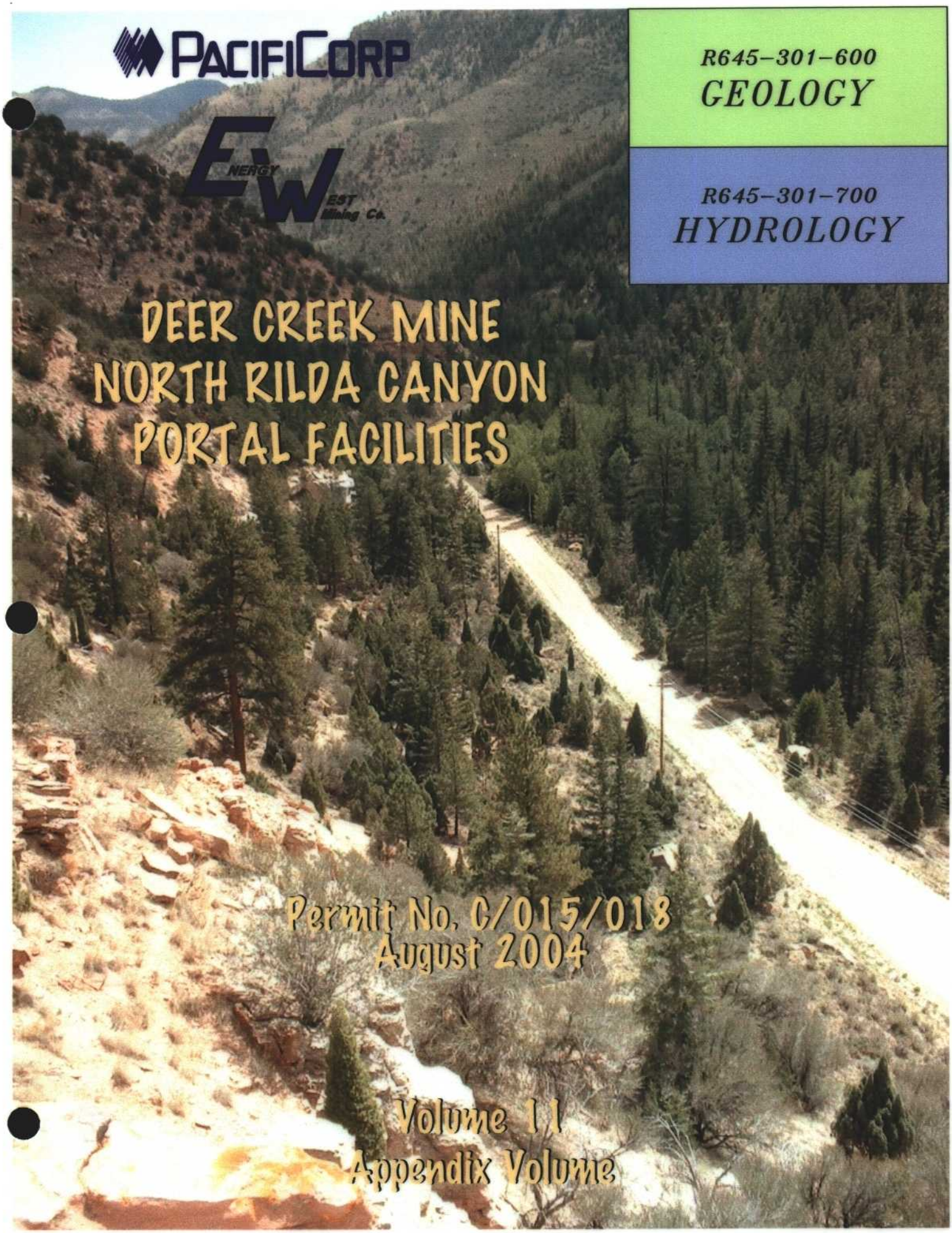

PACIFICORP

ENERGY WEST Mining Co.

R645-301-600
GEOLOGY

R645-301-700
HYDROLOGY

DEER CREEK MINE
NORTH RILDA CANYON
PORTAL FACILITIES

Permit No. C/015/018
August 2004

Volume 11
Appendix Volume

R645-301-600
APPENDIX A

North Rilda Permit Area
Existing Exploration Drillhole Completion Details

Hole No.	Completion Date	Total Depth (feet)	Hole Diameter	Completion Details
EM-47	10/08/1978	300	6"	Completed as monitoring well; casing perforated 210 - 270 foot depth
EM-48	08/27/1979	1860	6"	Plugged with 335 sacks of cement
EM-49	09/29/1979	1680	6"	Plugged with 306 sacks of cement
EM-56c	11/11/1979	422	6", $4^7/_8$"	Plugged with 76 sacks of cement
EM-52	07/30/1986	1560	6"	Plugged with 289 sacks of cement
EM-51	08/01/1986	1660	6", $5^5/_8$"	Plugged with 300 sacks of cement
EM-50	08/03/1986	1680	6", $5^5/_8$"	Plugged with 300 sacks of cement
EM-55	08/04/1986	1680	6", $5^5/_8$"	Plugged with 300 sacks of cement
EM-105	08/13/1986	1620	6", $5^5/_8$"	Plugged with 300 sacks of cement
EM-53	11/13/1995	716	3", $2^1/_2$"	Plugged with 27 sacks of cement, 3 sacks of bentonite pellets
EM-107	11/20/1995	767	3", $2^1/_2$"	Plugged with 33 sacks of cement
EM-153	09/27/1996	796	3", $2^1/_2$"	Plugged with 33 sacks of cement, Surface plug
EM-154	10/05/1996	795	3", $2^1/_2$"	Plugged with 35 sacks of cement, 17 sacks of bentonite pellets*
EM-155	10/09/1996	716	3", $2^1/_2$"	Plugged with 35 sacks of cement, 17 sacks of bentonite pellets*
EM-156	10/15/1996	755	3", $2^1/_2$"	Plugged with 35 sacks of cement, 16 sacks of bentonite pellets*
EM-157	10/18/1997	436	3", $2^1/_2$"	Plugged with 35 sacks of cement, 6 sacks of bentonite pellets*
EM-158	10/20/1996	227	3", $2^1/_2$"	Plugged with 20 sacks of cement, 1 sack of bentonite pellets*
EM-159	08/23/1997	227	3", $2^1/_2$"	Plugged with 20 sacks of cement, 1.5 sack of bentonite pellets*
EM-160	09/08/1997	257	3", $2^1/_2$"	Plugged with 10.5 sacks of cement, 2 sack of bentonite pellets*
EM-161	09/06/1997	287	3", $2^1/_2$"	Plugged with 15 sacks of cement,
EM-162	09/04/1997	307	3", $2^1/_2$"	Plugged with 16.5 sacks of cement, 0.5 sack of bentonite pellets*
EM-163	08/27/1997	327	3", $2^1/_2$"	Plugged with 12 sacks of cement,
EM-164	08/26/1997	366	3", $2^1/_2$"	Plugged with 28 sacks of cement, 1.5 sack of bentonite pellets*
EM-166	07/14/2000	589	3", $2^1/_2$"	Plugged with 27 sacks of cement, 6 sack of bentonite pellets*

*Cement volume more than adequate to fill hole, but did not, remainder of hole filled to surface with $^3/_8$" bentonite pellets.

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Report ID: 010314939

Soil Analysis Report

Energy West Mining Co.
P.O. Box 310
Huntington, UT 84528

Client Project ID: Deer Creek Mine
Date Received: 09/26/03

Set #0103S14939
Report Date: 10/13/03

Lab Id	Sample Id	pH	Saturation	EC @ 25°C	Calcium	Magnesium	Sodium	SAR
		s.u.	%	mmhos/cm	meq/L	meq/L	meq/L	
0103S14939	XC-6	7.3	30.8	0.48	1.64	1.35	0.94	0.77
0103S14940	XC-6	7.3	29.8	2.63	24.4	11.7	1.11	0.26
0103S14941	XC-6	7.3	29.1	1.69	9.99	9.26	0.99	0.32
0103S14942	XC-6	7.4	27.9	1.90	11.4	10.7	1.20	0.36
0103S14943	XC-6	7.5	24.7	1.55	7.01	9.13	1.53	0.54
0103S14944	XC-6	7.3	26.8	2.30	13.4	13.5	1.32	0.36
0103S14945	XC-6	7.2	25.1	3.20	21.4	19.9	1.49	0.33
0103S14946	XC-6	7.2	27.7	3.17	24.1	17.6	1.21	0.26
0103S14947	XC-6	7.0	25.1	3.31	25.3	19.6	1.31	0.28
0103S14948	XC-10	7.6	28.5	0.37	1.00	0.63	1.25	1.39
0103S14949	XC-10	7.6	30.6	0.26	0.54	0.43	0.85	1.22
0103S14950	XC-10	7.7	30.2	0.32	0.87	0.93	0.73	0.77
0103S14951	XC-10	7.7	28.5	0.67	1.94	3.28	0.93	0.57
0103S14952	XC-10	7.1	26.2	2.78	19.3	16.2	1.25	0.30
0103S14953	XC-10	7.5	28.8	1.35	5.67	7.40	1.03	0.40
0103S14954	XC-10	7.5	25.4	1.87	8.79	12.4	1.25	0.38
0103S14955	XC-10	7.4	27.4	1.85	9.49	11.1	1.23	0.38
0103S14956	XC-10	7.0	25.6	3.37	24.7	20.3	1.23	0.26
0103S14957	XC-10	7.2	22.7	2.50	15.8	14.6	1.26	0.32

Lab ID	Sample ID	Interval (feet)	Lab ID	Sample ID	Interval (feet)
0103S14939	XC-6	3.1-5.1	0103S14948	XC-10	3.3-5.3
0103S14940	XC-6	13.1-15.1	0103S14949	XC-10	13.3-15.3
0103S14941	XC-6	23.1-25.1	0103S14950	XC-10	23.4-25.4
0103S14942	XC-6	33.1-35.1	0103S14951	XC-10	33.4-35.4
0103S14943	XC-6	43.0-45.0	0103S14952	XC-10	43.4-45.4
0103S14944	XC-6	53.1-55.1	0103S14953	XC-10	53.4-55.4
0103S14945	XC-6	63.0-6.0	0103S14954	XC-10	63.4-65.4
0103S14946	XC-6	73.1-75.1	0103S14955	XC-10	73.4-75.4
0103S14947	XC-6	83.1-85.1	0103S14956	XC-10	83.4-85.4
			0103S14957	XC-10	93.3-95.3

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By: _____
Joey Sheeley, Soils Lab Supervisor

Inter-Mount Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Report ID: 010314939

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Energy West Mining Co.
P.O. Box 310
Huntington, UT 84528

Client Project ID: Deer Creek Mine
Date Received: 09/26/03

Set #0103S14939
Report Date: 10/13/03

Lab Id	Sample Id	Coarse Fragments %	Sand %	Silt %	Clay %	Texture	1/3 Bar %	15 Bar %
0103S14939	XC-6	23.5	84.0	6.0	10.0	LOAMY SAND	7.8	3.1
0103S14940	XC-6	38.9	82.0	10.0	8.0	LOAMY SAND	9.7	3.7
0103S14941	XC-6	39.3	82.0	10.0	8.0	LOAMY SAND	9.0	3.2
0103S14942	XC-6	49.7	74.0	16.0	10.0	SANDY LOAM	11.9	4.0
0103S14943	XC-6	59.2	68.0	20.0	12.0	SANDY LOAM	12.1	5.0
0103S14944	XC-6	55.3	74.0	15.0	11.0	SANDY LOAM	12.3	4.1
0103S14945	XC-6	58.9	72.0	16.0	12.0	SANDY LOAM	11.5	4.8
0103S14946	XC-6	58.0	74.0	16.0	10.0	SANDY LOAM	12.4	4.9
0103S14947	XC-6	59.3	68.0	19.0	13.0	SANDY LOAM	11.6	5.1
0103S14948	XC-10	59.1	82.5	6.2	11.3	LOAMY SAND	7.4	3.1
0103S14949	XC-10	37.3	84.0	7.0	9.0	LOAMY SAND	11.7	4.6
0103S14950	XC-10	45.8	80.0	10.0	10.0	SANDY LOAM	13.5	5.2
0103S14951	XC-10	52.9	74.0	15.0	11.0	SANDY LOAM	16.6	6.9
0103S14952	XC-10	60.9	70.0	19.0	11.0	SANDY LOAM	16.6	6.5
0103S14953	XC-10	53.0	73.0	17.0	10.0	SANDY LOAM	17.2	6.4
0103S14954	XC-10	62.0	70.0	20.0	10.0	SANDY LOAM	15.7	6.7
0103S14955	XC-10	58.0	72.5	17.5	10.0	SANDY LOAM	14.8	6.0
0103S14956	XC-10	61.6	64.0	22.0	14.0	SANDY LOAM	13.7	7.2
0103S14957	XC-10	67.8	60.0	24.0	16.0	SANDY LOAM	10.4	6.3

Lab ID	Sample ID	Interval (feet)	Lab ID	Sample ID	Interval (feet)
0103S14939	XC-6	3.1-5.1	0103S14948	XC-10	3.3-5.3
0103S14940	XC-6	13.1-15.1	0103S14949	XC-10	13.3-15.3
0103S14941	XC-6	23.1-25.1	0103S14950	XC-10	23.4-25.4
0103S14942	XC-6	33.1-35.1	0103S14951	XC-10	33.4-35.4
0103S14943	XC-6	43.0-45.0	0103S14952	XC-10	43.4-45.4
0103S14944	XC-6	53.1-55.1	0103S14953	XC-10	53.4-55.4
0103S14945	XC-6	63.0-6.0	0103S14954	XC-10	63.4-65.4
0103S14946	XC-6	73.1-75.1	0103S14955	XC-10	73.4-75.4
0103S14947	XC-6	83.1-85.1	0103S14956	XC-10	83.4-85.4
			0103S14957	XC-10	93.3-95.3

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
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Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

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Joey Sheeley, Soils Lab Supervisor

Inter-Mountain Laboratories, Inc.

Report ID: 010314939

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Sheridan, WY 82801

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Energy West Mining Co.
P.O. Box 310
Huntington, UT 84528

Client Project ID: Deer Creek Mine
Date Received: 09/26/03

Set #0103S14939
Report Date: 10/13/03

Lab Id	Sample Id	TOC	Total Sulfur	T.S. AB	Neutral. Pot.	T.S. ABP	TKN	Boron	Nitrogen Nitrate	Selenium
		%	%	t/1000t	t/1000t	t/1000t	%	ppm	ppm	ppm
0103S14939	XC-6	<0.1	0.01	0.31	0.79	0.48	<0.01	0.14	0.62	0.02
0103S14940	XC-6	0.1	0.04	1.25	45.4	44.2	<0.01	0.15	0.74	<0.02
0103S14941	XC-6	<0.1	0.05	1.56	58.5	57.0	0.01	0.10	0.54	<0.02
0103S14942	XC-6	0.1	<0.01	0.00	162	162	0.01	0.12	0.50	<0.02
0103S14943	XC-6	0.7	<0.01	0.00	214	214	0.02	0.15	0.64	0.02
0103S14944	XC-6	0.4	0.02	0.62	197	197	0.01	0.12	0.56	<0.02
0103S14945	XC-6	0.9	0.30	9.37	178	168	0.03	0.19	0.64	0.02
0103S14946	XC-6	0.3	0.15	4.69	113	109	0.01	0.17	0.50	<0.02
0103S14947	XC-6	0.5	0.21	6.56	127	120	0.02	0.22	0.74	<0.02
0103S14948	XC-10	0.1	<0.01	0.00	1.16	1.16	<0.01	0.14	0.60	<0.02
0103S14949	XC-10	<0.1	<0.01	0.00	2.43	2.43	0.01	0.13	0.32	<0.02
0103S14950	XC-10	<0.1	0.01	0.31	54.7	54.4	0.01	0.16	1.18	<0.02
0103S14951	XC-10	0.1	0.03	0.94	135	134	0.01	0.17	0.64	<0.02
0103S14952	XC-10	0.2	0.19	5.94	171	165	0.01	0.12	0.60	<0.02
0103S14953	XC-10	<0.1	0.03	0.94	124	123	0.01	0.13	0.56	0.02
0103S14954	XC-10	0.3	0.05	1.56	221	219	0.01	0.13	1.04	<0.02
0103S14955	XC-10	0.8	0.07	2.19	138	136	0.01	0.13	0.82	<0.02
0103S14956	XC-10	0.7	0.63	19.7	123	103	0.02	0.18	1.08	0.02
0103S14957	XC-10	1.1	0.16	5.00	163	158	0.03	0.22	0.78	0.04

Lab ID	Sample ID	Interval (feet)	Lab ID	Sample ID	Interval (feet)
0103S14939	XC-6	3.1-5.1	0103S14948	XC-10	3.3-5.3
0103S14940	XC-6	13.1-15.1	0103S14949	XC-10	13.3-15.3
0103S14941	XC-6	23.1-25.1	0103S14950	XC-10	23.4-25.4
0103S14942	XC-6	33.1-35.1	0103S14951	XC-10	33.4-35.4
0103S14943	XC-6	43.0-45.0	0103S14952	XC-10	43.4-45.4
0103S14944	XC-6	53.1-55.1	0103S14953	XC-10	53.4-55.4
0103S14945	XC-6	63.0-6.0	0103S14954	XC-10	63.4-65.4
0103S14946	XC-6	73.1-75.1	0103S14955	XC-10	73.4-75.4
0103S14947	XC-6	83.1-85.1	0103S14956	XC-10	83.4-85.4
			0103S14957	XC-10	93.3-95.3

These results only apply to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

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Joey Sheeley, Soils Lab Supervisor

Inter·Mount Laboratories, Inc.

Report ID: 010314939

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Lab Id	Sample Id	pH	Saturation	EC @ 25°C	Calcium	Magnesium	Sodium	SAR
		s.u.	%	mmhos/cm	meq/L	meq/L	meq/L	
0103S14948	XC-10	7.6	28.5	0.37	1.00	0.63	1.25	1.39
0103S14948D	XC-10	7.6	29.6	0.32	0.73	0.74	0.95	1.11
0103S14955	XC-10	7.4	27.4	1.85	9.49	11.1	1.23	0.38
0103S14955D	XC-10	7.4	26.8	1.83	9.10	11.0	1.18	0.37

Lab ID	Sample ID	Interval (feet)	Lab ID	Sample ID	Interval (feet)
0103S14939	XC-6	3.1-5.1	0103S14948	XC-10	3.3-5.3
0103S14940	XC-6	13.1-15.1	0103S14949	XC-10	13.3-15.3
0103S14941	XC-6	23.1-25.1	0103S14950	XC-10	23.4-25.4
0103S14942	XC-6	33.1-35.1	0103S14951	XC-10	33.4-35.4
0103S14943	XC-6	43.0-45.0	0103S14952	XC-10	43.4-45.4
0103S14944	XC-6	53.1-55.1	0103S14953	XC-10	53.4-55.4
0103S14945	XC-6	63.0-6.0	0103S14954	XC-10	63.4-65.4
0103S14946	XC-6	73.1-75.1	0103S14955	XC-10	73.4-75.4
0103S14947	XC-6	83.1-85.1	0103S14956	XC-10	83.4-85.4
			0103S14957	XC-10	93.3-95.3

These results only apply to the samples tested.

