



MEMORANDUM

Floodplain Management

Regional Flood Control District



DATE: June 13, 2007

TO: Flood Control District Staff

FROM: Brian Jones, CFM
Brian Jones
Principal Hydrologist

SUBJECT: 12-10 and 11-10 Area Special Study

The purpose of the 12-10 Special Study mapping is provide uniformity in how building permits are processed within the area in order to ensure that improvements are adequately protected from flood hazards.

The initial 12-10 Special Study mapping was approved for regulatory purposes in June, 2003 and covered the area within Township 12 South, Range 10 East that was not impacted by FEMA floodplains. Because the mapping focused on the specific Township and Range, it inadvertently created a small territory of land within Township 11 South, Range 10 East that, while flood prone, was not evaluated. This area, bounded on the south by the 12-10 mapping and bounded on the north, east and west by FEMA floodplains, was mapped and approved for regulatory use in March, 2006.

Both the 12-10 and 11-10 annex mapping was conducted in a manner equivalent to a Level I Flow Analysis for sheet flooding as outlined in Arizona State Standard SSA 4-95. More specifically, the assessment included:

- Size of the watersheds impacting the Township and Range
- Utilization of detailed topography, vegetative patterns and recent aerial photography to determine flow paths
- Identification of features such as agricultural ditches and berms with the potential to create ponding areas upstream and/or potential break-out flows downstream due to berm failure
- In the flat agricultural areas, assumptions were made about conditions under fully developed conditions with respect to encroachments within the floodplain and resultant diversion of flow.

Prior to the Floodplain and Erosion Hazard Management Ordinance 2005 FC-2 (2005 Ordinance), the 12-10 mapping constituted permitting guidelines for counter sign-offs, not necessarily requiring Floodplain Use Permits. Section 16.08.640 of the 2005 Ordinance, adopted by the Board of Supervisors in October, 2005 made this Special Study Area a regulatory floodplain by definition, thereby requiring Floodplain Use Permits for most development within the mapped areas.

ROADWAY DRAINAGE REPORT For SILVERBELL TRAILS ESTATES –

(Roadway Plan and Profile – Exhibit No. 5 Bound Separately)

DEI Job No. 03035

*ES ok'd
2/25/08*

October 1st, 2003

Prepared for:

**Pima County Department of Transportation and Flood Control
District**

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Tucson, Arizona 85701

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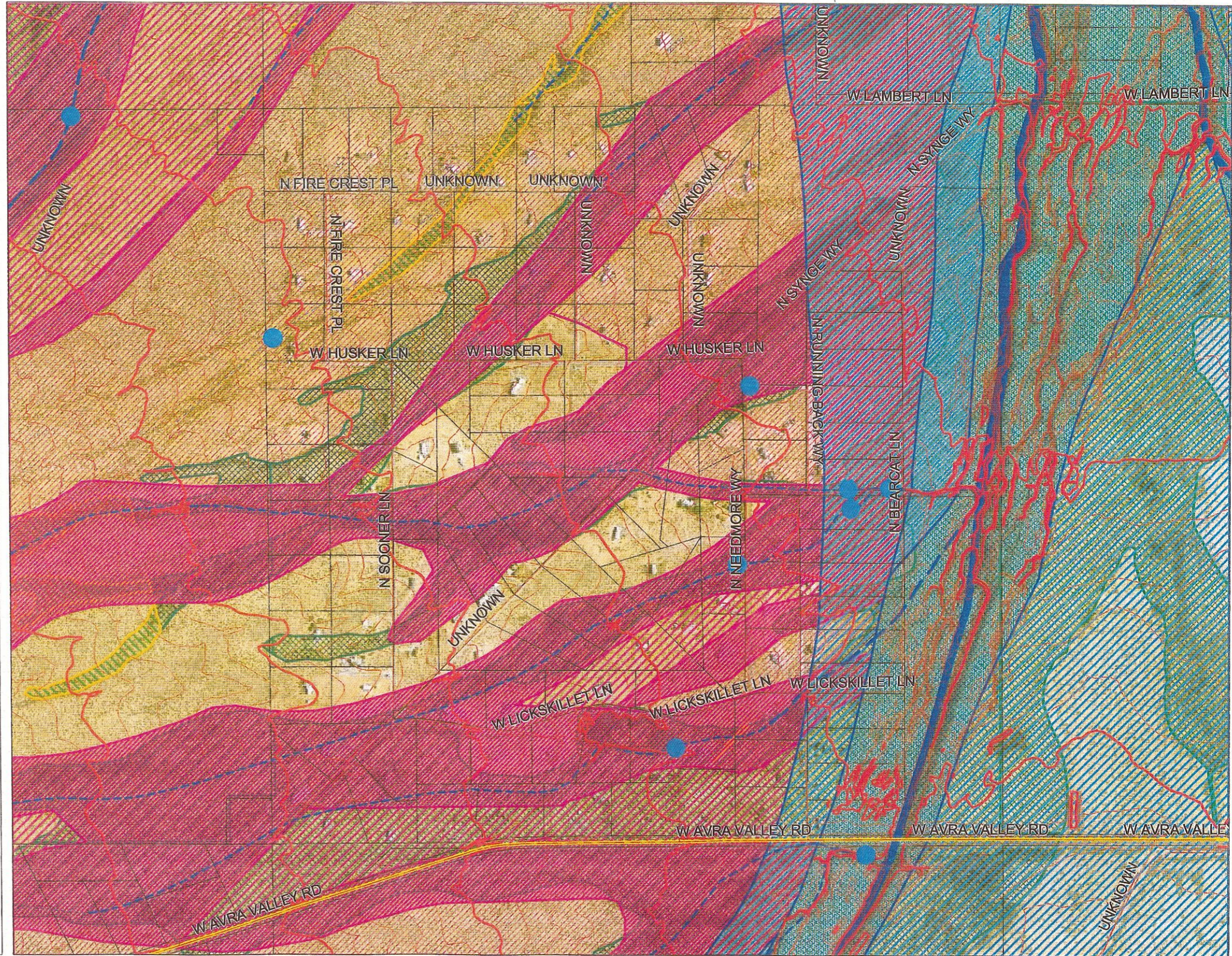
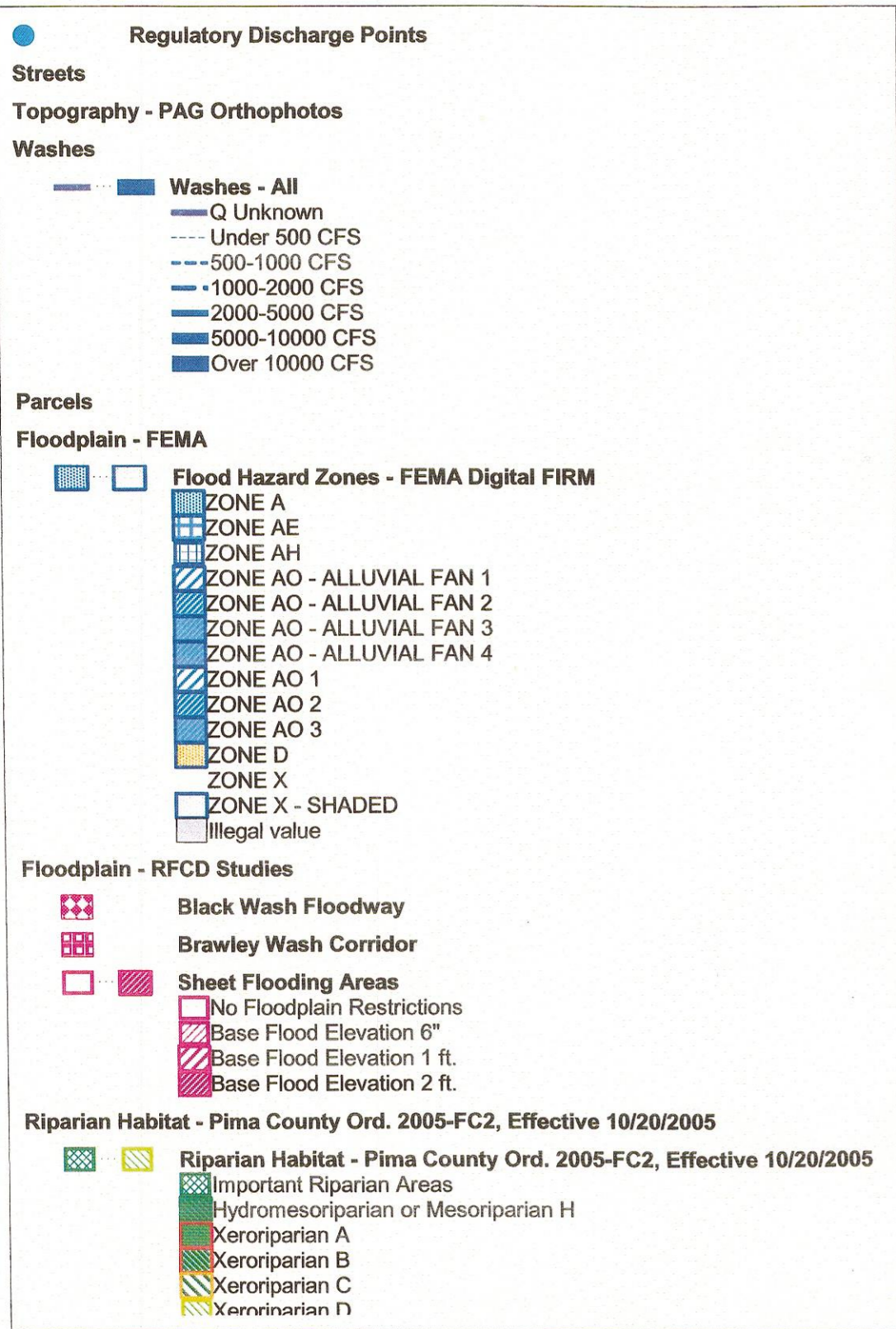


Prepared by:



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Silverbell Trails Estates



Eric Shepp

Subject: FW: Silverbell Trails Estates HOA Meeting Request for PFCD Supervisor

Thank you Mr. Shepp for your quick response. If you are able, could you bring an area flood control map for members to refer to during the meeting. Do you need a projector or computer to assist your presentation?

Most of the concerns are:

What are the regulations for natural water flow?

What is needed to install culverts to prevent road damage within the HOA?

What type of permits / inspections are required?

Thanks again in advance!

Matt Griffis
520-850-7235

-----Original Message-----

From:

I am sending this to you in hopes of getting a contact resource to speak to our community at our next HOA meeting scheduled for **Saturday October 17 2009 at 10:00 AM**. Our HOA is the Silverbell Trails Estates located off of W. Avra Valley Rd. and N. Micholob Rd. We meet at the Avra Valley Fire Station located at N. Trico Rd. and Silverbell Rd. Our community has asked lots of questions concerning Pima County Flood Control and these are questions that we would greatly appreciate having answered by the professionals. If you could, please forward this to the appropriate division manager so we can communicate about this request.

Thank you in advance!

Matt Griffis
17868 W. Avra Valley Rd.
Marana AZ 85653
Cell# 520-850-7235

Matt Griffis

10/16/2009

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A HYDROLOGY

B EXISTING CULVERT RATINGS

C 100-YEAR FLOODPLAIN AND ROADWAY RATINGS

1.0 INTRODUCTION

This report has been prepared by Delph Engineering, Inc.(DEI) to document existing drainage conditions related to Silverbell Trails Estates roadways and 100-year flow depths. The roadways were constructed with several 24-inch culverts for multiple parcels in Section 17, Township 12 South, Range 10 East (See Exhibit 1) The site is located in central Pima County north of Avra Valley Road, west of Brawley Wash. Although a portion of Section 17 is in a FIRM floodplain per Exhibit 2, all of the roads considered are outside of the Brawley Wash floodplain.

The specific roadways considered in this report are as follows:

- Michelob Lane;
- Lickskillet Lane;
- Sooner Lane;
- Husker Lane;
- Needmore Lane;
- Synge Way;
- Firecrest Place;

All roadways are considered interior ring roads, except for Firecrest Lane, which is in the northwest corner of the Section. This area is also referred to as Lot 1 and Firecrest Lane has no culverts. All roadways considered are private and have associated maintenance agreements with all relative land owners.

2.0 OBJECTIVES

This drainage report includes qualitative and quantitative analyses of the existing hydrologic and hydraulic conditions for the subject project. The purpose of this report is to analyze the regional flood condition and the impact on the subject roadways by estimating the 25-yr and 100-yr peak runoff impacting the property and calculating the related flow depths at selected locations using Manning's Equation.

The results include recommendations regarding the perceived roadway drainage impact as compared with typical Pima County roadway drainage improvement requirements for similar type projects.

This report has not addressed any non-roadway flood impacts related to Brawley Wash.

3.0 PROCEDURES

The offsite watersheds areas were calculated using recent (2000) aerial photo-topographic mapping and the USGS 7.5 Minute Quadrangle Map. The watershed delineations include Pima County Floodplain Management's more recent flow line locations and field reconnaissance performed as part of this study.

The peak runoff quantities were estimated at selected concentration points (CPs) using the procedures provided by Pima County's, *Hydrology Manual for Engineering Design and Floodplain Management within Pima County, Arizona*. The runoff quantities were over estimated for braided flow area based on conservative estimates of flows typical of Avra Valley.

The hydraulic computations for the existing culverts were performed using Haestad Methods Culvertmaster v1.0 software which accounts for inlet and outlet control. Regional roadway and street cross section flow depths for 100-year peak flowrates were computed using Manning's Equation via Haestad Methods Flowmaster v.5.12 software.

The roadway improvement requirements are based in part on *Drainage and Channel Design Standards for Local Drainage for Flood Plain Management within Pima County, Arizona*, effective June 1984 and the Pima County *FMO* 1999.

4.0. HYDROLOGY

The onsite and offsite hydrologic characteristics are typical of low-lying Sonoran Desert rangeland floodplain having average overland slopes at about one percent or less. The existing drainage pattern is from the southwest. The watersheds originate in the pediment and foothills of the Silverbell Mountains to the west. The property and adjacent areas are shown in exhibits 3 and 4. Exhibit 3 is an annotated USGS quadrangle showing regional drainage areas and Exhibit 4 is an Aerial Photo showing clear drainage flowpaths and cross sections used in the Mannings Ratings.

The property is located adjacent to Brawley Wash. Brawley Wash is considered a 'major watercourse' as defined by Pima County and is currently mapped by FEMA as a Special Flood Hazard Area as demonstrated on FIRM Panel 965K, effective February 8, 1999. The east portion of the property is located within this federally designated flood hazard area as shown in Exhibit 2. The property is impacted from the west by offsite runoff that discharges across the subject property and combines with Brawley Wash. These watersheds lack competent natural channels resulting in distributive drainage networks that combine and coalesce in response to flow rates. During low frequency, high magnitude, events (10yr - 100yr) the flooding is best described as shallow sheet flow with depth ranging between 0.5 and 1.0 feet. The runoff of lesser events, (2yr - 10yr) more closely matches the existing drainage system. The existing system is apparent by the vegetative response to flow seen on Figure 4. The watersheds are delineated to model the area perceived to concentrate runoff at the property during the more severe and less frequent events (10yr - 100yr). Exhibit 3 - Offsite Watershed Map provides the offsite watersheds delineation and concentration points. The hydrologic soils Group Classification is 100% B. The vegetation cover is estimated at 30 percent. The 2-year and 100-year, 6-hour and 24-hour precipitation depths are calculated at 1.55, 3.80, 1.85 and 4.80 inches respectively. The individual hydrologic calculation sheets are provided in Appendix A.

4.1 OFFSITE DRAINAGE

The parcel is impacted by storm water runoff from the west. The approximate locations of the concentration points (CP) and the offsite watershed delineations are provided in Exhibit 3. As shown on Exhibit 3 and Table 1, five offsite and three onsite watersheds were analyzed. The watershed areas, Q_{10} , Q_{25} and Q_{100} flow rates are summarized below.

**TABLE 1
DISCHARGE SUMMARY**

CP	AREA (ac)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{100} (cfs)
A	1562	363	649	1340
B	327	126	225	467
B2	16.5	16	27	50
C	455	134	244	499
D	180	75	136	278
1	672	177	322	665
2	689	177	320	660
3	386	132	236	488

4.1.1 OFFSITE WATERSHED A

The 100-year peak runoff for offsite watershed at CPA was calculated and compared to the flow capacity at sections A-A and A1-A1 at Pump Station Road. The objective is to determine whether this area discharges primarily to the north or to the east and toward the subject property. It is apparent that the flow capacity at sections A-A and A1-A1 greatly exceeds the perceived 100-year flow rate at that location. Therefore, the Q_{100} runoff from Watershed A apparently bypasses the property to the northwest and provides the northern boundary for the area that does concentrate runoff at the parcel (CPB).

