DRAINAGE REPORT

FOR

SEVILLE SUBDIVSION

JUNE 2000

PREPARED FOR:

Curb West, Inc.
6301 Indian School NE Suite 208
Albuquerque, NM   87110

PREPARED BY:

Easterling and Associates, Inc.
2600 American Rd. SE Suite 100
Rio Rancho, NM   87124

List of Figures / Plates / Appendices

I, Charles M. Easterling, do hereby certify that this report was prepared by me or under my direction and that I am a duly registered Professional Engineer under the laws of the State of New Mexico

Charles M. Easterling, P.E.
NM No. 6411

8-7-00
Date

CHARLES M. EASTERLING
NEW MEXICO
6411
REGISTERED PROFESSIONAL ENGINEER

TABLE OF CONTENTS

Introduction

Easterling & Associates Inc. prepared this drainage report under contract to *Curb West, Inc*. The document provides a basis for the design of storm water conveyance systems within the proposed subdivision of Seville. This report addresses the hydrology associated with the existing and developed conditions for the Seville subdivision site, off-site areas, and the Main Stem and West Branch of the Calabacillas Arroyo.

The parcel of land being developed is located on zone atlas sheet A-10-Z (Figure 1). A vicinity map showing the proposed subdivision is attached as Plate 1. The proposed subdivision is currently platted as Paradise Heights Unit 6. Vacation of the existing platting is proposed (160 lots to be vacated). The proposed subdivision consists of 236 lots. These lots will be distributed on approximately 52 currently undeveloped acres at approximately 4.5 dwelling units per acre.

Project Location

The subdivision project site is located northwest of the intersection of Irving Blvd. NW and La Paz Dr. NW. The subdivision will be located west of the confluence of the West Branch of the Calabacillas Arroyo and the Main Stem of the Calabacillas Arroyo. The current platted Ivy St. (proposed Kayenta Blvd.) will be the west boundary of the proposed subdivision (Figure 1).

Currently, the site typically slopes from west to east at grades of 2-5%. It is presently undeveloped and covered with typical west mesa desert vegetation. Historically, the site drains east into the West Branch or Main Stem of the Calabacillas Arroyo, then into Swinburne dam. Plate 5 shows the historical flows of the undeveloped site.

Plate 2 contains the September 20, 1996 FEMA Flood Insurance Rate Maps for the area which includes the proposed subdivision layout. The FEMA floodplain does not encumber the subdivision in any location.

Methodologies Used for Analysis

Hydrologic analysis in this report conforms to Section 22.2, Hydrology, of the Development Process Manual, Design Criteria for the City of Albuquerque, New Mexico (COA DPM). Hydrologic modeling was performed using AMAFCA's AHYMO model dated January 1994. ~~Input and summary files are located~~ *AHYMO output files are located in Appendices A through D.*

Storm water runoff volumes, peak discharge rates, storm water volume and detention basin systems were all modeled using AHYMO. The 100-year 24-hour event was used in design of this project.

Hydraulic Modeling of arroyo flows and crossings were done using the U.S. Army Corps of Engineers HEC-RAS water surface profile computer model. HEC-RAS calculations were used to determine flow depths, velocities, and sediment transport parameters for the West Branch of the Calabacillas Arroyo when designing the arroyo crossing.

Existing Conditions

The existing conditions hydrology used a bulking factor of 7%. The draft copy of the "Calabacillas Arroyo Prudent Line Study and Related Work Development of a Prudent Line for the West Branch" prepared by Mussetter Engineering, Inc., bulks the flow in the West Branch of the Calabacillas at an average of 7.75%. The bulking factor of 7.75% for the West Branch of the Calabacillas includes a bed load and a wash load. The existing conditions hydrology is bulked for a wash load, since it is not flowing in a defined channel. The bulking factor of 7% is a conservative wash load bulking factor.

Off-site Existing Conditions

The off-site runoff that historically flows through the proposed Seville Subdivision site comes from the west, largely as sheet flow. Plate 3 shows the existing contributing off-site watersheds as outlined.

The largest off-site drainage basin, labeled Basin 1, currently extends westward approximately one mile from the proposed Kayenta Blvd. alignment. This drainage basin encompasses approximately 180 acres of sandy soils with native vegetation. The calculated peak 100-yr runoff is ~~53 cfs~~ *57 cfs (added bulking factor)* with a total runoff volume of ~~6.66 acre-ft~~ *7.13 acre-ft (added bulking factor)*. Drainage Basin 2 is approximately 17 acres in size. The calculated peak 100-yr runoff is ~~16 cfs~~ *17 cfs (added bulking factor)* with a runoff volume of ~~0.63 acre-ft~~ *0.67 acre-ft (added bulking factor)*. The last off-site drainage basin that historically drained through the proposed site, labeled Basin 3, is approximately 3 acres. The calculated peak 100-yr runoff is ~~4 cfs~~ *4 cfs (added bulking factor)* with a total runoff volume of ~~0.11 acre-ft~~ *0.12 acre-ft (added bulking factor)*. Refer to Appendix A for the AHYMO results for the existing off-site analysis. *Basin 1 has lower peak runoff per acre for the off-site basins calculated. This is due to the time to peak calculation for the length of the basin. The volume per acre is the same for all off-site basins.*

On-site Existing Conditions

At present the site is undeveloped and covered with typical west mesa vegetation, as stated earlier. Type A land treatment covers the entire of the site. The northern portion of the site historically drains into a swale that empties directly into the main stem of the Calabacillas immediately upstream of Swinburne dam. The southern portion of the site historically drains into the West Branch of the Calabacillas arroyo.

