



*Revised 8/18/06*

**FINAL DRAINAGE REPORT**  
**For**  
**FIVE STAR CROSSING**

Developer:  
Nancy Kissner  
300 Main Street, Suite 308  
Grand Junction, Colorado 81501  
(970) 260-2087

Prepared By:  
LANDesign Consulting Engineers  
326 Main St. Suite 100  
Grand Junction, Colorado 81501  
(970) 245-4099

Job Number 205033

December 23, 2005  
(Revised April 24, 2006, July 18, 2006 & August 18, 2006)

I hereby certify that this report was prepared by myself.



William S. Merrell, P.E.  
Colorado P.E. #39263

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## I. General Location and Description

### A. Site and Major Basin Location

Five Star Crossing Subdivision is located on the north side of L Road between 18 Road and 18 ½ Road. The property is currently vacant. The property is surrounded by undeveloped land in all directions, although there is an existing subdivision (Casa Vista Subdivision) on the South side of L Road immediately west of this development. Exhibit 1 shows the general location of the proposed project, Exhibit 2 shows the general topography of the site and Exhibit 3 shows the topography of the surrounding area.

The major basin in which the project is located is commonly known as Little Salt Wash according to Mesa County. Little Salt Wash encompasses approximately 36.48 square miles. Exhibits 4 and 5 show the drainage basin map provided on the Mesa County interactive map internet web page, and the drainage plan for the site.

### B. Site and Major Basin Description

The site is approximately 15 acres in size and is currently vacant. The property has had a recent crop-oriented agricultural past and the site is covered with stubble from row crops. Exhibit 6 shows the composite plan for the site.

The soils located on the site, per the Mesa County web page, are described as Fruitland fine sandy loam, 0 to 2 percent slopes (Fp), hydro-group 'A', Fruitland fine sandy loam, 2 to 5 percent slopes (Fr), hydro-group 'A' and Killpack silty clay loam 0 to 2 percent slopes (Hk), which is best described as hydro-group 'D'. Exhibit 7 shows the soils map for the area. Exhibit 8 describes the soil characteristics.

Little Salt Wash is a large basin that drains about 36.48 square miles. The basin starts near the base of the Bookcliffs. The basin is largely undeveloped. The main channel of the basin drains under L Road approximately ½ mile east of the property, slightly east of 18 ½ Road. The basin then drains south to the Colorado River approximately two miles downstream.

## **II. Existing Drainage Conditions**

### **A. Major Basin**

The general topography of Little Salt Wash varies from moderately sloping to rolling and hilly. In general, the basin drains to the south passing from the base of the Bookcliffs, through undeveloped area, through agricultural ground, through developed areas, crossing underneath Highway I-70 and continuing to the Colorado River.

### **B. Site**

The subject property generally drains to the southeast at less than 2% slopes with some areas slightly exceeding 2%. A minimal amount of stormwater inflow from offsite enters the property from the north side. Adjacent lands to the east and west drain to L Road. The inflow characteristics are as follows; Concentrated flow from runoff located at the northwest corner of the site which then flows along the west side of the property to a pond that sits on a neighboring property southwest of the subdivision and then along the west side of the property to L Road.

The on-site stormwater runoff flows in two different directions depending on the location. The northwest quadrant of the property drains towards the southwest, to the west line of the property. The southeast quadrant of the property drains towards the south directly towards L Road.

Offsite, the downstream drainage crosses L Road in an existing 8" corrugated metal pipe immediately east of our property. It then drains along a swale along the west property line of the property south of L Road. This swale drains into the irrigation canal south of that property.

The subject property is not located within any established floodplain according to the Grand Junction or Mesa County floodplain maps.

## **III. Proposed Drainage Conditions**

### **A. Changes in Drainage Patterns**

There are no changes to the historical drainage patterns planned for the project.

### **B. Maintenance Issues**

The maintenance of drainage infrastructure outside of the public right-of-way will be the responsibility of the Homeowner's Association. The City of Fruita will maintain any surface or storm sewer facilities located within the public right-of-way.

#### **IV. Design Criteria & Approach**

##### **A. General Considerations**

There have been several drainage studies that were made for this drainage basin, but there is nothing that would directly relate to the runoff from this property. The minimal amount of offsite drainage going through this property would also indicate this.

This project will propose to discharge stormwater to the main channel utilizing the existing facilities that historically drained the site. With that said, the existing 8" CMP under L Road is inadequate to drain the property under the current conditions. And the road would be overtopped in something quite a bit less than the 100 year storm. However, the Grand Junction Drainage District has pointed out good reasons for leaving this line in place, so we have designed upstream detention to reduce the flow off of the site to less than existing conditions. Beyond that there is a new drainage channel that follows the property line to the south (replacing one that cut diagonally across the property) which appears to have the capacity to handle this reduced flow.

Constraints that would affect the drainage design would be the offsite flow entering the property and the existing pond that the main drainage flows through. We did no calculations on what effect this pond would have, although it is obvious that it would reduce the flow considerably. However, the pond is on a neighboring property, and there is no guarantee that it won't be filled in at some time, so it was not considered in our design.

##### **B. Hydrology**

The Stormwater Management Manual (SWMM) for Mesa County (1996) has been used for the preparation of this Final Drainage Report. The design storms are defined in the SWMM as the 2-year and 100-year events. The Grand Junction area precipitation information is used which are outlined within the SWMM.

The rational method is used for the hydrological analysis and conforms to the Mesa County SWMM Chapter VIII. SCS Methods were used to calculate the detention basin.

