CLARK CREEK WATERSHED STUDY

TECHNICAL MEMORANDUM 2

MAY 2012

PREPARED FOR

SAUK COUNTY, WISCONSIN
CONSERVATION, PLANNING AND ZONING DEPARTMENT

Montgomery Associates
Resource Solutions, LLC

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LIST OF ATTACHMENTS

1 Introduction

1.1 Background

The Clark Creek watershed experienced extreme flooding in June of 2008, causing extensive damage to private and public property on State Highway (STH) 113 south of Baraboo, Wisconsin. The Clark Creek watershed has experienced repeated damaging and hazardous flooding such as the 2008 event over the last 20 years. An initial evaluation of the flooding issues on Clark Creek and potential mitigation actions was completed by the Federal Emergency Management Agency (FEMA) in September 2008. In 2010 and 2011 a follow-up study was conducted by Montgomery Associates: resource solutions, LLC (MARS) for Sauk County to evaluate potential measures to mitigate damages due to future floods similar to the June 2008 event and to recommend which options are likely to be feasible and cost effective. The MARS report was issued in March 2011 and recommended a set of potential alternatives for flood mitigation which included creation of floodwater storage areas in the upstream portions of the Clark Creek watershed.

Based on the results of the MARS study, Sauk County chose to pursue multiple flood mitigation options, including construction of upland storage areas for flood peak flow reduction (**Figure 1**) and hired MARS to further develop the feasibility of constructing these upland storage areas. In a previous technical memorandum dated January 2012, MARS evaluated flood storage on the "Quarry Tributary" (storage areas 5, 6 and 12 on **Figure 1**) and the existing wetland area north of Tower Road near Neuman Road (Area 7 on **Figure 1**). That analysis concluded that constructing storage areas on the Quarry Tributary could reduce downstream peak discharge for a large flood similar to the June 2008 event by 11 – 15%, depending on the basin construction details. Additional storage in the wetland north of Tower Road was found to have minor downstream peak attenuation benefit and be subject to considerable environmental constraints.

1.2 This Study

As directed by Sauk County, this study evaluated flood storage potential at 3 locations in the headwaters of the "Southern Tributary" of Clark Creek, shown on **Figure 1** as storage areas 2, 3 and 4. Land in these areas is owned by the Wisconsin Department of Natural Resources (DNR) and currently leased for crop production; however, DNR plans to convert these locations to natural land management in the near future. Flood mitigation potential was evaluated as the peak flow reduction that would be realized in the reach of Clark Creek adjacent to STH 113 during a very large flood similar to the June 2008 event. The conceptual designs evaluated in this study also have the objective of minimizing impacts on fish habitat, as described below.

2 Data Sources and Methods

2.1 Data Sources

HEC-HMS model
We developed a rainfall-runoff model for the watershed using the U.S. Army Corps of Engineers watershed analysis program HEC-HMS, based on an original model developed by the DNR which was modified for our work completed in 2011. We modified this model to account for alternative storage area locations reported on in this memorandum. We use the same design storm data descriptions as were used in our 2011 report and in Technical Memorandum 1 issued in January 2012. The schematic layout of the subwatersheds and the linkages between them are shown in **Appendix A**.

Rainfall depths and distribution used
Based on the analysis in the MARS 2011 Watershed Study, the June 2008 flood (Design Flood) on Clark Creek was simulated using the FEMA FIS 100-year rainfall of 5.92 inches under extremely wet soil conditions. The DNR hydrologic model was modified to reflect this wet condition by adjusting runoff curve numbers from the typical Antecedent Moisture Condition 2 (used in the FEMA study) to Antecedent Moisture Condition 3 (representing very wet soil).

The Wisconsin DNR hydrologic analysis for the FEMA FIS describes 24-hour rainfall depths in the Clark Creek watershed as shown in **Table 1** using the rainfall distribution curve based on large events in the City of Madison. The same rainfall distribution, depth and duration were used for the design flood event used in this analysis. Additionally, the 1- and 2-year events are represented by the Sauk County rainfall depth from technical paper 40.

Table 1. 24-hour rainfall depths

Storm Event	Rainfall Depth (in)
1-year storm:	2.5
2-year storm:	2.9
100-year storm Design Storm:	5.92

Topography
Two foot contour data from Sauk County was used in defining the storage area volume.

2.2 Methods

The analysis was completed by modifying the DNR HEC-HMS model to include storage at the proposed locations. Storage areas were modeled as basins formed by low berms. The low flow outlets were modeled as culverts for simplicity, however other types of outlet structures could be considered for final design. A safe overflow flow path using an 50-foot long weir at a specified elevation that defines the height of the berm was used, with the assumption that the berm would have an additional 1-foot freeboard from the overflow elevation. The habitat considerations were evaluated by designing the outlet culvert to pass the 1- and 2-year events without headwater; i.e. the culvert would not create a hydraulic restriction for the 2-year event. The flood discharge peak attenuation was analyzed using the design flood conditions (see **Section 2.3**). Peak flow was evaluated at the HEC-HMS component located 1000 feet upstream of STH 113, representing the reach of Clark Creek that experienced the most substantial damages in the June 2008 flood.

Hydrology

In order to accurately represent the runoff volume and peak flow from the tributary areas to the storage areas, subwatershed R80W60 representing the Southern Tributary included in the USACE Hec-HMS was subdivided into three subwatersheds: 61, 62, and 63. Additionally, curve numbers and times of concentration were re-calculated for each of the three subwatersheds based on the respective land use characteristics and longest flow path according to TR-55 methodology. **Table 2** summarizes the changes in the hydrologic model watersheds.

Table 2. Modifications to HEC-HMS model watersheds.

Subwatershed	Area (Acres)	CN (AMC II)	CN (AMC III)	Tc (min.)
DNR model				
R80W60	323.4	61.0	78.0	121
Modified model				
61	70.7	71.7	84.9	50
62	27.6	55.0	73.8	85
63	225.1	60.2	77.3	106

Figure 2 shows the redefined subwatersheds and the longest flow path used to calculate the time of concentration. Subwatershed 61 is below the storage areas and is therefore not detained by the new storage areas, while subwatershed 63 is fully above the storage areas and is routed through them. Subwatershed 62, on the other hand, drains under STH 113 and currently follows a flow path that, if left unchanged, would by-pass the storage areas. In this study, it was assumed that discharge from subwatershed 62 would be redirected by grading a swale from the crossing under STH 113 and into storage area 2.

Note that subwatershed 62 primarily includes the agricultural field south of Tower Rd., and that the relatively high runoff curve number reflects the current row crop land use. When this area is taken out of agricultural production and restored to native vegetation, according to DNR's long-term plans, less runoff should be generated by this area.

Storage Areas – Stage-Area Relationships

The analysis for the Southern Tributary was completed by modifying the DNR HEC-HMS model to include new storage areas at proposed locations with stage-area relationships based on topographic data using the Sauk County 2-foot contours. The height of the berms used to provide the storage areas was defined as the greatest elevation from the culvert invert to the weir overflow elevation. An Additional 1-foot of freeboard was assumed between the overflow weir elevation and the top of the berm to provide for safe passage of discharge. These storage areas would not be classified as large dams subject to NR 333 based on either height or storage capacity.

Two berm elevation scenarios were used in the analysis: 4-foot and 6-foot-high berms. For each of these configurations, a stage-area relationship developed using the Sauk County 2-foot contours was used to define the capacity of the storage areas. **Table 3** shows the stage-area relationships that were used in developing the model scenarios.

Table 3. Stage-area relationships.

