Received 2/8/07 S

Final Drainage Report

SANTA ANA P.U.D.

Revised Report

February 3, 2007

Prepared for:

Gilbride Development, LLC
685 Curecanti Circle
Grand Junction, CO 81503

Prepared by:

River City Consultants, Inc.
744 Horizon Court, Suite 110
Grand Junction, CO 81506
PH. (970) 241-4722

Job No. 0870-001

TABLE OF CONTENTS ..... **I**
CERTIFICATION ..... **III**

I. Introduction **1**
A. Background 1
B. Project Loction 1
C. Project Description 1
D. Previous Investigations 2

II. Drainage System Description **3**
A. Existing Drainage Conditions 3
B. Master Drainage Plan 3
C. Offsite Tributary Area 3
D. Proposed Drainage System Description 4
E. Drainage Facility Maintenance 5

III DRAINAGE ANALYSIS AND DESIGN CRITERIA **5**
A. Regulations 5
B. Development Criteria 5
C. Hydrologic Criteria 6
D. Hydraulic Criteria 6
E. Variance from Criteria 6
F. Results for Developed Conditions 6

IV POST CONSTRUCTION STORMWATER MANAGEMENT **7**
A. Stormwater Quality Control Measures 7

V. CONCLUSIONS **8**
A. Compliance with Manual 8
B. Design Effectiveness 8
C. Areas in Flood Hazard Zone 8
D. Variances from Manual 8

VI REFERENCES **9**

FIGURES
General Location Map 1
Existing Conditions Drainage Map 2
Major Basin Drainage Map 3
Developed Conditions Drainage Map 4

APPENDIX

Hydrologic Calculations ..... A
Hydraulic Calculations ..... B
USGS Soils & Mesa County Floodplain Information C

Engineer's Certification

I hereby certify that this *Final Drainage Report* for the design of **Santa Ana P.U.D.** was prepared by me,or under my direct supervision, in accordance with the provisions of the *Stormwater Management Manual* (dated March 27,2006) for the owners thereof. I understand that the **City of Fruita** does not and will not assume liability for drainage facilities designed by others.

Jeffrey W. Mace, P.E.
State of Colorado Reg. No. 37343

Developer's Certification

I, **Gilbride Development, LLC.** hereby certify that the drainage facilities for **Santa Ana P.U.D.** shall be constructed according to the design presented in this report and the final construction plans approved by the **City of Fruita**. I understand that the **City of Fruita** does not and will not assume liability for drainage facilities designed and/or certified by my engineer. I understand that the **City of Fruita** reviews drainage plans but cannot, on behalf of **Santa Ana P.U.D.**, guarantee that final drainage design review will absolve **Gilbride Development, LLC.** and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the Final Plat and/or Final Development Plan does not imply approval of my engineer's drainage design.

Gilbride Development, LLC

Leo Gilbride, Manager Feb-6-2007
Name/Title/Date

I. Introduction

A. Background

The purpose of this Final Drainage Report is to identify pre and post development drainage conditions for the proposed site of the Santa Ana P.U.D.. This report identifies the following items with respect to the site: floodplain boundaries, existing drainage issues, potential drainage issues resulting from this development, solutions to the potential drainage issues, detention and water quality requirements, design of the various elements of the storm drain system for the site, and post construction BMPs.

River City Consultants, Inc. prepared this Santa Ana Final Drainage Report for Gilbride Development, LLC.. This report addresses the consolidated review comments received on January 8, 2007.

B. Project Loction

The proposed Santa Ana P.U.D is located at 970 17 ¼ Road, and lies between 17 ¼ Road and 17 ½ Road. In more legal terms, it lies within the Southeast ¼ of the Northwest ¼ of the Section 20, Township 1 North, Range 2 West of the Ute Meridian in Mesa County Colorado.

Existing residential development in the vicinity of the proposed subdivision includes Red Cliffs Mobile Home Park to the west, Liberty Glen Subdivision to the north, Stone Mountain Subdivision to the northeast, and Tuxedo Park Subdivision to the south. The existing developments in the vicinity are of similar type and size to the proposed subdivision. The project location is shown on the General Location Map, Figure 1, of this Report.

C. Project Description

The project site is comprised of one parcel totaling approximately 8.8 acres with an existing home site occupying the western portion of the site. The remainder of the site is previously undeveloped agricultural ground. The existing ground cover is pasture with good grass cover, except for the home site and associated outbuildings, which consist of impervious and lawn areas.

According to the NRCS web site, the soil present at the site consist of Fruitland sandy clay loam (R_C) (63.4%) and Turley clay loam (Tr) (36.6%). Both soils are well drained. R_C has a low runoff classification and moderately permeability. Tr has a medium runoff classification and moderately slow permeability. Fruitland and Turley soils have a runoff classification of B. It should be noted that Fruitland soils under wet conditions have a runoff classification of C. However, based on the existing conditions observed at the

site a runoff classification of B best describes the runoff conditions for the site. Soils information is included in Appendix C.

The existing topography at the site slopes from north to south at grades between 0.5 and 2 percent. The site receives off-site flow in the form of sheet flows from the property to the north. The vegetation over the area to the north is pasture/fallow with good grass cover and the soils are the same as those for the proposed development.

There are no existing storm drain facilities within the site boundary. A Grand Junction Drainage District (GJDD) drain exists on the western side of 17 ½ Road along the eastern boundary of the site.

Existing irrigation facilities on the property include small irrigation ditches and structures. An open irrigation ditch parallels 17 ½ Road along the eastern boundary of the site.

The proposed land use for the site will include single family lots, street right of way, and Homeowners' Association (HOA) lots for drainage, irrigation, and open space. Encumbrances at the site include the off-site drainage coming onto the site from the north, the lack of storm drain facilities to route on-site run-off to, and the lack of elevation change for routing water within the site.

D. Previous Investigations

The Mesa County Stormwater Master Plan (May 2003) included the area of the proposed development. The proposed development was included in the 118 Major Drainage Basin. This major basin includes 244 acres and drains directly into the Colorado River. Existing conditions within the major drainage basin vary from urbanized to undeveloped. The predominant drainage pattern for the major basin area is characterized by overland flow sloping towards the river at varying grades. Channels, ditches, roads and other features intermittently cross the sloping ground surface collecting and concentrating surface runoff. The general flow of surface water is from northeast to southwest. Consideration of these parameters led to the watershed boundary definitions of the major basin.

No previous drainage reports were found for the proposed site, nor were any previous drainage reports found that effect proposed development.

II. Drainage System Description

A. Existing Drainage Conditions

Existing topography at the site consists of grades between one and two percent over vegetated pasture. The site slopes from north to south. There are a few small irrigation ditches that may intercept and concentrate surface runoff. However, it appears that most of the surface runoff currently sheet flows across the shallow sloped site across the southern border and onto the adjacent parcel to the south. There are no historical points of flow concentration or point discharge locations leaving the site. The Existing Conditions Drainage Map, Figure 2, shows historical drainage conditions.

Currently one drainage pathway leads from the property to the Colorado River. An existing Grand Junction Drainage District Drain parallels the west side of 17 ½ Road and discharges to the Colorado River. The City of Fruita is planning on installing an additional storm drain down 17 ¼ Road, the west side of the property, in 2008.

The Existing Conditions Drainage Map, Figure 2, shows the historical basins for the property, including flows from off-site. As noted previously the off-site flows are not concentrated and occur as sheet flow, accordingly, they have not be separated out into a separate basin. The calculated peak 2 and 100 year historical peak flows for the site are 0.1 and 5.1 cubic feet per second respectively.