Exhibit 9 shows the Composite "C" determination for the subdivision.

C. Hydraulics

All hydraulic calculations for conveyance elements have been designed according to the SWMM. There is one culvert pipesdesigned for this subdivision, crossing Mimosa Drive. The design calculations for this pipe is part of the Pondpack analysis for the lower detention basin.

## V. Results and Conclusion

### A. Runoff Rates for 2 and 100 Year Storms

Runoff rates.

Basin A-1: 2-Year = 2.47 cfs

100-Year = 11.83 cfs

(Pre-development rates are 1.92 cfs and 9.52 cfs.)

Exhibits 12-16 are the calculation sheets for determining these runoff rates. Exhibit 17 is the Drainage Map for the subdivision.

For the detention basins design the SCS method was used for analysis of the 100 year storm. The existing peak flow was calculated at 11.18 cfs, while the flow after going through the detention basins is 4.95 cfs.

### B. Detention

Because of the difficulties presented by the Grand Junction Drainage District with replacing the pipe under L Road, we are constructing two small detention basins. The intent is to reduce the peak flows downstream of this development so that there will be no difficulties presented by the development of this subdivision. Thus the designed reduction in flow to roughly 44% of the existing condition flows. Exhibit 18 gives the Pondpack report for these basins.

Exhibits 18-25 are the Pondpack report and it is necessary to give a brief summary here.

The first part of Exhibit 18 (Pages 1-11) is the report for the existing conditions of the drainage at Five Star Crossing. Page 2 (1.01 in that part of the Pondpack Report) gives the summary of the flow for the current conditions. This is 11.18 cfs for the 100 Year flow. The hydrograph for this is Exhibit 19.

The second part of Exhibit 18 (Pages 12-45) is the report for the Upper Detention Basin. The sketch for this is Exhibit 20, while hydrographs are on Exhibit 21. Exhibit 22 is a chart showing the elevations of the water level in the detention pond. The summary of the flows is given on Page 14 (1.01)



\* and shows a peak flow (100 Year) of 6.90 cfs going into the pond and 2.58 cfs going out.

Pages 46 through 86 of Exhibit 18 is the report for the Lower Detention Basin. The layout for this is shown on Exhibit 23, with the hydrographs on Exhibit 24 and the Detention Pond water surface elevations on Exhibit 25. The outflow from the Upper Detention Basin is represented as a hydrograph, and it should be noted that travel time is not taken account of in this calculation. The summary is given on Page 48, and shows a total peak flow into the pond of 7.27 cfs (which

\* includes the area draining only into this pond and the flow out of the upper basin) and a peak flow out of 4.95 cfs. The downstream area was added to show the minimal amount of flow from this development that doesn't go to the west.

*Yes, but there is no guarantee the pond will remain in existence since it is off-site*

Note that none of these calculations take the existing pond into consideration since it is off-site. This pond will tend to provide additional detention and could also significantly reduce these flows.

\* No attempt was made to model the existing 8" pipe under L Road, although it certainly does not have the capacity to carry 4.95 cfs, and there is additional drainage area that flows into it. Exhibit 34 is a Flowmaster analysis of this 8" pipe, flowing full. This does not take entrance control conditions into account, but the full pipe discharge of 1.02 cfs would support the statement that the pipe does not have the capacity to carry 4.95 cfs. At the point where this pipe exceeds capacity, there would be some flow to the east and there would be a point where there would be flow over L Road. It should be noted again that the 4.95 cfs flow is actually only 44% of the current conditions.

Rational method calculations for the drainage areas going into the detention ponds are given in the remaining exhibits.

Exhibits 10 and 11 were Culvertmaster calculations of the designed culverts under the roads, and are not included in this revised report.

C. Compliance

This drainage report followed the Stormwater Management Manual (SWMM). This manual is the standard for drainage design, policy and criteria for the City of Fruita.

D. Report Limits

This report was prepared to analyze the developed conditions of the proposed site, the existing conditions of the limited off-site property and the design of the hydraulic elements on the site. Any changes or revisions to the project would necessitate a revised drainage study and design.

**Five Star Crossing  
Job Number 205033  
April 24, 2006**

<b>Onsite - Five Star Crossing</b>		<b>100 Year Storm</b>	
<b>2 Year Storm</b>	<b>"C"</b>	<b>"C"</b>	<b>Acres x C</b>
Acres			
A Soil - Row Crops	0.253	0.18	0.0455
D Soil - Row Crops	14.738	0.26	3.8319
	<u>14.991</u>		<u>4.7769</u>
			0.318652372
			<b>0.26</b>

**Composite C Prior to Development**

<b>Onsite - Five Star Crossing</b>		<b>100 Year Storm</b>	
<b>2 Year Storm</b>	<b>"C"</b>	<b>"C"</b>	<b>Acres x C</b>
Acres			
A Soil - Lawns	0.253	0.15	0.0379
D Soil - Lawns	13.532	0.28	3.7888
Driveways and Roads - D Soils	0.885	0.93	0.8233
Houses & Structures	0.321	0.93	0.2989
	<u>14.991</u>		<u>5.7951</u>
			0.386575002
			<b>0.33</b>

**Composite C After Development**

Rational "C" values taken from TABLE "B-1" of "Stormwater Management Manual" City of Grand Junction

- Fp - Fruitland fine sandy loam, 0 to 2 percent slopes - Runoff class: Very Low [Type A]
- Fr - Fruitland fine sandy loam, 2 to 5 percent slopes - Runoff class: Very Low [Type A]
- Hk - Killpack silty clay loam, 0 to 2 percent slopes - Runoff Class - High [Type D]