4.1.2 OFFSITE WATERSHED B, C AND D

Drainage areas B, C and D generate stormwater runoff that impacts the property. A summary discussion providing the impact at each location is provided below:

4.2 ONSITE

The onsite drainage areas and selected onsite concentration points are shown on Exhibit 3. Eight cross flow locations were identified and delineated in the Aerial Exhibit No. 4. The locations are based on the existing drainage patterns at the roadway alignment. The local offsite and onsite drainage network is distributary and therefore difficult to model exactly where each peak flow may arrive. To provide conservative methods for 100-year hydrologic calculations, the entire flow value of each offsite watershed is modeled at independent concentration points, e.g. $Q_{100} = 467$ cfs, Watershed B is analyzed at three separate locations along the west portion of the project, first at Firecrest Place and then at two independent locations crossing Sooner Lane. Also, offsite Watershed C is included at both CP1 and CP2.

5.0 HYDRAULICS

The onsite flooding was modeled at each roadway crossing using the 2-foot interval phototopographic mapping and where the roadway alignments are perpendicular to the onsite terrain. Existing Culvert capacities were also considered are detailed in Appendix B, Page B-1. Roadway profiles taken from the project topographic mapping were also rated for flow and the results compared to the corresponding topographic section rating. Table 2 provides a summary of the roadway flow data.

5.1 EXISTING CULVERT CAPACITY

The existing pipe culverts located beneath the roadways are summarized as Table 2. The capacities of the pipes are small in comparison to peak flows and regional sheet flooding. Their individual contribution to roadway cross drainage is negligible and not considered part of the floodplain flow conveyance.

The culvert ratings are summarized on page B-1 of Appendix B and the detailed Culvertmaster Ratings follow identified by Culvert Numbers noted in Exhibits 4 and 5. The culvert capacities without overtopping the roadways are on a range from 5 to 40 cfs. All culvert analysis is based on detailed field survey provided for the base map development of Exhibit 5.

5.2 100-YEAR FLOODPLAIN AND ROADWAY RATINGS

This section provides a discussion for each location where runoff apparently crosses the roadway and provides the 100-year flow rate and depth assuming each location provides flood conveyance independent of each other. Table 2 provides a summary of the roadway flow calculations. Each critical area considered corresponding to roadway stationing in Exhibit 5 is detailed below:

Firecrest Place, Station 50+00 to 65+00 (CP B)

As seen on Figure 4 runoff from offsite Watershed B flows over Firecrest Place at several locations. Firecrest Place does not align perpendicular to the regional slope and runs downgrade. The flow at this location is modeled as Section B1-B1. The maximum flow depth of 0.50 feet was calculated.

Husker Lane, Station 50+00 to 60+00

Runoff from Concentration B was also modeled at Husker Lane using Section B2.1-B2.1. The flow depth is 0.55 feet.

Husker Lane, Station 65+00 to 75+00

See Needmore Way at Husker Lane intersection below.

Synge Way, Station 75+00 to 87+00

Synge Way runs directly down grade and acts as a channel during any runoff event. Section 3-3 represents the typical sheet flow characteristics at this location and demonstrates the sheet flow depth of about 0.5 feet.

Needmore Way, Station 62+70 to 68+30

The roadway profile aligns somewhat perpendicular at this location. The depth of flow for the profile rating and Section 2-2 show a maximum flow depth of about 0.8 feet.

Needmore Way, Station 68+03 to 75+50

See Needmore Way at Husker Lane intersection below.

Sooner Lane, Station 41+50 to Firecrest Station 55+00

This area was modeled as Section B2-B2 and shows a maximum Q_{100} depth of 0.48 feet, and closely matches the 0.55 feet of flow depth calculated downstream at Section B2.1-B2.1.

Sooner Lane, Station 35+50 to 41+50

Runoff from offsite Watershed B concentrates at this location. Section B3-B3 shows a sheet flow depth of about 0.90 feet. The roadway alignment closely matches Section B3-B3, the roadway profile section rating showing a maximum depth of 1.00 feet.

Sooner Lane, Sta. 28+50 to 32+50

Runoff from this local offsite watershed concentrates at the flowline at about Station 30+50. A profile rating at 50 cfs (Q_{100} , CPB2) results in a maximum flow depth of 0.37 feet.

Needmore Way @ Husker Lane Intersection at Synge Way

Runoff leaves the property at this intersection at the northeast. The flow line is Synge Way. Section 3-3 represents the typical sheet flow characteristics at this location and demonstrates the sheet flow depth of less than one 0.5 feet.

Michelob Lane, Station 37+00 to 45+00

The roadway profile was rated at this location using the 100-year discharge calculated at CP1. A 100-year maximum depth of 0.90 feet results from the 665 peak flow.

Lickskillet Lane

Like Synge Way, Lickskillet Lane collects runoff and flows during any rainfall event. However, the majority of the regional runoff appears to bypass the property to the south as shown by cross-section C1-C1. This runoff collects just upstream of the intersection of Lickskillet Lane and Michelob Lane with an existing stock pond. This man-made feature was constructed by excavating a four-foot deep hole. A 100-year flow depth was calculated just down stream across the Michelob Lane roadway profile.

TABLE 2 - 100-YEAR ROADWAY RATING SUMMARY

Roadway and Station	Watershed	Cross Section	Q₁₀₀ (cfs)	Maximum Flow Depth ft.
Firecrest Place Sta. 50+00 to 65+00	CPB	B1-B1	467	0.50
Husker Lane Sta. 50+00 to 60+00	CPB	B2.1-B2.1	467	0.55
Husker Lane @ Needmore Way	CP3	3-3	488	0.49
Needmore Way Sta. 62+70 to 68+30	CP3	Roadway profile	488	0.82
Needmore Way Sta. 62+70 to 68+30	CP3	2-2	488	0.76
Needmore Way Sta. 51+35 to 57+07	CP2	Roadway profile	660	1.01
Sooner Lane 41+50 To Firecrest 55+00	CPB	B2-B2	467	0.48
Sooner Lane Sta. 35+50 to 41+50	CPB	Roadway profile	467	1.00
Sooner Lane Sta. 35+50 to 41+50	CPB	B3-B3	467	0.90
Sooner Lane Sta. 28+50 to 32+50	CPB2	Roadway profile	50	0.37
Synge Way	CP3	3-3	488	0.49
Michelob Lane Sta. 37+00 to 45+00	CPC &CPD	Roadway profile	777	0.69
Section 1-1	CP1	1-1	665	0.69
Section C1-C1	CPC &CPD	C1-C1	777	0.55

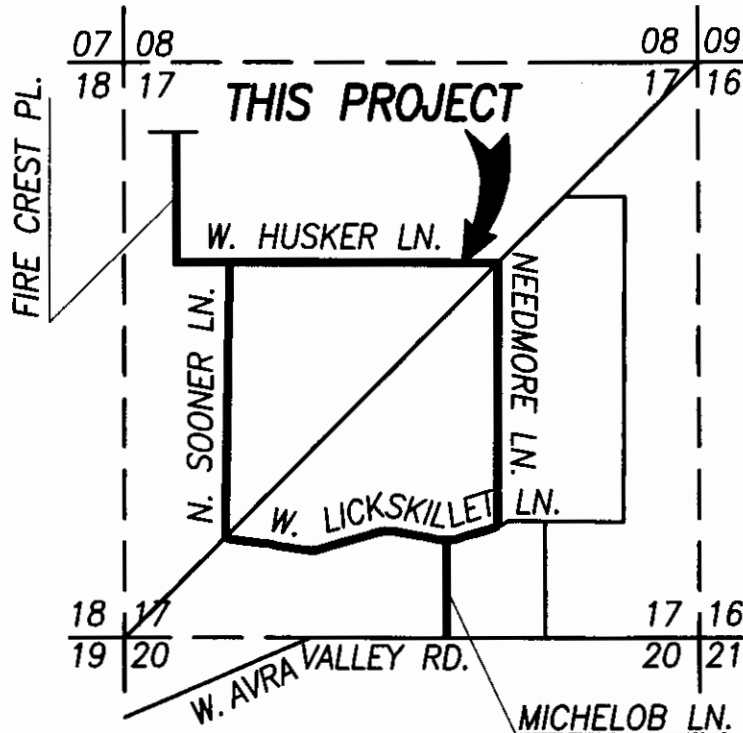
Exhibit 5 has been developed to show plan and profile plans for the roadways and are bound separately from this report. Proposed scour protection, roadway double chip seal and shoulders per the associated Pima County consent agreement for this project are all complied with in the stand alone Exhibit 5.

6.0 SUMMARY

The eastern most portion of the property is currently mapped by FEMA as Special Flood Hazard Area as demonstrated on FIRM Panel 965K, effective February 8, 1999. The remaining property is impacted by sheet flow runoff from the west. The calculated maximum onsite sheet flow depth varies between about 0.5 and 1.0 feet. The east portion of the property is located within a Federal Flood Hazard Area that is designated at 1.0 to 2.0 feet of depth, Zones A0-1 and A02.

The roadway drainage improvement requirements for a project of this type, assuming a public roadway "Local Streets" are: *as required to provide all weather access for 100-year flows greater than 100cfs. If this requirement is not met for any reason, then an obvious disclosure must be made on the final plat stating that all weather access is not provided to all lots.* Required road association agreements to this effect will be executed in addition to disclosing that all roadways are private and Pima County will not be responsible for maintenance of the subject roadways.

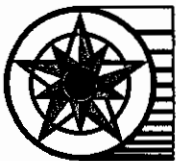
EXHIBIT 1
LOCATION MAP



SITE LOCATION MAP

SCALE: 3" = 1 MILE

A PORTION OF THE SECTION 17, T-12-S, R-10-E
 GILA AND SALT RIVER BASE AND MERIDIAN, PIMA COUNTY, ARIZONA



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Drawing Title

LOCATION MAP

Project Name

SILVERBELL TRAILS DRAINAGE STUDY

Job Number

03035

Drawing Number

EXHIBIT

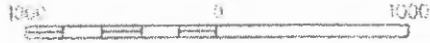
1

EXHIBIT 2

FIRM MAP



APPROXIMATE SCALE IN FEET



ZONE

N. FIRECREST PL.

THIS PROJECT

ZONE AO (DEPTH 1)

ONE X



W. HUSKER LN.

17

N. SOONER LN.

N. NEEDMORE WY.

W. LICKSKILLET LN.

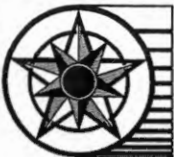
MICHELOB LN.

AVRA VALLEY PI

AVRA VALLEY ROAD

ZONE 20 AO (DEPTH 2)

JOINS PANEL 15/5



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Drawing Title

FIRM MAP
MAP NO. 04019C0965 K

Project Name

SILVERBELL TRAILS

Job Number

03035

Drawing Number

EXHIBIT

2

EXHIBIT 3

REGIONAL DRAINAGE AREAS



EXHIBIT 4

AERIAL PHOTO AND FLOODPLAIN RATINGS

EXHIBIT 5

ROADWAY DRAINAGE EXHIBIT (BOUND
SEPARATELY)



APPENDIX A

HYDROLOGY

PROJECT NAME AND LOCATION: SILVERBELL

DRAINAGE CONCENTRATION POINT: B

WATERSHED AREA (A): 327.00 acres

LENGTH OF WATERCOURSE (Lc): 13000. ft

LENGTH TO CENTER OF GRAVITY (Lca): 5200. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft INCREMENTAL CHANGE IN ELEV (Hi) - ft

13000. 180.0

MEAN SLOPE (Sc): .0138 ft BASIN FACTOR (Nb): .0500

WATERSHED TYPE(S): VALLEY-sheetflow

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.21	1.59	1.85	2.17	2.47	2.77
P 2	1.33	1.77	2.06	2.44	2.78	3.12
P 3	1.40	1.88	2.20	2.61	2.99	3.35
P 6	1.55	2.10	2.47	2.94	3.38	3.80
P24	1.85	2.57	3.06	3.68	4.24	4.80

SOIL GROUPS

100. % B, CN= 82, COVER TYPE= DESERT BRUSH , COVER DENSITY= 30 %
IMPERVIOUS COVER= 1. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.123	.263	.344	.431	.496	.549
Tc (FUNCTION OF i) :	171.39	126.74	113.80	103.94	98.25	94.34
SOLUTION OF Tc (MINUTES):	267	141	109	87	74	65
RAINFL INT. @ Tc (IN/HR):	.331	.769	1.113	1.581	2.063	2.580
RUNOFF RATE @ Tc (IN/HR):	.041	.202	.382	.682	1.024	1.417
PEAK DISCHARGE (CFS) :	13.	67.	126.	225.	337.	467.

PROJECT NAME AND LOCATION: SILVERBELL

DRAINAGE CONCENTRATION POINT: B2

WATERSHED AREA (A): 16.50 acres

LENGTH OF WATERCOURSE (Lc): 1920. ft

LENGTH TO CENTER OF GRAVITY (Lca): 960. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft INCREMENTAL CHANGE IN ELEV (Hi) - ft

1920. 16.0

MEAN SLOPE (Sc): .0083 ft BASIN FACTOR (Nb): .0500

WATERSHED TYPE(S): VALLEY-sheetflow

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.21	1.59	1.85	2.17	2.47	2.77
P 2	1.33	1.77	2.06	2.44	2.78	3.12
P 3	1.40	1.88	2.20	2.61	2.99	3.35
P 6	1.55	2.10	2.47	2.94	3.38	3.80
P24	1.85	2.57	3.06	3.68	4.24	4.80

SOIL GROUPS

100. % B, CN= 82, COVER TYPE= DESERT BRUSH , COVER DENSITY= 30 %

IMPERVIOUS COVER= 1. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.123	.263	.344	.431	.496	.549
Tc (FUNCTION OF i) :	71.27	52.70	47.32	43.22	40.85	39.23
SOLUTION OF Tc (MINUTES):	70	39	31	26	22	20
RAINFL INT. @ Tc (IN/HR):	1.056	2.135	2.846	3.719	4.673	5.503
RUNOFF RATE @ Tc (IN/HR):	.130	.561	.978	1.603	2.318	3.023
PEAK DISCHARGE (CFS) :	2.17	9.32	16.27	26.66	38.56	50.27

PROJECT NAME AND LOCATION: SILVERBELL

DRAINAGE CONCENTRATION POINT: C

WATERSHED AREA (A): 455.00 acres

LENGTH OF WATERCOURSE (Lc): 15500. ft

LENGTH TO CENTER OF GRAVITY (Lca): 8000. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft INCREMENTAL CHANGE IN ELEV (Hi) - ft

15500.

200.0

MEAN SLOPE (Sc): .0129 ft BASIN FACTOR (Nb): .0500

WATERSHED TYPE(S): VALLEY-sheetflow

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.21	1.59	1.85	2.17	2.47	2.77
P 2	1.33	1.77	2.06	2.44	2.78	3.12
P 3	1.40	1.88	2.20	2.61	2.99	3.35
P 6	1.55	2.10	2.47	2.94	3.38	3.80
P24	1.85	2.57	3.06	3.68	4.24	4.80

SOIL GROUPS

100. % B, CN= 82, COVER TYPE= DESERT BRUSH , COVER DENSITY= 30 %

IMPERVIOUS COVER= 1. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.123	.263	.344	.431	.496	.549
Tc (FUNCTION OF i) :	211.49	156.39	140.42	128.25	121.24	116.41
SOLUTION OF Tc (MINUTES):	366	193	150	118	101	89
RAINFL INT. @ Tc (IN/HR):	.254	.590	.853	1.235	1.594	1.979
RUNOFF RATE @ Tc (IN/HR):	.031	.155	.293	.532	.791	1.087
PEAK DISCHARGE (CFS) :	14.	71.	134.	244.	363.	499.

PROJECT NAME AND LOCATION: SILVERBELL

DRAINAGE CONCENTRATION POINT: D

WATERSHED AREA (A): 180.00 acres

LENGTH OF WATERCOURSE (Lc): 10000. ft

LENGTH TO CENTER OF GRAVITY (Lca): 5000. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft INCREMENTAL CHANGE IN ELEV (Hi) - ft

10000.

