SH00

Alternative Stormwater Management Analysis

Village of Shorewood Hills, Wisconsin

Submitted by
Steven I. Apfelbaum
Dr. Doug Eppich

June 2001

Applied
Ecological
Services, Inc.

An Analysis of the Potential to Integrate Stormwater Management throughout the Willow Creek Watershed in Shorewood Hills and Madison

By

Steven I. Apfelbaum, Ecologist
Dr. Doug Eppich, P.E.
Applied Ecological Services, Inc.
17921 Smith Rd.
Brodhead, WI 53520

INTRODUCTION

Flooding problems are commonplace in many municipalities in Wisconsin, and in other Midwestern states. Communities are often faced with trying to alleviate localized flooding problems. In many communities, problems develop over an extended time as watersheds are developed. These problems are noticed either during an infrequent heavy rain event or the problems are more frequently observed as development proceeds. Often a watershed is quite far along in its development before a storm event occurs to cause a flooding problem. The Willow Creek watershed is an urbanized area which had few stormwater improvements (other than conveyance systems with limited capacity) constructed during the period that the watershed area was developed. Now, this watershed has been fully developed for many years.

The upper watershed is characterized by moderate to steep sloping hills on glacial moraine and bedrock ridges. Another ridge borders Lake Mendota, and the south side of this ridge is tributary to the flood-prone area. Flooding problems are found between these two ridges in a valley where waters meet from the elevated uplands and ridge to the south, and the ridge along Lake Mendota's south shore. The construction of impervious surfaces (e.g., buildings, parking lots, roads, etc.) within the watershed has increased the total volume of water running off the land, and has accelerated the rate at which water runs off the land. Historically, prior to settlement and development of the area, much of the water worked its way slowly through dense native vegetation in the watershed, and much infiltrated through undisturbed soils into the groundwater reserves. Now, this runoff is diverted to a piped conveyance system that prevents the historic tendency for water to move slowly. Instead, the piped system causes accelerated surface flows that have contributed to documented flooding and water quality problems in the watershed. Now when a rainfall or snowmelt event occurs, a very large percentage of the precipitation is conveyed within an hour or so to the valley. Especially during heavier runoff events, this creates flooding of homes, several businesses and roadways.

It is useful to understand that historically, prior to development of this watershed, water may have taken weeks to work its way through the watershed to this valley. Also, because of the presence of historic vegetation rather than the impervious landscapes of today, much of the water did not run off the land; it infiltrated and evaporated. It is likely that the historic wetlands in the valley and Willow Creek were supported by a more regular base flow of groundwater seepage. Now, less infiltration occurs and may not occur at all. Certainly infiltration is prevented in locations with impervious features such as parking lots, homes, and commercial buildings. Because water rushes from the land so quickly during the storm event, little or no opportunity exists for evaporative water loss to occur. The upshot is that Lake Mendota used to receive less water, and certainly it received less surface water flows. Water that did reach the lake was cooler and cleaner, and the discharge of stormwater into the lake was supported by a more consistent base flow rather than the irregular pulses of surface waters that now enter Lake Mendota from the watershed.

In this analysis, AES has not attempted an evaluation of alternatives to reduce or undo development or impervious lands in the watershed. Neither have we attempted to turn back the hands of time to recreate or restore the historic conditions of yesteryear. Instead, we sought to recognize the causes for the changes in hydrology and flooding in the watershed, within the context of how this watershed functioned historically. On the basis of this understanding, we then focused on using ecological planning principles and traditional and alternative stormwater management engineering approaches to rethink how stormwater management might be successfully implemented in this watershed. The basic ecological and stormwater management planning principles used in this process included the following:

ECOLOGICAL STORMWATER MANAGEMENT PRINCIPLES

1. **Manage stormwater as close to where it hits the ground as possible.**
2. **Manage stormwater throughout the watershed.**
3. **Give stormwater an opportunity to infiltrate and evaporate.**
4. **Manage the total volume, rate, and quality of stormwater in stormwater management projects.**
5. **Integrate stormwater management projects with open-space systems, parks and parking lots, and design them so they can become part of the community aesthetic – creating a sense of place – and to offer public educational opportunities.**
6. **Provide stormwater management solutions that work at all scales, from large regional and watershed scale approaches to small backyard projects, so that everyone in the watershed can participate in ecologically sensitive stormwater management solutions..**
7. **Use low-maintenance and low-cost designs for stormwater management including native landscaping and reduced engineering infrastructure (pipes, curbs, gutters, etc.) to reduce initial costs for stormwater management projects and to alleviate the long-term public and private financial burden of these projects.**
8. **Retrofit stormwater management projects in problem tributary areas to reduce the stormwater contribution from such areas.**

In watersheds where these principles have been used to rethink existing or proposed conventional stormwater management plans, the process has often resulted in substantial improvements to flooding problems and water quality problems in receiving waters such as Lake Mendota. They have also saved considerable money. Using these principles for stormwater management disperses water management throughout the watershed, rather than relying on only a few locations (e.g., large detention ponds) to provide this function. Also, slowing the rate at which water moves through the watershed, allows time for infiltration and for evaporative water losses to occur, thus reducing the total volume of surface water leaving the land.

In this project, AES has used these planning principles with stormwater management options including alternative stormwater management, native landscaping and open space systems to develop alternatives to manage the Willow Creek stormwater runoff. We have started with the premise that it is important to alleviate flooding and also to avoid negative impacts to water quality in important places within the community, such as parks, roads, and other features and resources, including Lake Mendota. We understand the imperative need to address serious flooding problems in the Garden Homes subdivision, in order to alleviate the safety and property threats and damages occurring. Although this review of alternatives will result in solutions of direct and indirect benefit to Garden Homes, we have not intended to directly address solutions for the short-term flood damage reduction needs of this community in this report. It is our understanding that floodproofing studies and projects are currently underway to address these locations.

We have reviewed the Task Force minutes and understand the following to be the draft Mission Statement of the Task Force:

Through community collaboration, take a comprehensive approach to:

1. **Eliminate the negative impacts of flooding in the Hilldale/University Avenue area.**
2. **Improve water quality characteristics of stormwater.**
3. **Minimize adverse impacts of stormwater quality and quantity on Lake Mendota.**
4. **Create cost effective solutions.**

It would be our goal to carefully adhere to and honor this Mission Statement in this project.

AES has routinely designed alternative stormwater management engineering strategies involving the use of infiltration, evaporative and evapo-transpiration, infiltration, storage and strategic releases to manage the rate and volume of stormwater generated and released from a watershed. We have done this by creating native landscapes that generate far less stormwater runoff than impervious lands or even turfgrass lawns.. We have also used open space in parks, yards, road right of ways, boulevard medians, and numerous other locations to create dispersed water storage areas throughout a watershed. Often these areas are integrated with native landscaping. Based on our reconnaissance review of the tributary project area, the following solution categories seem practical:

Solutions/Opportunities For Alternative Stormwater Management

1. **Sunken road median islands.**
2. **Retrofitting parking lots with sunken islands. (Hilldale, Pyare Square, etc.)**
3. **On-parking lot and below-lot storage (same lots).**
4. **Park-use for storage/water cleansing.**
5. **Rain gardens and native landscaping.**
6. **Stabilize eroded lake shore/existing channel with soil bioengineering.**
7. **Develop infiltration systems on south slope of golf course, along rail line (beneath trail), within parking lot areas, etc.**
8. **Provide incentives for citizen/property owner involvement.**

This study was focused on addressing the following questions at a conceptual level:

1. Can the identified flooding problems be solved using ecological stormwater planning principles and are there opportunities for integration of dispersed stormwater detention/treatment elements within the watershed?
2. How can water quality in Willow Creek and Lake Mendota benefit from use of the dispersed stormwater management improvements?
3. What are key elements and their estimated costs in such a stormwater management plan?
4. What degree of flood protection is desired for each of the presently flooded locations?

Conceptual drawing for Segoe Park ballfield which could be used for detention/infiltration.

METHODS

Design Of Alternative Stormwater Management Systems

The methods and process we have used in the development of this planning process are outlined and described here as a series of nine tasks. Prior to beginning this process, we reviewed previous studies and reports on geology and soils, as well as previous designs for flood damage reduction. Attachment 1 includes a summary of the conclusions and our review comments on the recently prepared "Environmental Report -- Stormwater Relief Culvert" for the Village of Shorewood Hills. In Attachment 2, we identified recommendations for additional work required to further develop and refine the concepts presented in this report.

Task 1. Preparation of basemaps

Task 1 included the preparation of base map data for the project's study area. The Dane County Land Conservation Department, Strand Associates, Inc. and the City of Madison provided available mapped information for the watershed including aerial photographs, topographic data, land-use mapping, hydrologic and hydraulic modeling results, water quality modeling results and other information. We have used this information to develop base maps for use on this project.

Task 2. Reconnaissance definition of appropriate alternatives for stormwater management -- Watershed Inventory

On May 17 and 19, we conducted watershed site visits and met with the Dane County Land Conservation Department to review existing soils mapping. During the site visits, several areas were observed with potential to provided dispersed stormwater detention and treatment within the watershed.

Task 3. Identification of potential applicable locations for stormwater management

After the site visits, locations with potential for alternative stormwater management opportunities within the watershed were delineated as part of task 3. A map product was made in ArcView format with the locations highlighted where water storage, infiltration, and other types of stormwater management strategies could potentially be retrofitted. A listing of the potential sites and their acreages was also produced as part of this task.

Task 4. Create conceptual designs for alternative stormwater management areas

For each of the delineated areas, a conceptual stormwater management design was generated in task 4. These concept plans are intended to communicate the types of dispersed stormwater management improvements being proposed. They are also to be used to define the extent of stormwater management area required and the management volume available in each of the concept locations.