**COMPOSITE RUNOFF COEFFICIENTS WORKSHEET**

**JOB NAME:** Five Star Crossing  
**JOB NUMBER:** 205033.40  
**DATE:** 12/19/2005

SUBBASIN I.D.	LAND USE /SURFACE DESCRIPTION	STORM FREQUENCY	SCS HYDROLOGIC SOIL GROUP AND NAME (eg - B:RAVOLA)										COMPOSITE C VALUE
			A:		A (Other):		D: (Other)		D:		C:		
			% OF SUBBASIN	"C" VALUE	% OF SUBBASIN	"C" VALUE	% OF SUBBASIN	"C" VALUE	% OF SUBBASIN	"C" VALUE	% OF SUBBASIN	"C" VALUE	
<b>Historic Conditions (Basin H1)</b>													
2-Year	Row Crops	2	7.44	0.18	1.41	0.27	7.12	0.23	84.03	0.23	0.23	0.23	0.23
100-Year	Row Crops	100	7.44	0.23	1.41	0.36	7.12	0.29	84.03	0.29	0.29	0.29	0.29
<b>Historic Conditions</b>													
2-Year		2											0.00
100-Year		100											0.00
<b>Historic Conditions</b>													
2-Year		2											0.00
100-Year		100											0.00
<b>Developed Conditions (Basin A1)</b>													
2-Year	3 Acre Lots	2	6.18	0.18	2.67	0.27	7.12	0.23	84.03	0.23	0.23	0.33	0.31
100-Year	3 Acre Lots	100	6.18	0.23	2.67	0.36	7.12	0.29	84.03	0.29	0.29	0.39	0.37

## TIME OF CONCENTRATION CALCULATION WORKSHEET

**JOB NAME:** Five Star Crossing  
**JOB NUMBER:** 205033.40  
**DATE:** 12/19/2005

**BASIN DESIGNATION:** H1 - Historic on-site

Flowing to: Pipe crossing L Road at SE Corner of property

<b>OVERLAND FLOW:</b>	2-Year	100-Year
Surface Description:	Row Crop	Row Crop
Rational Coefficient:	c<2>: 0.26	0.32
Flow Length, L (total < 300 ft.)	250 ft.	250 ft.
Land Slope, S	0.010629 ft/ft	0.010629 ft/ft
To<2> (Figure E-2):	<b>23.43</b> min.	
To<100> (Figure E-2):		<b>21.75</b> min.

### SHALLOW CONCENTRATED FLOW

Surface Description:	Row Crop	Row Crop
Flow Length, L	550 ft.	550 ft.
Flow Slope, S	0.010629 ft/ft	0.010629 ft/ft
Flow Velocity: (Figure E-3)	0.5 ft/sec	0.5 ft/sec
Travel Time = L/(60V)	<b>18.33</b> min.	<b>18.33</b> min.

### CHANNEL FLOW

Cross-Sectional Flow Area, a	2.11 ft <sup>2</sup>
Wetted Perimeter, Pw	6.68 ft.
Hydraulic Radius, r = a/Pw	0.32 ft.
Channel Slope, S	0.011 ft./ft.
Manning's Coefficient, n	0.030
Velocity, V=1.49r <sup>0.67</sup> s <sup>0.5</sup> /n	2.37 ft./sec.
Flow Length, L	1430.00 ft.
Travel Time = L/(60V)	<b>10.04</b> min.

### CHANNEL FLOW (2)

Cross-Sectional Flow Area, a	2.93 ft <sup>2</sup>
Wetted Perimeter, Pw	6.29 ft.
Hydraulic Radius, r = a/Pw	0.47 ft.
Channel Slope, S	0.011 ft./ft.
Manning's Coefficient, n	0.030
Velocity, V=1.49r <sup>0.67</sup> s <sup>0.5</sup> /n	3.08 ft./sec.
Flow Length, L	270.00 ft.
Travel Time = L/(60V)	<b>1.46</b> min.

### TIME OF CONCENTRATION

Tc<2> **53.26** min.  
Tc<100> **51.59** min.

## TIME OF CONCENTRATION CALCULATION WORKSHEET

**JOB NAME:** Five Star Crossing  
**JOB NUMBER:** 205033.40  
**DATE:** 12/19/2005

**BASIN DESIGNATION:** A1 - Developed Conditions

**Flowing to:** Pipe crossing L Road at SE Corner of property

<b>OVERLAND FLOW:</b>	2-Year	100-Year
Surface Description:	Grass Yard	Grass Yard
Rational Coefficient:	0.33	0.39
Flow Length, L (total < 300 ft.)	300 ft.	300 ft.
Land Slope, S	0.010629 ft/ft	0.010629 ft/ft
To<2> (Figure E-2):	<b>23.53 min.</b>	
To<100> (Figure E-2):		<b>21.69 min.</b>

### SHALLOW CONCENTRATED FLOW

Surface Description:	Grass Yard	Grass Yard
Flow Length, L	500 ft.	500 ft.
Flow Slope, S	0.010629 ft/ft	0.010629 ft/ft
Flow Velocity: (Figure E-3)	0.500 ft/sec	0.500 ft/sec
Travel Time = L/(60V)	<b>16.67 min.</b>	<b>16.67 min.</b>

### CHANNEL FLOW

Cross-Sectional Flow Area, a	2.11
Wetted Perimeter, Pw	6.68 ft.
Hydraulic Radius, $r = a/Pw$	0.32 ft.
Channel Slope, S	0.011 ft./ft.
Manning's Coefficient, n	0.035
Velocity, $V = 1.49r^{.67}s^{.5}/n$	2.03 ft./sec.
Flow Length, L	1430.00 ft.
Travel Time = L/(60V)	<b>11.71 min.</b>