	4ft berm height		6 ft berm height	
Elevation (feet)	Cumulative area (acres)	Cumulative volume (acre-feet)	Cumulative area (acres)	Cumulative volume (acre-feet)
		Area 2		
1246	0	0	0	0
1248	0.61	0.61	0.61	0.61
1250	3.18	4.40	3.18	4.40
1252			4.13	11.7
		Area 3		
1250	0	0	0	0
1252	7.30	7.30	7.30	7.30
1254	15.2	29.8	15.2	29.8
1256			24.1	69.1
		Area 4		
1254	0	0	0	0
1256	6.69	6.69	6.69	6.69
1258	13.0	26.3	13.0	26.3
1260			18.6	58.0

The storage areas were all assumed to be in-line structures, meaning they are in the existing flowpath of the tributary. The storage areas were also assumed to be in sequence one after the other, which means that the discharge from Area 4 flows into Area 3 which discharges directly into Area 2.

Outlet Structures

The primary outlets of the storage areas were modeled as circulate corrugated metal pipe (CMP) culverts for simplicity and to be consistent with previous evaluations of flood storage in the Clark Creek watershed. Three culvert diameters were evaluated: 2 feet, 4 feet and 6 feet. Other outlet types, such as pipe arches or oval pipes, may be necessary in the final design to facilitate fish passage and to fit within the height of the berm (in the case of the 6-foot diameter scenarios). Alternative outlet types with similar conveyance capacity to those simulated in this study would provide similar flood detention performance.

3 Flood Detention Performance

3.1 Detention on Southern Tributary at Areas 2, 3 and 4

Six different scenarios for flood storage basin design and runoff routing were evaluated as summarized in **Table 5** and describe in more detail below. Scenarios 1 through 4 evaluated the performance of basins 2, 3 and 4 with different berm heights and outlet structure sizes. These scenarios did not include the Quarry Tributary basins evaluated in the January 2012 report. Scenario 5 includes both the Southern Tributary and Quarry Tributary storage areas. Scenario 6 includes the storage areas on both tributaries, plus diversion of some Quarry Tributary floodwaters into storage areas 2, 3 and 4 on the Southern Tributary.

Table 5. Peak discharge reduction 1000 ft upstream of STH 113

Scenario	Storage Areas Included	Storage Area Design Details	Peak Discharge Reduction on Clark Creek at STH 113
1	Southern Trib.: 2, 3 & 4	4' berms with 2' culverts	15%
2	Southern Trib.: 2, 3 & 4	4' berms with 4' culverts	14%
3	Southern Trib.: 2, 3 & 4	4' berms with 6' culverts	14%
4	Southern Trib.: 2, 3 & 4	6' berms with 2' culverts	15%
5	Southern Trib.: 2, 3 & 4 Quarry Trib: 5, 6 & 12	6' berms with 2' culverts	29%
6	Southern Trib.: 2, 3 & 4 Quarry Trib: 5, 6 & 12 Diversion of 75% of Quarry Trib flow to Area 4	6' berms with 2' culverts	42%

Scenarios 1 through 3 could reduce the peak discharge upstream of STH 113 by 13.7% to 15%. Note that scenario 4 shows no additional improvement in peak discharge reduction by increasing the berm height from 4 feet to 6 feet for the same culvert size as Scenario 1. This is the case because even the lower 4-foot berms create sufficient storage to detain flow in the Southern Tributary. No discharge over the berm spillway was predicted for storage areas 2 and 3 for any of the scenarios, and only scenario 1 (2-foot culverts) resulted in flow over the spillway of storage area 4. This indicates that these basins are large enough to handle additional inflow, if it could be routed to them.

The combined effect of storage areas 2, 3 and 4 on the Southern Tributary and storages areas 5, 6 and 12 on the Quarry Tributary, using 6-foot berms and 2-foot culverts, is a 29% reduction in the design flood peak discharge 1000 feet upstream of STH 113.

3.2 Runoff Diversion from Quarry Tributary to Enhance Storage Routing

Based on a discussion with John Vossberg of the NRCS, a preliminary analysis was conducted for diversion of some floodwater from the Quarry Tributary south across the current agricultural field to storage area 4 (**Figure 3**). The concept tested would entail a diversion structure on the Quarry Tributary a short distance upstream of Tower Rd. (and downstream of storage areas 5, 6, and 12) which would allow low flows to continue down the current channel but divert a portion of flood flows. Designing such a diversion structure would be a complex undertaking, and a detailed hydraulic analysis is beyond the capabilities of HEC-HMS. The simulation in scenario 6 explores the potential flood detention benefits of this concept to help determine if it merits further consideration. Due to the limitations of the HEC-HMS model, the scenario 6 simulation routes 75% of the flood discharge in the Quarry Tributary to storage area 4, with 25% of the discharge continuing down the Quarry Tributary. This split in flood discharge was chosen as a reasonable first approximation, and not based on hydraulic calculations.

Divsersion of Quarry Tributary flow in scenario 6 results in greater utilization of storage areas 2, 3 and 4, as overflow occurs in all three of them. The predicted peak discharge reduction upstream of STH 113 is 42% for the design flood.

3.3 PLANNING LEVEL COSTS

Planning-level cost estimates for permitting and construction of the storage areas are summarized in **Table 6**, with details in **Appendix C**. The most expensive item is the earthwork required to construct berms. There are two options for construction: importing fill and excavating soil at the site to use for berm creation. The unit rate for earthwork with an on-site source of fill would be considerably lower, however other costs would increase due to the need to strip and replace topsoil and restore vegetation at the borrow pit area. Nonetheless, using an on-site soil source appears to be the less expensive option. Three issues that should be considered in evaluating the use of on-site soils for berm construction include the following.

1. Soils at the site may not be suitable for berm construction. This study did not evaluate on-site soils.
2. Shallow groundwater may limit the depth of excavation that can be performed. These cost estimates assume that soil would be excavated by scraping to an average depth of 2 feet. A shallower scrape depth would require disturbing a larger area to generate the same volume of soil, and this would add to the restoration cost.
3. Borrowing soil from the storage area locations would make them deeper and increase their storage capacity, potentially improving flood detention performance.

Note that these estimates do not include long-term maintenance, which would include vegetation maintenance and occaisional repairs to outlets and the berm. These cost estimates may change depending on the layout and construction details of the final design.

Estimating the cost to construct the Quarry Tributary diversion simulated in scenario 6 is beyond the scope of this study, as significant design details would need to be determined first. Key design issues are discussed in **Section 3.5**.

Table 6. Planning Level Cost Estimates for Storage Areas 2, 3 and 4

Berm Height	Fill Source	Cost [1]
4-ft overflow / 5-ft crest	Import	$616,900
4-ft overflow / 5-ft crest	On-site	$477,700
6-ft overflow / 7-ft crest	Import	$987,100
6-ft overflow / 7-ft crest	On-site	$723,600

[1] Includes environmental permitting, engineering, and a 50% estimating contingency on construction costs.

3.4 Fish Habitat Considerations

Issues

The Wisconsin Department of Natural Resources has indicated that brook trout may be present in the headwaters of Clark Creek and has expressed concerns about how flood protection measures could impact fish habitat. Fish habitat concerns include two issues: the ability for fish to pass through a basin control structure (e.g. culvert) during low flows, and impacts to the stream channel habitat caused by changes in sedimentation and erosion processes.