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Lab Id	Sample Id	Coarse Fragments %	Sand %	Silt %	Clay %	Texture	1/3 Bar %	15 Bar %
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0103S14948D	XC-10		82.5	7.5	10.0	LOAMY SAND		
0103S14955	XC-10	58.0	72.5	17.5	10.0	SANDY LOAM	14.8	6.0
0103S14955D	XC-10		72.5	17.5	10.0	SANDY LOAM		

Lab ID	Sample ID	Interval (feet)	Lab ID	Sample ID	Interval (feet)
0103S14939	XC-6	3.1-5.1	0103S14948	XC-10	3.3-5.3
0103S14940	XC-6	13.1-15.1	0103S14949	XC-10	13.3-15.3
0103S14941	XC-6	23.1-25.1	0103S14950	XC-10	23.4-25.4
0103S14942	XC-6	33.1-35.1	0103S14951	XC-10	33.4-35.4
0103S14943	XC-6	43.0-45.0	0103S14952	XC-10	43.4-45.4
0103S14944	XC-6	53.1-55.1	0103S14953	XC-10	53.4-55.4
0103S14945	XC-6	63.0-6.0	0103S14954	XC-10	63.4-65.4
0103S14946	XC-6	73.1-75.1	0103S14955	XC-10	73.4-75.4
0103S14947	XC-6	83.1-85.1	0103S14956	XC-10	83.4-85.4
			0103S14957	XC-10	93.3-95.3

These results only apply to the samples tested.

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Lab Id	Sample Id	TOC	Total Sulfur	T.S. AB	Neutral. Pot.	T.S. ABP	TKN	Boron	Nitrogen Nitrate	Selenium
		%	%	t/1000t	t/1000t	t/1000t	%	ppm	ppm	ppm
0103S14948	XC-10	0.1	<0.01	0.00	1.16	1.16	<0.01	0.14	0.60	<0.02
0103S14948D	XC-10	<0.1	<0.01	0.00	1.29	1.29	0.01	0.13	0.48	<0.02
0103S14955	XC-10	0.8	0.07	2.19	138	136	0.01	0.13	0.82	<0.02
0103S14955D	XC-10	0.8	0.07	2.19	139	137	0.01	0.12	0.66	<0.02

Lab ID	Sample ID	Interval (feet)	Lab ID	Sample ID	Interval (feet)
0103S14939	XC-6	3.1-5.1	0103S14948	XC-10	3.3-5.3
0103S14940	XC-6	13.1-15.1	0103S14949	XC-10	13.3-15.3
0103S14941	XC-6	23.1-25.1	0103S14950	XC-10	23.4-25.4
0103S14942	XC-6	33.1-35.1	0103S14951	XC-10	33.4-35.4
0103S14943	XC-6	43.0-45.0	0103S14952	XC-10	43.4-45.4
0103S14944	XC-6	53.1-55.1	0103S14953	XC-10	53.4-55.4
0103S14945	XC-6	63.0-6.0	0103S14954	XC-10	63.4-65.4
0103S14946	XC-6	73.1-75.1	0103S14955	XC-10	73.4-75.4
0103S14947	XC-6	83.1-85.1	0103S14956	XC-10	83.4-85.4
			0103S14957	XC-10	93.3-95.3

These results only apply to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed By: _____
Joey Sheeley, Soils Lab Supervisor

N.: [illegible]

E.: 2,098,079

COAL LITHOLOGIC LOG
ENERGY WEST MINING COMPANY

PROJECT: 2ND RIGHT STAR POINT SAMPLE HOLES DRILL HOLE: 2R SP 1

LOCATION: 2ND RIGHT XC-10 INTAKE
COLLAR ELEV.: 7,725.8'
HOLE TYPE: AX CORE
PLUG INTERVAL: —
CORE INTERVAL: 0-99.4
TOTAL DEPTH: 99.4
DATE: 9/5/03 - 9/6/03
SCALE: 1" = 10'
GEOLOGIST: K.S. FLECK

GEOPHYSICAL DATA

LOG	FROM	TO
DENSITY:		
H.R.D.:		
E. LOG:		
GAMMA:		
CALIPER:		
S.P.:		

COAL SUMMARY:

SEAM	THICKNESS	INT.

DEPTH	PLUG	CORE	GRAPHIC LOG	FORMATION NAME	LITHOLOGIC DESCRIPTION	R.Q.D.	BOX NO.	RUN NO.	% REC.	SAMPLE
0			COAL		MINE FLOOR 0-2.3 COAL, HIAWATHA SEAM	39.8				
					2.3-3.4 SANDSTONE, LT. BROWN ROOTED, BLOTCHY F.G.	59		1	95	
					3.4-9.9 SANDSTONE LT. BROWN, MASSIVE, BECOMES GRAYER BELOW F.G. VERT FRAC 3.3-4.4	100	1	4.4 2	100	3.2-5.3
10					9.9-16.2 SANDSTONE, F.G., OCC. CARBY X.BEDS, GRAYISH BROWN S&P. TEXTURE	100	2	9.4 3	100	
								14.4		13.3-15.3
					16.2-17.1 SANDSTONE F.G., A.A., BUT V. SLIGHTLY WEATH.	100		4	100	
					17.1-17.6 SANDSTONE VFG, MASSIVE WEATH.	100				
					17.6-19.2 SANDSTONE, F.G., OCC CARBY X-BEDS, GRAYISH-BUFF. SL. WEATH.	100	19.4	19.4		
20					SANDSTONE, F.G., V. CARBY INTERVAL. 19.2-19.3	0				
					19.3-24.9 SANDSTONE F.G. OCC CARBY V-BEDS, MANICH RUFF, SL. WEATH	100	3	5 24.4	100	23.4-25.4
					24.9-28.5 SANDSTONE, VFG., ABDT WORM BURROWS, SL. WEATH.	100		6	100	
					28.5-29.1 SANDSTONE VFG, W/ABDT CARB LAMS WEATH.	0	29.4	29.4		
30					29.1-37.3 SANDSTONE, F.G., ROOTED & BURROWED, SL. WEATH DOWN TO 35.3	100	4	7 34.4	100	33.4-35.3
								8	100	
					37.3-47.4 SANDSTONE, F.G., MASSIVE, GRAY MINOR CLASTS & BURROWS NEAR BOTTOM.	92.7	39.4	39.4		
40							5	9 44.4	100	43.4-45.4
					47.4-49.4 INTERBEDS SANDSTONE/SILTSTONE/MUDSTONE, FINELY LAMINATED, BURROWED	60	49.4	10 49.4	100	
50					49.4-65.8 SANDSTONE, F.G., FAINT CARB BEDDING, OCC BURROWS NOT WEATHERED COOL WORM BURROW @ 59.8	100	6	11 54.4	100	53.4-55.4
								12	100	
60							59.4	59.4		
							7	13 64.4	100	63.4-65.4
					65.8-66.6 INTERBEDS, SANDSTONE/MUDSTONE, BURROWED	62.5		14	100	
					66.6-70.4 SANDSTONE, F.G., FAINT BEDDING, OCC. BURROWS	-0.1 97.3	69.4	69.4		
70										

COAL LITHOLOGIC LOG
ENERGY WEST MINING COMPANY

PROJECT: _____
DRILL HOLE: ZR SP 1
PAGE 2 OF 2

DEPTH	PLUG	CORE	GRAPHIC LOG	FORMATION NAME	LITHOLOGIC DESCRIPTION	R.Q.D.	BOX NO.	RUN NO.	% REC.	SAMPLE
70					70.4-70.9 INTERBEDS, SANDSTONE/MUDSTONE, BURROWED.	0				
					70.9-75.9 SANDSTONE, VFG., MASSIVE, OCC. BURROWS	100	8	15 / 74.4	100	73.9-75.4
					75.9-81.5 SANDSTONE VFG, FAINTLY BEDDED, BURROWED, SL. DARKER THAN ABOVE	100	79.4	16 / 79.4	100	
80					81.5-99.4 INTERBEDS, SANDSTONE/MUDSTONE, BURROWED.	-0.8	9	17 / 84.4	100	83.3-85.3
							89.4	18 / 89.4	100	
90						-0.5 92.7	10	19	100	93.3-95.3
							99.4	20 / 99.4	100	
100			T.D.							

N.: [illegible]

E.: 2,097,687

COAL LITHOLOGIC LOG
ENERGY WEST MINING COMPANY

PROJECT: 2ND RIGHT STAR POINT SAMPLE HOLES DRILL HOLE: 2R SP 2

LOCATION: 2ND RIGHT XC-6 INTAKE
COLLAR ELEV.: 7,741.8
HOLE TYPE: AX CORE
PLUG INTERVAL: —
CORE INTERVAL: 0-
TOTAL DEPTH:
DATE: 9/6/03 - 9/7/03
SCALE: 1" = 10'
GEOLOGIST: K.S. FLECK

GEOPHYSICAL DATA

LOG	FROM	TO
DENSITY:		
H.R.D.:		
E. LOG:		
GAMMA:		
CALIPER:		
S.P.:		

COAL SUMMARY:

SEAM	THICKNESS	INT.

DEPTH	PLUG	CORE	GRAPHIC LOG	FORMATION NAME	LITHOLOGIC DESCRIPTION	R.Q.D.	BOX NO.	RUN NO.	% REC.	SAMPLE
0			COAL		MINE FLOOR 0-2.7' COAL, HIAWATHA, BROKEN UP	0		1	100	
					2.7-3.1' MUDSTONE, SOFT, SANDY BROWN	0	1	4.1		3.1-5.1
					3.1-9.5 SANDSTONE, F.G., LT BROWN, MASSIVE, FADES DOWNWARD TO GRAY	100	2.1	2 9.1	100	
10					9.5-18.3 SANDSTONE, F.G., CARBY X-BEDS 800 CC. LAMS, SLIGHTLY WEATHERED IN SPOTS	100	2	3 14.1	100	13.1-15.1
								4 19.1	100	
20					18.3-27.1 SANDSTONE, A.A., WEATHERING ENDS @ 22.4, BURROWS BOTTOM 2'	99.5	3	5 24.1	100	23.1-25.1
					27.1-27.7 INTERBEDS, MUDSTONE/SANDSTONE, MINOR BIOTURB	58.3	29.1	6 29.1	100	
30					27.7-40.6 SANDSTONE, F.G., GRAY & WHITE, X-BEDDED.	99.2	4	7 34.1	100	33.1-35.1
							39.1	8 39.1	100	
40					40.6-44.2 SANDSTONE, VFG., W/OCC. MS INT, ADDT BURROWS & BIOTURB. SM INCIDENT V. FRAC	93.3	5	9 44.1	100	43.0-45.0
					44.2-54.7 SANDSTONE, F.G., GRAY, W/OCC. BURROWS, FAINT X-BEDS	99.0	49.1	10 49.1	100	
50							6	11 54.1	100	53.1-55.1
					54.7-63.8 SANDSTONE, F.G., GRAY, W/ ISOLATED MS INT. + LAMS.	97.8	59.1	12 59.1	100	
60							7	13 64.1	100	63.0-65.0
					63.8-64.6 INTERBEDS, MUDSTONE/SANDSTONE, BIOTURB	62.5				
					64.6-67.3 SANDSTONE, F.G., MASSIVE, FAINT X-BEDS	100		14 69.1	100	
					67.3-68.5 INTERBEDS, MUDSTONE/SANDSTONE, BIOTURB	83	69.1			
70					68.5-72.5 SANDSTONE, F.G., MASSIVE					

COAL LITHOLOGIC LOG
ENERGY WEST MINING COMPANY

PROJECT: _____
DRILL HOLE: 2R SP 2
PAGE 2 OF 2

DEPTH	PLUG	CORE	GRAPHIC LOG	FORMATION NAME	LITHOLOGIC DESCRIPTION	R.Q.D.	BOX NO.	RUN NO.	% REC.	SAMPLE
70						100	8	15	100	
					72.5-77.5 SANDSTONE, F.G., MASSIVE, GRAT. HEDT WORK BIOTROBUS	100		74.1		73.1-75.1
								16	100	
					77.5-82.5 SANDSTONE, F.G., MASSIVE, OCC. LAMIS & BIOTROBU	100	79.1	79.1		
80								17	100	
					82.5-89.1 SANDSTONE F.G., W/OCC MUDSTONE INTERLAMS THAT ARE INTENSELY BIOTURB.	92.4	9	84.1		83.1-85.1
							89.1	89.1	100	
90			T.D.							

IC 9405

INFORMATION CIRCULAR/1994

Response of Springs to Longwall Coal Mining at the Deer Creek and Cottonwood Mines, Wasatch Plateau, UT

By Liane L. M. Kadnuck

United States Department of the Interior

Bureau of Mines

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U.S. Department of the Interior Mission Statement

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally–owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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Cover: Clockwise from top left: topography of East Mouintain Summit; typical topography of Wasatch Plateau; surveying instrument in winter snowpack, soure of recharge for local springs; spring I and the stock watering pond it creates.

Information Circular 9405

Response of Springs to Longwall Coal Mining at the Deer Creek and Cottonwood Mines, Wasatch Plateau, UT

By Liane L. M. Kadnuck

UNITED STATES DEPARTMENT OF THE INTERIOR
Bruce Babbitt, Secretary

BUREAU OF MINES

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

cm	centimeter	m	meter
km	kilometer	pct	percent
L/s	liter per second		

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BUREAU OF MINES
SPRING CROSS REFERENCE

U.S. B. M. SPRING ID.	ENERGY WEST ID.
A	ELK SPRINGS
B	SHEBA SPRINGS
C	79-15
D	79-35
E	79-29
F	82-52
G	TED'S TUB
H	79-23
I	BURNT TREE
J	79-2
K	80-44
L	80-41
M	80-46
N	84-56

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RESPONSE OF SPRINGS TO LONGWALL COAL MINING AT THE DEER CREEK AND COTTONWOOD MINES, WASATCH PLATEAU, UT

By Liane L. M. Kadnuck[1]

ABSTRACT

This report summarizes the results of a hydrologic research study conducted by the U.S. Bureau of Mines (USBM) in cooperation with Energy West Mining Co. at the Deer Creek and Cottonwood Mines, near Orangeville, UT. The USBM evaluated hydrologic and overburden failure data to assess the response of local ground water to underground coal mining in single- and multiple-seam conditions. Fourteen springs located over the two mines were investigated in the study along with overburden failure response caused by longwall panel extraction. Spring discharge was compared to climatic variation and time of undermining to quantify response to undermining. Spring discharge had been reduced owing to below-normal precipitation during the period evaluated. The response of springs to mining in the vicinity was influenced in part by the thick overburden present at the study site, the presence of hydrophilic clays and mudstones in the overburden stratigraphy, and elevation of the springs above the mine level, which buffered the effects of undermining.

[1]Environmental engineer, Denver Research Center, U.S. Bureau of Mines, Denver, CO.

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INTRODUCTION

To quantify the response of overburden stratigraphy to high-extraction coal mining, the U.S. Bureau of Mines (USBM) initiated a research program to evaluate the effects of mining and associated subsidence in varying geologic conditions. The primary objective of this program is to understand the mechanics of subsidence and overburden failure response resulting from underground mining in Western U.S. coalfields. Previous USBM studies have focused on surface effects of underground coal mining *(1-5)*.[2] Recognizing that subsidence produces alterations in overburden characteristics which in turn produce associated changes in the hydrologic system, the program was expanded to include characterization of the response of hydrologic systems contained in the overburden. This study addresses the effects of overburden failure on hydrologic resources in proximity to a mined area.

This report describes the response of ground water contained in the overburden to underground mining in the Wasatch Plateau Coalfield. The study involved evaluating the response of local ground water resources overlying the Deer Creek and Cottonwood coal mines in Emery County, UT. The goals of this study were to (1) quantify fluctuations in spring discharge associated with undermining, (2) assess longevity of discharge fluctuations, and (3) correlate the stratigraphic locations and elevations of springs in the overburden stratigraphic column with zones of overburden failure.

ACKNOWLEDGMENTS

PacifiCorp's Fuel Resources Division provided valuable assistance in performing this research. Specifically, Chuck Semborski of the Energy West Mining Co. and Rodger Fry of InterWest Mining contributed much of the data and information contained in this report. Without their assistance, this study could not have been undertaken.

DEER CREEK AND COTTONWOOD MINES STUDY SITE

The Deer Creek and Cottonwood Mines are located in the Wasatch Plateau Coalfield in south-central Utah (figure 1). Two major coal seams are mined in the area by Energy West Mining Co., a subsidiary of PacifiCorp.; the Deer Creek Mine operates in the Blind Canyon Seam, and the Cottonwood Mine produces coal from the Hiawatha Seam approximately 26 m below. The Deer Creek Mine overlies and partly overlaps the Cottonwood Mine; hence the study area contains areas of both single- and multiple-seam mining. The mines are located on East Mountain (elevation 2,942 m). The local topography is typified by rugged mountains dissected by stream-incised canyons. The overburden thickness averages 518 m but ranges from 260 to over 700 m, depending on local topography.

[2]Italic numbers in parentheses refer to items in the list of references preceding the appendix.

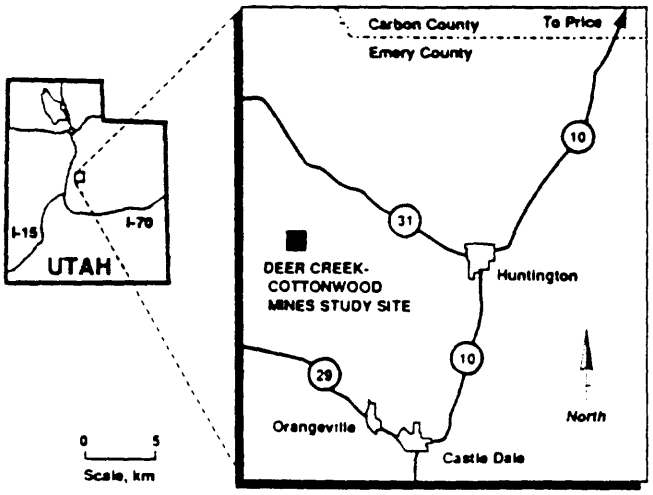

Figure 1.—Project location map.

Both mines currently extract coal using longwall retreat methods, and each contains areas of past room-and-pillar extraction. The coal is hard, dense, and ranked B to C bituminous. The Deer Creek Mine operates at an average extraction height of 3.3 m, and the Cottonwood Mine has an average extraction height of 2.6 m.

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GEOLOGY

Regional Geology

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The mines are located on the Wasatch Plateau, a broad, north-south-trending, flat-topped mesa. The eastern edge of the plateau lies on the western flank of the San Rafael Swell and is typified by gently westward-dipping strata. The western edge of the plateau is complexly faulted and represents the transition between the Colorado plateau

region and the Great Basin. Geologic units outcropping in the area range in age from Cretaceous to Tertiary, with some thin, unconsolidated Quaternary deposits present in stream valleys.

