ENGINEER'S REPORT

Pelican Lake Stormwater Project

Breezy Point, Minnesota

May 24, 2010

Prepared For:

Thirty Lakes Watershed District
17064 Commercial Park Road
Brainerd, MN 56401

THIRTY LAKES WATERSHED DISTRICT

Prepared By:

Westwood

Engineer's Report
Pelican Lake Stormwater Project
Breezy Point, Minnesota

Prepared for:

Thirty Lakes Watershed District
17064 Commercial Park Road
Brainerd, MN 56401
(218) 828-0243

Prepared by:

Westwood Professional Services, Inc.
423 Laurel Street
Brainerd, MN 56401
(218) 829-1751

Project Number: 20097607.00

May 24, 2010

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the Laws of the State of Minnesota

_____

Timothy T. Ramerth

Date 05/24/10 Reg. No. 41966

CONTENTS

APPENDICES

1.0 INTRODUCTION

The Point was a proposed development approved in the late 80's for an expansion of a resort on Pelican Lake. As part of the project, a stormwater ponding system was installed to treat runoff generated by the project. At one point, the ponding area had breached the berm and was allowing water to enter Pelican Lake with little or no treatment. This condition exists today.

The Pelican Lake Association brought this issue to the Thirty Lakes Watershed District for assistance in gaining resolution to the matter in an attempt to protect Pelican Lake. This process was selected, as it was clear that there were many entities contributing runoff to the stormwater management facility with no maintenance agreement in place. The Thirty Lakes Watershed District has engaged with a few engineering firms to assess the situation and provide solutions. The solutions ranged from pervious pavement with under parking storage, sedimentation basin, mechanical treatment, pump station with storage basin to bio-retention and infiltration practices. These solutions were at the direction of the groups involved and were an attempt to fix the problem in a cost effective manner while meeting the current regulations of the 100 year storm event criterion. Many of the solutions were not appealing to the group as a result of cost or the fact that the solution rendered too much of the property to a use that was not compatible with the surrounding resort. This essentially rendered the project to be not practical or feasible.

Westwood Professional Services, Inc. was contacted in the summer of 2009 to review the site and the materials provided to the Watershed District to date. The intent was to provide a cost effect solution for treating the stormwater runoff prior to discharging to Pelican Lake. As part of the process, we reviewed all of the documentation provided and prepared recommendations for correcting the situation based on current technical standards. Upon our recommendation, a meeting was held on August 3, 2009 with the appropriate stakeholders to discuss potential solutions and get feedback from the affected parties regarding key features for the subject property. This information was gathered and incorporated into the recommendations that were later presented to the Board of Managers on September 28, 2009. A couple of design layouts were prepared and shared with the managers as well as the stakeholders on this date. One design concept was selected and a few minor modifications were made to the overall design. The Board of Managers ordered the final plans and specifications to be prepared based on these modifications. The design is based on sound water quality engineering principles and will provide the protection that Pelican Lake deserves. As a result of this project, three property owners will be affected by the construction of the stormwater management system.

During the development of the project, a grant opportunity became available for the Clean Water Legacy Grant funds. An application was completed and mailed to the Board of Water and Soil Resources (BWSR) for the December deadline. The grant application was approved under the Soil and Water Conservation District application in February of 2009. Prior to this report, negotiations have begun with the affected property owners in an attempt to acquire consensus with this project and discuss how to move forward cooperatively. It has been explained that the project will be constructed utilizing grant dollars and that the Watershed District will be responsible for the initial maintenance to ensure the project functions as designed. The Watershed District has also met with the City of Breezy Point to discuss the long term maintenance responsibility to be transferred to the City to ensure that the project will be

maintained for its entire effective life and beyond through its normal maintenance programs. There has been a general recognition of project support and favorable negotiations with the various parties involved. These negotiations will continue until the project easement areas have been secured.

2.0 SITE SURVEY

A survey of the potential infiltration basin area was completed to document the existing conditions of the subject area as well as tie in ground water elevations and any other project constraints that would affect the overall design. Appendix A contains the drainage area map that identifies the contributory area to the selected best management practices for this project. In total, approximately 6.6 acres of adjacent properties drain to this proposed infiltration area. Of this drainage area, approximately 4.5 acres is impervious surface. The existing ground elevation of the proposed infiltration area (basins 4 & 4A) is approximately 1209.00 with the seasonal high water table established at approximately 1206.00. Essentially, the existing ground elevation will not be lowered to accommodate the proposed infiltration practices.

Currently, the runoff from the existing impervious surfaces discharges at the location of the proposed basin 1 and flows across approximately 140 feet of sand and beach prior to discharging into Pelican Lake. This is essentially an unconfined channel and provides no treatment of the runoff prior to discharge into Pelican Lake.

3.0 HYDROLOGIC ANALYSIS

For this particular project, runoff volume control will be a key component for providing water quality benefits. The Natural Resources Conservation Service (NRCS), formally known as the Soil Conservation Service (SCS), has developed hydrology methods for estimating runoff. These methods are utilized in many proprietary and non-proprietary software applications.

Site constraints severely limited the area available to treat runoff from the urban landscape; therefore the infiltration areas have been maximized to accommodate as much runoff as possible without causing damage to the surrounding facilities. The SCS Curve Number method was used for calculating the post runoff volumes generated from the proposed site for various 24 hour rainfall events. Based on the U.S. Weather Bureau Technical Paper 40 and the Minnesota Hydrology Guide, the runoff volume stored was equated to a runoff depth which in turn was converted to a rainfall depth that would be treated. The equations used for calculating runoff volumes are as follows:

Maximum retention = S (in) $S = (1000/CN) - 10$

Runoff Curve Number = CN

Runoff = Q (in.) $Q = (P - 0.2S)^2 / (P + 0.8S)$

Upon maximization of the infiltration storage areas, the 100 year 24 hour storm event was routed through the stormwater management system utilizing the HydroCAD Stormwater Model. The

hydrology and hydraulics were verified to not impact the surrounding facilities. The results of this analysis are contained in Appendix C for reference.

4.0 DESIGN CRITERIA

The intent of this project is to remedy the current situation that is allowing runoff from impervious surfaces to enter Pelican Lake with no treatment. The stakeholders of the property and the end users of the resort have identified that the key components of the existing resort need to remain intact to the fullest extent practicable. These components include the beach, play ground area, infiltration area adjacent to the parking lot (existing basin 1), and a large grass area in the overflow portion of the infiltration basin (basin 4A). The large grass area is utilized for weddings, family gatherings and special events as it is one of the limited green space areas in this vicinity of the resort. Any proposed stormwater management plan shall avoid these areas.

The current policy of the Thirty Lakes Watershed District is to analyze runoff for the 100 year 24 hour critical duration storm event, or approximately 5.6 inches of rainfall. The proposed infiltration area was analyzed under this criteria, but it was determined that this was not achievable with the site constraints that were identified above by the appropriate stakeholders. In addition, the seasonal high groundwater elevations limit the amount of excavation to accommodate any additional runoff to meet this criterion. Infiltration practices need to limit the depth of water for infiltrating in an attempt to control the dewatering time of the infiltration basin. Depths typically over 1.5 feet will dewater in a timeframe that will be detrimental to the vegetative cover in the infiltration basin.

The concern for Pelican Lake is the fact that runoff from impervious surfaces enters the lake with no treatment. This runoff will contain phosphorus, heavy metals, oils, greases, pesticides and other contaminants that will degrade water quality if left untreated. It has been documented that these contaminants currently exist in the runoff entering Pelican Lake.

Literature[1] indicates that 90 percent of all rainfall events in Minnesota amount to 1 inch of rain or less. Rains between 0.5 and 1.5 inches account for approximately 75% of the annual runoff-pollutant mass discharges from residential areas, and are the key rains that need to be addressed when concerned with mass discharges of pollutants. The National Pollutant Discharge Elimination System, under its General Permit Authorization to Discharge Stormwater Associated with Construction Activity, further defines the importance of dealing with smaller rainfall events to provide adequate water quality benefits. This document requires the water quality volume to consist of ½ inch of runoff from the new impervious surfaces created. From a water quality perspective, it is clear that any runoff management system should be designed such that treatment is provided for a minimum storm event of 1 inch or greater.

[1] Minnesota Pollution Control Agency, 2000. Protecting Water Quality in Urban Areas: Best Management Practices for Dealing with Storm Water Runoff for Urban, Suburban and Developing Areas of Minnesota.

5.0 RECOMMENDATIONS

5.1 Project Solutions

Based on the fact that this is a retrofit situation, site constraints and limitations dictate the appropriate Best Management Practices (BMP's) that may be utilized. The treatment train approach is the most appropriate for this situation. Bio-retention and infiltration practices will be utilized for stormwater treatment. Refer to Appendix B for more specific layout details. All BMP's will be constructed within 300 feet of Pelican Lake.