The calculated peak runoff for the approximately 25.0 acres of land that drains to the main stem of the Calabacillas is ~~17.69 cfs~~ *18.93 cfs (added bulking factor)* with a volume of ~~0.9162 acre-ft~~ *0.09803 acre-ft (added bulking factor)*. While the 27.5 acres that historically drained to the West Branch of the Calabacillas arroyo has a calculated peak discharge of ~~16.39 cfs~~ *17.54 cfs (added bulking factor)* with a volume of ~~1.0052 acre-ft~~ *1.0756 acre-ft (added bulking factor)*. In the developed condition this basin will drain to the site's storm sewer outfall which will discharge into the Main Stem of the Calabacillas Arroyo immediately upstream of Swinburne Dam. Plate 4 shows these drainage basins and hydrologic data. Appendix B contains AHYMO output regarding in-site existing conditions.

Proposed Conditions

Off-site Developed Conditions

Off-site historical flows (Basins 1 and 2 on Plate 3) passing through the proposed subdivision will be routed to a temporary de-silting basin. This de-silting basin will be designed to retain the 10-year storm so as to serve as frequency mitigation (Plate 4). AHYMO output of the temporary pond is located in Appendix F. The de-silting basin will have an armored inlet and a spillway that will release the flow in excess of the 10-year storm and up to the 100-year into a swale that parallels the north boundary ~~(Ibiza Ave.)~~ *(Rio Segura Ave.)* of the proposed subdivision. This proposed swale is located along a historic drainage path. *Easements will be received to grade on property to west and AMAFCA property to south (per 7/18/00 meeting).*

When the development begins for the northern portion of the Seville subdivision (labeled 'Future Development' on Plate 3) the swale located to the north of Glover Ave. will no longer exist and the drainage will be diverted ~~north~~ into the Calabacillas Arroyo via a storm drain system. The temporary de-silting basin will then discharge into the future storm drain (labeled as such on Plate 3) and be taken ~~north~~ through the site to the Calabacillas Arroyo. The calculated 100-yr 24-storm undeveloped peak off-site flow that will be conveyed ~~north~~ to the Main Stem of the Calabacillas is approximately ~~78 cfs~~ ***83 cfs (added bulking factor)***. Appendix A contains the off-site undeveloped hydrology.

In the developed condition, Universe Ave. (as labeled on Plate 3) will serve as a water block for the remaining western portion of the watershed if designed to city standards. The developed flow that is generated west of Universe will be diverted south to the West Branch of the Calabacillas or north to the Main Stem of the Calabacillas. *Universe Blvd. is on the long range street plan. Drainage will not be taken under Universe Blvd. in the developed condition. (per 7/18/00 meeting)*

The developed off-site flow that historically drains through the site, an 86 –acre portion of the off-site watershed east of Universe and west of the proposed Kayenta Blvd., will be conveyed ~~north~~ to the Main Stem of the Calabacillas via a storm drain (as labeled on Plate 3). *The existing platting of lots to the north of the proposed subdivision will be* *vacated with the preliminary plat.* The future developed watersheds that contribute to this proposed storm drain are labeled basin 4 and ~~5~~ *2* on Plate 3. The calculated 100-yr 24-storm developed peak off-site flow that will be conveyed through the proposed storm drain is **291 cfs**. The AHYMO output for this watershed is shown in Appendix C.

On-site Developed Conditions

Land treatment areas were calculated on an individual basin basis. Plate 4 shows the basin boundaries and the calculated land treatment areas. The back yards of the lots were assumed to e type B land treatment, the front yards were assumed to be type C, with the pad, street, sidewalk, and driveway assumed to be type D. A typical lot's land treatment areas area shown on Plate 4 as well.

Storm Drain

There will be approximately 2500' linear feet of storm drain located in the subdivision. Plate 4 shows the locations, sizes and slopes for the proposed storm drain. The storm drain shown in this drainage report is an approximation. Final design and hydraulic grade lines will be provided in a separate, more detailed hydraulic analysis, in conjunction with the construction plan review process. Storm drain sizes were based on full pipe flow without additional head. Final design will optimize the pipe sizes.

Plate 4 shows the developed site drainage patterns. Drainage basins are labeled and a table showing each basins treatment types and runoff values is located on Plate 4 as well. The calculated 100-year 24-hour storm will discharge a peak runoff rate of **152 cfs** for the entire subdivision. Appendix D contains AHYMO output for the developed site. All of this storm runoff will be flowing into the Calabacillas arroyo immediately upstream of Swinburne dam through a single stabilized outfall (as shown on Plate 4).

