WOODBURY COUNTY APPROXIMATE FLOOD STUDY
BROWN'S LAKE
WOODBURY COUNTY, IOWA
PROJECT NO. 110.0660

SEPTEMBER 28, 2011

I hereby certify that this Engineering Document was prepared by me or under my direct personal supervision and that I am a duly Licensed Professional Engineer under the Laws of the State of Iowa.

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My License Renewal Date is December 31, 2012

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1. INTRODUCTION

1.1. Purpose

The following approximate hydrologic and hydraulic analysis was prepared to support a revision to the Zone A Special Flood Hazard Area (SFHA) determination within Woodbury County, Iowa. This analysis provides both scientific and technical corrections to the methods used to determine the Zone A SFHA shown in the effective FIRM panels dated September 29, 2011. Our justification for the revision can generally be classified into the following categories:

- Watershed and flow path delineation based on more detailed topographic data
- Hydrologic modeling revisions using rainfall-runoff methods using HEC-HMS and updated delineations
- Updated hydraulic modeling based on hydrologic revisions and cross section data from more detailed topographic data using HEC-RAS
- Floodplain mapping based on more detailed topographic data

The Hydraulics Report[1] to perform new hydrologic and hydraulic analyses for Woodbury County, Iowa was reviewed in preparation of this report. In addition to this report, the FIRM panels, DFIRM data, and Flood Insurance Study dated September 29, 2011 was reviewed and incorporated in the revised mapping.

1.2. Study Reaches

This report covers the hydrologic and hydraulic modeling for the area north and east of the Brown's Lake area of Woodbury County. Brown's Lake and its surrounding tributaries are located in the SW ¼ of Township 87N Range 47W and extends in to the NW ¼ of Township 87N Range 47W. The new approximate analysis starts at the zone break between Zone A and Zone AE in Brown's Lake. It continues north to the intersection of 235th Street and Interstate 29. It also extends to the east at the wetland just to the east of Benton Avenue and Interstate 29.

2. HYDROLOGIC MODELING

2.1. Source of Error

We suggest that the hydrological analysis used to determine the 1% Annual Chance Flood discharge should be replaced due to the availability of better topographic data which allows for development of better hydrologic data. The mapping partner developed hydrologic data for this area using 10 meter DEM data from the USGS. Statewide LiDAR[2] data is now readily available for the state of Iowa and is much more detailed.

Discharges for this area were developed by the mapping partner using regional regression equations for ungaged sites on ungaged streams presented in *USGS, Techniques for Estimating Flood-Frequency Discharges for Streams in Iowa, 2001*. This methodology is not necessarily

[1] Hydraulics Report, Woodbury County, Iowa, AMEC Earth & Environmental, March 2, 2010
[2] Iowa LiDAR Project: Iowa LiDAR Consortium, Flights: Spring 2008 – Spring 2010

inappropriate for this watershed. However, the regression equations presented in the USGS report should only apply to watersheds that are "within the range or explanatory space of the characteristic values used to develop the regression equations."[3] LiDAR data allows for basins to be delineated below the minimum drainage area (1.30 sq. mi.) used to develop the regional regression equations. Furthermore our rainfall-runoff method provides a more site specific analysis that takes into account the studied area in more depth rather than a regional regression equation that is designed to be broader reaching.

2.2. Revised Hydrology

2.2.1. Methodology

The revised hydrological analysis was performed using the U.S. Army Corps of Engineers' Hydraulic Engineering Center Hydrologic Modeling System (HEC-HMS) computer program (Version 3.4). The watershed was delineated using topographic data processed from Iowa Statewide LiDAR and broken into sub-watersheds at appropriate locations as shown on the Drainage Area Map, Appendix A, Exhibit A.

