on infiltration and watershed management scenarios.

Relevance: The document supports the need for the SWWD to define and adopt infiltration design standards, particularly for infiltration rates. The document asserts that a 0.42-inch target infiltration depth is optimal for balancing cost and effectiveness.

D. Monitoring Reports

Watershed Monitoring Reports, by Washington Conservation District (WCD):

2000 South Washington Watershed District Monitoring. WCD. May 2001.

2001 South Washington Watershed District Monitoring. WCD. Feb. 2002.

2002 South Washington Watershed District Monitoring. WCD. March 2003.

2003 South Washington Watershed District Monitoring. WCD. April 2004.

2004 South Washington Watershed District Monitoring. WCD. Feb. 2005.

Contents: These documents contain a summary of methods and results for various surface water monitoring efforts by the Washington Conservation District (WCD). Generally, data is presented with respect to 8 lake levels, groundwater levels at 7 stations; stream flow discharge rate, volume and quality, runoff discharge rate and volume, precipitation; and, lake water quality for Armstrong and Powers Lakes. Discussion and interpretation of the results was outside the scope of the documents.

Relevance: These documents provide data for future analysis (at the discretion of the SWWD).

2003-2004 Frost/Snow Monitoring Report. Washington Conservation District. Aug. 2003.

Contents: At the request of the South Washington Watershed District (SWWD), the Washington Conservation District (WCD) conducted frost/snow monitoring at fifteen existing frost monitoring sites (Cottage Grove Ravine Park, Bailey Lift Station, CDP-85 locations, CDP-86 locations, and two new frost/snow monitoring sites at the center of CDP-85 (north and south halves). This report summarizes the methods and results for monitoring conducted from November 24, 2004 to March 26, 2004.

Relevance: This report provides data for future analysis (at the discretion of the SWWD).

E. Natural Resource Management Reports

Powers Lake Management Plan, Washington County, Minnesota.
Bonestroo, Rosene, Anderlik and Associates. March 2000.

Contents: This lake management plan involved a broad characterization of the existing conditions of the Powers Lake. The plan presented information on the wetlands surrounding the lake, the lake shoreline, and in-lake features such as fish, zooplankton, macrophytes, sediments, and stratification dynamics. The plan focused on illustrating the water quality of Powers Lake, and discussed impacts from future development. Ultimate conditions for the lake include a significantly increased drainage area and urbanized land use.

Watershed modeling coupled with an in-lake response model were tools used in the plan to assess water quality impacts and effectiveness of mitigation techniques. A major outcome was the recognition that NURP ponds would not maintain water quality at its present level and the need to consider infiltration techniques (especially in subwatershed CD-50.2b) to reduce watershed loading. A recommended list of projects was developed which included construction site management actions, lake projects, and public information.

Relevance: This document provides general guidance for managing future development within the ultimate drainage area for Powers Lake. The plan quantitatively estimated water quality impacts to Powers Lake based on general development patterns and assumed mitigation techniques.

Comprehensive Lake Management Plan for Ravine Lake, Washington County, Minnesota. Steve McComas, Blue Water Science. January 2003.

Contents: This lake management plan was prepared based on the results from a comprehensive study conducted from 2000 - 2002. The study found that while the lake is nutrient-enriched, there are healthy vegetative communities (both aquatic and shoreline) which show minimal signs of disturbance. High groundwater inputs were noted at the north end of the lake. Fisheries are also noteworthy with walleye populations surviving. Watershed and lake response modeling indicated that it will be difficult to attain low in-lake nutrient levels even under minimally impacted reference conditions. The findings suggest the lake is desirable for wildlife, habitat, and passive recreation

Seven management options were recommended by the study. Lake Management Recommendations - 1. Erosion control in several stretches of steep gradient stream channels. 2. Implement stormwater management programs of the Cities within the watershed. 3. Leave the standing trees in the lake in place. They serve as wildlife habitat. 4. Continue to work with the MnDNR on fishing improvements. 5. Establish shoreline openings to get to the lake. 6. Designate a non-motorized lake or a trolling motor only lake. 7. The lake strongly stratifies in summer and there is no oxygen in water deeper than 6-ft. Nutrient release from lake sediments probably occurs. One option is to set-up an aeration system for summer and winter

aeration. A second option is a lake sediment alum treatment. The third option is no aeration and no alum.