Task 5. Test stormwater management strategy benefits

A comprehensive watershed map with tributary sub-areas was developed as part of previous work done for the Village. This work included characterizing the land uses of the sub-areas and developing a stormwater model using HEC-1. The watershed model was later re-run as part of ongoing work for the Village using XP-SWMM.

For the analysis done as part of this study, the hydrologic model PondPack v7.0 was used. This model uses the same watershed input parameters previously determined for the HEC-1 analysis (area, CN, and Tc) which allowed reuse of previously compiled watershed input data. PondPack incorporates a more detailed detention modeling package than most other hydrologic models. This detention modeling is required to evaluate the many detention basin options possible in the watershed.

The initial analysis consisted of modeling a 50-year recurrence interval design rainfall event (MCC Research Report 92-03 Bulletin 71 -- 24-hour duration storm, 6.06 inches of precipitation, Huff 3rd quartile, point rainfall distribution) using the conceptual stormwater management alternatives to retard stormwater runoff. The modeled runoff results were compared with the previously determined capacity of the box culvert along University Avenue between Midvale Blvd. and the Willow Creek outlet to determine if flows in the culvert could be sufficiently decreased with watershed detention to be within the culvert capacity for the 50-year design storm. (It was assumed in this study that flood proofing already planned for the Garden Grove subdivision would provide 100-year flood protection for the subdivision, that the Kohl's store was not subject to flooding and that 50-year flood protection would be adequate for University Avenue and the commercial area parking north of the University-Midvale intersection.)

Due to time and budget constraints, the Muskingum reach routing method was used in the model (K was assumed to be 0.2 hours for each reach and X was assumed to be 0.25). This reach routing will be refined in future phases.

Also potential detention areas were coded using estimated site areas available for detention and maximum water bounce depths of 3-feet in park and public areas and 1-foot in parking lot detention areas. Release rates from the detention basins were varied to maintain the detained storage within the area and bounce limitations for each area.

The modeling results should be used as a test of the conceptual alternatives; the modeling was not done in sufficient detail to be used for design purposes but could be refined for later use in design.

Task 6. Refinement of conceptual designs to improve efficiency and stormwater management benefits

Refinement of conceptual designs was done concurrently with the stormwater modeling task. Several model runs were conducted to refine the conceptual designs for efficiency and produced benefits.

Task 7. Development of stormwater management alternatives cost estimates

Opinions of probable costs for the conceptual alternatives will be made based on 2001 construction pricing. However, the lack of detailed site data for the concept locations means that the cost opinions should be considered only in the conceptual context. These cost opinions should be refined using better estimates of quantities required for the site improvements, and using a more refined design to estimate these quantities, prior to making detailed comparisons of the stormwater management concepts proposed as part of this study.

Task 8. Task Force site visit

As part of this project, we will engage the Task Force in a field visit to solicit feedback and to acquaint the Task Force with the site conditions. This field visit will result in an understanding of the site conditions and adjacency issues for the sites identified as potential locations for stormwater management. Notes from that meeting will be integrated into this report.

Task 9. Meeting with key stakeholders to present the stormwater management program

As a part of this conceptual design project, following submission of this draft report, AES is to develop and present an overview of the project outcomes to the Task Force, and other stakeholders. The presentation will describe the potential benefits to the stormwater management program from using alternative stormwater management strategies in specific locations in the watershed.

As part of this process, we will identify opportunities for developing demonstration projects to engage landowners in alternative stormwater management. We will also identify opportunities for procurement of funding for implementation of the stormwater management program, including final design and engineering, and including educational programs to inform the public on the activities and benefits of the program.

RESULTS

Management Strategies

Our review of the watershed and specific sites where stormwater management potentially could be accomplished suggests that many areas offer opportunities for storing stormwater and optimizing the timing of the stormwater release from the watershed using the following general management strategies:

- Rennebohm Park and the Hamilton School fields have relatively large tributary areas and the potential to provide major volumes of stormwater detention. Use of these two facilities for stormwater management is critical to the dispersed stormwater management option.
- Disperse the stormwater management opportunities throughout the watershed.
- Water quality treatment can be incorporated with water quantity management within the watershed study area to reduce contaminant and sediment entry into Willow Creek and Lake Mendota
- Restore savanna and forest areas and increase ground-story native vegetation (from the existing bare ground conditions) to reduce surface water runoff and sedimentation, and to foster the infiltration of stormwater in degraded ecological areas such as Hoyt Park.
- Involve educational facilities and school children in demonstration projects especially for water quality management in the watershed, and to focus attention on dispersed stormwater management.
- Integrate stormwater management improvements in many public open spaces including parks, boulevard medians, and other locations. Design these as attractive public assets, without compromising the current use of the land or the safety of citizens, while reducing site maintenance costs.
- Use the larger areas for stormwater *quantity* management and water quality enhancement and use smaller areas, especially linear median boulevards, for stormwater *quality* enhancement, since quantity management is needed for larger, less frequent rain events and quality management focuses on smaller, more frequent events.
- Prioritize stormwater management based on available capacity in the University Avenue storm sewer. The western area of the watershed should have highest priority for implementation of improvements and the eastern area should have the lowest priority.

Stormwater Quantity Management Sites

Selection Criteria -- Several criteria were established for areas considered for stormwater quantity management. These included:

1. Sufficient tributary watershed area to fully utilize the detention capacity available in the potential management area

2. Proximity to existing stormwater conveyance systems

3. Sufficient size to provide a minimum of 2 acre-feet of detention

Twenty-seven possible sites were initially identified based on field and map investigation (see Figure 1, page 11). Use of the above criteria resulted in 18 sites being included in the conceptual stormwater quantity management modeling analysis for the watershed. These sites are identified with green shading in Figure 1, their stormwater management characteristics are tabulated in Table 1, and each site is more specifically described in the Site Description section following.

Table 1
Detention Area Characteristics

site identification	*Total Area (Acres)*	*Detention Area (Acres)*	*Detention Depth (ft.)*	*Tributary Area (Acres)*	*Conceptual Storage Volume (Ac. Ft.)*	*Conceptual Release Rate (cfs)*
Hamilton School	17.97	11.7	3	275.7	35.7	70.9
Hilldale Center	5.34	6.05	1	32.6	2.1	11.0
Hoyt Park	27.16	3.2	3	37.7	9.7	2.8
Kohl's Parking	3.34	1.65	1	23.3	0.6	7.2
Lucia Crest Park	5.23	3.7	3	73.8	11.3	12.5
Queen Peace Church	5.79	4.3	3	18.7	13.1	1.6
Rennebohm Park	20.35	7.8	3	217.8	24.0	37.5
Robin Park	3.8	1.5	3	68.7	4.7	17.7
Segoe Park*	3.53	2.15	3	106.7	6.7	30.2
Shorewood Hills Park #1	18.8	14.5	3	59.7	44.1	6.0
Shorewood Hills Park #2	7.38	2.4	3	135.3	7.4	45.0
Shorewood Hills Park #3	3.02	1.7	3	33.0	5.4	12.8
Shorewood Hills Park #4	2.58	2.15	3	67.6	6.6	20.4
Sunset Park	1.37	0.7	3	49.1	2.2	20.4
Vernon Blvd.	0.59	0.5	5	19.0	2.5	5.7
WDOT parking	10.24	5.2	1	23.3	8.7	2.8
green area		2.4	3			
West High School	12.05	7.15	2	77.0	14.4	4.6

** Willow State Park and Segoe Park are combined*

Tributary Area Routed Through Detention	1319.0
Total Tributary Area	1948.1

Stormwater Quality Management Sites

An additional 9 possible sites were identified as having good potential for stormwater quality enhancement (identified with blue shading in Figure 1), although their stormwater detention potential was limited. The following criteria were used to select possible sites for stormwater quality management:

1. Sufficient tributary watershed area to fully utilize the treatment capacity available in the potential management area

2. Proximity to existing stormwater conveyance systems

3. Shaped to provide a linear stormwater treatment train configuration

4. Location in an easily accessible area for maintenance

The sites identified with high stormwater treatment potential are also described in more detail in the following Site Description section.