Local Geology

Exposed strata in the mine area are of sedimentary origin. The economic coal deposits are found in the lower part of the stratigraphic section. Generalized lithologies and thicknesses of each geologic unit are summarized in figure 2 *(6)*.

The youngest geologic unit in the area, the Flagstaff Limestone, is a freshwater limestone that caps portions of the top of East Mountain. The Flagstaff is underlain by the North Horn Formation, a variegated shale and mudstone sequence derived from fluvial and lacustrine origins. The Price River Formation forms a steep, receding slope under the North Horn and consists of a conglomeratic fluvial sandstone with shale layers. The North Horn and Price River Formations each contain claystones and mudstones that are rich in hydrophilic clays. The fluvial Castlegate Sandstone forms a cliff between the Price River and Blackhawk Formations. The Blackhawk Formation is a marginal marine sequence of lenticular sandstone beds and carbonaceous shales with economic coal deposits. The Blackhawk is typified as having fluvial channels scoured into the top of the coal deposits. Underlying the Blackhawk is the Star Point Sandstone, a thinly bedded marine sandstone with shale interbeds at the base where it intertongues with the older Masuk Shale Member of the Mancos Formation.

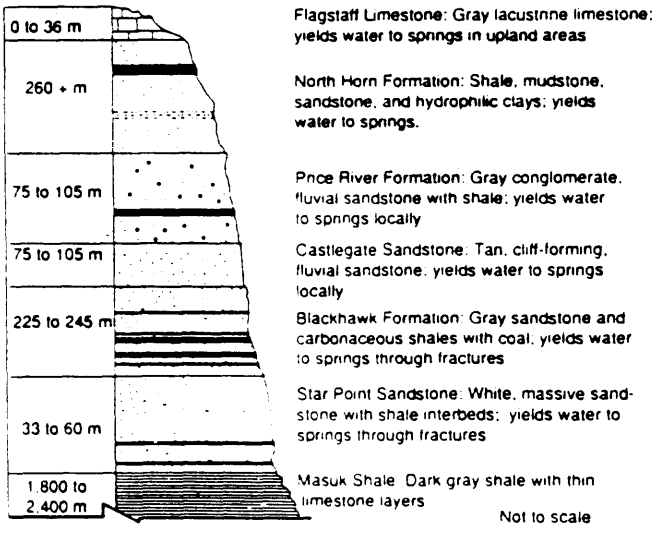

Figure 2.—Generalized overburden stratigraphy (modified from Danielson and others (7)).

The regional dip of the strata is broken by the northeast-trending axis of the Straight Canyon syncline, located on the western end of East Mountain. Faulting is common on the Wasatch Plateau, and three faults, the Deer Creek, Pleasant Valley, and Roan's Canyon, crosscut the permit area *(6)*. Jointing is also prevalent in the area, and joint sets trending northeast-southwest and northwest-southeast crosscut the study area. Figure 3 shows the locations and trends of the major structural features.

HYDROLOGIC SYSTEM

Ground Water Hydrology

Ground water occurs in all exposed geologic units discussed in the previous section in continuous or discontinuous water-bearing zones. The formations yield ground water from perched zones[3] to springs[4] where the hydraulic conductivity of the water-bearing zone is higher than that of the surrounding rock, and where the formations are fractured or faulted. The lateral continuity of these perched water tables is not known, though there is some evidence for limited lateral extent based on springs located at the same elevation *(6)*. The lateral extent of water-bearing zones is limited based on the discontinuous nature of the local topography. A continuous water-bearing unit was found to be present in the Star Point sandstone through drillers' logs and regional ground water studies.

Ground water in the area is recharged largely from precipitation, most of it from snowmelt, which percolates into the subsurface through fractures or matrix flow *(9)*. The flat top of East Mountain allows water to infiltrate to the subsurface through fractures exposed at the surface. Some recharge also infiltrates to the subsurface on the mountain flanks. Older units are recharged mainly from water that migrates through fractures. Impermeable lenses of shale and mudstone in the North Horn and Price River Formations retard downward migration of water, although some water is transmitted to the lower geologic units through continuous fractures. Geotechnical tests performed on the North Horn Formation indicated hydrophilic or swelling materials were present in the clays and mudstones that swelled 40 pct in the first hour of testing *(10)*. As a result, a large number of springs issue from the North Horn and Price River Formations. The Star Point Sandstone and the Blackhawk Formation are recharged from overlying units, mainly through faults and fractures *(6)*.

[3]By definition, perched water is "unconfined ground water separated from an underlying main body of ground water by an unsaturated zone" *(7)*.

[4]By definition, springs are a place where ground water flows naturally from a rock or the soil onto the land surface or into a body of water, and the occurrence depends upon the nature and relationship of rocks, especially permeable and impermeable strata *(8)*.

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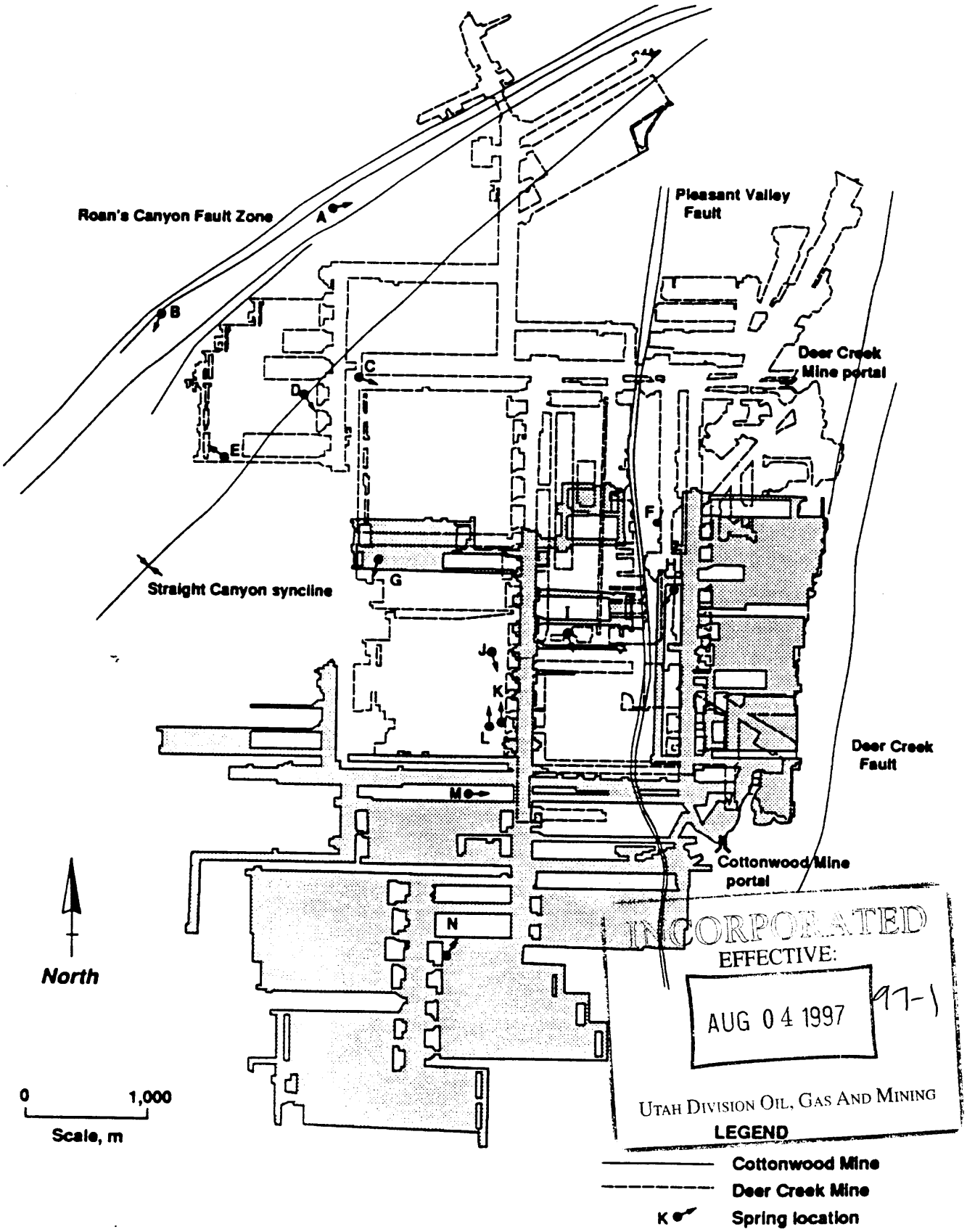

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Figure 3.—Mine map showing spring locations.

Water movement is controlled by dip of bedding, primary hydraulic conductivity, and fractures. Regional ground water flow in the immediate area is affected by the Joes Valley and Pleasant Valley fault zones, which are thought to be major conduits of interbasin flow. Water-bearing fractures encountered in the mines further indicate that ground water is transported along faults and fractures *(10)*.

Surface Water Hydrology

As shown on figure 4, East Mountain forms a drainage divide between Huntington Creek to the north and Cottonwood Creek on the south. The north fork of Cottonwood Creek drains the area between Trail and East Mountains, while Huntington Creek drains the area between East Mountain and Gentry Mountain to the north. There are numerous tributaries to these creeks, most of which are ephemeral, flowing only during precipitation events, or intermittent, flowing during wet seasons of the year.

Most of the overland drainage is derived from snowmelt, and most baseflow in the streams originates as ground water discharged from perched aquifers issuing water to springs *(6, 11)*. Large fracture systems associated with the fault zones in the area are thought to control the surface drainage and may intercept creek flow and divert it into other basins. A lineament analysis *(12)* coupled with a drainage trace analysis indicated that the major trunk streams follow a regional northwest-southeast trend and that tributary drainages follow either a north-south, east-west, or northeast-southwest trend. The linearity of the drainage traces suggests that the surface drainage is following fracture or joint systems.

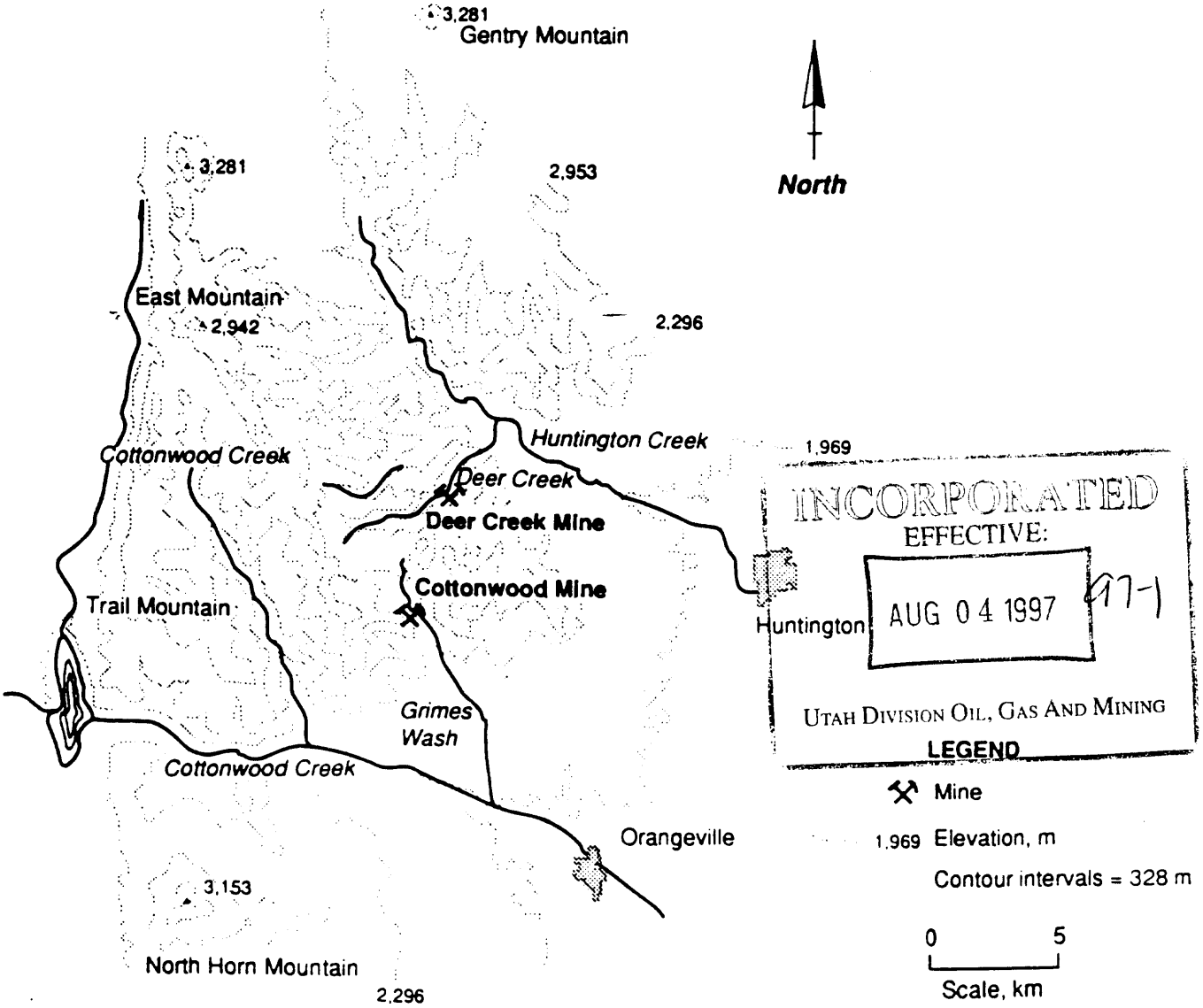

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Figure 4.—Topography of East Mountain showing surface drainage.

HYDROLOGIC DATA COLLECTION

The mining company is required by law to monitor quantity of water resources within the permit area. Monitoring includes spring and stream discharge, piezometric levels in the mine floor, and mine discharge from both the Deer Creek and Cottonwood Mines. This study focused on ground water resources located above the mine level, namely springs, that could potentially be affected by mining. Springs issuing from East Mountain within the Deer Creek and Cottonwood Mines permit area were chosen by PacifiCorp and the Utah Division of Oil, Gas and Mining to be monitored for discharge and water quality. Thirty springs within the permit area are monitored, some on a semiannual basis and some on a monthly basis. Discharge monitoring was started in 1979, and additional springs have been added each year since that time; thus records vary for all the springs monitored. Discharge is measured by weirs, flumes, or manually. The 14 springs selected for use in this study were those with the longest available monitoring records. The springs monitored on a monthly basis are measured from July through October, since they are inaccessible during winter months. Discharge is reported from annual runoff through baseflow in the fall.

The monitoring is performed to allow comparison and assessment of the effects that mining has on the springs. The springs were characterized by mine personnel for issuing mechanism (for example, a fracture or a perched zone), issuing formation, and elevation measurements taken. This information is provided in table 1.

Water enters the mines through faults, fractures, and drill holes, and where localized saturated zones (fluvial sandstone channels) are intercepted by mine workings. Water discharged from the mines is measured at the discharge point on a daily basis and reported as a monthly total. Mine water from the Cottonwood Mine is discharged into Grimes Wash, and water from the Deer Creek Mine is discharged into Huntington Creek (figure 4).

Table 1.—Spring characteristics

Spring	Geologic unit	Issuing mechanism	Elevation, m	Location	Date undermined
A	North Horn	Fracture	2,850	Not in mined area	Not applicable.
B	Flagstaff	..do.	2,969	..do.	Do.
C	North Horn	..do.	2,831	Deer Creek barrier pillar	Do.
D	Flagstaff	Formation contact	2,921	Deer Creek panel	Oct. 1991.
E	North Horn	Perched zone	2,868	..do.	Feb. 1992.
F	Price River	..do.	2,743	Deer Creek barrier pillar	Not applicable.
G	North Horn	Fracture	2,831	Deer Creek panel	Apr. 1988.
H	..do.	Formation contact	2,754	Deer Creek mains, Cottonwood pillar	May 1976.
I	..do.	Perched zone	2,822	Deer Creek submains, Cottonwood panel	Aug. 1993.
J	..do.	..do.	2,831	Deer Creek panel	Aug. 1986.
K	Price River	Fracture	2,737	..do.	Dec. 1982.
L	..do.	Perched zone	2,743	..do.	Aug. 1982.
M	North Horn	..do.	2,850	Cottonwood barrier pillar	Not applicable.
N	..do.	Fracture	2,845	Cottonwood panel	Aug. 1989.

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ANALYSIS OF SPRING RESPONSE TO MINING

This study concentrates on characterizing the impacts mining has on perched water-bearing zones in the overburden. In the study area, water-bearing zones above the mine level issue water to springs, representing an important part of water supply in the region for stream baseflow, agricultural, irrigation, and wildlife habitat purposes. Fourteen springs located on East Mountain were targeted for study based on availability of monitoring records and proximity to the mines and were designated with a letter identifier of A to N. Analysis of spring response followed a method used by Coe and Stowe (*13*), which is one of the few published studies that have examined responses of springs to undermining. This methodology required use of information sets including precipitation, spring discharge, and time of undermining.

This method involved comparing spring discharge hydrographs to precipitation for the period of monitoring. Monthly and total annual precipitation data for water years[5] 1981 to 1993 were utilized and are shown on figure A-1 in the appendix. Precipitation data are collected at a weather station on East Mountain on a daily basis. The availability of seasonal, monthly discharge data dictated using seasonal recession curves to assess mining impacts by determining if the springs departed from normal response. Patterns or trends in the spring discharge recession curves were sought to assess if the springs showed similar responses each year to precipitation, runoff, and baseflow conditions. Curves were compared to one another to discern if springs in the area responded differently based on issuing mechanism (fracture versus perched zone). There did not appear to be large differences in response as a result of issuing mechanism. Several years of data prior to mining were incorporated to establish baseline conditions. Spring discharges, shown as seasonal recession curves, are given on figure A-2.

Initial comparison of spring discharge to precipitation indicated that discharge did not immediately follow precipitation. Therefore, a statistical analysis that cross-correlated precipitation data with spring discharge was performed for two of the springs. This analysis showed that the springs in the study area respond to precipitation events within 6 months to 1 year (*14*). Discharge data for springs I and M were correlated with precipitation; this indicated that there is an approximate 6-month to 1-year lag time between precipitation events and discharge. The lag information was used to better assess variations due to climatic events without confusing them with response that may have been a result of mining. Results of the statistical analysis are given graphically on figure A-3. The graphs show the calculated lag time by offsetting the spring flow hydrograph by 1 year on the precipitation curve; for example, spring flow for 1982 is placed over precipitation for 1981. Local variation of lag time is expected based on differences in elevation, recharge source, and issuing mechanism for each of the springs studied. The statistical correlation gives an indication of the approximate lag time for the area. Figure A-4 gives the statistical results showing match position and correlation coefficient to demonstrate the validity of the correlation of the two data sets.

Spring discharge variation of both preundermining and postundermining was evaluated to identify if the spring discharge changed as the spring was undermined, or as mining progressed close by. Each spring location was compared with a map of mine workings and located with regard to placement over a mine structure such as a panel or a barrier pillar, as shown on figure 3. This information is also listed on table 1. Springs D, E, G, I, J, K, L, and N are located over longwall panels. Springs C, F, H, and M are located over other mine structures such as barrier pillars or mains. Springs A and B are located in an area that has not been undermined and were thus used as controls to identify discharge fluctuations due to climatic events. Spring discharge was carefully compared with precipitation, location of the spring over the extracted area, and time of undermining to assess response.