130.0

MEAN SLOPE (Sc): .0130 ft BASIN FACTOR (Nb): .0500

WATERSHED TYPE(S): VALLEY-sheetflow

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.21	1.59	1.85	2.17	2.47	2.77
P 2	1.33	1.77	2.06	2.44	2.78	3.12
P 3	1.40	1.88	2.20	2.61	2.99	3.35
P 6	1.55	2.10	2.47	2.94	3.38	3.80
P24	1.85	2.57	3.06	3.68	4.24	4.80

SOIL GROUPS

100. % B, CN= 82, COVER TYPE= DESERT BRUSH , COVER DENSITY= 30 %

IMPERVIOUS COVER= 1. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.123	.263	.344	.431	.496	.549
Tc (FUNCTION OF i) :	160.57	118.74	106.61	97.37	92.05	88.38
SOLUTION OF Tc (MINUTES):	241	128	99	78	67	59
RAINFL INT. @ Tc (IN/HR):	.362	.835	1.204	1.733	2.246	2.793
RUNOFF RATE @ Tc (IN/HR):	.045	.219	.414	.747	1.114	1.534
PEAK DISCHARGE (CFS) :	8.11	39.80	75.06	135.59	202.21	278.35

PROJECT NAME AND LOCATION: SILVERBELL

DRAINAGE CONCENTRATION POINT: 1

WATERSHED AREA (A): 672.00 acres

LENGTH OF WATERCOURSE (Lc): 17550. ft

LENGTH TO CENTER OF GRAVITY (Lca): 9000. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft INCREMENTAL CHANGE IN ELEV (Hi) - ft

17550.

216.0

MEAN SLOPE (Sc): .0123 ft BASIN FACTOR (Nb): .0500

WATERSHED TYPE(S): VALLEY-sheetflow

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.21	1.59	1.85	2.17	2.47	2.77
P 2	1.33	1.77	2.06	2.44	2.78	3.12
P 3	1.40	1.88	2.20	2.61	2.99	3.35
P 6	1.55	2.10	2.47	2.94	3.38	3.80
P24	1.85	2.57	3.06	3.68	4.24	4.80

SOIL GROUPS

100. % B, CN= 82, COVER TYPE= DESERT BRUSH , COVER DENSITY= 30 %

IMPERVIOUS COVER= 1. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.123	.263	.344	.431	.496	.549
Tc (FUNCTION OF i) :	231.76	171.38	153.87	140.54	132.86	127.56
SOLUTION OF Tc (MINUTES):	423	223	172	135	115	101
RAINFL INT. @ Tc (IN/HR):	.222	.521	.762	1.103	1.437	1.786
RUNOFF RATE @ Tc (IN/HR):	.027	.137	.262	.475	.713	.981
PEAK DISCHARGE (CFS) :	19.	93.	177.	322.	483.	665.

PROJECT NAME AND LOCATION: SILVERBELL

DRAINAGE CONCENTRATION POINT: 2

WATERSHED AREA (A): 689.00 acres

LENGTH OF WATERCOURSE (Lc): 18250. ft

LENGTH TO CENTER OF GRAVITY (Lca): 9125. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft INCREMENTAL CHANGE IN ELEV (Hi) - ft

18250.

220.0

MEAN SLOPE (Sc): .0121 ft BASIN FACTOR (Nb): .0500

WATERSHED TYPE(S): VALLEY-sheetflow

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.21	1.59	1.85	2.17	2.47	2.77
P 2	1.33	1.77	2.06	2.44	2.78	3.12
P 3	1.40	1.88	2.20	2.61	2.99	3.35
P 6	1.55	2.10	2.47	2.94	3.38	3.80
P24	1.85	2.57	3.06	3.68	4.24	4.80

SOIL GROUPS

100. % B, CN= 82, COVER TYPE= DESERT BRUSH , COVER DENSITY= 30 %

IMPERVIOUS COVER= 1. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.123	.263	.344	.431	.496	.549
Tc (FUNCTION OF i) :	237.43	175.57	157.64	143.98	136.11	130.68
SOLUTION OF Tc (MINUTES):	440	231	178	140	119	105
RAINFL INT. @ Tc (IN/HR):	.214	.505	.741	1.070	1.399	1.731
RUNOFF RATE @ Tc (IN/HR):	.026	.133	.255	.461	.694	.951
PEAK DISCHARGE (CFS) :	18.	92.	177.	320.	482.	660.

PROJECT NAME AND LOCATION: SILVERBELL

DRAINAGE CONCENTRATION POINT: 3

WATERSHED AREA (A): 386.00 acres

LENGTH OF WATERCOURSE (Lc): 15000. ft

LENGTH TO CENTER OF GRAVITY (Lca): 5800. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft INCREMENTAL CHANGE IN ELEV (Hi) - ft

13300. 180.0
 2000. 22.0

MEAN SLOPE (Sc): .0132 ft BASIN FACTOR (Nb): .0500

WATERSHED TYPE(S): VALLEY-sheetflow

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.21	1.59	1.85	2.17	2.47	2.77
P 2	1.33	1.77	2.06	2.44	2.78	3.12
P 3	1.40	1.88	2.20	2.61	2.99	3.35
P 6	1.55	2.10	2.47	2.94	3.38	3.80
P24	1.85	2.57	3.06	3.68	4.24	4.80

SOIL GROUPS

100. % B, CN= 82, COVER TYPE= DESERT BRUSH , COVER DENSITY= 30 %
 IMPERVIOUS COVER= 1. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.123	.263	.344	.431	.496	.549
Tc (FUNCTION OF i) :	188.69	139.53	125.28	114.43	108.17	103.86
SOLUTION OF Tc (MINUTES):	308	163	126	100	85	75
RAINFL INT. @ Tc (IN/HR):	.294	.681	.988	1.410	1.836	2.283
RUNOFF RATE @ Tc (IN/HR):	.036	.179	.340	.608	.911	1.254
PEAK DISCHARGE (CFS) :	14.	70.	132.	236.	354.	488.

APPENDIX B

EXISTING CULVERT RATINGS

Culvert Design Data
Silverbell Trails

Delph Engineering Inc. / xxxxxxxxxxxxxxxxxxxxxx
8/30/2003

Alignment: Husker Ln.

Culvert No.	Road Elevation	Station	Pipe Type/Size	Length (ft)	U/S Invert (ft)	D/S Invert (ft)	Qcap (cfs)
1	2016.45	50+15	(2) 24" CMP'S	40	2014.36	2014.15	21.80
2	2014.44	53+42	(2) 18" CMP'S	40	2013.07	2012.60	8.90
3	2011.95	57+38	(2) 18" CMP'S	40	2010.57	2010.35	8.50
4	2001.49	69+87	(2) 18" CMP'S	40	2000.38	1999.76	5.90
5	1999.48	73+58	(1) 18" CMP	40	1998.07	1997.74	4.6
23	17	50+79	(1) 18" CMP	40	15.00	14.50	7.63

Alignment: Needmore Wy.

Culvert No.	Road Elevation	Station	Pipe Type/Size	Length (ft)	U/S Invert (ft)	D/S Invert (ft)	Qcap (cfs)
6	1998.89	75+53	(3) 24" CMP'S	40	1996.87	1995.25	30.3
7	1998.44	75+40	(1) 18" CMP	40	1996.55	1996.00	7.25
8	2001.29	66+19	(1) 24" CMP	40	1999.44	1999.04	9.35
9	2001.84	62+71	(1) 18" CMP	40	2000.37	1999.99	4.95
10	2002.62	60+73	(1) 18" CMP	40	2001.2	2000.80	4.7
11	2005.12	54+56	(1) 18" CMP	40	2003.8	2003.63	3.85
12	2007.03	51+55	(2) 24" CMP	40	2004.91	2004.48	23.2

Alignment: Michelob Ln.

Culvert No.	Road Elevation	Station	Pipe Type/Size	Length (ft)	U/S Invert (ft)	D/S Invert (ft)	Qcap (cfs)
13	2009.84	44+37	(1) 18" CMP	40	2007.98	2007.47	7.05
14	2009.55	40+32	(1) 18" CMP	40	2007.8	2007.56	6

Alignment: Lickskillet Ln.

Culvert No.	Road Elevation	Station	Pipe Type/Size	Length (ft)	U/S Invert (ft)	D/S Invert (ft)	Qcap (cfs)
15	2014.32	38+37	(1) 18" CMP	40	2012.32	2012.6	5.22

Alignment: Sooner Ln.

Culvert No.	Road Elevation	Station	Pipe Type/Size	Length (ft)	U/S Invert (ft)	D/S Invert (ft)	Qcap (cfs)
16	2023.67	24+53	(1) 24" CMP	40	2021.95	2021.43	8.1
17	2023.48	30+59	(1) 18" CMP	40	2021.49	2021.24	6.85
18	2020.47	38+17	(2) 18" CMP	40	2018.5	2018.18	14.05
19	2020.02	39+54	(2) 18" CMP	40	2018.16	2017.39	14.06
20	2019.79	40+29	(1) 18" CMP	40	2017.99	2017.78	6.15
21	2019.72	40+62	(1) 18" CMP	40	2017.7	2017.34	7.27
22	2018.19	45+30	(2) 18" CMP	40	2016.69	2016.51	9.5

Culvert Analysis Report

CULVERT 1: Husker In. West Sta. 50+15

Analysis Component			
Storm Event	Design	Discharge	21.80 cfs
Peak Discharge Method: User-Specified			
Design Discharge	21.80 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	2,015.15 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	2-24 inch Circular	21.80 cfs	2,016.45 ft	5.63 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report

CULVERT 1: Husker In. West Sta. 50+15

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,016.45 ft	Discharge	21.80 cfs
Inlet Control HW Elev	2,016.29 ft	Tailwater Elevation	2,015.15 ft
Outlet Control HW Elev	2,016.45 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.05		

Grades			
Upstream Invert	2,014.36 ft	Downstream Invert	2,014.15 ft
Length	40.00 ft	Constructed Slope	0.005250 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.18 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.18 ft
Velocity Downstream	5.63 ft/s	Critical Slope	0.018278 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev	2,016.45 ft	Upstream Velocity Head	0.25 ft
Ke	0.90	Entrance Loss	0.22 ft

Inlet Control Properties			
Inlet Control HW Elev	2,016.29 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	6.3 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
CULVERT 2: Husker In. East Sta. 53+42

Analysis Component			
Storm Event	Design	Discharge	8.90 cfs
Peak Discharge Method: User-Specified			
Design Discharge	8.90 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	2,013.35 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	2-18 inch Circular	8.90 cfs	2,014.44 ft	4.58 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report

CULVERT 2: Husker In. East Sta. 53+42

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,014.44 ft	Discharge	8.90 cfs
Inlet Control HW Elev	2,014.35 ft	Tailwater Elevation	2,013.35 ft
Outlet Control HW Elev	2,014.44 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.91		

Grades			
Upstream Invert	2,013.07 ft	Downstream Invert	2,012.60 ft
Length	40.00 ft	Constructed Slope	0.011750 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.81 ft
Slope Type	Mild	Normal Depth	0.94 ft
Flow Regime	Subcritical	Critical Depth	0.81 ft
Velocity Downstream	4.58 ft/s	Critical Slope	0.018986 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev	2,014.44 ft	Upstream Velocity Head	0.22 ft
Ke	0.90	Entrance Loss	0.20 ft

Inlet Control Properties			
Inlet Control HW Elev	2,014.35 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	3.5 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

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Culvert Analysis Report

CULVERT 3: Husker Ln. East Sta. 57+38

Analysis Component			
Storm Event	Design	Discharge	8.50 cfs
Peak Discharge Method: User-Specified			
Design Discharge	8.50 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	2,011.10 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	2-18 inch Circular	8.50 cfs	2,011.95 ft	4.50 ft/s
Weir	Not Considered	N/A	N/A	N/A

R-1

Culvert Analysis Report

CULVERT 3: Husker Ln. East Sta. 57+38

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,011.95 ft	Discharge	8.50 cfs
Inlet Control HW Elev	2,011.81 ft	Tailwater Elevation	2,011.10 ft
Outlet Control HW Elev	2,011.95 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.92		
Grades			
Upstream Invert	2,010.57 ft	Downstream Invert	2,010.35 ft
Length	40.00 ft	Constructed Slope	0.005500 ft/ft
Hydraulic Profile			
Profile	M2	Depth, Downstream	0.79 ft
Slope Type	Mild	Normal Depth	1.24 ft
Flow Regime	Subcritical	Critical Depth	0.79 ft
Velocity Downstream	4.50 ft/s	Critical Slope	0.018723 ft/ft
Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	2		
Outlet Control Properties			
Outlet Control HW Elev	2,011.95 ft	Upstream Velocity Head	0.15 ft
Ke	0.90	Entrance Loss	0.13 ft
Inlet Control Properties			
Inlet Control HW Elev	2,011.81 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	3.5 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report

CULVERT 4: Husker Ln. East Sta. 69+87

Analysis Component			
Storm Event	Design	Discharge	5.90 cfs
Peak Discharge Method: User-Specified			
Design Discharge	5.90 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	2,000.51 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	2-18 inch Circular	5.90 cfs	2,001.49 ft	3.34 ft/s
Weir	Not Considered	N/A	N/A	N/A

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Culvert Analysis Report

CULVERT 4: Husker Ln. East Sta. 69+87

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,001.49 ft	Discharge	5.90 cfs
Inlet Control HW Elev	2,001.35 ft	Tailwater Elevation	2,000.51 ft
Outlet Control HW Elev	2,001.49 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.74		

Grades			
Upstream Invert	2,000.38 ft	Downstream Invert	1,999.76 ft
Length	40.00 ft	Constructed Slope	0.015500 ft/ft

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.75 ft
Slope Type	Mild	Normal Depth	0.67 ft
Flow Regime	Subcritical	Critical Depth	0.65 ft
Velocity Downstream	3.34 ft/s	Critical Slope	0.017424 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev	2,001.49 ft	Upstream Velocity Head	0.23 ft
Ke	0.90	Entrance Loss	0.20 ft

Inlet Control Properties			
Inlet Control HW Elev	2,001.35 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	3.5 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report

CULVERT 5: Husker Ln. East Sta. 73+58

Analysis Component			
Storm Event	Design	Discharge	4.60 cfs
Peak Discharge Method: User-Specified			
Design Discharge	4.60 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	1,998.49 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	4.60 cfs	1,999.48 ft	4.63 ft/s
Weir	Not Considered	N/A	N/A	N/A

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Culvert Analysis Report

CULVERT 5: Husker Ln. East Sta. 73+58

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	1,999.48 ft	Discharge	4.60 cfs
Inlet Control HW Elev	1,999.38 ft	Tailwater Elevation	1,998.49 ft
Outlet Control HW Elev	1,999.48 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.94		
Grades			
Upstream Invert	1,998.07 ft	Downstream Invert	1,997.74 ft
Length	40.00 ft	Constructed Slope	0.008250 ft/ft
Hydraulic Profile			
Profile	M2	Depth, Downstream	0.82 ft
Slope Type	Mild	Normal Depth	1.10 ft
Flow Regime	Subcritical	Critical Depth	0.82 ft
Velocity Downstream	4.63 ft/s	Critical Slope	0.019153 ft/ft
Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		
Outlet Control Properties			
Outlet Control HW Elev	1,999.48 ft	Upstream Velocity Head	0.18 ft
Ke	0.90	Entrance Loss	0.16 ft
Inlet Control Properties			
Inlet Control HW Elev	1,999.38 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.8 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

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Culvert Analysis Report

CULVERT 6: Needmore Wy Sta. 75+53

Analysis Component			
Storm Event	Design	Discharge	30.30 cfs
Peak Discharge Method: User-Specified			
Design Discharge	30.30 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	1,996.25 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	3-24 inch Circular	30.30 cfs	1,998.89 ft	7.46 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report

CULVERT 6: Needmore Wy Sta. 75+53

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	1,998.89 ft	Discharge	30.30 cfs
Inlet Control HW Elev.	1,998.67 ft	Tailwater Elevation	1,996.25 ft
Outlet Control HW Elev	1,998.89 ft	Control Type	Entrance Control
Headwater Depth/ Height	1.01		

Grades			
Upstream Invert	1,996.87 ft	Downstream Invert	1,995.25 ft
Length	40.00 ft	Constructed Slope	0.040500 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.89 ft
Slope Type	Steep	Normal Depth	0.89 ft
Flow Regime	Supercritical	Critical Depth	1.14 ft
Velocity Downstream	7.46 ft/s	Critical Slope	0.017786 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	3		

Outlet Control Properties			
Outlet Control HW Elev	1,998.89 ft	Upstream Velocity Head	0.47 ft
Ke	0.90	Entrance Loss	0.42 ft