Site Descriptions

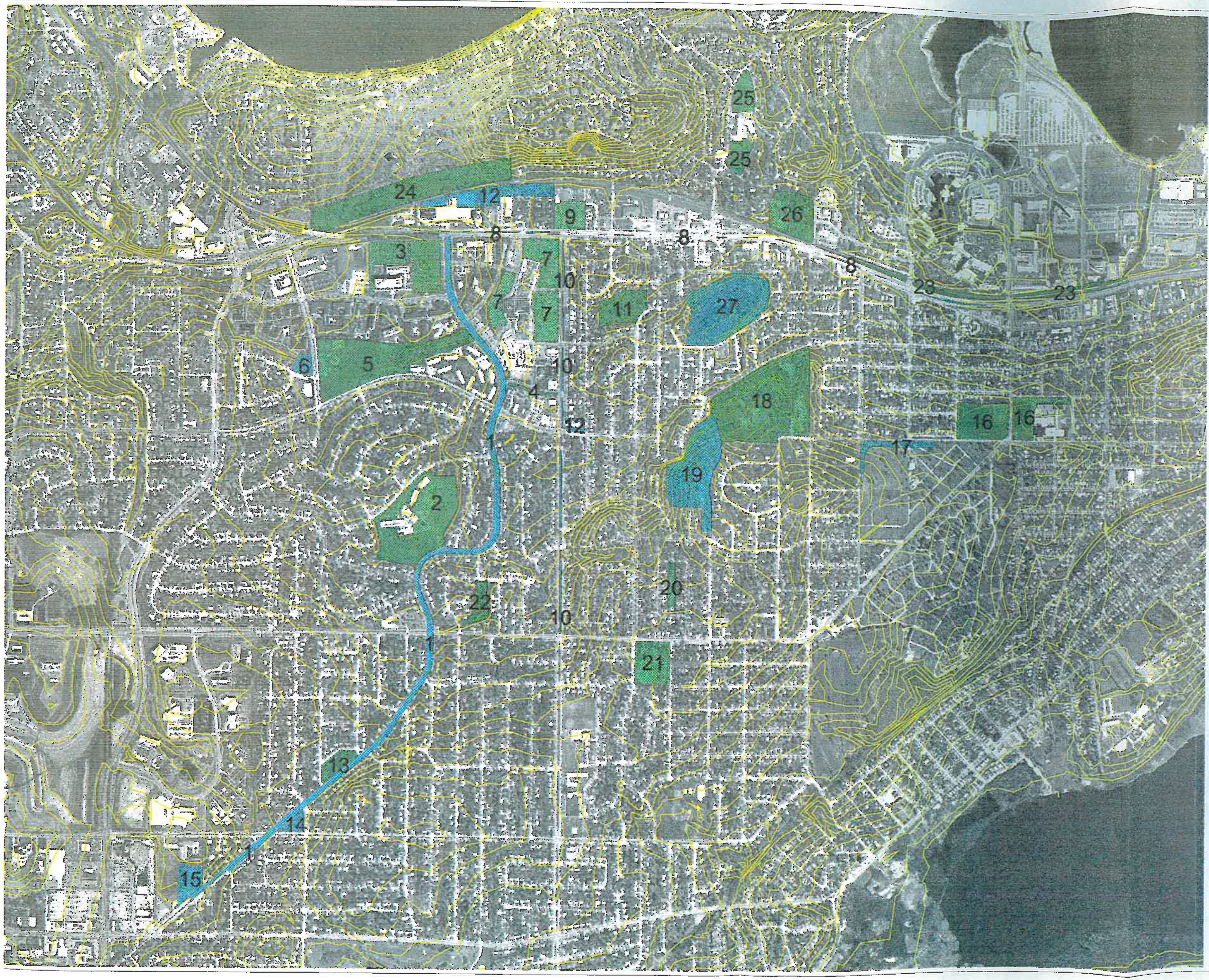
Asterisk (*) denotes detention sites used in modeling work

1. *Segoe Road (South of University Avenue)*
2. *Velma B. Hamilton School**
3. *WDOT Office Complex**
4. *Vernon Blvd. (Segoe Road to Midvale Blvd)**
5. *Rennebohm Park**
6. *Buffalo - Eau Claire Detention Basin*
7. *Hilldale Shopping Center**
8. *University Avenue Boulevard*
9. *Kohl's Food Emporium**
10. *Midvale Boulevard Median*
11. *Lucia Crest Park**
12. *Regent Street Fire Station*
13. *Segoe Park**
14. *Willow State Park**
15. *Odana School Park*
16. *West High School**
17. *Holy Cross Cemetery*
18. *Hoyt Park**
19. *Owen Parkway Savanna & Forest Restoration*
20. *Sunset Park**
21. *Queen of Peace Church**
22. *Robin Park**
23. *Shorewood Hills Park #1**
24. *Shorewood Hills Park #2**
25. *Shorewood Hills Park #3**
26. *Shorewood Hills Park #4**
27. *Quarry Park*

Figure 1

Potential Stormwater Management Locations Map Village of Shorewood Hills Madison, Wisconsin

Rough Draft



2000 0 2000 4000 6000 Feet

Legend

Contours

Potential Stormwater Management Locations

- Stormwater Quality Management Locations
- Stormwater Quantity Management Locations

1. Segoe Road to Mineral Point Road (South of University Avenue)
2. Velma B. Hamilton School
3. Wisconsin DOT Office Complex
4. Vernon Boulevard (Segoe Road to Midvale Boulevard)
5. Rennebohm Park
6. Buffalo-Eau Claire Detention Basin
7. Hilldale Shopping Center
8. University Avenue Boulevard Median
9. Kohl's Food Emporium
10. Midvale Boulevard Median
11. Lucia Crest Park
12. Regent Street Fire Station
13. Segoe Park
14. Willow Slater Park
15. Odana School Park
16. West High School
17. Holy Cross Cemetery
18. Hoyt Park
19. Owen Parkway Savanna & Forest Restoration
20. Sunset Park
21. Queen of Peace Church
22. Robin Park
23. Shorewood Hills Park #1
24. Shorewood Hills Park #2
25. Shorewood Hills Park #3
26. Shorewood Hills Park #4
27. Quarry Park

1. Segoe Road to Mineral Point Road (South of University Avenue)

Stormwater storage and slowed conveyance can be accomplished in this boulevard median which is currently storm sewered with an inlet already in place. Site improvements could include:

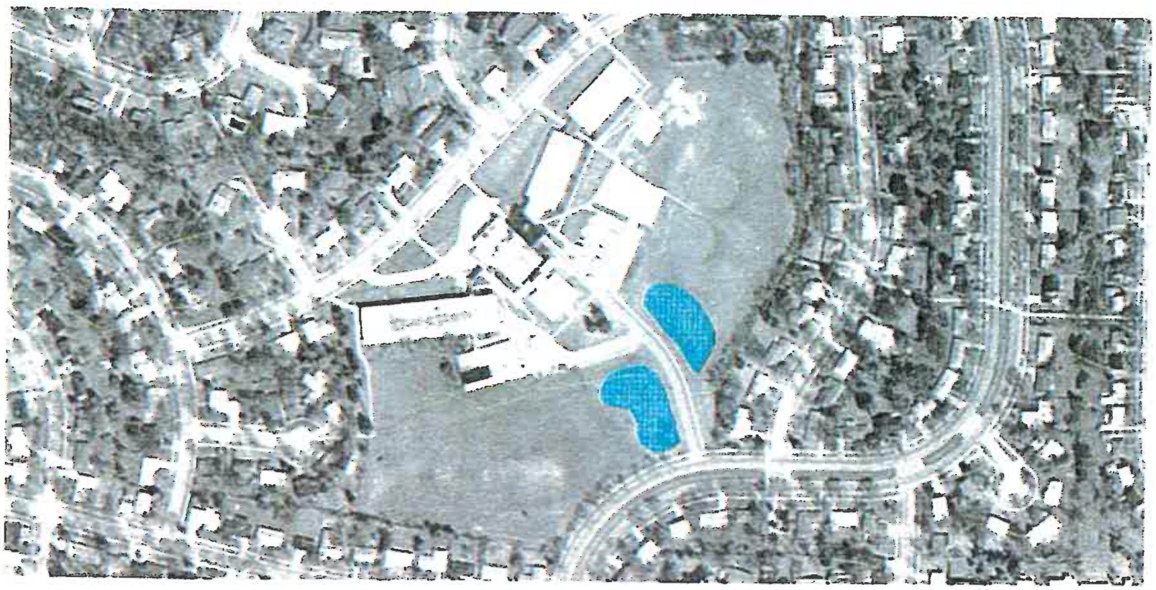
- Creation of a sunken median with pools and conveyance swales integrated into below-grade profile
- Restrict storm sewer inlets in order to surcharge sunken swales; existing storm sewer is 5+ feet from top of inlet to bottom of pipe
- Landscape current 25-foot wide median with native prairie species to promote infiltration and evapotranspiration

Site #1-Segoe Rd to Mineral Point Rd
Village of Shorewood Hills
Madison, Wisconsin
Rough Draft

2. Velma B. Hamilton School*

This site offers 12 acres for use as stormwater storage. Site improvements could include:

- Excavation to provide a stormwater storage and infiltration system around the soccer fields and in areas south of the soccer field
- Soccer fields can be designed for rare event stormwater storage and management coupled with underdrains to dry the fields after storm event detention storage.
- Areas surrounding active recreation areas can be planted with native prairie species to promote infiltration/evapotranspiration. This site is critical for use in the dispersed detention concept and was modeled to provide nearly 36 acre-feet of detention storage for the 50-year design event storm.



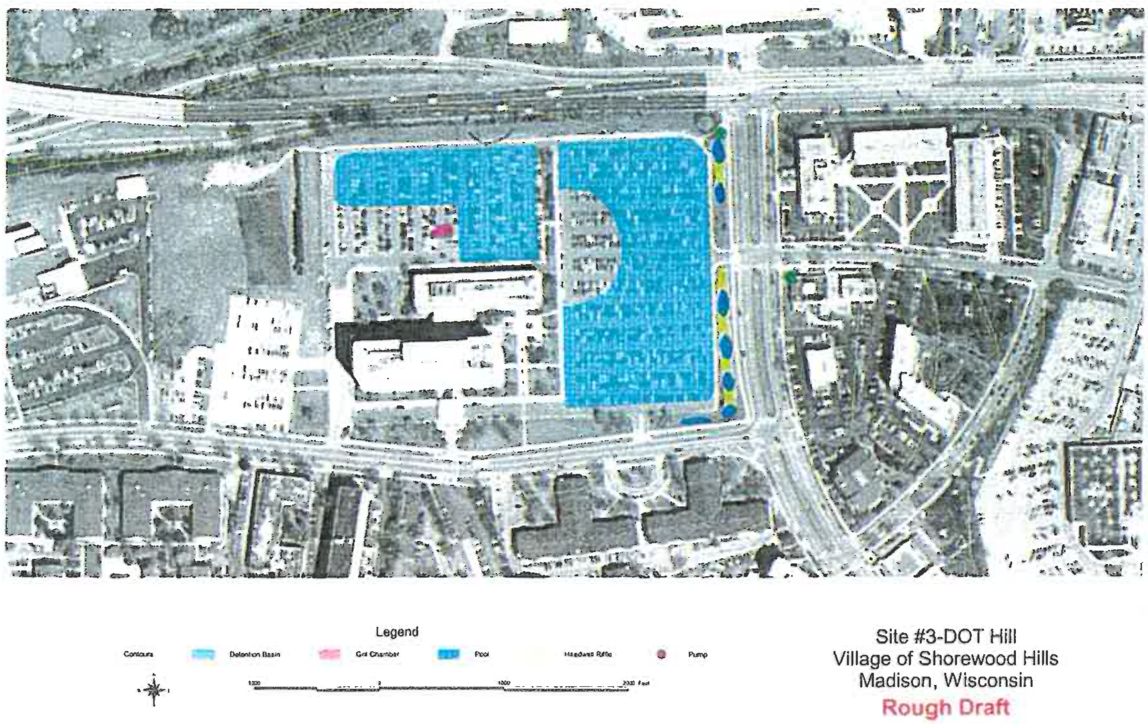
Legend
Contours Detention Basin

Site #2-Velma B. Hamilton School
Village of Shorewood Hills
Madison, Wisconsin
Rough Draft

