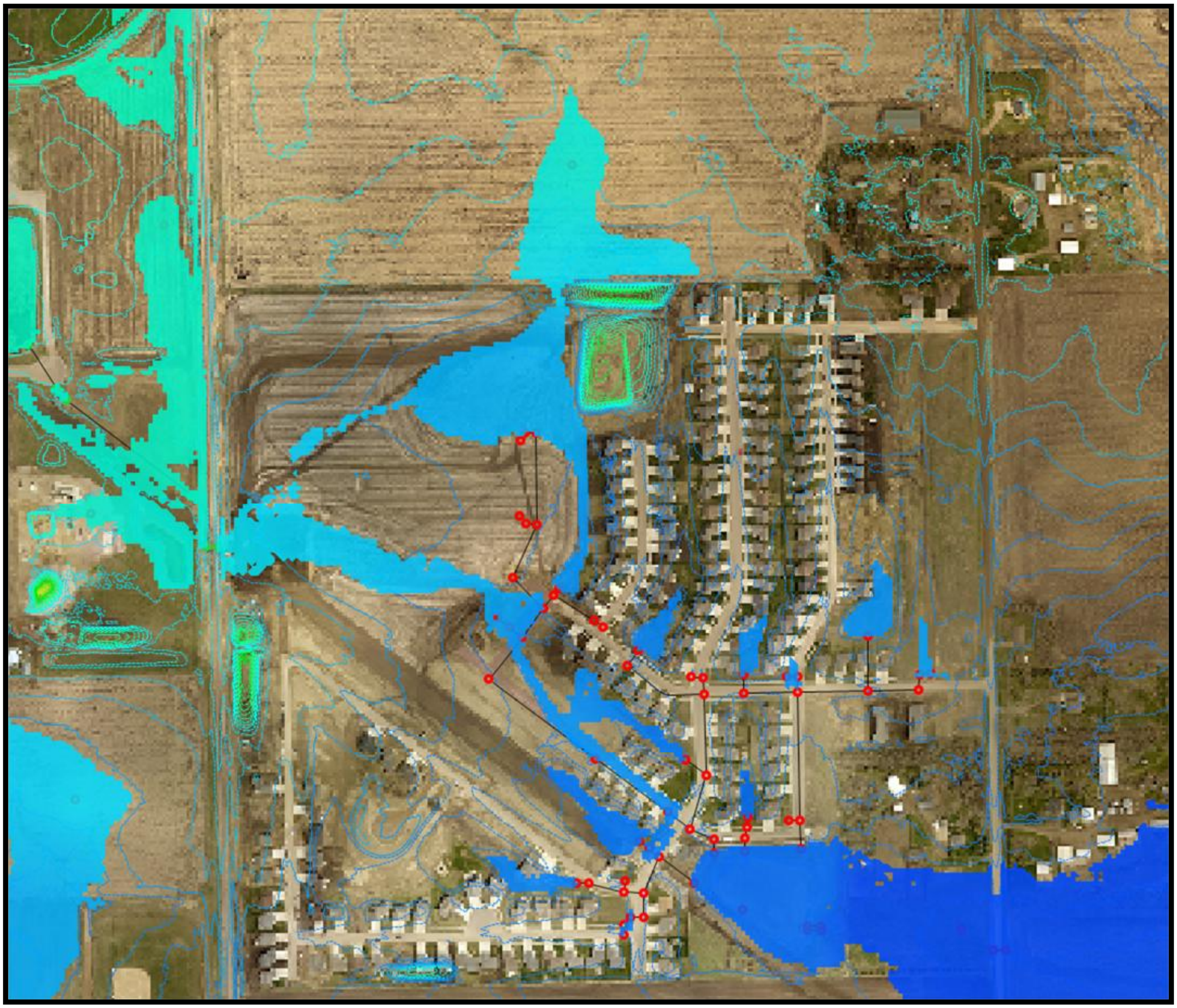
LEGENDARY ESTATES
DRAINAGE ANALYSIS



August 2016

STOCKWELL

PROJECT: Legendary Estates Drainage Analysis
Harrisburg, South Dakota

PROJECT NO: 11115

DATE: August 8, 2016

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of South Dakota.

Heidi Condon, P.E.

S.D. Registration No. 8469

REGISTERED PROFESSIONAL ENGINEER
REG. NO. 8469
HEIDI A. CONDON
SOUTH DAKOTA

STOCKWELL

EXECUTIVE SUMMARY

The City of Harrisburg authorized Stockwell Engineers to analyze the existing storm drainage system at Legendary Estates residential development as part of a much larger, overall Comprehensive Drainage Analysis for the City. The intent of the Comprehensive Master Plan is to provide a tool, to be referred to in order to ensure sound development within the City as Harrisburg continues to grow. The following report specifically outlines existing conditions at Legendary Estates and presents recommendations for improvements to alleviate flooding concerns within the neighborhood.

Significant, and intense rainfall events that occurred in 2014 caused damage to several residential properties bringing to light the severity of drainage issues that can occur in Legendary Estates. Property owners in the development brought their concerns to the City, resulting in the authorization for detailed hydrologic and hydraulic modeling of the drainage basin.

SCOPE OF STUDY

The scope of services for this project include the following:

- Identify drainage basin boundaries for existing conditions and identify land uses.
- Identify major drainage ways and controlling structures.
- Identify problem areas regarding drainage.
- Develop a hydrologic model to estimate peak flows for the 5 and 100-year rainfall events for all basins.
- Develop hydraulic analysis for major drainage ways and determine necessary upgrades.
- Identify recommended locations for flood control detention facilities.
- Make recommendations necessary to upgrade the storm sewer system to meet current design standards.

BASIS OF ANALYSIS

Recommendations within this report are based on the analysis of the existing network of storm sewer, within Legendary Estates, based on the approved construction plans prepared by the developer's representative. This report includes analysis of the existing storm sewer system, and detention facilities. Estimated flow rates for drainage basins during the 5 and 100-year rainfall events are provided in this study and are used as a planning tool for the recommended improvements to the storm drainage system.

Review of the Flood Insurance Rate Maps issued by the Federal Emergency Management Agency indicates that the City of Harrisburg and surrounding areas are classified as Zone X. Zone X is defined as areas of minimal flood hazard, and are not located within the Special Flood Hazard Area (SFHA). The area included in this study is not subject to inundation by the 1% annual chance flood (100-year) in accordance with FEMA standards and definitions. We do, however, believe that areas within the development would fall into the SFHA if the maps were to be revised to reflect current conditions.