### CHANNEL FLOW (2)

Cross-Sectional Flow Area, a	2.93
Wetted Perimeter, Pw	6.29 ft.
Hydraulic Radius, $r = a/Pw$	0.47 ft.
Channel Slope, S	0.011 ft./ft.
Manning's Coefficient, n	0.035
Velocity, $V = 1.49r^{.67}s^{.5}/n$	2.64 ft./sec.
Flow Length, L	220.00 ft.
Travel Time = L/(60V)	<b>1.39 min.</b>

### PIPE FLOW

Pipe Size	12.00 in.
Flow Length	50.00 ft.
Flow Velocity	5.00 ft/sec
Travel Time = L/(60V)	<b>0.17 min.</b>

### TIME OF CONCENTRATION

Tc<2>	<b>52.07 min.</b>
Tc<100>	<b>50.24 min.</b>

## RUNOFF CALCULATION WORKSHEET RATIONAL METHOD

**JOB NAME:** Five Star Crossing  
**JOB NUMBER:** 205033.40  
**DATE:** 12/19/2005

**BASIN DESIGNATION:** A1 - Developed Conditions  
**FLOWING TO:** Pipe crossing L Road at SE Corner of property

1. Basin Area 19.957 acres

2. Time of Concentration

	2-Year	<u>52.07</u>	min.
	100-Year	<u>50.24</u>	min.

3. Storm Intensity (for use in the Grand Valley)  
per Table "A-1a"

	2-year	$\frac{26.71}{T_c + 19.01}$	<u>0.38</u> in/hr
	100-Year	$\frac{104.94}{T_c + 18.8}$	<u>1.52</u> in/hr

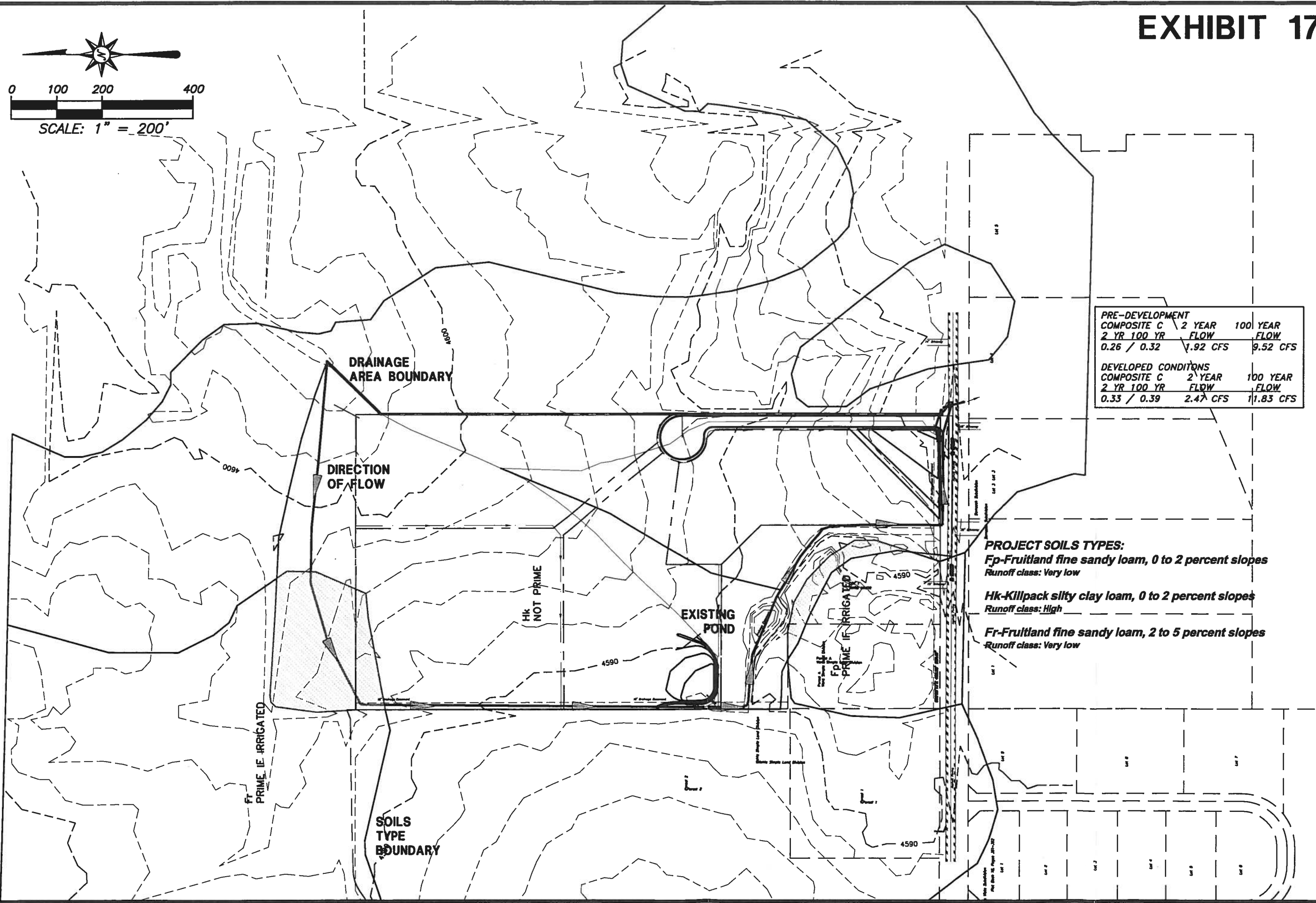
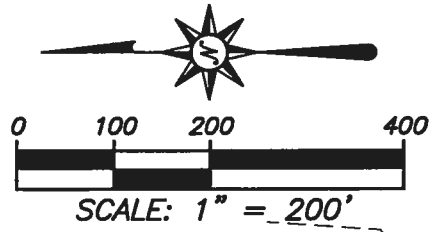
4. Composite Runoff Coefficients