Storm Sewer Outfall

A graphic showing the storm sewer outfall's approximate location is shown on Plate 4. *This storm sewer will utilize the proposed AMAFCA drop structure as its outfall*. The location of the storm sewer outfall is desirable because it is located in very close proximity to Swinburne dam 100-year flood pool (elevation of 5285.1 feet), thus the water will only be flowing in the Calabacillas for approximately 600 feet before it enters into Swinburne Dam. ~~A future AMAFCA drop structure may be placed in a location immediately downstream of our storm sewer outfall at some time. Forethought was given to this possibility and a meeting with AMAFCA ensued. A drop structure in that approximate location is not on the immediate horizon for AMAFCA. However, the proposed storm sewer outfall will be a Ring Chamber Outfall with a rip-rap stilling basin, or equivalent and can be viewed as permanent. Appendix G contains a report written by Richard Heggen that contains specifics about this type of energy dissipator.~~

Discharge into West Branch

The West Branch of the Calabacillas arroyo will be protected from all but very little developed flow. Approximately 2000 feet of the proposed Kayenta Blvd. will drain into the West Branch. Also, a very small, 3.2-acre, off-site watershed labeled as Basin 3 on Plate 3 may drain into the West Branch of the Calabacillas as well. In the 100-year 24-hour event the peak runoff being discharged into the West Branch of the Calabacillas is approximately 16 cfs. This runoff water is intended to support native vegetation in the West Branch.

Grading Scheme

A backyard retention-grading scheme will be used in this subdivision. However, for the purpose of street hydraulic calculations, it is assumed that the entire lot will drain to the street it fronts. The exceptions are those lots that back up to the West Branch of the Calabacillas, discussed in the following paragraph. Runoff contained in backyards will be limited from flowing laterally onto the adjacent property owner's backyard by building perimeter block walls. *The 100-yr storm will be contained within the back yard ponds, as shown on Plate 7. The spillway for the interior lots that pond in the backyards is to the front of the lots*. Plate 7 shows the typical lots grading scheme.

Those lots that back up to the West Branch of the Calabacillas will utilize the backyard retention concept as previously stated. The entire roof is assumed to drain to the front of the lot as well. This is a conservative assumption, as it is not known how the roof of each house will drain until it is built. These lots however will have a spillway to the West Branch of the Calabacillas, for flows larger than the 100-year storm runoff, as opposed to the interior lots that spill to the street in the event the backyard flood. The advantage of retention in the backyards of these lots as opposed to free discharging the runoff into the West Branch is that of frequency mitigation and erosion control. Erosion to the West Branch of the Calabacillas will be minimized and nuisance flows will not be released into the West Branch of the Calabacillas.

Slope Restoration Plans

The lots on the south edge of the subdivision back up to the West Branch of the Calabacillas. There will be a minor amount of grading associated with these lots that will need to be done inside AMAFCA's land with a slope easement. Land sculpting is proposed to tie the designed backyard elevations to existing ground and will be coordinated with AMAFCA and COA Open Space to maintain the naturalistic qualities of the West Branch of the Calabacillas. *Slope easements will be granted by AMAFCA as part of a land exchange agreement.*

Phasing

A phasing plan is proposed for construction of the Seville Subdivision (Figure 2). Two phases of development are proposed. The first will contain 114 lots while the second will contain 122 lots. Interim drainage will be dealt with during the construction of these phases with temporary retention ponds located within the street right-of-way consistent with current practice. Plate 8 illustrates how the phasing drainage will be dealt with.

Roll-Type Curb

The proposed Seville subdivision will have a mix of standard curb and mountable roll type curb. Roll type curb was placed at all locations the street capacity would allow. Refer to Plate 6 to see the sections of the subdivision that will be built with roll-type curb. The conjugate/sequent depth of the street flow was contained within 0.2' above top of curb at all analysis points as is shown in the table located on Plate 6. Detailed analysis of the street hydraulics at various analysis points is shown in Appendix E. *The conjugate / sequent depth is contained within the street right-of-way at all analysis points not just those where a jump "may occur". If a jump were to occur at a "T" intersection, it would be contained within the street right-of-way.*

Hydraulic Analysis of West Branch of Calabacillas Crossing

The hydraulic effects of the proposed crossing of the West Branch of the Calabacillas Arroyo by Kayenta Blvd. will be provided in a detailed report titled, "An Hydraulic Analysis for Kayenta Blvd. Crossing the West Branch of the Calabacillas." This report will address the hydraulic considerations and sediment transport associated with the crossing and will be submitted in support of the construction plan review process. *Figure 3 shows the proposed lot layout with the FEMA floodplain and proposed crossing. The crossing will amend the FEMA floodplain, but it will not encumber any houses at any location along the West Branch of the Calabacillas. The amendment to the floodplain will move the floodplain away from the proposed lots. The FEMA floodplain is located entirely inside of AMAFCA property as well. Erosion Setback Limits (ESB) have not been adopted on the West Branch of the Calabacillas Arroyo yet. A draft copy of the ESB may be obtained by John Kelly of AMAFCA. The proposed layout honored the draft ESB.*

Conclusion

The calculations performed in this report demonstrate the proposed subdivision, as planned, will meet current City of Albuquerque and community design standards.