Inlet Control Properties			
Inlet Control HW Elev	1,998.67 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	9.4 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
CULVERT 7: Needmore Wy Sta. 75+40

Analysis Component			
Storm Event	Design	Discharge	7.25 cfs
Peak Discharge Method: User-Specified			
Design Discharge	7.25 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	1,996.75 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	7.25 cfs	1,998.44 ft	5.53 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report

CULVERT 7: Needmore Wy Sta. 75+40

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	1,998.44 ft	Discharge	7.25 cfs
Inlet Control HW Elev	1,998.37 ft	Tailwater Elevation	1,996.75 ft
Outlet Control HW Elev	1,998.44 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.26		

Grades			
Upstream Invert	1,996.55 ft	Downstream Invert	1,996.00 ft
Length	40.00 ft	Constructed Slope	0.013750 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.04 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.04 ft
Velocity Downstream	5.53 ft/s	Critical Slope	0.023580 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	1,998.44 ft	Upstream Velocity Head	0.30 ft
Ke	0.90	Entrance Loss	0.27 ft

Inlet Control Properties			
Inlet Control HW Elev	1,998.37 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.8 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report

CULVERT 8: Needmore Wy Sta. 66+19

Analysis Component			
Storm Event	Design	Discharge	9.35 cfs
Peak Discharge Method: User-Specified			
Design Discharge	9.35 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	2,000.04 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	9.35 cfs	2,001.29 ft	5.33 ft/s
Weir	Not Considered	N/A	N/A	N/A

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Culvert Analysis Report

CULVERT 8: Needmore Wy Sta. 66+19

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,001.29 ft	Discharge	9.35 cfs
Inlet Control HW Elev	2,001.17 ft	Tailwater Elevation	2,000.04 ft
Outlet Control HW Elev	2,001.29 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.93		

Grades			
Upstream Invert	1,999.44 ft	Downstream Invert	1,999.04 ft
Length	40.00 ft	Constructed Slope	0.010000 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.09 ft
Slope Type	Mild	Normal Depth	1.31 ft
Flow Regime	Subcritical	Critical Depth	1.09 ft
Velocity Downstream	5.33 ft/s	Critical Slope	0.017357 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	2,001.29 ft	Upstream Velocity Head	0.29 ft
Ke	0.90	Entrance Loss	0.26 ft

Inlet Control Properties			
Inlet Control HW Elev	2,001.17 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	3.1 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

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Culvert Analysis Report

CULVERT 9: Needmore Wy Sta. 62+71

Analysis Component			
Storm Event	Design	Discharge	4.95 cfs
Peak Discharge Method: User-Specified			
Design Discharge	4.95 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	2,000.74 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	4.95 cfs	2,001.84 ft	4.75 ft/s
Weir	Not Considered	N/A	N/A	N/A

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Culvert Analysis Report

CULVERT 9: Needmore Wy Sta. 62+71

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,001.84 ft	Discharge	4.95 cfs
Inlet Control HW Elev	2,001.75 ft	Tailwater Elevation	2,000.74 ft
Outlet Control HW Elev	2,001.84 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.98		

Grades			
Upstream Invert	2,000.37 ft	Downstream Invert	1,999.99 ft
Length	40.00 ft	Constructed Slope	0.009500 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.86 ft
Slope Type	Mild	Normal Depth	1.10 ft
Flow Regime	Subcritical	Critical Depth	0.86 ft
Velocity Downstream	4.75 ft/s	Critical Slope	0.019626 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	2,001.84 ft	Upstream Velocity Head	0.20 ft
Ke	0.90	Entrance Loss	0.18 ft

Inlet Control Properties			
Inlet Control HW Elev	2,001.75 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.8 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report

CULVERT 10: Needmore Wy Sta. 60+73

Analysis Component			
Storm Event	Design	Discharge	4.70 cfs
Peak Discharge Method: User-Specified			
Design Discharge	4.70 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	2,001.55 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	4.70 cfs	2,002.62 ft	4.66 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report

CULVERT 10: Needmore Wy Sta. 60+73

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,002.62 ft	Discharge	4.70 cfs
Inlet Control HW Elev	2,002.53 ft	Tailwater Elevation	2,001.55 ft
Outlet Control HW Elev	2,002.62 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.95		
Grades			
Upstream Invert	2,001.20 ft	Downstream Invert	2,000.80 ft
Length	40.00 ft	Constructed Slope	0.010000 ft/ft
Hydraulic Profile			
Profile	M2	Depth, Downstream	0.83 ft
Slope Type	Mild	Normal Depth	1.04 ft
Flow Regime	Subcritical	Critical Depth	0.83 ft
Velocity Downstream	4.66 ft/s	Critical Slope	0.019274 ft/ft
Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		
Outlet Control Properties			
Outlet Control HW Elev	2,002.62 ft	Upstream Velocity Head	0.21 ft
Ke	0.90	Entrance Loss	0.18 ft
Inlet Control Properties			
Inlet Control HW Elev	2,002.53 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.8 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

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Culvert Analysis Report

CULVERT 11: Needmore Wy Sta. 54+56

Analysis Component			
Storm Event	Design	Discharge	3.85 cfs
Peak Discharge Method: User-Specified			
Design Discharge	3.85 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	2,004.38 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	3.85 cfs	2,005.12 ft	4.35 ft/s
Weir	Not Considered	N/A	N/A	N/A

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Culvert Analysis Report

CULVERT 11: Needmore Wy Sta. 54+56

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,005.12 ft	Discharge	3.85 cfs
Inlet Control HW Elev	2,004.96 ft	Tailwater Elevation	2,004.38 ft
Outlet Control HW Elev	2,005.12 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.88		

Grades			
Upstream Invert	2,003.80 ft	Downstream Invert	2,003.63 ft
Length	40.00 ft	Constructed Slope	0.004250 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.75 ft
Slope Type	Mild	Normal Depth	1.29 ft
Flow Regime	Subcritical	Critical Depth	0.75 ft
Velocity Downstream	4.35 ft/s	Critical Slope	0.018285 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	2,005.12 ft	Upstream Velocity Head	0.12 ft
Ke	0.90	Entrance Loss	0.11 ft

Inlet Control Properties			
Inlet Control HW Elev	2,004.96 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.8 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report

CULVERT 12: Needmore Wy Sta. 51+55

Analysis Component			
Storm Event	Design	Discharge	23.20 cfs
Peak Discharge Method: User-Specified			
Design Discharge	23.20 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	2,005.23 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	2-24 inch Circular	23.20 cfs	2,007.03 ft	5.76 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report

CULVERT 12: Needmore Wy Sta. 51+55

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,007.03 ft	Discharge	23.20 cfs
Inlet Control HW Elev	2,006.93 ft	Tailwater Elevation	2,005.23 ft
Outlet Control HW Elev	2,007.03 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.06		

Grades			
Upstream Invert	2,004.91 ft	Downstream Invert	2,004.48 ft
Length	40.00 ft	Constructed Slope	0.010750 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.22 ft
Slope Type	Mild	Normal Depth	1.50 ft
Flow Regime	Subcritical	Critical Depth	1.22 ft
Velocity Downstream	5.76 ft/s	Critical Slope	0.018745 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev	2,007.03 ft	Upstream Velocity Head	0.34 ft
Ke	0.90	Entrance Loss	0.31 ft

Inlet Control Properties			
Inlet Control HW Elev	2,006.93 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	6.3 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
CULVERT 13: Michelob Ln. Sta. 44+37

Analysis Component			
Storm Event	Design	Discharge	7.05 cfs
Peak Discharge Method: User-Specified			
Design Discharge	7.05 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	2,008.22 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	7.05 cfs	2,009.84 ft	5.46 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report

CULVERT 13: Michelob Ln. Sta. 44+37

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,009.84 ft	Discharge	7.05 cfs
Inlet Control HW Elev	2,009.76 ft	Tailwater Elevation	2,008.22 ft
Outlet Control HW Elev	2,009.84 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.24		

Grades			
Upstream Invert	2,007.98 ft	Downstream Invert	2,007.47 ft
Length	40.00 ft	Constructed Slope	0.012750 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.03 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.03 ft
Velocity Downstream	5.46 ft/s	Critical Slope	0.023139 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	2,009.84 ft	Upstream Velocity Head	0.29 ft
Ke	0.90	Entrance Loss	0.26 ft

Inlet Control Properties			
Inlet Control HW Elev	2,009.76 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.8 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report

CULVERT 14: Michelob Ln. Sta. 40+32

Analysis Component			
Storm Event	Design	Discharge	6.00 cfs
Peak Discharge Method: User-Specified			
Design Discharge	6.00 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	2,008.31 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	6.00 cfs	2,009.55 ft	5.11 ft/s
Weir	Not Considered	N/A	N/A	N/A

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Culvert Analysis Report

CULVERT 14: Michelob Ln. Sta. 40+32

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,009.55 ft	Discharge	6.00 cfs
Inlet Control HW Elev	2,009.38 ft	Tailwater Elevation	2,008.31 ft
Outlet Control HW Elev	2,009.55 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.16		

Grades			
Upstream Invert	2,007.80 ft	Downstream Invert	2,007.56 ft
Length	40.00 ft	Constructed Slope	0.006000 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.95 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	0.95 ft
Velocity Downstream	5.11 ft/s	Critical Slope	0.021193 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	2,009.55 ft	Upstream Velocity Head	0.19 ft
Ke	0.90	Entrance Loss	0.17 ft

Inlet Control Properties			
Inlet Control HW Elev	2,009.38 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.8 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
CULVERT 15: Lickskillet Ln. Sta. 38+37

Analysis Component				
Storm Event	Design	Discharge	5.22 cfs	

Peak Discharge Method: User-Specified				
Design Discharge	5.22 cfs	Check Discharge	0.00 cfs	

Tailwater Conditions: Constant Tailwater				
Tailwater Elevation	2,013.35 ft			

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	5.22 cfs	2,014.32 ft	4.85 ft/s
Weir	Not Considered	N/A	N/A	N/A

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Culvert Analysis Report

CULVERT 15: Lickskillet Ln. Sta. 38+37

Component: Culvert-1

Culvert Summary

Computed Headwater Elevation	2,014.32 ft	Discharge	5.22 cfs
Inlet Control HW Elev	2,014.04 ft	Tailwater Elevation	2,013.35 ft
Outlet Control HW Elev	2,014.32 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.33		

Grades

Upstream Invert	2,012.32 ft	Downstream Invert	2,012.60 ft
Length	40.00 ft	Constructed Slope	-0.007000 ft/ft

Hydraulic Profile

Profile	Composite A2 Pressure	Depth, Downstream	0.88 ft
Slope Type	Adverse	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	0.88 ft
Velocity Downstream	4.85 ft/s	Critical Slope	0.020004 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev	2,014.32 ft	Upstream Velocity Head	0.14 ft
Ke	0.90	Entrance Loss	0.12 ft

Inlet Control Properties

Inlet Control HW Elev	2,014.04 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.8 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

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Culvert Analysis Report

CULVERT 16: Sooner Ln. Sta. 24+53

Analysis Component				
Storm Event	Design	Discharge	8.10 cfs	
Peak Discharge Method: User-Specified				
Design Discharge	8.10 cfs	Check Discharge	0.00 cfs	
Tailwater Conditions: Constant Tailwater				
Tailwater Elevation	2,022.43 ft			

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	8.10 cfs	2,023.67 ft	5.07 ft/s
Weir	Not Considered	N/A	N/A	N/A

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Culvert Analysis Report

CULVERT 16: Sooner Ln. Sta. 24+53

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,023.67 ft	Discharge	8.10 cfs
Inlet Control HW Elev	2,023.52 ft	Tailwater Elevation	2,022.43 ft
Outlet Control HW Elev	2,023.67 ft	Control Type	Outlet Control
Headwater Depth/ Height	0.86		
Grades			
Upstream Invert	2,021.95 ft	Downstream Invert	2,021.43 ft
Length	40.00 ft	Constructed Slope	0.013000 ft/ft
Hydraulic Profile			
Profile	M2	Depth, Downstream	1.01 ft
Slope Type	Mild	Normal Depth	1.09 ft
Flow Regime	Subcritical	Critical Depth	1.01 ft
Velocity Downstream	5.07 ft/s	Critical Slope	0.016703 ft/ft
Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		
Outlet Control Properties			
Outlet Control HW Elev	2,023.67 ft	Upstream Velocity Head	0.33 ft
Ke	0.90	Entrance Loss	0.30 ft
Inlet Control Properties			
Inlet Control HW Elev	2,023.52 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	3.1 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report

CULVERT 17: Sooner Ln. Sta. 30+59

Analysis Component				
Storm Event	Design	Discharge	6.85 cfs	
Peak Discharge Method: User-Specified				
Design Discharge	6.85 cfs	Check Discharge	0.00 cfs	
Tailwater Conditions: Constant Tailwater				
Tailwater Elevation	2,021.99 ft			

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	6.85 cfs	2,023.48 ft	5.39 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report

CULVERT 17: Sooner Ln. Sta. 30+59

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,023.48 ft	Discharge	6.85 cfs
Inlet Control HW Elev	2,023.24 ft	Tailwater Elevation	2,021.99 ft
Outlet Control HW Elev	2,023.48 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.33		
Grades			
Upstream Invert	2,021.49 ft	Downstream Invert	2,021.24 ft
Length	40.00 ft	Constructed Slope	0.006250 ft/ft
Hydraulic Profile			
Profile	CompositeM2Pressure	Depth, Downstream	1.01 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.01 ft
Velocity Downstream	5.39 ft/s	Critical Slope	0.022754 ft/ft
Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		
Outlet Control Properties			
Outlet Control HW Elev	2,023.48 ft	Upstream Velocity Head	0.23 ft
Ke	0.90	Entrance Loss	0.21 ft
Inlet Control Properties			
Inlet Control HW Elev	2,023.24 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.8 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report

CULVERT 18: Sooner Ln. Sta. 38+17

Analysis Component				
Storm Event	Design	Discharge	14.05 cfs	
Peak Discharge Method: User-Specified				
Design Discharge	14.05 cfs	Check Discharge	0.00 cfs	
Tailwater Conditions: Constant Tailwater				
Tailwater Elevation	2,018.93 ft			

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	2-18 inch Circular	14.05 cfs	2,020.47 ft	5.45 ft/s
Weir	Not Considered	N/A	N/A	N/A

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Culvert Analysis Report

CULVERT 18: Sooner Ln. Sta. 38+17

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,020.47 ft	Discharge	14.05 cfs
Inlet Control HW Elev	2,020.28 ft	Tailwater Elevation	2,018.93 ft
Outlet Control HW Elev	2,020.47 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.32		

Grades			
Upstream Invert	2,018.50 ft	Downstream Invert	2,018.18 ft
Length	40.00 ft	Constructed Slope	0.008000 ft/ft

Hydraulic Profile			
Profile	CompositeM2Pressure	Depth, Downstream	1.03 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.03 ft
Velocity Downstream	5.45 ft/s	Critical Slope	0.023105 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev	2,020.47 ft	Upstream Velocity Head	0.25 ft
Ke	0.90	Entrance Loss	0.22 ft

Inlet Control Properties			
Inlet Control HW Elev	2,020.28 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	3.5 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report

CULVERT 19: Sooner Ln. Sta. 39+54

Analysis Component			
Storm Event	Design	Discharge	14.06 cfs
Peak Discharge Method: User-Specified			
Design Discharge	14.06 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	2,018.14 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	2-18 inch Circular	14.06 cfs	2,020.02 ft	5.45 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report

CULVERT 19: Sooner Ln. Sta. 39+54

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,020.02 ft	Discharge	14.06 cfs
Inlet Control HW Elev	2,019.93 ft	Tailwater Elevation	2,018.14 ft
Outlet Control HW Elev	2,020.02 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.24		

Grades			
Upstream Invert	2,018.16 ft	Downstream Invert	2,017.39 ft
Length	40.00 ft	Constructed Slope	0.019250 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.03 ft
Slope Type	Mild	Normal Depth	1.10 ft
Flow Regime	Subcritical	Critical Depth	1.03 ft
Velocity Downstream	5.45 ft/s	Critical Slope	0.023115 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev	2,020.02 ft	Upstream Velocity Head	0.40 ft
Ke	0.90	Entrance Loss	0.36 ft

Inlet Control Properties			
Inlet Control HW Elev	2,019.93 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	3.5 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