3. Wisconsin DOT Office Complex*

This site offers four different potential strategies for alternative stormwater management and was modeled to provide 8.7 acre-feet of detention storage:

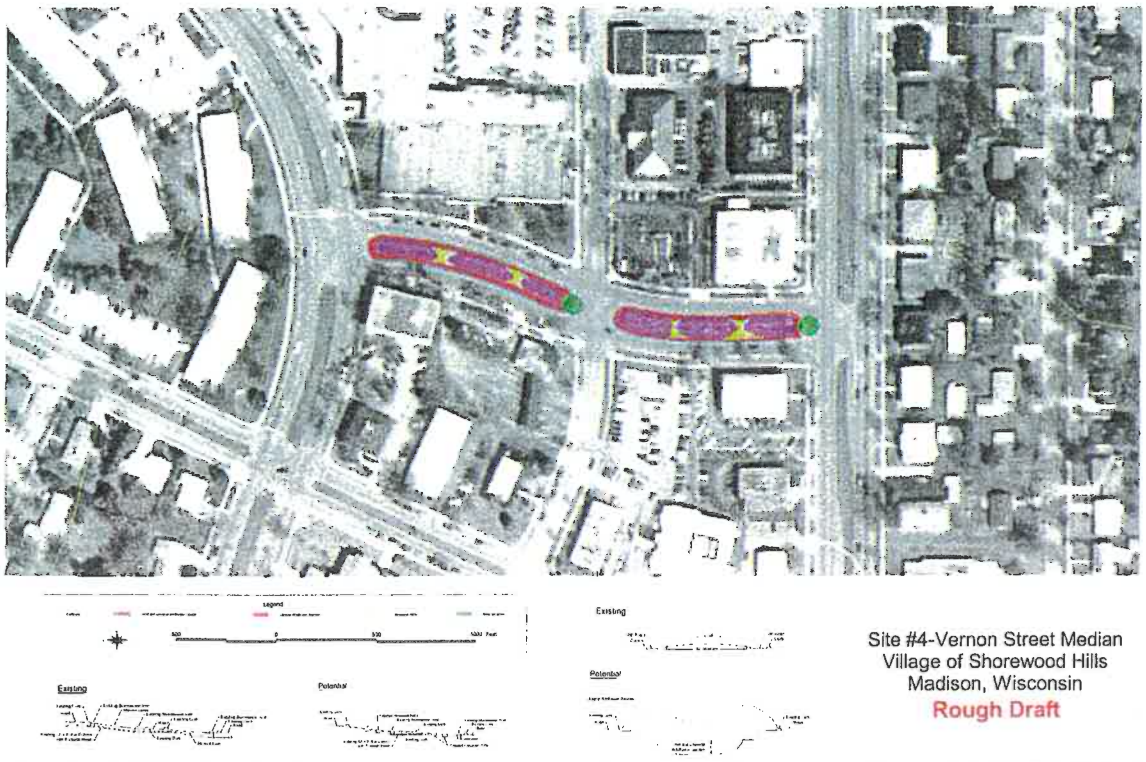
- Retrofit parking lots to include sunken median strips and/or conveyance to detention/infiltration areas surrounding parking lots
- Landscape open space areas with native prairie species for infiltration/evapotranspiration
- Create depressional Rain Gardens with native species landscaping for stormwater collection and infiltration/evapotranspiration
- Reconstruct the deteriorated parking lot to provide on lot detention



4. Vernon Boulevard (Segoe Road to Midvale Boulevard)*

This 42-foot wide median offers the same opportunity to create a sunken median as on Segoe Road while providing 2.5 acre-feet of detention volume. Improvements could include:

- Creation of a sunken median with pools and conveyance swales integrated into below-grade profile
- Restrict storm sewer inlets in order to surcharge sunken swales; south end is storm sewered at 5 feet below grade
- Landscape median with native prairie species to promote infiltration and evapotranspiration



5. Rennebohm Park*

This site offers large areas for native landscaping to provide infiltration and evapotranspiration. Native landscaped areas would be designed around active recreation areas and would provide passive recreation opportunities, as well as stormwater improvements. Excavation of large areas can provide significant stormwater detention. This area is also critical to providing significant stormwater detention and 24 acre-feet of detention storage was conceptually proposed within the Park.

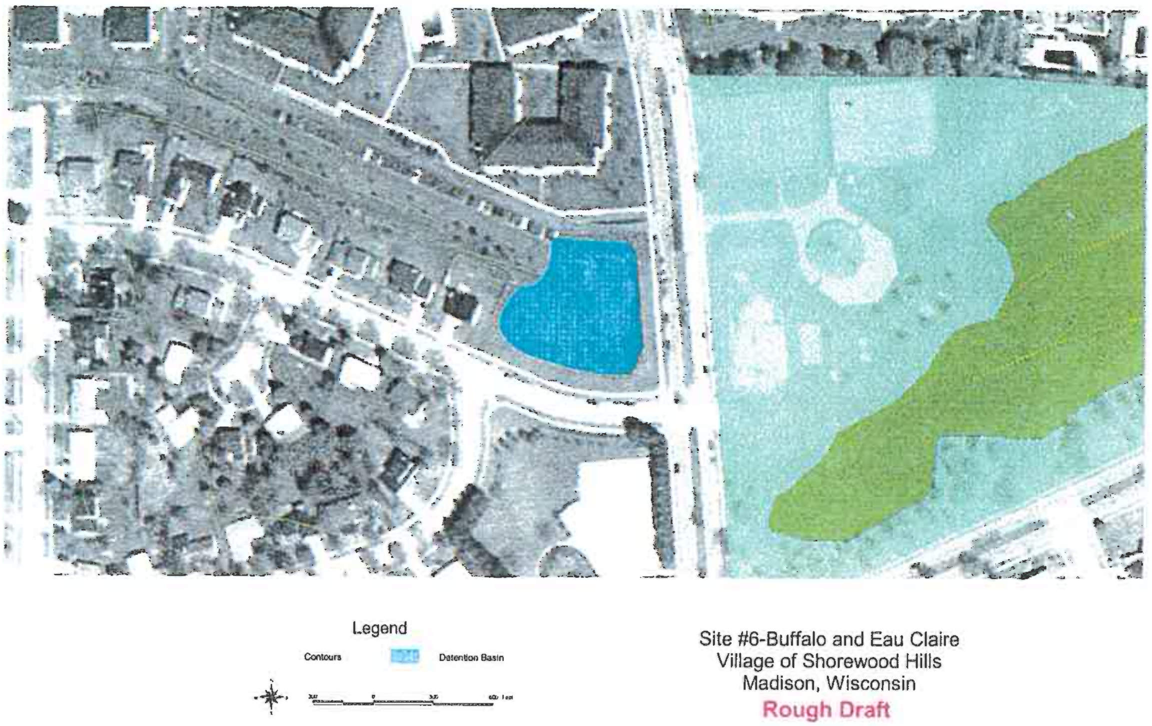
Site #5-Rennebohm Park
Village of Shorewood Hills
Madison, Wisconsin
Rough Draft

Current cement lined-channel

6. Buffalo - Eau Claire Detention Basin

This existing detention basin offers opportunities to increase stormwater volume management and improve infiltration/evapotranspiration benefits.

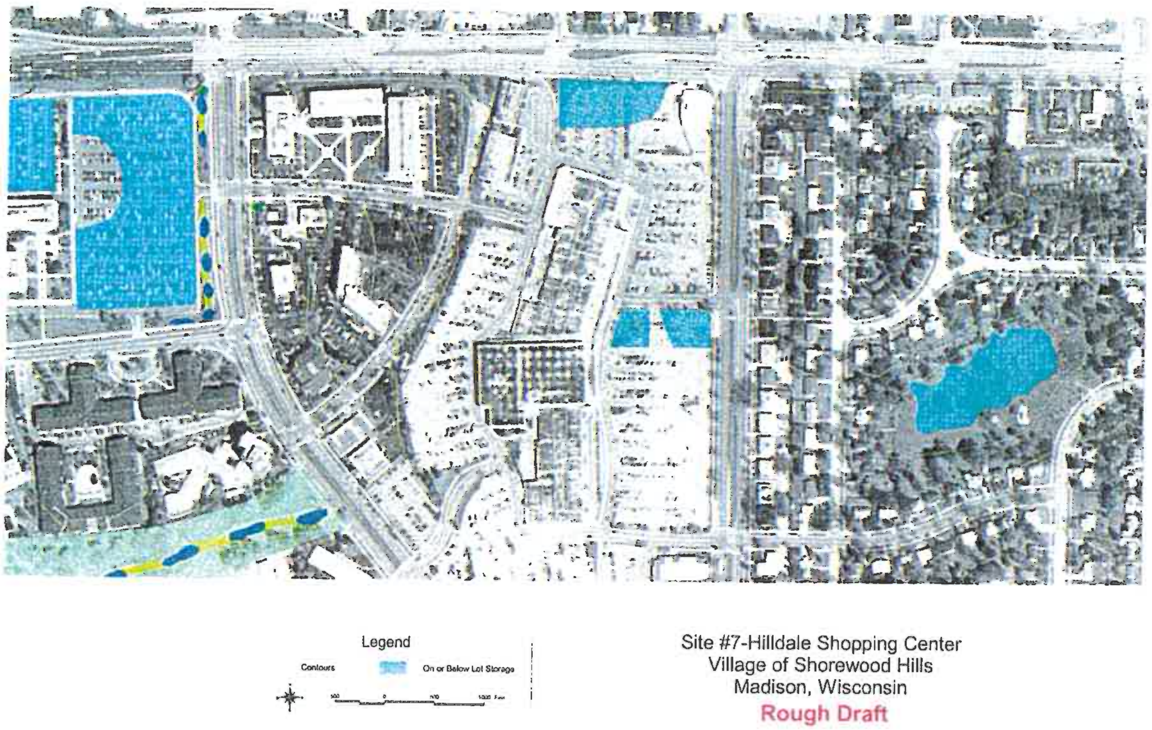
- Deepen detention basin to expand volume storage
- Convert lawn to native landscaping as in a natural park setting, offering passive recreational benefits in addition to improving infiltration/evapotranspiration