Area A1 is the largest drainage area and contains the most impervious surface. A bio-retention area (basin 1) will be installed at the location of the existing ponding area constructed in the late 80's. Over time, this area had been modified and a poly liner was installed at that location. These materials will need to be removed and the soil will need to be replaced and augmented with compost for improving the infiltration media. This retention area will act as a forebay for the larger primary infiltration area (basin 4) and overflow infiltration area (basin 4A) and will minimize the transport of larger particulate matter to these infiltration areas. This will assist with long term maintenance costs as long as a regular maintenance schedule is followed. Plantings will be included to assist with moisture and nutrient uptake for this area. This bio-retention area alone will accommodate the runoff for a 0.8 inch rainfall event. A culvert will connect the bio-retention basin (basin 1) to the large overflow infiltration areas (basins 4 & 4A). The large overflow infiltration area will be constructed with two levels to minimize the impact under smaller rainfall events. The primary portion of the overflow infiltration area (basin 4) will be large enough to accommodate the runoff from the one inch event for the entire area contributing to the basin. This will minimize the amount of time and area inundated of the overflow infiltration area (basin 4A) to assist with the request for maintaining green space for social gatherings. The primary infiltration area (basin 4) will also have the soils augmented to promote infiltration.

Area A2 is the next largest drainage area with the second largest amount of impervious coverage. A bio-retention basin (basin 2) will be installed to act as a forebay for drainage coming off of area A2. The soils in this bio-retention area will be augmented with organic soils to assist with the soils infiltration capacity. Plantings will be included to assist with moisture and nutrient uptake for this area. This bio-retention area will accommodate the runoff for a 0.7 inch rainfall event. This is the largest facility we could construct in this location to meet all appropriate guideline setbacks. Any overflow from this bio-retention area will be to the large overflow infiltration basin (basins 4 and 4A). Runoff will be directed to the lower cell (basin 4), where the storage has been designed to accommodate this runoff up to the one inch event and eventually will fill the overflow portion of the basin (basin 4A).

Area A3 is the smallest of the urban watersheds and contains the least amount of impervious surface coverage. A bio-retention basin (basin 3) will be installed to treat the runoff from this watershed. Due to the size of the drainage area and the position of the retention area on the landscape, it is not likely that organic soils will need to be added to

the soil profile. This bio-retention area will accommodate runoff up to the 2.3 inch rainfall event. Any overflow from this bio-retention area will be directed to the bio-retention area for A2 (basin 2), which ultimately will discharge to the primary infiltratin area and overflow infiltration areas (basins 4 & 4A).

Ultimately, all areas will have the potential to provide runoff to the primary and overflow infiltration basins (basins 4 & 4A). This infiltration area has been sized such that the runoff from all contributing areas will be stored in the bio-retention areas and the overflow infiltration basins for up to the 2 inch rainfall event. In no case, will there be runoff leaving the site unless we have a rainfall event larger than 2 inches in depth or we get back to back storm events. The infiltration basin will be equipped with an outlet structure (system overflow structure) and a 21 inch Reinforced Concrete Pipe (RCP) to provide for slow release of larger rainfall events. This will ensure that the additional runoff is dealt with in a non-erosive manner and will protect the integrity of the infiltration systems. A HydroCAD computer model was run for verification that the infiltration basin would not affect the surrounding facilities and has been included in Appendix C for reference. The primary infiltration basin (basin 4) bottom elevation will be at 1209.00, which is 3 feet above the seasonal high water table. The primary infiltration basin will fill to an elevation of 1209.50 prior to spilling over to the overflow infiltration area (basin 4A). This shelf will suffice as a way to compromise with the neighborhood to provide for a green space to facilitate social gatherings. Water will accumulate in the infiltration basin to elevation 1210.25, where it will then be allowed to pass into Pelican Lake. The runoff contained below the 1210.25 elevation will equal the runoff from the 2 inch event for the entire watershed area contributing to the system. The HydroCAD analysis contained in Appendix C documents this criteria. This water quality volume exceeds the design criteria listed previously in this report. The proposed system will provide adequate protection for Pelican Lake. The top of the berm for the overflow infiltration basins (basin 4 & 4A) will be at 1211.00. The anticipated high water elevation in the pond during the 100 year 24 hour critical duration storm event (5.6 inch rainfall) will be 1210.70+/-. The infiltration basin will not overtop and will not affect the surrounding properties.

5.2 Easement Needs

The intent of this project is to replace a failing system that is no longer providing water quality treatment for runoff entering Pelican Lake. Having said this, the system will be similar in nature to the original system installed in the late 80's. Improvements will be made and the facility will be enlarged to accommodate the appropriate water quality volume. It is anticipated that the modified infiltration system will occupy approximately the same land area required for the original system and will affect the same property owners. There was never a drainage and utility easement placed over this area to accommodate future maintenance and there was not a document that outlined who would be responsible for the maintenance of this facility. As identified in Appendix D, there will be three property owners that will be affected by this project. They include: Point Place Time Share Owners Association, Whitebirch Inc. and The Lodge.

The Thirty Lakes Watershed District has engaged in preliminary negotiations with the affected property owners. It is the hope of the Thirty Lakes Watershed District that these owners will continue their willingness to work with the District in an effort to correct a current failing situation. The District has secured the funds to remedy the situation and it is desire of the District to get cooperation from the affected landowners to provide the necessary easements to replace an existing condition. The intent is for the Thirty Lakes Watershed District to seek a donation of the easement areas without direct compensation. Draft easement documents have been prepared and will be distributed to the affected property owners for review and approval. A public hearing will be scheduled to bring closure to the necessary process for this project type.

5.3 Opinion of Probable Costs

The cost of the project has been estimated for the construction of the stormwater management system. It is anticipated that the District will be successful in dealing with the affected property owners in acquiring a drainage and utility easement. The Opinion of Probable Costs is contained in Appendix C.

5.4 Impacted Infrastructure and Property

The proposed stormwater management system is a replacement of a failing existing system. The anticipated construction is contained completely on private property and will affect only the property owners that the original system affected. This project will not affect any public highways, utilities, bridges or infrastructure. We are not anticipating any significant impacts to private utilities.

5.5 Future Maintenance

The details to the future maintenance of this stormwater management system will need to be addressed and provided in the form of an agreement. The City of Breezy Point has indicated that a stormwater utility fund may be implemented in the near future and has other controls in place to provide the maintenance of this facility. The intent of the Thirty Lakes Watershed District is to assume the responsibility of the maintenance of this system until such time that the City is capable of performing this responsibility. A cooperative approach with the City will be taken to address this matter. Negotiations with the city have been initiated to provide for the long term maintenance of this facility. This approach would be the most logical for this particular application.

As part of the overall project, care will need to be taken with the infiltration areas. An agreement will need to be reached that protects these areas from excessive traffic, traffic during wet conditions, winter use and access, impervious surface snow removal or salting best management practices and any other uses that may have the potential to minimize infiltration capabilities. A draft easement document has been prepared that will be distributed for review and approval. This document will clearly identify the maintenance issues as discussed above.

6.0 CONCLUSIONS

Westwood Professional Services, Inc. (Westwood) completed the necessary engineering documentation to assess the feasibility of constructing infiltration practices to meet water quality standards for runoff currently entering Pelican Lake with no treatment. Based on our review and assessment, we have concluded that a system can be constructed that will provide the necessary water quality treatment for the anticipated runoff. The long term maintenance of this system will be critical in assuring a long term benefit to Pelican Lake. Negotiations have begun to ensure this is complied with.

Based on a thorough review of the previously prepared engineering reports and by completing an onsite assessment, we have concluded that a treatment train approach would be the most economical and practical solution for this particular situation. We have engaged the local affected parties early on in the process to acquire and incorporate any concerns for the area to the fullest extent practicable. The final design described in this engineer's report incorporates the concerns addressed at the public meetings and represent the least cost alternative to meet the intended goals. Documentation has been provided herein to support the water quality criteria has been incorporated into the final design.

The Thirty Lakes Watershed District has initiated negotiations with the benefitted property owners in an attempt to acquire easements and discuss future maintenance of the proposed stormwater management system. This system is a replacement of an existing stormwater management system that has surpassed its effective life or is no longer functioning. The benefitted parties will realize this is a benefit to them and hopefully consider this when negotiating the easement details.