Easterling & Associates, Inc.

2600 The American Road, Suite 100
Rio Rancho, New Mexico 87124
(505) 898-8021
FAX (505) 898-8501

Project Name SEVILLE SUBDIVISION
Date 2/7/00 Project No. 4881
Subject TIME TO PEAK CALCULATIONS

By RRP Sheet 1 of 1
Reviewed by CMC Date 8-5-00

TIME TO PEAK CALCULATIONS FOR OFF-SITE WATERSHED WEST OF KAYENTA (EXISTING UNDEVELOPED CONDITIONS)

~~L ≐ 5500' (use eq. for 4000 → 12,000')~~

$t_c = ((12000 - L)/(72000 * K * S^{0.5})) + ((L-4000) * K_N * (L_{CA}/L)^{0.33} / (552.2 * S^{0.165}))$

$L ≐ 5500'$

$K = 0.7$ (p. 22-23 DPM) Table B-1

$S = \frac{100'}{5500'} = .0181$ ft/ft

$K_N = 0.033$ (p. 22-24 DPM) Table B-2

$L_{CA} \cong 3600'$

$t_c = ((12000 - 5500)/(72000 * 0.7 * (.0181)^{.5})) + ((5500-4000) * .033 * (\frac{3600}{5500})^{0.33}) / (552.2 * (.0181)^{0.165})$

$t_c = 1.110$ hours

$t_p = \frac{2}{3}(t_c)$; $t_p = .740$ hours

AREA BETWEEN UNIVERSE & KAYENTA THAT TRADITIONALLY DRAINS THROUGH SEVILLE SITE =

$6 in^2 * 2 = 12 in^2 * \frac{500^2 ft^2}{1 in^2} * \frac{1 ACRE}{43560 FT^2} \Rightarrow$ 68.9 ACRES

↑ FR: PLANIMETER

OR

.10761 MILES²

Easterling & Associates, Inc.
2600 The American Road, Suite 100
Rio Rancho, New Mexico 87124
(505) 898-8021
FAX (505) 898-8501

Project Name SEVILLE SUBDIVISION
Date 2/9/00 Project No. 4881
Subject TIME TO PEAK CALCULATIONS

By RRP Sheet 1 of 1
Reviewed by GME Date 6-5-00

TIME TO PEAK CALCULATIONS FOR EXISTING WATERSHED WEST OF KAYENTA (BLUE OUTLINED)

1.) L = 1500' ±

$t_c = (L_1/V_1 + L_2/V_2 + \ldots + L_x/V_x) / 3600 \text{ sec/hour}$

$V = K * 10 * \sqrt{S}$

$K = 1$

$S = .02 \text{ ft/ft}$

$V = 1 * 10 * \sqrt{.02} \Rightarrow 1.414 \text{ ft/sec}$

$t_c = \left(\frac{1500}{1.414}\right) * \left(\frac{1}{3600}\right) \Rightarrow .2946$

$t_p = \frac{2}{3} * t_c \Rightarrow \quad t_p = \underline{.1964} \text{ hours}$

Easterling & Associates, Inc.
2600 The American Road, Suite 100
Rio Rancho, New Mexico 87124
(505) 898-8021
FAX (505) 898-8501

Project Name SEVILLE SUBDIVISION
Date 2/9/00 Project No. 4381
Subject TIME TO PEAK CALCULATIONS

By RRP Sheet 1 of 1
Reviewed by CME Date 6-5-00

TIME TO PEAK CALCULATIONS FOR EXISTING WATERSHED WEST OF KAYENTA
(ORANGE OUTLINE)

1.) L = 750'

$t_c = (L_1/V_1 + L_2/V_2 + \ldots + L_x/V_x) / 3600 \text{ sec/hour}$

$V = K * 10 * \sqrt{S}$

$K = 1$

$S = 4.26\%$

$V = 1 * 10 * \sqrt{.0426} \Rightarrow 2.06$ ft/sec

$t_c = \left(\frac{750'}{2.06 \text{ ft/s}}\right) * \left(\frac{1}{3600}\right) \Rightarrow .101$ hours

since $t_c < 0.2$ hours; use $t_c = 0.2$ hours

$t_p = \frac{2}{3} * t_c$; $t_p =$ .133 hours

Easterling & Associates, Inc.