B. Master Drainage Plan

According to the Mesa County Drainage Basins Map, the proposed development is within the 118 Major Drainage Basin. This major basin includes 244 acres and drains directly into the Colorado River. The Major Drainage Basin Map, Figure 3, shows the project location relative to the Major Drainage Basin Boundaries and Colorado River. The project is located relatively close to the Major Basin's Discharge location to the Colorado River.

C. Offsite Tributary Area

As previously noted, this site receives off-site flows from the parcel to the north. The parcel to the north is currently undeveloped and all off-site flows enter the site as sheet flow. It is assumed if the parcel to the north develops, discharge from the parcel will not exceed historical rates. The off-site flows have increased the catchment area associated with the site. Accordingly, the drainage facilities have been sized to accommodate the off-site historical flow.

D. Proposed Drainage System Description

Under proposed conditions, Santa Ana Drive will run along the northern border of the site. Accordingly the off-site sheet flow from the parcel north of the site will be collected by Santa Ana Drive. Water will enter inlets located at the vertical low point of Santa Ana Drive and will be routed to the on-site retention pond. Ultimately, after the City of Fruita constructs the new storm drain, runoff will be direct discharged to the new storm drain. The new storm drain will convey all flows to the Colorado River.

The site will have two basins under proposed conditions. Two basins were necessary to make the lots "A-Type Lots". A-Type Lots are lots that drain all runoff from the lot to the street. The majority of the site (80%) and all off-site flows from the north will drain to the retention pond located in the western ¼ of the site. A smaller basin was created around San Luis Court, the eastern most street in the subdivision. The smaller basin will drain directly to the GJDD line to the east of the property. In general stormwater runoff from both basins follow the same flow progression of sheet flow to shallow concentrated flow, to concentrated flow in gutters and storm drain pipes.

Runoff for the majority of the site (80% plus the off-site flows) will be routed to a retention pond until the installation of the 17 ¼ Road storm sewer. The pond will be located between Lots 1 and 2 in the western ¼ of the site. The 100 year water surface elevation will be at least one foot less than the finished floor elevation of the existing house on Lot 1. The floor of the pond is approximately 2 feet above the groundwater table as per the geotechnical report for the site. Until the 17 ¼ Road storm drain is constructed stormwater will leave the retention pond through infiltration. After installation of the 17 ¼ Road storm drain, flows will be direct discharged. Runoff from the small eastern catchment will be direct discharged to the Grand Junction Drainage District line in 17 ½ Road. The design characteristics of the retention pond are summarized in the following table.

Pond Characteristics

	Required Storage (ft^3)	Available Storage (ft^3)
2 Year Event (Retention)	4,158	48,500
100 Year Event (Retention)	45,145	48,500

Access to and through the site shall be by dedicated public right of way. Easements will be provided along pipelines located outside the public right of way.

The retention pond will be constructed on a tract owned by the Homeowners' Association. The tract will serve drainage purposes as well as open space.

E. Drainage Facility Maintenance

Ownership and maintenance of the proposed drainage improvements within public right of way shall be by the City of Fruita. Ownership and maintenance of the proposed drainage improvements on private property shall be by the Homeowners' Association. Easements will be provided to the City to maintain drainage facilities on private property in the event that the Home Owners' Association does not provide adequate maintenance of the drainage facilities.

Maintenance of all drainage facilities shall be performed by the owner, in accordance with SWMM Section 403.10, *Drainage Facility Maintenance*. All facilities shall be inspected annually by a qualified erosion control specialist to verify maintenance activities. Inspection reports documenting said activities shall be provided to the City of Fruita.

III DRAINAGE ANALYSIS AND DESIGN CRITERIA

A. Regulations

The policy, design criteria, design constraints, methods of analysis, recommendations, and conclusions presented in this report are in conformance with standard engineering practice and the Stormwater Management Manual (March 27,2006).

B. Development Criteria

The primary drainage constraint for this project is the lack of storm drain infrastructure in 17 ¼ Road. The City of Fruita plans is construct a drain in 17 ¼ Road in 2008. However this project was designed assuming that this facility would not be available until after construction of the development. Accordingly a retention facility was designed to retain up to the 100 year storm. As per the City of Fruita, this project will direct discharge into the new 17 ¼ Road storm drain after it has been constructed. Drain constructed 5/1/2011.

Santa Ana Drive was aligned along the northern edge of the property to align it with the road to be constructed across 17 ½ Road from the property. Placement of the road along north edge of the property created drainage

constraints. These drainage constraints were a result of changing the historical drainage pattern of the site from north-south to south-north. The drainage pattern was reversed to prevent stormwater runoff from leaving the site. Changing the historical flow pattern required cutting Santa Ana Drive into the existing topography to get A-Type Lots, which would prevent stormwater from flowing onto the property to the south. Changing the historical flow pattern and the topography constraints within the site caused the creation of two basins under developed conditions. The primary basin covers most the site and all off-site flows (i.e., all water draining to Santa Ana Drive). A second basin was created on the western end of property where all the water drains to San Luis Court and is ultimately direct discharged to the GJDD drain along 17 ½ Road.

It should be noted that due to grading constraints across the entire site, it was not feasible to drain the entire site to the existing GJDD line.

C. Hydrologic Criteria

The hydrologic design criteria presented in this report are in conformance with standard engineering practice and the Stormwater Management Manual (March 27,2006).

D. Hydraulic Criteria

The hydraulic design criteria presented in this report are in conformance with standard engineering practice and the Stormwater Management Manual (March 27,2006).

E. Variance from Criteria

It is understood that the City of Fruita 17 ¼ storm drain will have regional detention downstream of this property once constructed. The regional facility will address water quality and storage issues for upstream areas. Accordingly water quality BMPs are not included in this report.

F. Results for Developed Conditions

The results of the analysis of the site drainage under developed conditions are presented in the following paragraphs. The developed drainage conditions are shown on the Developed Conditions Drainage Map, Figure 4, of this report.

The peak flow for 2 and 100 year storms for developed conditions are 0.5 and 8.1 cfs respectively for Basin 1 (the larger basin). The 2 and 100 year flows for Basin 2 (San Luis Court) are 0.1 and 0.8 cfs. The storm sewer system was

designed to convey the 100-Year flows while flowing at approximately 80% capacity. The gutter and road cross section were designed to carry the 2 and 100 year storms. The flow depth and spread during a 100 year storm on Santa Ana Drive (worse case for Basin 1) were 0.35 feet and 12.8 feet respectively. The flow depth and spread during a 100 year storm on San Luis Court (worse case for Basin 2) were 0.18 feet and 4.4 feet respectively.

The following table summarizes the hydraulic calculations performed for inlets and pipes.

Hydraulic Calculations

Description	Type/Size	Slope	100-Year Flow (ft^3/sec)	% of Capacity
Inlets along Santa Ana Drive	Single Inlet on each side of road at vertical low point in road (i.e., sump condition)	N/A	8.1/2 = 4	33
Storm Drain	18" HDPE	0.5%	8.1	83
Inlets along San Luis Court	Single Inlet at vertical low point in road (i.e., sump condition)	N/A	0.81	6.7
Storm Drain	12" HDPE	0.5%	0.81	37

IV POST CONSTRUCTION STORMWATER MANAGEMENT

A. Stormwater Quality Control Measures

It is understood that the City of Fruita 17 ¼ storm drain will have regional detention downstream of this property once constructed. The regional facility will address water quality and storage issues for upstream areas. Accordingly water quality BMPs are not included in this report.