The 1% annual chance, 24-hr precipitation for the county is 7.00 inches. This total is for Iowa Region 4 taken from Bulletin 71 – Rainfall Frequency Atlas of the Midwest, 1992. The loss method used was the SCS Curve Number (CN) method which is defined in the equations below. Aerial photography was used to develop CNs based on land-use in each respective sub-watershed in accordance with the Soil Conservations Service's TR-55 guidance. An initial abstraction was assumed and this value was set to 0.2S for each basin, with "S" also defined in the equations below.

$$\mathbf{Q = (P - 0.2S)^2 / (P + 0.8S)}$$
$$\mathbf{S = (1000 / CN) - 10}$$

Q = Precipitation excess (runoff) [inches]
P = Cumulative precipitation [inches]
S = Potential maximum retention [inches]
CN = SCS Curve Number

The transform method used was the SCS Unit Hydrograph method utilizing the CN Lag Method to develop the Lag parameter needed for the HEC-HMS model. The CN Lag method equation can be found below with "S" defined previously when discussing the loss methodology.

$$\mathbf{L = I^{0.8} * (S + 1)^{0.7} / 1900 * Y^{0.5}}$$

L = Lag time [hours]
I = Watershed Hydraulic Length [feet]
Y = Average Land Slope [percent]

[3] USGS, Techniques for Estimating Flood-Frequency Discharges for Streams in Iowa, 2001

2.2.2. Model Setup

After consulting topographic data and local drainage it was determined that during the 1% Annual Chance Flood, Brown's Lake is under the backwater effects of the Missouri River. Therefore, the hydrologic analysis of the lake was not considered during this study.

Topographic data and local drainage shows there is a depression area that is near Barker Avenue and Interstate 29 that does not have a traditional surface runoff outlet. The only major drainage outlet for this area is via subsurface drainage tile. These tile lines drain this area eventually, but are not meant to handle surface runoff. During high precipitation rain events water flows from the north and southwest tributaries and ponds there until it slowly drains. This area was entered as a reservoir in the HEC-HMS model as "I-29 Storage."

The storage capacity for this area was measured via the HEC-GeoRAS extension within ArcGIS. GeoRAS was used to delineate and run calculations for the ponding area as a storage area. This data was then entered in to HEC-HMS. Since the Interstate 29 Storage area does not have a surface water outlet it was modeled without an outfall. This allows for the entirety of the runoff volume from the upstream basins to build in the storage area giving a peak elevation for the storage area. The storage area method was also implemented for the wetland east of Interstate 29 and Benton Avenue.

Finally, the area northeast of Brown's Lake, but southwest of I-29 does not naturally flow directly in to the Lake. Flow paths suggest that some water heads east toward the wetland and some south to Lakeview Lane and 275th St.

2.2.3. Results

Table 2.1 summarizes the peak elevations that were modeled in HEC-HMS for both storage areas. The elevations also seem to be representative when topographic data is examined.

Table 2.1: Storage Area Hydrologic Results

Storage Area	*Peak Elevation (ft)*	*Peak Storage (ac-ft)*
I-29	1082.8	1101.3
Wetland	1081.0	178.4

Table 2.2 summarizes the peak discharges for the five tributaries that were modeled as riverine flooding sources as a part of this revised study. Due to consistent land use and soil type throughout the studied area a constant CN of 74 was used throughout. Lag was then calculated on a sub-watershed level. Due to the more complex nature of this analysis compared to the Preliminary analysis direct comparison of discharges cannot be made. The digital copy of the HEC-HMS model is included on the attached disk.

Table 2.2: Peak Discharges

Flooding Source	*Drainage Area (sq mi)*	*Peak Discharge (cfs)*
BL_Trib1	1.33	867
BL_Trib1.1	0.49	238
BLT2.2	0.26	206
BLT3	0.24	215
BLT4	0.45	238

3. HYDRAULIC MODELING

3.1. Source of Error

We suggest that the hydraulic analysis used to determine the 1% Annual Chance Flood elevations does not represent the best available topographic information for the study reach. The Mapping Partner utilized 10 meter DEM data from the USGS to develop cross section data for the approximate hydraulic analysis. The hydraulic model developed for this study reflects updated topographic data from Statewide LiDAR and the updated hydrologic analysis. The updated information will produce more accurate georeferenced floodplain mapping from the updated topographic mapping and more accurate floodplain extent with the updated hydrologic data.