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Culvert Analysis Report

CULVERT 20: Sooner Ln. Sta. 40+29

Analysis Component			
Storm Event	Design	Discharge	6.15 cfs
Peak Discharge Method: User-Specified			
Design Discharge	6.15 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	2,018.53 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	6.15 cfs	2,019.79 ft	5.16 ft/s
Weir	Not Considered	N/A	N/A	N/A

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Culvert Analysis Report

CULVERT 20: Sooner Ln. Sta. 40+29

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,019.79 ft	Discharge	6.15 cfs
Inlet Control HW Elev	2,019.60 ft	Tailwater Elevation	2,018.53 ft
Outlet Control HW Elev	2,019.79 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.20		
Grades			
Upstream Invert	2,017.99 ft	Downstream Invert	2,017.78 ft
Length	40.00 ft	Constructed Slope	0.005250 ft/ft
Hydraulic Profile			
Profile	M2	Depth, Downstream	0.96 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	0.96 ft
Velocity Downstream	5.16 ft/s	Critical Slope	0.021454 ft/ft
Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		
Outlet Control Properties			
Outlet Control HW Elev	2,019.79 ft	Upstream Velocity Head	0.19 ft
Ke	0.90	Entrance Loss	0.17 ft
Inlet Control Properties			
Inlet Control HW Elev	2,019.60 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.8 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

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Culvert Analysis Report

CULVERT 21: Sooner Ln. Sta. 40+62

Analysis Component				
Storm Event	Design	Discharge	7.27 cfs	
Peak Discharge Method: User-Specified				
Design Discharge	7.27 cfs	Check Discharge	0.00 cfs	
Tailwater Conditions: Constant Tailwater				
Tailwater Elevation	2,018.09 ft			

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	7.27 cfs	2,019.72 ft	5.53 ft/s
Weir	Not Considered	N/A	N/A	N/A

B-41

Culvert Analysis Report

CULVERT 21: Sooner Ln. Sta. 40+62

Component: Culvert-1

Culvert Summary			
Computed Headwater Elevation	2,019.72 ft	Discharge	7.27 cfs
Inlet Control HW Elev	2,019.53 ft	Tailwater Elevation	2,018.09 ft
Outlet Control HW Elev	2,019.72 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.35		
Grades			
Upstream Invert	2,017.70 ft	Downstream Invert	2,017.34 ft
Length	40.00 ft	Constructed Slope	0.009000 ft/ft
Hydraulic Profile			
Profile	CompositeM2Pressure	Depth, Downstream	1.04 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.04 ft
Velocity Downstream	5.53 ft/s	Critical Slope	0.023623 ft/ft
Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		
Outlet Control Properties			
Outlet Control HW Elev	2,019.72 ft	Upstream Velocity Head	0.26 ft
Ke	0.90	Entrance Loss	0.24 ft
Inlet Control Properties			
Inlet Control HW Elev	2,019.53 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.8 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report

CULVERT 22: Sooner Ln. Sta. 45+30

Analysis Component				
Storm Event	Design	Discharge	9.50 cfs	
Peak Discharge Method: User-Specified				
Design Discharge	9.50 cfs	Check Discharge	0.00 cfs	
Tailwater Conditions: Constant Tailwater				
Tailwater Elevation	2,017.26 ft			

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	2-18 inch Circular	9.50 cfs	2,018.19 ft	4.68 ft/s
Weir	Not Considered	N/A	N/A	N/A

R-42

Culvert Analysis Report

CULVERT 22: Sooner Ln. Sta. 45+30

Component: Culvert-1

Culvert Summary

Computed Headwater Elevation	2,018.19 ft	Discharge	9.50 cfs
Inlet Control HW Elev	2,018.03 ft	Tailwater Elevation	2,017.26 ft
Outlet Control HW Elev	2,018.19 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.00		

Grades

Upstream Invert	2,016.69 ft	Downstream Invert	2,016.51 ft
Length	40.00 ft	Constructed Slope	0.004500 ft/ft

Hydraulic Profile

Profile	M2	Depth, Downstream	0.84 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	0.84 ft
Velocity Downstream	4.68 ft/s	Critical Slope	0.019362 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	2		

Outlet Control Properties

Outlet Control HW Elev	2,018.19 ft	Upstream Velocity Head	0.15 ft
Ke	0.90	Entrance Loss	0.13 ft

Inlet Control Properties

Inlet Control HW Elev	2,018.03 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	3.5 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report

CULVERT 23:Husker Ln West Sta. 50+79

Analysis Component			
Storm Event	Design	Discharge	7.63 cfs
Peak Discharge Method: User-Specified			
Design Discharge	7.63 cfs	Check Discharge	0.00 cfs
Tailwater Conditions: Constant Tailwater			
Tailwater Elevation	15.25 ft		

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	7.63 cfs	17.00 ft	5.66 ft/s
Weir	Not Considered	N/A	N/A	N/A

R-45

Culvert Analysis Report

CULVERT 23:Husker Ln West Sta. 50+79

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	17.00 ft	Discharge	7.63 cfs
Inlet Control HW Elev	16.90 ft	Tailwater Elevation	15.25 ft
Outlet Control HW Elev	17.00 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.33		

Grades			
Upstream Invert	15.00 ft	Downstream Invert	14.50 ft
Length	40.00 ft	Constructed Slope	0.012500 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.07 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.07 ft
Velocity Downstream	5.66 ft/s	Critical Slope	0.024427 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	17.00 ft	Upstream Velocity Head	0.30 ft
Ke	0.90	Entrance Loss	0.27 ft

Inlet Control Properties			
Inlet Control HW Elev	16.90 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	1.8 ft ²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

R-46



APPENDIX C

100-YEAR ROADWAY AND FLOODPLAIN RATINGS

A-A capacity rating
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163.fm2
Worksheet	A-A
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data				
Channel Slope	0.008000 ft/ft			
Water Surface Elevation	62.00 ft			
Elevation range: 58.00 ft to 62.00 ft.				
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	62.00	0.00	370.00	0.045
45.00	60.00			
110.00	58.00			
190.00	58.00			
300.00	60.00			
370.00	62.00			

Results	
Wtd. Mannings Coefficient	0.045
Discharge	5,352.42 cfs
Flow Area	960.00 ft ²
Wetted Perimeter	370.12 ft
Top Width	370.00 ft
Height	4.00 ft
Critical Depth	61.12 ft
Critical Slope	0.023207 ft/ft
Velocity	5.58 ft/s
Velocity Head	0.48 ft
Specific Energy	62.48 ft
Froude Number	0.61
Flow is subcritical.	

C-1

A1-A1 capacity rating
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163.fm2
Worksheet	A1-A1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data					
Channel Slope	0.008000 ft/ft				
Water Surface Elevation	58.00	ft			
Elevation range: 56.00 ft to 60.00 ft.					
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness	
0.00	60.00	0.00	940.00	0.045	
40.00	58.00				
90.00	56.00				
560.00	56.00				
940.00	58.00				

Results		
Wtd. Mannings Coefficient	0.045	
Discharge	5,354.09	cfs
Flow Area	1,370.00	ft ²
Wetted Perimeter	900.05	ft
Top Width	900.00	ft
Height	2.00	ft
Critical Depth	57.42	ft
Critical Slope	0.028246 ft/ft	
Velocity	3.91	ft/s
Velocity Head	0.24	ft
Specific Energy	58.24	ft
Froude Number	0.56	
Flow is subcritical.		

Michelob Lane
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163.fm2
Worksheet	Michelob Lane sta. 37+00 - 45+00
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data	
Channel Slope	0.009000 ft/ft
Elevation range: 2,008.48 ft to 2,010.21 ft.	

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
3,700.00	2,010.21	3,700.00	4,500.00	0.022
3,750.00	2,009.82			
3,800.00	2,009.31			
3,850.00	2,008.97			
3,900.00	2,008.74			
3,950.00	2,008.48			
4,000.00	2,008.65			
4,050.00	2,009.21			
4,100.00	2,009.01			
4,150.00	2,009.04			
4,200.00	2,009.29			
4,250.00	2,009.48			
4,300.00	2,009.47			
4,350.00	2,009.03			
4,400.00	2,009.22			
4,450.00	2,009.48			
4,500.00	2,009.19			
Discharge	665.00	cfs		

Results	
Wtd. Mannings Coefficient	0.022
Water Surface Elevation	2,009.38 ft
Flow Area	206.76 ft ²
Wetted Perimeter	581.41 ft
Top Width	581.21 ft
Height	0.90 ft
Critical Depth	2,009.36 ft
Critical Slope	0.010024 ft/ft
Velocity	3.22 ft/s
Velocity Head	0.16 ft
Specific Energy	2,009.54 ft
Froude Number	0.95
Flow is subcritical.	
Flow is divided.	

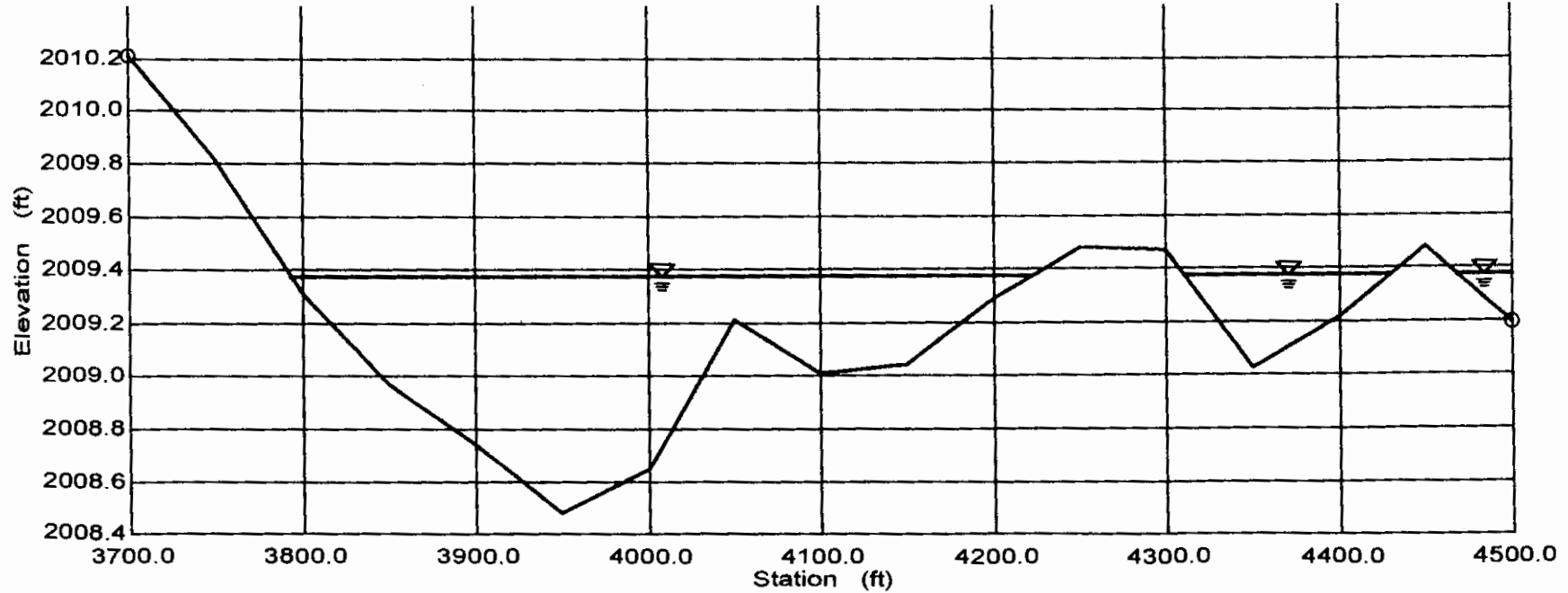
C-3

Michelob Lane
Cross Section for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163.fm2
Worksheet	Michlob Lane sta. 37+00 - 45+00
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.022
Channel Slope	0.009000 ft/ft
Water Surface Elevation	2,009.38 ft
Discharge	665.00 cfs

C-4



Needmore Way 51+35 - 57+07 CP2

Worksheet for Irregular Channel

Discharge 660.00 cfs

Results

Wtd. Mannings Coefficient	0.022	
Water Surface Elevation	2,005.13	ft
Flow Area	164.01	ft ²
Wetted Perimeter	301.65	ft
Top Width	301.54	ft
Height	1.01	ft
Critical Depth	2,005.11	ft
Critical Slope	0.008663	ft/ft
Velocity	4.02	ft/s
Velocity Head	0.25	ft
Specific Energy	2,005.38	ft
Froude Number	0.96	
Flow is subcritical.		
Flow is divided.		

Needmore Way 51+35 - 57+07 CP2
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163.fm2
Worksheet	Needmore Way 51+35 - 57+07 CP2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

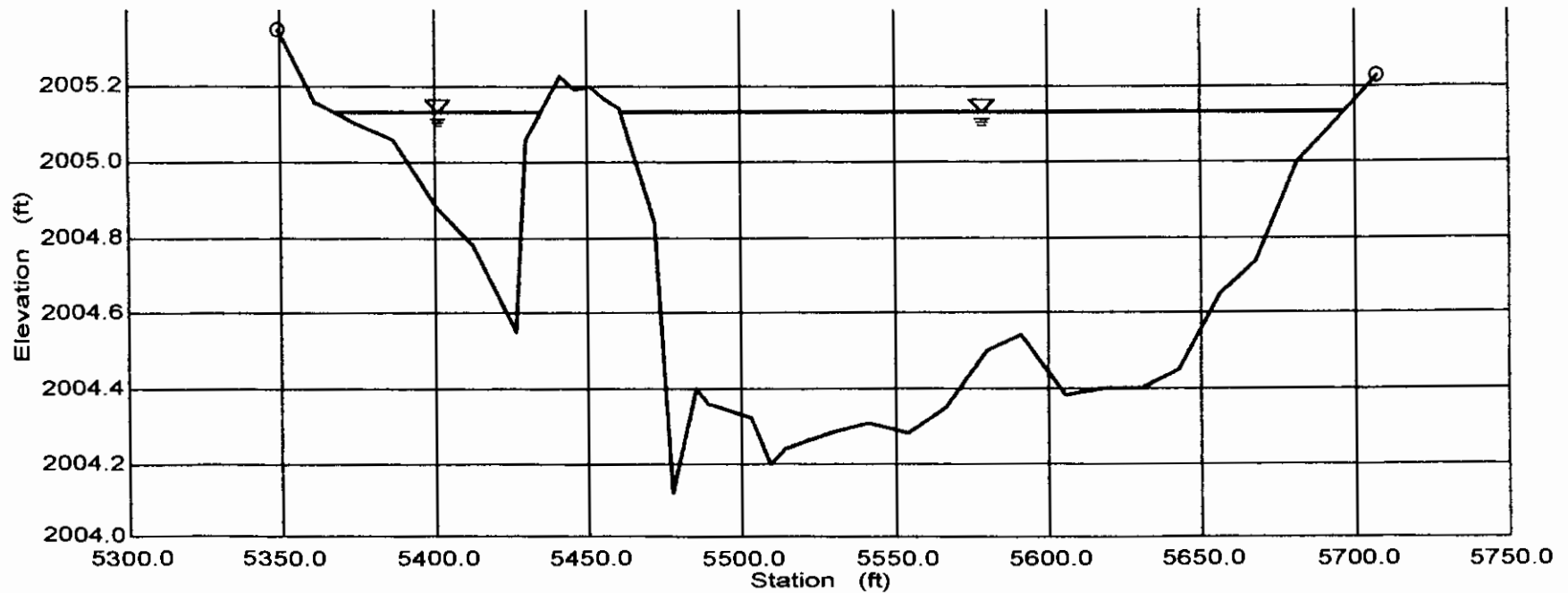
Input Data				
Channel Slope	0.008000 ft/ft			
Elevation range:	2,004.12 ft to 2,005.35 ft.			
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
5,349.26	2,005.35	5,349.26	5,707.53	0.022
5,361.21	2,005.16			
5,375.09	2,005.10			
5,386.79	2,005.06			
5,400.85	2,004.88			
5,412.64	2,004.78			
5,426.79	2,004.55			
5,430.03	2,005.06			
5,441.30	2,005.23			
5,446.14	2,005.19			
5,450.96	2,005.20			
5,455.70	2,005.17			
5,460.62	2,005.14			
5,472.07	2,004.84			
5,477.43	2,004.12			
5,485.45	2,004.40			
5,489.13	2,004.36			
5,503.04	2,004.32			
5,509.64	2,004.20			
5,514.16	2,004.24			
5,528.26	2,004.28			
5,541.20	2,004.31			
5,554.39	2,004.28			
5,566.40	2,004.35			
5,580.12	2,004.50			
5,591.37	2,004.54			
5,605.62	2,004.38			
5,617.71	2,004.40			
5,630.23	2,004.40			
5,642.41	2,004.45			
5,655.97	2,004.65			
5,668.04	2,004.74			
5,681.43	2,005.00			
5,693.94	2,005.11			
5,707.53	2,005.23			

Needmore Way 51+35 - 57+07 CP2
 Cross Section for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163.fm2
Worksheet	Needmore Way 51+35 - 57+07 CP2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.022
Channel Slope	0.008000 ft/ft
Water Surface Elevation	2,005.13 ft
Discharge	660.00 cfs

C-7



Sooner Lane Sta. 35+50 - 42+00
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163.fm2
Worksheet	Sooner Lane sta. 35+50 - 42+00
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data				
Channel Slope	0.008000 ft/ft			
Elevation range: 2,017.98 ft to 2,019.79 ft.				
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
3,550.00	2,019.79	3,550.00	4,150.00	0.022
3,600.00	2,019.59			
3,650.00	2,019.30			
3,700.00	2,018.99			
3,750.00	2,018.67			
3,800.00	2,018.55			
3,850.00	2,018.78			
3,900.00	2,018.43			
3,950.00	2,019.19			
4,000.00	2,018.44			
4,050.00	2,017.98			
4,100.00	2,018.98			
4,150.00	2,019.60			
Discharge	467.00	cfs		

Results		
Wtd. Mannings Coefficient	0.022	
Water Surface Elevation	2,018.98	ft
Flow Area	144.90	ft ²
Wetted Perimeter	371.86	ft
Top Width	371.84	ft
Height	1.00	ft
Critical Depth	2,018.96	ft
Critical Slope	0.009806 ft/ft	
Velocity	3.22	ft/s
Velocity Head	0.16	ft
Specific Energy	2,019.14	ft
Froude Number	0.91	
Flow is subcritical.		
Flow is divided.		