	2-Year	<u>0.33</u>	
	100-Year	<u>0.39</u>	

5. Q = CIA

$$\begin{aligned}
 Q(2) &= 0.33 \times 0.38 \times 19.957 = \mathbf{2.47 \text{ cfs}} \\
 Q(100) &= 0.39 \times 1.52 \times 19.957 = \mathbf{11.83 \text{ cfs}}
 \end{aligned}$$

# EXHIBIT 17



PRE-DEVELOPMENT			
COMPOSITE C	2 YEAR	100 YEAR	
2 YR 100 YR	FLOW	FLOW	
0.26 / 0.32	1.92 CFS	9.52 CFS	
DEVELOPED CONDITIONS			
COMPOSITE C	2 YEAR	100 YEAR	
2 YR 100 YR	FLOW	FLOW	
0.33 / 0.39	2.47 CFS	11.83 CFS	

**PROJECT SOILS TYPES:**  
*Fp-Fruitland fine sandy loam, 0 to 2 percent slopes*  
*Runoff class: Very low*  
*Hk-Killpack silty clay loam, 0 to 2 percent slopes*  
*Runoff class: High*  
*Fr-Fruitland fine sandy loam, 2 to 5 percent slopes*  
*Runoff class: Very low*

**LANDesign**  
 ENGINEERS • SURVEYORS • PLANNERS  
 326 MAIN STREET, SUITE 100  
 GRAND JUNCTION, COLORADO 81501 (970) 245-4099