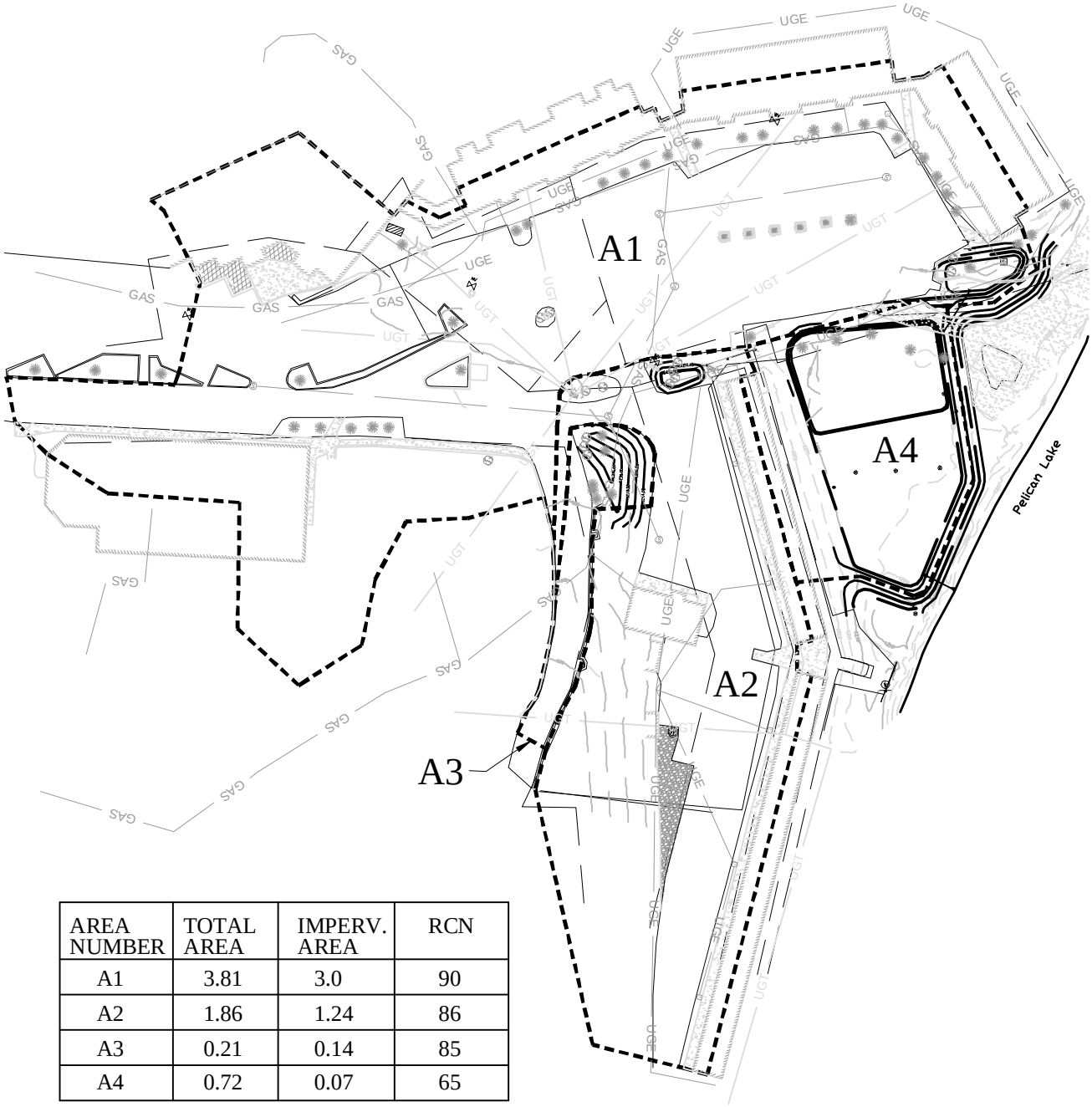
Upon review of the opinion of probable costs, it is anticipated that this is a feasible project and will attain the intended goals for protecting water quality. This is the least cost alternative and will likely provide the least amount of disruption to the resort community while protecting our resources.

Appendix A

Watershed Boundary Map

Pelican Lake Stormwater Project

Breezy Point, Minnesota



AREA NUMBER	TOTAL AREA	IMPERV. AREA	RCN
A1	3.81	3.0	90
A2	1.86	1.24	86
A3	0.21	0.14	85
A4	0.72	0.07	65

SCALE: NTS

Westwood Professional Services, Inc.
423 Laurel Street
Brainerd, MN 56401
Phone: (218) 829-1751 Fax: (218) 829-4733

PROJECT NAME:
Pelican Lake Stormwater Project
Watershed Boundary Map

Breezy Point MINN.

DATE: 0/2/10 PROJECT NO. 20097607

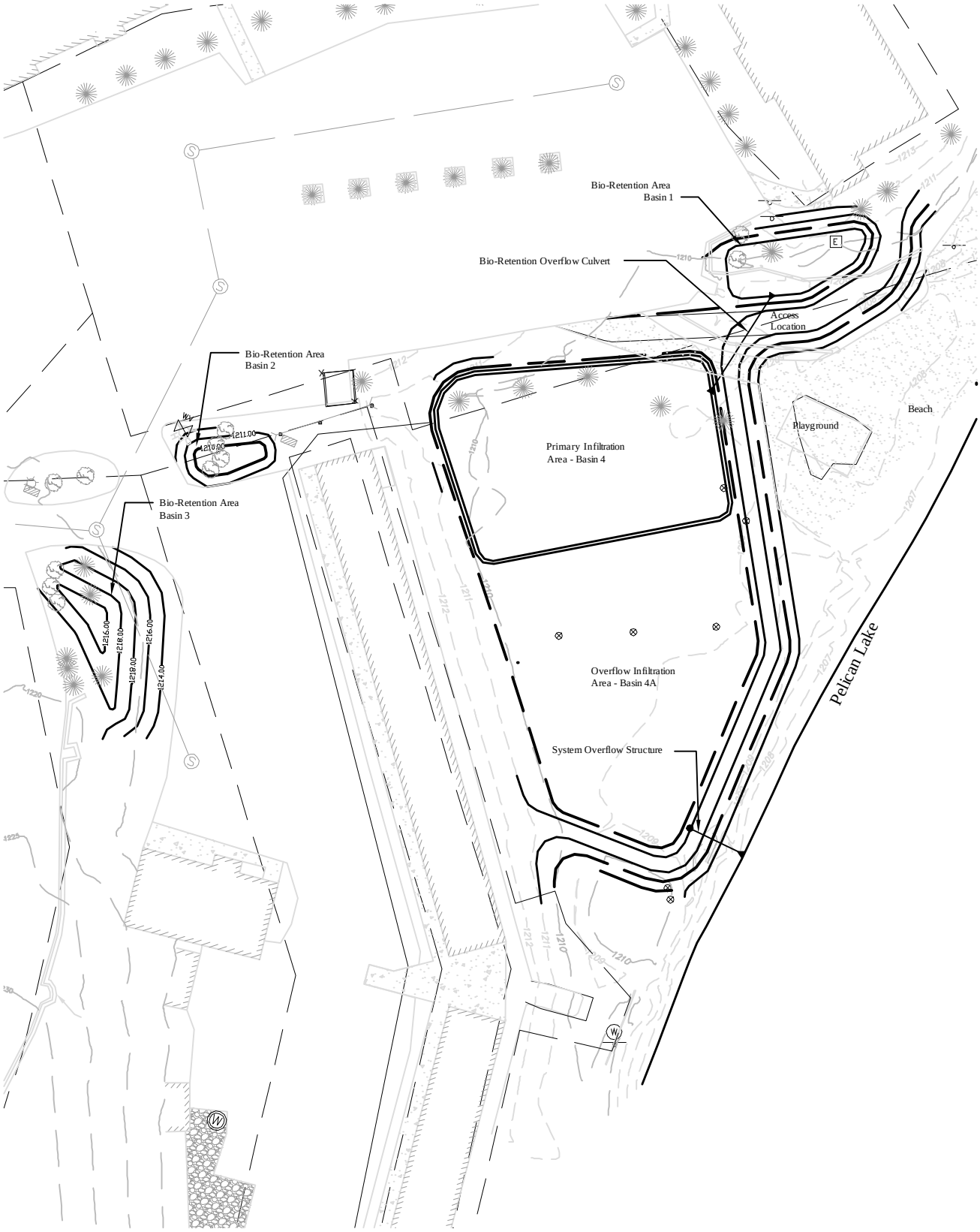
SHEET:
1 of **1**

Appendix B

Bio-retention and Infiltration Areas

Pelican Lake Stormwater Project

Breezy Point, Minnesota



SCALE: 1"=60'

Westwood Professional Services, Inc.
423 Laurel Street
Brainerd, MN 56401
Phone: (218) 829-1751 Fax: (218) 829-4733

PROJECT NAME:

Pelican Lake Stormwater Project Bio-Retention & Infiltration Areas

Breezy Point MINN.

