

FINAL
STORMWATER REPORT
for
STREETS OF WEST PRYOR

NWQ PRYOR ROAD AND LOWENSTEIN DRIVE
LEE'S SUMMIT, MISSOURI

Revisions:

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KVE Project No. A14D7067-1

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INTRODUCTION

This drainage report was prepared to accompany the submittal of final construction documents for the overall drainage improvements for the Streets of West Pryor development. The proposed development includes approximately 72.7 acres of mixed-use commercial development and multi-family and single-family housing.

This revised version accounts for the following changes:

- Revised grading that decreased drainage area leading to West Detention Basin
- Elevation changes to pond and outlet structures in West Detention Basin
- Revisions to storm sewer lines J and M

DESIGN CRITERIA

- Adopted design Criteria
 - APWA - Division V - Section 5600 – Storm Drainage Systems and Facilities

PROJECT LOCATION



Figure 1: Project Location Map

As shown in Figure 1, the project is located in the NWC of NW Lowenstein Drive and NW Pryor Road. The project site is bound by NW Pryor Road and Summit Woods Crossing shopping center to the East, Lowenstein Park and residential properties to the south and southwest, and by Interstate 470 to the north.

EXISTING CONDITIONS

The project site is mostly undeveloped with the exception of some single family residential homes that are being removed. The project site is well covered with a low scrubby vegetation interspersed with dense stands of trees. See **APPENDIX A** for existing and proposed drainage area maps.

FEMA FIRM

The site is currently located on FIRM Map Number 29095C0291F Panel 291 of 6480. The project site is located in Areas determined to be outside the 1% and 0.2% annual chance floodplains. See **APPENDIX B** for a FEMA Firmette encompassing the project site.

Existing Watershed

The project site is located within Cedar Creek and Boggs Hollow Watersheds and discharges in several directions.

The South watershed discharges to the roadside ditch along Lowenstein Drive and into the drainage way through the City Park. The West watershed drains to the west into a roadside ditch and concrete channel that proceeds along Lowenstein Drive and through open ditches to the west towards Cedar Creek. Both systems are part of the Cedar Creek watershed.

The East watershed ultimately discharges to several crossroad culverts under I-470. A portion of the roadside flow on Pryor, up to the inlet capacities, is directed via storm sewers into the detention pond on the Summit Woods development, which then drains via pipe system under I-470 on the east side of US-50. The remainder of the area, including all overflow beyond inlet capacities on Pryor, drains to the existing MoDOT ditch on I-470 until it reaches the box culvert crossing I-470 and ramps approximately 1,100 feet west of Pryor Road. The East watershed is tributary to the Boggs Hollow watershed, which then ultimately joins Cedar Creek.

The total pre-project acreages tributary of each of these three primary sub-basins is as follows:

Table 1: Pre-Project Tributary Areas

	Subwatershed Area (acres)
East (Boggs Hollow)	23.0
South (Cedar Creek)	24.0
West (Cedar Creek)	24.9
Total	71.9

The difference between this total and the formal site size of 72.7 acres is attributable to excluding Lowenstein Road right-of-way from the drainage area and the addition of a sliver of the cell tower tract that drains into the West watershed.

Existing Soils

Soils data for the site was obtained from the NRCS soil survey. A summary of the site soils and their properties is shown on the chart below. According to the NRCS, the on-site soils are predominately Type D soils (17%), Type C soils (66%) or Type C/D (17%). The composite CN values used for rainfall mass calculations reflect a conservative estimate of the predominant Type D soils contained onsite.

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
10113	Oska silty clay loam, 5 to 9 percent slopes, eroded	D	5.6	8.2%
10117	Sampsel silty clay loam, 5 to 9 percent slopes	C/D	11.3	16.7%
10120	Sharpsburg silt loam, 2 to 5 percent slopes	C	27.3	40.2%
10128	Sharpsburg-Urban land complex, 2 to 5 percent slopes	D	5.2	7.6%
10141	Snead-Rock outcrop complex, 14 to 30 percent slopes	D	0.6	0.9%
10179	Udarents-Urban land-Oska complex, 5 to 9 percent slopes	C	0.4	0.5%
10181	Udarents-Urban land-Sampsel complex, 5 to 9 percent slopes	C	17.6	25.9%
Totals for Area of Interest			67.9	100.0%

Existing Stormwater Appurtenances

There are three existing small ponds on the project that capture and detain an undetermined amount of storm water. The existing watersheds discharging to the ponds and their respective outlet structures have not been investigated as the ponds will be removed and larger detention basins will be provided to accommodate the proposed development. There are miscellaneous culverts located on the project site allowing storm water to pass under residential driveways and through other existing features. No other storm water appurtenances are present on the project site.

Offsite Drainage Areas

The project site sits at the upper portion of the Cedar Creek and Boggs Hollow Watersheds and therefore has minimal offsite drainage areas passing through the project site. The only offsite area

is a sliver of land from the cell tower property which drains into the western basin, as shown on the Existing Drainage Area exhibit in **APPENDIX A**.

PRE- AND POST-DEVELOPMENT SITE CONDITIONS

Due to space constraints on the eastern portion of the site, the project proposes to transfer a substantial portion of the East and South watersheds via storm sewer into the West watershed, where it can be detained in a larger regional detention basin (the “West Basin”). The basin will capture 44.4 acres, an increase from the original 24.9 acres that drained to the west.

Revisions to grading following the first submittal of this drainage study caused the west basin to capture 44.4 acres instead of the original 46.4 acres. This 2.0-acre space that is no longer detained is shown in **APPENDIX F**.

To transfer this area, two main trunk lines (A & B) of storm sewer will pass under the ridge lines to discharge into the West basin. These trunk lines and the inlets and lateral pipes leading to them are designed to capture up to the 100-year flow, so that they can be directed into the West basin.

A remaining portion of the South watershed located near the relocated intersection of Lowenstein Road and Pryor Avenue will be directed to a basin at the corner of Chipman Road and Pryor Ave (the “South Basin”). This basin captures 11.0 acres.

Cumulatively, the two detention basins capture 55.4 acres. The remaining, un-detained 16.5 acres is primarily from the fringes of the development as shown on the Proposed Drainage Area Map in Appendix A.

Portions of Lots 12 and 13 are also designed to remain in the East watershed and be discharged primarily through an outlet into the MoDOT ditch at a point approximately 430 ft west of Pryor Road.

A small portion of the remaining area will drain to storm sewer which connects into the drain system on Pryor Road near the northernmost entrance to the site, which will then connect to the detention pond in the Summit Woods development.

The area has been limited so that the predevelopment peak runoff from the East watershed is not exceeded in post-development conditions.

Per APWA 5600, pre- and post-development site flows will be analyzed for the 2-, 10-, and 100-year design storms.

Pre / Post Site Land use

The pre-project CN is estimated for preliminary study purposes as 77. The post-project curve number is estimated as 94 for commercial areas, and 83 in the single-family residential portion of

the West watershed. The composite CN for the areas to the West Basin was estimated at 92. The composite CN to the South Basin is estimated at 94.

Allowable Release Rates by Watershed

The allowable release rates for three watersheds were calculated by considering both the pre-development versus post-development peaks and by the detention basin release rate guidance given in APWA 5608.4. Considering the changes made to watershed boundaries, the allowable release rates were based on pre-project drainage areas to each outlet.

Table 2: Allowable Release Rates

Drainage Area	Area (Acres) (Pre-Project)	Design Storm	APWA Allowable Release Rate (cfs/acre)	Total Allowable Release Rate (cfs) from Watershed – per APWA	Pre- Development Release Rate (cfs)
West Watershed	24.9	50% (2 yr)	0.5	12.5	43
		10% (10 yr)	2	49.8	83
		1% (100 yr)	3	74.7	167
South Watershed	24	50% (2 yr)	0.5	12	41
		10% (10 yr)	2	48	80
		1% (100 yr)	3	72	161
East Watershed	23	50% (2 yr)	0.5	11.5	41
		10% (10 yr)	2	46	80
		1% (100 yr)	3	69	160

Actual Detention Pond Release Rates

The calculation of the actual release rates from each watershed was based on the size of the adjusted watersheds and the proposed detention basins. Runoff from the undetained areas was added to the detention basin outflows to calculate an equivalent total watershed release rate. For the post-project area of the East basin, there is no detention structure, but the total contributory area is less than before the project.

The detention areas were analyzed using Hydraflow Hydrographs. The detailed calculations are found in **APPENDIX D**. The SCS method was used to generate hydrographs, and then routed through standard methods in each pond. Orifice and weir structures were estimated to control the release rate. Storage volumes were obtained from the grading plan. Each basin contains a wet pond as a water feature/amenity, as well as an excess volume above the permanent pool to be used

for detention. The West watershed contains a second upper pond that will act as an additional amenity and a sediment forebay.

As shown in the charts below, the proposed extended wet detention basins adequately accommodate and reduce post-development storm water flows to APWA required levels for the West and South watersheds. The only exception is in the net release rate from the 2-year storm for the West watershed, which is exceeded slightly. This is unavoidable due to impact from the undetained residual areas. However, in all cases, the net release rate is less than the pre-development flows from the original drainage areas, as can be seen in the data in **APPENDIX D**.

The APWA release rates set as the target were impractical as a control for the East watershed, since there was no detention basin proposed in that area. In the case of the East watershed, the area is draining into MoDOT's right of way and then ultimately into the much larger Bogg's Hollow watershed. There are no habitable structures or neighborhoods through which this flow would pass first before joining the larger watershed. For these reasons, it is proposed to use the pre-development limit from the full watershed area as the controlling target in the East watershed. This target is met for all storm events analyzed. No adverse impact is anticipated to the downstream system as a result.

Table 3: Summary of Discharge Rates

Watershed	Post-Project Area to Detention (acres)	Post-Project Area Undetained (acres)	Design Storm	Actual Release Rate from Detention Area (cfs)	Total Release Rate from Watershed (including undetained area) (cfs)	Allowable Release Rate from Watershed - APWA (cfs)	Pre-Development Release Rate (cfs)
West Watershed	44.4	6.4	50% (2 yr)	4.76	25.97*	12.5	42.9
			10% (10 yr)	13.62	46.17	49.8	83.2
			1% (100 yr)	29.03	86.33*	74.7	166.8
South Watershed	11	2.22	50% (2 yr)	4.8	11.7	12	41.4
			10% (10 yr)	15.3	22	48	80.2
			1% (100 yr)	43.8	62.1	72	160.8
East Watershed	0	7.7	50% (2 yr)	n/a	31.3*	11.5	41.4
			10% (10 yr)	n/a	49.2*	46	80.2
			1% (100 yr)	n/a	83.5*	69	160.3

* Release rate from the combination of detained and undetained areas exceeds APWA but is less than pre-development condition. Variance requested.

PROPOSED STORM SEWER SYSTEM

The proposed storm sewer system is comprised of several general systems that direct site storm sewer flows to the proposed extended wet detention basins located in the west and south

watersheds. A particular feature of the storm sewer system is the two main trunk lines needed to carry flows from the East and South watersheds to the West basin for detention. These pipes are sized to carry up to the 100-year flow. Due to the crossing of the ridge line, they become deep in places, with corresponding deep junction structures. See **APPENDIX C** for sizing and layout of the primary trunk line for this system. The pipe system feeding the South basin from north of Lowenstein will also be sized for the 100-year flow, since otherwise any overland swale flow would be intercepted at Lowenstein and bypass the detention area.

Revisions to the storm sewer system included changes to storm line J, and a pipe size increase in line M.