V. CONCLUSIONS

A. Compliance with Manual

The policy, design criteria, design constraints, methods of analysis, recommendations, and conclusions presented in this report are in conformance with standard engineering practice and the Stormwater Management Manual (March 27,2006).

B. Design Effectiveness

This design will be very effective for controlling runoff from this site. The net effect of this design will be a reduction in impacts to adjacent properties. All lots are A-Type Lots, accordingly only small amounts of runoff from the fringes of the property have potential to leave the site. This design will accommodate off-site flows from the undeveloped property to the north.

Only a small portion of the site will be direct discharged to the GJDD line and this will have little to no effect on this line because a) the tributary catchment is small (and thus the time of concentration is small) and b) the catchment is located very close to the downstream end of the basin. Accordingly the small basin will have reached its discharge peak flow (which is considerably less than the peak flow for the basin) long before the basin peak flow comes through the line (because of the difference in the times of concentration).

C. Areas in Flood Hazard Zone

According to the floodplain maps on Mesa County web site, this site is not affected by any previously known flood hazard zones.

D. Variances from Manual

As previously stated, it is understood that the City of Fruita 17 ¼ storm drain will have regional detention downstream of this property once constructed. Further, it is understood the regional facility will address water quality and storage issues for upstream areas. Accordingly water quality BMPs are not included in this report.

No other variances from the manual are requested.

VI REFERENCES

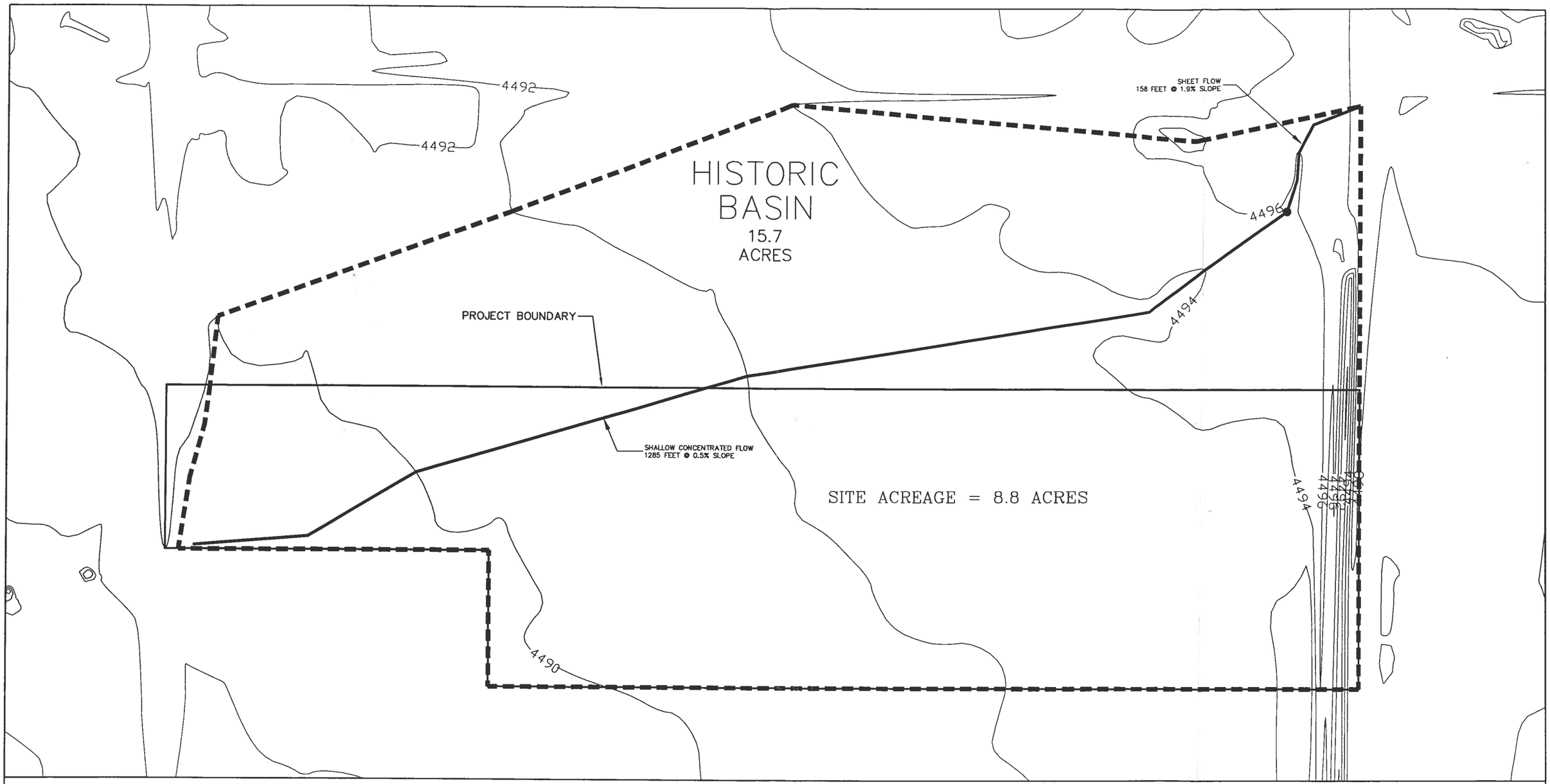
1. Stormwater Management Manual, WRC Engineering under the direction of Mesa County Colorado, March 27, 2006.

2. Stormwater Management Manual, Williams Engineering for the City of Grand Junction and Mesa County Colorado, May 1996.

3. Mesa County Colorado GIS Website, http://gis.mesacounty.us/interactive.aspx .

4. Natural Resources Conservation Service National Cooperative Soils Survey Website, http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx .

FIGURES



2 YEAR STORM	
RUNOFF COEFFICENT, C	0.03
INTENSITY, I	0.23 INCHES
TIME OF CONCENTRATION, Tc	109 MINUTES
AREA	15.7 ACRES
PEAK FLOW	0.1 CFS

100 YEAR STORM	
RUNOFF COEFFICENT, C	0.36
INTENSITY, I	0.91 INCHES
TIME OF CONCENTRATION, Tc	109 MINUTES
AREA	15.7 ACRES
PEAK FLOW	5.1 CFS

LEGEND

- PROJECT BOUNDARY
- CATCHMENT BOUNDARY
- FLOW PATH
- MAJOR CONTOUR
- MINOR CONTOUR
- EXISTING BUILDING

N

50 0 25 50 100

(IN FEET)
1 inch = 50 ft.