DATE: 05/24/10 PROJECT NO. 20097607

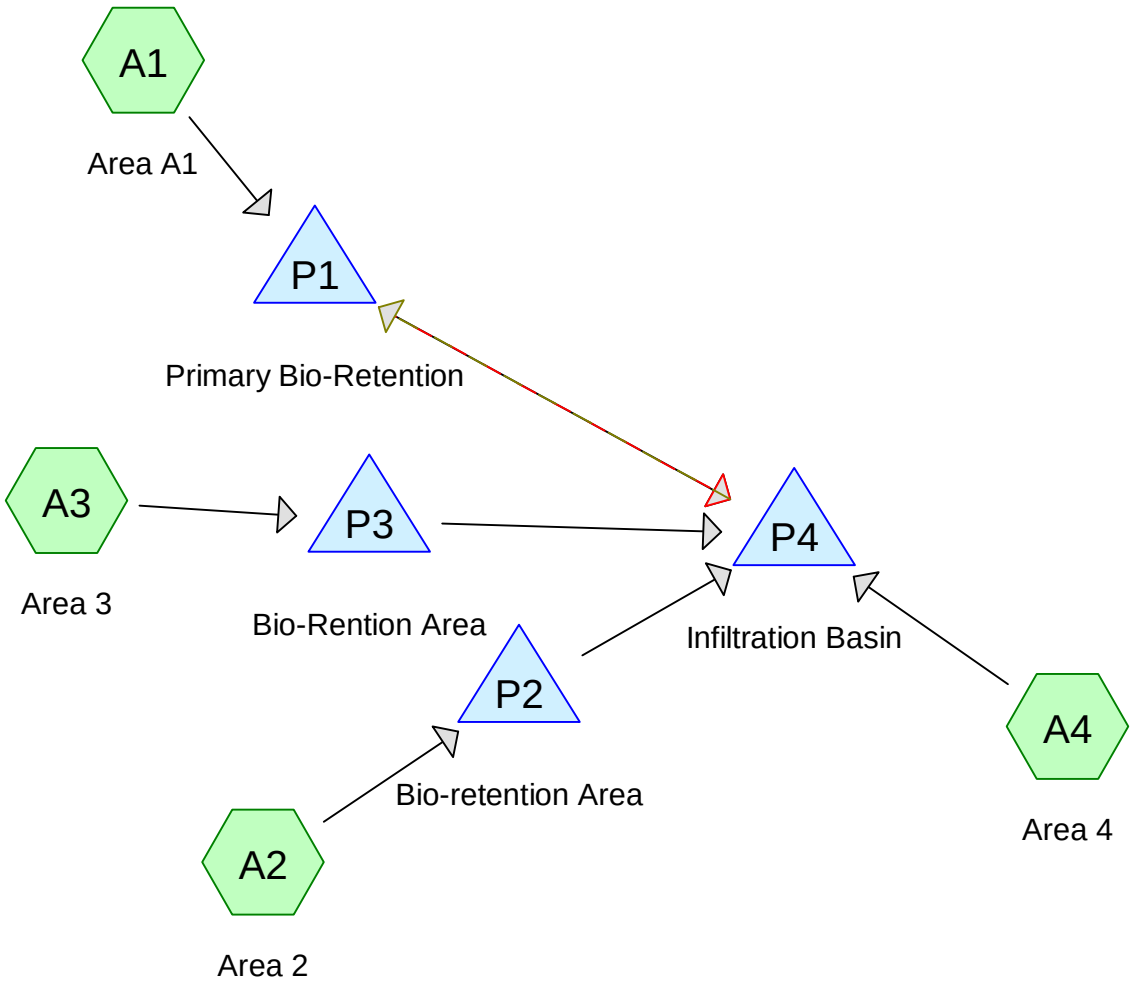
SHEET:

Appendix C

HydroCAD Analysis Reports

Pelican Lake Stormwater Project

Breezy Point, Minnesota



Subcat Reach Pond Link

Drainage Diagram for Pelican Lake Stormwater Project - Sim Routing
Prepared by Westwood Professional Services, Printed 5/21/2010

Summary for Subcatchment A1: Area A1

Runoff = 5.23 cfs @ 12.08 hrs, Volume= 0.347 af, Depth= 1.09"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 2" Event Rainfall=2.00"

Area (ac)	CN	Description
3.000	98	Paved parking, HSG B
0.810	61	>75% Grass cover, Good, HSG B
3.810	90	Weighted Average
0.810		21.26% Pervious Area
3.000		78.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.0					**Direct Entry, Overland Flow And Parking Lot Flow**

Summary for Subcatchment A2: Area 2

Runoff = 2.03 cfs @ 12.08 hrs, Volume= 0.132 af, Depth= 0.85"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 2" Event Rainfall=2.00"

Area (ac)	CN	Description
1.240	98	Paved parking, HSG B
0.620	61	>75% Grass cover, Good, HSG B
1.860	86	Weighted Average
0.620		33.33% Pervious Area
1.240		66.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Overland Flow and Pavement Flow**

Summary for Subcatchment A3: Area 3

Runoff = 0.29 cfs @ 11.99 hrs, Volume= 0.014 af, Depth= 0.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 2" Event Rainfall=2.00"

Area (ac)	CN	Description
0.135	98	Paved parking, HSG B
0.075	61	>75% Grass cover, Good, HSG B
0.210	85	Weighted Average
0.075		35.71% Pervious Area
0.135		64.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, Gutter Flow**

Summary for Subcatchment A4: Area 4

Runoff = 0.04 cfs @ 12.11 hrs, Volume= 0.008 af, Depth= 0.14"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 2" Event Rainfall=2.00"

Area (ac)	CN	Description
0.070	98	Paved parking, HSG B
0.650	61	>75% Grass cover, Good, HSG B
0.720	65	Weighted Average
0.650		90.28% Pervious Area
0.070		9.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Overland Flow**

Summary for Pond P1: Primary Bio-Retention

Inflow = 5.23 cfs @ 12.08 hrs, Volume= 0.958 af
Outflow = 5.07 cfs @ 12.12 hrs, Volume= 0.899 af, Atten= 3%, Lag= 2.3 min
Primary = 3.55 cfs @ 12.12 hrs, Volume= 0.346 af
Secondary = 1.75 cfs @ 24.26 hrs, Volume= 0.554 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,210.28' @ 21.86 hrs Surf.Area= 3,438 sf Storage= 2,645 cf

Plug-Flow detention time= 87.8 min calculated for 0.899 af (94% of inflow)
Center-of-Mass det. time= 35.3 min (1,334.5 - 1,299.2)

Volume	Invert	Avail.Storage	Storage Description
#1	1,209.00'	4,652 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,209.00	1,153	0	0
1,210.00	2,500	1,827	1,827
1,210.50	4,200	1,675	3,502
1,210.75	5,000	1,150	4,652

Device	Routing	Invert	Outlet Devices
#1	Primary	1,209.25'	**12.0" Round Culvert X 2.00** L= 44.0' RCP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 1,209.00' S= 0.0057 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished
#2	Secondary	1,210.00'	**15.0' long Broad-Crested Rectangular Weir**

Head (feet) 1.00
Coef. (English) 3.00

Primary OutFlow Max=3.55 cfs @ 12.12 hrs HW=1,210.10' TW=1,209.43' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 3.55 cfs @ 3.34 fps)

Secondary OutFlow Max=1.85 cfs @ 24.26 hrs HW=1,210.27' TW=1,210.27' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 1.85 cfs @ 0.45 fps)

Summary for Pond P2: Bio-retention Area

Inflow Area = 1.860 ac, 66.67% Impervious, Inflow Depth = 0.85" for 2" Event event
Inflow = 2.03 cfs @ 12.08 hrs, Volume= 0.132 af
Outflow = 1.07 cfs @ 12.23 hrs, Volume= 0.125 af, Atten= 47%, Lag= 9.4 min
Primary = 1.07 cfs @ 12.23 hrs, Volume= 0.125 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,211.24' @ 12.23 hrs Surf.Area= 6,177 sf Storage= 1,404 cf

Plug-Flow detention time= 56.9 min calculated for 0.125 af (95% of inflow)
Center-of-Mass det. time= 29.9 min (879.8 - 849.9)

Volume	Invert	Avail.Storage	Storage Description
#1	1,210.00'	12,474 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,210.00	288	0	0
1,211.00	830	559	559
1,212.00	23,000	11,915	12,474

Device	Routing	Invert	Outlet Devices
#1	Primary	1,210.60'	**18.0" Round Culvert** L= 40.0' CMP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 1,210.55' S= 0.0012 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=1.07 cfs @ 12.23 hrs HW=1,211.24' TW=1,209.67' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 1.07 cfs @ 2.19 fps)

Summary for Pond P3: Bio-Rention Area

Inflow Area = 0.210 ac, 64.29% Impervious, Inflow Depth = 0.80" for 2" Event event
Inflow = 0.29 cfs @ 11.99 hrs, Volume= 0.014 af
Outflow = 0.00 cfs @ 3.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 3.00 hrs, Volume= 0.000 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,217.37' @ 24.40 hrs Surf.Area= 679 sf Storage= 606 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	1,216.00'	1,099 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,216.00	204	0	0
1,218.00	895	1,099	1,099