3.2. Revised Hydraulics

3.2.1. Methodology

Approximate hydraulic analyses were performed with U.S Army Corps of Engineers Hydraulic Engineering Center River Analysis System (HEC-RAS) computer program (Version 4.1). Geometry data was generated using U.S. Army Corps of Engineers HEC-GeoRAS, GIS tools for support of HEC-RAS using ArcGIS. Cross sections were placed at critical locations with additional sections added where needed for model stability.

Cross section geometry was developed from Iowa Statewide LiDAR topography. The data is referenced to the North American Vertical Datum of 1988 (NAVD88). No field survey data was obtained for this approximate analysis. The hydraulic model is georeferenced to the North American Datum of 1983, Iowa State Plane North. Cross sections were drawn left to right looking downstream.

Overbank Manning's "n" values were determined from color aerial imagery of Woodbury County, 2009 and were set to a constant value of 0.06. As previously stated the land use and soil type is consistent throughout the studied area so the same overbank and channel "n" values were used. Channel "n" values are assumed to be 0.04.

Boundary conditions for the study reach were selected in accordance with *Guidelines and Specifications for Flood Hazard Mapping Partners, C.3.3.1, page C-35, FEMA, November 2009*. Normal depth was assumed for all studied reaches.

3.2.2. Results

The results of the revised hydraulic model for the 1% Annual Chance Flood again cannot be compared to the Preliminary analysis. The revised analysis included five studied reaches and two storage areas and the Preliminary analysis only studied one reach for this area leading up to Brown's Lake.

The results of the revised hydraulic models for the 1% annual chance flood are shown in Table 3.1 and 3.2. Tributary 1 and 1.1 flow in to the Interstate 29 storage area and Tributary 3 flows in to the Wetland storage area. Table 3.1 shows the peak elevations from the hydrologic model for the appropriate storage area and the starting elevation from each hydraulic model. The results show that each flooding source was studied far enough downstream to determine where backwater effects from each respective storage area takes over.

Table 3.1: Hydraulic Results - Ponding

Flooding Source	*Starting Elevation (ft)*	*Storage Elevation (ft)*
BL_Trib1	1081.5	1082.8
BL_Trib1.1	1080.5	1082.8
BLT3	1080.5	1081.0

Table 3.2: Hydraulic Results – Riverine

River	*Cross Section*	*1% Annual Chance Flood*	*River*	*Cross Section*	*1% Annual Chance Flood*
BLT2.2	34	1082.24	BLT4	4970	1083.74
BLT2.2	404	1082.75	BLT4	5699	1083.93
BLT2.2	1513	1083.28	BLT4	6718	1084.11
BLT2.2	2099	1083.45	BLT4	7205	1084.16
BLT2.2	3500	1083.80	BLT4	7742	1084.19
BLT2.2	4233	1083.98	BLT4	8086	1084.20
BLT2.2	4398	1084.04	BLT4	8384	1084.22
BLT2.2	5061	1084.48	BL_Trib1	3468	1081.47
BLT2.2	5259	1084.93	BL_Trib1	4872	1082.46
BLT2.2	5653	1085.64	BL_Trib1	6742	1083.66
BLT2.2	6213	1086.42	BL_Trib1	8132	1083.96
BLT3	225	1080.49	BL_Trib1	9699	1084.12
BLT3	378	1082.57	BL_Trib1	11458	1084.30
BLT3	777	1083.28	BL_Trib1	14666	1084.98
BLT3	1899	1083.60	BL_Trib1	16697	1085.34
BLT3	2669	1083.73	BL_Trib1	18919	1087.07
BLT3	3423	1083.91	BL_Trib1.1	483	1080.46
BLT3	3623	1084.05	BL_Trib1.1	703	1082.40
BLT3	3877	1084.37	BL_Trib1.1	1299	1084.42
BLT3	4317	1084.61	BL_Trib1.1	1906	1084.96
BLT4	732	1080.81	BL_Trib1.1	3322	1085.59
BLT4	1705	1082.05	BL_Trib1.1	4128	1085.83
BLT4	2470	1082.48	BL_Trib1.1	5432	1086.14
BLT4	3283	1082.81	BL_Trib1.1	7536	1086.68
BLT4	3967	1083.24	BL_Trib1.1	9330	1087.59