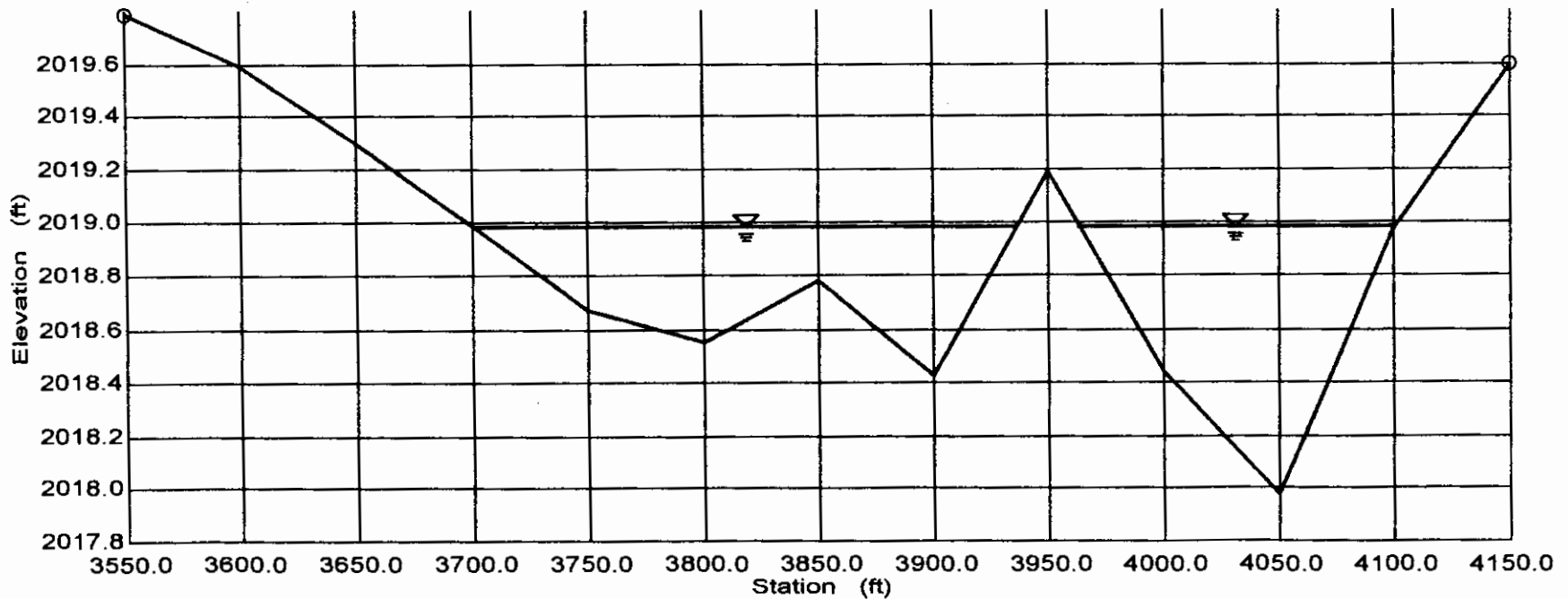
C-8

Sooner Lane Sta. 35+50 + 42+00
 Cross Section for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163.fm2
Worksheet	Sooner Lane sta. 35+50 - 42+00
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.022
Channel Slope	0.008000 ft/ft
Water Surface Elevation	2,018.98 ft
Discharge	467.00 cfs

b-c



Needmore Way Sta. 62+71 - 68+28
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163.fm2
Worksheet	Needmore Way sta. 62+71 - 68+28
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data

Channel Slope 0.010000 ft/ft
Elevation range: 2,000.34 ft to 2,002.08 ft.

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
6,271.22	2,001.97	6,271.22	6,828.29	0.022
6,273.33	2,001.85			
6,277.39	2,001.77			
6,287.92	2,001.85			
6,292.52	2,001.80			
6,297.46	2,001.65			
6,311.13	2,001.53			
6,322.69	2,001.41			
6,338.26	2,001.17			
6,349.18	2,001.15			
6,363.31	2,001.11			
6,374.39	2,001.00			
6,390.02	2,000.97			
6,400.58	2,000.92			
6,414.97	2,000.90			
6,426.46	2,000.84			
6,437.39	2,000.74			
6,453.66	2,000.66			
6,465.77	2,000.67			
6,479.97	2,000.71			
6,491.44	2,000.76			
6,506.38	2,000.75			
6,520.59	2,000.59			
6,532.64	2,000.53			
6,546.46	2,000.59			
6,558.11	2,000.65			
6,573.30	2,000.92			
6,584.81	2,000.88			
6,588.11	2,001.07			
6,595.97	2,001.18			
6,607.04	2,001.12			
6,612.44	2,001.16			
6,615.34	2,001.16			
6,619.53	2,001.31			
6,622.46	2,001.26			

Needmore Way Sta. 62+71 - 68+28
Worksheet for Irregular Channel

6,627.83	2,000.54
6,633.49	2,000.34
6,647.15	2,000.43
6,658.85	2,000.53
6,673.34	2,000.57
6,685.16	2,000.68
6,699.07	2,000.79
6,711.36	2,000.88
6,725.14	2,000.99
6,737.77	2,001.09
6,751.48	2,001.31
6,763.62	2,001.44
6,777.36	2,001.44
6,789.52	2,001.50
6,803.13	2,001.58
6,814.98	2,002.04
6,828.29	2,002.08

Discharge 488.00 cfs

Results

Wtd. Mannings Coefficient	0.022	
Water Surface Elevation	2,001.16	ft
Flow Area	140.45	ft ²
Wetted Perimeter	380.66	ft
Top Width	380.60	ft
Height	0.82	ft
Critical Depth	2,001.16	ft
Critical Slope	0.009856	ft/ft
Velocity	3.47	ft/s
Velocity Head	0.19	ft
Specific Energy	2,001.35	ft
Froude Number	1.01	

Flow is supercritical.

Flow is divided.

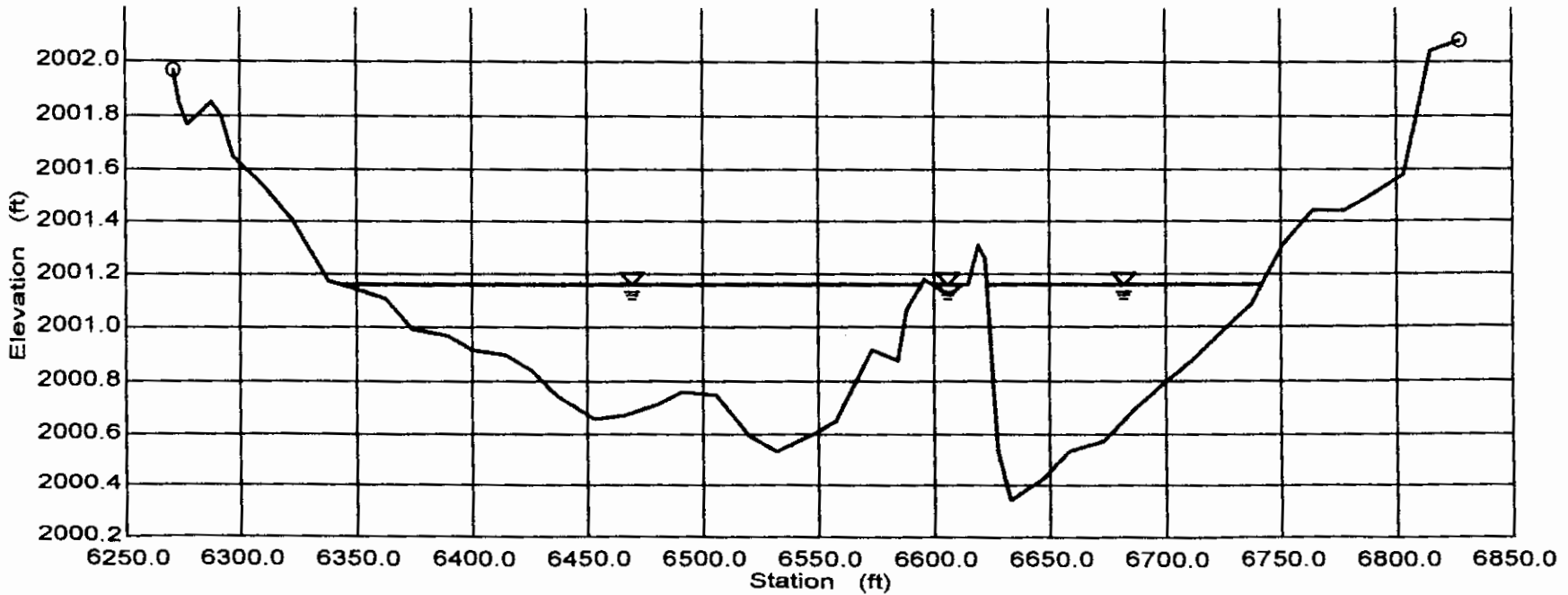
C-11

Needmore Way sta. 62+71 - 68+28
 Cross Section for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163.fm2
Worksheet	Needmore Way sta. 62+71 - 68+28
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.022
Channel Slope	0.010000 ft/ft
Water Surface Elevation	2,001.16 ft
Discharge	488.00 cfs

(-12)



B1-B1
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163092.fm2
Worksheet	B1-B1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

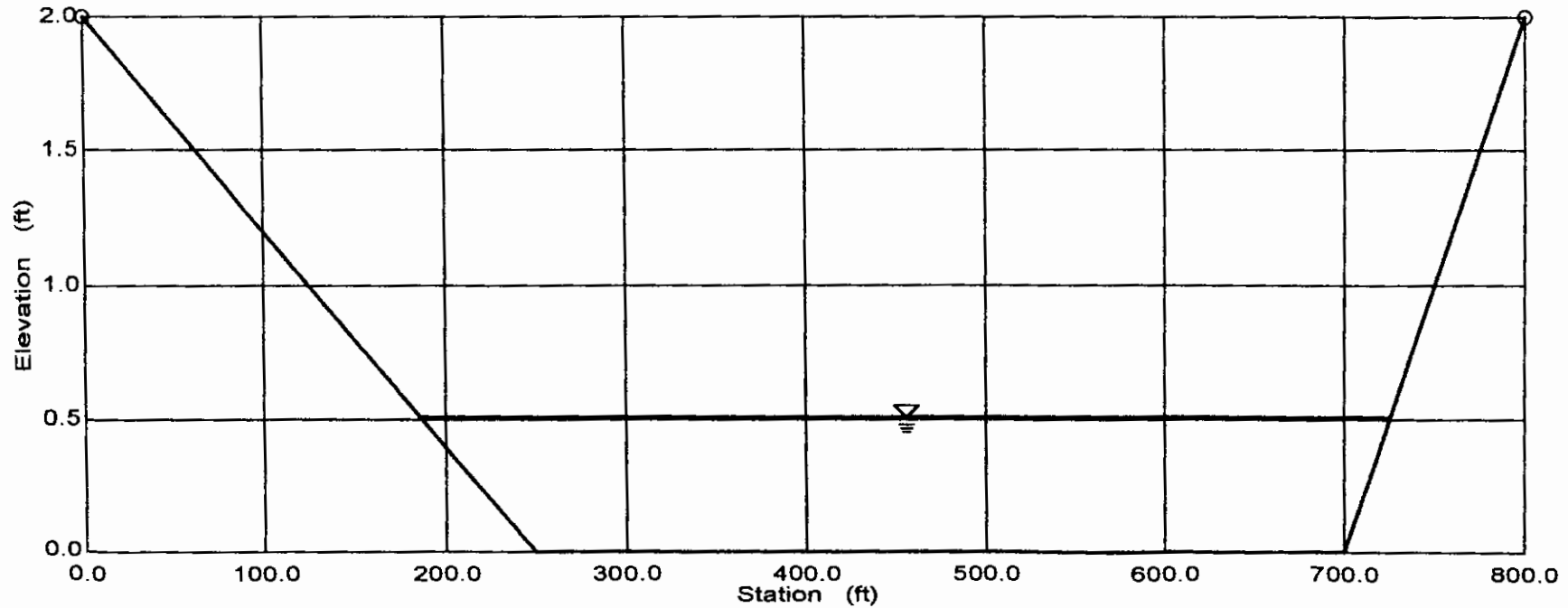
Input Data					
Channel Slope	0.009000 ft/ft				
Elevation range: 0.00 ft to 2.00 ft.					
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness	
0.00	2.00	0.00	800.00	0.045	
250.00	0.00				
700.00	0.00				
800.00	2.00				
Discharge	467.00	cfs			

Results		
Wtd. Mannings Coefficient	0.045	
Water Surface Elevation	0.50	ft
Flow Area	249.14	ft ²
Wetted Perimeter	538.24	ft
Top Width	538.24	ft
Height	0.50	ft
Critical Depth	0.32	ft
Critical Slope	0.044161	ft/ft
Velocity	1.87	ft/s
Velocity Head	0.05	ft
Specific Energy	0.56	ft
Froude Number	0.49	
Flow is subcritical.		