PROJECT OVERVIEW

HISTORY OF CONCERN

Legendary Estates is a 127-acre subdivision located in the NE corner of Harrisburg, SD that includes a variety of single family and multi-family properties. The entire subdivision drains to a detention facility located at the downstream end of the subdivision. Rainfall events that occurred in July of 2011, May of 2013 and June of 2014 resulted in backyards flooding, and water entering homes at several locations.

Stockwell Engineers has reviewed the subdivision plans, and it appears that the enclosed system was sized to capture and convey the minor, 5-year rainfall event. Events that exceed the 5-year storm cause water to pond in areas outside of the right-of-way, on private property where drainage easements have not been dedicated. These low-lying areas, which flood on a regular basis, have become detention areas where storm water is stored during rainfall events before entering the enclosed storm sewer system.

MODEL DEVELOPMENT

PROCEDURE

Storm water drainage basins were developed by analyzing existing topographic maps for Legendary Estates and the surrounding areas. Peak flows were determined for each of the basins, based on existing land uses outside of the development footprint, and fully developed land uses within Legendary Estates, for the 5 and 100-year rainfall events. For the purpose of this report, all flow data used in the analysis was estimated through standard engineering practices. Actual or recorded flow data was researched for model calibration and comparison to real-time events.

Factors affecting runoff include the size and slope of the basin, hydrologic soil group classification, imperviousness, land use or type of crop cover, travel time and the intensity of the rainfall event. Stockwell Engineers utilized XP-SWMM modeling software specifically designed for hydrology modeling and runoff routing to determine design flows. This hydrologic analysis is paired with an integrated 1D/2D detailed hydraulic analysis of both the existing enclosed system and the digital terrain model to simulate the conveyance of storm flows on the surface.

Current city design standards outline that the drainage system shall be designed to provide protection against regularly recurring damage, to reduce street maintenance costs, and to provide an orderly urban drainage system. Consequently, urban areas generally have two separate and distinct drainage systems. First is the enclosed system that corresponds to the minor (5-year) storm event recurring at regular intervals. The other is the overflow system that is designed to convey the major storm event which has a one percent probability of occurring in any one year, also referred to as the 100-year storm event.

HYDROLOGIC ANALYSIS

Determining flow for a storm sewer conveyance system is largely contingent upon the size of the contributing watershed boundary. The watershed boundary is determined by the topography of the basin. It is defined by the area tributary to a specific discharge point and is separated from adjacent basins by a divide or ridge that can be traced on topographic maps. Watershed boundaries can be relatively large depending on the location of the discharge point. Typically, they are divided into smaller tributary basins and sub-basins. Watershed boundaries shown in Figures 1 and 2 indicate which areas drain through Legendary Estates, and which areas drain into the Schindler Creek Basin.

Other significant factors in determining storm runoff for a basin is the type of land use and slope of the land. Existing land uses were used surrounding Legendary Estates, however fully developed conditions were used to estimate flows within the development itself. From there, each sub-basin was analyzed to determine the imperviousness used to calculate weighted runoff coefficients. This information is then used to calculate the time it takes for runoff to travel from the hydraulically most distant point to reach the point of discharge, referred to as the time of concentration. Figure 3 indicates the variables used to calculate the reported peak flows from each of the designated basins for both the 5-year and 100-year rainfall events.

HYDRAULIC ANALYSIS

The hydraulic analysis was performed by developing an integrated 1D/2D hydraulic model using XP-SWMM that models the 1D sewer system and the 2D overland flow in tandem. The model was set up by delineating drainage basins, and applying the hydrology parameters described above. The existing enclosed system was input into the software program based on construction plans provided by the developer that included inlet locations and types along with pipe lengths, sizes, types and slopes.

A digital elevation model was used to represent the surface. The DEM was taken from LiDAR data provided by Lincoln County, that was flown in 2012. Roughness coefficients were assigned for existing land uses, which included industrial, agricultural, and residential uses. The model was executed to simulate the 5-year and 100-year events through the stormwater collection and conveyance system. Figures 5 and 6 show inundated areas for both rainfall events.

ENGINEERING DESIGN STANDARDS

City of Harrisburg Engineering Design standards require urban areas to have two separate and distinct drainage systems. One is the minor system corresponding to the minor, or 5-year event for storms that occur at regular intervals. The other is the major system that corresponds to the Major, or 100-year event that has a one percent probability of occurring in any one year.

The minor storm drainage system shall be designed to provide protection against regularly recurring damage, to reduce street maintenance costs, to provide and orderly urban drainage system and to provide convenience to the urban residents. Storm sewer systems consisting of underground piping, natural drainageways, and other required appurtenances shall be considered as part of the minor storm drainage system. It appears that the enclosed storm sewer system in Legendary Estates is adequate to satisfy these requirements.

The major storm drainage system shall be designed to prevent major property damage or loss of life. The route of the major storm shall be noted to assure an outlet to a designated major drainageway is available. All channels shall be designed for the 5-year and 100-year storm frequencies considered. Property corner elevations of properties abutting a major drainageway shall be 1 foot above the 100-year design storm. Recommended minimum ground elevations for homes abutting or affected by the major drainageway shall be 2 feet above the overflow elevation. Recommended minimum ground elevations for homes abutting or affected by major drainageways, where an overflow system is not available, will be either a minimum of 4 feet above the 100-year high water elevation or at an elevation that provides for 150 percent of the 100-year flow capacity.

MODEL RESULTS

A typical drainage system will use enclosed pipe network to capture and convey the minor event. Storm runoff from major events that exceed the capacity of the pipe network is generally conveyed to major drainageways, or street right-of-way that have been appropriately designed with identified overtopping locations at specified elevations. The results of the Hydrologic and Hydraulic model indicate that the enclosed storm sewer has been appropriately designed to capture and convey the minor, 5-year rainfall event. Storm flows are conveyed to curb inlets, and flared end sections where runoff enters the enclosed network and eventually drains into the detention facility located at the downstream end of the development. The detention facility can store water to a high water elevation of 1417.50 which is adequate to retain the minor events without overtopping.