Design of structures for fish passage typically addresses the following issues:[1]

- Maintaining adequate water depth at low flows;
- Maintaining the natural stream channel slope;
- Providing a natural channel bottom through the structure, rather than a bare pipe; and
- Sizing the structure so that flow velocity is low enough that fish can swim upstream through the length of the structure.

Sedimentation and erosion processes control the shape of a stream channel and, therefore, the physical habitat it provides. Over the long term, frequent floods, such as the 1- and 2-year events, typically have the biggest impact on these processes. To accommodate the concern expressed by the Department of Natural Resources, a design objective was set to provide an outlet structure with sufficient capacity to pass the 1- and 2-year events without without attenuating their flows or causing water to pond upstream of the structure.

Ability to Pass the 1- and 2- year events

The peak discharge for the 1- and 2- year events was quantified using the typical Antecedent Moisture Condition II runoff curve numbers (**Table 4**). Subwatershed 61 is not included in this analysis because it is downstream of storage areas 2, 3 and 4.

[1] Fish Friendly Culverts: Proper design, installation, and maintenance can protect both roadways and fish. University of Wisconsin-Extension and Wisconsin Department of Natural Resources.

Table 4. 1- and 2-year peak discharge (cfs) from watersheds upstream of flood storage basins.

Recurrence Interval	Subwshed 62	Subwshed 63
1 year	0.2	5.3
2 year	0.6	11

The conveyance capacity of the outlet of the storage areas would have to be sufficient to pass the 2-year peak flow of 12 cfs. The typical channel bottom slope where the storage area 2 culvert would be located is 0.88%. Hydraflow was used to evaluate the conveyance capacity of a culvert with that slope (**Appendix B**). The results show that a 24" circular pipe or equivalent conveyance capacity is required to meet this criterion.

Outlent Design

Equivalent pipe geometries could be used to promote improved fish passage and meet soil cover needs as discussed above. One option with an equivalent capacity to a 2-foot-diameter circular culvert is a 28" wide by 20" high pipe arch. If this pipe arch were buried 6" to provide a natural stream bed and facilitate fish passage as described above, the culvert size would have to increase to maintain the conveyance capacity.

3.5 Design Considerations for the Quarry Tributary Diversion

Some key issues to consider for a diversion from the Quarry Tributary to storage areas on the Southern Tributary include the following.

- The requirements for stream habitat on the Quarry Tributary would need to be determined to further evaluate the low flow outlet design.
- Hydraulic calculations of the amount of flood water diverted would need to be conducted for different diversion structure designs, and the predicted flood attenuation performance would need to be updated accordingly.
- The diversion would require sufficient armoring to prevent scour damage and breaching of the structure.
- A diversion channel would need to be constructed to convey floodwaters from the Quarry Tributary to storage area 4. The channel would likely be a cut-and-fill section with a berm on the downslope side to provide maximum hydraulic capacity for the earthwork involved.
- The diversion channel would need to have sufficient capacity and stability to keep diverted flood waters on the intended route to storage area 4.
- The potential impact of sedimentation on the diversion structure and channel would need to be evaluated.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

- Three storage areas constructed on the Southern Tributary could reduce the peak discharge of a flood similar to the June 2008 event by approximately 15% in the lower reach of Clark Creek along STH 113.
- These three storage areas on the Southern Tributary in combination with the three storage areas on the Quarry Tributary described in the January 2012 report could reduce the design flood peak discharge by approximately 30% in the reach near STH 113.
- Diversion of some floodwater from the Quarry Tributary to the storage areas on the Southern Tributary has potential for even greater flood peak reduction, estimated roughly at 42%. However, this alternative would need to be evaluated in more detail to determine its feasibility, cost and expected performance. Although such a diversion would potentially be effective for flood detention, significant engineering and environmental issues would need to be addressed.

4.2 RECOMMENDATIONS

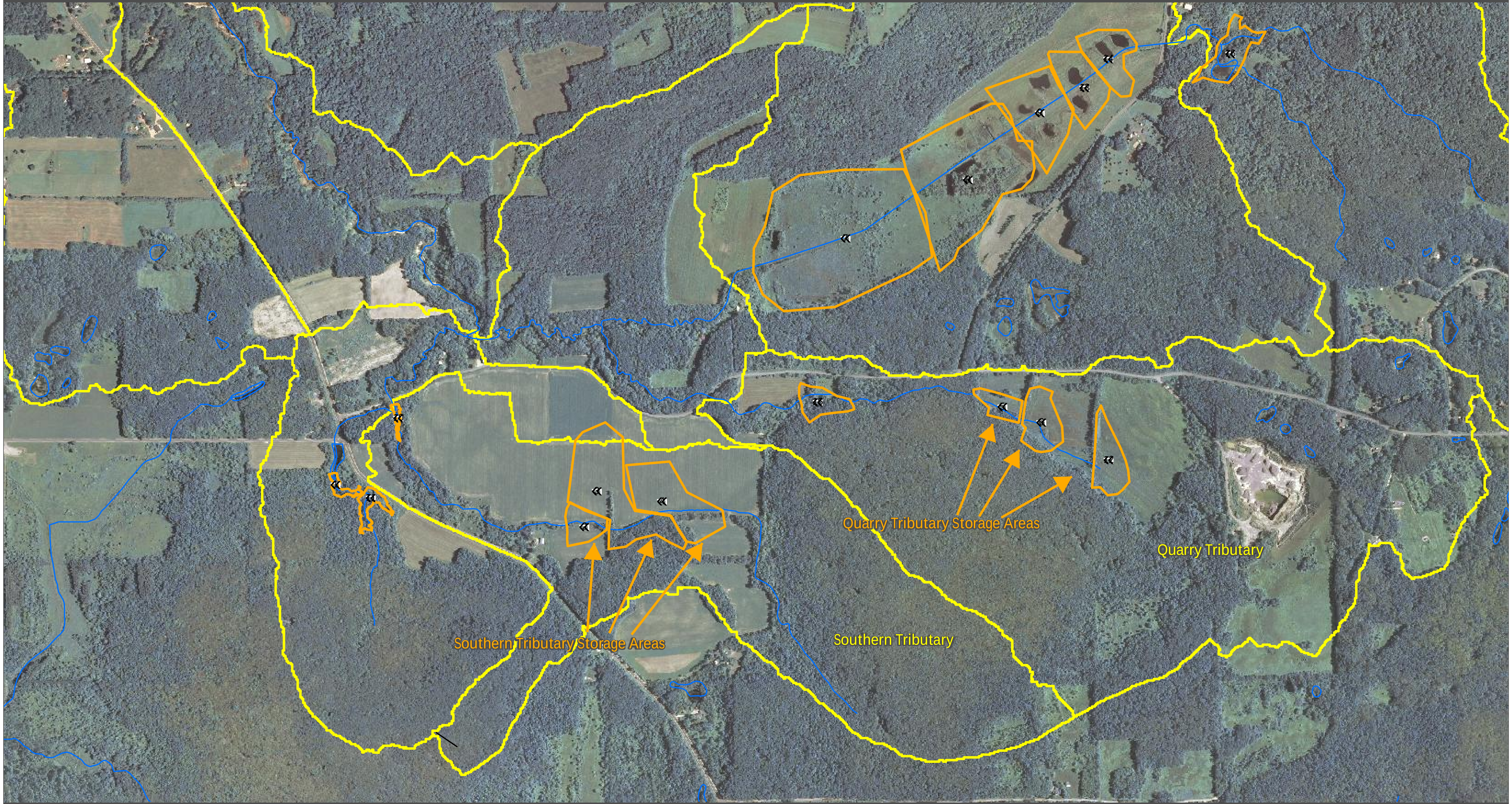
1. We recommend further consideration of storage areas 2, 3 and 4 on the Southern Tributary. This includes continuing discussions with DNR regarding permit requirements, preparing preliminary designs and an opinion of probable cost, obtaining permits, and preparing final design and construction documents. Final design of berms and outlets should provide sufficient freeboard to accommodate the design flows without berm overtopping.
2. The results of this analysis should be discussed with DNR to determine habitat-related constraints that may affect the flood storage basins design, including basin locations, berm layouts, and outlet structure size and design.
3. We recommend discussion and further evaluation of a diversion from the Quarry Tributary to the Southern Tributary with DNR to identify environmental permitting issues which may affect the design, cost and performance. Based on that information, a preliminary design and more detailed performance evaluation could be conducted.