Device	Routing	Invert	Outlet Devices
#1	Primary	1,217.60'	**6.0' long Broad-Crested Rectangular Weir** Head (feet) 1.00 Coef. (English) 3.00

Primary OutFlow Max=0.00 cfs @ 3.00 hrs HW=1,216.00' TW=1,209.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond P4: Infiltration Basin

Inflow	=	6.08 cfs @ 12.12 hrs,	Volume=	1.033 af
Outflow	=	0.99 cfs @ 24.28 hrs,	Volume=	0.663 af, Atten= 84%, Lag= 729.7 min
Primary	=	0.14 cfs @ 22.73 hrs,	Volume=	0.052 af
Secondary	=	0.00 cfs @ 3.00 hrs,	Volume=	0.000 af
Tertiary	=	0.87 cfs @ 24.28 hrs,	Volume=	0.611 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,210.27' @ 22.73 hrs Surf.Area= 20,208 sf Storage= 16,608 cf

Plug-Flow detention time= 570.8 min calculated for 0.663 af (64% of inflow)
Center-of-Mass det. time= 274.4 min (1,551.0 - 1,276.6)

Volume	Invert	Avail.Storage	Storage Description
#1	1,209.00'	31,769 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,209.00	7,959	0	0
1,209.50	8,490	4,112	4,112
1,210.00	19,739	7,057	11,170
1,211.00	21,460	20,600	31,769

Device	Routing	Invert	Outlet Devices
#1	Primary	1,208.00'	**21.0" Round Culvert** L= 28.0' RCP, square edge headwall, Ke= 0.500 Outlet Invert= 1,207.50' S= 0.0179 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished
#2	Device 1	1,210.25'	**48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Tertiary	1,209.50'	**12.0" Round Reverse flow to P1 X 2.00** L= 44.0' Ke= 0.700 Inlet Invert= 1,209.00' S= -0.0114 '/' Cc= 0.900 n= 0.012
#4	Secondary	1,210.30'	**25.0' long Broad-Crested Rectangular Weir** Head (feet) 1.00 Coef. (English) 3.00

Primary OutFlow Max=0.13 cfs @ 22.73 hrs HW=1,210.27' (Free Discharge)
└─**1=Culvert** (Passes 0.13 cfs of 13.69 cfs potential flow)
└─**2=Orifice/Grate** (Weir Controls 0.13 cfs @ 0.48 fps)

Secondary OutFlow Max=0.00 cfs @ 3.00 hrs HW=1,209.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Tertiary OutFlow Max=0.68 cfs @ 24.28 hrs HW=1,210.27' TW=1,210.25' (Dynamic Tailwater)
└─**3=Reverse flow to P1** (Inlet Controls 0.68 cfs @ 0.53 fps)

Summary for Subcatchment A1: Area A1

Runoff = 7.50 cfs @ 12.08 hrs, Volume= 0.500 af, Depth= 1.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-year Rainfall=2.55"

Area (ac)	CN	Description
3.000	98	Paved parking, HSG B
0.810	61	>75% Grass cover, Good, HSG B
3.810	90	Weighted Average
0.810		21.26% Pervious Area
3.000		78.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.0					**Direct Entry, Overland Flow And Parking Lot Flow**

Summary for Subcatchment A2: Area 2

Runoff = 3.10 cfs @ 12.07 hrs, Volume= 0.199 af, Depth= 1.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-year Rainfall=2.55"

Area (ac)	CN	Description
1.240	98	Paved parking, HSG B
0.620	61	>75% Grass cover, Good, HSG B
1.860	86	Weighted Average
0.620		33.33% Pervious Area
1.240		66.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Overland Flow and Pavement Flow**

Summary for Subcatchment A3: Area 3

Runoff = 0.44 cfs @ 11.99 hrs, Volume= 0.021 af, Depth= 1.22"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-year Rainfall=2.55"

Area (ac)	CN	Description
0.135	98	Paved parking, HSG B
0.075	61	>75% Grass cover, Good, HSG B
0.210	85	Weighted Average
0.075		35.71% Pervious Area
0.135		64.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, Gutter Flow**

Summary for Subcatchment A4: Area 4

Runoff = 0.22 cfs @ 12.07 hrs, Volume= 0.019 af, Depth= 0.32"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-year Rainfall=2.55"

Area (ac)	CN	Description
0.070	98	Paved parking, HSG B
0.650	61	>75% Grass cover, Good, HSG B
0.720	65	Weighted Average
0.650		90.28% Pervious Area
0.070		9.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Overland Flow**

Summary for Pond P1: Primary Bio-Retention

Inflow = 7.50 cfs @ 12.08 hrs, Volume= 1.208 af
Outflow = 7.42 cfs @ 12.11 hrs, Volume= 1.151 af, Atten= 1%, Lag= 1.7 min
Primary = 4.00 cfs @ 12.11 hrs, Volume= 0.360 af
Secondary = 3.40 cfs @ 12.11 hrs, Volume= 0.791 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,210.32' @ 13.71 hrs Surf.Area= 3,586 sf Storage= 2,799 cf

Plug-Flow detention time= 73.9 min calculated for 1.151 af (95% of inflow)
Center-of-Mass det. time= 28.7 min (1,229.4 - 1,200.7)

Volume	Invert	Avail.Storage	Storage Description
#1	1,209.00'	4,652 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,209.00	1,153	0	0
1,210.00	2,500	1,827	1,827
1,210.50	4,200	1,675	3,502
1,210.75	5,000	1,150	4,652

Device	Routing	Invert	Outlet Devices
#1	Primary	1,209.25'	**12.0" Round Culvert X 2.00** L= 44.0' RCP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 1,209.00' S= 0.0057 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished
#2	Secondary	1,210.00'	**15.0' long Broad-Crested Rectangular Weir**

Head (feet) 1.00
Coef. (English) 3.00

Primary OutFlow Max=3.91 cfs @ 12.11 hrs HW=1,210.18' TW=1,209.72' (Dynamic Tailwater)
└**1=Culvert** (Outlet Controls 3.91 cfs @ 3.34 fps)

Secondary OutFlow Max=3.39 cfs @ 12.11 hrs HW=1,210.18' TW=1,209.71' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 3.39 cfs @ 1.27 fps)

Summary for Pond P2: Bio-retention Area

Inflow Area = 1.860 ac, 66.67% Impervious, Inflow Depth = 1.28" for 2-year event
Inflow = 3.10 cfs @ 12.07 hrs, Volume= 0.199 af
Outflow = 1.46 cfs @ 12.25 hrs, Volume= 0.193 af, Atten= 53%, Lag= 10.4 min
Primary = 1.46 cfs @ 12.25 hrs, Volume= 0.193 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,211.35' @ 12.25 hrs Surf.Area= 8,660 sf Storage= 2,235 cf

Plug-Flow detention time= 46.0 min calculated for 0.193 af (97% of inflow)
Center-of-Mass det. time= 27.5 min (865.5 - 838.0)

Volume	Invert	Avail.Storage	Storage Description
#1	1,210.00'	12,474 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,210.00	288	0	0
1,211.00	830	559	559
1,212.00	23,000	11,915	12,474

Device	Routing	Invert	Outlet Devices
#1	Primary	1,210.60'	**18.0" Round Culvert** L= 40.0' CMP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 1,210.55' S= 0.0012 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=1.46 cfs @ 12.25 hrs HW=1,211.35' TW=1,209.96' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 1.46 cfs @ 2.40 fps)

Summary for Pond P3: Bio-Rention Area

Inflow Area = 0.210 ac, 64.29% Impervious, Inflow Depth = 1.22" for 2-year event
Inflow = 0.44 cfs @ 11.99 hrs, Volume= 0.021 af
Outflow = 0.01 cfs @ 17.31 hrs, Volume= 0.004 af, Atten= 98%, Lag= 319.4 min
Primary = 0.01 cfs @ 17.31 hrs, Volume= 0.004 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,217.61' @ 17.31 hrs Surf.Area= 759 sf Storage= 773 cf

Plug-Flow detention time= 520.9 min calculated for 0.004 af (17% of inflow)
Center-of-Mass det. time= 379.3 min (1,213.7 - 834.4)

Volume	Invert	Avail.Storage	Storage Description
#1	1,216.00'	1,099 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,216.00	204	0	0
1,218.00	895	1,099	1,099

Device	Routing	Invert	Outlet Devices
#1	Primary	1,217.60'	**6.0' long Broad-Crested Rectangular Weir** Head (feet) 1.00 Coef. (English) 3.00

Primary OutFlow Max=0.01 cfs @ 17.31 hrs HW=1,217.61' TW=1,210.29' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.01 cfs @ 0.23 fps)