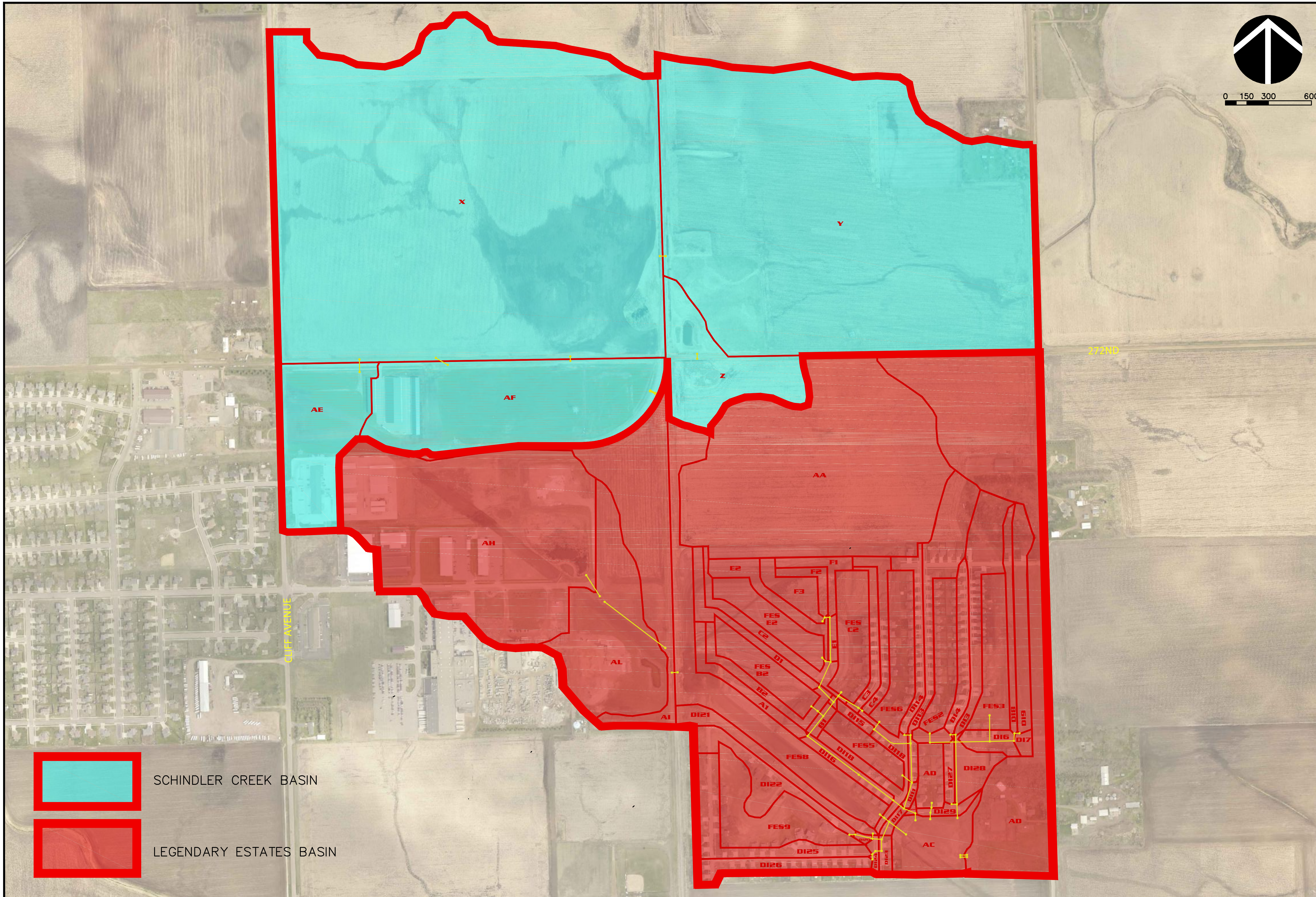
The completed hydraulic model for Legendary Estates indicates that runoff generated by storm events larger than a 5-year event are not being routed to the major conveyance element, which in this particular development, is the street right-of way. Flared end sections located between lots at various locations have been constructed several feet below the overtopping elevation at the street. This allows for ponding, or the storage of storm water on private property. This storage, depending on the severity of the event, backs up into yards and in some cases residential structures.

The inundated areas and resulting 100-year high-water elevations are shown on Figure 7. Events occurring in excess of the 100-year event will further impede private property, until the overtopping location allows for relief. Several homes in these areas have been constructed at elevations that are below the 100-year high-water elevations as well as below the overtopping elevations.

RECOMMENDATIONS

During events greater than a 5-year event, storm flows that do not enter the enclosed storm sewer system should be conveyed in the street right-of-way or designed drainage easements to convey a 100-year storm. Legendary Estates residential development does not meet City of Harrisburg Engineering Design Standards. The following improvements are recommended in an effort to resolve the existing drainage concerns in back yards.

1. Areas adjacent to inundated areas shown on Figure 7 need to be analyzed in greater detail to determine what the resulting overtopping elevation is based on as-built conditions.
2. Existing structures adjacent to ponding areas as shown on Figure 7 and have water entry elevations below the overtopping elevation, as identified by the City Engineer, must be converted so that the adjacent grade and lowest water entry elevation is a minimum 1’ above the overtopping elevation.
3. Future structures shall be located a minimum 2’ above the overtopping elevation, as identified by the City Engineer.
4. Building permits should be reviewed by the City Engineer to assure conformance to engineering design standards and these recommendations.