On average, the revised 1% Annual Chance Flood profiles are lower than the Mapping Partner's approximate analysis. The lower flood profile is a direct result of the updated hydrologic methods using the best available topographic data. This is also a result of more accurate flow path and cross section data based on the same updated topographic data. The digital copy of the HEC-RAS model is included on the attached disk.

4. MAPPING REVISIONS

All floodplain mapping was delineated based on Iowa Statewide LiDAR data.

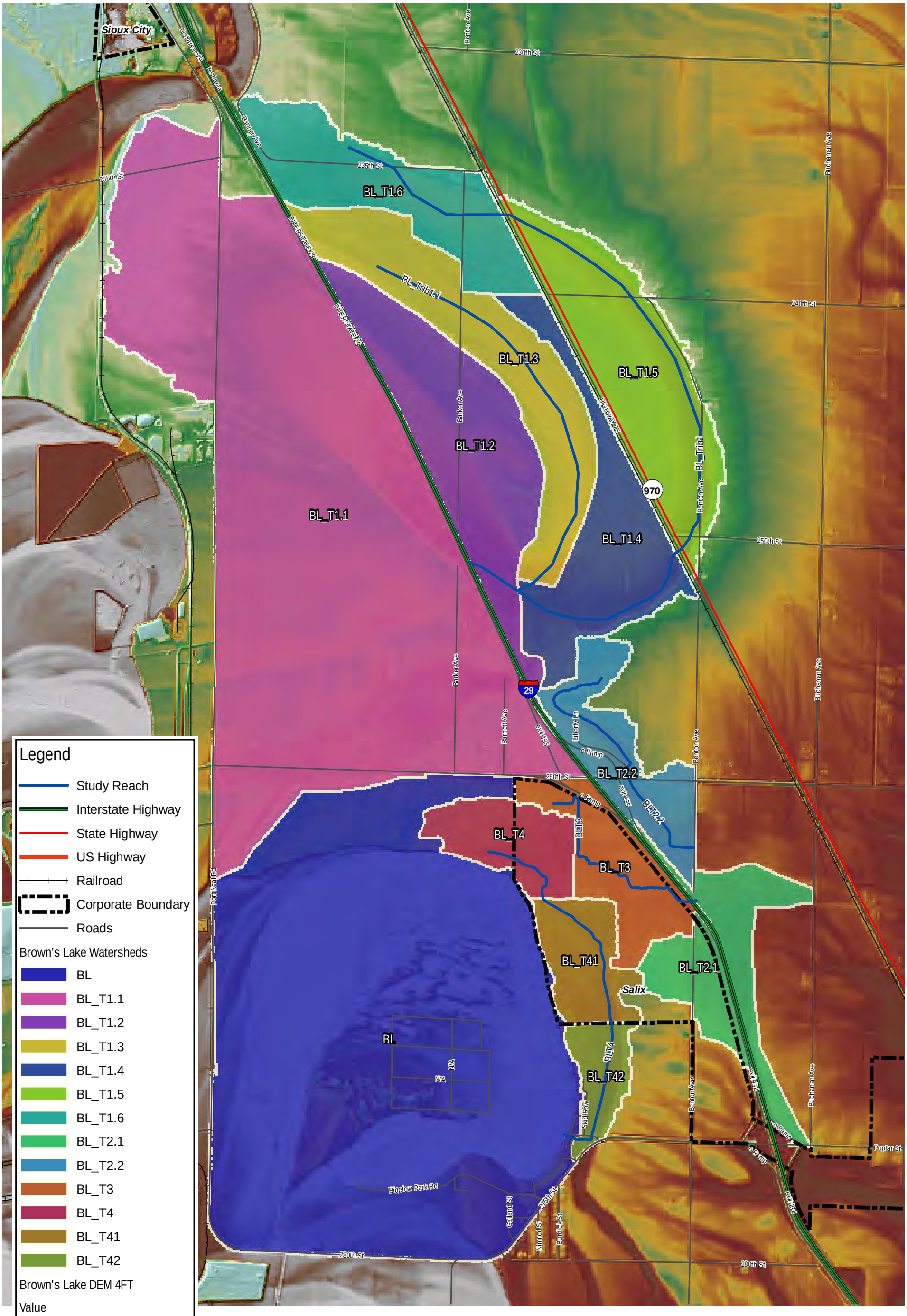
Flood inundation mapping for the 1% Annual Chance flood for Brown's Lake is controlled by backwater from Missouri River. The backwater delineation reflects the elevation at Missouri River cross section BDW.