PROPOSED EXTENDED WET DETENTION

Wet detention ponds are proposed for the West and South watersheds to reduce the increase in post-development storm water flows and to provide aesthetic water features for the proposed development. See **APPENDIX D** for wet detention pond routing. See the information below for design information. The wet detention ponds will hold water at their design wet pond elevation and storm water detention and water quality treatment will occur above this elevation.

West Wet Detention Pond

Top Elevation = 962.0

Bottom elevation = 942.0

Wet Pond Elevation = 952.0

Storage Volume at Wet Pond Elevation = 819,430 Cubic Feet

Primary Outlet

Elevation 954: (30" W x 12" H orifice)

Elevation 957: (30" W x 18" H orifice)

Emergency Overflow

Elevation 959.5 (80-ft broad-crested weir)

Max 100 yr WSE = 957.87

Max 100 yr Storage Volume = 1,619,395 Cubic Feet

South Wet Detention Pond

Top Elevation = 978.0

Bottom elevation = 960.0

Wet Pond Elevation = 966.0

Storage Volume at Wet Pond Elevation = 71,763 Cubic Feet

Primary Outlet

Elevation 968: (2 x 8" orifices)

Elevation 969: (2 x 8" orifices)

Elevation 970.50: (2' x 2' Square Grate Riser)

Emergency Overflow

Elevation = 973.5 (20-ft broad-crested weir)

Max 100 yr WSE = 972.57

Max 100 yr Storage Volume = 153,332 Cubic Feet

MARC/APWA BMP CALCULATIONS

Per APWA 5608.4, the project site is required to provide 40-hour extended detention of runoff from the local 90% mean annual event (1.37"/24-hour rainfall). Both basins are extended wet detention basins (EWDBs) with a permanent pool elevation. The water quality event will be stored between the permanent water pool surface and the lowest primary outlet elevation. See Appendix E for detailed orifice calculations and a summary below.

West Basin

Water Quality Volume = 108,239 ft³
Permanent Pool Elevation/Water Quality Orifice Elevation = 952
Lowest Primary Outlet Elevation = 954
Storage Provided from Elevation 952 to 954: 226,806 ft³
Water Quality Orifice Diameter = 4.63 inches

South Basin

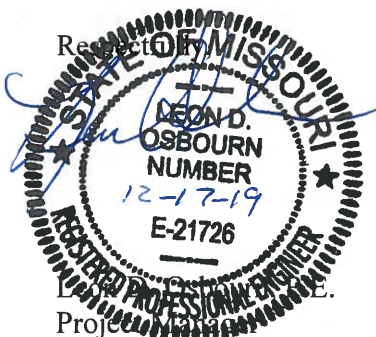
Water Quality Volume = 32,770 ft³
Permanent Pool Elevation/Water Quality Orifice Elevation = 966
Lowest Primary Outlet Elevation = 968
Storage Provided from Elevation 966 to 968: 35,859 ft³
Water Quality Orifice Diameter = 2.55 inches

DOWNSTREAM CONDITIONS

The proposed development will mitigate for changes to the watershed by providing significant detention and addressing the water quality storm. Release rates from detention areas are in line with APWA allowable release rates, except for deviations as reported for the West Watershed 2- and 100-year storm and for the East Watershed. Release rates from all watersheds under proposed conditions are less than those of existing conditions.

CONCLUSION

The proposed development will effectively capture, detain and treat stormwater from the proposed development in substantial accordance with the requirements set forth by the City of Lee's Summit. A waiver from the strict application of the APWA 5608.4 release rate standard is requested for the combined releases in the 2- and 100-year storm for the West Watershed and for all events from the East Watershed, based on both conditions remaining below the pre-development peak of the existing watershed.




Kirk C. Stewart, E.I.T.
Project Engineer

APPENDIX A – EXISTING AND PROPOSED DRAINAGE AREA MAPS

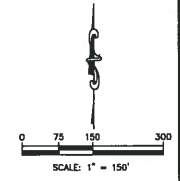
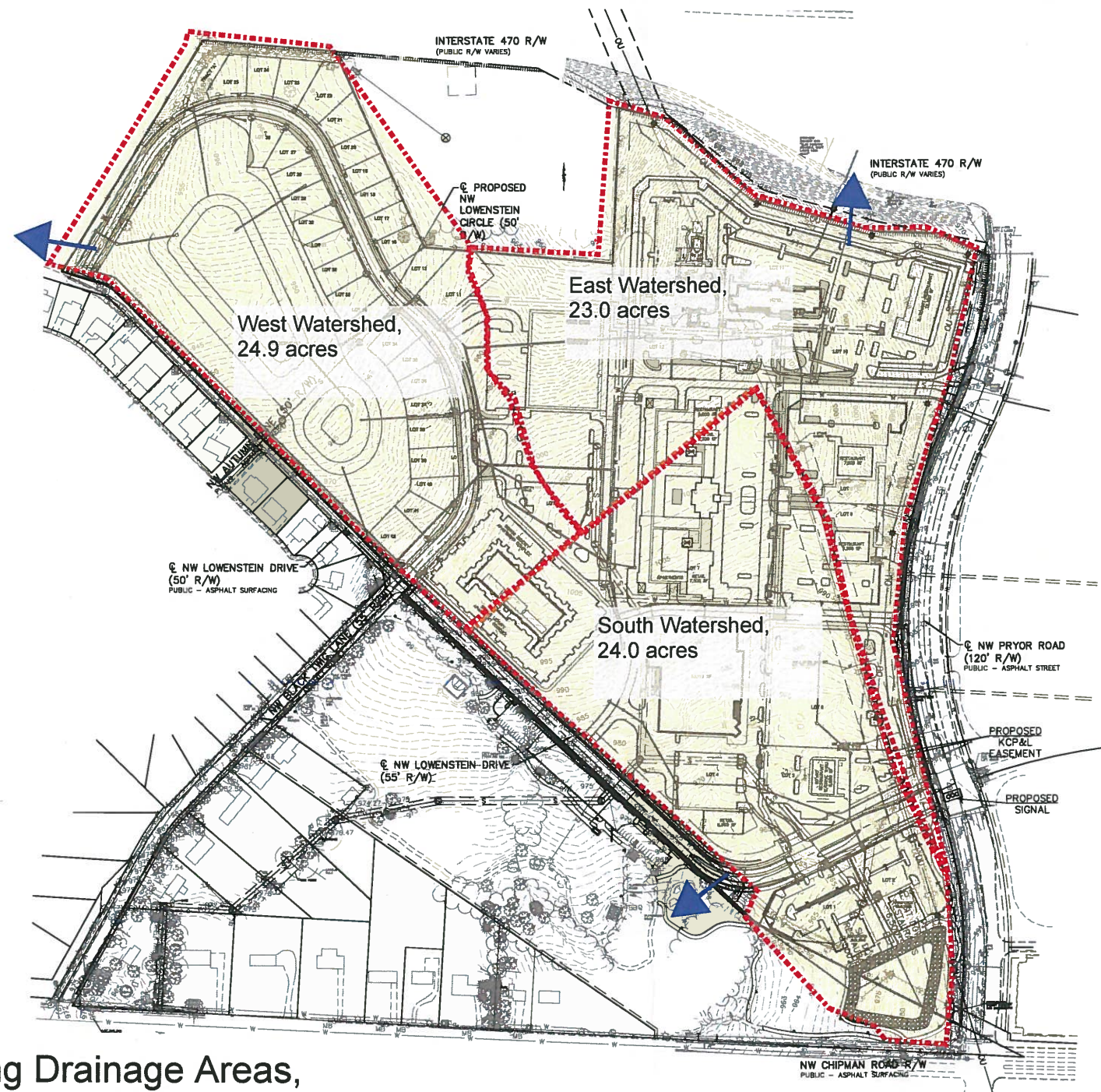


Exhibit: Existing Drainage Areas,
Streets of West Pryor Site

THIS DRAWING SHALL NOT BE UTILIZED BY ANY PERSON, FIRM, OR CORPORATION IN WHOLE OR IN PART WITHOUT THE SPECIFIC PERMISSION OF KAW VALLEY ENGINEERING, INC.

KAW VALLEY ENGINEERING		DSN	DWN	CHK
KAW VALLEY ENGINEERING, INC. IS AUTHORIZED TO OFFER ENGINEERING SERVICES IN THE STATE OF MISSOURI UNDER LICENSE NO. 000002, EXPIRES 12/31/18		REV	DATE	DESCRIPTION
STREETS OF WEST PRYOR NWQ NW PRYOR ROAD & NW LOWENSTEIN DRIVE LEE'S SUMMIT, MISSOURI PRELIMINARY DEVELOPMENT PLAN DRAINAGE AREA MAP				
PROJ. NO.	A14-7087-1			
DESIGNER	LDO	DRAWN BY	JT	
CHECKED	7/26/17	DATE	7/26/17	
SHEET	1	REV		