LEGENDARY ESTATES

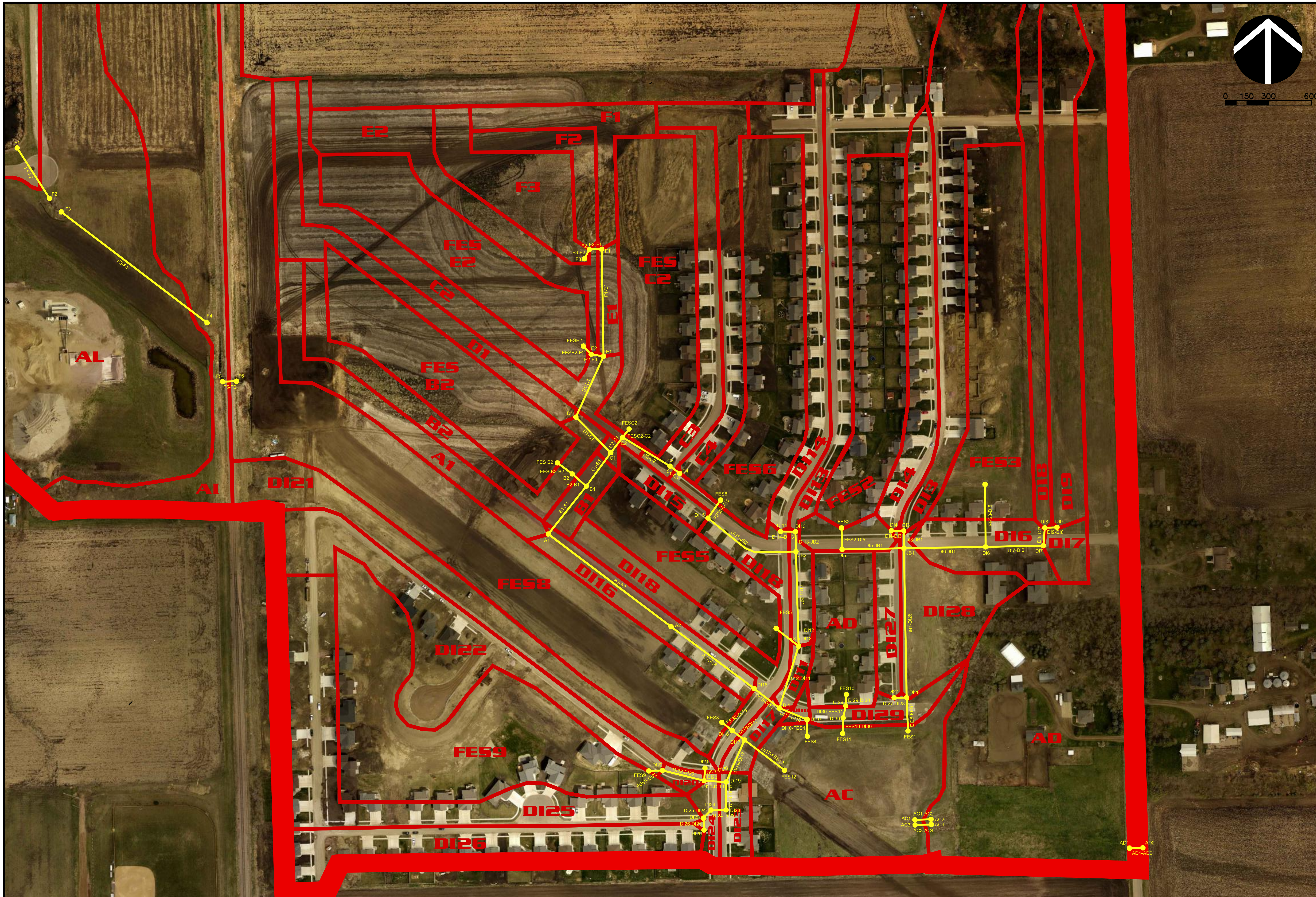
DRAINAGE ANALYSIS
HARRISBURG, SD

BASIN BOUNDARIES

DESIGNED BY: HAC
DRAWN BY: HAC ACAD FILE: LEGENDARY_HISTORIC.dwg
CHECKED BY: JRB DATE: 06/14/2016
REVISIONS: BY: DATE:
BY: DATE:

STOCKWELL ENGINEERS
SIOUX FALLS, SD

SHEET NO.
1



LEGENDARY ESTATES
DRAINAGE ANALYSIS
HARRISBURG, SD

BASIN BOUNDARIES

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STOCKWELL ENGINEERS
SIOUX FALLS, SD

SHEET NO.
2

Name	Area (ac)	Pervious Area Curve Number	Time of Concentration (min)	Max Flow (cfs) 5-Year Event	Max Flow (cfs) 100-Year Event
A1	2.5	75	18	3.0	9.0
AA	44.3	67.5	55.2	14.4	61.2
AC	5.1	69	15	4.5	16.8
AD	32.1	68.6	62.7	10.5	42.2
AE	13.6	91	15	38.0	77.8
AF	27.0	89.7	15	72.0	151.4
AH	44.3	88.8	15	114.3	244.6
AI	15.1	88.5	15	38.5	83.0
AL	16.5	80.8	15	30.1	77.1
B1	0.5	75	19	0.6	1.8
B2	2.1	75	21	2.3	7.1
C1	0.1	75	15	0.1	0.4
C2	2.5	75	26	2.5	7.6
C3	1.7	75	22	1.9	5.8
C4	2.1	75	22	2.3	7.0
D1	2.2	75	17	2.8	8.4
DI10	0.1	0	0	0.0	0.0
DI11	0.3	75	15	0.4	1.1
DI12	0.5	75	15	0.6	1.9
DI13	5.8	75	35	4.7	14.5
DI14	2.3	75	25	2.3	7.1
DI15	0.5	75	15	0.7	2.0
DI16	1.3	75	18.9	1.6	4.7
DI17	0.4	75	15	0.5	1.6
DI18	2.7	75	22	2.9	8.9
DI20	0.2	75	15	0.2	0.6
DI21	3.0	75	18	3.7	11.1
DI22	3.9	75	21	4.4	13.4
DI23	0.6	75	15	0.8	2.3
DI24	0.4	75	15	0.5	1.5
DI25	5.0	75	35	4.0	12.5
DI26	3.1	75	35	2.5	7.8
DI27	0.7	75	15	1.0	3.0
DI28	2.1	75	22.9	2.2	6.7
DI3	5.2	75	17.9	6.4	19.4
DI30	0.7	75	15	0.9	2.6
DI4	2.4	75	17.5	2.9	8.8
DI5	0.5	75	15	0.7	2.1
DI6	1.4	87	15	3.2	7.2
DI7	0.4	87	15	1.1	2.4
DI8	2.0	75	20.2	2.3	6.9
DI9	3.9	75	18.9	4.6	13.9
E1	0.5	75	15	0.6	1.9
E2	2.4	75	23	2.6	7.9
F1	1.4	75	17	1.8	5.3
F2	1.0	75	15	1.3	3.8
F3	2.1	75	21	2.3	7.1
FES B2	3.8	75	28	3.5	10.9
FES E2	3.8	75	30	3.4	10.4
FES10	1.9	75	32.2	1.6	5.1
FES2	4.0	75	24.8	4.1	12.4
FES3	4.9	75	24.4	5.0	15.3
FES5	2.4	75	29.6	2.2	6.8
FES6	4.8	75	35	3.9	12.0
FES8	14.0	75	30	12.6	38.8
FES9	6.9	75	42	4.9	15.3
FESC2	4.7	75	78	2.1	6.6
X	135.3	70	102.7	34.3	129.5
Y	107.2	69.8	62.4	38.9	148.4
Z1	11.5	74.9	64.9	5.9	18.6

LEGENDARY ESTATES
DRAINAGE ANALYSIS
HARRISBURG, SD

NODES TABLE OF RESULTS - HYDROLOGIC ANALYSIS

DESIGNED BY: HAC
DRAWN BY: HAC ACAD FILE: LEGENDARY_HISTORIC.dwg
CHECKED BY: JRB DATE: 06/14/2016
REVISIONS: BY: DATE:
BY: DATE:

STOCKWELL ENGINEERS
SIOUX FALLS, SD

SHEET NO.
3

Name	Length (ft)	Diameter (ft)	Shape	Conduit Slope (%)	Roughness	Design Full Flow (cfs)	Upstream Node Name	Upstream Invert Elevation (ft)	Downstream Node Name	Downstream Invert Elevation (ft)	5-Year Event			100-Year Event		
											Max Flow (cfs)	Max Velocity (ft/s)	Maximum Water Elevation (ft)	Max Flow (cfs)	Max Velocity (ft/s)	Maximum Water Elevation (ft)
A1-A2	458.0	4	Circular	0.08	0.013	39.7	A1	1418.74	A2	1418.39	29.9	4.55	1420.89	78.4	6.49	1422.63
A2-DI16	160.0	4	Circular	0.94	0.013	139.1	A2	1418.39	DI16	1416.89	29.9	7.46	1419.76	78.3	8.78	1421.01
AC1-AC2	47.0	2.5	Circular	0.00	0.013	1.3	AC1	1414.18	AC2	1414.18	15.8	3.21	1417.44	43.2	8.74	1419.36
AC3-AC4	47.0	2.5	Circular	0.06	0.013	10.4	AC3	1414.09	AC4	1414.06	15.7	4.03	1417.43	44.7	9.04	1419.36
AD1-AD2	39.0	1.5	Circular	1.05	0.022	6.4	AD1	1410.56	AD2	1410.15	13.0	7.30	1415.02	13.7	7.65	1416.26
AE1-AE2	88.0	1.5	Circular	0.74	0.013	9.0	AE1	1443.57	AE2	1442.92	8.1	4.54	1446.41	11.3	6.34	1447.17
AE3-AE4	93.5	2	Circular	0.54	0.013	16.5	AE3	1440.2	AE4	1439.7	7.3	3.49	1442.54	10.7	3.39	1442.95
AF1-AF2	31.0	1.25	Circular	1.90	0.022	5.3	AF1	1434.39	AF2	1433.8	6.0	4.90	1436.82	6.0	4.84	1437.17
AF3-AF4	40.2	2.417	Special	0.32	0.013	34.1	AF3	1434.45	AF4	1434.32	0.0	0.00	1434.45	-8.9	-1.24	1437.36
AF5-AF6	40.2	2.417	Special	0.47	0.013	41.1	AF5	1434.45	AF6	1434.26	0.0	0.00	1434.45	-5.2	-2.28	1437.36
AF7-AF8	39.9	2.417	Special	0.25	0.013	30.0	AF7	1434.49	AF8	1434.39	0.0	0.00	1434.49	-4.8	-2.02	1437.36
B1-A1	169.0	4	Circular	0.26	0.013	73.3	B1	1419.23	A1	1418.79	27.2	4.61	1421.12	72.5	5.98	1423.00
B2-B1	33.0	2	Circular	0.55	0.013	16.7	B2	1420.67	B1	1420.49	5.7	4.82	1421.48	17.5	5.52	1423.18
C1-B1	112.0	3.5	Circular	0.44	0.013	66.6	C1	1419.97	B1	1419.48	21.0	5.52	1421.41	57.3	7.07	1423.29
C2-C1	47.5	3	Circular	0.40	0.013	42.2	C2	1420.41	C1	1420.22	7.2	3.79	1421.45	43.5	7.74	1423.34
C3-C2	124.0	2	Circular	0.39	0.013	14.1	C3	1421.42	C2	1420.94	4.2	3.90	1422.17	12.6	4.52	1423.59
C4-C3	33.0	1.5	Circular	0.30	0.013	5.8	C4	1421.78	C3	1421.68	2.3	3.33	1422.40	7.0	4.04	1423.71
D1-C1	145.0	3	Circular	0.81	0.013	59.9	D1	1421.14	C1	1419.97	13.8	5.96	1422.19	41.0	7.22	1423.60
DI10-FES4	40.0	4	Circular	0.30	0.013	78.7	DI10	1416.32	FES4	1416.2	43.9	6.84	1418.36	114.5	10.44	1419.90
DI11-DI10	77.0	4	Circular	0.30	0.013	78.5	DI11	1416.6	DI10	1416.37	44.0	6.78	1418.66	114.6	9.89	1420.29
DI12-DI11	112.0	3	Circular	0.49	0.013	46.7	DI12	1417.35	DI11	1416.8	13.4	4.47	1418.73	31.9	4.80	1420.49
DI13-JB2	53.5	2	Circular	0.26	0.013	11.6	DI13	1418.39	JB2	1418.25	6.8	3.60	1419.54	20.9	6.63	1421.97
DI14-DI13	41.0	1.5	Circular	0.51	0.013	7.5	DI14	1418.7	DI13	1418.49	2.3	2.64	1419.56	7.1	4.00	1422.10
DI15-JB2	283.0	2	Circular	0.50	0.013	16.0	DI15	1419.67	JB2	1418.25	4.1	3.87	1420.36	14.1	4.91	1421.86
DI16-DI11	83.5	4	Circular	0.25	0.013	72.0	DI16	1416.86	DI11	1416.65	31.2	5.14	1418.81	82.1	7.05	1420.50
DI17-FES12	146.0	3.333	Circular	0.11	0.013	29.2	DI17	1416.36	FES12	1416.2	33.3	5.08	1418.73	72.8	8.09	1420.47
DI18-DI17	41.0	2.583	Special	0.24	0.013	33.3	DI18	1416.56	DI17	1416.46	15.2	2.32	1418.74	32.2	4.59	1420.56
DI19-DI17	128.0	2.583	Special	0.25	0.013	33.7	DI19	1416.78	DI17	1416.46	17.8	2.87	1418.79	48.1	6.85	1420.90
DI20-DI19	60.0	2.5	Circular	0.50	0.013	29.0	DI20	1417.18	DI19	1416.88	11.1	3.66	1418.82	30.3	6.16	1421.05
DI21-DI20	33.0	1.5	Circular	1.00	0.013	10.5	DI21	1418.31	DI20	1417.98	3.7	5.37	1418.97	11.1	6.24	1421.27
DI22-DI20	122.5	2	Circular	0.70	0.013	19.0	DI22	1418.44	DI20	1417.58	7.9	5.29	1419.39	18.7	5.94	1421.64
DI23-DI19	71.0	2.5	Circular	0.35	0.013	24.3	DI23	1417.13	DI19	1416.88	7.1	2.17	1418.81	21.8	4.42	1421.09
DI24-DI23	41.0	2	Circular	0.49	0.013	15.8	DI24	1417.43	DI23	1417.23	6.8	3.29	1418.84	20.8	6.57	1421.43