2600 The American Road, Suite 100
Rio Rancho, New Mexico 87124
(505) 898-8021
FAX (505) 898-8501

Project Name SEVILLE SUBDIVISION
Date 5/16/00 Project No. 4881
Subject TIME TO PEAK CALCULATIONS

By RRP Sheet 1 of 1
Reviewed by OME Date 6-5-00

Time to peak calculations for on-site; undeveloped (basin #1)

$L \cong 1700$ feet

$t_C = (L_1/V_1 + L_2/V_2 + \ldots L_x/V_x) / 3600 \text{ sec/hour}$

$V = K * \sqrt{(S*100)} = 10*K*\sqrt{S}$

$S \cong 2\%$

$K = 0.7$ (undeveloped)

$V = 10*(0.7)*\sqrt{0.02} \Rightarrow 1.00$ ft/sec

$t_C = \frac{1700}{1.00} \times \frac{1}{3600} \Rightarrow 0.4722$ hours

$t_p = \frac{2}{3}(.472) \Rightarrow 0.315$ hours

Easterling & Associates, Inc.
2600 The American Road, Suite 100
Rio Rancho, New Mexico 87124
(505) 898-8021
FAX (505) 898-8501

Project Name SEVILLE SUBDIVISION
Date 5/16/00 Project No. 4881
Subject TIME TO PEAK CALCULATIONS

By RRP Sheet 1 of 1
Reviewed by CMC Date 6-5-00

Time to peak calculations for on-site undeveloped (basin #2)

$L \cong 1700$ feet

$t_c = \left(L_1/V_1 + L_2/V_2 + \dots L_x/V_x \right) / 3600$ sec/hour

$V = K * 10 * \sqrt{S}$

$S = 3\%$

$K = 0.7$ (undeveloped)

$V = 10 * (0.7) * \sqrt{0.03} \Rightarrow 1.21$ ft/sec

$$t_c = \frac{1700}{1.21} * \frac{1}{3600} \Rightarrow .389 \text{ hours}$$

$$t_p = \frac{2}{3}(0.389) \Rightarrow \underline{0.260 \text{ hours}}$$

Easterling & Associates, Inc.

2600 The American Road, Suite 100
Rio Rancho, New Mexico 87124
(505) 898-8021
FAX (505) 898-8501

Project Name SEVILLE SUBDIVISION
Date 2/8/00 Project No. 4021
Subject TIME TO PEAK CALCULATIONS

By RRP Sheet 1 of 1
Reviewed by CME Date 6-5-00

TIME TO PEAK CALCULATIONS FOR DEVELOPED WATERSHED WEST OF KAYENTA; ASSUMING UNIVERSE IS BUILT & SERVES TO CUT-OFF REST OF WATERSHED.

1.) WATERSHED L IS <4000' SO;

$$t_c = \left(L_1/V_1 + L_2/V_2 + \ldots + L_x/V_x \right) / 3600 \text{ sec/hour}$$

$V = K * 10 * \sqrt{S}$

$L = 2200'$

$S = \frac{32'}{2200'} \Rightarrow .01455 \text{ ft/ft}$

$K = 3$;

$V: 3 * 10 * \sqrt{.01455} \Rightarrow 3.62 \text{ ft/sec}$

$t_c = \frac{2200'}{3.62} \cdot \frac{1}{3600} = .1689 \text{ hours}$;

since $t_c < 0.2$ hours; use 0.2 hours

$t_p = \frac{2}{3}(0.2) \Rightarrow .1333$ hours

THIS IS LOW FOR A T_c (6.6 ft/sec) AND THEREFORE SHOULD RESULT IN A CONSERVATIVE PEAK Q. CME

Analysis Point #1
Worksheet for Irregular Channel

Project Description	
Worksheet	rollover32FF
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Slope	0.018000	ft/ft
Water Surface Elevation	4.00	in

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.015	
Elevation Range	0.00 to 0.53	
Discharge	17.78	cfs
Flow Area	4.8	ft²
Wetted Perimeter	388.95	in
Top Width	388.02	in
Actual Depth	0.33	ft
Critical Elevation	0.40	ft
Critical Slope	0.005741	ft/ft
Velocity	3.6836	ft/s
Velocity Head	0.21	ft
Specific Energy	6.53	in
Froude Number	1.6807	
Flow Type	Supercritical	

Calculation Messages:
Flow is divided.

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+31.50	0.013
0+31.50	3+67.00	0.017
3+67.00	3+99.00	0.013

Natural Channel Points

Station (in)	Elevation (in)
0+00.00	6.40
0+00.00	4.00
0+19.19	0.00
0+31.50	0.75
1+99.50	4.11
3+67.00	0.75
3+79.81	0.00
3+99.00	4.00

Analysis Point #1
Worksheet for Irregular Channel

Natural Channel Points	
Station (in)	Elevation (in)
3+99.00	6.40

Analysis Point #2
Worksheet for Irregular Channel

Project Description	
Worksheet	rollover28FF
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data	
Slope	0.020000 ft/ft
Water Surface Elevation	4.00 in

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.015
Elevation Range	0.00 to 0.53
Discharge	19.40 cfs > 15.8
Flow Area	4.8 ft²
Wetted Perimeter	351.93 in
Top Width	351.00 in
Actual Depth	0.33 ft
Critical Elevation	0.41 ft
Critical Slope	0.005635 ft/ft
Velocity	4.0645 ft/s
Velocity Head	0.26 ft
Specific Energy	7.08 in
Froude Number	1.7739
Flow Type	Supercritical