7. Hilldale Shopping Center*

Parking areas at this site can be retrofitted to provide 2.1 acre-feet of stormwater volume storage and enhance infiltration. Site improvements could include:

- On-lot storage
- Below-lot storage
- Installation of infiltration systems surrounding parking areas
- Parking island infiltration systems



Site #7-Hilldale Shopping Center
Village of Shorewood Hills
Madison, Wisconsin
Rough Draft

8. University Avenue Boulevard Median

This boulevard offers an opportunity to retrofit a sunken median for stormwater conveyance, infiltration and storage. Improvements could include:

- Creation of a sunken median with pools and conveyance swales integrated into below-grade profile
- Landscape median with native prairie species to promote infiltration and evapotranspiration

9. Kohl's Food Emporium*

Parking areas can be retrofitted to provide approximately 1 acre-foot of on-lot detention for stormwater volume management, with detention areas converted to park-like settings and planted with native vegetation to provide infiltration/evapotranspiration.

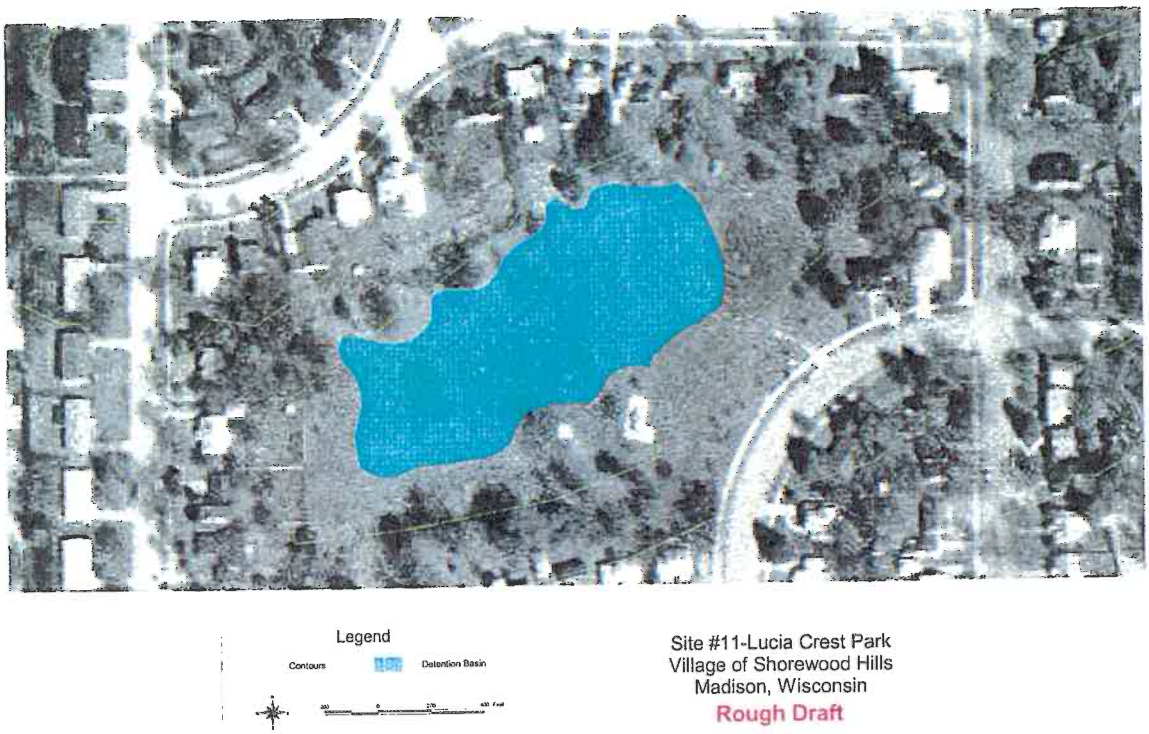
10. Midvale Boulevard Median

This median strip offers opportunities for infiltration and slowed conveyance, as with Segoe Road. The existing storm sewer and the grade divided between Mineral Point Road and University Avenue offer opportunities for design strategies.

- Retrofit a sunken median with pools and conveyance swales integrated into below-grade profile
- Restrict storm sewer inlets in order to surcharge sunken swales
- Landscape median with native prairie species to promote infiltration and evapotranspiration

11. Lucia Crest Park

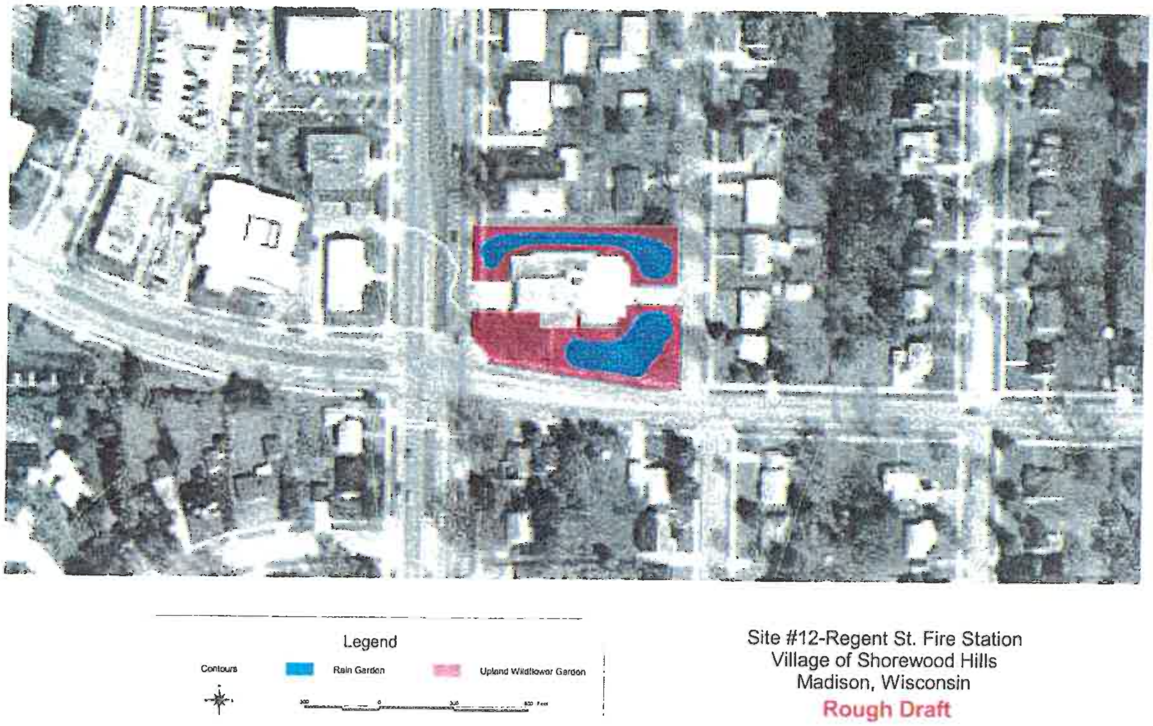
This site offers opportunities for stormwater volume detention storage (11.3 acre-feet) and water quality enhancement through native landscaping. Water quality benefits can be provided through infiltration and evapotranspiration in native landscaped areas along the bike trail and railroad grade which can be used for conveyance and storage.



Site #11-Lucia Crest Park
Village of Shorewood Hills
Madison, Wisconsin
Rough Draft