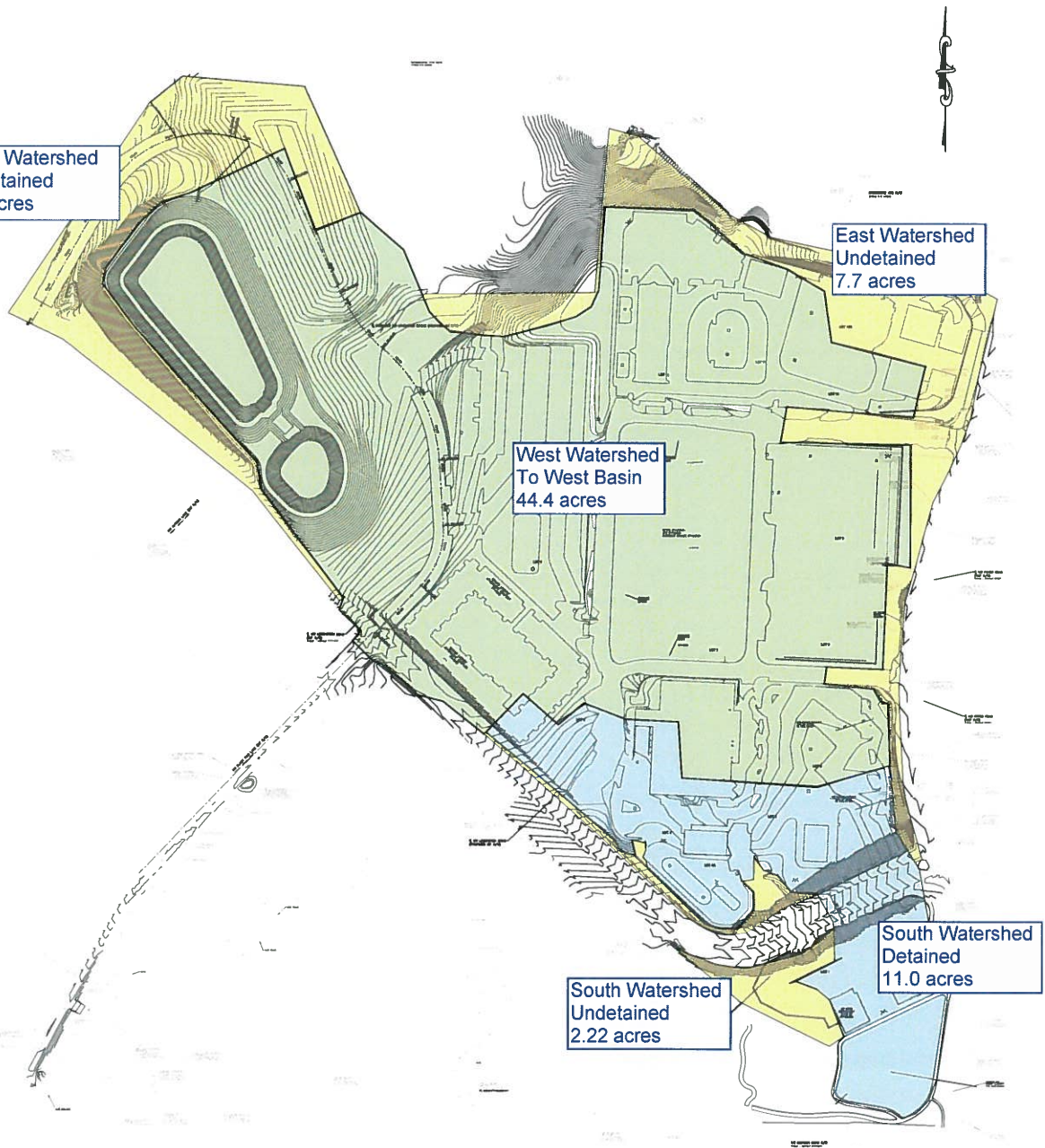
West Watershed
Undetained
6.4 acres

East Watershed
Undetained
7.7 acres

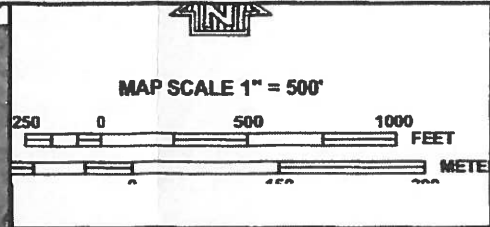
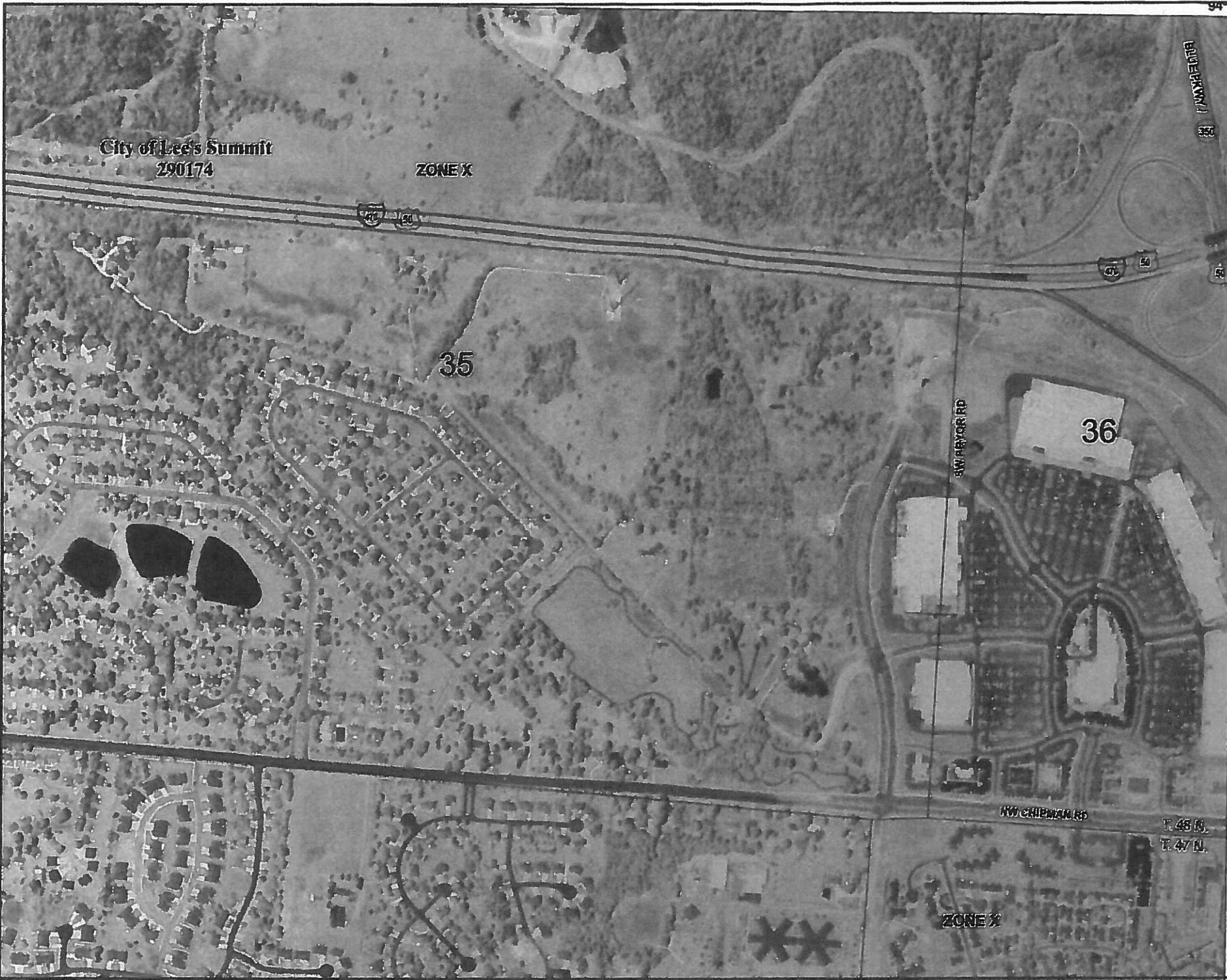
West Watershed
To West Basin
44.4 acres