Flood inundation mapping for the Interstate 29 and Wetland storage areas were delineated based on the previously mentioned peak elevations taken from the HEC-HMS model. To delineate the floodplain in these areas the peak elevations were projected over the topographic data within each storage area. Wherever the peak elevation was greater than the natural topographic elevation it was mapped as inundated during the 1% Annual Chance Flood.

Flood inundation mapping for the five riverine studied reaches was generated using HEC-GeoRAS. The floodplain was delineated using the elevations at each cross section. In between cross sections the elevations were interpolated. For the three reaches that flow in to storage areas the floodplain was mapped as stated until the backwater extents were reached. Once the floodplain for these sources reached the backwater extents the mapped floodplain is under the influence of the peak elevations from the HEC-HMS model.

A certified work map of the cross section locations and inundation mapping is included as Exhibit B in Appendix A. Digital shapefiles of the flood inundation mapping, stream centerlines, hydraulic model cross sections, and map tie-in points are included on the attached disk.

APPENDIX A



Drainage Area Map
Woodbury County Approximate Flood Study
Brown's Lake Woodbury County, Iowa

Exhibit A

SNYDER & ASSOCIATES
Engineers and Planners

J:\2010_projects\110.0660\GIS\Deliverables\mxds\ExA_Drainage Area Map.mxd

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I hereby certify that this Engineering Document was prepared by me or under my direct personal supervision and that I am a duly Licensed Professional Engineer under the Laws of the State of Iowa.

Adam Bullerman 9/28/11

Adam R. Bullerman, P.E. Date
License Number 17362
My License Renewal Date is December 31, 2012
Pages or sheets covered by this Seal:
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Legend

Study Reach
- BLT2.2
- BLT3
- BLT4
- BL_Trib1
- BL_Trib1.1

XS Cutlines
- BLT2.2
- BLT3
- BLT4
- BL_Trib1
- BL_Trib1.1
- Effective Map Tie-in Points
- Revised 1% Annual Chance Flood
- Interstate Highway
- State Highway
- Railroad
- Roads
- Corporate Boundary
- River

Special Flood Hazard Line (DFIRM)
- Limit of Study

Special Flood Hazard Area (DFIRM)
- 0.2% Annual Chance
- A
- AE

0 2,000 Feet

Map Elevations in NAVD88

Hydraulic Work Map
Woodbury County Approximate Flood Study
Brown's Lake Woodbury County, Iowa

Exhibit B

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