B1-B1
Cross Section for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163092.fm2
Worksheet	B1-B1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.045
Channel Slope	0.009000 ft/ft
Water Surface Elevation	0.50 ft
Discharge	467.00 cfs



B2-B2
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163092.fm2
Worksheet	B2-B2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data					
Channel Slope	0.009000 ft/ft				
Elevation range: 0.00 ft to 2.00 ft.					
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness	
0.00	2.00	0.00	850.00	0.045	
200.00	0.00				
700.00	0.00				
850.00	2.00				
Discharge	467.00	cfs			

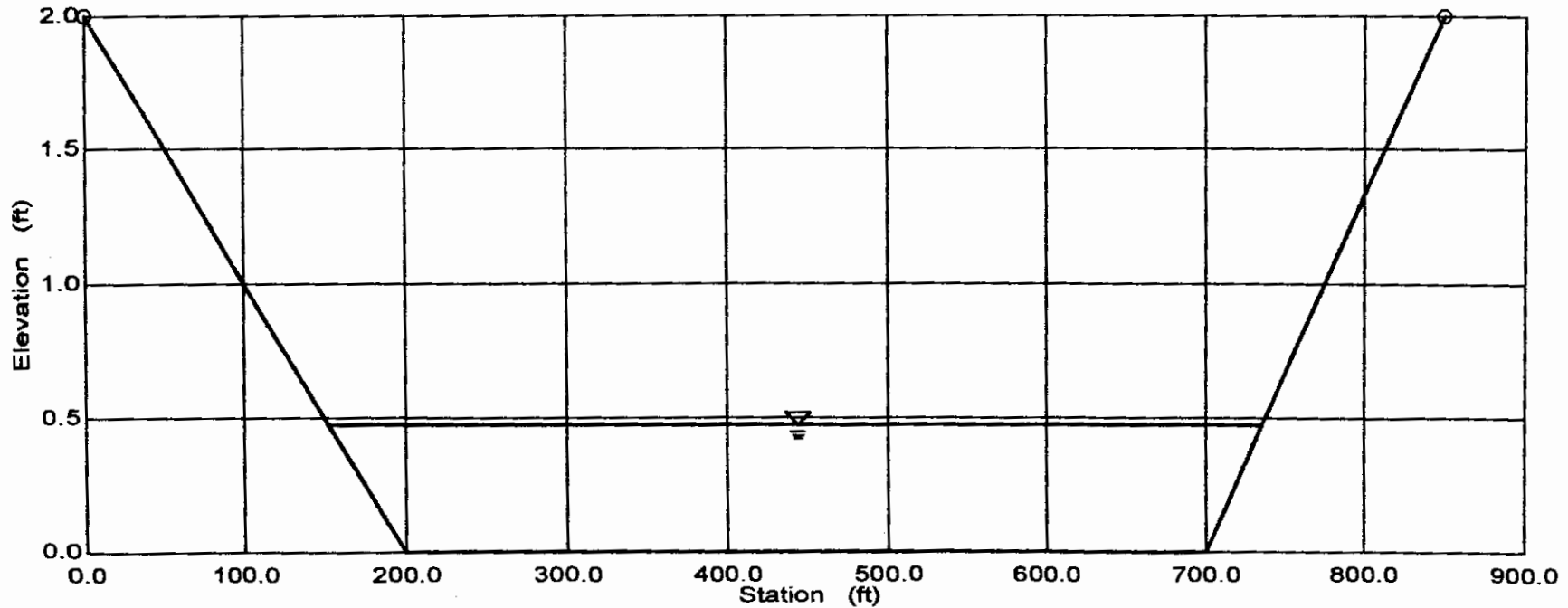
Results		
Wtd. Mannings Coefficient	0.045	
Water Surface Elevation	0.48	ft
Flow Area	257.25	ft ²
Wetted Perimeter	583.13	ft
Top Width	583.13	ft
Height	0.48	ft
Critical Depth	0.30	ft
Critical Slope	0.045030	ft/ft
Velocity	1.82	ft/s
Velocity Head	0.05	ft
Specific Energy	0.53	ft
Froude Number	0.48	
Flow is subcritical.		

C-15

B2-B2
Cross Section for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163092.fm2
Worksheet	B2-B2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.045
Channel Slope	0.009000 ft/ft
Water Surface Elevation	0.48 ft
Discharge	467.00 cfs



B2.1 - B2.1
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163.fm2
Worksheet	B2.1-B2.1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data					
Channel Slope	0.010000 ft/ft				
Elevation range: 0.00 ft to 2.00 ft.					
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness	
0.00	1.00	0.00	800.00	0.045	
320.00	0.00				
650.00	0.00				
800.00	2.00				
Discharge	467.00	cfs			

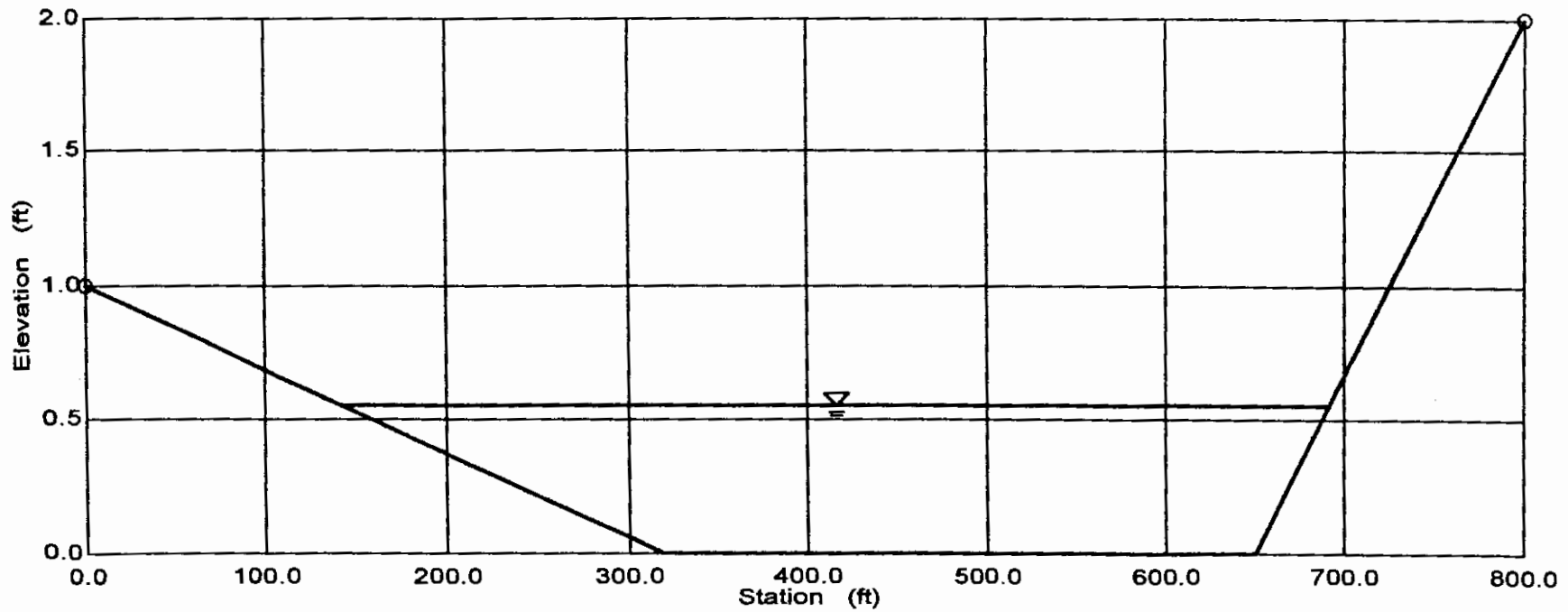
Results		
Wtd. Mannings Coefficient	0.045	
Water Surface Elevation	0.55	ft
Flow Area	243.25	ft ²
Wetted Perimeter	548.70	ft
Top Width	548.70	ft
Height	0.55	ft
Critical Depth	0.37	ft
Critical Slope	0.043556	ft/ft
Velocity	1.92	ft/s
Velocity Head	0.06	ft
Specific Energy	0.61	ft
Froude Number	0.51	
Flow is subcritical.		

C-17

B2.1 - B2.1
Cross Section for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163.fm2
Worksheet	B2.1-B2.1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.045
Channel Slope	0.010000 ft/ft
Water Surface Elevation	0.55 ft
Discharge	467.00 cfs



B3-B3
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163092.fm2
Worksheet	B3-B3
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

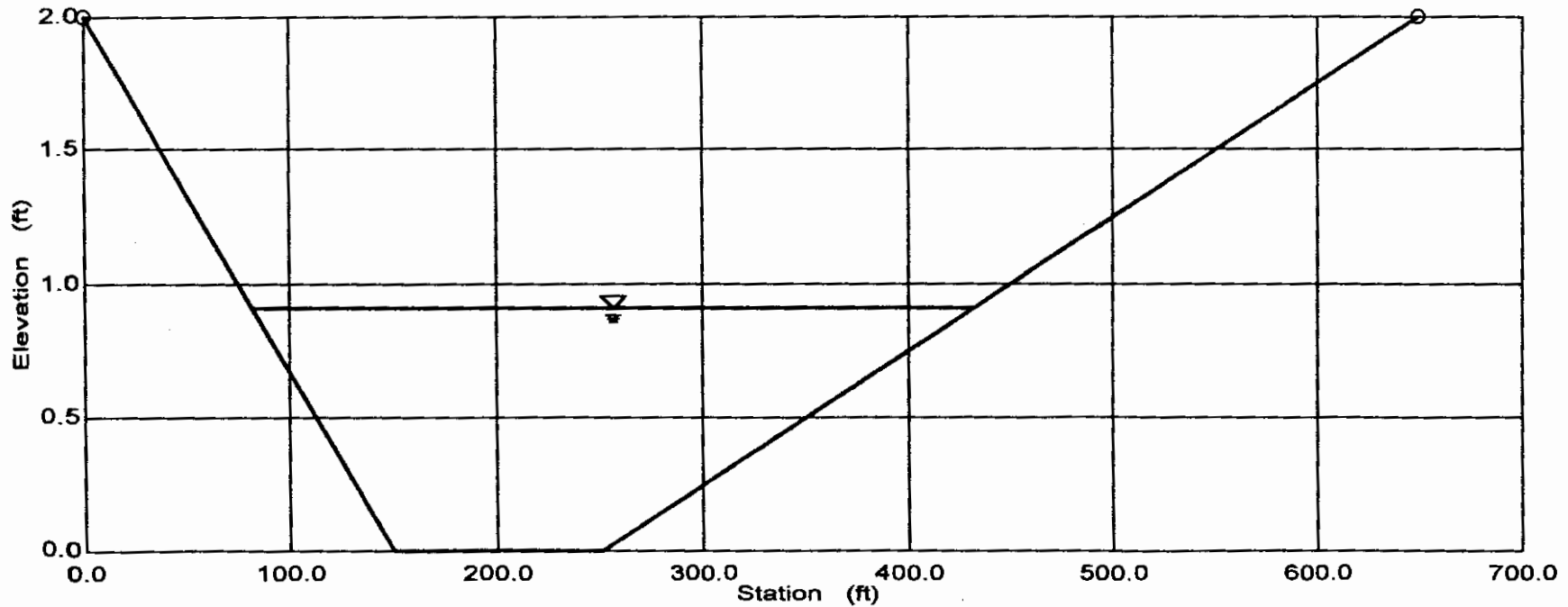
Input Data					
Channel Slope	0.010000 ft/ft				
Elevation range: 0.00 ft to 2.00 ft.					
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness	
0.00	2.00	0.00	650.00	0.045	
150.00	0.00				
250.00	0.00				
650.00	2.00				
Discharge	467.00	cfs			

Results		
Wtd. Mannings Coefficient	0.045	
Water Surface Elevation	0.90	ft
Flow Area	202.91	ft ²
Wetted Perimeter	348.72	ft
Top Width	348.72	ft
Height	0.90	ft
Critical Depth	0.65	ft
Critical Slope	0.038713	ft/ft
Velocity	2.30	ft/s
Velocity Head	0.08	ft
Specific Energy	0.99	ft
Froude Number	0.53	
Flow is subcritical.		

B3-B3
Cross Section for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163092.fm2
Worksheet	B3-B3
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.045
Channel Slope	0.010000 ft/ft
Water Surface Elevation	0.90 ft
Discharge	467.00 cfs



C1-C1
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163092.fm2
Worksheet	C1-C1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data					
Channel Slope	0.008000 ft/ft				
Elevation range: 0.00 ft to 2.00 ft.					
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness	
0.00	2.00	0.00	1,340.00	0.045	
100.00	0.00				
770.00	0.00				
1,340.00	2.00				
Discharge	777.00	cfs			

Results		
Wtd. Mannings Coefficient	0.045	
Water Surface Elevation	0.55	ft
Flow Area	421.58	ft ²
Wetted Perimeter	855.20	ft
Top Width	855.20	ft
Height	0.55	ft
Critical Depth	0.34	ft
Critical Slope	0.043467	ft/ft
Velocity	1.84	ft/s
Velocity Head	0.05	ft
Specific Energy	0.61	ft
Froude Number	0.46	
Flow is subcritical.		

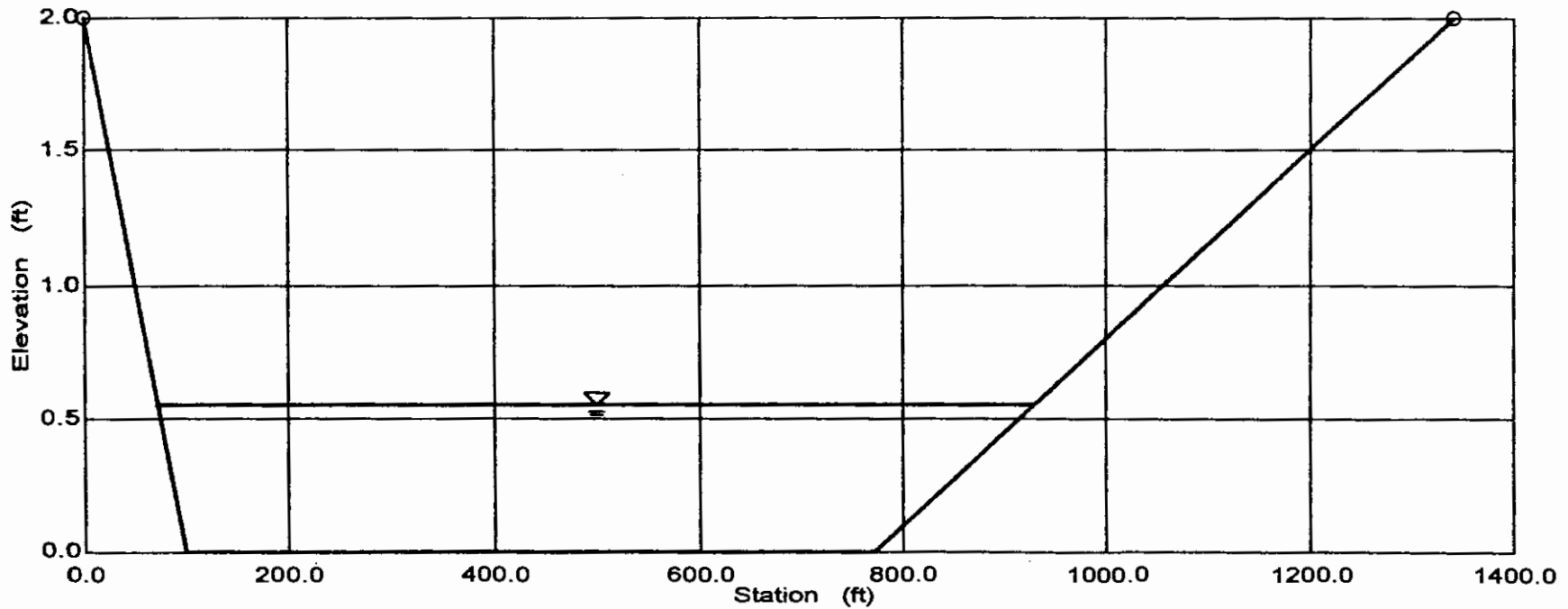
C-72

C1-C1
Cross Section for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163092.fm2
Worksheet	C1-C1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.045
Channel Slope	0.008000 ft/ft
Water Surface Elevation	0.55 ft
Discharge	777.00 cfs

C-23



1-1
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163092.fm2
Worksheet	1-1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data					
Channel Slope	0.010000 ft/ft				
Elevation range: 0.00 ft to 2.00 ft.					
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness	
0.00	2.00	0.00	880.00	0.045	
110.00	0.00				
440.00	0.00				
880.00	2.00				
Discharge	665.00	cfs			

Results		
Wtd. Mannings Coefficient	0.045	
Water Surface Elevation	0.69	ft
Flow Area	294.42	ft ²
Wetted Perimeter	520.42	ft
Top Width	520.41	ft
Height	0.69	ft
Critical Depth	0.47	ft
Critical Slope	0.039960	ft/ft
Velocity	2.26	ft/s
Velocity Head	0.08	ft
Specific Energy	0.77	ft
Froude Number	0.53	
Flow is subcritical.		