FIGURES

Clark Creek Watershed Study
Sauk County, WI

Figure 1
Wetland Storage Areas

Montgomery Associates: Resource Solutions, LLC
119 South Main Street, Cottage Grove, WI 53527
(608) 839-4422 | www.ma-rs.org | 01/20/2012



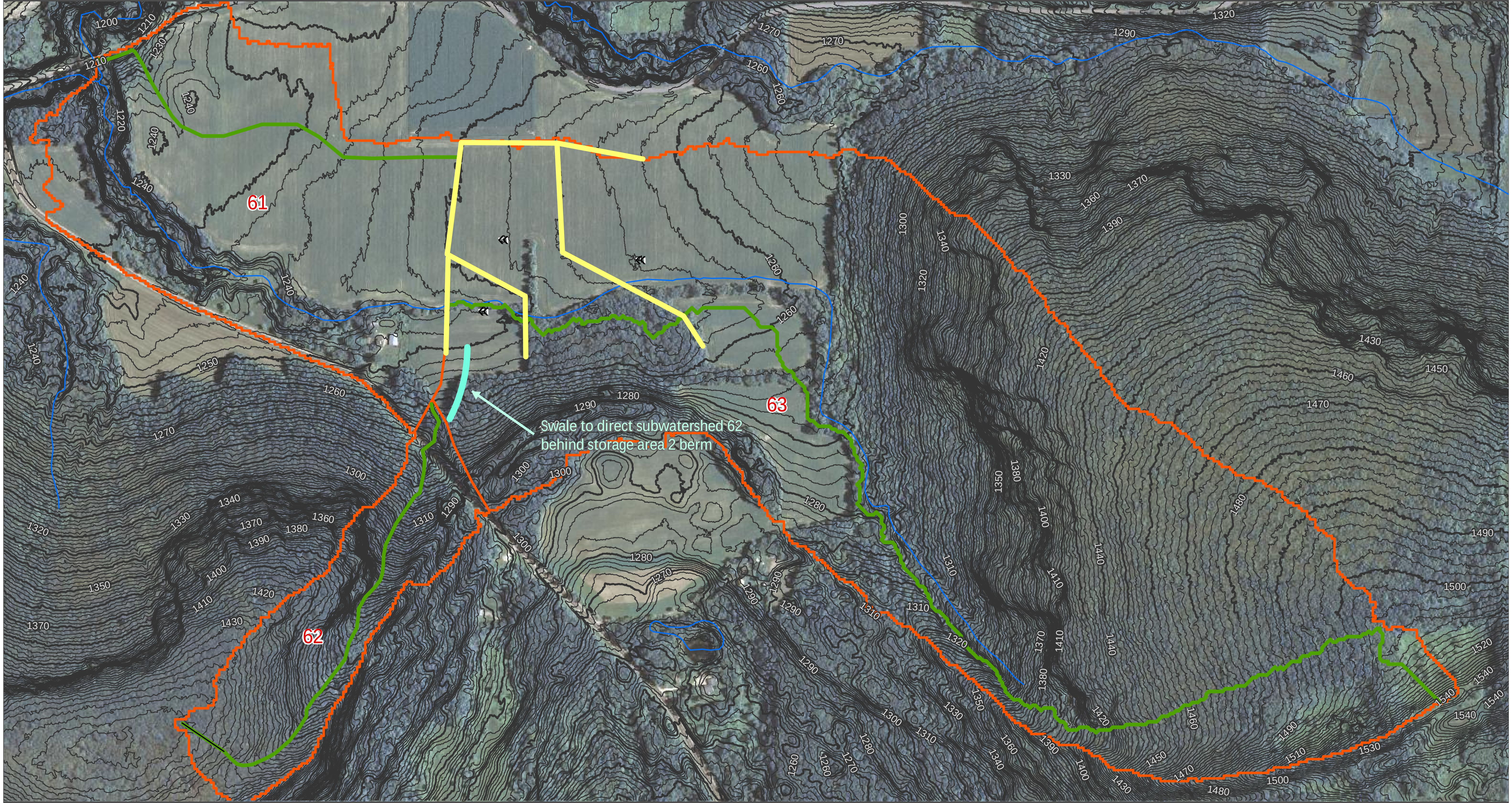
Feet
0 1,000
1 inch = 1,000 feet

Potential Wetland Storage Areas
Hydrography
2-Foot Contours
10-Foot Contours
Subwatersheds

Clark Creek Watershed Study
Sauk County, WI

Figure 2
Southern Tributary Storage Areas

Montgomery Associates: Resource Solutions, LLC
119 South Main Street, Cottage Grove, WI 53527
(608) 839-4422 | www.ma-rs.org | 01/20/2012