South Watershed
Undetained
2.22 acres

South Watershed
Detained
11.0 acres



APPENDIX B – FEMA FIRMETTE MAP



NFP

PANEL 0291F

FIRM

FLOOD INSURANCE RATE MAP

JACKSON COUNTY, MISSOURI

AND INCORPORATED AREAS

PANEL 291 OF 480

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

COMMUNITY	COMMUNITY NUMBER	PANEL	SUFFIX
LEE'S SUMMIT, CITY OF	290174	0291	F

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
29095C0291F

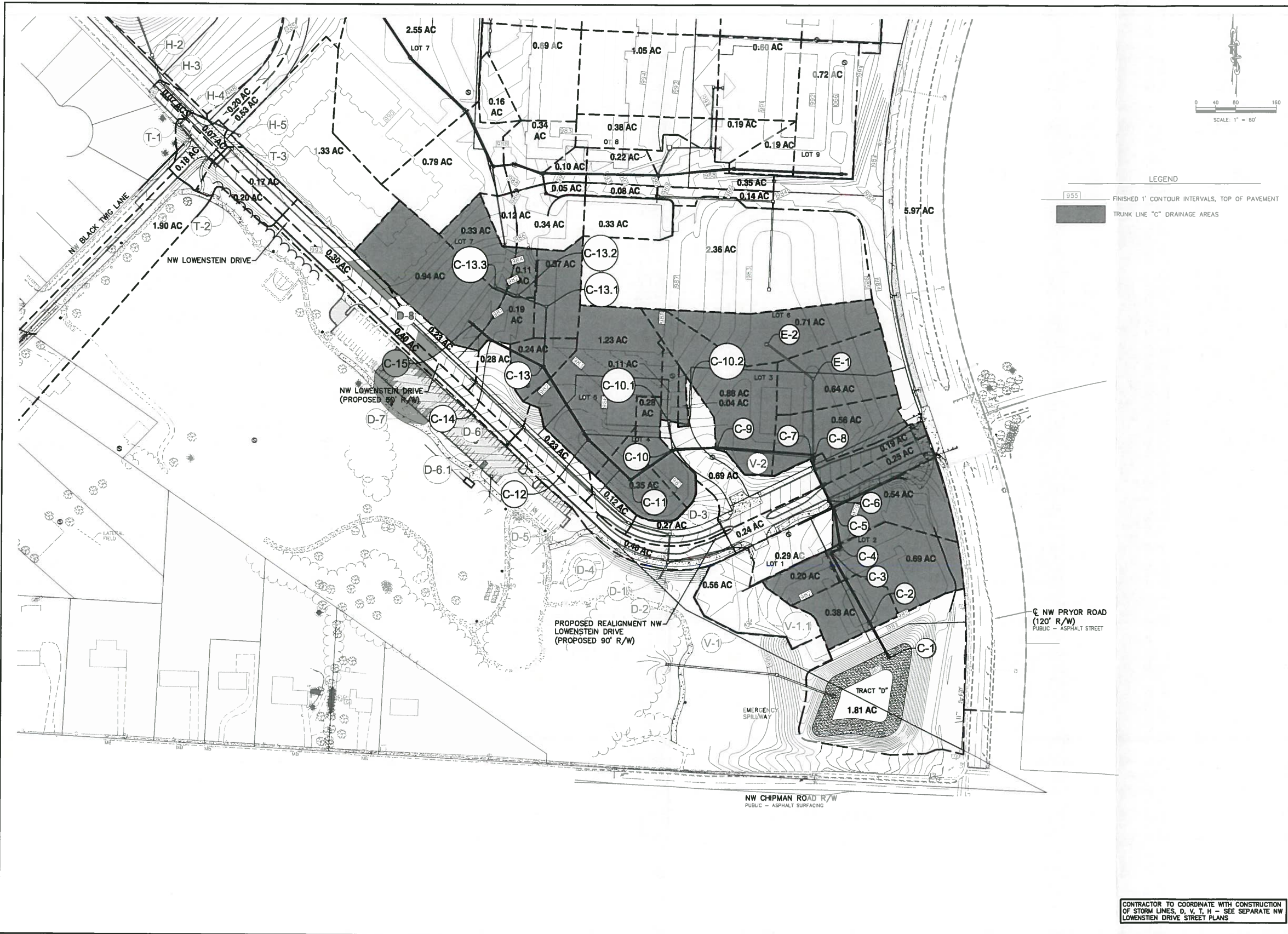
EFFECTIVE DATE
SEPTEMBER 29, 2006

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

APPENDIX C – STORM SEWER DESIGN

Design Storm	Overland Flow														System Flow					Node	Pipe Design															Structure Design		Hydraulic Grade Line (100-YR)				
	Structure	Downstream Structure	Pipe	Triangular Area (A)	Runoff coefficient (C)	A x C	Antecedent Precipitation (in)	A x C x K	Time of Concentration to	Runoff Intensity	Triangular Runoff (in)	Bypass Target	Upstream Bypass Flow - Design Storm Only	Total Runoff (in)	Total Area	Summation of A x C x K	System Tc	System Runoff Intensity	System Discharge (cfs)		Node Condition	Pipe Material	Pipe Shape	Pipe Size	Manning's Coefficient	Upstream Invert	Downstream Invert	Length	Pipe Slope	Design Flow	Full Flow Capacity	Design Velocity	Full Flow Velocity	Depth (ft.)	Flow Time (sec)	Upstream Crown Elevations	Downstream Crown Elevations	Upstream Depth of Cover	Downstream Depth of Cover	Rim Elevation	Downstream	Upstream
LINE A																																										
25-yr	A11	A10	A11-A10	2.36	0.90	2.12	1.1	2.34	5.0	8.5	19.9		0.00	19.9	2.36	2.34	5.0	8.5	19.9	Inlet	RCP	Circular	30	0.013	978.00	977.10	174.0	0.52%	27.4	29.5	6.825	6.0	22.869	25.5	980.5	979.6	1.5	4.8	982.00	978.88	979.78	
100-yr	A10	A9	A10-A9	0.49	0.90	0.44	1.1	0.49	5.0	8.5	2.1		0.00	2.1	2.85	2.82	5.4	6.4	23.9	Inlet	RCP	Circular	30	0.013	976.90	975.40	232.0	0.65%	32.8	33.0	7.659	6.7	24.231	30.3	979.4	977.9	5.1	11.6	984.50	977.27	979.84	
25-yr	A9	A8	A9-A8	0.41	0.90	0.37	1.1	0.41	5.0	8.5	3.5		0.00	3.5	3.26	3.23	5.9	9.1	26.5	Inlet	RCP	Circular	30	0.013	975.20	974.80	42.0	0.95%	36.5	40.0	9.243	8.2	22.494	4.5	977.7	977.3	11.8	12.2	989.50	977.55	977.24	
100-yr	A8	A7	A8-A7	3.35	0.90	3.02	1.1	3.32	5.0	8.5	28.3		0.00	28.3	6.91	6.84	6.0	19.9	38.5	Inlet	RCP	Circular	42	0.013	973.80	972.50	231.0	0.56%	73.8	75.5	8.941	7.8	33.596	25.8	977.3	976.0	12.2	14.0	989.50	975.09	976.48	
25-yr	A7	A6	A7-A6	0.15	0.90	0.14	1.1	0.15	5.0	8.5	1.3		0.00	1.3	6.76	7.44	6.4	9.8	23.3	Inlet	RCP	Circular	42	0.013	972.30	971.90	59.0	0.68%	74.2	82.8	9.738	8.6	31.025	6.1	975.8	975.4	14.2	11.8	990.00	974.44	974.99	
100-yr	A6	A5	A6-A5	0.34	0.90	0.31	1.1	0.34	5.0	8.5	1.7		0.00	1.7	7.01	7.01	6.0	10.0	26.8	Inlet	RCP	Circular	42	0.013	971.70	971.40	44.0	0.68%	77.6	83.1	9.812	8.6	32.189	4.5	975.2	974.9	12.0	12.3	987.20	973.89	974.44	
25-yr	A5	A4	A5-A4	1.25	0.90	1.13	1.1	1.24	5.0	8.5	10.8		0.00	10.8	8.35	8.37	6.5	8.0	88.0	Inlet	RCP	Circular	48	0.013	970.00	970.20	123.0	0.57%	81.1	108.4	9.662	8.6	33.091	12.7	974.9	974.2	12.0	15.8	987.20	972.86	973.77	
100-yr	A4	A3	A4-A3			0.00	1.1	0.00	5.0	8.5	0.0		0.00	0.0	8.35	8.27	6.8	7.9	55.5	Junction Box	RCP	Circular	48	0.013	970.00	969.20	152.0	0.53%	90.3	104.2	9.336	8.3	34.517	16.3	974.0	973.2	16.0	14.3	990.00	972.23	972.86	
25-yr	A3	A2	A3-A2	2.56	0.90	2.30	1.1	2.52	5.0	8.5	21.5		0.00	21.5	10.90	10.79	7.1	7.8	84.8	Inlet	RCP	Circular	48	0.013	969.00	966.70	345.0	0.67%	116.7	117.3	10.640	9.3	39.130	32.4	973.0	970.7	14.5	12.3	987.50	970.45	972.23	
100-yr	A2	A1	A2-A1	15.02	0.90	13.52	1.1	14.87	5.0	8.5	108.9		0.00	108.9	25.92	25.78	7.6	9.3	187.2	Junction Box	RCP	Circular	48	0.013	966.50	954.85	305.0	3.82%	272.1	280.7	25.454	22.3	38.074	12.0	970.5	958.9	12.5	0.0	983.00	958.82	970.45	
25-yr	L4	L3	L4-L3	0.60	0.90	0.54	1.1	0.59	5.0	8.5	5.1		0.00	5.1	0.60	0.60	5.0	8.5	5.1	Inlet	HDPE	Circular	18	0.01	985.50	985.30	19.0	1.05%	7.0	14.0	7.917	7.9	8.971	2.4	987.0	986.8	2.5	2.7	989.50			
100-yr	L3	L2	L3-L2	1.05	0.90	0.95	1.1	1.04	5.0	8.5	8.9		0.00	8.9	1.65	1.63	5.0	8.5	13.9	Inlet	HDPE	Circular	24	0.01	984.80	983.90	120.0	0.75%	18.1	25.5	8.900	8.1	15.823	13.5	986.5	985.9	2.7	3.6	989.50			
25-yr	L2	L1	L2-L1	0.57	0.90	0.51	1.1	0.56	5.0	8.5	2.8		0.00	2.8	2.22	2.20	5.3	6.4	18.9	Inlet	RCP	Circular	30	0.013	983.40	982.90	62.0	0.61%	25.5	32.0	7.243	6.5	20.229	11.3	985.9	985.4	3.6	6.8	989.50			
100-yr	L1	A8	L1-A8			0.00	1.1	0.00	5.0	8.5	0.0		0.00	0.0	2.22	2.20	5.5	6.4	25.3	Junction Box	RCP	Circular	30	0.013	982.70	982.40	60.0	0.50%	26.3	29.0	6.659	5.9	21.896	9.0	985.2	984.9	6.8	4.6	992.00			
25-yr	L2.1	L2	L2.1-L2	0.19	0.90	0.17	1.1	0.19	5.0	8.5	1.8		0.00	1.8	0.19	0.19	5.0	8.5	1.8	Inlet	HDPE	Circular	18	0.01	985.50	985.30	19.0	1.05%	2.2	14.0	5.783	7.9	4.829	3.3	987.0	986.8	2.5	2.7	989.50			
100-yr							1.1	0.21	5.0	10.3	2.2		0.00	2.2	0.21	0.21	5.0	10.3	2.2																							
25-yr	A8.1	A8	A8.1-A8	0.33	0.90	0.30	1.1	0.33	5.0	8.5	2.8		0.00	2.8	0.33	0.33	5.0	8.5	2.8	Inlet	HDPE	Circular	18	0.01	982.50	982.20	11.0	2.73%	3.8	22.8	9.513	12.8	5.020	1.2	984.0	983.7	2.5	5.8	988.50			
100-yr							1.1	0.39	5.0	10.3	3.1		0.00	3.1	0.39	0.39	5.0	10.3	3.1																							
25-yr	A10.1	A10	A10.1-A10	0.35	0.90	0.32	1.1	0.35	5.0	8.5	3.0		0.00	3.0	0.35	0.35	5.0	8.5	3.0	Inlet	HDPE	Circular	18	0.01	978.10	977.90	11.0	1.82%	4.1	18.4	8.365	10.4	5.748	1.3	979.8	979.4	4.9	5.1	984.50			
100-yr							1.1	0.41	5.0	10.3	3.1		0.00	3.1	0.41	0.41	5.0	10.3	3.1																							
25-yr	A7.1	A7	A7.1-A7	0.05	0.90	0.05	1.1	0.05	5.0	8.5	0.4		0.00	0.4	0.05	0.05	5.0	8.5	0.4	Inlet	HDPE	Circular	18	0.01	986.50	986.00	41.0	1.22%	0.6	15.1	4.113	8.5	2.412	10.0	988.0	987.5	2.0	2.5	990.00			
100-yr							1.1	0.06	5.0	10.3	0.5		0.00	0.5	0.06	0.06	5.0	10.3	0.5																							
25-yr	M2	M1	M2-M1	0.34	0.90	0.31	1.1	0.34	5.0	8.5	2.9		0.00	2.9	0.34	0.34	5.0	8.5	2.9	Inlet	HDPE	Circular	15	0.01	982.70	982.20	47.5	1.05%	3.9	8.6	6.868	7.0	7.128	6.9	984.0	983.5	1.3	1.8	985.20			
100-yr	M1	A5	M1-A5	0.12	0.90	0.11	1.1	0.12	5.0	8.5	1.4		0.00	1.4	0.46	0.46	5.1	10.3	1.4	Inlet	HDPE	Circular	24	0.01	981.80	980.80	155.0	0.82%	5.3	26.8	6.600	8.5	7.282	24.2	983.9	982.6	1.3	4.6	985.20			
25-yr	R3	R2	R3-R2	0.72	0.90	0.65	1.1	0.71	5.0	8.5	6.1		0.00	6.1	0.72	0.71	5.0	8.5	6.1	Inlet	HDPE	Circular	18	0.01	983.20	982.50	98.0	0.71%	8.4	11.5	7.117	6.5	11.356	13.8	984.7	984.0	5.3	6.0	990.00	983.61	984.32	
100-yr	R2	R1	R2-R1	1.03	0.90	0.93	1.1	1.02	5.0	8.5	8.7		0.00	8.7	1.75	1.71	5.2	8.4	14.9	Inlet	HDPE	Circular	24	0.01	982.00	981.70	33.6	0.89%	20.1	27.8	9.840	8.8	15.144	3.5	984.0	983.7	6.0		990.00	983.31	983.61	
25-yr	J4	J3	J4-J3	0.23	0.90	0.21	1.1	0.23	5.0	8.5	1.9		0.00	1.9	0.23	0.23	5.0	8.5	1.9	Inlet	HDPE	Circular	18	0.01	984.70	984.81	27.8	6.80%	2.7	35.8	11.841	20.2	3.334	2.3	986.2	984.3	3.8	3.4	990.00	983.75	985.27	
100-yr	J3	J2	J3-J2	0.23	0.90	0.21	1.1	0.23	5.0	8.5	1.9		0.00	1.9	0.46	0.46	5.0	8.5	1.9	Inlet	HDPE	Circular	18	0.01	982.80	973.50	138.3	6.72%	6.3	35.4	14.428	20.0	4.721	9.6	984.3	975.0	3.4	12.6	987.67	974.94	983.75	
25-yr	J2.1	EX2	J2.1-EX2	0.08	0.90	0.08	1.1	0.08	5.0	8.5	0.8		0.00	0.8	0.55	0.54	5.2	8.5	0.8	Inlet	HDPE	Circular	18	0.01	989.64	986.65	77.1	3.86%	6.3	26.9	12.439	15.2	5.945	6.2	971.1	968.2	18.5	5.1	987.60	987.24	970.69	
100-yr	EX2	EX1	EX2-EX1	6.48	0.90	5.83	1.1	6.42	5.0	8.5	54.7		0.00	54.7	7.93	6.96	5.3	6.4	83.9	Inlet	RCP	Circular	42	0.013	980.40	958.86	138.0	1.12%	80.7	106.3	12.151	11.0	27.369	11.4	983.9	982.4	8.4	8.4	973.28	980.97	983	
25-yr	EX3	EX2	EX3-EX2	6.25	0.90	5.59	1.1	6.22	5.0	8.5	51.1		0.00	51.1	7.21	6.21	5.4	6.4	62.2	Inlet	RCP	Circular	42	0.013	980.40																	



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STREETS OF WEST PRYOR NWQ NW PRYOR ROAD & NW LOWENSTEIN DRIVE LEE'S SUMMIT, MISSOURI		MASS GRADING PLANS DRAINAGE AREA MAP - STORM SEWER LINE C	
PROJ. NO. A14-7067-1		REV. 0	
DESIGNER LDO		DRAWN BY JT	
CONTRACTOR TO COORDINATE WITH CONSTRUCTION OF STORM LINES, D, V, T, H - SEE SEPARATE NW LOWENSTEIN DRIVE STREET PLANS		REV. 0	
KAW VALLEY ENGINEERING, INC. IS AUTHORIZED TO OFFER ENGINEERING SERVICES BY MISSOURI STATE CERTIFICATE OF AUTHORITY # 00042, EXPIRES 12/31/19		KAW VALLEY ENGINEERING	
2318 N. JACKSON P.O. BOX 1304 PH: (785) 782-5040 FAX: (785) 782-7744 jle@kvw.com www.kvw.com		LEON D. OSBOURN ENGINEER MO # 021726	
STATE OF MISSOURI Professional Engineer Leon D. Osbourn No. 021726 Exp. 12/31/19		REV. DATE DESCRIPTION	
		LDO DSN DWN CHK	