[5]The water year runs from October 1 to September 30.

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RESULTS AND DISCUSSION

Spring A

Possible responses of springs to coal extraction include enhanced recharge to the spring from dilation of pre-existing fractures, reduction of spring discharge due to drainage into subsidence-induced fractures or dilation of existing fractures, or flow loss along planes of bedding separation *(9)*. Springs located over panels are expected to show a greater response to undermining than those located over mains or barrier pillars since most subsidence, and hence overburden deformation, occurs over the longwall panels. In a study in Appalachia where the overburden ranged from 120 to 245 m, rapid and dramatic decreases in spring discharge were observed as the longwall face passed underneath *(13)*. Trevits and Matetic observed a similar response in water wells located over longwall panels with 70 to 210 m of overburden present *(15)*. With the longwall mining method, subsidence occurs quickly after the coal is extracted as the immediate mine roof caves in behind the active face. Reports from mine personnel indicate that the majority of subsidence occurs at the site over single panels within 1 month after undermining.[6] Previous USBM studies reported that maximum subsidence occurred at these mines within a year where a group of panels had been extracted *(1, 3)*. Given these observations, hydrologic response is expected to occur within a similar timeframe as overburden response. As soon as the overburden fractures and moves in response to coal extraction and roof caving, the hydrologic system is also altered. The expected response of springs would be dramatic changes in discharge after undermining occurred.

Springs A and B were located outside the area disturbed by mining and provided information on the normal seasonal response of springs in the area to precipitation or recharge. From 1986 to 1992, precipitation in the area was 70 to 85 pct of normal. The recession curves for these springs show a general downward trend from 1986, in response to the decreased precipitation during that period. Precipitation increased in 1993 and is shown in the increase in spring discharge on the hydrographs (figure A-2). The shapes of the recession curves show smooth and repeatable patterns for the period of record.

Spring I is used as a water source for a stock watering pond. It was undermined by submains in the Deer Creek Mine in 1985, and by a longwall panel in the Cottonwood Mine in August 1993. It was noted that the recession curves departed from a normal shape coincident with mining activity underneath spring I. However, adjustments of valves and blockage in the pipe installed at the spring also occurred during this time, and available data do not allow for distinguishing the effects of the two activities. Weekly discharge measurements were available after the longwall panel passed underneath. Although surface tension cracks appeared in the vicinity, the spring discharge remained constant at 0.6 L/s. According to aerial surveys, the surface subsidence in the vicinity of spring I ranged from 0.6 to 1.2 m.

Spring E was undermined by a Deer Creek panel in February 1992. This spring exhibited inconsistent recession curves in the 5 years prior to undermining and then had a flat recession curve in the year after undermining. The surface subsidence at spring E was estimated to be 1.6 to 1.8 m. The spring has a very low discharge, making detection of discharge alteration more difficult. It is felt that the discharge alteration for this spring is a result of reduced recharge available from the decrease in precipitation.

Spring N was undermined by a Cottonwood panel in August 1989. The recession curves for the spring have a less consistent shape than those for springs A and B, although the shapes of the spring N curves are repeated over several years. The spring exhibits the same response both before and after undermining and also shows a general downward trend from 1986 due to decreased precipitation. The surface subsidence in the vicinity of spring N was 0.6 to 1.2 m. Given the repeatable nature of the recession curves, spring N does not appear to have been affected by mining.

The remaining springs located over panels and springs located over pillars or mains did not exhibit discernible effects from undermining.

Springs H, K, L, and M exhibited flat recession curves at some point during the period of monitoring. In these cases, the springs were reduced to low or no flow. These springs experienced no-flow conditions for several years corresponding to the drought years. Flow returned in springs K, L, and M in 1993; spring H had not recharged

[6]Personal communication with C. A. Semborski, Energy West Mining Co., Sept. 1993.

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to normal flow by 1993. The flat curves are likely due to depleted recharge from precipitation to the spring source or to depleted storage. Springs D and N each had 1 year where the recession curves were flat, but returned to normally shaped curves the following year. In these cases, the flat recession curves did not correspond to times of undermining. The control springs, A and B, did not show flat recession curves during the period of study, which is likely a result of fracture recharge conditions and locations at high elevations.

The undermined springs do not show the dramatic decreases in flow that have been observed in other studies. The lack of dramatic effects and the limited response observed may be attributed to several factors. One factor is that the springs that have been undermined are situated above the panels at ratios of panel width to overburden thickness (between the spring and the mine level) greater than 1.0. In a study by Tieman and Rauch (*16*), partial to total dewatering was observed in springs that were located above the panels at panel width to overburden ratios of 0.75 to 1.0. Table 2 summarizes the range of panel width to overburden ratios for springs undermined by panels evaluated in this study. Since the ratios are greater than 1.0 for the springs in this study, dewatering would not be anticipated, based on the observations made by Tieman and Rauch. This does not preclude minor discharge variations occurring as a result of strata movement or stress redistribution. Table 2 also lists the estimated surface subsidence in the vicinity of the springs located over panels.

Table 2.—Ratios of panel width to overburden thickness for springs over panels

Spring	Ratio of panel width to overburden thickness	Surface subsidence, m
D	1.1	0.6 - 1.2
E	1.3	1.2 - 1.8
G	1.1	0.6 - 1.2
I	1.2	0.6 - 1.2
J	1.3	0.6 - 1.2
K	1.2	< 0.6
L	1.1	0.6 - 1.2
N	1.1	0.6 - 1.2

The limited response observed for the springs was thought to be influenced by site-specific conditions that buffered the effects of mining. These include the thick overburden present and the presence of formations in the overburden that contain hydrophilic clays and mudstones. Results from other studies have concluded that the presence of hydrophilic clays lessens the extent of strata dewatering *(13, 17)*. Additionally, the presence of a massive sandstone layer (the Castlegate Sandstone) can cause bridging in the overburden, thereby limiting subsidence and associated hydrologic response *(1)*.

Another factor contributing to the limited spring response was the elevations of the springs above anticipated heights of fracturing and caving in the overburden, as estimated using formulas developed by Peng *(18)*. The relationship of fracture height equal to 30 times mining thickness was used. This relationship was developed based on mining conditions common to Eastern U.S. coalfields and does not account for differences in Western U.S. conditions such as the presence of massive sandstones in the overburden or thicker overburden. However, no similar value has been developed for the West, so the published relationship is commonly applied. Use of the relationship indicated that overburden fracturing might occur up to an elevation of 2,400 m from the Deer Creek Mine and up to approximately 2,330 m from the Cottonwood Mine. Spring K was the lowermost spring studied and was located at 2,737 m, 337 m above the computed height of fracturing. For the case that both coal seams had been extracted, gob formation and fracturing associated with mining the second lower seam would be incorporated into the fracturing produced by mining the first upper seam.[7] A conceptual subsurface overburden failure schematic is shown on figure 5.

Although all the springs studied were located at elevations higher than the computed elevations of fracturing in the overburden, the springs were located in a zone of the overburden where, according to Peng, continuous bending of the strata occurs. Preexisting fractures can dilate in response to the bending, causing flow variation. The bending and redistribution of stresses in the overburden can also cause flow variations.

[7]Personal communication with C. Haycocks, Department of Mining Engineering, Virginia Polytechnic Institute, Aug. 1993.

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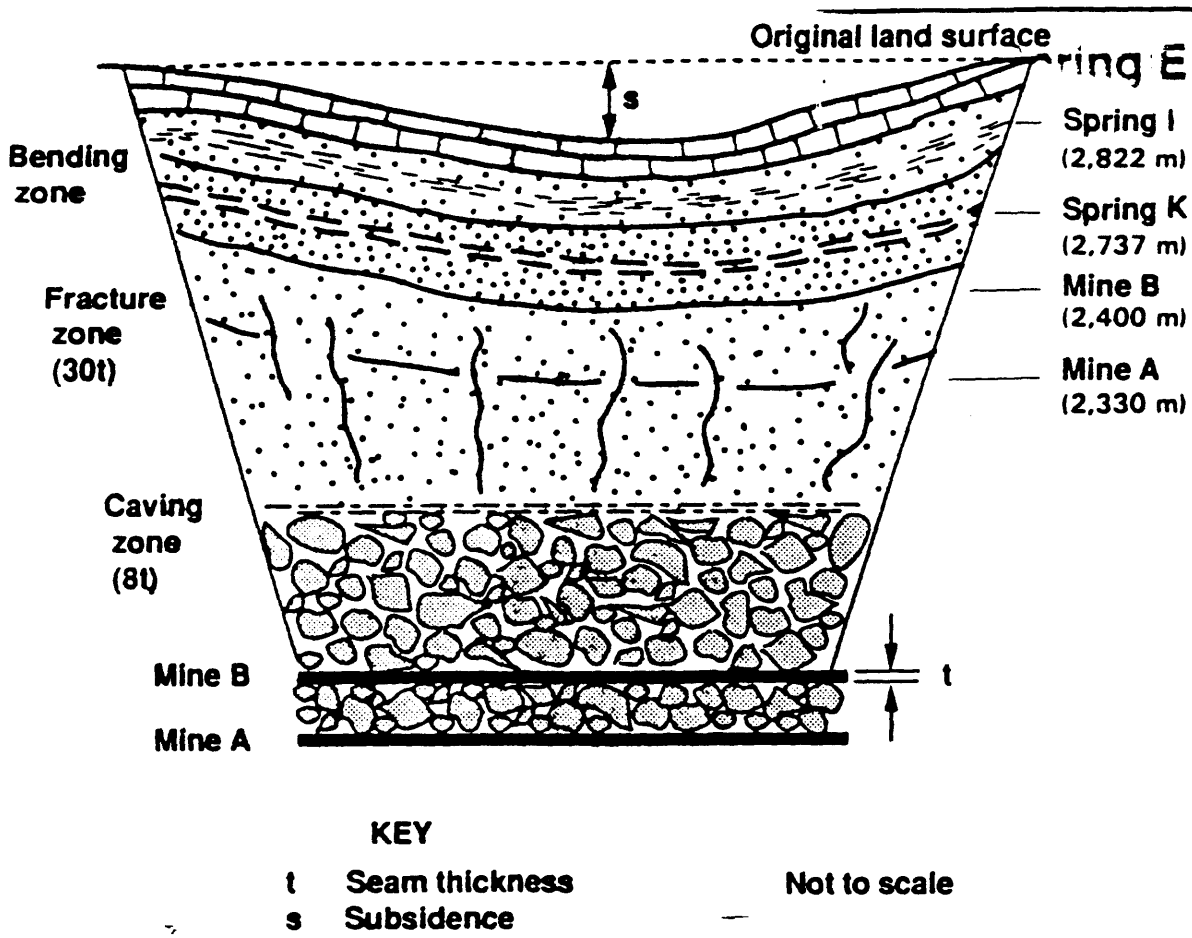

Figure 5.—Conceptual overburden failure schematic.

SUMMARY

The USBM used data available from the Deer Creek and Cottonwood Mines to perform a study of underground coal mining effects on local overburden hydrology. Data used in the study included seasonal and annual spring discharge, precipitation, surface subsidence, and overburden failure mechanics information. These data sets were used to quantify the response of 14 springs to underground mining.

Eight springs occurred over longwall panels. One of the eight, spring I, exhibited a departure from a normal recession curve coincident with the time of mining activity underneath it. Adjustments to valves and blockage of a pipe installed at the spring also occurred in the same time period and contributed to the variations in curve shape. The spring exhibited a constant discharge rate in the weeks after being undermined by a longwall panel, indicating that little variation occurred as a result of mining. The eight springs over panels all occurred at locations where the ratio of panel width to overburden thickness was greater than 1.0, thus limiting dewatering effects, as was observed in previous studies in Eastern U.S. coalfields. Surface subsidence did not appear to play a major role in the response of springs at this site.

Four springs experienced no discharge conditions during the period of study that were attributed to effects of regional decreased precipitation. Springs located over mine structures such as pillars or mains did not exhibit discernible effects from mining. For this study, the long-term availability of water resources was important and therefore dictated examining the seasonal response of springs in relation to mining.

The expected response of springs to undermining would be dramatic alterations in flow, as previously documented in other studies. The lack of observed responses was attributed to geologically driven site-specific conditions that buffered the effects of mining. These conditions included the thickness of overburden between the mine level and the springs, which ranged from 440 to over 600 m. Studies performed in the Appalachian coalfields noted dramatic decreases in spring discharge and water levels in wells

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where thinner (70 to 245 m) overburden was present *(13, 15, 17)*. Additionally, the presence of hydrophilic clays and mudstones in the overburden, which act as aquitards retarding the migration of water, likely lessened the vertical extent of strata dewatering, as has been observed in other studies *(17)*. The location of the springs above the estimated elevations of fracturing and caving in the overburden due to subsidence also contributed to the limited effects.

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APPENDIX.—HYDROLOGIC DATA G:

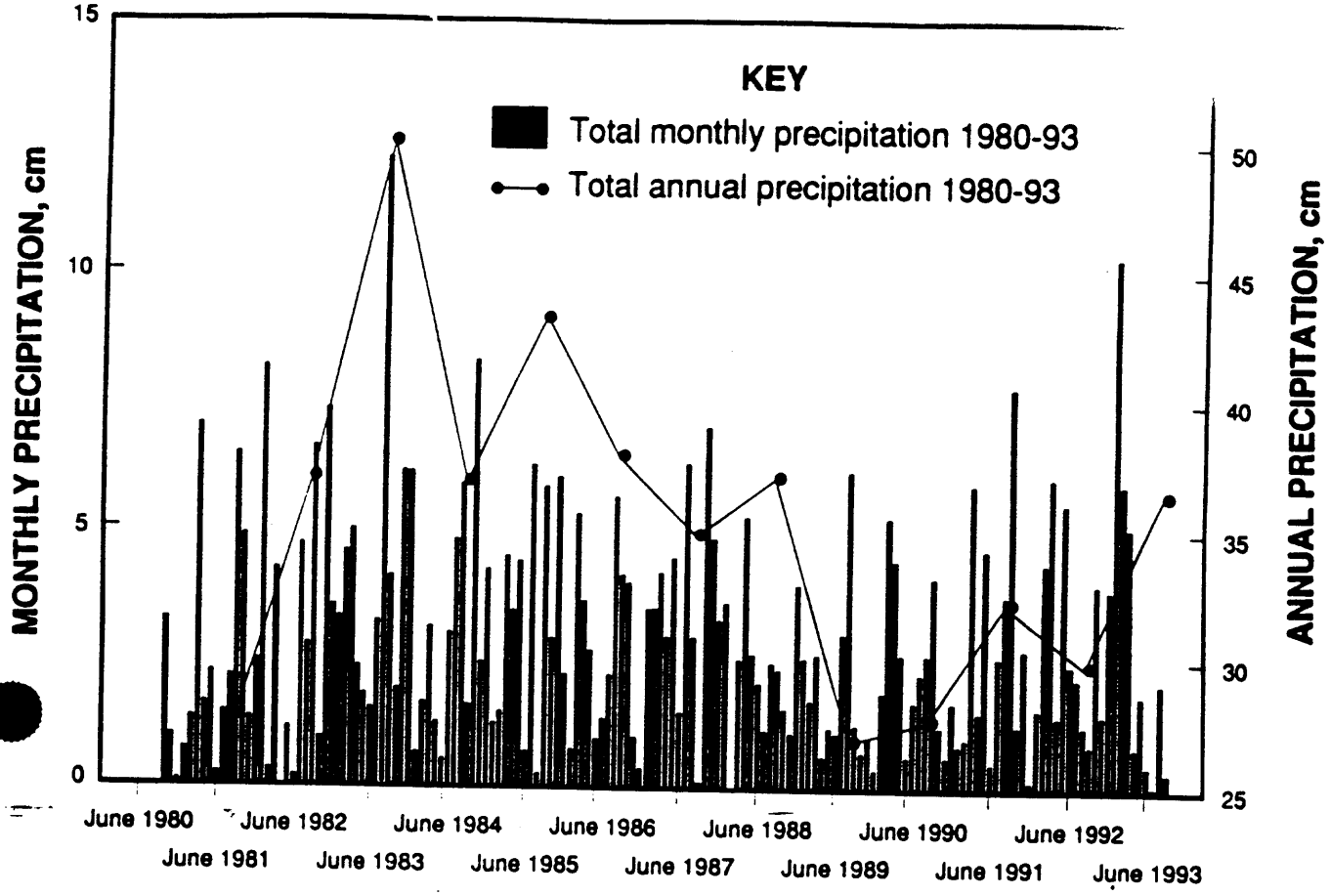

Figure A-1.—East Mountain precipitation for water years 1981-93.

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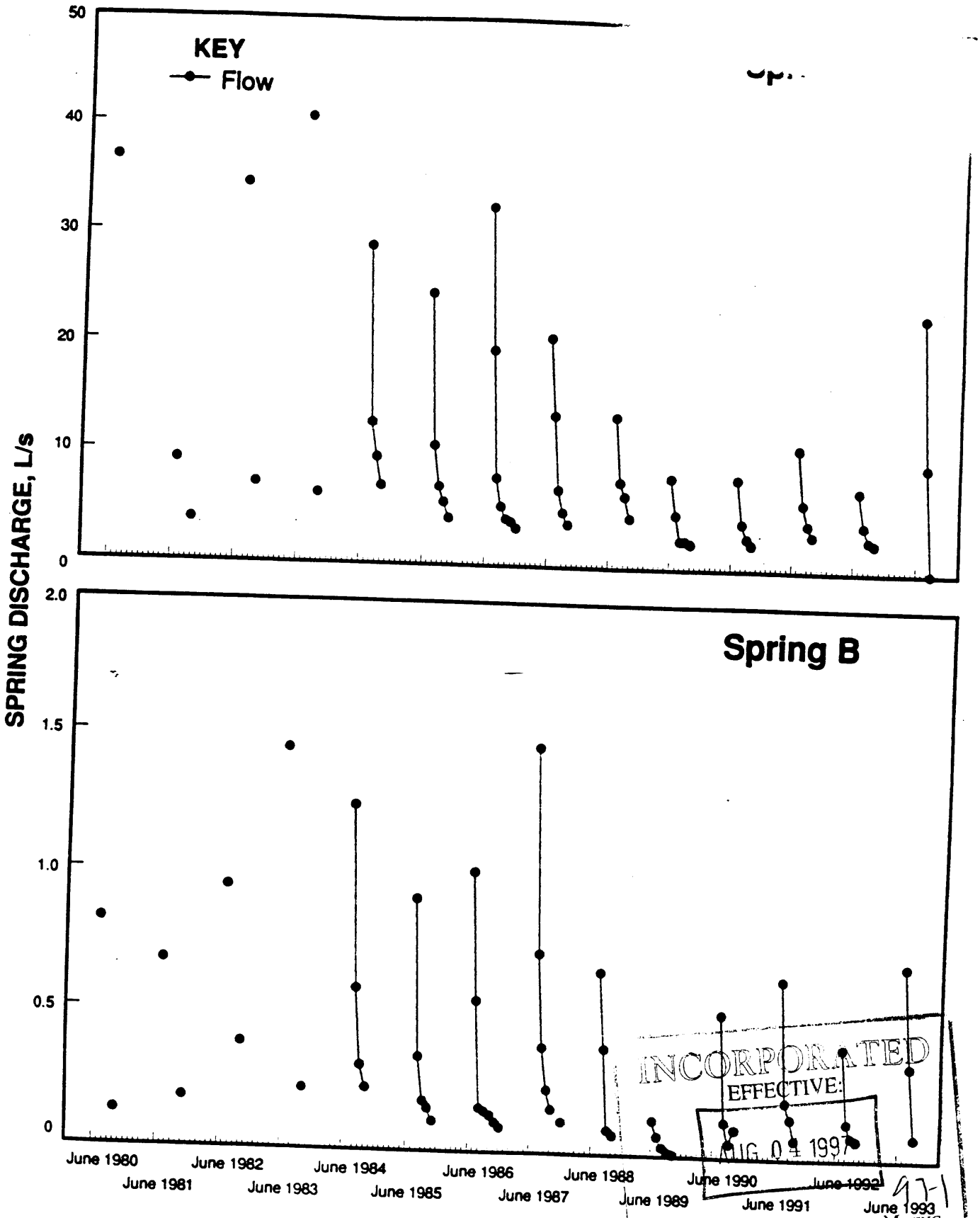

Figure A-2.—Spring discharge hydrographs for water years 1981-93.