**DRAINAGE MAP**

**FIVE STAR CROSSING  
 FRUITA, COLORADO**

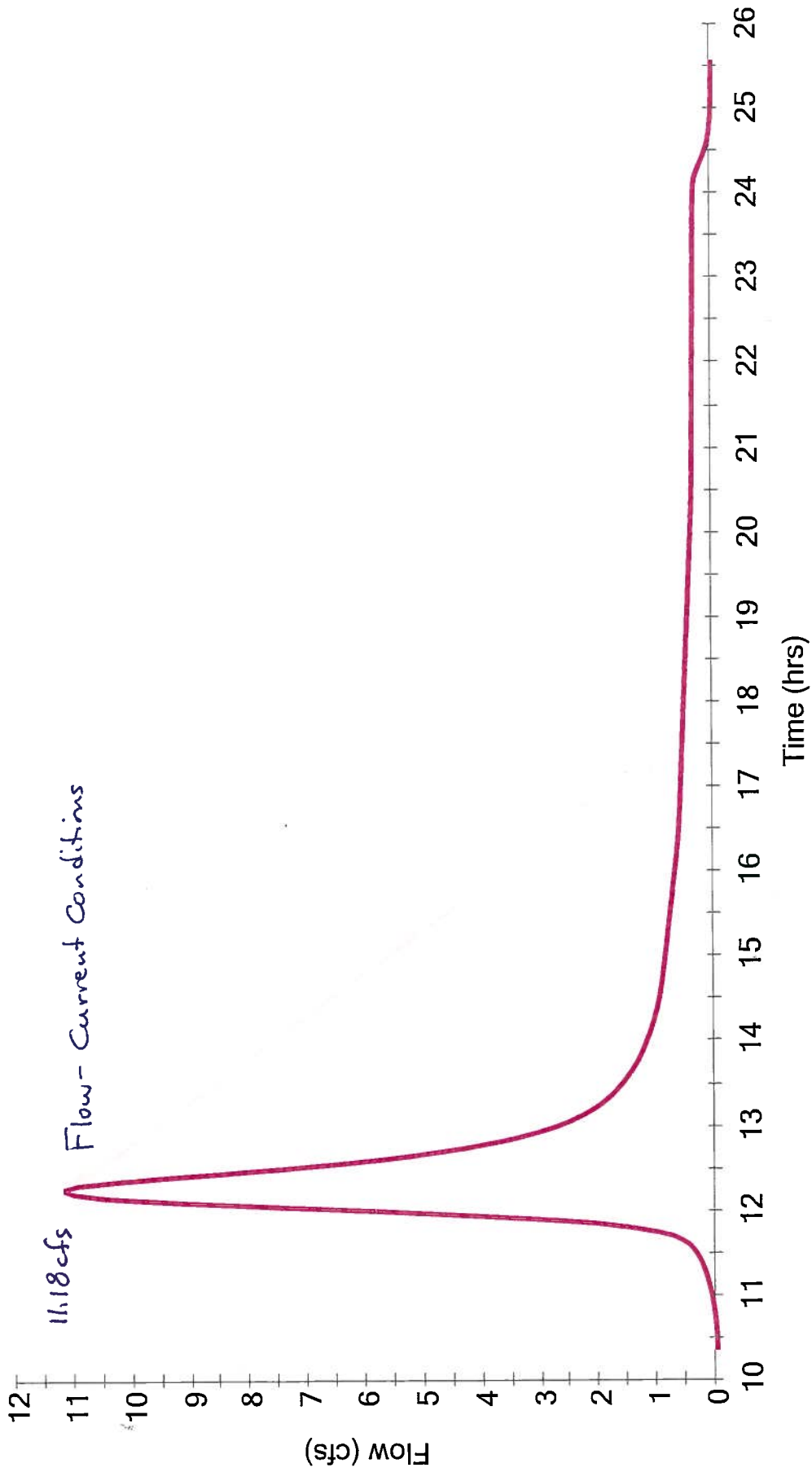
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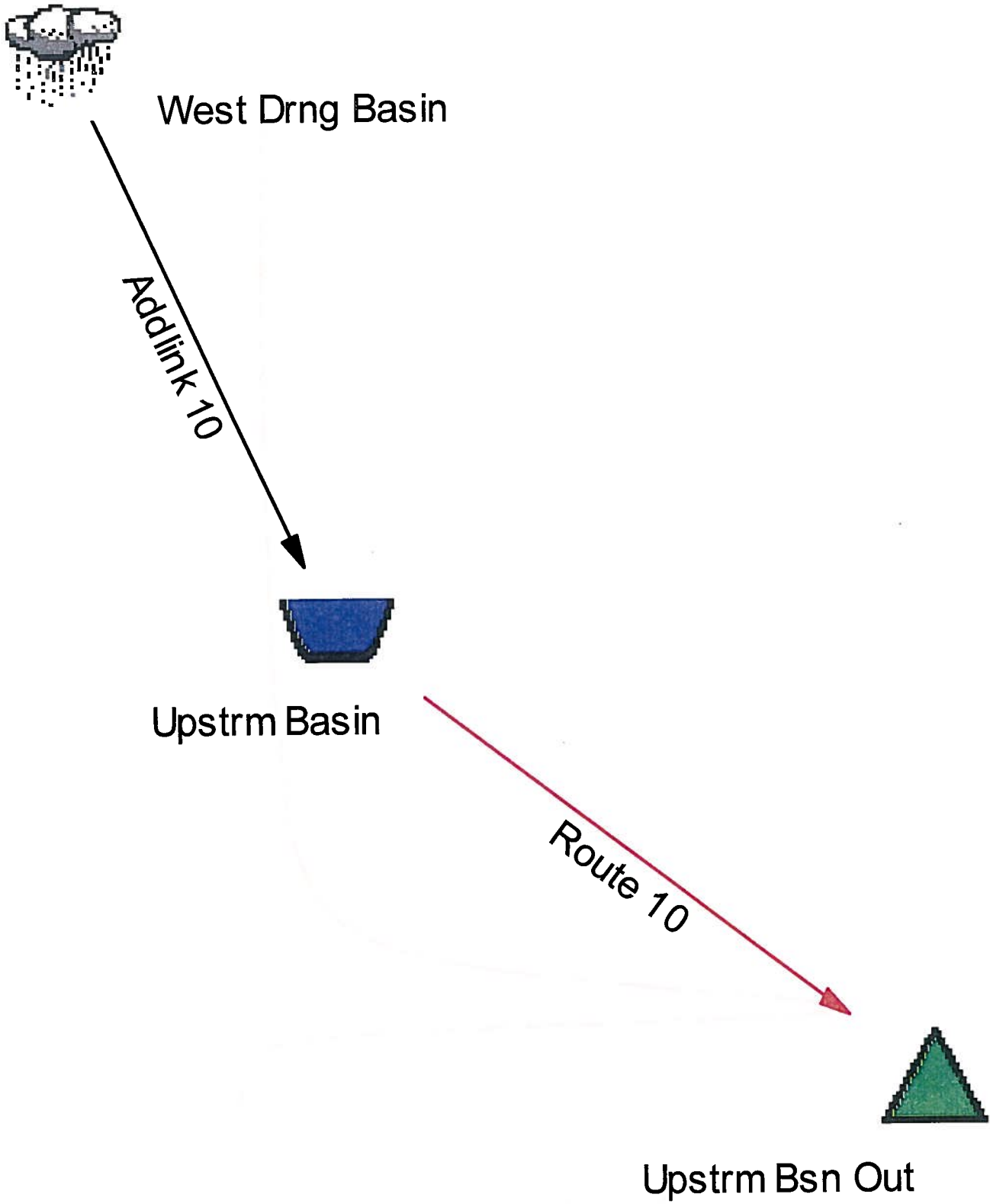
DATE: 05/02/06 DRAWN: wsm CHK'D: wsm