Overland Flow														System Flow				Node	Pipe Design														Structure Design	Hydraulic Grade Line (100-YR)						
KVE	Design Storm	Structure	Downstream Structure	Pipe	Tributary Area (A)	Runoff Coefficient (C)	A x C	Antecedent Precipitation (in)	Time of Concentration (min)	Runoff Intensity (in/hr)	Tributary Runoff (cfs)	Total Runoff (cfs)	Total Area (A x C x K)	System Tc	System Runoff Intensity	System Discharge (cfs)	Node Condition	Pipe Material	Pipe Shape	Pipe Size	Manhole's Condition	Upstream Invert	Downstream Invert	Length	Pipe Slope	Design Flow	Full Flow Capacity	Design Velocity	Full Flow Velocity	Depth (in.)	Flow Time (sec)	Upstream Crown Elevation	Downstream Elevation	Crown Slope	Upstream Depth of Cover	Downstream Depth of Cover	Rim Elevation	Downstream	Upstream	
	25-year	C15	C14	C15 - C14	0.95	0.60	0.57	1.1	0.63	5.0	8.5	3.2	7.3	0.95	0.63	5.0	8.5	3.2	Inlet	RCP	Circular	18	0.013	977.10	976.80	47.0	0.64%	7.4	8.4	5.355	4.7	13.059	8.8	978.6	978.3	1.8	2.1	980.40	979.73	980.17
	100-year	C14	C13	C14 - C13	0.17	0.90	0.15	1.1	0.17	5.0	8.5	1.4	8.8	1.12	0.80	5.1	8.5	8.7	Inlet	RCP	Circular	24	0.013	976.30	975.70	118.0	0.51%	8.3	16.1	5.313	5.1	13.049	22.2	978.3	977.7	2.1	4.3	980.40	979.33	979.65
	25-year	C13	C12	C13 - C12	1.05	0.90	0.95	1.1	1.04	5.0	8.5	8.9	15.8	2.17	1.83	5.6	8.3	15.3	Inlet	RCP	Circular	30	0.013	975.20	974.30	170.0	0.53%	21.1	29.8	6.581	6.1	18.606	25.8	977.7	976.8	4.3	2.2	982.00	978.58	979.1
	100-year	C12	C11	C12 - C11	1.23	0.90	1.11	1.1	1.22	5.0	8.5	10.4	26.0	3.40	2.68	5.8	8.2	25.0	Inlet	RCP	Circular	36	0.013	973.80	973.20	116.0	0.52%	34.5	48.0	7.364	6.8	22.594	15.7	976.8	976.2	2.2	2.8	979.00	978.12	978.44
	25-year	C11	C10	C11 - C10	0.35	0.90	0.32	1.1	0.35	5.0	8.5	3.0	29.0	3.75	2.40	8.2	8.1	27.5	Inlet	RCP	Circular	36	0.013	973.10	972.50	104.0	0.56%	38.0	50.7	7.868	7.2	23.270	13.2	976.1	975.5	2.9	5.0	979.00	977.27	977.81
	100-year	C10	C9	C10 - C9	0.43	0.90	0.39	1.1	0.43	5.0	8.5	3.6	33.9	4.18	2.82	8.4	8.0	30.9	Junction Box	RCP	Circular	36	0.013	972.30	971.80	84.0	0.60%	42.4	51.5	8.131	7.3	24.905	10.3	975.3	974.8	5.2	4.9	980.50	976.58	976.9
	25-year	C9	C8	C9 - C8	0.88	0.90	0.79	1.1	0.87	5.0	8.5	7.4	46.1	5.08	3.50	9.6	8.0	42.4	Inlet	RCP	Circular	42	0.013	971.30	970.40	195.0	0.48%	51.7	66.4	7.811	7.1	27.313	25.0	974.8	973.9	4.9	7.1	979.70	975.99	976.48
	100-year	C8	C7	C8 - C7	1.91	0.90	1.72	1.1	1.89	5.0	8.5	16.1	86.2	6.97	4.59	7.0	7.9	51.8	Inlet	RCP	Circular	42	0.013	970.20	970.00	26.0	0.80%	71.8	90.0	10.377	8.4	28.262	2.4	973.7	973.9	7.3	8.0	981.00	974.97	975.09
	25-year	C7	C6	C7 - C6	0.19	0.90	0.17	1.1	0.19	5.0	8.5	1.8	37.2	7.18	3.77	7.1	7.5	33.2	Inlet	RCP	Circular	48	0.013	969.50	969.10	72.0	0.58%	73.4	107.1	9.177	8.5	29.179	7.8	973.5	973.1	6.0	6.4	979.50	974.53	974.7
	100-year	C6	C5	C6 - C5	0.25	0.90	0.23	1.1	0.25	5.0	8.5	2.1	86.9	7.41	3.85	7.2	7.8	54.9	Inlet	RCP	Circular	48	0.013	968.60	968.20	22.0	0.45%	75.7	96.8	8.525	7.7	31.930	2.6	972.9	972.8	6.6	4.6	979.50	974.38	974.44
25-year	C5	C4	C5 - C4	0.54	0.90	0.49	1.1	0.51	5.0	8.5	4.6	84.5	7.95	4.25	7.2	7.8	86.9	Inlet	RCP	Circular	48	0.013	968.60	968.20	78.0	0.53%	81.3	104.2	9.171	8.3	31.896	8.3	972.6	972.2	4.8	7.9	977.35	973.95	974.17	
100-year	C4	C3	C4 - C3	0.89	0.90	0.82	1.1	0.86	5.0	8.5	9.8	10.3	8.64	5.24	7.4	7.8	69.9	Inlet	RCP	Circular	54	0.013	967.70	967.60	21.5	0.47%	88.2	134.1	9.001	8.4	31.957	2.4	972.2	972.1	7.9	7.6	980.10	973.43	973.47	
25-year	C3	C2	C3 - C2	0.20	0.90	0.18	1.1	0.20	5.0	8.5	1.7	72.0	8.84	4.44	7.4	7.7	66.4	Junction Box	RCP	Circular	54	0.013	967.40	966.60	198.0	0.51%	90.2	139.9	9.349	8.8	31.547	16.9	971.9	971.1	7.9	10.3	978.75	972.63	972.92	
100-year	C2	C1	C2 - C1	0.38	0.90	0.34	1.1	0.38	5.0	8.5	3.2	78.2	9.22	4.81	7.7	7.7	67.5	Inlet	RCP	Circular	54	0.013	966.40	966.00	80.6	0.50%	93.3	138.5	9.345	8.7	32.443	6.6	970.9	970.5	10.5		981.36	972.39	972.55	
25-year	C13.3	C13.2	C13.3 - C13.2	0.33	0.90	0.30	1.1	0.33	5.0	8.5	2.8	2.8	0.33	0.33	5.0	8.5	2.8	Inlet	RCP	Circular	15	0.013	978.00	977.60	48.0	0.83%	3.8	5.9	5.115	4.8	8.808	9.4	978.3	978.9	2.3	2.6	981.50			
100-year	C13.2	C13.1	C13.2 - C13.1	0.11	0.90	0.10	1.1	0.11	5.0	8.5	0.9	0.9	0.44	0.50	5.2	8.5	1.7	Inlet	RCP	Circular	15	0.013	977.40	976.20	61.0	1.97%	5.1	9.1	7.593	7.4	8.030	8.0	978.7	977.5	2.9	4.5	981.50			
25-year	C13.1	C13	C13.1 - C13	0.37	0.90	0.33	1.1	0.37	5.0	8.5	3.1	8.8	0.81	0.81	5.3	10.2	8.8	Inlet	RCP	Circular	18	0.013	975.90	974.90	118.0	0.84%	8.3	9.8	6.207	5.4	14.224	19.2	977.4	976.4	4.6	5.8	982.00			
100-year																																								
25-year	C10.2	C10.1	C10.2 - C10.1	0.04	0.90	0.04	1.1	0.04	5.0	8.5	0.3	0.3	0.04	0.04	5.0	8.5	0.3	Inlet	RCP	Circular	15	0.013	978.00	977.60	39.0	1.03%	6.5	6.5	3.082	5.3	2.708	12.7	979.3	978.9	2.3	3.1	981.50			
100-year	C10.1	C10	C10.1 - C10	0.11	0.90	0.10	1.1	0.11	5.0	8.5	0.9	0.9	0.15	0.17	5.2	10.2	1.7	Inlet	RCP	Circular	15	0.013	977.40	977.00	57.5	0.70%	1.7	5.4	3.907	4.4	8.838	14.7	978.7	978.3	3.4	2.3	982.00			
25-year	E2	E1	E2 - E1	0.71	0.90	0.64	1.1	0.70	5.0	8.5	6.0	8.0	0.71	0.70	5.0	8.5	6.0	Inlet	RCP	Circular	18	0.013	977.50	976.70	115.0	0.70%	8.2	8.8	5.638	5.0	13.862	20.4	979.0	978.2	3.0	2.8	982.00			
100-year	E1	C8	E1 - C8	0.64	0.90	0.58	1.1	0.63	5.0	8.5	5.4	11.4	1.35	1.34	5.3	8.4	11.2	Inlet	RCP	Circular	24	0.013	976.20	975.30	151.0	0.60%	15.5	17.5	6.278	5.8	17.561	24.1	978.2	977.3	2.6	3.7	981.00			

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KV KAW VALLEY ENGINEERING
KAW VALLEY ENGINEERING, INC. IS AUTHORIZED TO OFFER ENGINEERING SERVICES BY MISSOURI STATE CERTIFICATE OF AUTHORITY # 000842.
EXPIRES 12/31/19

STREETS OF WEST PRYOR
NWQ NW PRYOR ROAD & NW LOWENSTEIN DRIVE
LEE'S SUMMIT, MISSOURI
MASS GRADING PLANS
DRAINAGE AREA MAP - DESIGN TABLES STORM LINES C

PROJ. NO. A14-7087-1
DESIGNER LDO
DRAWN BY JT
CFR 707-16 D.M. CHART
SHEET
C-13

REV 0
DATE 1-16-19
INITIAL ISSUE
DESCRIPTION

LDO
JT
DSN
DWN
CHK

APPENDIX D – HYDRAFLOW HYDROGRAPH DETENTION CALCULATIONS

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NEW.SOWP Final Detention BH.gpw