12. Regent Street Fire Station

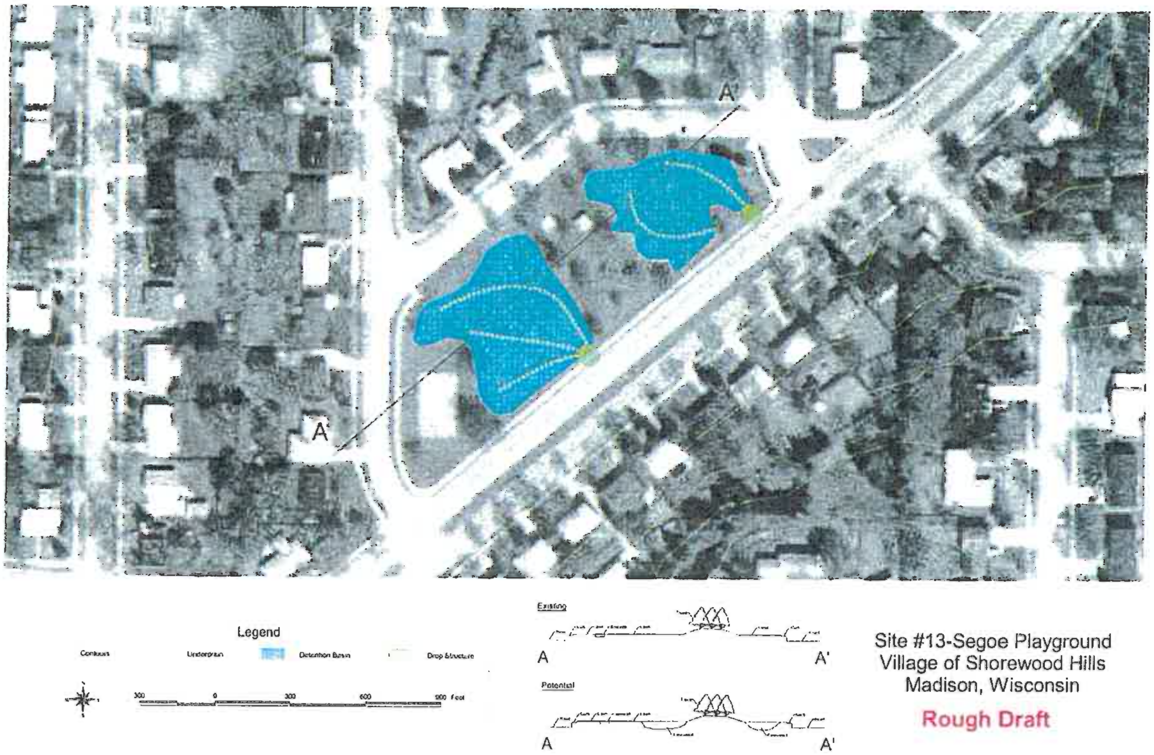
This site is the lowest point on the block and can be useful for stormwater collection and infiltration. Native landscaping would promote infiltration and evapotranspiration as would the design and installation of shallow depressional Rain Gardens to manage stormwater runoff from rooftops and other impermeable surfaces.



Site #12-Regent St. Fire Station
Village of Shorewood Hills
Madison, Wisconsin
Rough Draft

13. Segoe Park *

Retrofit opportunities are available for stormwater detention by excavating two large areas of the park. Based on the existing storm sewer in the median in Segoe road, detention areas could be excavated approximately 3-feet to provide 6.7 acre-feet of storage in combination with the detention proposed in Willow Slater Park while maintaining adequate space for playground and active recreation areas.



14. Willow Slater Park*

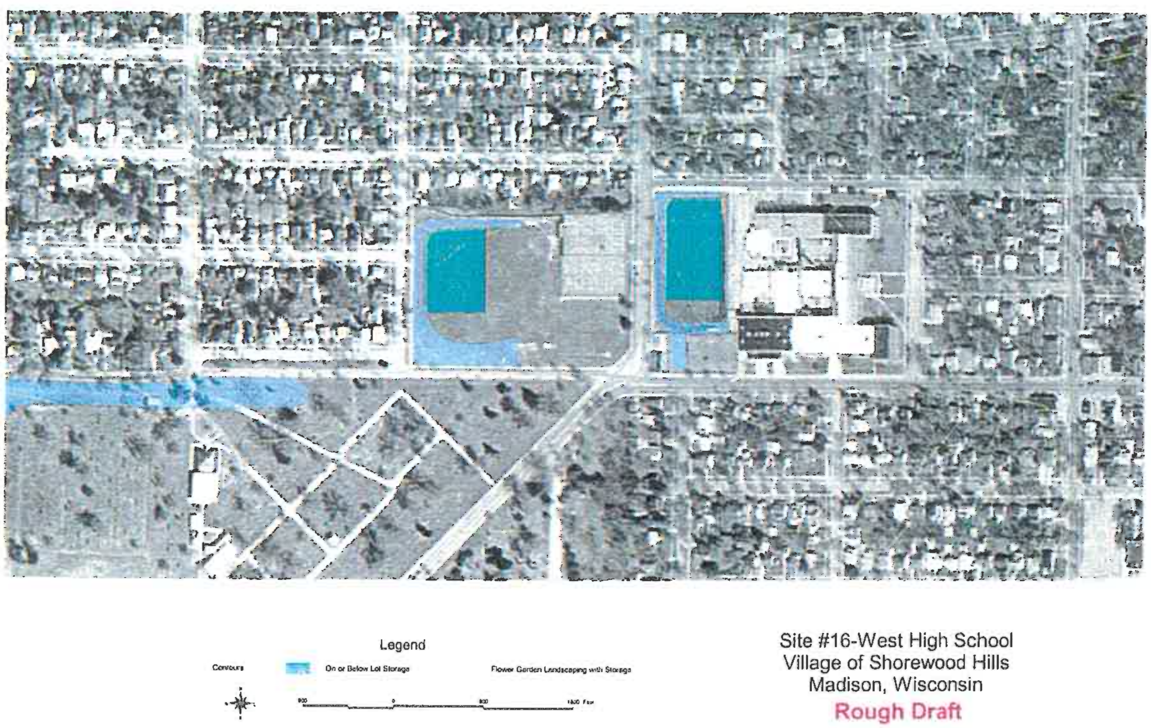
This park is south of Segoe Park and slightly smaller. Potential exists to provide detention within excavated areas within this park.

15. Odana School Park

This small school lot offers opportunities for improved infiltration through native landscaping in areas not required for active recreation.

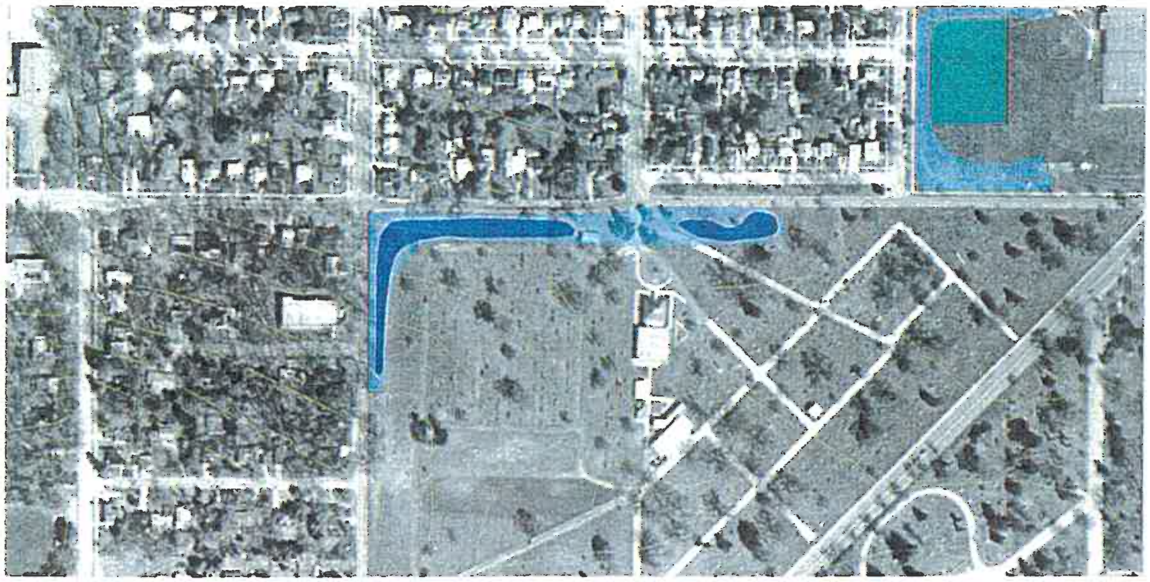
16. West High School*

Large areas of playing field open space are available for stormwater volume storage which can be constructed with under-drain systems to dry the fields after storm events. Infiltration and drainage would allow for slowed release of stormwater held in short-term storage. Additionally, native landscaping can be designed for improved infiltration, and shallow depressional rain gardens can be implemented to provide additional storage and infiltration/evapotranspiration.



17. Holy Cross Cemetery

Native landscaping could provide for additional stormwater infiltration and evaporation/evaportranspiration.



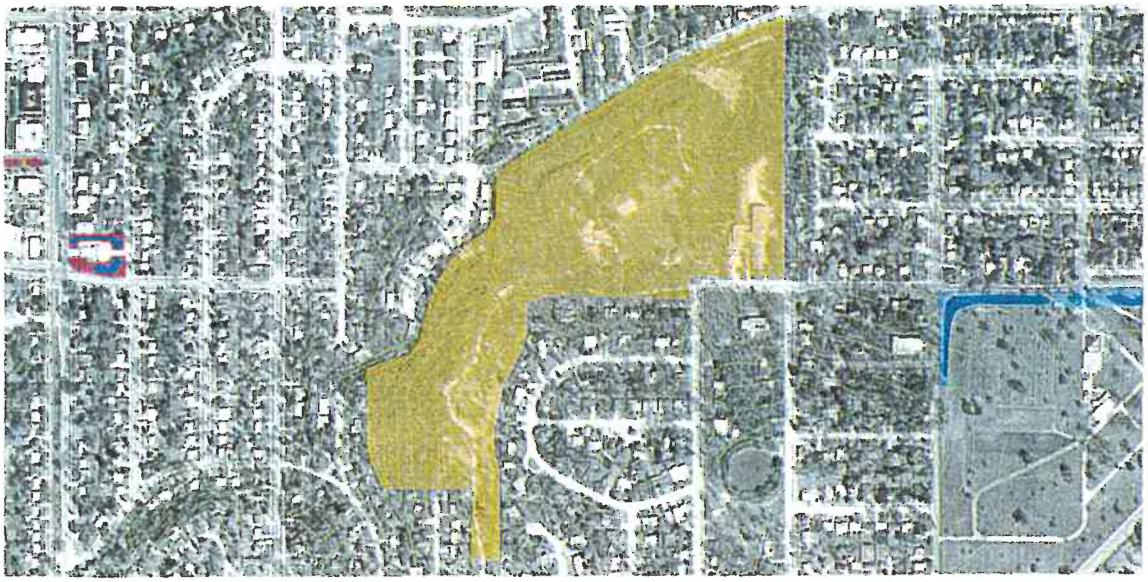
Legend

Contours — Rain Garden — Flower Garden Landscaping with Storage

Site #17-Cemetery Detention Area
Village of Shorewood Hills
Madison, Wisconsin
Rough Draft

18. Hoyt Park*

Restoration of the oak savanna ecosystem on-site can provide stormwater infiltration and evaporation/evapotranspiration benefits as well as some volume reduction. The northern area of the Park could be used for 9.9 acre-feet of detention.