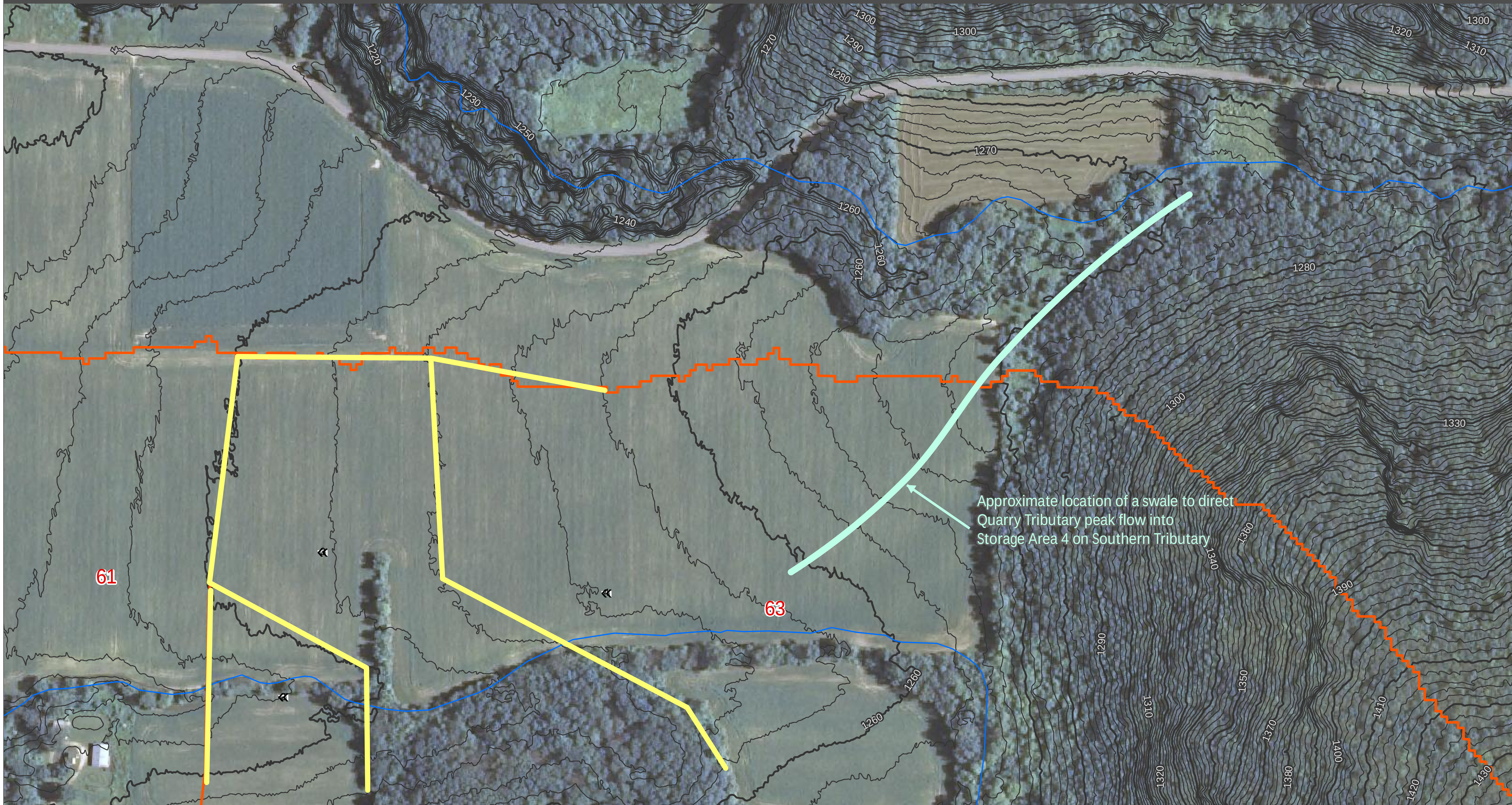
Feet
0 500
1 inch = 500 feet

Hydrography
Berm Locations
2-Foot Contours
10-Foot Contours
Subwatersheds
Tc Flow Path

Clark Creek Watershed Study
Sauk County, WI

Figure 3
Quarry Tributary Diversion

Montgomery Associates: Resource Solutions, LLC
119 South Main Street, Cottage Grove, WI 53527
(608) 839-4422 | www.ma-rs.org | 01/20/2012



Feet
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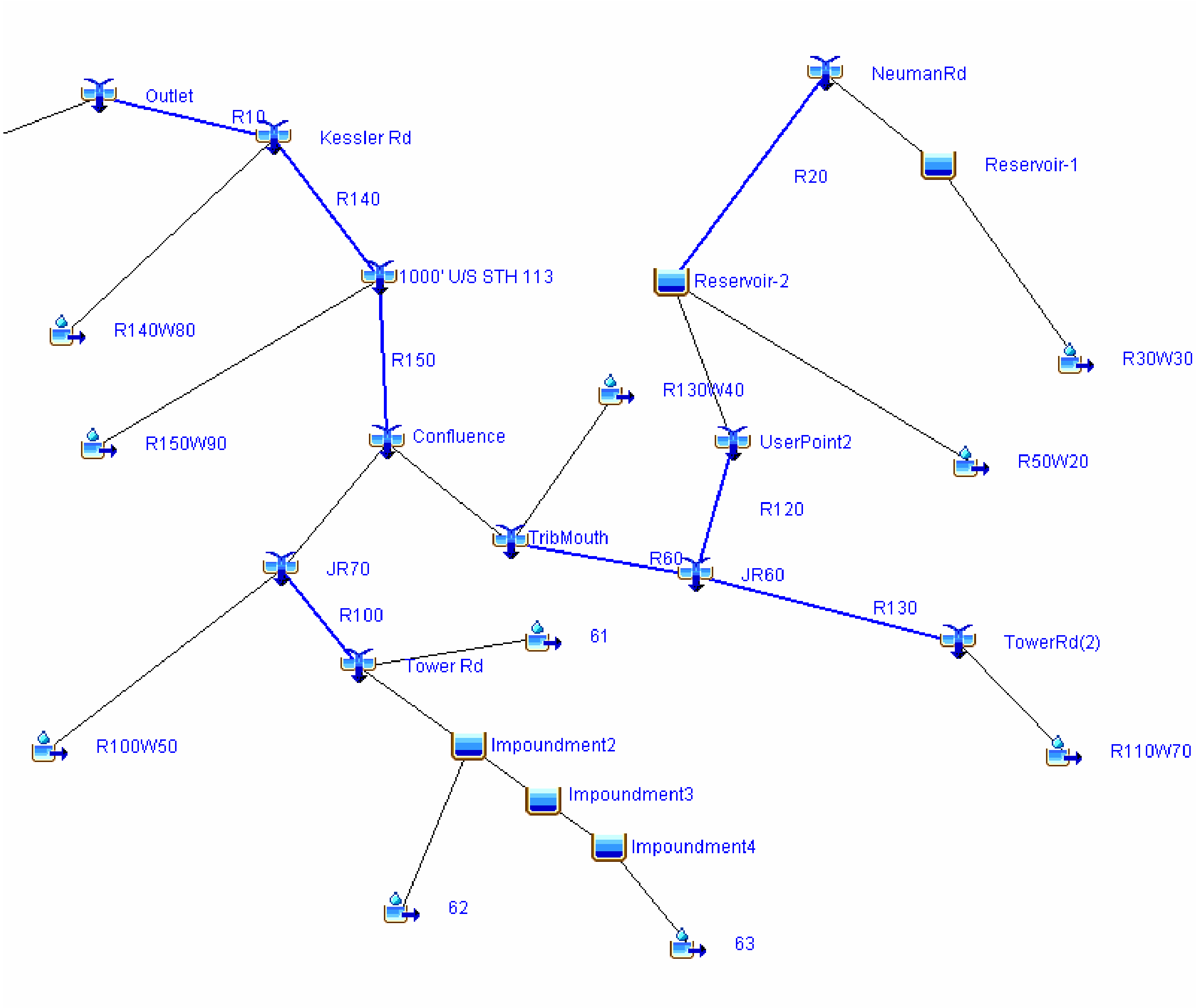
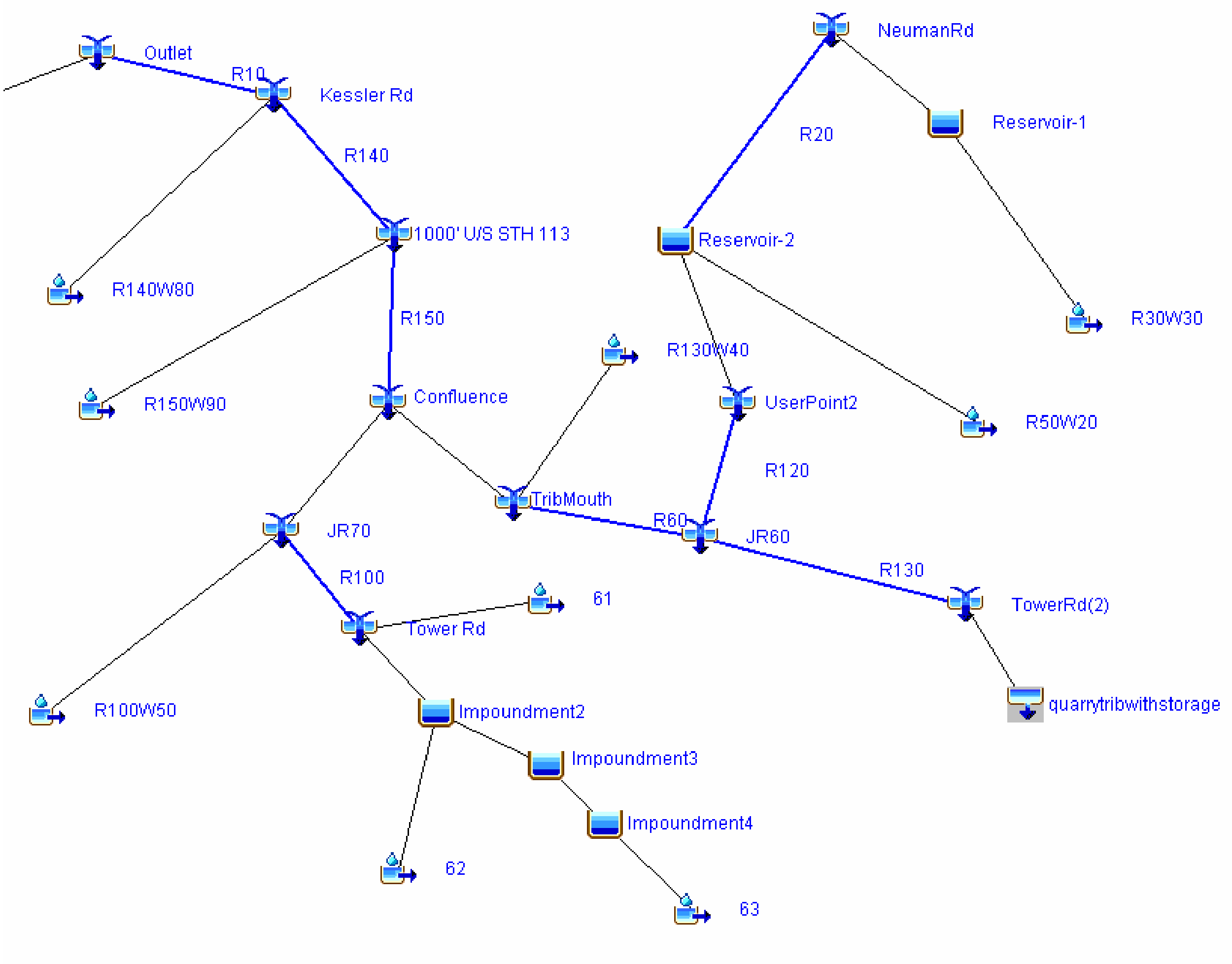
1 inch = 250 feet