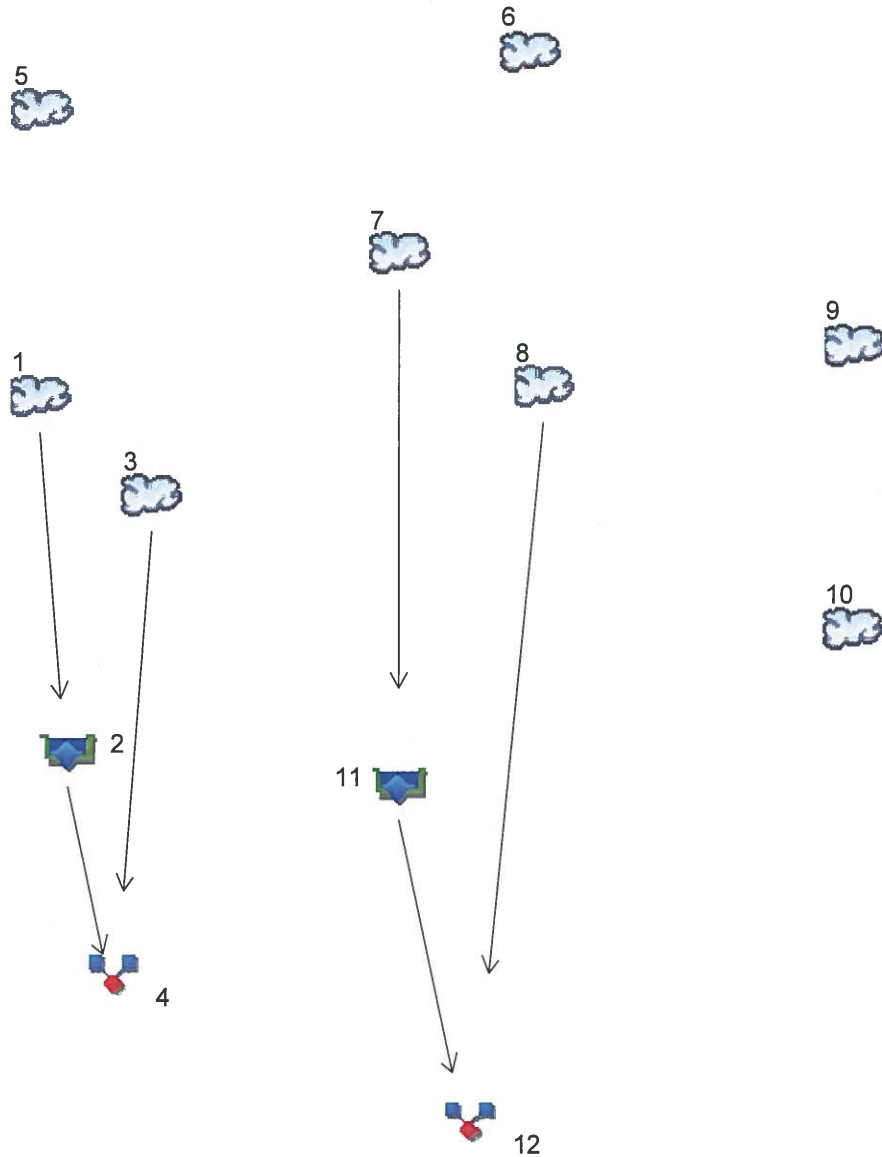
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Tuesday, 12 / 17 / 2019

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Watershed Model Schematic

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020



Legend

Hyd.	Origin	Description
1	SCS Runoff	South (portion to detention)
2	Reservoir	South Basin Routing
3	SCS Runoff	South (portion undetained)
4	Combine	Combined South Basin Post Dev
5	SCS Runoff	South - PreDev
6	SCS Runoff	West Basin - PreDev
7	SCS Runoff	To West Basin
8	SCS Runoff	West (undetained)
9	SCS Runoff	East Basin - PreDev
10	SCS Runoff	East Watershed Post Dev
11	Reservoir	West Basin Routing
12	Combine	Combined West Basin Post Dev

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	14.35	48.06	-----	-----	73.32	-----	-----	121.68	South (portion to detention)
2	Reservoir	1	0.000	5.228	-----	-----	15.43	-----	-----	39.84	South Basin Routing
3	SCS Runoff	-----	2.897	9.699	-----	-----	14.80	-----	-----	24.56	South (portion undetained)
4	Combine	2, 3	2.897	12.75	-----	-----	22.37	-----	-----	57.43	Combined South Basin Post Dev
5	SCS Runoff	-----	2.533	41.36	-----	-----	80.24	-----	-----	160.78	South - PreDev
6	SCS Runoff	-----	2.628	42.91	-----	-----	83.24	-----	-----	166.81	West Basin - PreDev
7	SCS Runoff	-----	49.33	185.03	-----	-----	288.14	-----	-----	485.15	To West Basin
8	SCS Runoff	-----	6.528	25.97	-----	-----	40.90	-----	-----	69.43	West (undetained)
9	SCS Runoff	-----	2.573	41.43	-----	-----	80.18	-----	-----	160.31	East Basin - PreDev
10	SCS Runoff	-----	7.854	31.25	-----	-----	49.21	-----	-----	83.53	East Watershed Post Dev
11	Reservoir	7	0.000	4.764	-----	-----	13.62	-----	-----	29.03	West Basin Routing
12	Combine	8, 11	6.528	25.97	-----	-----	46.17	-----	-----	86.33	Combined West Basin Post Dev

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	48.06	1	719	117,121	-----	-----	-----	South (portion to detention)
2	Reservoir	5.228	1	744	79,117	1	969.41	69,316	South Basin Routing
3	SCS Runoff	9.699	1	719	23,637	-----	-----	-----	South (portion undetained)
4	Combine	12.75	1	720	102,754	2, 3	-----	-----	Combined South Basin Post Dev
5	SCS Runoff	41.36	1	725	131,134	-----	-----	-----	South - PreDev
6	SCS Runoff	42.91	1	725	136,051	-----	-----	-----	West Basin - PreDev
7	SCS Runoff	185.03	1	719	440,410	-----	-----	-----	To West Basin
8	SCS Runoff	25.97	1	719	61,238	-----	-----	-----	West (undetained)
9	SCS Runoff	41.43	1	724	124,242	-----	-----	-----	East Basin - PreDev
10	SCS Runoff	31.25	1	719	73,677	-----	-----	-----	East Watershed Post Dev
11	Reservoir	4.764	1	896	209,359	7	954.68	1,136,462	West Basin Routing
12	Combine	25.97	1	719	270,597	8, 11	-----	-----	Combined West Basin Post Dev
NEW.SOWP Final Detention BH.gpw					Return Period: 2 Year			Tuesday, 12 / 17 / 2019	

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

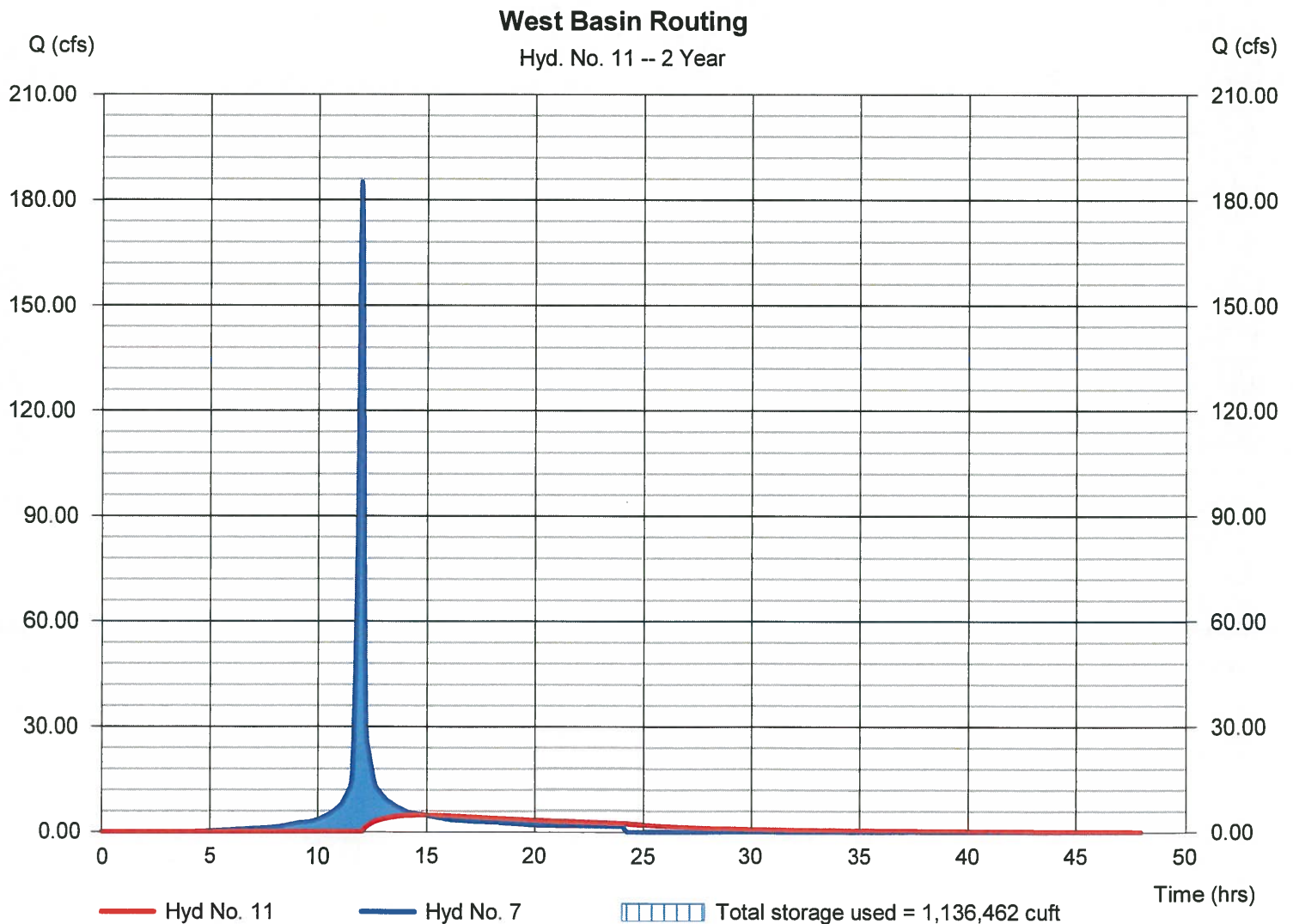
Tuesday, 12 / 17 / 2019

Hyd. No. 11

West Basin Routing

Hydrograph type	= Reservoir	Peak discharge	= 4.764 cfs
Storm frequency	= 2 yrs	Time to peak	= 14.93 hrs
Time interval	= 1 min	Hyd. volume	= 209,359 cuft
Inflow hyd. No.	= 7 - To West Basin	Max. Elevation	= 954.68 ft
Reservoir name	= West Basin	Max. Storage	= 1,136,462 cuft

Storage Indication method used. Wet pond routing start elevation = 952.00 ft.



Pond Report

5

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Tuesday, 12 / 17 / 2019

Pond No. 1 - West Basin

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 942.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	942.00	63,864	0	0
2.00	944.00	70,802	134,593	134,593
4.00	946.00	78,003	148,732	283,325
6.00	948.00	85,455	163,385	446,710
8.00	950.00	93,155	178,537	625,247
10.00	952.00	101,102	194,183	819,430
12.00	954.00	126,189	226,805	1,046,236
14.00	956.00	141,036	267,061	1,313,296
16.00	958.00	187,589	327,488	1,640,784
18.00	960.00	218,192	405,355	2,046,139
20.00	962.00	237,915	455,919	2,502,058

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 36.00	12.00	15.00	0.00
Span (in)	= 36.00	30.00	30.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 942.00	954.00	957.00	0.00
Length (ft)	= 300.00	0.00	0.00	0.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	Inactive	80.00	0.00	0.00
Crest El. (ft)	= 0.00	959.50	0.00	0.00
Weir Coeff.	= 3.33	2.60	3.33	3.33
Weir Type	= ---	Broad	---	---
Multi-Stage	= No	No	No	No
Exfil.(in/hr)	= 0.000 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	942.00	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
0.20	13,459	942.20	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
0.40	26,919	942.40	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
0.60	40,378	942.60	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
0.80	53,837	942.80	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
1.00	67,296	943.00	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
1.20	80,756	943.20	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
1.40	94,215	943.40	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
1.60	107,674	943.60	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
1.80	121,134	943.80	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
2.00	134,593	944.00	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
2.20	149,466	944.20	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
2.40	164,339	944.40	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
2.60	179,213	944.60	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
2.80	194,086	944.80	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
3.00	208,959	945.00	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
3.20	223,832	945.20	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
3.40	238,705	945.40	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
3.60	253,579	945.60	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
3.80	268,452	945.80	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
4.00	283,325	946.00	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
4.20	299,663	946.20	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
4.40	316,002	946.40	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
4.60	332,340	946.60	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
4.80	348,679	946.80	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
5.00	365,017	947.00	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
5.20	381,356	947.20	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
5.40	397,694	947.40	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
5.60	414,033	947.60	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
5.80	430,371	947.80	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
6.00	446,710	948.00	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
6.20	464,564	948.20	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000

Continues on next page...