NOTES

1. CONTOURS PROVIDED BY MESA COUNTY CONTOUR INTERVAL = 2 FT.

REVISIONS			
NO.	DATE	DESCRIPTION	BY

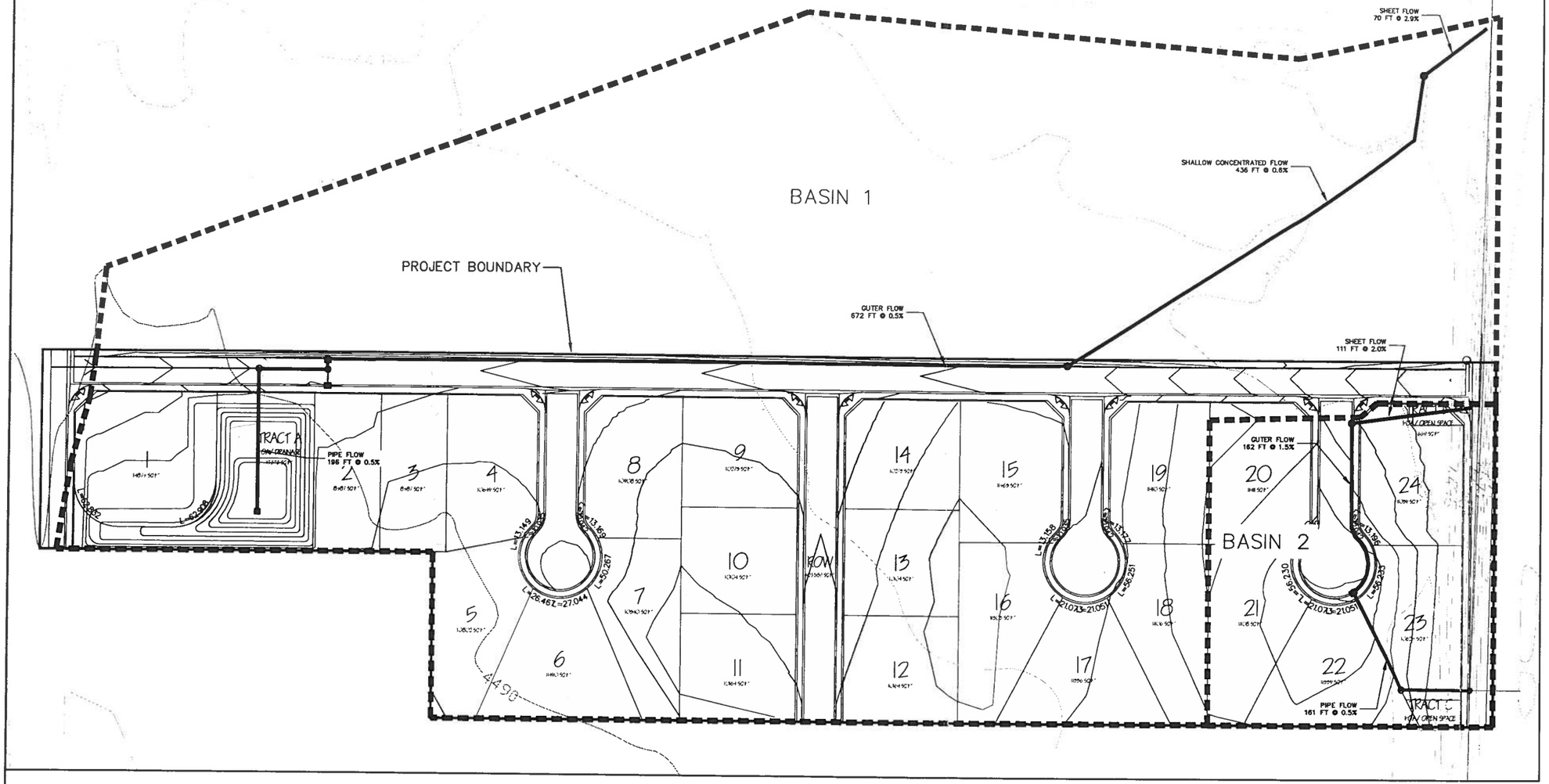
River City CONSULTANTS, INC.
Integrated Design Solutions
744 Horizon Court, Suite 110
Grand Junction, CO 81506
Phone 970-241-4722
Fax 970-241-8841

SANTA ANA

DRAINAGE MAP
HISTORICAL CONDITIONS

PROJECT #0870-001	SCALE	DATE ISSUED: 11/22/06	
DRAWN BY: MJK	HORIZ: AS SHOWN		
CHECKED BY: JWM	VERT. N/A	SHEET NO. OF SHEETS	2

S:\PROJECTS\0870 Gilbride\Santa Ana\FINAL DRAINAGE RPT\Santa Ana Drainage Report.dwg 2/1/2007 9:46:52 AM, HP LJ 5200



BASIN 1

2 YEAR STORM		100 YEAR STORM	
RUNOFF COEFFICENT, C	0.12	RUNOFF COEFFICENT, C	0.44
INTENSITY, I	0.31 INCHES	INTENSITY, I	1.32 INCHES
TIME OF CONCENTRATION, Tc	70 MINUTES	TIME OF CONCENTRATION, Tc	64 MINUTES
AREA	14 ACRES	AREA	14 ACRES
PEAK FLOW	0.5 CFS	PEAK FLOW	8.1 CFS

POND DESIGN	
2 YR RETENTION VOL.	4,158 CF
100 YR RETENTION VOL.	45,145 CF
AVAILABLE VOLUME	48,500 CF

BASIN 2

2 YEAR STORM		100 YEAR STORM	
RUNOFF COEFFICENT, C	0.12	RUNOFF COEFFICENT, C	0.44
INTENSITY, I	0.27 INCHES	INTENSITY, I	1.08 INCHES
TIME OF CONCENTRATION, Tc	88.3 MINUTES	TIME OF CONCENTRATION, Tc	85.3 MINUTES
AREA	1.7 ACRES	AREA	1.7 ACRES
PEAK FLOW	0.1 CFS	PEAK FLOW	0.8 CFS

LEGEND

- PROJECT BOUNDARY
- CATCHMENT BOUNDARY
- FLOW PATH
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- EXISTING PARCEL LINES
- PROPOSED PARCEL LINES

N

(IN FEET)
1 inch = 60 ft.

NO.	DATE	REVISIONS DESCRIPTION	BY

River City CONSULTANTS, INC.
Integrated Design Solutions
744 Horizon Court, Suite 110
Grand Junction, CO 81506
Phone 970-241-4722
Fax 970-241-8841

SANTA ANA

DRAINAGE MAP
DEVELOPED CONDITIONS

PROJECT #0870-001	SCALE	DATE ISSUED: 11/22/06
DRAWN BY: MJK	HORIZ: AS SHOWN	
CHECKED BY: JWM	VERT: N/A	SHEET NO. OF SHEETS

APPENDIX A

Hydrologic Calculations

SANTA ANA SUBDIVISION
FINAL DRAINAGE REPORT

River City Consultants, Inc.
744 Horizon Drive
Grand Junction, CO 81506

COMPOSITE RUNOFF COEFICIENTS
USING MAY 27,2006 SWMM MANUAL (SECTION 700)

$C_{CD}=K_{CD}+(0.858*i^3-0.786*i^2+0.774*i+0.04)$

$C_A=K_A+(1.31*i^3-1.44*i^2+1.135*i-0.12)$

$C_B=(C_A+C_{CD})/2$

Where:

C_{CD}=Runoff coefficient for C and D soils
C_A=Runoff coefficients for A soils
C_B=Runoff coefficients for B soils
i=% impervious (asphalt, concrete, etc.) as a decimal
K_{CD}=Coefficient adjustment for C and D soils)
K_A=Coefficient adjustment for A soils)

ADJUSTMENT FACTORS FOR RUNOFF EQUATIONS (FROM TABLE 707)

	2 YEAR	100 YEAR
K_{CD}	0	-0.39*i+0.46
K_A	0	-0.25*i+0.32

Historical Conditions

Area	Impervious Area Description
0.27	Impervious (asphalt, concrete, etc.)
15.7	Total area
0.017	Impervious (i) as decimal

2 Year Runoff Coefficients
C_{CD}= 0.05
C_A= 0.00
C_B= 0.03

100 Year Runoff Coefficients
C_{CD}= 0.51
C_A= 0.21
C_B= 0.36

Developed Conditions - BASIN 1

Area	Impervious Area Description
2.84	Impervious (asphalt, concrete, etc.)
14	Total area
0.203	Impervious (i) as decimal

2 Year Runoff Coefficients
C_{CD}= 0.17
C_A= 0.06
C_B= 0.12

100 Year Runoff Coefficients
C_{CD}= 0.55
C_A= 0.33
C_B= 0.44

Developed Conditions - BASIN 2

Area	Impervious Area Description
0.80	Impervious (asphalt, concrete, etc.)
1.7	Total area
0.471	Impervious (i) as decimal

2 Year Runoff Coefficients
C_{CD}= 0.32
C_A= 0.23
C_B= 0.28

100 Year Runoff Coefficients
C_{CD}= 0.60
C_A= 0.43
C_B= 0.52

Soil Type for project = Type B

Notes:
1. Assumed 0.125 acres of impervious area under historical conditions based on number of existing structures.