Summary for Pond P4: Infiltration Basin

Inflow	=	8.89 cfs @ 12.11 hrs,	Volume=	1.365 af
Outflow	=	1.56 cfs @ 13.73 hrs,	Volume=	0.994 af, Atten= 82%, Lag= 97.6 min
Primary	=	0.62 cfs @ 13.72 hrs,	Volume=	0.283 af
Secondary	=	0.09 cfs @ 13.72 hrs,	Volume=	0.004 af
Tertiary	=	0.89 cfs @ 13.73 hrs,	Volume=	0.708 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,210.31' @ 13.72 hrs Surf.Area= 20,275 sf Storage= 17,398 cf

Plug-Flow detention time= 415.2 min calculated for 0.994 af (73% of inflow)
Center-of-Mass det. time= 179.1 min (1,351.8 - 1,172.7)

Volume	Invert	Avail.Storage	Storage Description
#1	1,209.00'	31,769 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,209.00	7,959	0	0
1,209.50	8,490	4,112	4,112
1,210.00	19,739	7,057	11,170
1,211.00	21,460	20,600	31,769

Device	Routing	Invert	Outlet Devices
#1	Primary	1,208.00'	**21.0" Round Culvert** L= 28.0' RCP, square edge headwall, Ke= 0.500 Outlet Invert= 1,207.50' S= 0.0179 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished
#2	Device 1	1,210.25'	**48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Tertiary	1,209.50'	**12.0" Round Reverse flow to P1 X 2.00** L= 44.0' Ke= 0.700 Inlet Invert= 1,209.00' S= -0.0114 '/' Cc= 0.900 n= 0.012
#4	Secondary	1,210.30'	**25.0' long Broad-Crested Rectangular Weir** Head (feet) 1.00 Coef. (English) 3.00

Primary OutFlow Max=0.61 cfs @ 13.72 hrs HW=1,210.31' (Free Discharge)
└**1=Culvert** (Passes 0.61 cfs of 13.88 cfs potential flow)
└**2=Orifice/Grate** (Weir Controls 0.61 cfs @ 0.81 fps)

Secondary OutFlow Max=0.08 cfs @ 13.72 hrs HW=1,210.31' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Weir Controls 0.08 cfs @ 0.31 fps)

Tertiary OutFlow Max=0.61 cfs @ 13.73 hrs HW=1,210.31' TW=1,210.30' (Dynamic Tailwater)
└**3=Reverse flow to P1** (Inlet Controls 0.61 cfs @ 0.45 fps)

Summary for Subcatchment A1: Area A1

Runoff = 13.20 cfs @ 12.07 hrs, Volume= 0.897 af, Depth= 2.82"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-year Rainfall=3.90"

Area (ac)	CN	Description
3.000	98	Paved parking, HSG B
0.810	61	>75% Grass cover, Good, HSG B
3.810	90	Weighted Average
0.810		21.26% Pervious Area
3.000		78.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.0					**Direct Entry, Overland Flow And Parking Lot Flow**

Summary for Subcatchment A2: Area 2

Runoff = 5.88 cfs @ 12.07 hrs, Volume= 0.381 af, Depth= 2.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-year Rainfall=3.90"

Area (ac)	CN	Description
1.240	98	Paved parking, HSG B
0.620	61	>75% Grass cover, Good, HSG B
1.860	86	Weighted Average
0.620		33.33% Pervious Area
1.240		66.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Overland Flow and Pavement Flow**

Summary for Subcatchment A3: Area 3

Runoff = 0.84 cfs @ 11.98 hrs, Volume= 0.041 af, Depth= 2.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-year Rainfall=3.90"

Area (ac)	CN	Description
0.135	98	Paved parking, HSG B
0.075	61	>75% Grass cover, Good, HSG B
0.210	85	Weighted Average
0.075		35.71% Pervious Area
0.135		64.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, Gutter Flow**

Summary for Subcatchment A4: Area 4

Runoff = 0.93 cfs @ 12.05 hrs, Volume= 0.058 af, Depth= 0.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-year Rainfall=3.90"

Area (ac)	CN	Description
0.070	98	Paved parking, HSG B
0.650	61	>75% Grass cover, Good, HSG B
0.720	65	Weighted Average
0.650		90.28% Pervious Area
0.070		9.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Overland Flow**

Summary for Pond P1: Primary Bio-Retention

Inflow = 13.20 cfs @ 12.07 hrs, Volume= 1.609 af
Outflow = 12.11 cfs @ 12.08 hrs, Volume= 1.551 af, Atten= 8%, Lag= 0.6 min
Primary = 3.64 cfs @ 12.02 hrs, Volume= 0.444 af
Secondary = 9.04 cfs @ 12.10 hrs, Volume= 1.107 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,210.47' @ 12.26 hrs Surf.Area= 4,096 sf Storage= 3,374 cf

Plug-Flow detention time= 57.6 min calculated for 1.550 af (96% of inflow)
Center-of-Mass det. time= 20.1 min (1,122.4 - 1,102.3)

Volume	Invert	Avail.Storage	Storage Description
#1	1,209.00'	4,652 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,209.00	1,153	0	0
1,210.00	2,500	1,827	1,827
1,210.50	4,200	1,675	3,502
1,210.75	5,000	1,150	4,652

Device	Routing	Invert	Outlet Devices
#1	Primary	1,209.25'	**12.0" Round Culvert X 2.00** L= 44.0' RCP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 1,209.00' S= 0.0057 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished
#2	Secondary	1,210.00'	**15.0' long Broad-Crested Rectangular Weir**

Head (feet) 1.00
Coef. (English) 3.00

Primary OutFlow Max=3.50 cfs @ 12.02 hrs HW=1,210.28' TW=1,209.99' (Dynamic Tailwater)
└**1=Culvert** (Outlet Controls 3.50 cfs @ 2.69 fps)

Secondary OutFlow Max=8.61 cfs @ 12.10 hrs HW=1,210.38' TW=1,210.21' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 8.61 cfs @ 1.51 fps)

Summary for Pond P2: Bio-retention Area

Inflow Area = 1.860 ac, 66.67% Impervious, Inflow Depth = 2.46" for 10-year event
Inflow = 5.88 cfs @ 12.07 hrs, Volume= 0.381 af
Outflow = 2.35 cfs @ 12.27 hrs, Volume= 0.374 af, Atten= 60%, Lag= 12.2 min
Primary = 2.35 cfs @ 12.27 hrs, Volume= 0.374 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,211.57' @ 12.27 hrs Surf.Area= 13,437 sf Storage= 4,616 cf

Plug-Flow detention time= 37.7 min calculated for 0.374 af (98% of inflow)
Center-of-Mass det. time= 27.4 min (846.9 - 819.5)

Volume	Invert	Avail.Storage	Storage Description
#1	1,210.00'	12,474 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,210.00	288	0	0
1,211.00	830	559	559
1,212.00	23,000	11,915	12,474

Device	Routing	Invert	Outlet Devices
#1	Primary	1,210.60'	**18.0" Round Culvert** L= 40.0' CMP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 1,210.55' S= 0.0012 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=2.35 cfs @ 12.27 hrs HW=1,211.57' TW=1,210.45' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 2.35 cfs @ 2.77 fps)

Summary for Pond P3: Bio-Rention Area

Inflow Area = 0.210 ac, 64.29% Impervious, Inflow Depth = 2.37" for 10-year event
Inflow = 0.84 cfs @ 11.98 hrs, Volume= 0.041 af
Outflow = 0.45 cfs @ 12.08 hrs, Volume= 0.024 af, Atten= 47%, Lag= 5.7 min
Primary = 0.45 cfs @ 12.08 hrs, Volume= 0.024 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,217.69' @ 12.08 hrs Surf.Area= 786 sf Storage= 835 cf

Plug-Flow detention time= 206.1 min calculated for 0.024 af (57% of inflow)
Center-of-Mass det. time= 94.6 min (910.0 - 815.4)

Volume	Invert	Avail.Storage	Storage Description
#1	1,216.00'	1,099 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,216.00	204	0	0
1,218.00	895	1,099	1,099

Device	Routing	Invert	Outlet Devices
#1	Primary	1,217.60'	**6.0' long Broad-Crested Rectangular Weir** Head (feet) 1.00 Coef. (English) 3.00

Primary OutFlow Max=0.45 cfs @ 12.08 hrs HW=1,217.69' TW=1,210.15' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.45 cfs @ 0.88 fps)

Summary for Pond P4: Infiltration Basin

Inflow	=	15.32 cfs @	12.08 hrs, Volume=	2.007 af
Outflow	=	8.22 cfs @	12.29 hrs, Volume=	1.637 af, Atten= 46%, Lag= 12.2 min
Primary	=	3.75 cfs @	12.29 hrs, Volume=	0.658 af
Secondary	=	4.47 cfs @	12.29 hrs, Volume=	0.266 af
Tertiary	=	0.90 cfs @	14.65 hrs, Volume=	0.713 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,210.45' @ 12.29 hrs Surf.Area= 20,518 sf Storage= 20,281 cf