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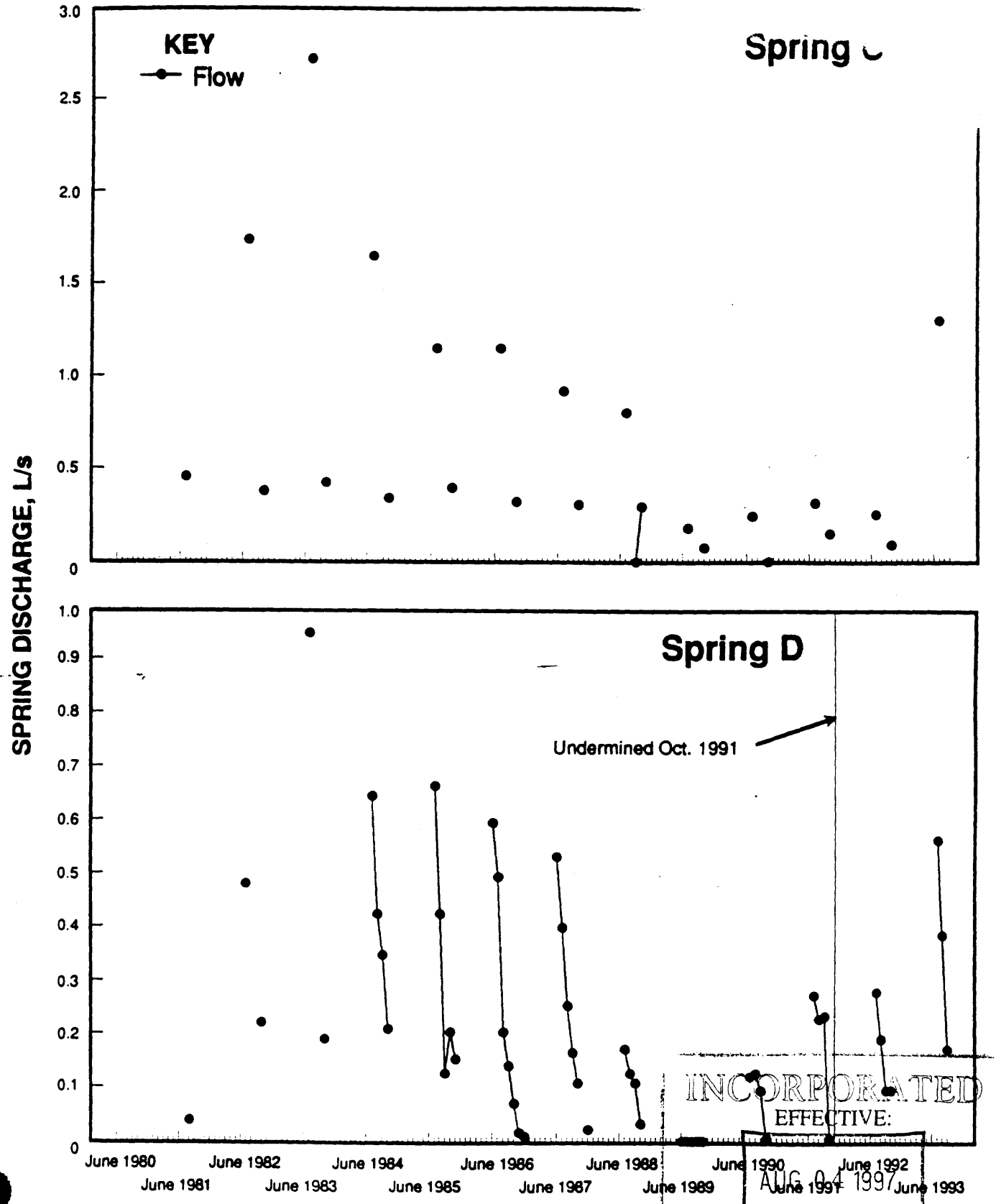

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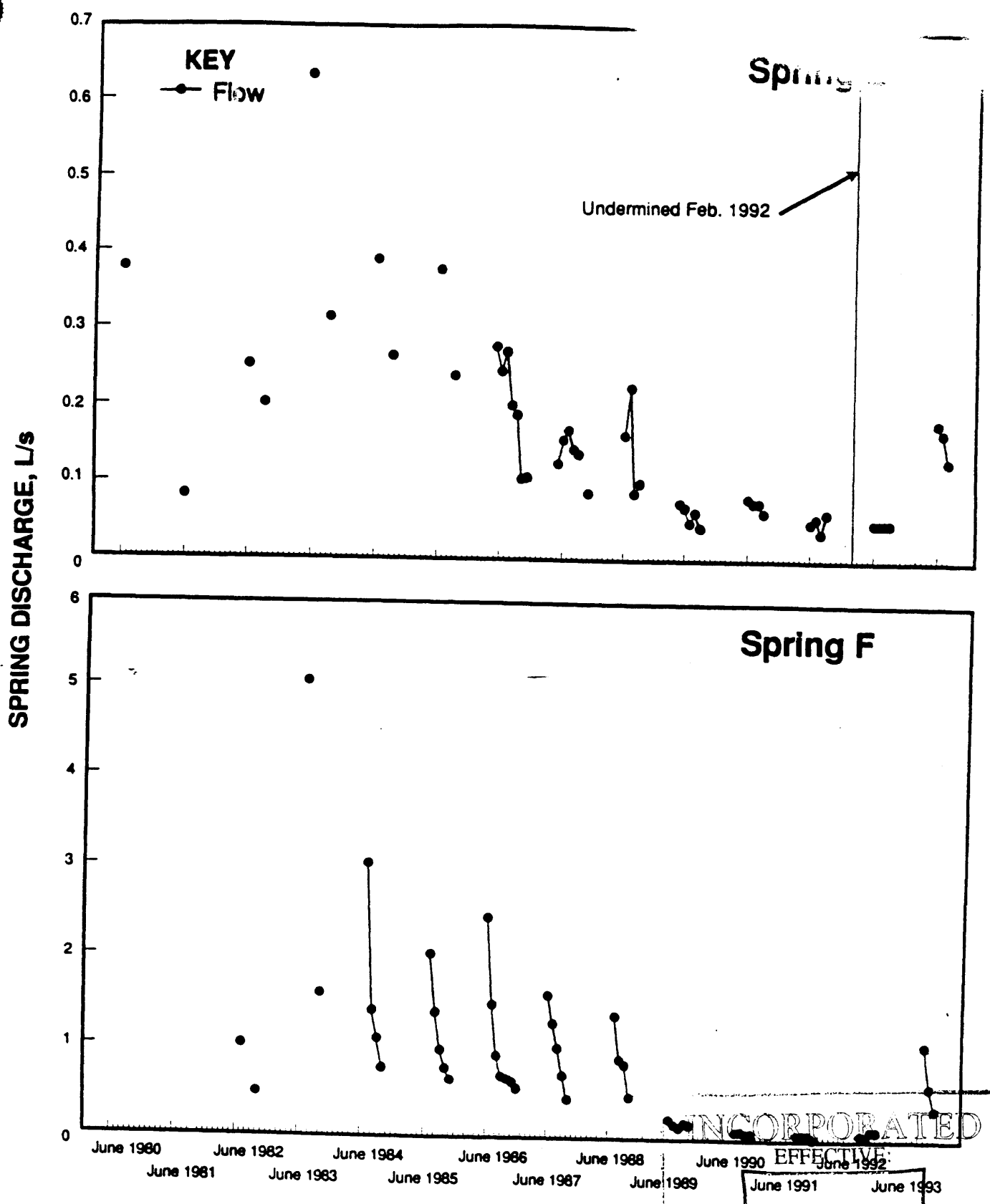

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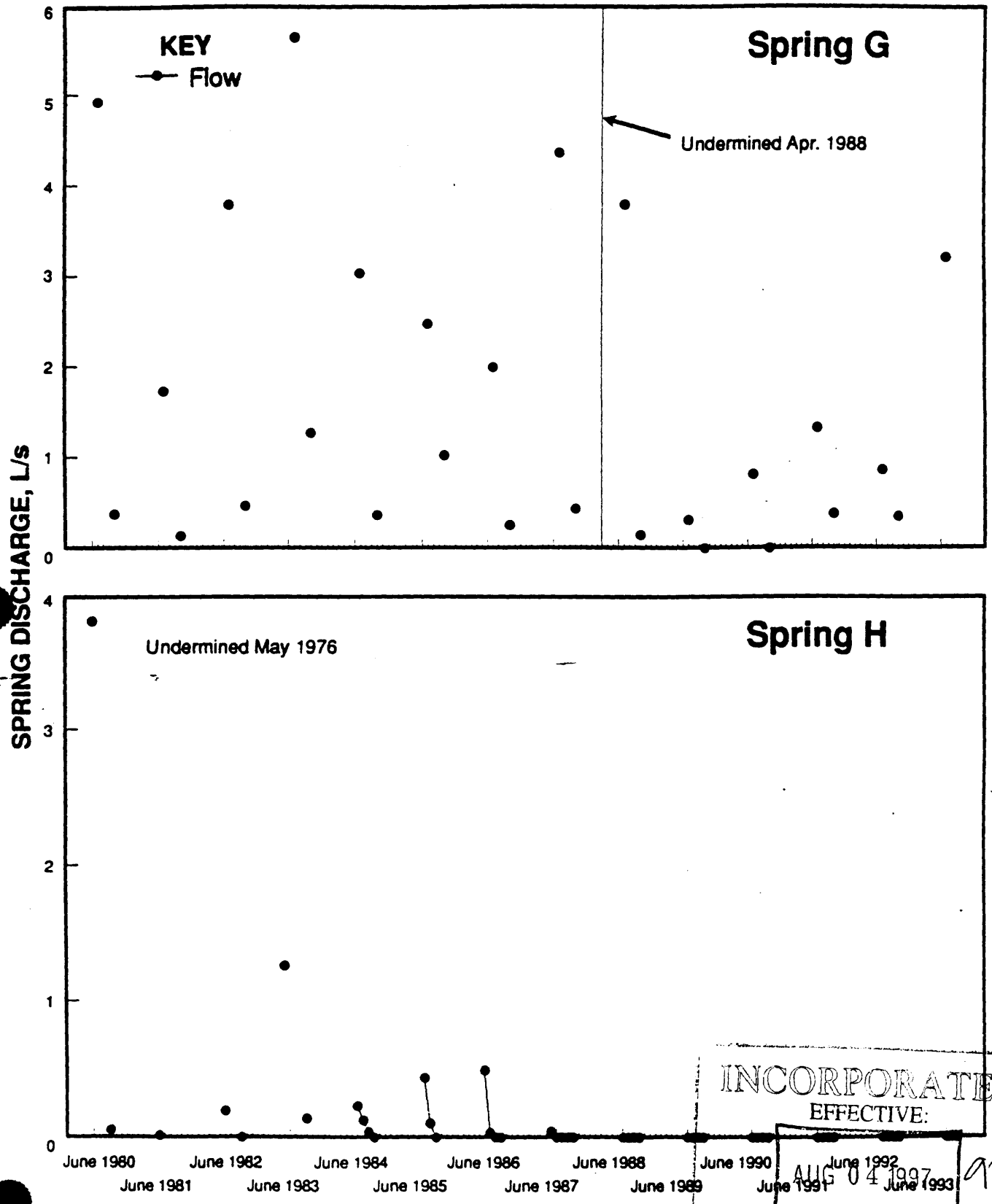

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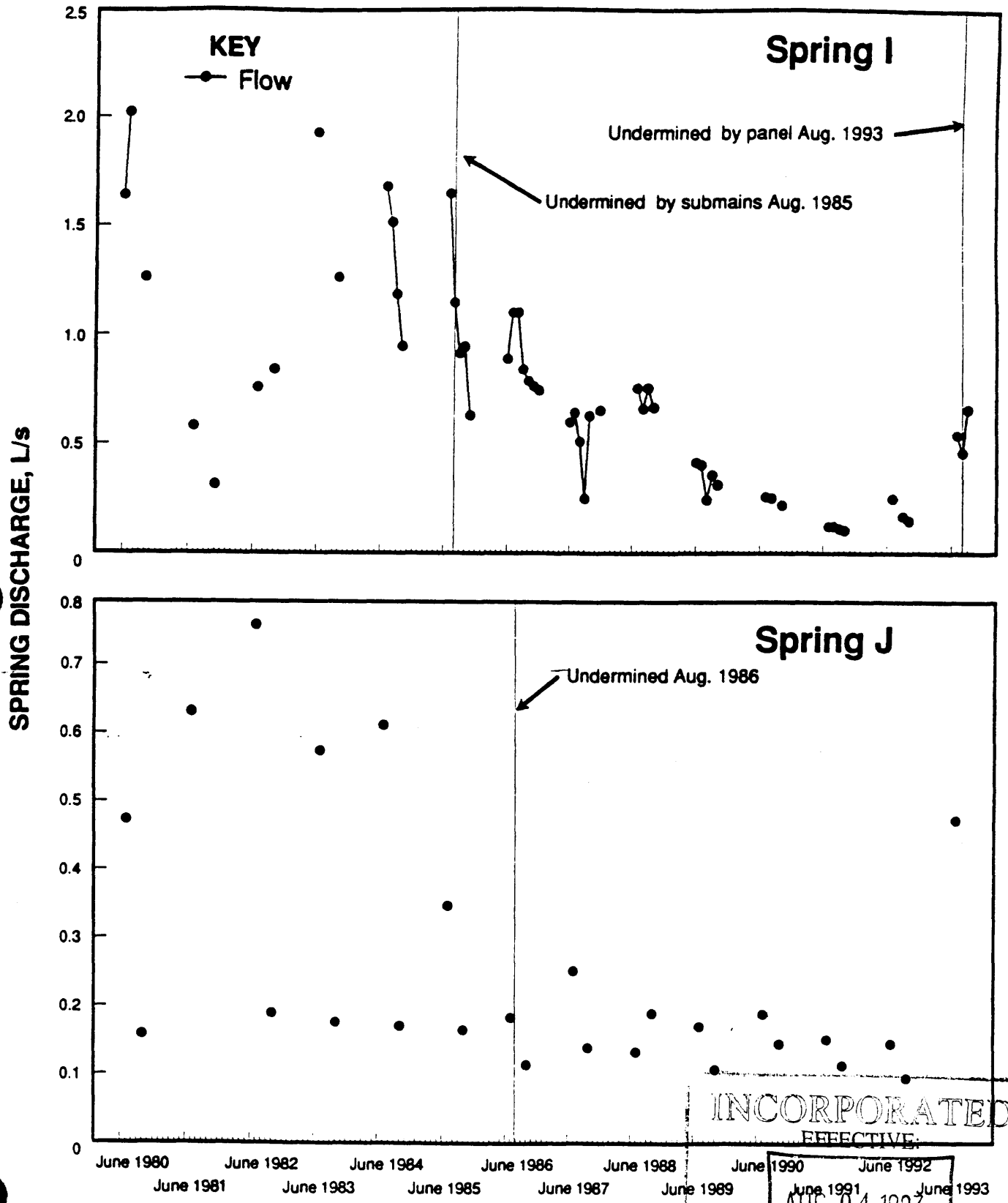

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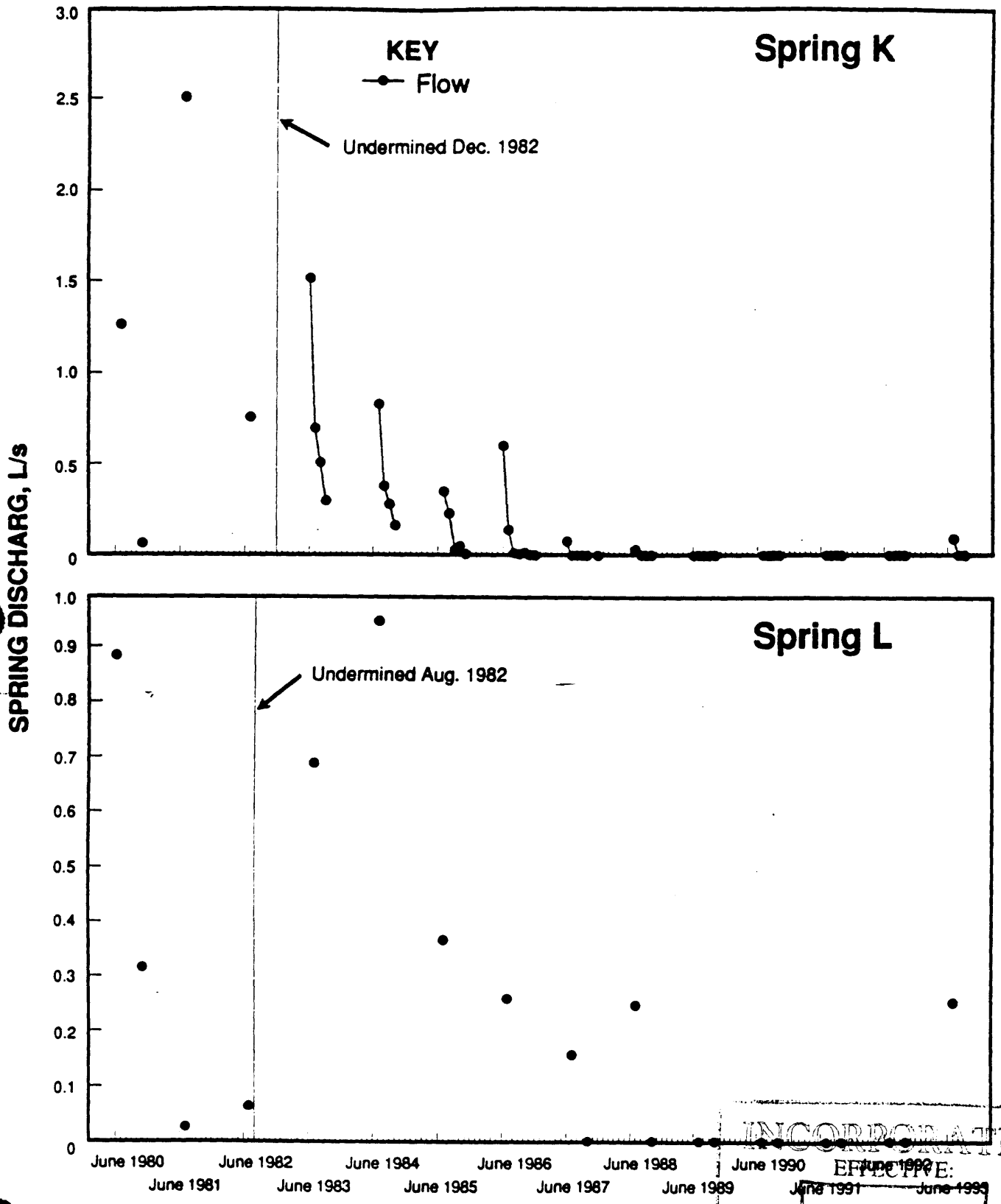