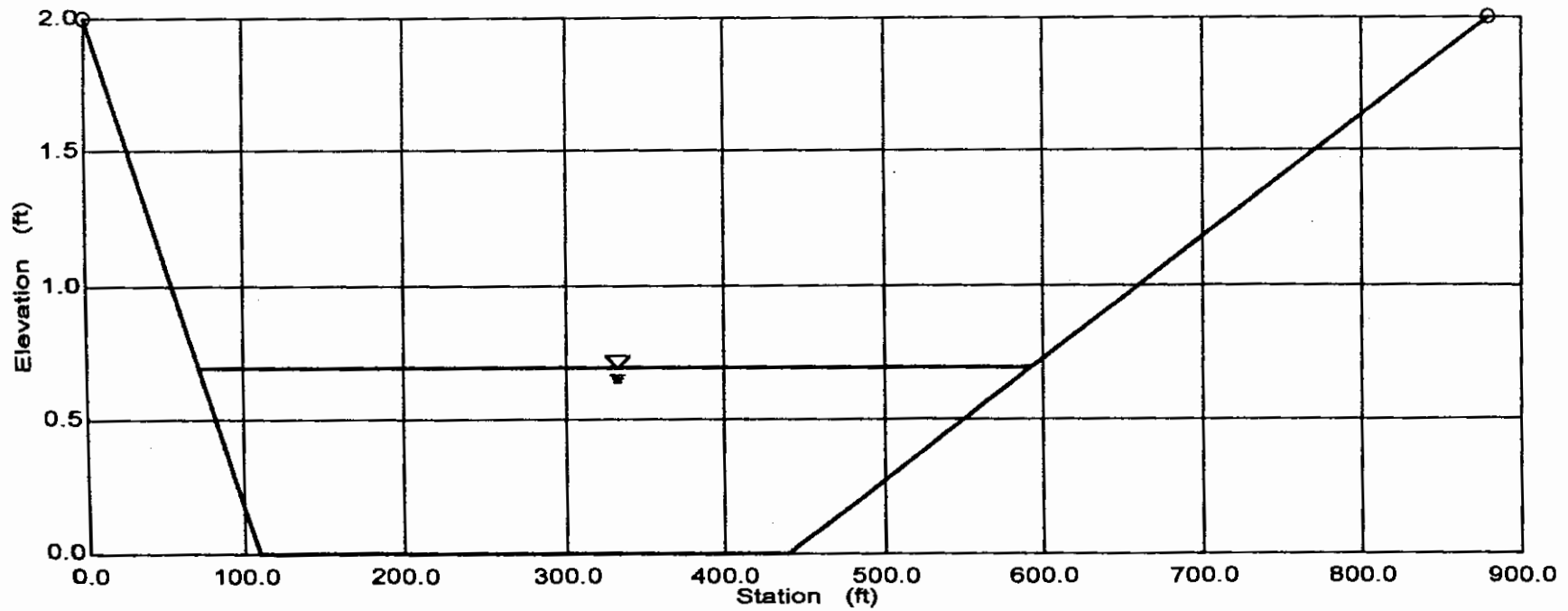
C-24

1-1
Cross Section for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163092.fm2
Worksheet	1-1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.045
Channel Slope	0.010000 ft/ft
Water Surface Elevation	0.69 ft
Discharge	665.00 cfs

1-25



2-2
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163092.fm2
Worksheet	2-2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

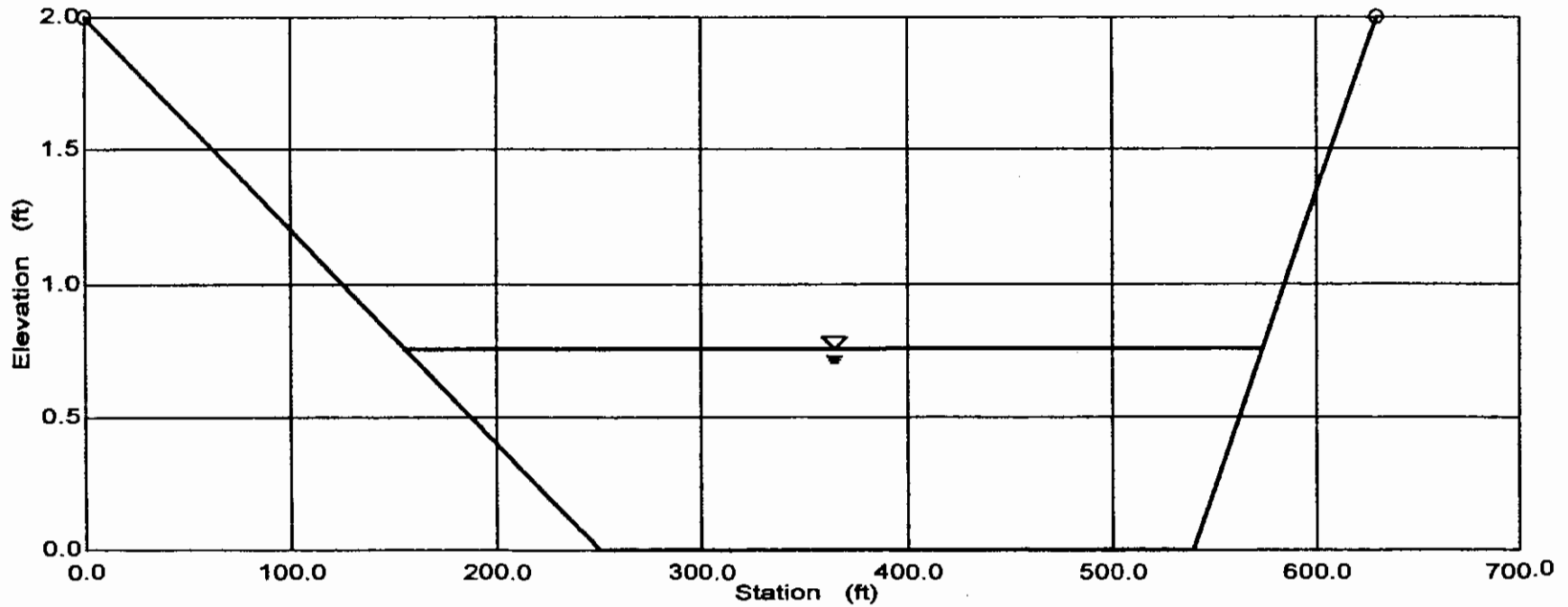
Input Data					
Channel Slope	0.010000 ft/ft				
Elevation range: 0.00 ft to 2.00 ft.					
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness	
0.00	2.00	0.00	630.00	0.045	
250.00	0.00				
540.00	0.00				
630.00	2.00				
Discharge	660.00	cfs			

Results		
Wtd. Mannings Coefficient	0.045	
Water Surface Elevation	0.76	ft
Flow Area	268.72	ft ²
Wetted Perimeter	418.90	ft
Top Width	418.89	ft
Height	0.76	ft
Critical Depth	0.52	ft
Critical Slope	0.038335	ft/ft
Velocity	2.46	ft/s
Velocity Head	0.09	ft
Specific Energy	0.85	ft
Froude Number	0.54	
Flow is subcritical.		

2-2
Cross Section for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163092.fm2
Worksheet	2-2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.045
Channel Slope	0.010000 ft/ft
Water Surface Elevation	0.76 ft
Discharge	660.00 cfs



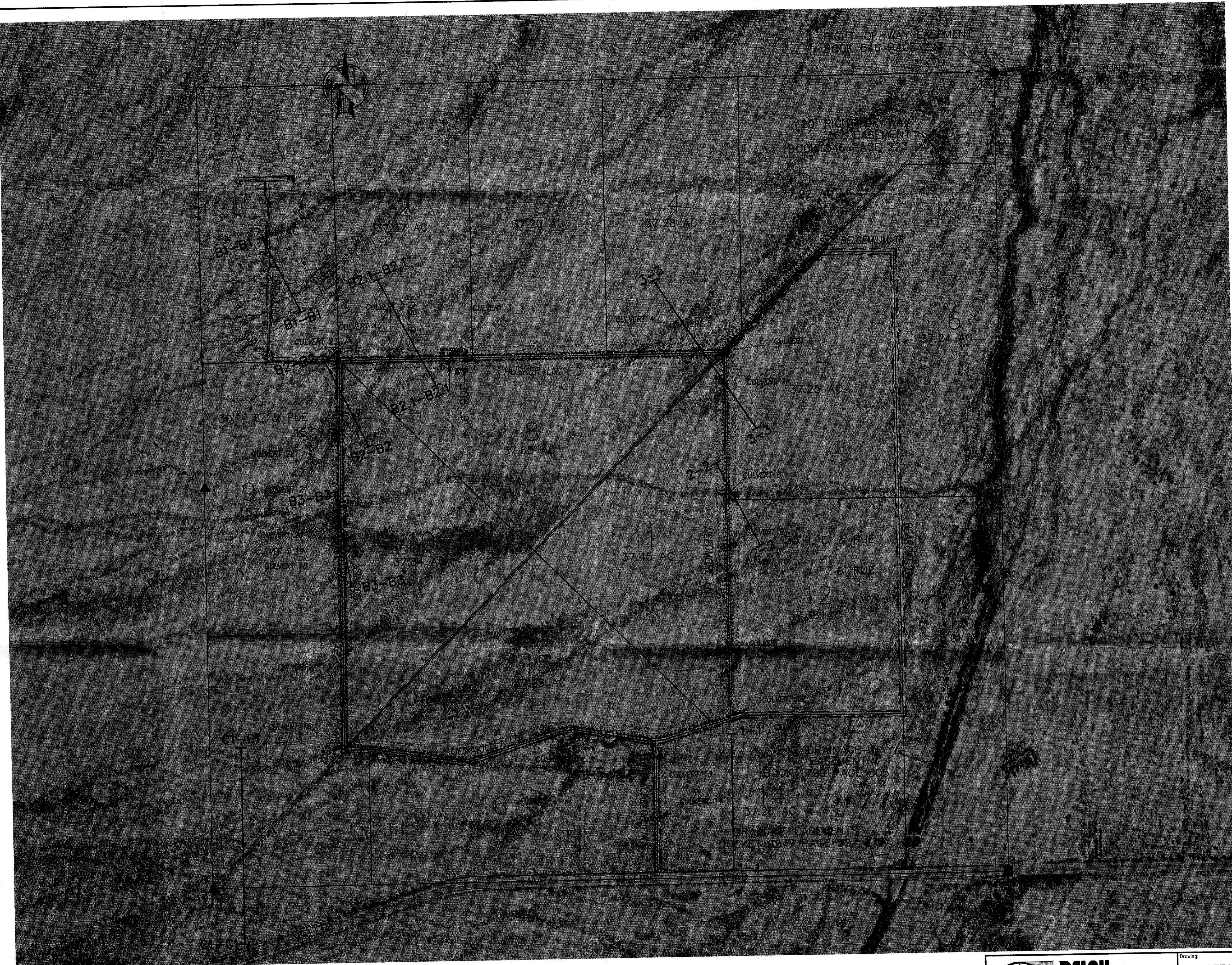
3-3
Worksheet for Irregular Channel

Project Description	
Project File	c:\haestad\fmw\03163092.fm2
Worksheet	3-3
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

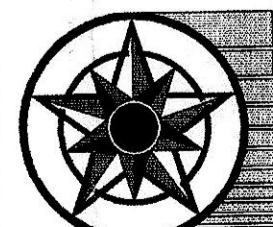
Input Data					
Channel Slope	0.008000 ft/ft				
Elevation range: 0.00 ft to 2.00 ft.					
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness	
0.00	2.00	0.00	1,120.00	0.045	
300.00	0.00				
810.00	0.00				
1,120.00	2.00				
Discharge	488.00	cfs			

Results		
Wtd. Mannings Coefficient	0.045	
Water Surface Elevation	0.49	ft
Flow Area	287.51	ft ²
Wetted Perimeter	659.91	ft
Top Width	659.91	ft
Height	0.49	ft
Critical Depth	0.30	ft
Critical Slope	0.045441	ft/ft
Velocity	1.70	ft/s
Velocity Head	0.04	ft
Specific Energy	0.54	ft
Froude Number	0.45	
Flow is subcritical.		

C-28



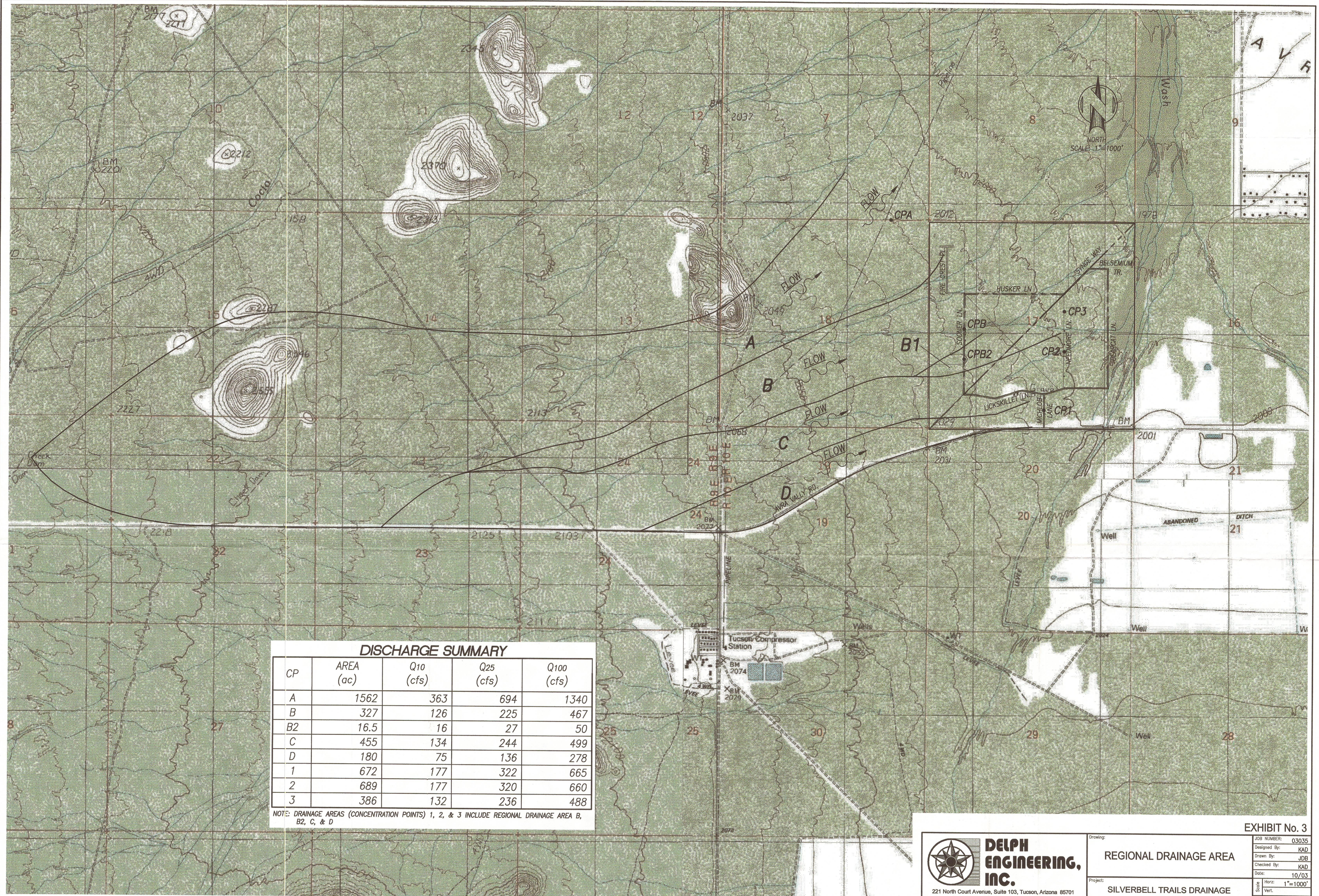
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Drawing: **AERIAL PHOTO WITH 100-YEAR FLOODPLAIN RATINGS**
 Project: **SILVERBELL TRAILS DRAINAGE STUDY**

JOB NUMBER:	
Designed By:	
Drawn By:	
Checked By:	
Date:	
Scale:	
Horz:	1" = 100'
Vert:	1" = 10'
Sheet Number:	1

EXHIBIT NO.



DISCHARGE SUMMARY

CP	AREA (ac)	Q10 (cfs)	Q25 (cfs)	Q100 (cfs)
A	1562	363	694	1340
B	327	126	225	467
B2	16.5	16	27	50
C	455	134	244	499
D	180	75	136	278
1	672	177	322	665
2	689	177	320	660
3	386	132	236	488

NOTE: DRAINAGE AREAS (CONCENTRATION POINTS) 1, 2, & 3 INCLUDE REGIONAL DRAINAGE AREA B, B2, C, & D

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 Phone: 520.882.6568 / Fax: 520.882.6570
 www.delphengineering.com ~ del@delphengineering.com
 User: JDB
 Project: REGIONAL DRAINAGE AREA
 Date: 10/03
 Scale: 1"=1000'
 Project: SILVERBELL TRAILS DRAINAGE STUDY
 Project: 03035

EXHIBIT No. 3

DELPH ENGINEERING, INC.
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Job Number:	03035
Designed By:	KAD
Drawn By:	JDB
Checked By:	KAD
Date:	10/03
Scale:	1"=1000'
Sheet Number:	

Project: SILVERBELL TRAILS DRAINAGE STUDY