Legend

Contours Savanna Restoration

Sites #18 & #19-Hoyt Park and Owen Parkway
Village of Shorewood Hills
Madison, Wisconsin
Rough Draft

19. Owen Parkway Savanna & Forest Restoration

Removal of invasive European buckthorn and restoration of the parkway to native oak savanna vegetation systems can increase stormwater infiltration and provide water quality enhancement as well as some volume reduction.

20. Sunset Park*

An open channel running for 75 to 100 feet along the north edge of park can be re-graded to slow stormwater conveyance and improve stormwater volume storage. Vegetation systems can be retrofitted with native landscaping to maximize infiltration and evapotranspiration. Detention potential is 2.2 acre-feet.

21. Queen of Peace Church*

Large parking lots can be retrofitted with sunken islands for stormwater retention and infiltration. Possible relocation of this church presents an opportunity for additional open space acquisition and detention use. Although the Church is located at the upper boundary of the watershed, provision of detention on this site would significantly reduce peak runoff from the area tributary to the Church.

22. Robin Park*

This 3.8 acre park has approximately 1.5 acres with detention storage potential. The available detention area would yield about 4.7 acre-feet of storage volume.

23. Shorewood Hills Park #1*

This large area in the northwestern part of the watershed has 14.5 acres with detention potential in its southern area. Utilizing this now grassed area to provide 44.1 acre-feet of storage would reduce runoff from its 60 acre tributary of 6 cfs for the 50 design storm event.

24. Shorewood Hills Park #2*

This open area is located on the south part of the VA Hospital site and has potential for 7.4 acre-feet of detention within the 2.4 acre open area on which detention could be placed.

25. Shorewood Hills Park #3*

Shorewood Hills Park #3 is a 3.0 acre area south of the Amherst Drive intersection with Shorewood Boulevard. Approximately 1.7 acres of the area could be used to provide 5.4 acre-feet of detention.

26. Shorewood Hills Park #4*

This 2.6 acre area on the east side of Shorewood Boulevard south of Park #3 could provide 6.6 acre-feet of detention in available open area.

27. Quarry Park

This site offers stormwater quality enhancement potential through infiltration/evapotranspiration as well as stormwater volume detention.

HYDROLOGIC ANALYSIS RESULTS

Analysis of the watershed contributing runoff to the University Avenue conveyance sewer between Midvale Blvd and the Willow Creek outlet included defining possible detention sites in dispersed locations throughout the watershed and modeling the effects of this detention on the runoff flows which would be conveyed by the University Avenue sewer. Limited capacity of the sewer had been identified in previous studies as the primary reason for flooding problems in the vicinity of the University Avenue - Midvale Boulevard intersection.

Possible detention areas were identified from existing mapping and field visits at locations (Figure 1) and conceptual designs were prepared for these possible sites (Pages 12-28). The conceptual designs resulted in the storage volumes shown in Table 1). The watershed tributary area characteristics previously reported to the Village (Environmental Report Stormwater Relief Culvert by Strand Associates, Inc., February 2001) were modified slightly to match several sub-basins tributary areas to the conceptual detention areas (Table 2), and a hydrologic model was prepared using PondPack v7.0 to determine the feasibility of using dispersed detention as a means to lower the flows in the University Avenue sewer to the sewer's capacity using the routing shown in Figure 2.

Table 2
Tributary Area Characteristics

watershed id	total area (acres)	composite CN	Time of Concentration (hr.)
university east			
100A	77.0	73.4	0.71
100B	191.0	84.1	0.62
110A	37.7	72.0	0.48
110B	37.2	86.9	0.34
130	64.4	84.3	0.41
university/midvale			
205	68.9	80.7	0.40
210	9.8	84.4	0.36
215	9.5	75.0	0.30
225	27.8	83.1	0.26
230	23.3	92.0	0.13
235	16.8	92.0	0.17
240	16.0	92.0	0.09
245	16.6	92.0	0.08
250	19.0	88.2	0.12
255	23.3	84.9	0.70

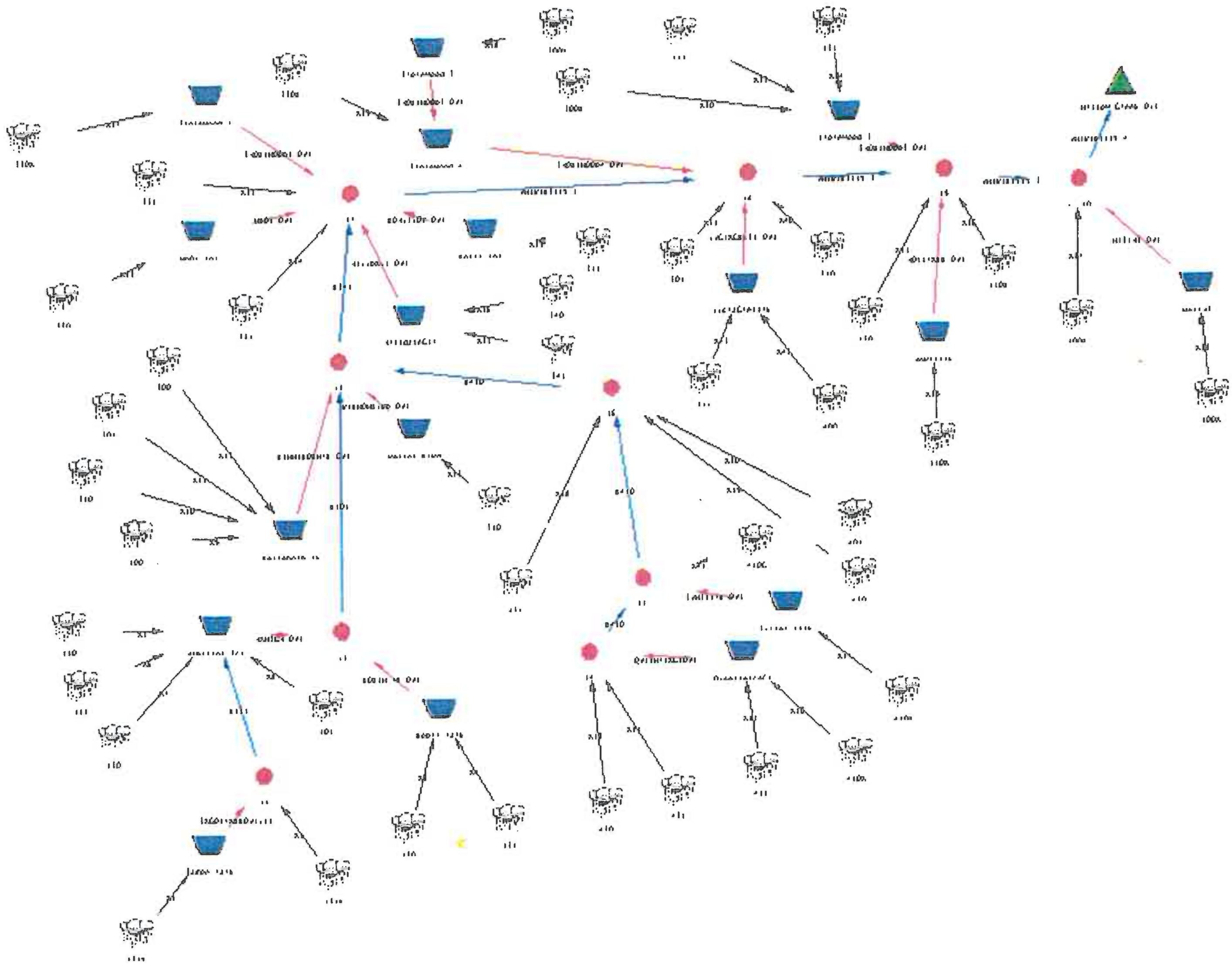
university hills/regent			
300	**62.2**	**82.6**	**0.95**
305	**96.3**	**77.0**	**0.51**
310	**5.3**	**72.0**	**0.51**
shorewood hills			
111	**27.0**	**88.9**	**0.33**
135	**30.0**	**73.7**	**0.62**
200A	**33.0**	**67.6**	**0.43**
200B	**78.3**	**78.7**	**0.59**
220A	**59.7**	**61.0**	**0.46**
220B	**67.6**	**73.6**	**0.85**
midvale south			
400	**64.3**	**73.5**	**0.60**
405	**55.9**	**73.2**	**0.44**
410A	**9.1**	**85.0**	**0.20**
410B	**49.1**	**76.9**	**0.54**
410C	**38.6**	**75.0**	**0.52**
415	**9.6**	**81.0**	**0.13**
420	**19.7**	**77.1**	**0.63**
425	**14.0**	**75.0**	**0.48**
430	**19.6**	**76.7**	**0.43**
435	**65.4**	**76.0**	**0.72**
Segoe road			
500	**54.0**	**74.3**	**0.71**
505	**39.5**	**71.9**	**0.82**
510	**112.8**	**74.8**	**0.54**
515	**14.9**	**77.9**	**0.3?**
520	**71.0**	**76.9**	
525	**19.3**	**73.5**	
530	**49.4**	**75.0**	
535A	**106.7**	**7[illegible]**	
535B	**37.5**		

Runoff was calculated for a 50-year re
Methods Section) consistent with t
that the Garden Grove Developmen
design flood as a separate project and
event was not included in this analysis.

The model was run and modified several ti
areas matched the detention areas' storage cap
release rates tabulated in Table 1 resulted from
conceptual detention storage available.