DI25-DI24	30.0	2	Circular	1.00	0.013	22.6	DI25	1417.83	DI24	1417.53	6.6	4.73	1418.82	20.3	6.41	1421.66
DI26-DI25	33.0	1.5	Circular	1.00	0.013	10.5	DI26	1418.56	DI25	1418.23	2.5	4.84	1419.08	7.8	4.37	1421.84
DI27-DI28	33.0	1.25	Circular	0.52	0.013	4.6	DI27	1417.37	DI28	1417.2	1.0	1.68	1418.61	3.0	2.40	1419.84
DI28-FES1	88.0	3	Circular	0.39	0.013	41.5	DI28	1416.54	FES1	1416.2	31.3	6.01	1418.61	60.5	8.33	1419.83
DI29-DI30	34.0	1.5	Circular	0.50	0.013	7.4	DI29	1417.24	DI30	1417.07	1.6	3.37	1417.72	3.9	3.65	1419.55
DI3-JB1	47.5	2	Circular	0.65	0.013	18.3	DI3	1418.95	JB1	1418.64	9.3	5.12	1420.11	26.2	8.29	1422.84
DI30-FES11	40.0	1.5	Circular	1.93	0.013	14.6	DI30	1416.97	FES11	1416.2	2.1	5.07	1417.65	6.2	4.91	1419.53
DI4-DI3	33.0	1.25	Circular	1.00	0.013	6.5	DI4	1419.63	DI3	1419.3	2.9	4.62	1420.29	7.5	6.10	1422.97
DI5-JB1	176.0	2	Circular	0.50	0.013	16.0	DI5	1419.47	JB1	1418.59	4.6	3.76	1420.28	12.9	4.27	1422.43
DI6-JB1	234.5	2.5	Circular	0.52	0.013	29.5	DI6	1419.7	JB1	1418.49	14.7	5.69	1420.98	23.5	5.76	1422.91
DI7-DI6	160.0	2	Circular	0.53	0.013	16.4	DI7	1420.68	DI6	1419.84	7.8	4.94	1421.68	19.1	6.06	1423.92
DI8-DI7	48.0	1.5	Special	0.50	0.013	10.4	DI8	1421.02	DI7	1420.78	6.9	4.78	1421.87	16.8	7.58	1424.47
DI9-DI8	33.0	1.5	Circular	0.52	0.013	7.5	DI9	1421.29	DI8	1421.12	4.6	4.54	1422.13	11.0	6.20	1424.75
E1-D1	188.0	2.5	Circular	0.40	0.013	25.9	E1	1421.89	D1	1421.14	11.2	5.11	1423.05	33.7	6.59	1424.76
E2-E1	32.0	2	Circular	0.44	0.013	15.0	E2	1422.28	E1	1422.14	5.8	4.49	1423.16	18.0	5.72	1424.96
F1-E1	234.0	2	Circular	0.51	0.013	16.2	F1	1423.34	E1	1422.14	5.3	4.50	1424.13	15.2	5.31	1425.70
F2-F1	33.0	1.5	Circular	0.55	0.013	7.8	F2	1424.02	F1	1423.84	3.5	4.28	1424.73	10.2	6.01	1426.00
F3-F2	17.0	1.5	Circular	1.06	0.013	10.8	F3	1424.3	F2	1424.12	2.3	4.24	1424.83	7.2	5.03	1426.08
FES B2-B2	26.0	2	Circular	4.27	0.013	46.7	FES B2	1421.88	B2	1420.77	3.5	7.67	1422.25	10.9	8.38	1423.01
FES E2-E2	30.0	1.5	Circular	3.20	0.013	18.8	FES E2	1423.49	E2	1422.53	3.4	7.55	1423.93	11.0	8.81	1425.26
FES10-DI30	19.0	1.5	Circular	0.32	0.013	5.9	FES10	1417.47	DI29	1417.41	1.6	3.10	1417.98	3.9	4.04	1419.56
FES2-DI5	56.0	1.5	Circular	0.55	0.013	7.8	FES2	1419.88	DI5	1419.57	4.1	4.46	1420.65	12.5	7.03	1422.70
FES3-DI6	176.0	1.5	Circular	0.52	0.013	7.6	FES3	1420.85	DI6	1419.94	4.8	4.52	1421.73	10.7	6.11	1423.14
FES5-DI12	80.0	1.5	Circular	1.00	0.013	10.5	FES5	1418.95	DI12	1418.15	2.2	4.54	1419.42	10.0	6.76	1420.62
FES6-DI15	33.0	2	Circular	0.94	0.013	21.9	FES6	1420.08	DI15	1419.77	3.8	5.16	1420.65	13.7	5.90	1421.89
FES8-DI18	32.0	2.583	Special	0.50	0.013	47.7	FES8	1416.82	DI18	1416.66	12.6	2.12	1418.74	29.5	4.20	1420.62
FES9-DI22	32.0	1.5	Circular	1.19	0.013	11.5	FES9	1419.22	DI22	1418.84	4.9	6.23	1419.91	13.3	7.51	1421.70
FESC2-C2	24.0	2.5	Circular	3.00	0.013	71.0	FESC2	1421.13	C2	1420.41	3.7	6.63	1421.53	41.8	10.69	1423.34
G1-G2	174.6	3	Circular	0.46	0.013	45.2	G1	1433.87	G2	1433.07	0.0	0.00	1433.87	7.6	1.42	1435.95
G3-G4	532.6	3	Circular	0.14	0.013	25.2	G3	1432.38	G5	1431.62	-1.1	-0.54	1435.16	7.5	1.03	1435.94
G6-G7	40.6	3	Circular	0.20	0.013	29.6	G6	1431.28	G7	1431.2	1.7	2.05	1432.58	11.8	2.72	1433.05
JB1-DI28	424.5	3	Circular	0.34	0.013	39.0	JB1	1418.09	DI28	1416.64	28.3	5.95	1420.00	51.5	7.25	1422.27
JB2-DI12	270.0	2.5	Circular	0.29	0.013	22.2	JB2	1418.19	DI12	1417.4	10.8	4.46	1419.43	25.8	5.24	1421.55
X1-X2	40.4	3	Circular	-0.99	0.013	66.4	X1	1433	X2	1433.4	9.9	1.76	1435.28	36.6	5.28	1435.95
Y1-Y2	36.4	2	Circular	0.96	0.022	13.1	Y1	1423.76	Y2	1423.41	8.5	2.69	1426.31	18.8	5.95	1427.71
Y3-Y4	36.8	2	Circular	0.62	0.022	10.6	Y3	1423.71	Y4	1423.48	8.4	2.68	1426.31	18.7	5.92	1427.71
Z1-Z2	34.0	2	Circular	0.21	0.013	10.3	Z1	1432.64	Z2	1432.57	5.4	2.89	1434.82	13.3	4.73	1435.16