Hydrography
Berm Locations
2-Foot Contours
10-Foot Contours
Subwatersheds

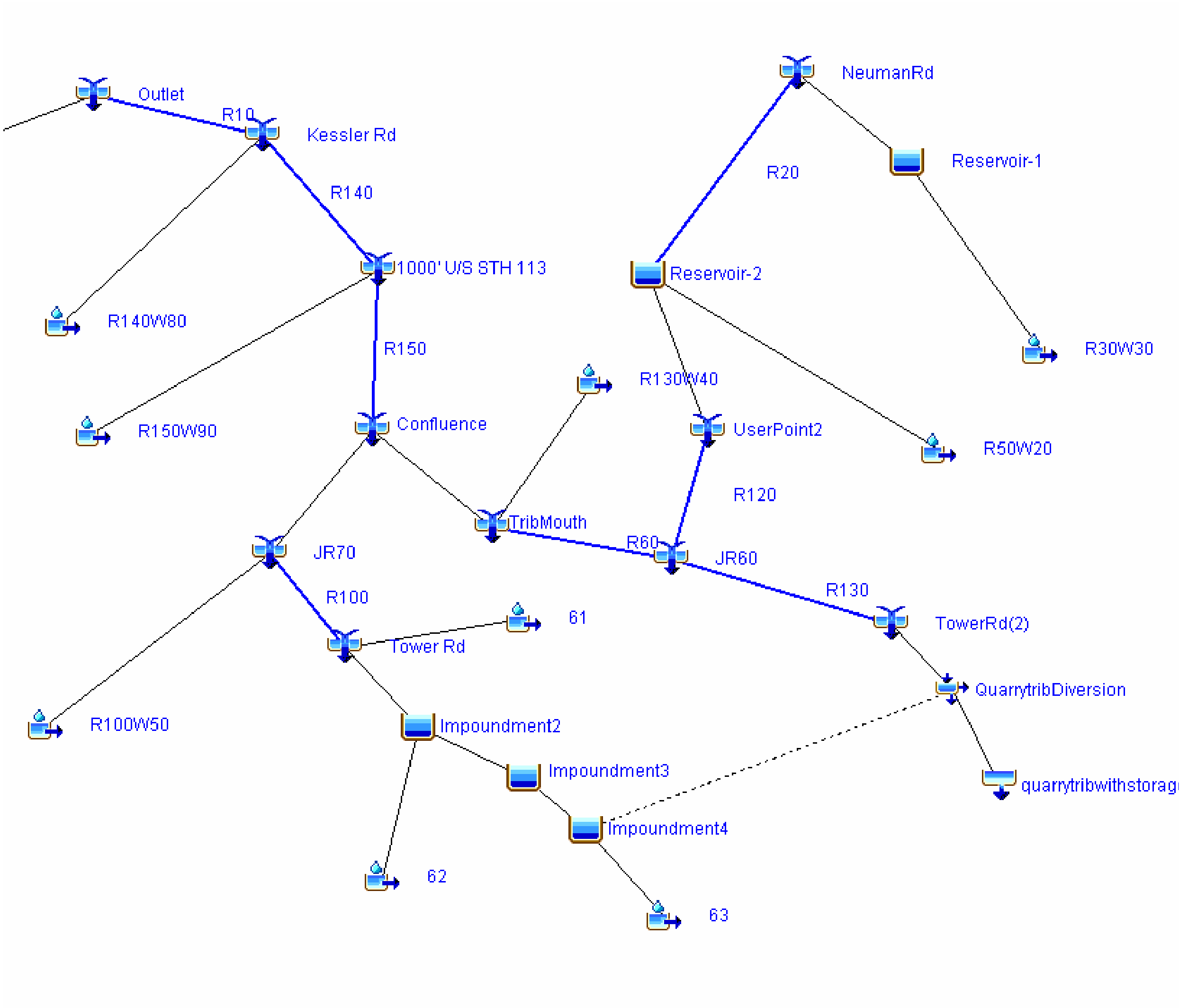
APPENDIX A – HEC-HMS MODEL LAYOUTS



Layout of HEC-HMS model of potential Southern Tributary storage areas 2, 3 and 4.



Layout of HEC-HMS model of potential Southern Tributary storage areas 2, 3 and 4 plus Quarry Tributary storage areas 5, 6 and 12.



Layout of HEC-HMS model of Quarry Diversion with potential Southern Tributary storage areas 2, 3 and 4 plus Quarry Tributary storage areas 5, 6 and 12.