The model input data provides sufficient accuracy for the conceptual analysis in this study. However, as with all computer based models, the quality of the result is a function of the quality of the inputs. The watershed data inputs are sufficiently accurate to be used for design analysis; however, the watershed routing parameters and the detention basin volume and outlet characteristics will require more detail for design purposes and this detail can be added as the conceptual detention alternatives are further designed.

Figure 2
Hydrologic Model Routing Plan



The conveyance sewer between University Avenue and Willow Creek has a rectangular box section which varies between a 4.5' height x 12' width and a 6' height x 15' width. The smallest section outlets to Willow Creek and the largest sections are in the middle of the sewer run. Near the University-Midvale intersection, the sewer section is 5' x 12'. The sewer in this area is nearly level.

Reported characteristics of this sewer (Environmental Report Stormwater Relief Culvert by Strand Associates, Inc., February 2001) show that calculated capacity of the sewer is below the peak flows for the 50-year recurrence interval storm event (Table 3) in several runs of the University Avenue sewer and that even if the sewer is surcharged at Midvale Blvd to compensate for the level sewer gradient between Midvale and Highbury, the capacity of the sewer is still below that required to convey the 50-year design storm runoff.

Table 3
University Avenue Sewer Capacity vs. 50-Year Design Storm Flows Assuming Present Conditions

node	*ground elevation*	*invert elevation*	*crown elevation*	*pipe length*	*pipe size*	*modeled flow w/ no-detention (cfs)*	*reported pipe capacity (cfs)*	*capacity w/ 0.5' surcharge at Midvale (cfs)*
Midvale Blvd.	38.7	27.74	32.74					
				630	12x5	***498***	32.4	413
Highbury Rd.	42.5	27.73	32.73					
				1440	12x5	***486***	317	
Shorewood Blvd	36.7	25.55	30.55					
				1420	15x5	***606***	369	
Ridge St.	34.5	23.83	29.83					
				770	15x6	***637***	555	
Franklin Ave.	30.9	22.6	28.6					
				700	15x6	***637***	490	
University Bay Dr.	31	21.73	27.73					
				2530	12x6	510	622	
Walnut St.	27.2	13.05	18.05					
				750	12x4.5	510	875	
outlet	12.3	1.2	5.7					

note: bold flows exceed the calculated sewer capacity
modeled flows as reported in Environmental Report Stormwater Relief Culvert by Strand Associates, Inc., February 2001

If the dispersed stormwater detention concepts are implemented, however, the peak runoff from the watershed is reduced to well below the capacity of the sewer (Table 4) for the 50-year design storm event. Therefore, the results of the hydrologic modeling suggest that implementation of dispersed stormwater detention throughout the University Avenue's tributary area would significantly reduce the peak flows in the sewer during major flood events and that for the 50-year design storm event, the peak runoff rates from the watershed would be within the conveyance capacity of the sewer.

The modeling also showed that both the Rennebohm Park detention and the Hamilton School detention areas would be critical to the successful implementation of the dispersed detention concept. Thirty-six acre-feet of detention was used in the model for stormwater storage in the Hamilton School area and 24 acre-feet of detention volume was used in Rennebohm Park. The model also showed that lesser volumes of detention which could be placed in smaller areas throughout the watershed significantly reduced peak runoff rates in the sewer and that a high percentage of these areas, although not all, are also necessary for successful implementation of the concept.

Table 4
University Avenue Sewer Capacity vs. 50-Year Design Storm Flows Assuming Dispersed Detention within Watershed

node	*pipe length*	*pipe size*	*modeled flow w/ detention (cfs)*	*sewer capacity (cfs)*	*capacity w/ 0.5' surcharge at 2400 * (cfs)*
Midvale Blvd.					
	630	12x5	287.9	32.4	413
Highbury Rd.					
	1440	12x5	287.9	317	
Shorewood Blvd					
	1420	15x5	349.1	369	
Ridge St.					
	770	15x6	349.1	555	
Franklin Ave.					
	700	15x6	349.1	490	
University Bay Dr.					
	2530	12x6	444.7	622	
Walnut St.					
	750	12x4.5	543.2	875	
outlet					

COST ASSESSMENT

As a part of this project, AES will develop very preliminary cost opinions for implementation of a program of stormwater management that utilizes some or all of the strategies and locations identified in this report. The preliminary cost estimates will be developed following presentation of the study and discussions of results and conclusions with the Village of Shorewood Hills Task Force.

This opinion of projected costs will assume that there is no cost for land acquisition or use for stormwater management on existing public lands, above the costs for implementing the stormwater management program. We will also assume that this stormwater management program will be implemented over a period of years, rather than all at once, and that this will reduce the public stakeholder process costs, regulatory costs, and construction costs.

Initially, however, AES feels confident the cost of implementing the concepts presented in this analysis will be substantially less than the tunnel option.

CONCLUSIONS

Based on our analysis, AES feels the following conclusions are supportable:

1. It appears conceptually feasible to integrate stormwater management solutions in key locations throughout the watershed for the purpose of substantially reducing flooding problems at University Ave and Midvale Boulevard, and at Garden Homes subdivision. The combination of altering the timing of flood water flow's through these areas by detaining, retaining, and integrating stormwater in landscape features appears highly feasible.

2. Sufficient area exists within the watershed on which to manage stormwater to reduce the peak flows in the University Avenue conveyance storm sewer to the capacity of the sewer for a 50-year design storm event.

3. Dispersed stormwater management within the watershed will provide measurable water quality benefits in Willow Creek and Lake Mendota.

4. Although cost estimates are yet to be determined following Task Force discussions and potential program revisions, we believe costs for implementation of this project will be substantially less than the tunnel option..

5. Use of public lands for alternative stormwater management and flood reduction purposes has potential to add a variety of benefits for community uses of the public lands. We anticipate that the use of public lands for stormwater management will not reduce the acreage of existing active recreational uses in parks, school grounds, etc. In fact, land-use changes may improve the utility of areas such as playing fields that are currently feature uneven ground, or that have wet soil conditions which hamper active recreational use.

6. Once flood proofing for the Garden Homes area is addressed by other programs, the urgency to address flooding is diminished and the strategies included in this report can be implemented over time as budgets and the public process dictate. A phased approach to final design and implementation will also allow for full participation of stakeholders in individual site design projects.

7. Both the Hamilton School field area and the Rennebohm Park area will be required to provide significant stormwater detention for the dispersed detention option to be feasible for the 50-year design storm event.

8. From our perspective of having conducted alternative stormwater management projects around the U. S., we feel this alternative approach has very high potential to serve as a national model program and may in fact be eligible for funding from federal and state agencies who are attempting to encourage the alternative stormwater management strategies recommended in this report.

ATTACHMENT 1. Summary and critical analysis of the process and conclusions of the Strand Associates, Inc. report titled "Environmental Report – Stormwater Relief Culvert"

Summary and Critical Analysis of Present Analysis

Alternatives analysis

- focused on 100-year flood protection
  - detention
    - large detention volumes in existing major parks
      - disbursed detention throughout the watershed was not included
  - conveyance --
    - relief sewer construction
    - parallel sewer construction (from Midvale to outlet)
      - an optional partial parallel sewer construction alternative for 2000 feet from Midvale to Shorewood Blvd. to provide required major flood conveyance capacity from the depressed area, coupled with use of the University Avenue conveyance as an overland flood route from Shorewood Blvd. to the Willow Creek outlet was not included in analysis. This would appear to cost about $2,000,000.
  - flood proofing -- Garden Grove Subdivision
- hydrologic modeling
  - based on Bulletin 71 (Midwestern Climate Center) for various storm durations and first quartile Huff rainfall distribution (not in conformance with Bulletin 71 recommendations for longer storm durations)
  - model verified with June 1996 observed precipitation and flooding conditions
- contaminant modeling
  - estimated total suspended solids in stormwater runoff at 564,133 pounds/year and 1919 pounds of particulate and filterable phosphorous annually in the runoff from the study watershed using the SLAMM model
    - Dane County analysis using P-8 estimated 566,810 pounds/year in 3-year period 1992-1994.
    - No recommendations in report for reducing this sediment or phosphorous loading into Lake Mendota through watershed stormwater treatment

ATTACHMENT 2. Recommended Additional Tasks to Understand Flood Damage Reduction Needs and Opportunities

1) Define individual elements requiring flood protection and the minimum level of flood protection required for each element

    - Garden Homes Subdivision residences
    - Garden Homes Subdivision yards/roads
    - Commercial development buildings
    - Commercial development parking lots/landscaping
    - University Avenue accessibility

2) Define the construction timing for implementing the required flood protection

    - catastrophic property protection
    - accessibility protection
    - non-catastrophic property protection

3) Define additional flood protection options for each of the elements requiring flood protection

    - conveyance options
        - hydraulic modifications to existing sewer to increase efficiency
        - partial parallel sewer
    - larger detention options (>10 acre-feet)
        - park modifications
        - lot purchases and conversion to detention
        - modifications to existing large parking lots
    - diffused neighborhood detention options
        - restricted storm sewers
        - neighborhood road/parkway detention
        - neighborhood park detention
        - individual lot rain gardens
        - parking lot modifications
    - redevelopment detention requirements

4) Include water quality issues related to Lake Mendota and water quality enhancement options for the flood protection options

5) Prepare hydrologic/hydraulic modeling analysis for evaluating the possible flood protection options.

    - statistical storm analysis
        - 10, 50 and 100 year recurrence interval storms
        - 1, 6, 12, 24, 48 hour storm durations
        - Huff Bulletin 71 precipitation amounts and rainfall distributions

- historic event storm analysis
    - precipitation data from historic storms
    - calibration to actual flooding observed during the historic storm event
        - flood heights
        - flooding duration

6) Prepare water quality modeling analysis for evaluation of possible flood protection options

    - use long term analysis period of at least five years with historical rainfall precipitation history

7) Detail the flood protection options in terms of location, costs, and implementation timing