West Basin

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
6.40	482,417	948.40	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
6.60	500,271	948.60	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
6.80	518,125	948.80	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
7.00	535,978	949.00	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
7.20	553,832	949.20	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
7.40	571,686	949.40	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
7.60	589,539	949.60	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
7.80	607,393	949.80	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
8.00	625,247	950.00	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
8.20	644,665	950.20	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
8.40	664,083	950.40	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
8.60	683,502	950.60	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
8.80	702,920	950.80	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
9.00	722,338	951.00	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
9.20	741,757	951.20	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
9.40	761,175	951.40	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
9.60	780,593	951.60	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
9.80	800,012	951.80	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
10.00	819,430	952.00	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
10.20	842,111	952.20	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
10.40	864,791	952.40	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
10.60	887,472	952.60	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
10.80	910,152	952.80	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
11.00	932,833	953.00	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
11.20	955,514	953.20	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
11.40	978,194	953.40	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
11.60	1,000,875	953.60	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
11.80	1,023,555	953.80	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
12.00	1,046,236	954.00	0.00	0.00	0.00	---	---	0.00	---	---	---	---	0.000
12.20	1,072,942	954.20	0.81 ic	0.76 ic	0.00	---	---	0.00	---	---	---	---	0.761
12.40	1,099,648	954.40	2.16 ic	2.15 ic	0.00	---	---	0.00	---	---	---	---	2.154
12.60	1,126,354	954.60	4.09 ic	3.96 ic	0.00	---	---	0.00	---	---	---	---	3.956
12.80	1,153,060	954.80	6.28 ic	6.09 ic	0.00	---	---	0.00	---	---	---	---	6.091
13.00	1,179,766	955.00	8.68 ic	8.51 ic	0.00	---	---	0.00	---	---	---	---	8.512
13.20	1,206,472	955.20	10.07 ic	10.07 ic	0.00	---	---	0.00	---	---	---	---	10.07
13.40	1,233,178	955.40	11.49 ic	11.42 ic	0.00	---	---	0.00	---	---	---	---	11.42
13.60	1,259,885	955.60	12.63 ic	12.63 ic	0.00	---	---	0.00	---	---	---	---	12.63
13.80	1,286,591	955.80	13.81 ic	13.73 ic	0.00	---	---	0.00	---	---	---	---	13.73
14.00	1,313,296	956.00	15.03 ic	14.74 ic	0.00	---	---	0.00	---	---	---	---	14.74
14.20	1,346,045	956.20	15.86 ic	15.69 ic	0.00	---	---	0.00	---	---	---	---	15.69
14.40	1,378,794	956.40	16.71 ic	16.59 ic	0.00	---	---	0.00	---	---	---	---	16.59
14.60	1,411,543	956.60	17.57 ic	17.44 ic	0.00	---	---	0.00	---	---	---	---	17.44
14.80	1,444,291	956.80	18.43 ic	18.26 ic	0.00	---	---	0.00	---	---	---	---	18.26
15.00	1,477,040	957.00	19.30 ic	19.03 ic	0.00 ic	---	---	0.00	---	---	---	---	19.03
15.20	1,509,789	957.20	20.62 ic	19.78 ic	0.76 ic	---	---	0.00	---	---	---	---	20.54
15.40	1,542,538	957.40	22.82 ic	20.50 ic	2.15 ic	---	---	0.00	---	---	---	---	22.65
15.60	1,575,286	957.60	25.43 ic	21.19 ic	3.96 ic	---	---	0.00	---	---	---	---	25.15
15.80	1,608,035	957.80	27.96 ic	21.87 ic	6.09 ic	---	---	0.00	---	---	---	---	27.96
16.00	1,640,784	958.00	31.12 ic	22.52 ic	8.51 ic	---	---	0.00	---	---	---	---	31.03
16.20	1,681,319	958.20	34.34 ic	23.15 ic	11.19 ic	---	---	0.00	---	---	---	---	34.34
16.40	1,721,855	958.40	37.13 ic	23.77 ic	13.25 ic	---	---	0.00	---	---	---	---	37.02
16.60	1,762,390	958.60	39.26 ic	24.37 ic	14.86 ic	---	---	0.00	---	---	---	---	39.23
16.80	1,802,926	958.80	41.27 ic	24.96 ic	16.31 ic	---	---	0.00	---	---	---	---	41.27
17.00	1,843,461	959.00	43.18 ic	25.54 ic	17.64 ic	---	---	0.00	---	---	---	---	43.18
17.20	1,883,997	959.20	44.98 ic	26.10 ic	18.88 ic	---	---	0.00	---	---	---	---	44.98
17.40	1,924,532	959.40	46.69 ic	26.65 ic	20.05 ic	---	---	0.00	---	---	---	---	46.69
17.60	1,965,068	959.60	48.33 ic	27.18 ic	21.15 ic	---	---	6.59	---	---	---	---	54.92
17.80	2,005,603	959.80	49.90 ic	27.71 ic	22.19 ic	---	---	34.20	---	---	---	---	84.10
18.00	2,046,139	960.00	51.42 ic	28.23 ic	23.19 ic	---	---	73.54	---	---	---	---	124.96
18.20	2,091,731	960.20	52.89 ic	28.74 ic	24.15 ic	---	---	121.82	---	---	---	---	174.71
18.40	2,137,323	960.40	54.30 ic	29.24 ic	25.07 ic	---	---	177.60	---	---	---	---	231.91
18.60	2,182,915	960.60	55.68 ic	29.73 ic	25.95 ic	---	---	239.98	---	---	---	---	295.66
18.80	2,228,507	960.80	57.03 ic	30.21 ic	26.81 ic	---	---	308.32	---	---	---	---	365.35
19.00	2,274,099	961.00	58.33 ic	30.69 ic	27.64 ic	---	---	382.14	---	---	---	---	440.48
19.20	2,319,691	961.20	59.61 ic	31.16 ic	28.45 ic	---	---	461.07	---	---	---	---	520.68
19.40	2,365,283	961.40	60.86 ic	31.62 ic	29.24 ic	---	---	544.78	---	---	---	---	605.64
19.60	2,410,875	961.60	62.08 ic	32.07 ic	30.00 ic	---	---	633.03	---	---	---	---	695.10
19.80	2,456,467	961.80	63.27 ic	32.52 ic	30.75 ic	---	---	725.58	---	---	---	---	788.85
20.00	2,502,058	962.00	64.44 ic	32.97 ic	31.47 ic	---	---	822.19	---	---	---	---	886.63

...End

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	73.32	1	719	183,844	-----	-----	-----	South (portion to detention)
2	Reservoir	15.43	1	730	145,835	1	970.81	104,110	South Basin Routing
3	SCS Runoff	14.80	1	719	37,103	-----	-----	-----	South (portion undetained)
4	Combine	22.37	1	723	182,938	2, 3	-----	-----	Combined South Basin Post Dev
5	SCS Runoff	80.24	1	725	250,547	-----	-----	-----	South - PreDev
6	SCS Runoff	83.24	1	725	259,942	-----	-----	-----	West Basin - PreDev
7	SCS Runoff	288.14	1	719	706,358	-----	-----	-----	To West Basin
8	SCS Runoff	40.90	1	719	99,288	-----	-----	-----	West (undetained)
9	SCS Runoff	80.18	1	724	237,379	-----	-----	-----	East Basin - PreDev
10	SCS Runoff	49.21	1	719	119,456	-----	-----	-----	East Watershed Post Dev
11	Reservoir	13.62	1	791	474,279	7	955.78	1,284,097	West Basin Routing
12	Combine	46.17	1	720	573,567	8, 11	-----	-----	Combined West Basin Post Dev
NEW.SOWP Final Detention BH.gpw					Return Period: 10 Year			Tuesday, 12 / 17 / 2019	

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

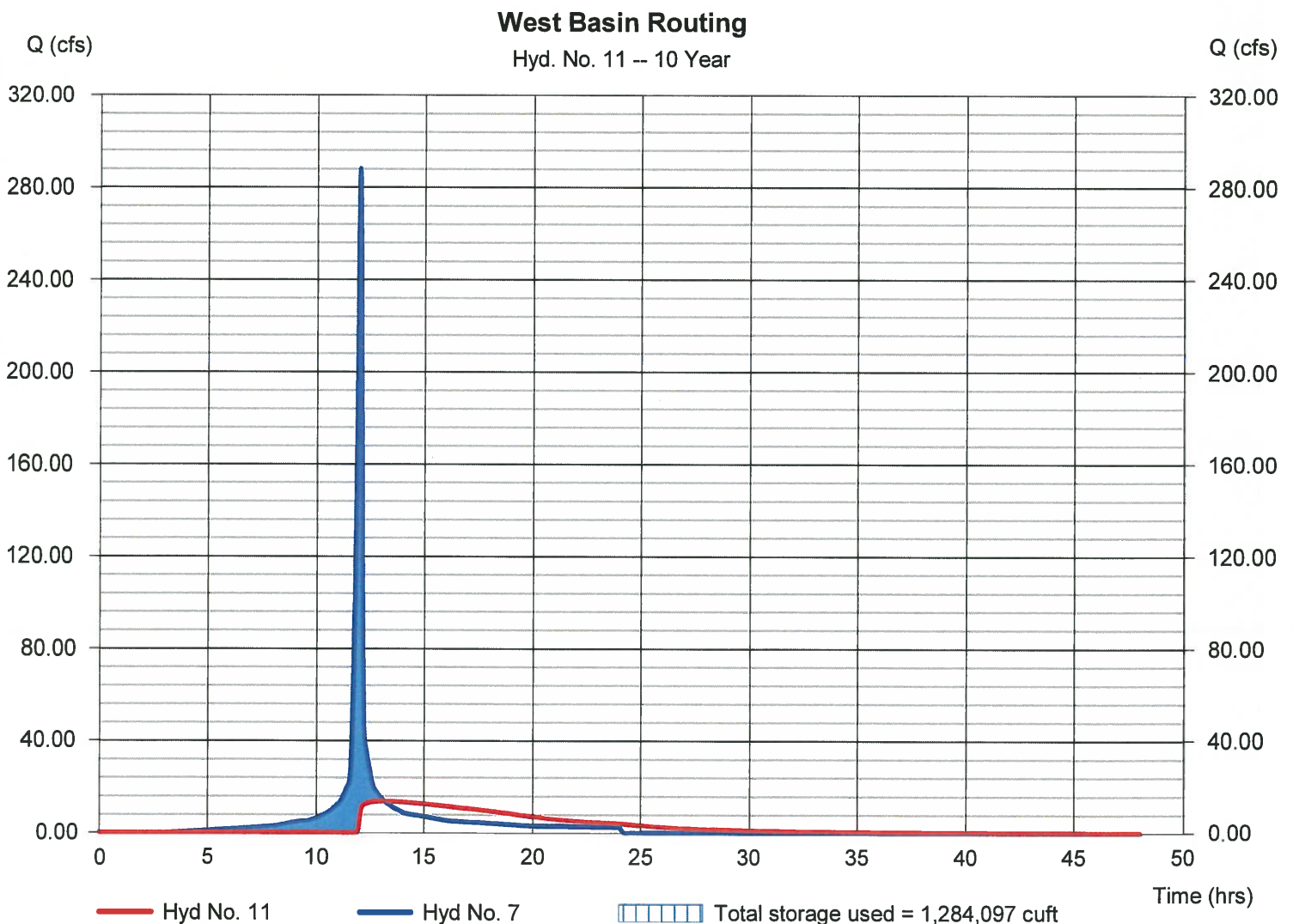
Tuesday, 12 / 17 / 2019

Hyd. No. 11

West Basin Routing

Hydrograph type	= Reservoir	Peak discharge	= 13.62 cfs
Storm frequency	= 10 yrs	Time to peak	= 13.18 hrs
Time interval	= 1 min	Hyd. volume	= 474,279 cuft
Inflow hyd. No.	= 7 - To West Basin	Max. Elevation	= 955.78 ft
Reservoir name	= West Basin	Max. Storage	= 1,284,097 cuft