APPENDIX B - HYDRAFLOW OUTPUT

Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. — Wednesday, May 16 2012

Clark Creek 1-yr event

Invert Elev Dn (ft)	= 1246.00
Pipe Length (ft)	= 30.00
Slope (%)	= 0.87
Invert Elev Up (ft)	= 1246.26
Rise (in)	= 24.0
Shape	= Cir
Span (in)	= 24.0
No. Barrels	= 1
n-Value	= 0.024
Inlet Edge	= Mitered
Coeff. K,M,c,Y,k	= 0.021, 1.33, 0.0463, 0.75, 0.7

Embankment

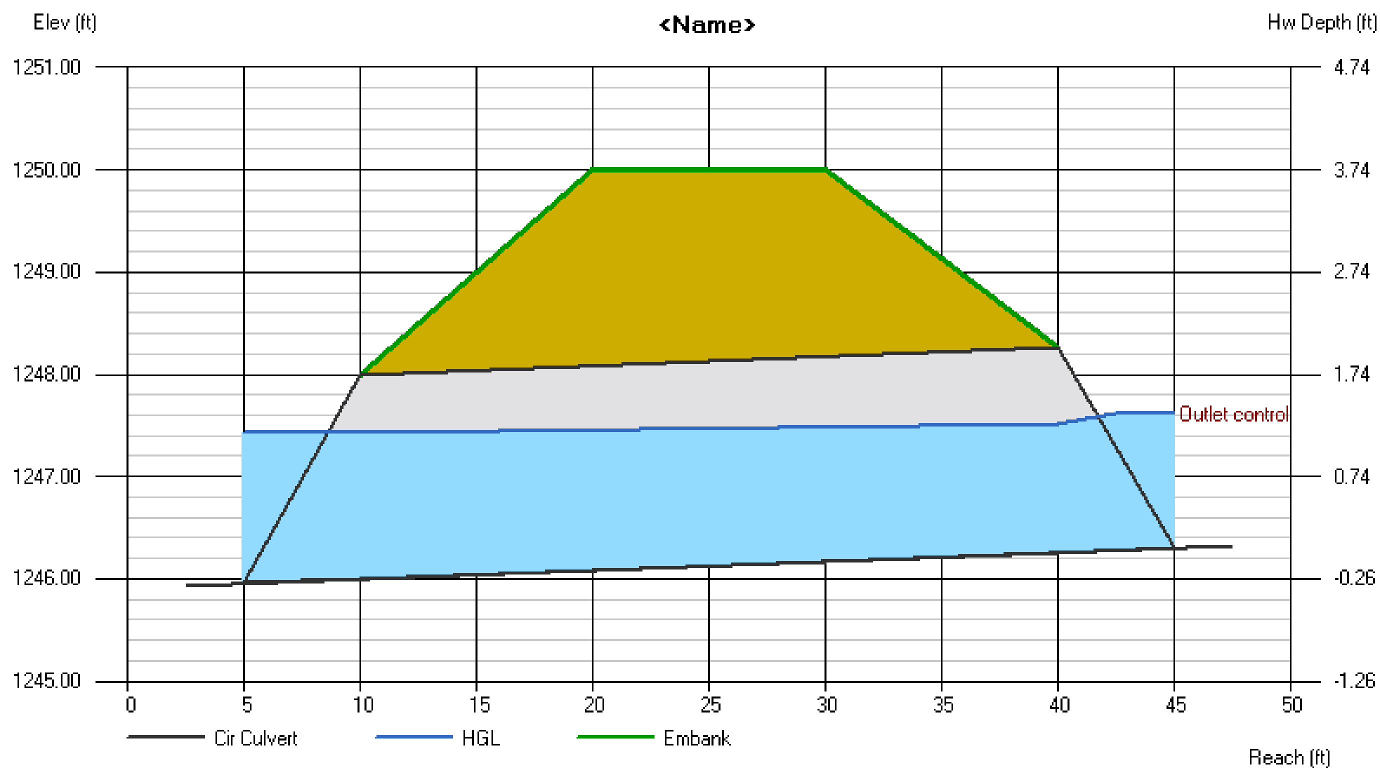
Top Elevation (ft)	= 1250.00
Top Width (ft)	= 10.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 2.00
Qmax (cfs)	= 20.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 6.00
Qpipe (cfs)	= 6.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 2.49
Veloc Up (ft/s)	= 2.87
HGL Dn (ft)	= 1247.44
HGL Up (ft)	= 1247.52
Hw Elev (ft)	= 1247.61
Hw/D (ft)	= 0.68
Flow Regime	= Outlet Control



Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. Thursday, May 10 2012

Cir Culvert

Invert Elev Dn (ft)	=	1246.00
Pipe Length (ft)	=	30.00
Slope (%)	=	0.87
Invert Elev Up (ft)	=	1246.26
Rise (in)	=	24.0
Shape	=	Cir
Span (in)	=	24.0
No. Barrels	=	1
n-Value	=	0.024
Inlet Edge	=	Mitered
Coeff. K,M,c,Y,k	=	0.021, 1.33, 0.0463, 0.75, 0.7

Embankment

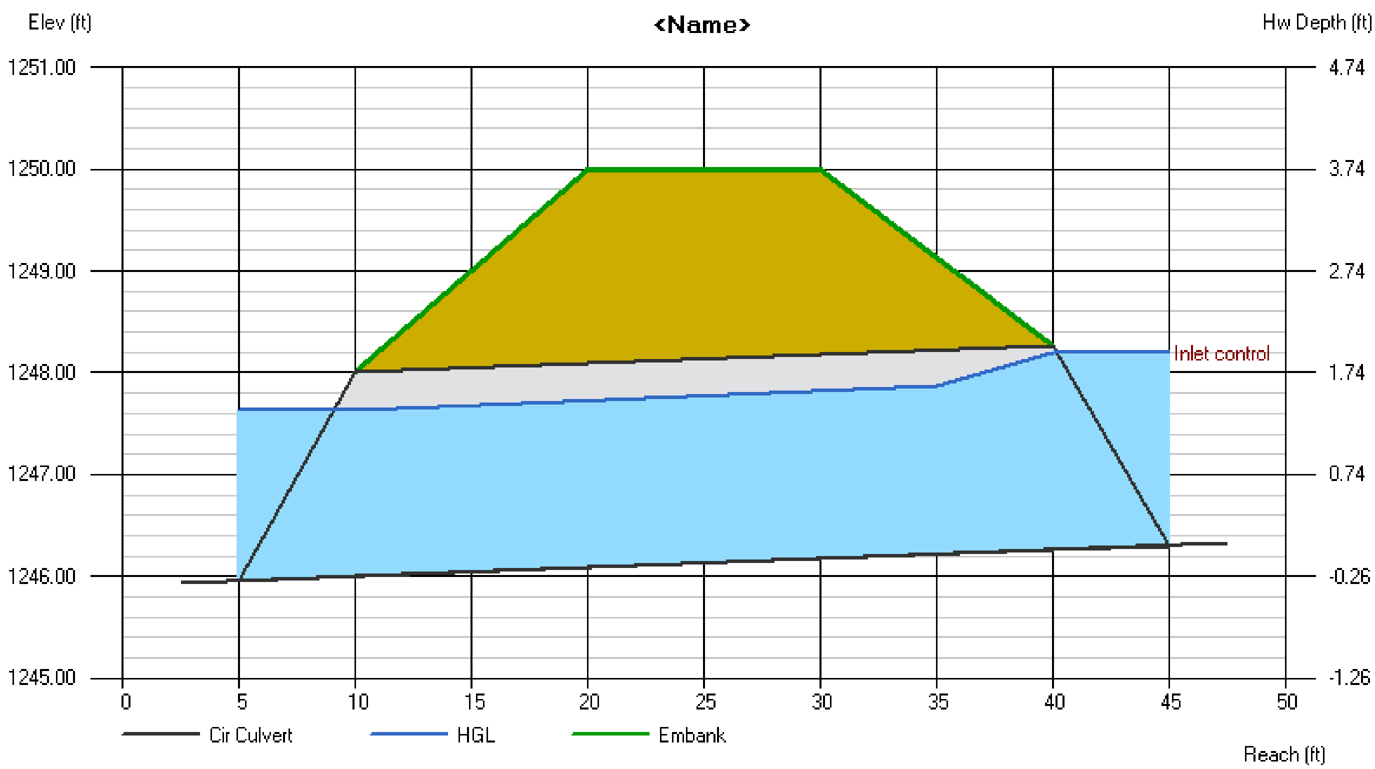
Top Elevation (ft)	=	1250.00
Top Width (ft)	=	10.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	10.00
Qmax (cfs)	=	20.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	12.00
Qpipe (cfs)	=	12.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	4.39
Veloc Up (ft/s)	=	4.29
HGL Dn (ft)	=	1247.63
HGL Up (ft)	=	1247.93
Hw Elev (ft)	=	1248.19
Hw/D (ft)	=	0.97
Flow Regime	=	Inlet Control