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+31.50	0.013
0+31.50	3+19.50	0.017
3+19.50	3+51.00	0.013

Natural Channel Points

Station (in)	Elevation (in)
0+00.00	6.40
0+00.00	4.00
0+19.19	0.00
0+31.50	0.75
1+75.50	3.63
3+19.50	0.75
3+31.81	0.00
3+51.00	4.00
3+51.00	6.40

Analysis Point #3
Worksheet for Irregular Channel

Project Description	
Worksheet	rollover32FF
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Slope	0.016000	ft/ft
Water Surface Elevation	4.00	in

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.015	
Elevation Range	0.00 to 0.53	
Discharge	16.77	cfs
Flow Area	4.8	ft²
Wetted Perimeter	388.95	in
Top Width	388.02	in
Actual Depth	0.33	ft
Critical Elevation	0.39	ft
Critical Slope	0.005813	ft/ft
Velocity	3.4729	ft/s
Velocity Head	0.19	ft
Specific Energy	6.25	in
Froude Number	1.5846	
Flow Type	Supercritical	

Calculation Messages:
Flow is divided.

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+31.50	0.013
0+31.50	3+67.00	0.017
3+67.00	3+99.00	0.013

Natural Channel Points

Station (in)	Elevation (in)
0+00.00	6.40
0+00.00	4.00
0+19.19	0.00
0+31.50	0.75
1+99.50	4.11
3+67.00	0.75
3+79.31	0.00
3+99.00	4.00

Easterling & Associates, Inc.
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666
Project Engineer: Charles Easterling

Analysis Point #3
Worksheet for Irregular Channel

Natural Channel Points	
Station (in)	Elevation (in)
3+99.00	6.40

Analysis Point #4
Worksheet for Irregular Channel

Project Description	
Worksheet	rollover28FF
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Slope	0.016000	ft/ft
Water Surface Elevation	4.00	in

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.015	
Elevation Range	0.00 to 0.53	
Discharge	17.35	cfs
Flow Area	4.8	ft²
Wetted Perimeter	351.93	in
Top Width	351.00	in
Actual Depth	0.33	ft
Critical Elevation	0.39	ft
Critical Slope	0.005767	ft/ft
Velocity	3.6354	ft/s
Velocity Head	0.21	ft
Specific Energy	6.46	in
Froude Number	1.5866	
Flow Type	Supercritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+31.50	0.013
0+31.50	3+19.50	0.017
3+19.50	3+51.00	0.013

Natural Channel Points

Station (in)	Elevation (in)
0+00.00	6.40
0+00.00	4.00
0+19.19	0.00
0+31.50	0.75
1+75.50	3.63
3+19.50	0.75
3+31.81	0.00
3+51.00	4.00
3+51.00	6.40

Analysis Point #5
Worksheet for Irregular Channel

Project Description	
Worksheet	rollover32FF
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Slope	0.016000	ft/ft
Water Surface Elevation	4.00	in

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.015	
Elevation Range	0.00 to 0.53	
Discharge	16.77	cfs
Flow Area	4.8	ft²
Wetted Perimeter	388.95	in
Top Width	388.02	in
Actual Depth	0.33	ft
Critical Elevation	0.39	ft
Critical Slope	0.005813	ft/ft
Velocity	3.4729	ft/s
Velocity Head	0.19	ft
Specific Energy	6.25	in
Froude Number	1.5646	
Flow Type	Supercritical	

Calculation Messages:
Flow is divided.

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+31.50	0.013
0+31.50	3+67.00	0.017
3+67.00	3+99.00	0.013

Natural Channel Points

Station (in)	Elevation (in)
0+00.00	6.40
0+00.00	4.00
0+19.19	0.00
0+31.50	0.75
1+99.50	4.11
3+67.00	0.75
3+79.81	0.00
3+99.00	4.00

Analysis Point #5
Worksheet for Irregular Channel

Natural Channel Points	
Station (in)	Elevation (in)
3+99.00	6.40

Analysis Point #6
Worksheet for Irregular Channel

Project Description	
Worksheet	rollover32FF
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Slope	0.020000	ft/ft
Water Surface Elevation	4.00	in

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.015	
Elevation Range	0.00 to 0.53	
Discharge	18.74	cfs
Flow Area	4.8	ft²
Wetted Perimeter	388.95	in
Top Width	388.02	in
Actual Depth	0.33	ft
Critical Elevation	0.40	ft
Critical Slope	0.005678	ft/ft
Velocity	3.8828	ft/s
Velocity Head	0.23	ft
Specific Energy	6.81	in
Froude Number	1.7716	
Flow Type	Supercritical	

Calculation Messages:
Flow is divided.