SANTA ANA SUBDIVISION
FINAL DRAINAGE REPORT

River City Consultants, Inc.
744 Horizon Drive
Grand Junction, CO 81506

Historical Conditions

TIME OF CONCENTRATION/ INTENSITY/ FLOW

Description of Flow	L Length ft.	S Slope %	K^1 / n^2 coef.	V_2 Velocity fps 2 yr	V_{100} Velocity fps 100 yr	Tt_2 Travel Time minutes 2 yr	Tt_{100} Travel Time minutes 100 yr	Tc_2 Time of Concentration minutes 2 yr	Tc_{100} Time of Concentration minutes 100 yr	i_2 Intensity[6] Grand Junction Curves 2 yr	i_{100} Intensity[6] Grand Junction Curves 100 yr
Sheet Flow[4]	158.00	1.90%	~~0.320~~	---	---	83.68	83.68	108.9	108.9	0.23	0.91
Shallow Flow[3]	1285.00	0.50%	---	0.85	0.85	25.20	25.20			#	
Channel Flow[5]	0.00			1.00	1.00	0.00	0.00			~~0.21~~	~~0.82~~

Notes
1. "K" is an overland flow resistance factor. As per SWMM the 5 year C value is used from the appropriate formula (based in imperviousness) or a value from Table 702.
2. "n" is the Mannings coefficient
3. Velocities for Shallow Channel Flow derived from Figure 701 from Updated SWMM manual.
4. Overland "To" based on SCS formula pg. E-2 Storm Water Management Manual
5. Mannings Equation in Haestads FlowMaster was used to determine open channel velocities.
6. Intensity data based of formulas for use in the Grand Valley provided on page A-2 of the SWMM manual.

RATIONAL CALCULATION OF DESIGN FLOWS

$Q=C*C_f*I*A$

	C Composite Coefficient n/a	C_f Antecedent Precip. Fac. n/a	I* Rainfall Intensity in/hr	A Basin Area acres	Q Volume cfs	
2-year	0.03	1.00	0.23	15.7	0.10	<<<<<<<<<<<<<<<<<<<<
100-year	0.36	1.00	0.91	15.7	5.13	<<<<<<<<<<<<<<<<<<<<

SANTA ANA SUBDIVISION
FINAL DRAINAGE REPORT

Developed Conditions - BASIN 1

River City Consultants, Inc.
744 Horizon Drive
Grand Junction, CO 81506

TIME OF CONCENTRATION/ INTENSITY/ FLOW

Description of Flow	L Length ft.	S Slope %	K^1 / n^2 coef.	V_2 Velocity fps 2 yr	V_{100} Velocity fps 100 yr	Tt_2 Travel Time minutes 2 yr	Tt_{100} Travel Time minutes 100 yr	Tc_2 Time of Concentration minutes 2 yr	Tc_{100} Time of Concentration minutes 100 yr	i_2 Intensity* Grand Junction Curves 2 yr	i_{100} Intensity* Grand Junction Curves 100 yr
Sheet Flow[4]	70.00	2.90%	---	---	---	52.87	52.87	71.1	64.9	0.31	1.30
Shallow Flow[3]	436.00	0.60%	---	0.80	0.80	9.08	9.08				
Gutter Flow[5]	672.00	0.5%	0.016	1.43	4.77	7.83	2.35				
Pipe Flow[5]	196.00	0.5%	0.012	2.55	5.19	1.28	0.63			0.30	1.25

Notes
1. "K" is an overland flow resistance factor. As per SWMM the 5 year C value is used from the appropriate formula (based in imperviousness) or a value from Table 702.
2. "n" is the Mannings coefficient
3. Velocities for Shallow Channel Flow derived from Figure 701 from Updated SWMM manual.
4. Overland "To" based on FFA formula pg. 704 of the Storm Water Management Manual
5. Mannings Equation in Haestads FlowMaster was used to determine open channel velocities.
   Mannings "n" for curb and gutter and conc. pipe = 0.016, PVC pipe = 0.012.
6. Intensity data based of formulas for use in the Grand Valley provided on page A-2 of the SWMM manual.

RATIONAL CALCULATION OF DESIGN FLOWS

$Q=C*C_f*I*A$

	C Composite Coefficient n/a	C_f Antecedent Precip. Fac. n/a	I* Rainfall Intensity in/hr	A Basin Area acres	Q Volume cfs	
2-year	0.12	1.00	0.31	14.00	0.51	<<<<<<<<<<<<<<<<<<<<
100-year	0.44	1.00	1.30	14.00	8.05	<<<<<<<<<<<<<<<<<<<<

SANTA ANA SUBDIVISION
FINAL DRAINAGE REPORT

River City Consultants, Inc.
744 Horizon Drive
Grand Junction, CO 81506

Developed Conditions - BASIN 2

TIME OF CONCENTRATION/ INTENSITY/ FLOW

Description of Flow	L Length ft.	S Slope %	K^1 / n^2 coef.	V_2 Velocity fps 2 yr	V_{100} Velocity fps 100 yr	Tt_2 Travel Time minutes 2 yr	Tt_{100} Travel Time minutes 100 yr	Tc_2 Time of Concentration minutes 2 yr	Tc_{100} Time of Concentration minutes 100 yr	i_2 Intensity° Grand Junction Curves 2 yr	i_{100} Intensity° Grand Junction Curves 100 yr
Sheet Flow[4]	111.00	2.00%	---	---	---	83.56	83.56	88.3	85.3	0.27	1.08
Shallow Flow[3]	0.00	0.60%	---	0.90	0.90	0.00	0.00				
Gutter Flow[5]	162.00	1.5%	0.016	1.00	3.11	2.70	0.87				
Pipe Flow[5]	161.00	0.5%	0.012	1.34	3.03	2.00	0.89			0.25	1.01

Notes
1. "K" is an overland flow resistance factor. As per SWMM the 5 year C value is used from the appropriate formula (based in imperviousness) or a value from Table 702.
2. "n" is the Mannings coefficient
3. Velocities for Shallow Channel Flow derived from Figure 701 from Updated SWMM manual.
4. Overland "To" based on FFA formula pg. 704 of the Storm Water Management Manual
5. Mannings Equation in Haestads FlowMaster was used to determine open channel velocities.
   Mannings "n" for curb and gutter and conc. pipe = 0.016, PVC pipe = 0.012.
6. Intensity data based of formulas for use in the Grand Valley provided on page A-2 of the SWMM manual.