APPENDIX C – PLANNING LEVEL COSTS

Clark Creek Watershed Study
Sauk County, WI

Planning-Level Cost Estimates

SouthernTributary Flood Storage Areas # 2, 3 and 4

4-ft-high berms. Offsite fill source.

NO.	ITEM DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	TOTAL
1	**Site Preparation**				
1a	Mobilization / Demobilization	1	LS	$ 20,000.00	$ 20,000.00
1b	Clearing and grubbing	4.8	AC	$ 6,000.00	$ 28,800.00
	Subtotal for Site Preparation				**$ 48,800.00**
2	**Erosion Control**				
2a	Riprap	3	LS	$ 2,000.00	$ 6,000.00
	Subtotal for Erosion Control				**$ 6,000.00**
3	**Berm Construction**				
3a	Strip, stockpile, place and compact topsoil	5222	CY	$ 9.00	$ 47,000.00
3b	Earthwork	15250	CY	$ 15.00	$ 228,800.00
3c	Low-flow culverts	120	LF	$ 78.00	$ 9,400.00
	Subtotal for Berm Construction				**$ 285,200.00**
4	**Restoration**				
4a	Seeding	5.4	AC	$ 700.00	$ 3,800.00
4b	Mulch	10500	SY	$ 0.13	$ 1,400.00
4c	Erosion mat	15700	SY	$ 2.00	$ 31,400.00
4d	TRM	500	SY	$ 16.00	$ 8,000.00
	Subtotal for Restoration				**$ 44,600.00**
Cost - No Contingency					**$ 384,600**
Estimating Contingency (50%)					**$ 192,300**
Engineering and Permitting					**$ 40,000**
Total Estimated Cost - With Contingency					**$ 616,900**

Clark Creek Watershed Study

Sauk County, WI

Planning-Level Cost Estimates

SouthernTributary Flood Storage Areas # 2, 3 and 4

4-ft-high berms. Onsite fill source.

NO.	ITEM DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	TOTAL
1	**Site Preparation**				
1a	Mobilization / Demobilization	1	LS	$ 20,000.00	$ 20,000.00
1b	Clearing and grubbing	4.8	AC	$ 6,000.00	$ 28,800.00
	Subtotal for Site Preparation				**$ 48,800.00**
2	**Erosion Control**				
2a	Riprap	3	LS	$ 2,000.00	$ 6,000.00
	Subtotal for Erosion Control				**$ 6,000.00**
3	**Berm Construction**				
3a	Strip, stockpile, place and compact topsoil	12849	CY	$ 9.00	$ 115,700.00
3b	Earthwork	15250	CY	$ 4.00	$ 61,000.00
3c	Low-flow culverts	120	LF	$ 78.00	$ 9,400.00
	Subtotal for Berm Construction				**$ 186,100.00**
4	**Restoration**				
4a	Seeding	10.1	AC	$ 700.00	$ 7,100.00
4b	Mulch	33400	SY	$ 0.13	$ 4,400.00
4c	Erosion mat	15700	SY	$ 2.00	$ 31,400.00
4d	TRM	500	SY	$ 16.00	$ 8,000.00
	Subtotal for Restoration				**$ 50,900.00**
Cost - No Contingency					**$ 291,800**
Estimating Contingency (50%)					**$ 145,900**
Engineering and Permitting					**$ 40,000**
Total Estimated Cost - With Contingency					**$ 477,700**

Clark Creek Watershed Study
Sauk County, WI

Planning-Level Cost Estimates

SouthernTributary Flood Storage Areas # 2, 3 and 4

6-ft-high berms. Offsite fill source.

NO.	ITEM DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	TOTAL
1	**Site Preparation**				
1a	Mobilization / Demobilization	1	LS	$ 20,000.00	$ 20,000.00
1b	Clearing and grubbing	4.8	AC	$ 6,000.00	$ 28,800.00
	Subtotal for Site Preparation				**$ 48,800.00**
2	**Erosion Control**				
2a	Riprap	3	LS	$ 2,000.00	$ 6,000.00
	Subtotal for Erosion Control				**$ 6,000.00**
3	**Berm Construction**				
3a	Strip, stockpile, place and compact topsoil	7615	CY	$ 9.00	$ 68,600.00
3b	Earthwork	28880	CY	$ 15.00	$ 433,200.00
3c	Low-flow culverts	150	LF	$ 78.00	$ 11,700.00
	Subtotal for Berm Construction				**$ 513,500.00**
4	**Restoration**				
4a	Seeding	7.1	AC	$ 700.00	$ 5,000.00
4b	Mulch	11500	SY	$ 0.13	$ 1,500.00
4c	Erosion mat	22900	SY	$ 2.00	$ 45,800.00
4d	TRM	670	SY	$ 16.00	$ 10,800.00
	Subtotal for Restoration				**$ 63,100.00**
Cost - No Contingency					**$ 631,400**
Estimating Contingency (50%)					**$ 315,700**
Engineering and Permitting					**$ 40,000**
Total Estimated Cost - With Contingency					**$ 987,100**

Clark Creek Watershed Study

Sauk County, WI

Planning-Level Cost Estimates

SouthernTributary Flood Storage Areas # 2, 3 and 4

6-ft-high berms. Onsite fill source.

NO.	ITEM DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	TOTAL
1	**Site Preparation**				
1a	Mobilization / Demobilization	1	LS	$ 20,000.00	$ 20,000.00
1b	Clearing and grubbing	4.8	AC	$ 6,000.00	$ 28,800.00
	Subtotal for Site Preparation				**$ 48,800.00**
2	**Erosion Control**				
2a	Riprap	3	LS	$ 2,000.00	$ 6,000.00
	Subtotal for Erosion Control				**$ 6,000.00**
3	**Berm Construction**				
3a	Strip, stockpile, place and compact topsoil	22055	CY	$ 9.00	$ 198,500.00
3b	Earthwork	28880	CY	$ 4.00	$ 115,600.00
3c	Low-flow culverts	150	LF	$ 78.00	$ 11,700.00
	Subtotal for Berm Construction				**$ 325,800.00**
4	**Restoration**				
4a	Seeding	16.1	AC	$ 700.00	$ 11,300.00
4b	Mulch	54800	SY	$ 0.13	$ 7,200.00
4c	Erosion mat	22900	SY	$ 2.00	$ 45,800.00
4d	TRM	670	SY	$ 16.00	$ 10,800.00
	Subtotal for Restoration				**$ 75,100.00**
Cost - No Contingency					**$ 455,700**
Estimating Contingency (50%)					**$ 227,900**
Engineering and Permitting					**$ 40,000**
Total Estimated Cost - With Contingency					**$ 723,600**