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+31.50	0.013
0+31.50	3+67.00	0.017
3+67.00	3+99.00	0.013

Natural Channel Points

Station (in)	Elevation (in)
0+00.00	6.40
0+00.00	4.00
0+19.19	0.00
0+31.50	0.75
1+99.50	4.11
3+67.00	0.75
3+79.81	0.00
3+99.00	4.00

Analysis Point #6
Worksheet for Irregular Channel

Natural Channel Points	
Station (in)	Elevation (in)
3+99.00	6.40

Analysis Point #7
Worksheet for Irregular Channel

Project Description	
Worksheet	rollover36FF
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Slope	0.040000	ft/ft
Water Surface Elevation	3.10	in

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.015	
Elevation Range	0.00 to 0.53	
Discharge	12.66	cfs
Flow Area	2.7	ft²
Wetted Perimeter	290.10	in
Top Width	289.37	in
Actual Depth	0.26	ft
Critical Elevation	0.36	ft
Critical Slope	0.005837	ft/ft
Velocity	4.6842	ft/s
Velocity Head	0.34	ft
Specific Energy	7.19	in
Froude Number	2.4663	
Flow Type	Supercritical	

Calculation Messages:
Flow is divided.

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+31.50	0.013
0+31.50	4+15.50	0.017
4+15.50	4+47.00	0.013

Natural Channel Points

Station (in)	Elevation (in)
0+00.00	6.40
0+00.00	4.00
0+19.19	0.00
0+31.50	0.75
2+23.50	4.59
4+15.50	0.75
4+27.31	0.00
4+47.00	4.00

Easterling & Associates, Inc.
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666
Project Engineer: Charles Easterling

Analysis Point #7
Worksheet for Irregular Channel

Natural Channel Points	
Station (in)	Elevation (in)
4+47.00	6.40

Analysis Point #8
Worksheet for Irregular Channel

Project Description	
Worksheet	rollover28FF
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Slope	0.040000	ft/ft
Water Surface Elevation	3.25	in

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.015	
Elevation Range	0.00 to 0.53	
Discharge	14.52	cfs
Flow Area	3.0	ft²
Wetted Perimeter	306.57	in
Top Width	305.80	in
Actual Depth	0.27	ft
Critical Elevation	0.37	ft
Critical Slope	0.005544	ft/ft
Velocity	4.8194	ft/s
Velocity Head	0.36	ft
Specific Energy	7.58	in
Froude Number	2.4708	
Flow Type	Supercritical	

Calculation Messages:
Flow is divided.

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+31.50	0.013
0+31.50	3+19.50	0.017
3+19.50	3+51.00	0.013

Natural Channel Points

Station (in)	Elevation (in)
0+00.00	6.40
0+00.00	4.00
0+19.19	0.00
0+31.50	0.75
1+75.50	3.63
3+19.50	0.75
3+31.81	0.00
3+51.00	4.00

Analysis Point #8
Worksheet for Irregular Channel

Natural Channel Points	
Station (in)	Elevation (in)
3+51.00	6.40

Analysis Point #9
Worksheet for Irregular Channel

Project Description	
Worksheet	rollover28FF
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Slope	0.036000	ft/ft
Water Surface Elevation	3.45	in

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.015	
Elevation Range	0.00 to 0.53	
Discharge	16.38	cfs
Flow Area	3.5	ft²
Wetted Perimeter	328.53	in
Top Width	327.72	in
Actual Depth	0.29	ft
Critical Elevation	0.38	ft
Critical Slope	0.005497	ft/ft
Velocity	4.7415	ft/s
Velocity Head	0.35	ft
Specific Energy	7.64	in
Froude Number	2.3507	
Flow Type	Supercritical	

Calculation Messages:
Flow is divided.

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+31.50	0.013
0+31.50	3+19.50	0.017
3+19.50	3+51.00	0.013

Natural Channel Points

Station (in)	Elevation (in)
0+00.00	6.40
0+00.00	4.00
0+19.19	0.00
0+31.50	0.75
1+75.50	3.63
3+19.50	0.75
3+31.81	0.00
3+51.00	4.00

Analysis Point #9
Worksheet for Irregular Channel

Natural Channel Points	
Station (in)	Elevation (in)
3+51.00	6.40

100-yr storm

West Branch Calabacillas Arroyo Sediment Transport Spreadsheet

***done: RRP 11/16/99

***this spreadsheet uses the MPM Woo sediment transport equation given in the AMAFCA Sediment and Erosion Guide

Parameters

Soil d50:	0.27

(constants from table in AMAFCA Sediment and Erosion Guide)

a':	0.018
b:	2.35
c:	0.75
d:	-1.75
Cf:	30000
Q:	2979

HEC-RAS Cross Section

***cross sections 800 through 771 are concrete, therefore a higher transport capacity is desired

	810		800	791	760	750	730	
	Existing	Proposed	Proposed	Proposed	Proposed	Proposed	Existing	Proposed
Average Velocity:	11.37	11.33	11.09	11.31	11.73	12.76	11.74	12.00
→ Hydrualic Depth:	3.40	3.41	2.95	3.02	3.45	3.30	4.11	4.06
Top Width:	76.98	77.06	91.00	87.18	73.49	70.66	61.73	61.22
Unit width bed load:	14.39	14.30	12.20	13.00	15.65	18.45	17.89	18.66
Qs:	1107.76	1102.19	1110.25	1133.66	1150.44	1303.86	1104.13	1142.31
Qsf:	33.72	33.72	33.72	33.72	33.72	33.72	33.72	33.72
Qstotal:	1141.49	1135.92	1143.97	1167.38	1184.17	1337.58	1137.85	1176.04
Percent Change:		0.49	N/A	N/A	N/A	N/A		3.25