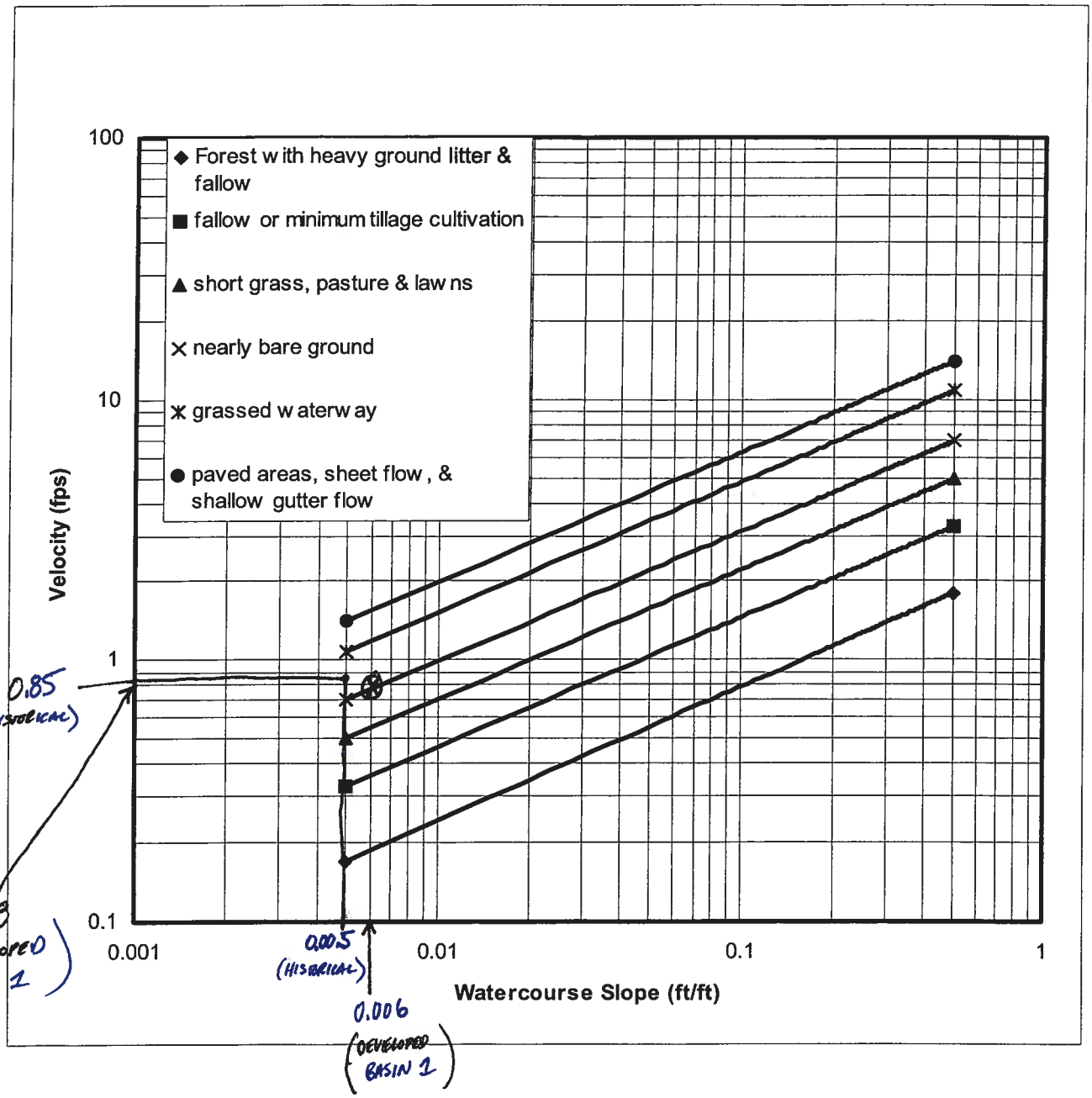
RATIONAL CALCULATION OF DESIGN FLOWS

$Q=C*C_f*I*A$

	C Composite Coefficient n/a	C_f Antecedent Precip. Fac. n/a	I* Rainfall Intensity in/hr	A Basin Area acres	Q Volume cfs	
2-year	0.12	1.00	0.27	1.70	0.05	<<<<<<<<<<<<<<<<<<<<
100-year	0.44	1.00	1.08	1.70	0.81	<<<<<<<<<<<<<<<<<<<<

TRAVEL VELOCITY FOR RATIONAL METHOD

SANTA ANA



Revision	Date
ORIGINAL ISSUE	3/27/06

WRC ENGINEERING, INC.

REFERENCE: Adapted from USDA, SCS 1975. Urban Hydrology for Small Watersheds, TR 55

FIGURE 701

APPENDIX B

Hydraulic Calculations

SANTA ANA SUBDIVISION
FINAL DRAINAGE REPORT

River City Consultants, Inc.
744 Horizon Drive
Grand Junction, CO 81506

STORMWATER RETENTION (Within Grand Valley only)

---

100 YR Storm Total Retention (without overflow)

$V = P_{10024hr} \times A \times C_{100d}$

$P_{10024hr}$=	2.01	(See Table A-2, Pg A-4, SWMM)
Area=	14.00 Ac. =	609840.00 Ft^2
C_{100d} =	0.44	

$$V(FT^3) = \frac{P_{10024hr}\text{ (inches)}}{12} \times \text{AREA } (FT^2) \times C_{100d}$$

= **45,145 Ft^3**

ROUGH AREA (ASSUME DEPTH OF 3 FT AND 3H:1V SIDES)

= 15048.49881 Ft^2

= 127 ft X 127 ft

---

2 YR Storm Total Retention (without overflow)

$V = P_{2\ Yr\ 24hr} \times A \times C_{2d}$

P2 Yr_{24hr}=	0.70	(See Table A-2, Pg A-4, SWMM)
Area=	14.00 Ac. =	609840.00 Ft^2
C_{2d} =	0.12	

$$V(FT^3) = \frac{P_{2\ Yr\ 24hr}\text{ (inches)}}{12} \times \text{AREA } (FT^2) \times C_{2d}$$

= **4,158 Ft^3**

ROUGH AREA (ASSUME DEPTH OF 3 FT AND 3H:1V SIDES)

= 1385.904331 Ft^2

= 42 ft X 42 ft

SANTA ANA 2 year gutter B1

Project Description

Solve For	Spread

Input Data

Channel Slope	0.50000	%
Discharge	0.51	ft^3/s
Gutter Width	1.46	ft
Gutter Cross Slope	8.33	%
Road Cross Slope	2.00	%
Roughness Coefficient	0.016	

Results

Spread	5.38	ft
Flow Area	0.36	ft^2
Depth	0.20	ft
Gutter Depression	0.09	ft
Velocity	1.43	ft/s

SANTA ANA 100 year gutter B1

Project Description

Solve For	Spread

Input Data

Channel Slope	2.60000	%
Discharge	8.15	ft^3/s
Gutter Width	1.46	ft
Gutter Cross Slope	8.33	%
Road Cross Slope	2.00	%
Roughness Coefficient	0.016	

Results

Spread	12.81	ft
Flow Area	1.71	ft^2
Depth	0.35	ft
Gutter Depression	0.09	ft
Velocity	4.77	ft/s

SANTA ANA 2 year pond inlet B1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.50000	%
Diameter	18.00	in
Discharge	0.51	ft^3/s