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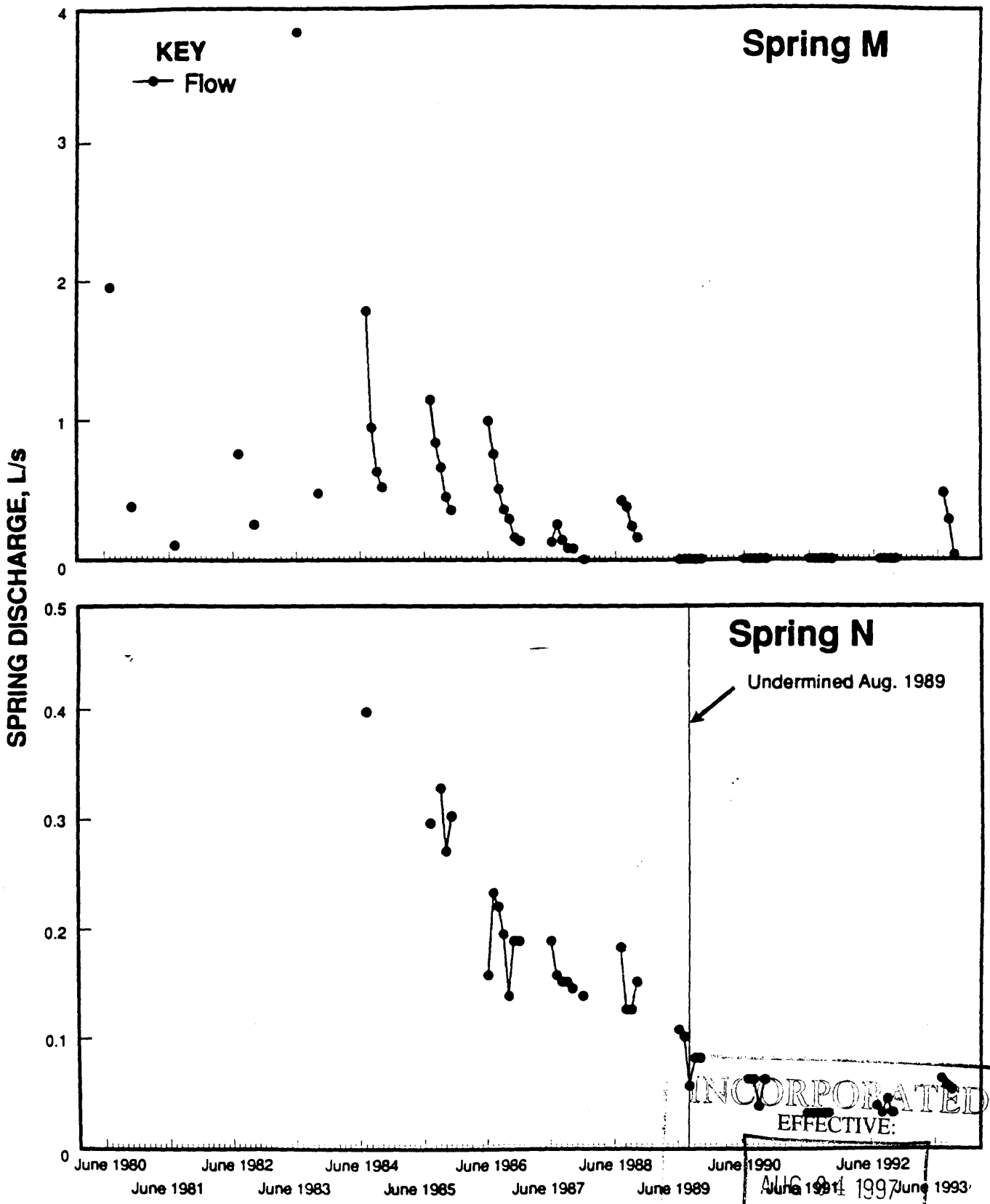

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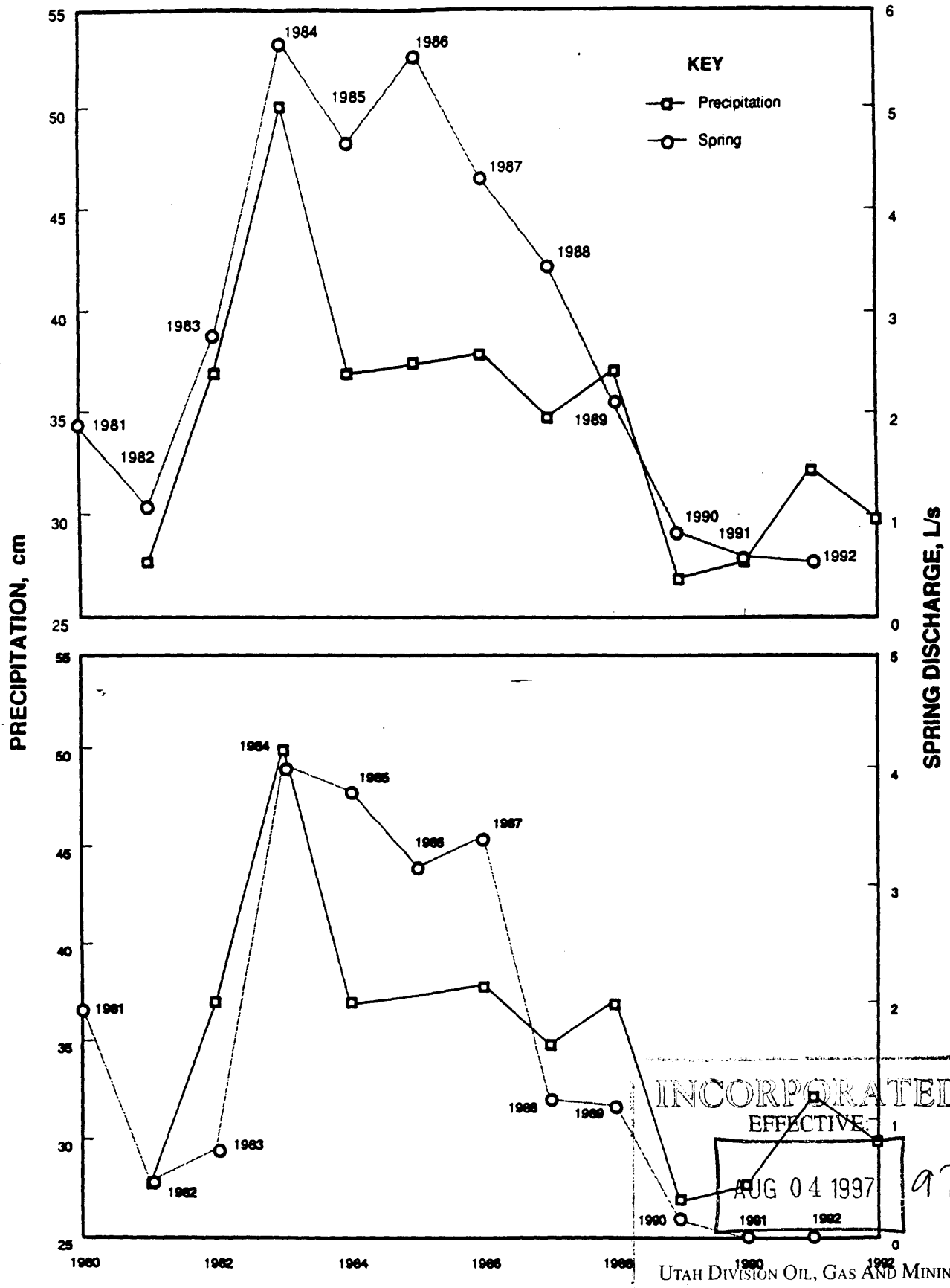

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Figure A-3.—Cross-correlated spring and precipitation data. Top, spring I; bottom, spring M.

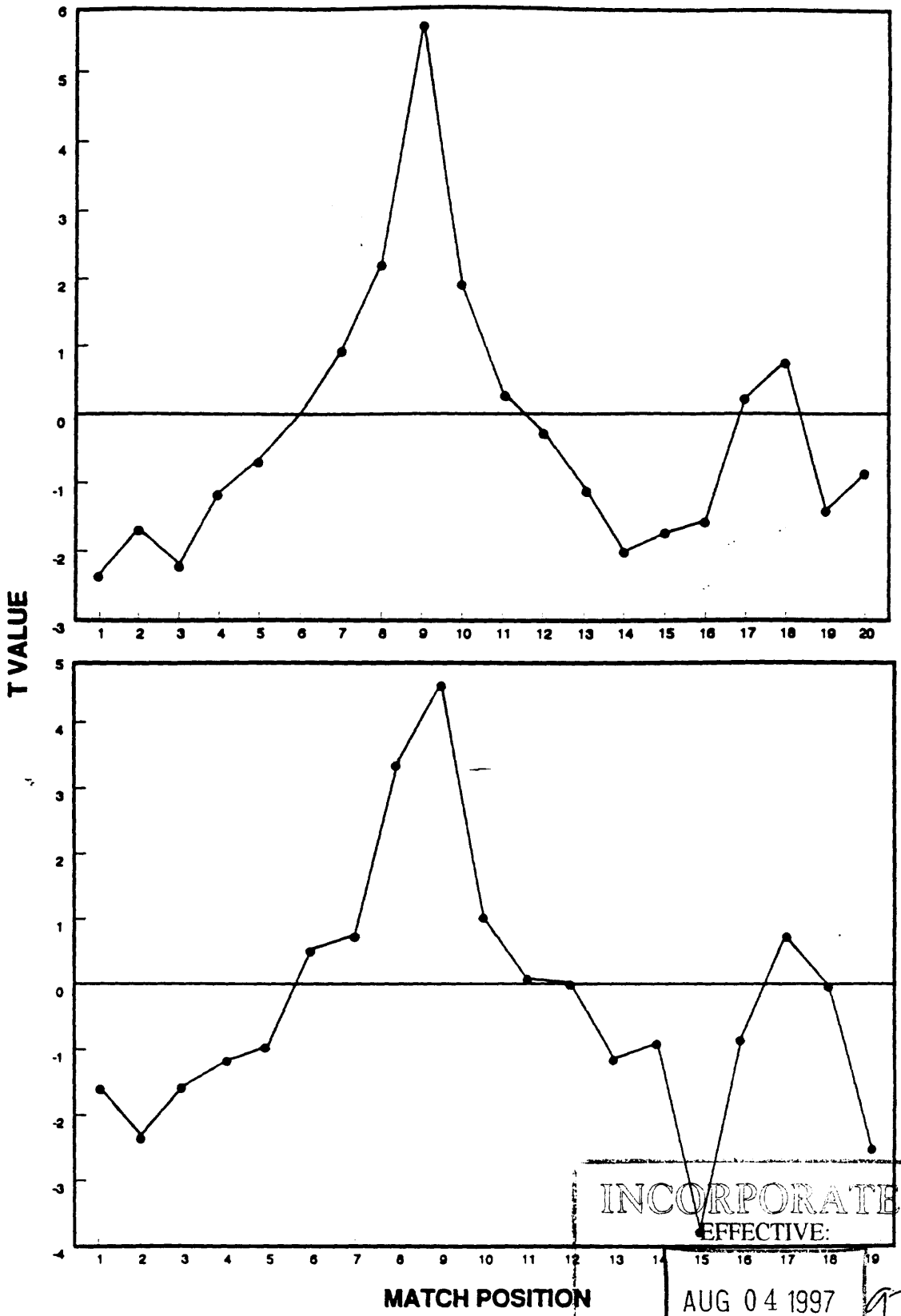

Figure A-4.—Match position versus T value. Top, spring I; bottom, spring M.

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DEER CREEK MINE

VOLUME 11 - NORTH RILDA CANYON PORTAL FACILITIES

R645-301-700: APPENDIX B

DRAINAGE AND SEDIMENT CONTROL PLAN

DRAINAGE AND SEDIMENT CONTROL PLAN

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DRAINAGE AND SEDIMENT CONTROL PLAN

1. INTRODUCTION

The Rilda Canyon Portal Facility is a satellite component of the Deer Creek Mine located in Rilda Canyon in a area previously disturbed by coal mining activities. The facilities are situated in the canyon bottom near the Rilda Canyon Springs. Drainage and Sediment Control for the Rilda Canyon Portal Facilities has been designed to conform to the recommendations of the Forest Service, the North Energy Water Users Association, and the State of Utah R645 - Coal Mining Rules (Revised August 1, 2001).

The plan has been divided into the following sections:

- Design of Drainage Control Structures for the Proposed Construction
- Design of Sediment Control Structures
- Design of Drainage Control Structures for Reclamation

The general concept of the plan is as follows:

1) A portion of the Mine Site yard will be paved with asphalt and/or concrete;

2) The Mine Site and county road will be sloped to the north away from the stream;

3) Natural runoff water from the north hillside will be diverted around and beneath the Disturbed Area via properly sized ditches and culverts;

4) Runoff water from the Disturbed Area will be collected in an engineered, asphalt or concrete ditch and culverts along the north side of the Mine Site, channeled to a 5,000 gallon runoff collection tank, and pumped into the mine;

5) Any overflow from the runoff collection tank will flow into a buried culvert and directly into the sediment pond to be constructed below the Mine Site;

6) In the unlikely event of a simultaneous failure of the pump and overflow pipe at the collection tank, any Disturbed Area runoff would still flow to the Sediment Pond via a surface ditch;

7) A berm and chain link fence will be installed along the south side of the Mine Site;

8) A Jersey barrier and fence will also be used to separate the Undisturbed and Disturbed Area drainages along the north side of the Mine Site.

DESIGN OF DRAINAGE CONTROL STRUCTURES FOR PROPOSED CONSTRUCTION

Design Parameters

2.1 Precipitation
2.2 Flow
2.3 Velocity
2.4 Drainage Area
2.5 Slope Lengths
2.6 Runoff
2.7 Runoff Curve Numbers
2.8 Culvert Sizing
2.9 Culverts
2.10 Ditches
2.11 ASCA Areas

Design Parameters

2.1 Precipitation

Design Storm Events

Two sources were considered for the precipitation amounts:

1) Precipitation - Frequency Atlas of the Western United States, Volume VI-Utah, NOAA Atlas 2

2) Richardson, Arlo E. "Estimated Return Periods for Short Duration Precipitation in Utah", Clear Creek Summit Station, NOAA Climatologist Utah State University, 1971.

Selected Source: Clear Creek Summit Station

Precipitation amounts listed in the Clear Station Summit closely matches values depicted in the NOAA Atlas 2.

For a complete discussion related to the design storm events relative to Rilda Canyon refer to Volume 2 Appendix VII.

Frequency - Duration	Precipitation
2 year - 6 hour	1.04"
10 year - 6 hour	1.55"
10 year - 24 hour	2.45"
25 year - 6 hour	1.88"
25 year - 24 hour	2.92"
100 year - 6 hour	2.07"
100 year- 24 hour	3.29"

Disturbed ditch and culvert designs for runoff control are based on the 10 year - 24 hour event of 2.45" and the 25 year - 6 hour event of 1.88", where required. Although regulations only require ditches to be designed for the 10 year - 6 hour event, the design has been increased to the 10 year - 24 hour event at the request of the Division.

Undisturbed culvert designs are based on the 10 year - 24 hour event of 2.45".

It should be noted that all hydrologic structures are proposed to be constructed larger than the minimum design requirements, as an added safety measure. Maintenance requirements, however, are expected to be as required by regulation.

The sedimentation pond is designed to contain the runoff from a 10 year - 24 hour event of 2.45" as required by the Division. Reclamation designs will be based on the 100 year - 6 hour event of 2.07", where applicable for permanent structures.

ASCA areas are sized to contain runoff from a 10 year - 24 hour precipitation event.

2.2 Flow

Peak flows, flow depths, areas and velocities were calculated using the computer program "Office of Surface Mining Watershed Model", Storm Version 6.21 by Gary E. McIntosh. (Trapezoidal Channel Flow). All flow is based on the SCS - TR55 Method for Type II storms.

Time of concentration of storm events was calculated for each drainage area using the following formula:

$$t_L = \frac{L^{0.8}(S+1)^{0.7}}{1900\,Y^{0.5}}$$

where: t_c = Time of Concentration (hrs.)

T_L = Lag Time (hrs.) = 0.6 t_c

L = Hydraulic Length of Watershed (ft.)

Y = Average Land Slope (%)

$$S = \frac{1000}{CN} - 10$$

2.3 Velocity

Flow velocities for each ditch structure were calculated using the Storm computer program with Manning's Formula:

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

where: V = Velocity (fps)
R = Hydraulic Radius (ft.)
S = Slope (ft. per ft.)
n = Manning's n; Table 3.1, p.159,

"Applied Hydrology and Sedimentology for Disturbed Areas", Barfield, Warner & Haan, 1983.

Note: The following Manning's n were used in the culculations:

Structure	Manning's n
Culverts (cmp)	0.024
Rip-rapped or Natural Drainage Channels	0.035
Unlined Disturbed Area Ditches	0.035

2.4 Drainage Areas

All drainage areas were computed directly from Maps 700-1 (Drainage Area Map) and 700-2 (Minesite Drainage Plan).

2.5 Slopes, Lengths

All slopes and hydraulic lengths were measured directly form the topography on Maps 700-1 and 700-2.