LEGENDARY ESTATES
DRAINAGE ANALYSIS
HARRISBURG, SD

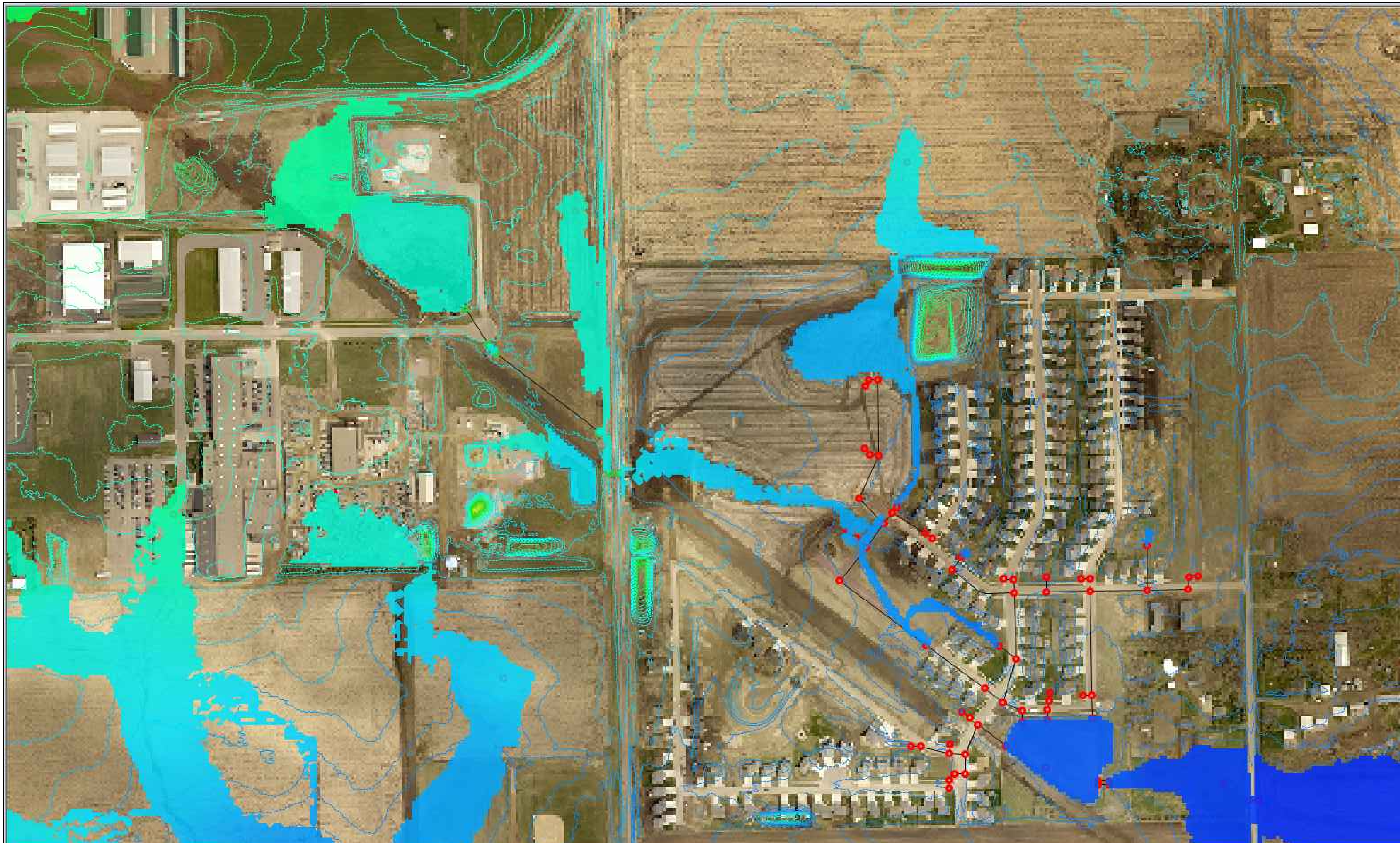
LINKS TABLE OF RESULTS - HYDRAULIC ANALYSIS

DESIGNED BY: HAC
DRAWN BY: HAC ACAD FILE: LEGENDARY_HISTORIC.dwg DATE: 06/14/2016
CHECKED BY: JRB BY: DATE:
REVISIONS: BY: DATE:

STOCKWELL ENGINEERS
SIOUX FALLS, SD

SHEET NO.