Plug-Flow detention time= 265.6 min calculated for 1.636 af (82% of inflow)
Center-of-Mass det. time= 96.7 min (1,158.2 - 1,061.5)

Volume	Invert	Avail.Storage	Storage Description
#1	1,209.00'	31,769 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,209.00	7,959	0	0
1,209.50	8,490	4,112	4,112
1,210.00	19,739	7,057	11,170
1,211.00	21,460	20,600	31,769

Device	Routing	Invert	Outlet Devices
#1	Primary	1,208.00'	**21.0" Round Culvert** L= 28.0' RCP, square edge headwall, Ke= 0.500 Outlet Invert= 1,207.50' S= 0.0179 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished
#2	Device 1	1,210.25'	**48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Tertiary	1,209.50'	**12.0" Round Reverse flow to P1 X 2.00** L= 44.0' Ke= 0.700 Inlet Invert= 1,209.00' S= -0.0114 '/' Cc= 0.900 n= 0.012
#4	Secondary	1,210.30'	**25.0' long Broad-Crested Rectangular Weir** Head (feet) 1.00 Coef. (English) 3.00

Primary OutFlow Max=3.75 cfs @ 12.29 hrs HW=1,210.45' (Free Discharge)
└**1=Culvert** (Passes 3.75 cfs of 14.55 cfs potential flow)
└**2=Orifice/Grate** (Weir Controls 3.75 cfs @ 1.47 fps)

Secondary OutFlow Max=4.47 cfs @ 12.29 hrs HW=1,210.45' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Weir Controls 4.47 cfs @ 1.17 fps)

Tertiary OutFlow Max=0.60 cfs @ 14.65 hrs HW=1,210.32' TW=1,210.31' (Dynamic Tailwater)
└**3=Reverse flow to P1** (Inlet Controls 0.60 cfs @ 0.44 fps)

Summary for Subcatchment A1: Area A1

Runoff = 20.38 cfs @ 12.07 hrs, Volume= 1.415 af, Depth= 4.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-year Rainfall=5.60"

Area (ac)	CN	Description
3.000	98	Paved parking, HSG B
0.810	61	>75% Grass cover, Good, HSG B
3.810	90	Weighted Average
0.810		21.26% Pervious Area
3.000		78.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.0					**Direct Entry, Overland Flow And Parking Lot Flow**

Summary for Subcatchment A2: Area 2

Runoff = 9.48 cfs @ 12.07 hrs, Volume= 0.625 af, Depth= 4.03"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-year Rainfall=5.60"

Area (ac)	CN	Description
1.240	98	Paved parking, HSG B
0.620	61	>75% Grass cover, Good, HSG B
1.860	86	Weighted Average
0.620		33.33% Pervious Area
1.240		66.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Overland Flow and Pavement Flow**

Summary for Subcatchment A3: Area 3

Runoff = 1.36 cfs @ 11.98 hrs, Volume= 0.069 af, Depth= 3.93"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-year Rainfall=5.60"

Area (ac)	CN	Description
0.135	98	Paved parking, HSG B
0.075	61	>75% Grass cover, Good, HSG B
0.210	85	Weighted Average
0.075		35.71% Pervious Area
0.135		64.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0					**Direct Entry, Gutter Flow**

Summary for Subcatchment A4: Area 4

Runoff = 2.10 cfs @ 12.04 hrs, Volume= 0.124 af, Depth= 2.06"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-year Rainfall=5.60"

Area (ac)	CN	Description
0.070	98	Paved parking, HSG B
0.650	61	>75% Grass cover, Good, HSG B
0.720	65	Weighted Average
0.650		90.28% Pervious Area
0.070		9.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Overland Flow**

Summary for Pond P1: Primary Bio-Retention

Inflow = 20.38 cfs @ 12.07 hrs, Volume= 2.118 af
Outflow = 19.17 cfs @ 12.10 hrs, Volume= 2.061 af, Atten= 6%, Lag= 1.7 min
Primary = 2.52 cfs @ 12.07 hrs, Volume= 0.549 af
Secondary = 16.70 cfs @ 12.10 hrs, Volume= 1.512 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,210.73' @ 12.13 hrs Surf.Area= 4,938 sf Storage= 4,555 cf

Plug-Flow detention time= 45.6 min calculated for 2.061 af (97% of inflow)
Center-of-Mass det. time= 15.5 min (1,039.5 - 1,024.0)

Volume	Invert	Avail.Storage	Storage Description
#1	1,209.00'	4,652 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,209.00	1,153	0	0
1,210.00	2,500	1,827	1,827
1,210.50	4,200	1,675	3,502
1,210.75	5,000	1,150	4,652

Device	Routing	Invert	Outlet Devices
#1	Primary	1,209.25'	**12.0" Round Culvert X 2.00** L= 44.0' RCP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 1,209.00' S= 0.0057 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished
#2	Secondary	1,210.00'	**15.0' long Broad-Crested Rectangular Weir**

Head (feet) 1.00
Coef. (English) 3.00

Primary OutFlow Max=2.39 cfs @ 12.07 hrs HW=1,210.69' TW=1,210.56' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 2.39 cfs @ 1.52 fps)

Secondary OutFlow Max=16.30 cfs @ 12.10 hrs HW=1,210.72' TW=1,210.60' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 16.30 cfs @ 1.50 fps)

Summary for Pond P2: Bio-retention Area

Inflow Area = 1.860 ac, 66.67% Impervious, Inflow Depth = 4.03" for 100-year event
Inflow = 9.48 cfs @ 12.07 hrs, Volume= 0.625 af
Outflow = 3.36 cfs @ 12.29 hrs, Volume= 0.618 af, Atten= 65%, Lag= 13.4 min
Primary = 3.36 cfs @ 12.29 hrs, Volume= 0.618 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,211.78' @ 12.29 hrs Surf.Area= 18,216 sf Storage= 8,027 cf

Plug-Flow detention time= 35.4 min calculated for 0.618 af (99% of inflow)
Center-of-Mass det. time= 29.1 min (834.5 - 805.4)

Volume	Invert	Avail.Storage	Storage Description
#1	1,210.00'	12,474 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,210.00	288	0	0
1,211.00	830	559	559
1,212.00	23,000	11,915	12,474

Device	Routing	Invert	Outlet Devices
#1	Primary	1,210.60'	**18.0" Round Culvert** L= 40.0' CMP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 1,210.55' S= 0.0012 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=3.36 cfs @ 12.29 hrs HW=1,211.78' TW=1,210.56' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 3.36 cfs @ 3.08 fps)

Summary for Pond P3: Bio-Rention Area

Inflow Area = 0.210 ac, 64.29% Impervious, Inflow Depth = 3.93" for 100-year event
Inflow = 1.36 cfs @ 11.98 hrs, Volume= 0.069 af
Outflow = 1.34 cfs @ 12.00 hrs, Volume= 0.051 af, Atten= 1%, Lag= 1.2 min
Primary = 1.34 cfs @ 12.00 hrs, Volume= 0.051 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,217.78' @ 12.00 hrs Surf.Area= 818 sf Storage= 908 cf

Plug-Flow detention time= 144.8 min calculated for 0.051 af (74% of inflow)
Center-of-Mass det. time= 53.1 min (854.1 - 801.0)

Volume	Invert	Avail.Storage	Storage Description
#1	1,216.00'	1,099 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,216.00	204	0	0
1,218.00	895	1,099	1,099

Device	Routing	Invert	Outlet Devices
#1	Primary	1,217.60'	**6.0' long Broad-Crested Rectangular Weir** Head (feet) 1.00 Coef. (English) 3.00

Primary OutFlow Max=1.34 cfs @ 12.00 hrs HW=1,217.78' TW=1,210.44' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 1.34 cfs @ 1.26 fps)

Summary for Pond P4: Infiltration Basin

Inflow	=	24.49 cfs @	12.09 hrs, Volume=	2.854 af
Outflow	=	22.42 cfs @	12.16 hrs, Volume=	2.483 af, Atten= 8%, Lag= 4.0 min
Primary	=	9.10 cfs @	12.16 hrs, Volume=	1.065 af
Secondary	=	13.32 cfs @	12.16 hrs, Volume=	0.714 af
Tertiary	=	0.90 cfs @	16.09 hrs, Volume=	0.704 af

Routing by Sim-Route method, Time Span= 3.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 1,210.62' @ 12.16 hrs Surf.Area= 20,799 sf Storage= 23,654 cf

Plug-Flow detention time= 185.5 min calculated for 2.483 af (87% of inflow)
Center-of-Mass det. time= 62.3 min (1,046.1 - 983.8)