2.6 Runoff

Runoff was calculated using the SCS Formula for Type II Storm:

$$Q = \frac{(P - 0.2\,S)^2}{P + 0.8\,S}$$

where: Q = Runoff in inches
P = Precipitation in inches
S = $\frac{1000}{CN} - 10$
CN = Runoff Curve Number

2.7 Runoff Curve Number

As defined in Barfield, Haan and Hayes (Design Hydrology and Sedimentology for Small Catchments, 1994) curve number of an area indicates the runoff potential of an area. In previous studies of Rilda Canyon (refer to Volume 3 Appendix VII), the SCS curve number was evaluated based on the soil types, review of aerial photography and vegetation research. Based on the review, the north facing slopes were found to be heavily vegetated with a conifer-grass complex, whereas the south facing slopes were found to be less well vegetated with sage, grass and a mixture of pinyon and juniper. The percent cover for north facing slopes was estimated at 80% and 40% for the south facing slopes. Soils were mostly classified as Type C and some Type B. Corresponding SCS curve numbers as estimated using the SCS Engineering Handbook - Section 4 (Figure are:

Conifer & Grass	with 80% cover	curve number = 62
Sage & Grass	With 40% cover	curve number = 68

Curve numbers for the various soil types have been discussed with the soil scientist retained for the project (refer to R645-301-200 Soils Section), United States Forest

Service (Hydrologic Basin Report) and previous research conducted for Rilda Canyon (refer to Volume 3 Appendix VII).

The following will show the slope perspective and resulting runoff curve number for each:

Description	Runoff Curve Number	
	SCS curve number was evaluated based on the soil types, review of aerial photography and vegetation research	Curve number selected for runoff estimation (adjusted to be conservative)
North Facing Slope - heavily vegetated with a conifer-grass complex	62	65
South Facing Slope - vegetated with sage, grass and a mixture of pinyon and juniper	68	70
Disturbed Area	90	90
Pave/Buildings	95	95

It should be noted that all Undisturbed Drainage to be diverted at this site flows from the South Facing Slope, the conservative Runoff Curve Number of 70 has been used for all Undisturbed Area calculations.

Since the Mine Site will be paved, a Runoff Curve Number of 95 has been used for all Mine Site Disturbed Area calculations.

The small Disturbed Area below the Mine Site, designated DA-8, will not be paved; therefore, a Runoff Curve Number of 90 was used for this area.

2.8 Culvert Sizing

All culverts were sized using the "Haestad Methods, Flowmaster I, Version 3.43" Computer Program.

Minimum culvert sizing is based on the following Manning's Equation:

$$D = \left(\frac{2.16\ Qn}{\sqrt{S}}\right)^{0.35}$$

where:	D	=	Required Diameter (ft.)
	Q	=	QP - Peak Discharge (cfs)
	n	=	Roughness Factor (0.025 for cmp)
	S	=	Slope (ft. per ft.)

Using the above formula, minimum required culvert sizes were calculated for each applicable area. Culverts were then selected above the required minimum, and these sizes were checked for adequacy against the Culvert Nomograph included as Figure 1 of this report.

2.9 Culverts

Culverts have been sized according to the calculations previously described, and are shown on Map 700-2, Minesite Hydrology. Culverts carrying undisturbed drainages are designated with UC-number (i.e. UC-1). All undisturbed area drainage culverts will be fitted with trash racks to minimize plugging by rocks or other debris.

Trash racks will be provided at the inlet for all undisturbed drainage culverts. These will consist of 3/4" steel bars welded on 6" centers across the flared inlet structures of each culvert. Bars will be sloped from the front of the inlet structure up to the top of the culvert. This ramp configuration will allow trash, branches and other potential obstructions to be swept up and away from the inlet rather than being impinged against

the grates during a flow event. Rip rap will be placed around the flared inlet structure and above it to a height of at least 6" above the required headwall for each culvert. Trash racks will be checked on a routine schedule and following precipitation events and all trash, branches and other obstructions will be removed.

It should be noted that all undisturbed area culverts are adequately sized to handle expected runoff from a 10 year - 24 hour event, which is larger than the 100 year- 6 hour event for maximum protection of the mine area, and undisturbed drainage. This is well in excess of the 10 year - 6 hour event required by the regulations and is proposed as an extra measure of safety.

Disturbed area culverts and ditches are shown on the Minesite Drainage Plan, Map 700-2. Culverts carrying disturbed drainage are designated with a DC-number (i.e. DC-1). Calculations for all disturbed area culverts and ditches are also included with this report, along with design criteria. Disturbed drainage areas draining to culverts and ditches are marked with a DA-number (i.e. DA-1).

All undisturbed drainage will be routed around and/or beneath the disturbed area by properly sized ditches and culverts. Undisturbed drainages with a UA-number "a" designation will flow to an undisturbed ditch with the same number designation, for example, UA-1a will drain to ditch UD-1. Undisturbed drainages with a UA-number "b" designation will flow to an undisturbed culvert with the same number designation, for example, UA-1b will drain to culvert UC-1. Each undisturbed ditch will also drain to the corresponding numbered culvert, for example, ditch UD-1 will drain to culvert UC-1, where it will be diverted beneath the disturbed area to the south to Rilda Creek.

Design details for all undisturbed drainage culverts is shown on the Undisturbed Drainage Culvert Profile, Map 700-3.

Culverts will be inspected regularly, and cleaned as necessary to provide for passage of design flows. Inlets and outlets shall also be maintained so as to prevent plugging or

undue restriction of water flow.

All culverts are temporary, and will be removed upon final reclamation.

2.10 Ditches

Ditches area shown on the Minesite Drainage Plan, Map 700-2, and are designated with a DD-number (i.e., DD-1).

Disturbed drainage areas report to disturbed drainage area ditches with the corresponding subscript number; for example, disturbed drainage area DA-3 reports to disturbed drainage area ditch DD-3.

All ditches are designed to carry the expected runoff from a 10 year - 24 hour event with a minimum freeboard of 0.5' (Refer to Table 12 and Figures 3-4). The 0.5' freeboard represents a minimum of 20% of the flow depth in all disturbed area ditches.

Ditches which exhibit expected flow velocities of 5 fps or greater will be lined with rip-rap, asphalt or concrete. Typical cross-sections, flow depths and areas for all lined and unlined ditches are shown on Figure 3 of this report.

Ditch slopes have been determined from Map 700-2.

All ditches will be inspected regularly, and maintained to the minimum dimensions to provide adequate capacity for the design flow. All ditches are temporary and will be removed as described under the reclamation hydrology section. (Section 4)

2.11 Alternate Sediment Control Areas (ASCA)

There are 3 proposed Alternate Sediment Control Areas on this site. These areas are labeled ASCA-1, ASCA-2 and ASCA-3 on the Map 700-2, Minesite Drainage Plan, and Map 700-5, ASCA Location Map.

ASCA-1: Cutslope Area - located on the south facing slope along the Minesite Facilities. This area is a combination of near vertical rock ledge and cutslopes, and is approximately 1.68 acres. The cutslopes will be constructed with 2:1 slopes. Sediment control is proposed to be accomplished with the use of vegetation on outslopes where the sandstone ledge is not exposed.

ASCA-2: Outslope Area - located on the outslope of the sediment pond. This area is 0.10 acres. The outslope will be constructed with 2:1 slopes. Sediment control is proposed to be accomplished with the use of vegetation.

ASCA-3: Soil Storage Area - Located approximately miles east of facility. This area is 3.13 acres. The outslope will be constructed with 2:1 slopes. Sediment control is proposed to be accomplished with the use of vegetation, berms and silt fences.

TABLE 1
HYDROLOGIC SUMMARY

Drainage	Area (acres)	Type	Drains To:	Runoff CN
UA-1a	1.91	UNDISTURBED	DITCH UD-1	70
UA-1b	6.01	UNDISTURBED	CULVERT UC-1	70
UA-2a	3.18	UNDISTURBED	DITCH UD-2	70
UA-2b	24.55	UNDISTURBED	CULVERT UC-2	70
UA-3a	1.16	UNDISTURBED	DITCH UD-3	70
UA-3b	7.22	UNDISTURBED	CULVERT UC-3	70
UA-4a	5.88	UNDISTURBED	DITCH UD-4	70
UA-4b	72.95	UNDISTURBED	CULVERT UC-4	70
UA-5a	0.08	UNDISTURBED	DITCH UD-5	70
UA-5b	3.80	UNDISTURBED	CULVERT UC-5	70
UA-6a	2.05	UNDISTURBED	DITCH UD-6	70
UA-6b	2.37	UNDISTURBED	CULVERT UC-6	70
UA-7a	1.95	UNDISTURBED	DITCH UD-7	70
UA-7b	2.66	UNDISTURBED	CULVERT UC-7	70
UA-8a	5.99	UNDISTURBED	DITCH UD-8	70
UA-8b	18.96	UNDISTURBED	CULVERT UC-8	70
UA-9	3.04	UNDISTURBED	DITCH UD-9	70
DA-1	3.49	PAVED OR UNPAVED DISTURBED	TANK/SED POND	95
DA-2	0.74	PAVED OR UNPAVED DISTURBED	TANK/SED POND	95
DA-3	0.23	PAVED OR UNPAVED DISTURBED	TANK/SED POND	95
DA-4	0.24	PAVED OR UNPAVED DISTURBED	TANK/SED POND	95
DA-5	0.25	PAVED OR UNPAVED DISTURBED	TANK/SED POND	95
DA-6	0.27	PAVED OR UNPAVED DISTURBED	TANK/SED POND	95
DA-7	1.33	PAVED OR UNPAVED DISTURBED	TANK/SED POND	95
DA-8	1.85	DISTURBED	SEDIMENT POND	90

TABLE 2

DRAINAGE STRUCTURES

Structure	Drainage From:	Remarks:
UC-1	UD-1, UA-1b	UA-1a flows to UD-1
UC-2	UD-2, UA-2b	UA-2a flows to UD-2
UC-3	UD-3, UA-3b	UA-3a flows to UD-3
UC-4	UD-4, UA-4b	UA-4a flows to UD-4
UC-5	UD-5, UA-5b	UA-5a flows to UD-5
UC-6	UD-6, UA-6b	UA-6a flows to UD-6
UC-7	UD-7, UA-7b	UA-7a flows to UD-7
UC-8	UD-8, UA-8b	UA-8a flows to UD-8
UD-1	UA-1a	Flows to UC-1
UD-2	UA-2a	Flows to UC-2
UD-3	UA-3a	Flows to UC-3
UD-4	UA-4a	Flows to UC-4
UD-5	UA-5a	Flows to UC-5
UD-6	UA-6a	Flows to UC-6
UD-7	UA-7a	Flows to UC-7
UD-8	UA-8a	Flows to UC-8
UD-9	UA-9	Existing Culvert
DD-1	DA-1	
DD-2	DD-2, DA-2	
DD-3	DD-2, DA-3	
DD-4	DD-3, DA-4	
DD-5	DD–4, DA-5	
DD-6	DD-5, DA-6	
DD-7	DD-6, DA-7	
DD-8	DA-8	

TABLE 2 (Continued)

DRAINAGE STRUCTURES

Structure	Drainage From:	Remarks:
DC-1	DD-1	
DC-2	DD-2	
DC-3	DD-3	
DC-4	DD-4	
DC-5	DD-5	
DC-6	DD-6	
DC-7	DD-7, Collection Tank	Overflow pipe to Sediment Pond

TABLE 3

DRAINAGE STRUCTURE FLOW SUMMARY

Structure	10/6 Cfs	10/24 Cfs	25/6 Cfs	100/6 Cfs	Flows To:
UC-1	0.23	2.01	0.49	0.69	Undisturbed Bypass
UC-2	0.83	6.49	1.70	2.36	Undisturbed Bypass
UC-3	0.24	2.12	0.52	0.73	Undisturbed Bypass
UC-4	2.32	16.03	4.52	6.30	Undisturbed Bypass
UC-5	0.11	0.99	0.25	0.34	Undisturbed Bypass
UC-6	0.13	1.16	0.26	0.41	Undisturbed Bypass
UC-7	0.14	1.19	0.28	0.42	Undisturbed Bypass
UC-8	0.74	5.97	1.54	2.13	Undisturbed Bypass
UD-1	0.05	0.50	0.11	0.18	UC-1
UD-2	0.09	0.81	0.20	0.28	UC-2
UD-3	0.03	0.31	0.07	0.11	UC-3
UD-4	0.17	1.49	0.36	0.51	UC-4
UD-5	0.01	0.03	0.01	0.01	UC-5
UD-6	0.06	0.54	0.12	0.19	UC-6
UD-7	0.06	0.51	0.12	0.18	UC-7
UD-8	0.17	1.51	0.37	0.52	UC-8
UD-9	0.09	0.79	0.18	0.28	Below Pond
DD-1	3.27	5.92	4.17	4.68	Collection Tank/Pond
DD-2	3.80	6.88	4.85	5.44	Collection Tank/Pond
DD-3	3.91	7.08	4.99	5.60	Collection Tank/Pond
DD-4	4.03	7.29	5.14	5.77	Collection Tank/Pond
DD-5	4.15	7.51	5.30	5.95	Collection Tank/Pond
DD-6	4.28	7.75	5.47	6.14	Collection Tank/Pond
DD-7	5.22	9.45	6.67	7.49	Collection Tank/Pond
DD-8	1.10	2.45	1.52	1.77	Sediment Pond

TABLE 3 (Continued)

DRAINAGE STRUCTURE FLOW SUMMARY

Structure	10/6 Cfs	10/24 Cfs	25/6 Cfs	100/6 Cfs	Flows To:
DC-1	3.27	5.92	4.17	4.68	Collection Tank/Pond
DC-2	3.80	6.88	4.85	5.44	Collection Tank/Pond
DC-3	3.91	7.08	4.99	5.60	Collection Tank/Pond
DC-4	4.03	7.29	5.14	5.77	Collection Tank/Pond
DC-5	4.15	7.51	5.30	5.95	Collection Tank/Pond
DC-6	4.28	7.75	5.47	6.14	Collection Tank/Pond
DC-7	5.22	9.45	6.67	7.49	Sediment Pond

TABLE 4
UNDISTURBED DRAINAGE AREA DATA

Area ID	Hydraulic Length	High Elevation	Low Elevation	Change Elevation	Slope %	Runoff CN
UA-1a	605	8095	7715	380	62.81	70
UA-1b	1541	8880	7725	1155	74.95	70
UA-2a	1085	8520	7685	835	76.96	70
UA-2b	2522	9400	7710	1690	67.01	70
UA-3a	362	7925	7660	265	73.20	70
UA-3b	1595	8880	7675	1205	75.55	70
UA-4a	1239	8480	7630	850	68.60	70
UA-4b	3191	9601	7627	1974	61.86	70
UA-5a	106	7660	7610	50	47.17	70
UA-5b	1222	8415	7635	780	63.83	70
UA-6a	690	8030	7585	445	64.49	70
UA-6b	834	8115	7570	545	65.35	70
UA-7a	853	8125	7560	565	66.24	70
UA-7b	1051	8275	7560	715	68.03	70
UA-8a	1280	8415	7545	870	67.97	70
UA-8b	2255	8850	7543	1305	57.96	70
UA-9	779	8065	7525	540	69.32	70

TABLE 5
UNDISTURBED DRAINAGE SUMMARY

Drainage Area	10 yr - 6 hr 1.55"	10 yr - 24 hr 2.45"		25 yr- 6 hr 1.88"	100 yr - 6 hr 2.07"
	Peak Flow (Cfs)	Peak Flow (Cfs)	Runoff (ac.ft)	Peak Flow (Cfs)	Peak Flow (Cfs)
UA-1a	0.05	0.50	0.07	0.11	0.18
UA-1b	0.18	0.51	0.22	0.38	0.51
UA-2a	0.09	0.81	0.11	0.20	0.28
UA-2b	0.74	5.68	0.88	1.50	2.08
UA-3a	0.03	0.31	0.04	0.07	0.11
UA-3b	0.21	1.81	0.26	0.45	0.62
UA-4a	0.17	1.49	0.21	0.36	0.51
UA-4b	2.15	14.54	2.62	4.16	5.79
UA-5a	0.00	0.03	0.00	0.01	0.01
UA-5b	0.11	0.96	0.14	0.24	0.33
UA-6a	0.06	0.54	0.07	0.12	0.19
UA-6b	0.07	0.62	0.09	0.14	0.22
UA-7a	0.06	0.51	0.07	0.12	0.18
UA-7b	0.08	0.68	0.10	0.16	0.24
UA-8a	0.17	1.51	0.22	0.37	0.52
UA-8b	0.57	4.46	0.68	1.17	1.61
UA-9	0.09	0.79	0.11	0.18	0.28

TABLE 6

UNDISTURBED DITCH DESIGN SUMMARY

Ditch	UD-1	UD-2	UD-3	UD-4	UD-5	UD-6	UD-7	UD-8	UD-9
Ditch Slope (%)	4.95	4.95	4.95	5.00	6.92	9.26	5.36	3.58	11.25
Ditch Length (ft.)	300.0	420.0	390.0	500.0	100.0	270.0	280.0	475.0	400.0
10 yr - 6 hr Event (in.)	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55
Peak Flow - 10/6 (cfs)	0.05	0.09	0.03	0.17	0.01	0.06	0.06	0.17	0.09
Velocity - 10/6 (fps)	1.44	1.66	1.26	1.96	1.09	1.90	1.55	1.73	2.26
Min. Ditch Area (ft^2)	0.03	0.05	0.02	0.09	0.01	0.03	0.04	0.10	0.04
Min. Flow Depth (ft.)	0.13	0.16	0.11	0.21	0.07	0.13	0.14	0.22	0.14
10 yr - 24 hr Event (in.)	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45
Peak Flow - 10/24 (cfs)	0.50	0.81	0.31	1.49	0.03	0.54	0.51	1.51	0.79
Velocity - 10/24 (fps)	2.55	2.88	2.27	3.37	1.43	3.29	2.64	2.98	3.90
Min. Ditch Area (ft^2)	0.20	0.28	0.14	0.44	0.02	0.16	0.19	0.51	0.20
Min. Flow Depth (ft.)	0.31	0.37	0.26	0.47	0.10	0.29	0.31	0.50	0.32
*Construction									
Minimum Area (ft^2)	1.31	1.51	1.16	1.88	0.72	1.25	1.31	2.00	1.35
Minimum Depth (ft.)	0.81	0.87	0.76	0.97	0.60	0.79	0.81	1.00	0.82

* Based on 10 year - 24 hour event.