25-year storm

West Branch Calabacillas Arroyo Sediment Transport Spreadsheet

****done: RRP 11/16/99*

****this spreadsheet uses the MPM Woo sediment transport equation given in the AMAFCA Sediment and Erosion Guide*

Parameters

Soil d50:	0.27

(constants from table in AMAFCA Sediment and Erosion Guide)

a':	0.018
b:	2.35
c:	0.75
d:	-1.75
Cf:	30000
Q:	2175

HEC-RAS Cross Section

****cross sections 800 through 771 are concrete, therefore a higher transport capacity is desired*

	810		800	791	760	750	730	
	Existing	Proposed	Proposed	Proposed	Proposed	Proposed	Existing	Proposed
Average Velocity:	10.32	10.29	10.20	10.58	10.89	11.95	10.80	10.83
Hydrualic Depth:	2.90	2.91	2.62	2.66	3.04	2.89	3.55	3.55
Top Width:	72.58	72.64	81.37	77.34	65.71	62.96	56.70	56.64
Unit width bed load:	10.17	10.13	9.17	10.11	11.96	14.32	13.17	13.26
Qs:	738.22	735.69	746.14	781.68	785.64	901.52	746.83	750.92
Qsf:	24.62	24.62	24.62	24.62	24.62	24.62	24.62	24.62
Qstotal:	762.84	760.31	770.77	806.30	810.26	926.14	771.45	775.54
Percent Change:		0.33	N/A	N/A	N/A	N/A		0.53

10-year storm

West Branch Calabacillas Arroyo Sediment Transport Spreadsheet

***done: RRP 11/16/99

***this spreadsheet uses the MPM Woo sediment transport equation given in the AMAFCA Sediment and Erosion Guide

Parameters

Soil d50:	0.27

(constants from table in AMAFCA Sediment and Erosion Guide)

a':	0.018
b:	2.35
c:	0.75
d:	1.75
Cf:	30000
Q:	1471

HEC-RAS Cross Section

***cross sections 800 through 771 are concrete, therefore a higher transport capacity is desired

	810		800	791	760	750	730	
	Existing	Proposed	Proposed	Proposed	Proposed	Proposed	Existing	Proposed
Average Velocity:	8.99	9.12	9.33	9.78	10.39	10.76	9.12	9.84
Hydraulic Depth:	2.40	2.37	2.24	2.26	2.52	2.47	3.07	2.91
Top Width:	68.29	68.07	70.39	66.62	56.17	55.30	52.58	51.31
Unit width bed load:	6.38	6.54	6.61	7.44	9.30	9.95	7.94	9.12
Qs:	435.79	445.07	465.42	495.34	522.42	550.08	417.43	467.82
Qsf:	16.65	16.65	16.65	16.65	16.65	16.65	16.65	16.65
Qstotal:	452.44	461.72	482.07	511.99	539.08	566.74	434.08	484.48
Percent Change:		2.01	N/A	N/A	N/A	N/A		10.40

2-year storm

West Branch Calabacillas Arroyo Sediment Transport Spreadsheet

****done: RRP 11/16/99*

****this spreadsheet uses the MPM Woo sediment transport equation given in the AMAFCA Sediment and Erosion Guide*

Parameters

Soil d50:	0.27

(constants from table in AMAFCA Sediment and Erosion Guide)

a':	0.018
b:	2.35
c:	0.75
d:	-1.75
Cf:	30000
Q:	429

HEC-RAS Cross Section

****cross sections 800 through 771 are concrete, therefore a higher transport capacity is desired*

	810		800	791	760	750	730	
	Existing	Proposed	Proposed	Proposed	Proposed	Proposed	Existing	Proposed
Average Velocity:	6.13	6.17	8.40	7.08	7.10	8.33	7.45	6.99
Hydrualic Depth:	1.22	1.21	1.22	1.38	1.54	1.40	1.48	1.54
Top Width:	57.56	57.43	41.92	43.83	39.15	36.80	38.82	39.97
Unit width bed load:	1.56	1.58	3.28	2.40	2.63	3.56	2.86	2.53
Qs:	89.92	90.54	137.30	105.36	102.86	131.03	110.85	101.23
Qsf:	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86
Qstotal:	94.77	95.39	142.16	110.22	107.72	135.89	115.71	106.09
Percent Change:		0.65	N/A	N/A	N/A	N/A		9.07