SHEET 1 OF 1  
 DATE NO. BY



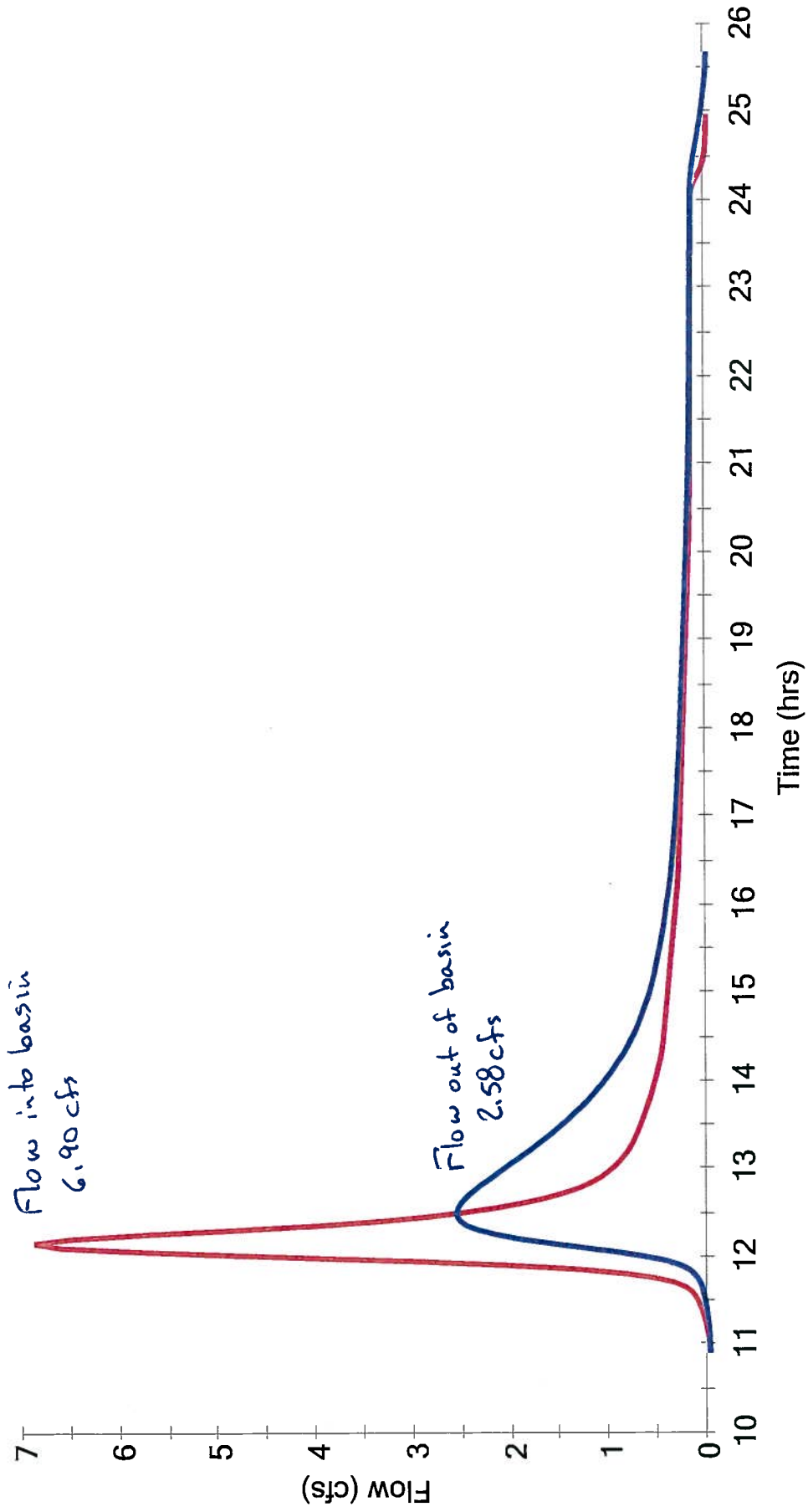
UNDEVELOPED CONDITIONS  
Hydrograph  
SUBAREA 10      100