Results

Normal Depth	0.26	ft
Flow Area	0.20	ft^2
Wetted Perimeter	1.28	ft
Top Width	1.13	ft
Critical Depth	0.26	ft
Percent Full	17.1	%
Critical Slope	0.00438	ft/ft
Velocity	2.55	ft/s
Velocity Head	0.10	ft
Specific Energy	0.36	ft
Froude Number	1.07	
Maximum Discharge	8.66	ft^3/s
Discharge Full	8.05	ft^3/s
Slope Full	0.00002	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	17.06	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

SANTA ANA 2 year pond inlet B1

GVF Output Data

Normal Depth	0.26	ft
Critical Depth	0.26	ft
Channel Slope	0.50000	%
Critical Slope	0.00438	ft/ft

SANTA ANA 100 year pond inlet B1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.50000	%
Diameter	18.00	in
Discharge	8.14	ft^3/s

Results

Normal Depth	1.25	ft
Flow Area	1.57	ft^2
Wetted Perimeter	3.44	ft
Top Width	1.13	ft
Critical Depth	1.11	ft
Percent Full	83.1	%
Critical Slope	0.00642	ft/ft
Velocity	5.19	ft/s
Velocity Head	0.42	ft
Specific Energy	1.66	ft
Froude Number	0.77	
Maximum Discharge	8.66	ft^3/s
Discharge Full	8.05	ft^3/s
Slope Full	0.00512	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	83.06	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

SANTA ANA 100 year pond inlet B1

GVF Output Data

Normal Depth	1.25	ft
Critical Depth	1.11	ft
Channel Slope	0.50000	%
Critical Slope	0.00642	ft/ft

SANTA ANA B2 2 year gutter

Project Description

Solve For	Spread

Input Data

Channel Slope	0.50000	%
Discharge	0.05	ft^3/s
Gutter Width	1.46	ft
Gutter Cross Slope	8.33	%
Road Cross Slope	2.00	%
Roughness Coefficient	0.016	

Results

Spread	1.10	ft
Flow Area	0.05	ft^2
Depth	0.09	ft
Gutter Depression	0.09	ft
Velocity	1.00	ft/s

SANTA ANA B2 100 year gutter

Project Description

Solve For	Spread

Input Data

Channel Slope	2.60000	%
Discharge	0.81	ft^3/s
Gutter Width	1.46	ft
Gutter Cross Slope	8.33	%
Road Cross Slope	2.00	%
Roughness Coefficient	0.016	

Results

Spread	4.40	ft
Flow Area	0.26	ft^2
Depth	0.18	ft
Gutter Depression	0.09	ft
Velocity	3.11	ft/s

SANTA ANA B2 2 year PIPE

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.50000	%
Diameter	12.00	in
Discharge	0.05	ft^3/s

Results

Normal Depth	0.09	ft
Flow Area	0.04	ft^2
Wetted Perimeter	0.62	ft
Top Width	0.58	ft
Critical Depth	0.09	ft
Percent Full	9.4	%
Critical Slope	0.00581	ft/ft
Velocity	1.34	ft/s
Velocity Head	0.03	ft
Specific Energy	0.12	ft
Froude Number	0.94	
Maximum Discharge	2.94	ft^3/s
Discharge Full	2.73	ft^3/s
Slope Full	0.00000	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	9.38	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

SANTA ANA B2 2 year PIPE

GVF Output Data

Normal Depth	0.09	ft
Critical Depth	0.09	ft
Channel Slope	0.50000	%
Critical Slope	0.00581	ft/ft

SANTA ANA B2 100 year PIPE

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.50000	%
Diameter	12.00	in
Discharge	0.81	ft³/s

Results

Normal Depth	0.37	ft
Flow Area	0.27	ft²
Wetted Perimeter	1.31	ft
Top Width	0.97	ft
Critical Depth	0.38	ft
Percent Full	37.3	%
Critical Slope	0.00485	ft/ft
Velocity	3.03	ft/s
Velocity Head	0.14	ft
Specific Energy	0.52	ft
Froude Number	1.02	
Maximum Discharge	2.94	ft³/s
Discharge Full	2.73	ft³/s
Slope Full	0.00044	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	37.33	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

SANTA ANA B2 100 year PIPE

GVF Output Data

Normal Depth	0.37	ft
Critical Depth	0.38	ft
Channel Slope	0.50000	%
Critical Slope	0.00485	ft/ft

APPENDIX C

USGS Soils & Mesa County Floodplain Information

HYDROLOGIC GROUP RATING FOR MESA COUNTY AREA, COLORADO

Santa Ana PUD

Meters
0 25 50 100

Feet
0 50 100 200 300 400

HYDROLOGIC GROUP RATING FOR MESA COUNTY AREA, COLORADO

Santa Ana PUD

MAP LEGEND

Hydrologic Group

{Dominant Condition, <}

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available
- Soil Map Units
- Cities
- Detailed Counties
- Detailed States
- Roads
- Rails
- Water
- Hydrography
- Oceans

MAP INFORMATION

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov

Coordinate System: UTM Zone 12

Soil Survey Area: Mesa County Area, Colorado
Spatial Version of Data: 2
Soil Map Compilation Scale: 1:24000

Map comprised of aerial images photographed on these dates:
8/1/1993; 8/3/1993

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables - Hydrologic Group

Summary by Map Unit - Mesa County Area, Colorado

Soil Survey Area Map Unit Symbol	Map Unit Name	Rating	Total Acres in AOI	Percent of AOI
Rc	Fruitland sandy clay loam, 0 to 2 percent slopes	B	5.5	64.9
Tr	Turley clay loam, 0 to 2 percent slopes	B	3.0	35.1

Description - Hydrologic Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are placed into four groups A, B, C, and D, and three dual classes, A/D, B/D, and C/D. Definitions of the classes are as follows:

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

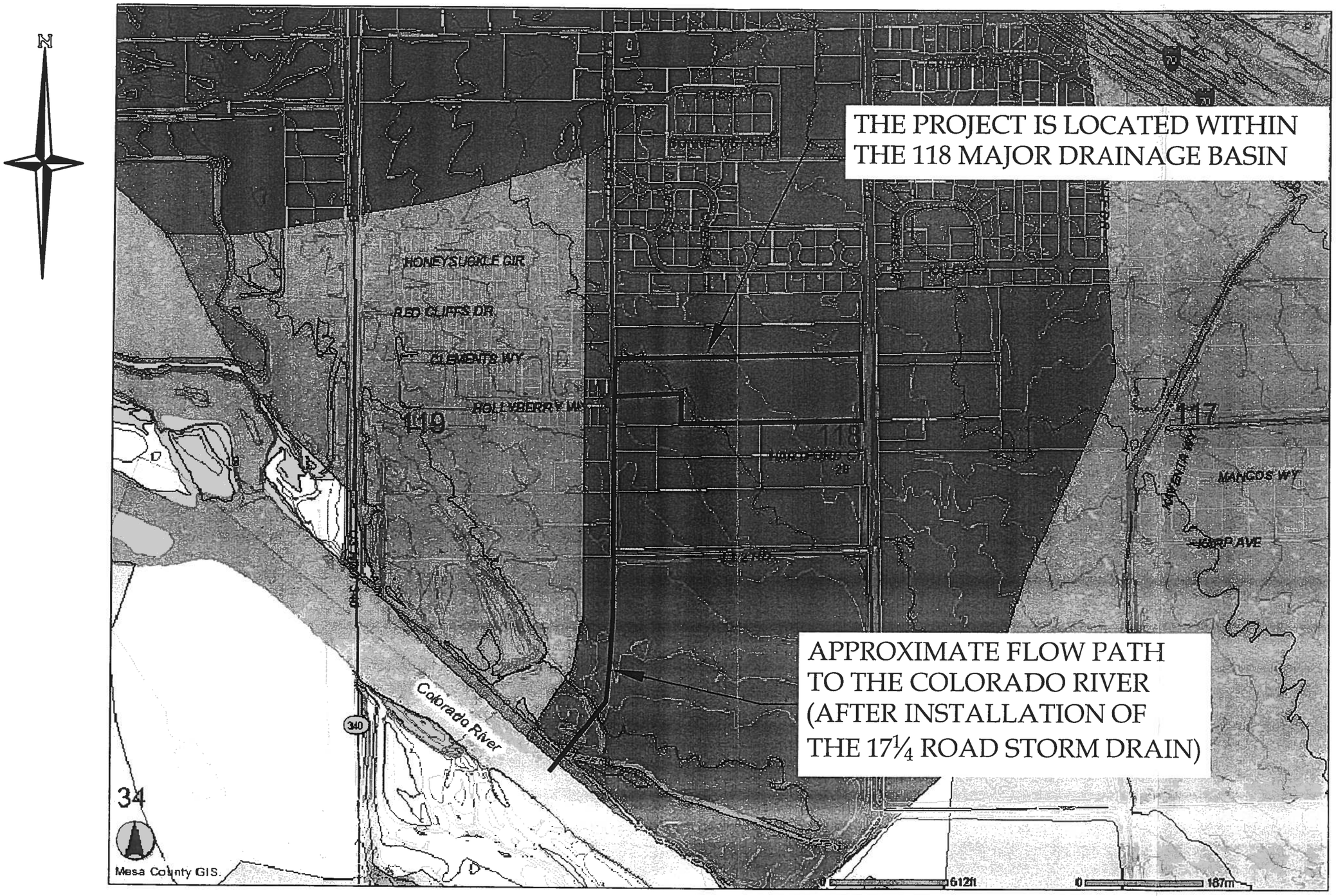
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only soils that are rated D in their natural condition are assigned to dual classes.