Storage Indication method used. Wet pond routing start elevation = 952.00 ft.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	121.68	1	719	314,599	-----	-----	-----	South (portion to detention)
2	Reservoir	39.84	1	728	276,584	1	972.60	154,288	South Basin Routing
3	SCS Runoff	24.56	1	719	63,492	-----	-----	-----	South (portion undetained)
4	Combine	57.43	1	721	340,076	2, 3	-----	-----	Combined South Basin Post Dev
5	SCS Runoff	160.78	1	725	507,689	-----	-----	-----	South - PreDev
6	SCS Runoff	166.81	1	725	526,727	-----	-----	-----	West Basin - PreDev
7	SCS Runoff	485.15	1	719	1,231,010	-----	-----	-----	To West Basin
8	SCS Runoff	69.43	1	719	174,643	-----	-----	-----	West (undetained)
9	SCS Runoff	160.31	1	724	481,006	-----	-----	-----	East Basin - PreDev
10	SCS Runoff	83.53	1	719	210,117	-----	-----	-----	East Watershed Post Dev
11	Reservoir	29.03	1	769	996,539	7	957.87	1,619,395	West Basin Routing
12	Combine	86.33	1	719	1,171,183	8, 11	-----	-----	Combined West Basin Post Dev
NEW.SOWP Final Detention BH.gpw					Return Period: 100 Year			Tuesday, 12 / 17 / 2019	

Hydrograph Report

10

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

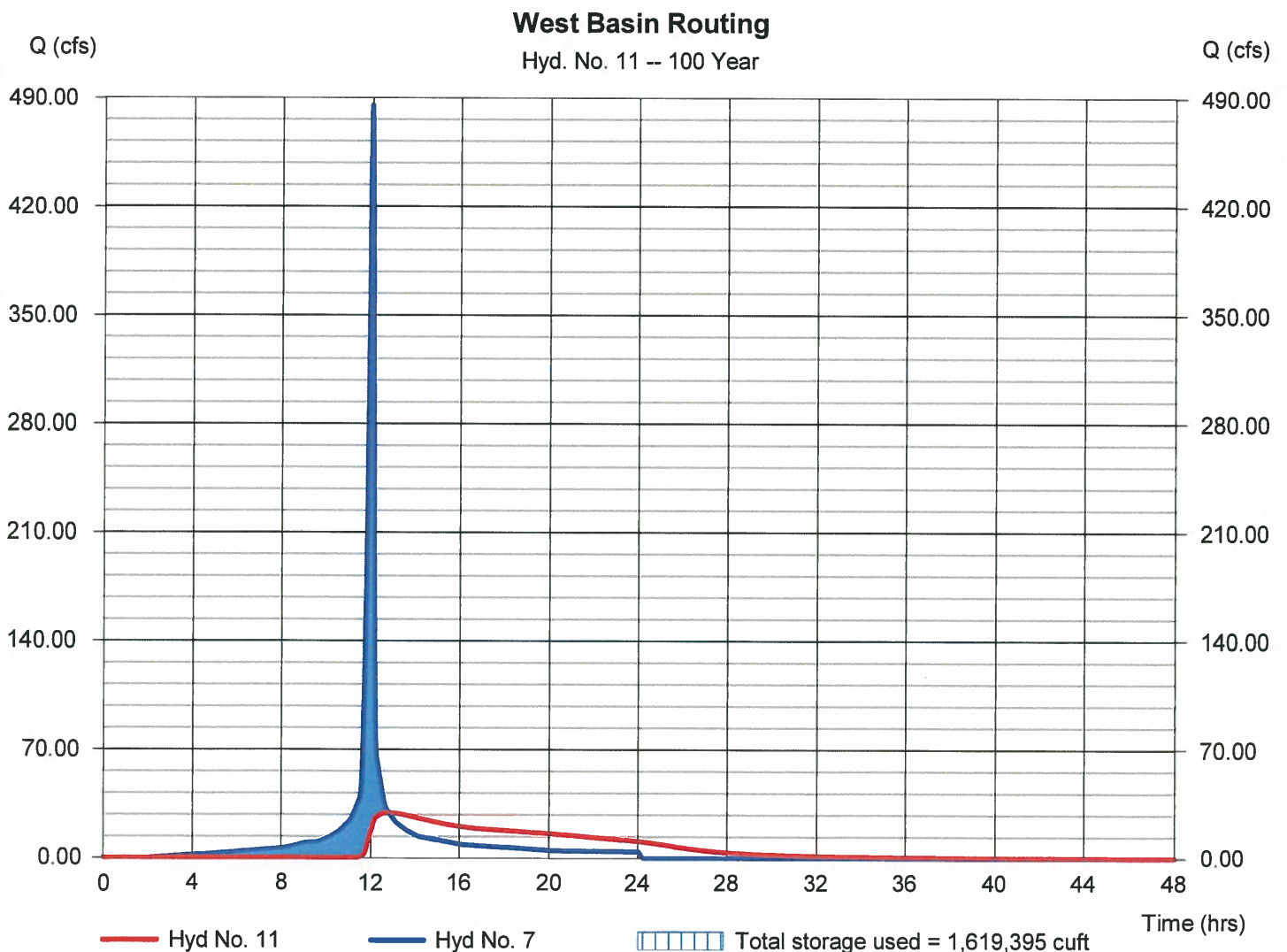
Tuesday, 12 / 17 / 2019

Hyd. No. 11

West Basin Routing

Hydrograph type	= Reservoir	Peak discharge	= 29.03 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.82 hrs
Time interval	= 1 min	Hyd. volume	= 996,539 cuft
Inflow hyd. No.	= 7 - To West Basin	Max. Elevation	= 957.87 ft
Reservoir name	= West Basin	Max. Storage	= 1,619,395 cuft

Storage Indication method used. Wet pond routing start elevation = 952.00 ft.



APPENDIX E – WATER QUALITY ORIFICE CALCULATIONS

West Basin

Water Quality Outlet, Single Orifice

Known:		Automatically calculated:	
$Z_{WQ} =$	2 ft	$t_{plate} =$	6 in
$WQ_v =$	108239 ft ³	$Q_{WQ} =$	0.75 cfs
		$g =$	32.2 ft/s ²

Step	Description	Symbol	Value	Units
1	Depth of water quality volume at outlet	Z_{WQ}	2	ft
2	Average head of water quality volume over invert of orifice	H_{WQ}	1	ft
3	Average water quality outflow rate	Q_{WQ}	0.75	cfs
4	Orifice discharge coefficient	C_0	0.8	$\geq$ 0.8
5	Water quality outlet orifice diameter	D_0	4.63	in

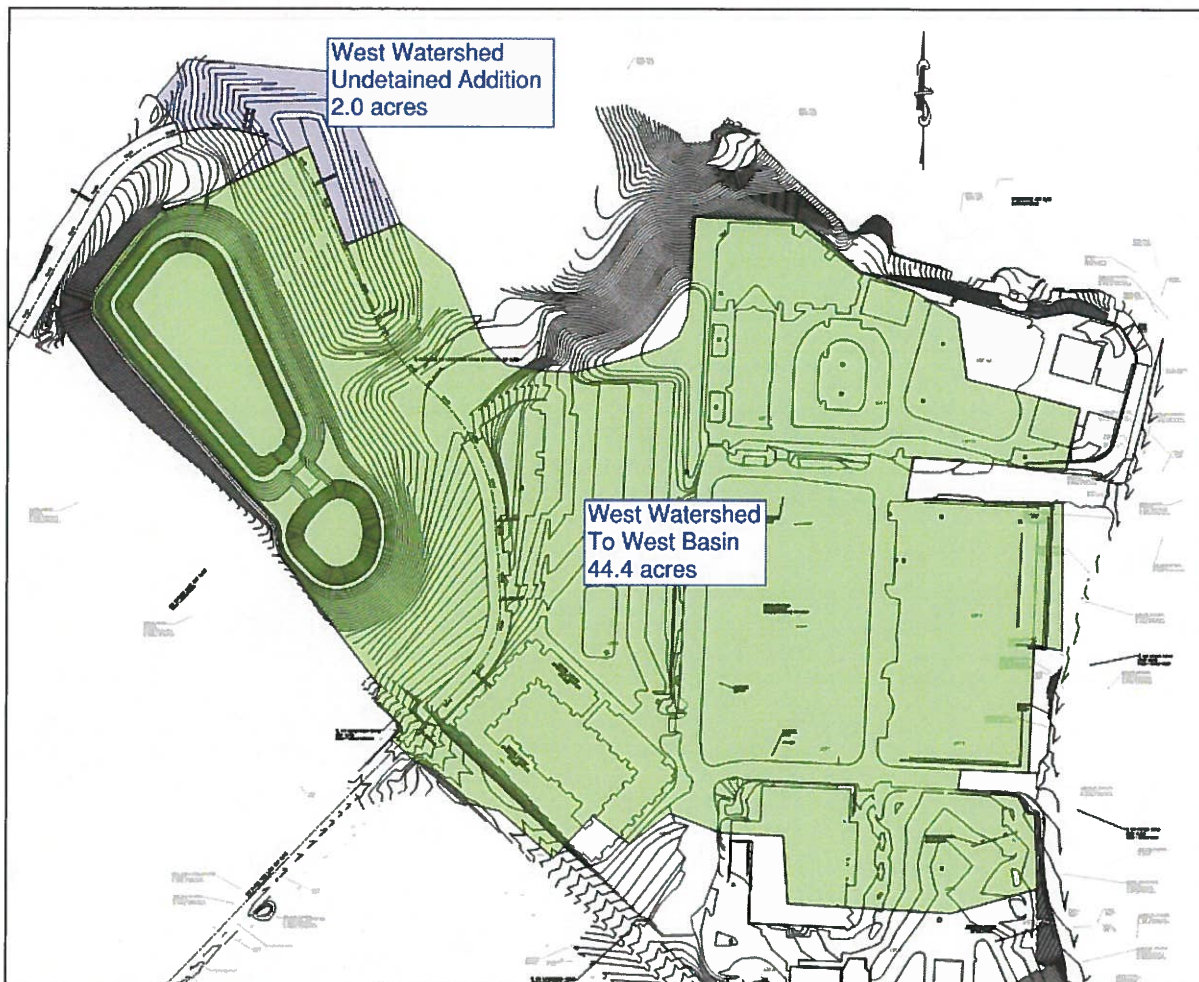
South Basin

Water Quality Outlet, Single Orifice

Known:		Automatically calculated:	
$Z_{WQ} =$	2 ft	$t_{plate} =$	6 in
$WQ_v =$	32770 ft ³	$Q_{WQ} =$	0.23 cfs
		$g =$	32.2 ft/s ²

Step	Description	Symbol	Value	Units
1	Depth of water quality volume at outlet	Z_{WQ}	2	ft
2	Average head of water quality volume over invert of orifice	H_{WQ}	1	ft
3	Average water quality outflow rate	Q_{WQ}	0.23	cfs
4	Orifice discharge coefficient	C_0	0.66	
5	Water quality outlet orifice diameter	D_0	2.55	in

APPENDIX F – DRAINAGE AREA CHANGE DUE TO REVISED GRADING



West Watershed Undetained Addition: Area that is no longer detained due to revised grading.