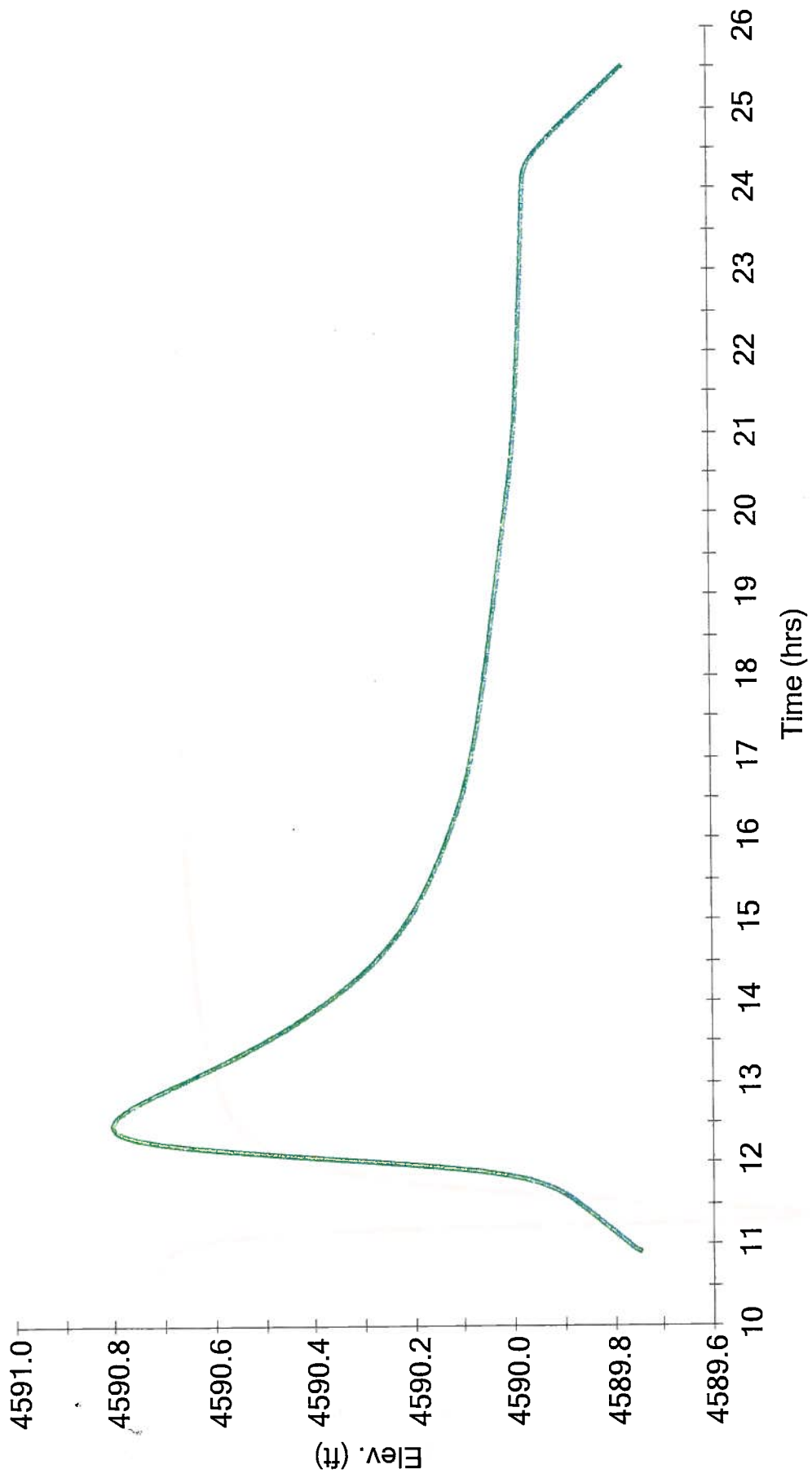


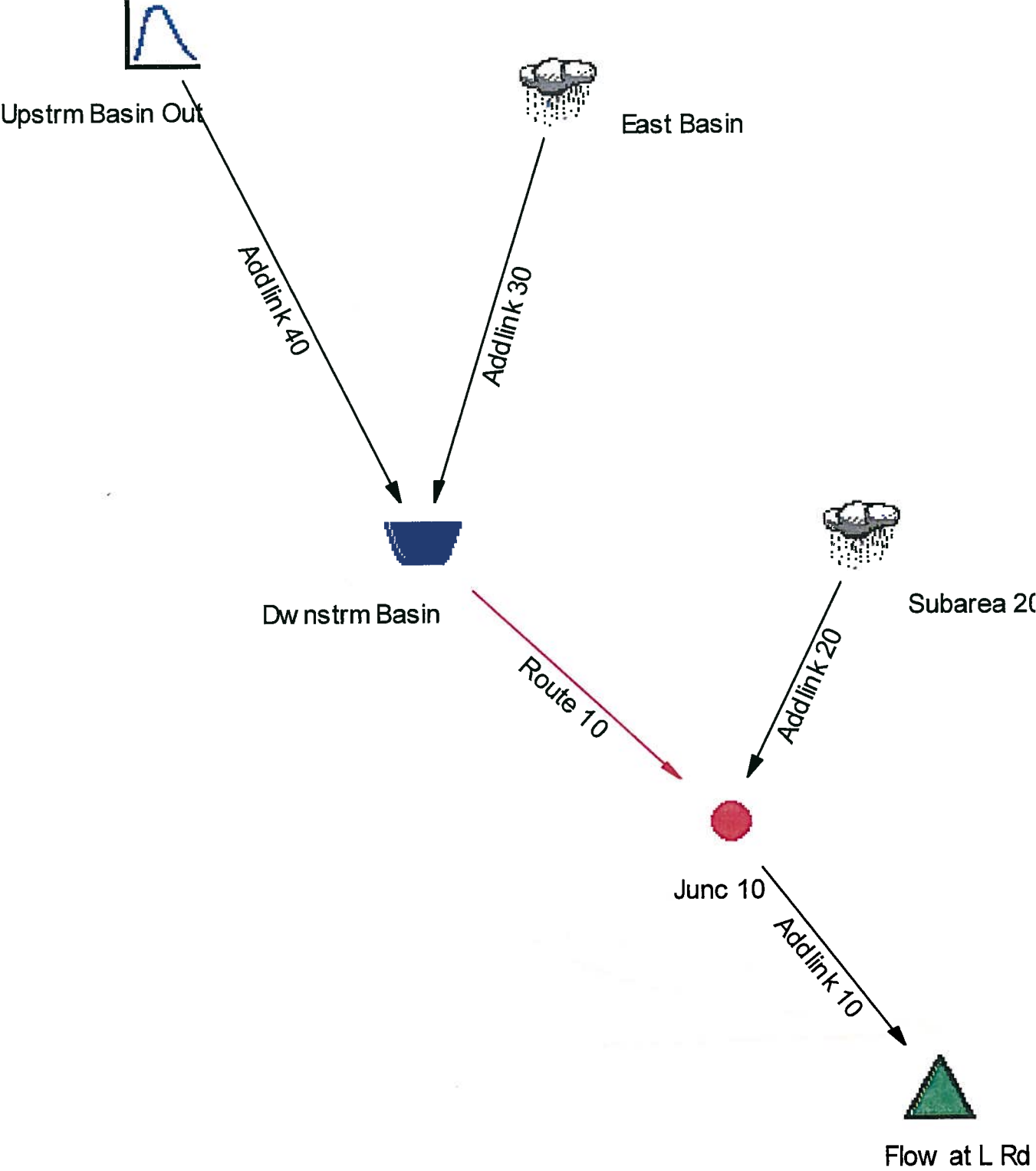
UPPER DETENTION BASIN

5 Star Crossing  
Upper Detention Basin  
Hydrograph  
POND 10 OUT 100



UPPER DETENTION BASIN  
Elev. vs. Time  
POND 10 OUT 100





LOWER DETENTION BASIN

# 5 Star Crossing - Lower Detention Basin Flow Vs. Time