Parameter Summary - Hydrologic Group

Aggregation Method: Dominant Condition

Component Percent Cutoff:

Tie-break Rule: Lower



REVISIONS			
NO.	DATE	DESCRIPTION	BY

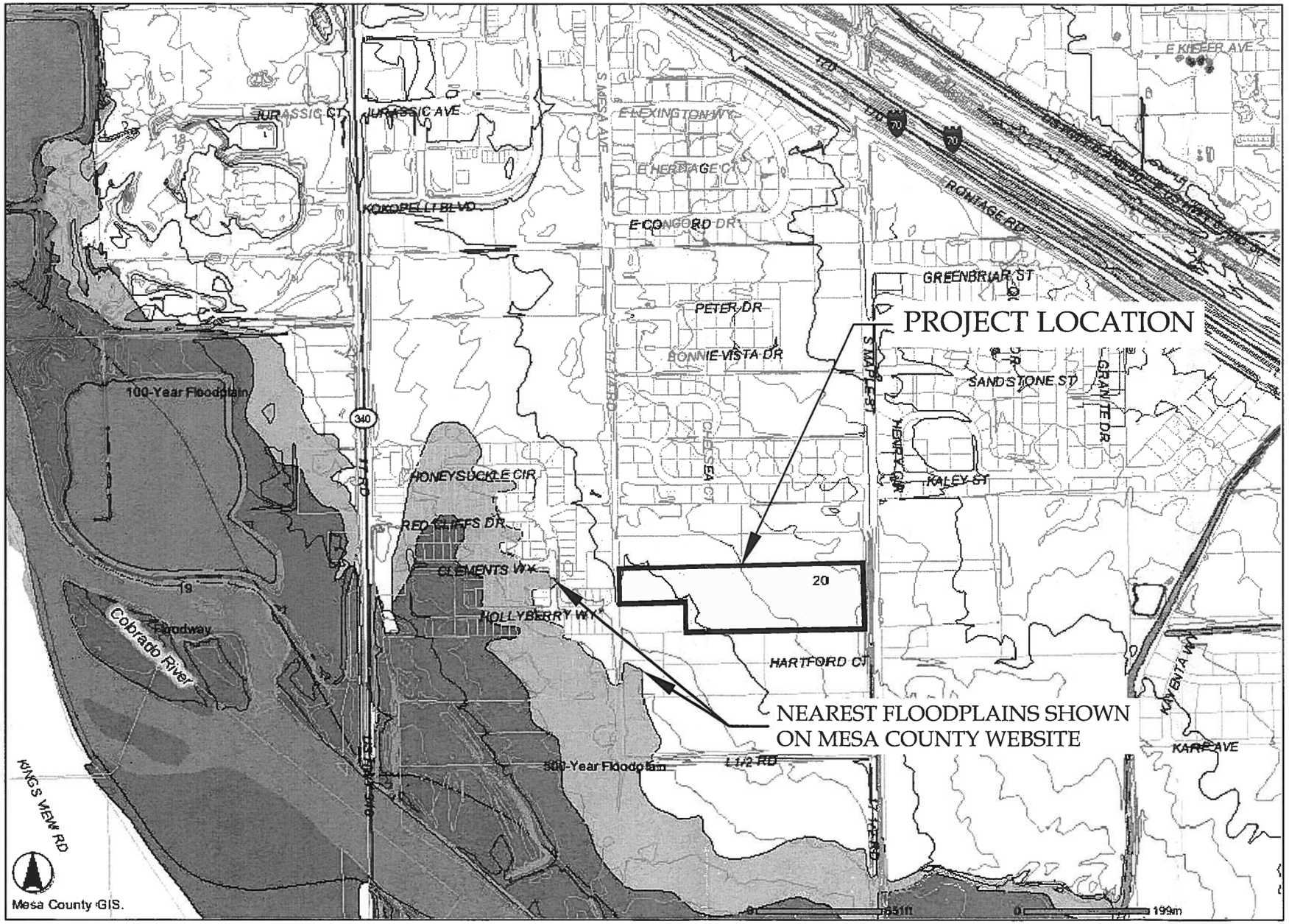
River City CONSULTANTS, INC.
Integrated Design Solutions
744 Horizon Court, Suite 110
Grand Junction, CO 81506
Phone 970-241-4722
Fax 970-241-8841

SANTA ANA

MAJOR DRAINAGE BASIN MAP

PROJECT #0970-001	SCALE		DATE ISSUED: 11/22/06	
DRAWN BY: MJK	HORIZ:	N.T.S	SHEET NO. OF N/A SHEETS	3
CHECKED BY: JWM	VERT:	N/A		

S:\PROJECTS\0970 Gilbride\Santa Ana\FINAL DRAINAGE RPT\Santa Ana Drainage Report.dwg, 1/30/2007 1:51:29 PM, HP LJ 5200



N

REVISIONS			
NO.	DATE	DESCRIPTION	BY

River City CONSULTANTS, INC.
Integrated Design Solutions
744 Horizon Court, Suite 110
Grand Junction, CO 81506
Phone 970-241-4722
Fax 970-241-8841

SANTA ANA

FLOODPLAIN MAP

PROJECT #0870-001	SCALE	DATE ISSUED: 11/22/08	APP. C
DRAWN BY: MJK	HORIZ: N.T.S.	SHEET NO. OF SHEETS	
CHECKED BY: JWM	VERT: N/A		

S:\PROJECTS\0870 Gilbride\Santa Ana\FINAL DRAINAGE RPT\Santa Ana Drainage Report.dwg 1/30/2007 1:52:19 PM, HP LJ 5200