Volume	Invert	Avail.Storage	Storage Description
#1	1,209.00'	31,769 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,209.00	7,959	0	0
1,209.50	8,490	4,112	4,112
1,210.00	19,739	7,057	11,170
1,211.00	21,460	20,600	31,769

Device	Routing	Invert	Outlet Devices
#1	Primary	1,208.00'	**21.0" Round Culvert** L= 28.0' RCP, square edge headwall, Ke= 0.500 Outlet Invert= 1,207.50' S= 0.0179 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished
#2	Device 1	1,210.25'	**48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Tertiary	1,209.50'	**12.0" Round Reverse flow to P1 X 2.00** L= 44.0' Ke= 0.700 Inlet Invert= 1,209.00' S= -0.0114 '/' Cc= 0.900 n= 0.012
#4	Secondary	1,210.30'	**25.0' long Broad-Crested Rectangular Weir** Head (feet) 1.00 Coef. (English) 3.00

Primary OutFlow Max=9.10 cfs @ 12.16 hrs HW=1,210.62' (Free Discharge)
└**1=Culvert** (Passes 9.10 cfs of 15.28 cfs potential flow)
└**2=Orifice/Grate** (Weir Controls 9.10 cfs @ 1.98 fps)

Secondary OutFlow Max=13.32 cfs @ 12.16 hrs HW=1,210.62' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Weir Controls 13.32 cfs @ 1.69 fps)

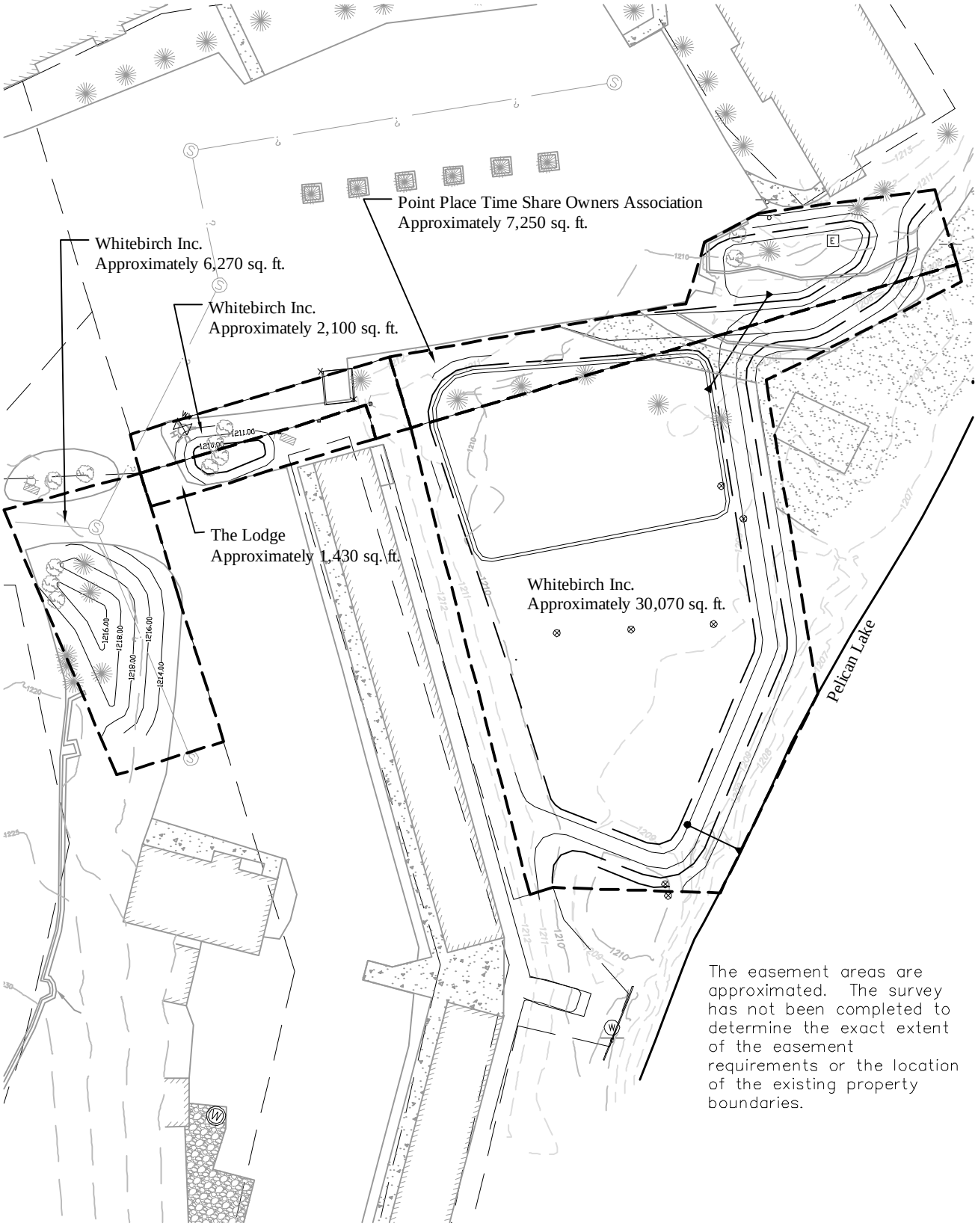
Tertiary OutFlow Max=0.59 cfs @ 16.09 hrs HW=1,210.32' TW=1,210.31' (Dynamic Tailwater)
└**3=Reverse flow to P1** (Inlet Controls 0.59 cfs @ 0.43 fps)

Appendix D

Easement Locations Map

Pelican Lake Stormwater Project

Breezy Point, Minnesota



SCALE: 1"=60'

Westwood Professional Services, Inc.
423 Laurel Street
Brainerd, MN 56401
Phone: (218) 829-1751 Fax: (218) 829-4733

PROJECT NAME:

Pelican Lake Stormwater Project Easement Locations Map

Breezy Point MINN.

DATE: 05/24/10 PROJECT NO. 20097607

SHEET: 1 of 1

Appendix E

Opinion of Probable Costs

Pelican Lake Stormwater Project

Breezy Point, Minnesota

Opinion of Probable Costs
Pelican Lake Stormwater Project
Breezy Point, Minnesota

Description	Unit	Estimated Quantity	Inflated Quantity	Unit Price	Total Price
GRADING					
Clearing and Grubbing (P)	A.C.	0.1	0	$3,000.00	$300.00
Common Excavation(EV) (P)	C.Y.	500	500	$3.00	$1,500.00
Removal of Existing Pond Liner and Materials (EV)	C.Y.	120	126	$10.00	$1,260.00
Import Common Borrow for Controlled Fill (CV)	C.Y.	600	630	$10.00	$6,300.00
Re-spread Topsoil (CV) (P)	C.Y.	450	450	$4.00	$1,800.00
Subtotal Grading					**$11,160.00**
EROSION CONTROL					
Rock Construction Entrance	EACH	1	1	$1,200.00	$1,200.00
Silt Fence (type regular)	L.F.	400	400	$1.50	$600.00
Seeding & Mulching MNDOT 250 (P)	ACRE	1.0	1	$3,500.00	$3,500.00
Bio-retention area soil amendment and planting (P)	S.F.	600.0	600	$12.00	$7,200.00
Class II Rip Rap	C.Y.	35.0	37	$80.00	$2,960.00
Subtotal Erosion Control					**$15,460.00**
STORM SEWER					
12" RC Pipe, (all depths)	L.F.	88	88	24.50	$2,156.00
21" RC Pipe, (all depths)	L.F.	28	28	32.00	$896.00
Pond Overflow Structure	EACH	1	1	1500.00	$1,500.00
Subtotal Storm Sewer					**$4,552.00**

SUMMARY

Subtotal Grading	**$11,160.00**
Subtotal Erosion Control	**$15,460.00**
Subtotal Storm Sewer	**$4,552.00**
SUBTOTAL	**$31,172.00**
Mobilization (5 percent maximum)	**$1,558.60**
Contingencies (19 percent)	**$5,894.63**
TOTAL	**$38,625.23**
Engineering Fees	**$11,500.00**
Administration Fees	**$1,325.00**
Easement Acquisition	**$0.00**
Survey, Legal Descriptions, Title Work and Meetings with Owners	**$4,000.00**
GRAND TOTAL	**$55,450.23**

Opinions of Probable Construction Cost

CONSULTANT's opinions of probable Construction Cost provided for herein are to be made on the basis of CONSULTANT's experience and qualifications and represent CONSULTANT's best judgement as an experienced and qualified professional generally familiar with the industry. However, since CONSULTANT has no control over the cost of labor, materials, equipment, or services furnished by others, or over the Contractor's methods of determining prices, or over competitive bidding or market conditions, CONSULTANT cannot and does not guarantee that proposals, bids, or actual Construction Cost will not vary from opinions of probable Construction Cost prepared by CONSULTANT. If OWNER wishes greater assurance as to probable Construction Costs, OWNER shall employ an independent cost estimator.