Relevance: Ultimately, the SWWD north, central and east watershed sub-districts may outlet through this lake. The modeling provides information to the District regarding potential impacts or improvements to the lake under different watershed scenarios. However, no TMDL considerations were made for the East Ravine because the impairment was not identified by the MPCA.

SWWD CD-P86 Natural Resources Management Plan. Emmons & Olivier Resources. July 19, 2002.

Contents: The goal of this Natural Resources Management Plan is to develop an ecologically-based management approach that improves, protects and maintains the ecological functions of CDP-86. This natural depression is a link in the Greenway Corridor. The CDP-86 area provides the critical connection between the City of Woodbury's trunk stormwater system and a natural drainageway through Cottage Grove that discharges into the Mississippi River. The plan establishes a framework for future restoration efforts on portions of the site including areas both inside and outside of the conservation easement.

Relevance: The SWWD will adhere to the recommendations set forth in this Management Plan in its efforts to implement the second phase of the Central Draw Project.

Comprehensive Wetland Management Plan (Draft). Emmons & Olivier Resources, 2002.

Contents: The draft comprehensive wetland management plan provides an inventory, functional assessment, and management classifications for all know wetlands within the watershed. There are also specific management standards such as stormwater susceptibility and stormwater protection standards for protecting these wetlands. The wetlands are classified according to the functions they provide. This wetland management plan assists the administration of the Wetland Conservation Act and designates wetland restoration/enhancements opportunities. It also outlines policies and regulations regarding wetland water quality, quantity, buffer zones, stewardship, enhancement, control of invasive species.

Relevance: This wetland management plan assists the administration of the Wetland Conservation Act.

City of Cottage Grove – Final Report Natural Resources Inventory. Bonestroo, Rosene, Anderlik and Associates, 1998.

Contents: This report prepared for the City of Cottage Grove identifies the significant natural features within the city. These features include natural communities, scenic areas, cultural resources and sensitive resources. Specifically they include prairie and savanna communities, forest

communities, wetland communities and other unique natural communities. There are general and focused recommendations for how to protect and preserve these resources. Twenty-nine sites were mapped with infrared aerial photographs and were field surveyed. All existing information on natural resources pertaining to the site was reviewed and the site was classified using the same method used by the DNR.

Relevance: The information in this report can be used by the City of Cottage Grove and the District to guide the management and preservation of key natural resources while providing for the future needs of its residents.

City of Woodbury – Report Natural Resources Inventory. Bonestroo, Rosene, Anderlik and Associates, 1997.

Contents: This final report contains a detailed description and priority ranking of natural features. There is a listing of priority sites for potential locations to preserve for open space. This report assigns a management class to thirty sites within the City of Woodbury. Those sites are broken down into ecological communities. A discussion of concerns and potential protection options for each site including invasive species, nutrient loading or development is included.

Relevance: The information in this report can be used by the City of Woodbury and the District to guide the management and preservation of key natural resources while providing for the future needs of its residents.

South Washington Watershed District Greenway Corridor Plan. Emmons & Olivier Resources, 2000.

Contents: A greenway corridor encompassing the major drainage route from the watershed runs from the Mississippi River north to Lake Elmo Regional Park linking important natural areas while providing stormwater conveyance to the Mississippi River. This Plan describes recreational opportunities, rare species habitats, groundwater recharge areas, water quality protection, and environmental education opportunities. This Plan highlights the restoration opportunities for historic prairie and oak savanna. It gives details about the missing links that have been identified in the corridor as well as the three protection areas of ecological significance that are currently in danger of loss or further degradation. There are opportunities to work with private/industrial landowners to define common goals.

Relevance: This Plan identifies and prioritizes key parcels and segments within the corridor and prescribes implementation steps for use by local units of government and the development community in collaborations with the SWWD.