4



LEGENDARY ESTATES

DRAINAGE ANALYSIS
HARRISBURG, SD

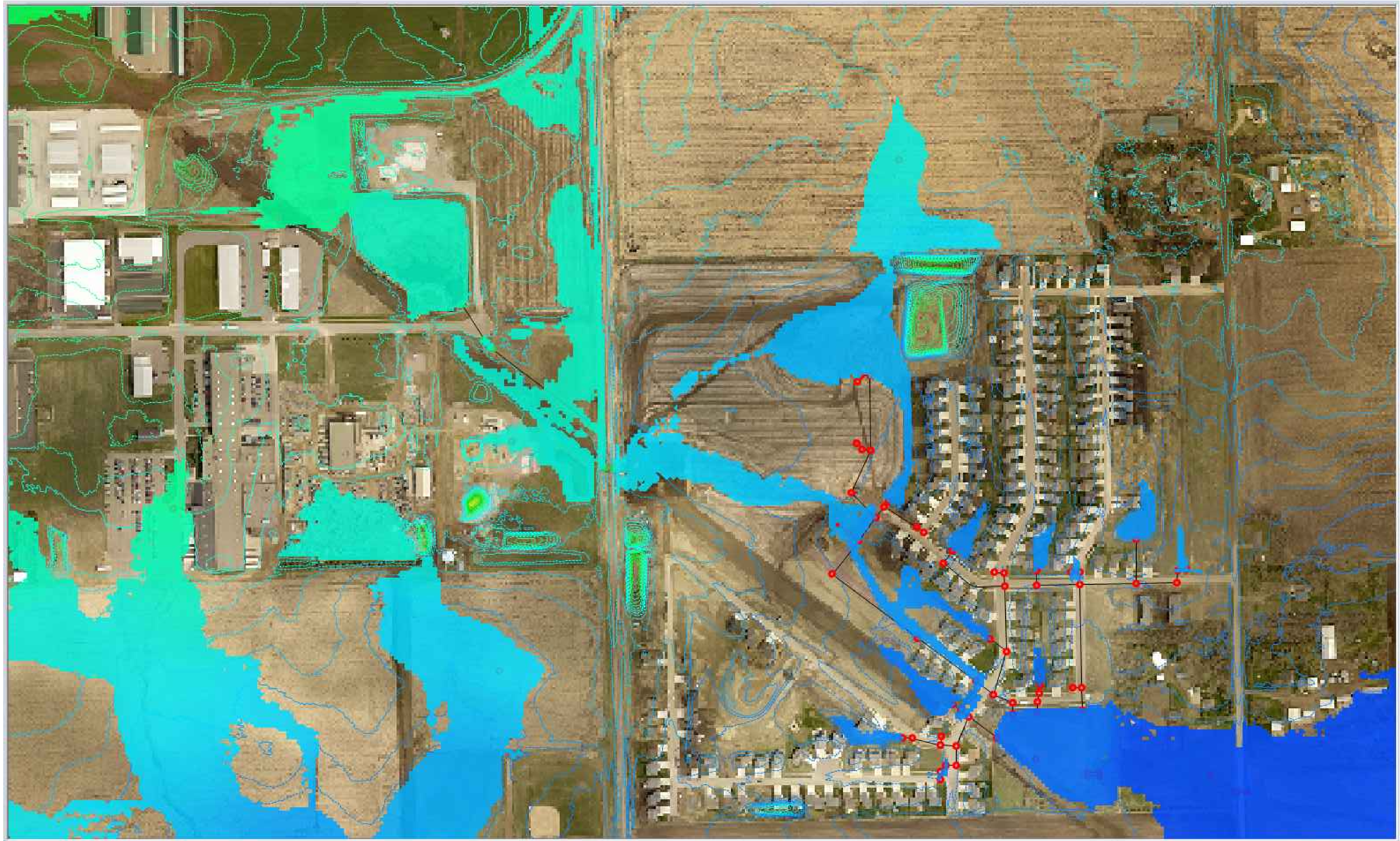
5-YEAR EVENT INUNDATION MAP

DESIGNED BY: HAC
DRAWN BY: HAC ACAD FILE: LEGENDARY_HISTORIC.dwg
CHECKED BY: JRB DATE: 06/14/2016
REVISIONS: BY: DATE:
BY: DATE:

STOCKWELL ENGINEERS
SIOUX FALLS, SD

SHEET NO.

5



LEGENDARY ESTATES

DRAINAGE ANALYSIS
HARRISBURG, SD

100-YEAR EVENT INUNDATION MAP

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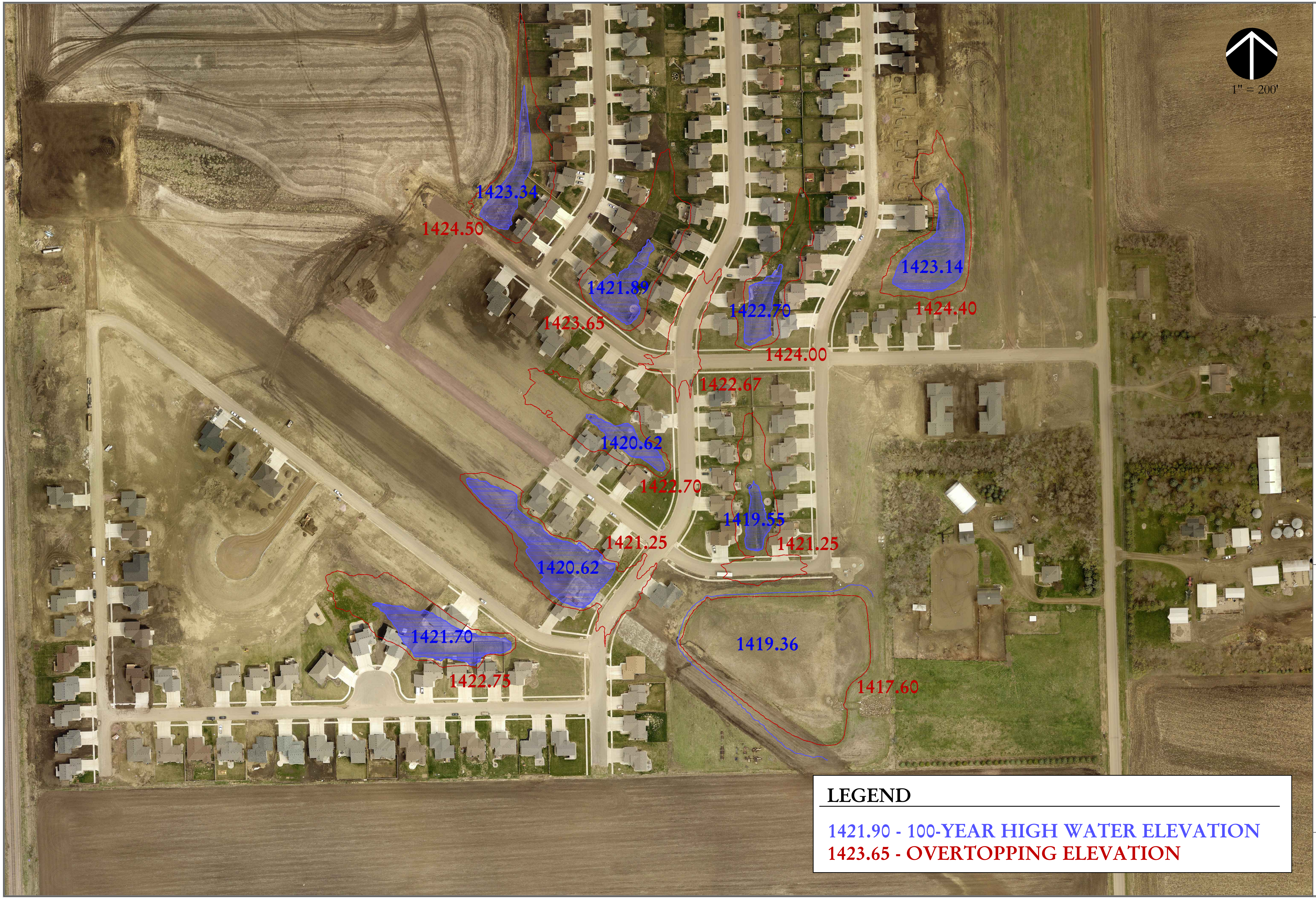
CHECKED BY: JRB DATE: 06/14/2016

REVISIONS: BY: DATE:
BY: DATE:

STOCKWELL ENGINEERS
SIOUX FALLS, SD

SHEET NO.

6



LEGENDARY ESTATES
DRAINAGE ANALYSIS
HARRISBURG, SD

INNUNDATED WATER LEVELS - 100-YEAR EVENT

STOCKWELL ENGINEERS
SIOUX FALLS, SD

SHEET NO.
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