TABLE 7
UNDISTURBED CULVERT DATA
(BYPASS CULVERTS)

Segment ID	Length	Slope %	Manning's No.
UC-1	210.0	5.24	0.024
UC-2	310.0	3.25	0.024
UC-3	210.0	5.24	0.024
UC-4	130.0	8.46	0.024
UC-5	265.0	7.92	0.024
UC-6	65.0	15.38	0.024
UC-7	85.0	17.65	0.024
UC-8	220.0	16.82	0.024

TABLE 8
UNDISTURBED CULVERT DESIGN SUMMARY

Culvert	10 yr - 6 hr Event 1.55"			10 yr - 24 hr Event 2.45"			25 yr - 6 hr Event 1.88"		
	Peak Flow Cfs	Velocity fps	Min. Diam. Req'd - Ft	Peak Flow Cfs	Velocity fps	Min. Diam. Req'd - Ft	Peak Flow Cfs	Velocity fps	Min. Diam. Req'd - Ft
UC-1	0.23	2.69	0.33	2.01	4.62	0.74	0.49	3.25	0.44
UC-2	0.83	3.10	0.58	6.49	5.18	1.26	1.70	3.70	0.76
UC-3	0.24	2.72	0.34	2.12	4.68	0.76	0.52	3.29	0.45
UC-4	2.32	5.73	0.72	16.03	9.29	1.48	4.52	6.77	0.92
UC-5	0.11	2.61	0.23	0.99	4.52	0.53	0.25	3.20	0.32
UC-6	0.13	3.49	0.22	1.16	6.03	0.49	0.26	4.15	0.28
UC-7	0.14	3.74	0.22	1.19	6.39	0.49	0.28	4.45	0.28
UC-8	0.74	5.57	0.41	5.97	9.39	0.90	1.54	6.69	0.54

TABLE 8 (Continued)
UNDISTURBED CULVERT DESIGN SUMMARY

Culvert	100 yr - 6 hr Event 2.07"			Recommended Construction (Diameter) (Ft.)	Flow Capacity (Cfs)	Headwater Req'd (ft.)
	Peak Flow Cfs	Velocity fps	Min. Diam. Req'd - Ft			
UC-1	0.69	3.54	0.50	1.5	13.02	-
UC-2	2.36	4.02	0.86	2.0	22.09	-
UC-3	0.73	3.59	0.51	1.5	13.02	-
UC-4	6.30	7.36	1.04	2.0	35.64	-
UC-5	0.34	3.46	0.35	1.5	16.01	-
UC-6	0.41	4.65	0.34	1.5	22.31	-
UC-7	0.42	4.92	0.33	1.5	23.90	-
UC-8	2.13	7.26	0.61	2.0	50.26	-

TABLE 9A
DISTURBED AREAS DATA

Area ID	Acres	Hydraulic Length	High Elevation	Low Elevation	Change Elevation	Slope %	Runoff CN
DA-1	3.49	1050.0	7707	7655	52	4.95	95
DA-2	0.74	170.0	7646	7644	2	1.18	95
DA-3	0.23	60.0	7634	7633	1	1.67	95
DA-4	0.24	60.0	7630	7629	1	1.67	95
DA-5	0.25	60.0	7626	7625	1	1.67	95
DA-6	0.27	60.0	7622	7621	1	1.67	95
DA-7	1.33	390.0	7617	7590	27	6.92	95
DA-8	1.85	1400.0	7590	7490	100	7.14	90

TABLE 9B
ASCA AREAS DATA

Area ID	Acres	Hydraulic Length	High Elevation	Low Elevation	Change Elevation	Slope %	Runoff CN
ASCA-1	1.68	20'	7725	7715	10	50.00	90
ASCA-2	0.10	30'	7510	7500	10	33.30	90
ASCA-3	3.13	950'	7363	7287	76	8.00	90

TABLE 10
DISTURBED DRAINAGE SUMMARY

Drainage	10 yr - 6 hr 1.55"	10 yr - 24 hr 2.45"		25 yr - 6 hr 1.88"	100 yr - 6 hr 2.07"
	Peak Flow Cfs	Peak Flow Cfs	Runoff ac. ft.	Peak Flow Cfs	Peak Flow Cfs
DA-1	3.27	5.92	0.56	4.17	4.68
DA-2	0.53	0.96	0.12	0.68	0.76
DA-3	0.11	0.20	0.04	0.14	0.16
DA-4	0.12	0.21	0.04	0.15	0.17
DA-5	0.12	0.22	0.04	0.16	0.18
DA-6	0.13	0.24	0.04	0.17	0.19
DA-7	0.94	1.70	0.21	1.20	1.35
DA-8	1.10	2.45	0.23	1.52	1.77
Drainage to Pond		11.9	1.28	8.19	-
ASCA-1	0.43	0.91	0.21	-	-
ASCA-2	0.03	0.06	0.01	-	-
ASCA-3	2.07	4.51	0.39	-	-

TABLE 11
DISTURBED DITCH DATA

Area ID	Hydraulic Length	Slope %	Runoff CN	Manning's No.
DD-1	1050.00	4.95	95	0.015
DD-2	170.00	1.18	95	0.015
DD-3	60.00	1.67	95	0.015
DD-4	60.00	1.67	95	0.015
DD-5	60.00	1.67	95	0.015
DD-6	60.00	1.67	95	0.015
DD-7	390.00	6.92	95	0.015
DD-8	1400.00	7.14	90	0.035

TABLE 12
DISTURBED DITCH DESIGN SUMMARY

Ditch Structure	DD-1	DD-2	DD-3	DD-4	DD-5
10 yr - 6 hr event (in.)	1.55	1.55	1.55	1.55	1.55
Peak Flow (cfs)	3.27	3.80	3.91	4.03	4.15
Velocity (fps)	7.71	4.67	5.36	5.40	5.44
Required Area (ft^2)	0.42	0.81	0.73	0.75	0.76
Flow Depth (ft.)	0.46	0.64	0.60	0.61	0.62
10 yr - 24 hr event (in.)	2.45	2.45	2.45	2.45	2.45
Peak Flow (cfs)	5.92	6.88	7.08	7.29	7.51
Velocity (fps)	8.94	5.42	6.22	6.27	6.31
Required Area (ft^2)	0.66	1.27	1.14	1.16	1.19
Flow Depth (ft.)	0.58	0.80	0.75	0.76	0.77
*Construction					
Minimum Area (ft^2)	2.33	3.38	3.13	3.18	3.23
Minimum Depth (ft.)	1.08	1.30	1.25	1.26	1.27

* Based on 10 year - 24 hour flow.

TABLE 12 (Continued)
DISTURBED DITCH DESIGN SUMMARY

Ditch Structure	DD-6	DD-7	DD-8
10 yr - 6 hr event (in.)	1.55	1.55	1.55
Peak Flow (cfs)	4.28	5.22	1.10
Velocity (fps)	5.49	9.82	3.57
Required Area (ft^2)	0.78	0.53	0.31
Flow Depth (ft.)	0.62	0.52	0.39
10 yr - 24 hr event (in.)	2.45	2.45	2.45
Peak Flow (cfs)	7.75	9.45	2.45
Velocity (fps)	6.36	11.40	4.36
Required Area (ft^2)	1.22	0.83	0.56
Flow Depth (ft.)	0.78	0.64	0.53
*Construction			
Minimum Area (ft^2)	3.28	2.60	**4.26
Minimum Depth (ft.)	1.28	1.14	1.46

* Based on 10 year - 24 hour flow.

** Note: DD8 will be constructed larger than required so it can carry the entire minesite disturbed area runoff in the event of a failure on the containment tank or culvert DC-7.

TABLE 13
DISTURBED CULVERT DATA

Culvert ID	Length (ft.)	Slope %	Manning's No.
DC-1	20	100.00	0.024
DC-2	10	100.00	0.024
DC-3	4	100.00	0.024
DC-4	4	100.00	0.024
DC-5	4	100.00	0.024
DC-6	4	100.00	0.024
DC-7	1400	7.14	0.024

TABLE 14

DISTURBED CULVERT DESIGN SUMMARY

Culvert	10 yr - 6 hr Event 1.55"			10 yr - 24 hr Event 2.45"			Recommended Construction Diameter (ft.)	Flow Capacity (cfs)	Rip-Rap Req'd Y/N	Rip-Rap D_{50}
	Peak Flow Cfs	Velocity fps	Min. Diam. Req'd ft.	Peak Flow Cfs	Velocity fps	Min. Diam. Req'd ft.				
DC-1	3.27	15.76	0.51	5.92	18.29	0.64	1.5	56.90	N	-
DC-2	3.80	16.37	0.54	6.88	18.99	0.68	1.5	56.90	N	-
DC-3	3.91	16.49	0.55	7.08	19.12	0.69	1.5	56.90	N	-
DC-4	4.03	16.61	0.56	7.29	19.26	0.69	1.5	56.90	N	-
DC-5	4.15	16.73	0.56	7.51	19.41	0.70	1.5	56.90	N	-
DC-6	4.28	16.86	0.57	7.75	19.56	0.71	1.5	56.90	N	-
DC-7	5.22	6.59	1.00	9.45	7.64	1.26	1.5	15.20	Y	0.50

FIGURES

Figure 1 Culvert Nomograph

Figure 2 Rip-Rap Chart

Figure 3 Undisturbed and Disturbed Ditch, Typical Section (Unlined Ditch)

Figure 4 Disturbed Ditch, Typical Section (Lined Ditch)

Figure 5 Undisturbed Culvert Inlet, Typical Section

DESIGN OF SEDIMENT CONTROL STRUCTURES

3.1 Design and Construction Specification for Sedimentation Pond
3.2 Sediment Yield
3.3 Sediment Pond Volume
3.4 Sediment Pond Summary
3.5 Temporary Sediment Pond Design

3.1 Design and Construction Specifications for Sediment Pond

a) All construction of sedimentation ponds will be performed under the direction of a qualified, registered professional engineer.

b) The pond will be constructed with a combination of 2 spillways. The principal spillway will be an 18" C.M.P. culvert riser and oil skimmer. This spillway will overflow at an elevation at least 3.0' below the emergency spillway. The emergency spillway will consist of an open-channel spillway with a bottom width of at least 3' and 2h:1v side slopes. The open-channel spillway will be constructed of grouted rip-rap or concrete. Both spillways will flow into undisturbed diversion ditch UD-9, located just below the pond.

c) The area of pond construction shall be examined for topsoil, and where present in removable quantities, such soil shall be removed separately and stored in an approved topsoil storage location.

d) In areas where fill is to be placed for the pond impoundment structures, natural ground shall be removed for at least 12" below the base of the structure.

e) Native materials shall be used where practical. Fill will be placed in lifts not to exceed 15" and compacted prior to placement of next left. Compaction of all fill materials shall be at least 95%.

f) Rip-rap or other protection (culverts, concrete, etc.) will be placed at all inlets and outlets to prevent scouring. Rip-rap will consist of substantial (non-slaking) rock material of adequate size.

g) Decanting of the ponds, as required, will be accomplished by use of a

portable pump with an inverted inlet, and pumping capacity of 100 gpm or greater.

h) Slopes of the embankments shall not be steeper than 2h:1v, inside or outside, with a total of the inslope and outslope not less than 5h:1v, except where areas of the pond are incised.

i) Tops and external slopes of the impoundments will be planted with an approved seed mix to help prevent erosion and promote stability.

j) Top width of the embankments shall be not less than (H+35)/5, where H = Height of Dam in feet.

k) The pond will be equipped with a sediment cleanout marker, a primary culvert overflow and a open-channel emergency spillway.

3.2 Sediment Yield

The Universal Soil Loss Equation (USLE) was used to estimate sediment yield from unpaved disturbed areas. All soil loss from this area was assumed to be delivered to, and deposited in the sedimentation pond. No sediment yield is expected from the paved Mine Site area.

Also, since all undisturbed area drainage is diverted, no sediment yield is expected to reach the sediment pond from those areas.

Erosion rate (A) in tons-per-acre-per-year is determined using the USLE as follows:

$$A = (R)\ (K)\ (LS)\ (CP)$$

where the variables R, K, LS, and CP are defined as follows:

Variable "R" is the rainfall factor which can be estimated from $R = 27p^{2.2}$, where P is the 2-year , 6-hour precipitation value. P for the Rilda Canyon area is 1.04" as shown in Section 2.1. Therefore, the estimated value of "R" for this area is 29.43.

Variable "K" is the soil erodibility factor. For disturbed, unpaved areas, the "K" value is conservatively estimated to be 0.5.

Variable "LS" is the length-slope factor. This figure was determined by applying the slope length and percentage for each sub-drainage area to the chart in Figure 5.15, p. 334, "Applied Hydrology and Sedimentology for Disturbed Areas", Barfield, Warner and Haan, 1983.

Variable "CP" is the control practice factor, which can be divided into a cover and a practice factor. For purposes of these calculations, the following "CP" values were used.

Site	CP Factor
Reseeded	0.38

The sediment volume is based on a density of 100 pounds per cubic foot of sediment.

Sediment Yield Calculations - USLE

Drainage	R	K	Acres	Slope Length Feet	Slope (%)	LS	CP	A*	Yield **
Disturbed/Unpaved Area	29.43	0.50	1.85	1400	7.14	3.00	0.38	16.78	0.014

Total Sediment 1 year (ac.ft.) 0.014
Total Sediment 3 years (ac.ft.) 0.040

* A = tons/acre-year
** Yield = acre-ft/year

A sediment marker will be installed in the pond, indicating the maximum sediment level, as shown on Map 700-3, "Sediment Pond". As indicated in Table 16, the proposed maximum sediment level will be at 2' above the pond bottom, providing approximately 0.207 acre feet or nearly 15 years of sediment storage.

3.3 Sediment Pond Volume

The volumes shown in Table 16 are from the volumes calculated from the precipitation, runoff and sediment yield for a 10 year - 24 hour precipitation event. The volumes were calculated based on the disturbed areas runoff values, developed using the design parameters described in this section.

TABLE 15
SEDIMENT POND DESIGN

1-	Use 2.45" for 10 year - 24 hour event.		
2-	Disturbed Area Draining to Pond = 8.40 acres.		
3-	Runoff Curve Number = CN = 90 (Disturbed); 95 (Paved)		
4-	Disturbed Area Runoff = (From Table 10, 10 yr./24 hr.)	=	1.280 ac.ft.
5-	Sediment Storage Volume (USLE)	=	0.042 ac.ft.
6-	Direct Precipitation into Pond 0.30 acres x 2.45" / 12 in./ft.	=	0.062 ac.ft.
7-	Total Required Pond Volume 1.280 + 0.042 + 0.062	=	1.384 ac.ft.
8-	Pond Actual Volume at Principal Spillway	=	1.630 ac.ft.
9-	Peak Flow (25 year - 6 hour event)	=	8.19 cfs

Note: Refer to Appendix 1 for computer backup data.

TABLE 16
SEDIMENT POND
STAGE VOLUME DATA

Elevation	Area (ft^2)	Volume (ac. ft.)	Acc. Volume (ac. ft.)	Remarks
0	3,900.0	0	0	Bottom of Pond
1	4,556.0	0.097	0.097	
2	5,069.0	0.110	0.207	Maximum Sediment Level
3	5,781.0	0.125	0.332	
4	6,336.0	0.139	0.471	
5	6,909.0	0.152	0.623	
6	7,701.0	0.168	0.791	
7	8,316.0	0.184	0.975	
8	9,164.0	0.201	1.176	
9	9,821.0	0.218	1.394	
10	10,725.0	0.236	1.630	Principal Spillway
11	11,424.0	0.249	1.879	Emergency Spillway
12	12,384.0	0.273	2.152	
13	13,125.0	0.293	2.445	Crest of Pond

TABLE 17
SEDIMENT POND
PRINCIPAL SPILLWAY
STAGE - DISCHARGE DATA
18" C.M.P. RISER

Stage (ft.)	Discharge (cfs)		
	Weir Flow	Orifice Flow	Pipe Flow
0.00	0.00	0.00	15.75
0.20	1.26	3.80	15.92
0.40	3.58	5.38	16.09
0.60	6.57	6.58	16.26
0.70	*8.28	7.11	16.34
0.80	10.12	7.60	16.42
1.00	14.14	8.50	16.59
1.20	18.59	9.31	16.75
1.40	23.42	10.06	16.91
1.60	28.62	10.75	17.08
1.80	34.15	11.40	17.23
2.00	39.99	12.02	17.39
*25 year - 6 hour Peak Flow = 8.19 cfs; Flow is weir controlled at H = 0.70'.			

Weir Flow

$Q = CLH^{3/2}$; *Where* $C = 3.0$, $L = 4.71$
$Q = 14.14\ H^{3/2}$

Orifice Flow

$Q = C'a\sqrt{2gH}$; *Where* $C' = 0.6$, $a = 1.77$, $g = 32$
Q *is* $8.50\sqrt{H}$

Pipe Flow

$$\frac{Q = a\,[\,2g\,H']^{1/2}}{(1 + Ke + Kb + KcL)};$$ *Where* $a = 1.77$, $g = 32$, $H' = H + 10 - [(0.6)(1.5)] = H + 9.1$, $Ke = 1.0$, $Kb = 0.5$, $Kc = 0.07$, $L = 30'$

$Q = 5.22\ (H + 9.1)^{1/2}$

TABLE 18
SEDIMENT POND
EMERGENCY OPEN-CHANNEL SPILLWAY
STAGE DISCHARGE DATA

STAGE (ft.)	DISCHARGE (cfs)
0.00	0.00
0.20	0.94
0.40	2.97
0.60	6.03
0.72	8.37
0.80	10.16
1.00	15.44

Note: *25 year - 6 hour Peak Flow to Pond = 8.19 cfs.
Flow will pass through spillway at a depth of 0.72'.

Calculations based on Broad Crested Weir Formula

$Q = 3.087\ bH^{1.5}$; Where b = Average Width = $\frac{3 + (3 + 4d)}{2}$

3.4 Sediment Pond Summary

a) The Sediment pond has been designed to contain the disturbed area (and contributing undisturbed area) runoff from a 10 year - 24 hour precipitation event, along with 3 years of sediment storage capacity. Runoff to the pond will be directed by various ditches and culverts as described in the plan.

b) The required volume for the sediment pond is calculated at 1.384 acre feet, including 3 years of sediment storage. The sediment pond size will be a single cell with a total volume of approximately 1.630 acre feet at the Principal Spillway, which is more than adequate.

c) The pond will meet a theoretical detention time of 24 hours. It is equipped with an 18" cmp culvert riser and oil skimmer for a principal spillway and a 3' wide open channel emergency spillway.

d) The pond inlets will be protected from erosion. The principal spillway, and/or emergency spillway will discharge directly to the undisturbed ditch UD-9, and to the main canyon drainage.

e) The pond is temporary, and will be removed upon final reclamation of the property.

f) The pond will be constructed according to the design criteria listed under "Construction Specifications for Sedimentation Ponds".

g) The principal spillway is sized to carry runoff from a 25 year - 6 hour precipitation event, which is shown on Table 10 as 8.19 cfs. This overflow will be a 18" cmp culvert fitted with an oil skimmer as shown on Map 700-3. The discharge will go into undisturbed diversion ditch UD-9 which will be located below the pond. In the event of failure of this

overflow, the pond will also be equipped with an additional 3' wide open channel emergency spillway as noted in c) above.

The 18" cmp principal spillway will carry the peak flow from a 25 year - 6 hour event at a depth of 0.70' over the pipe as shown on Table 17 and Figure 7. The emergency spillway will be constructed at least 1' above the principal spillway elevation this spillway will be a minimum of 2.0' below the top of the dam, and will carry the entire flow of the 25 year - 6 hour event at a depth of 0.72', leaving more than a foot of freeboard to the top of the dam. See Table 18 and Figure 8 to Stage - Discharge details for the Emergency Spillway.

h) The runoff from the spillway will travel into undisturbed diversion ditch UD-9, which will then discharge to the main channel below the minesite.

i) The culvert outlet will be equipped with an adequately sized rip-rap apron to slow the combined flow sufficiently to prevent erosion of the downstream channel.

3.5 Temporary Sediment Control

The primary means of the sediment control during construction of the minesite will be provided by a temporary sediment control practices; including sediment basins, silt fences and straw bales. Temporary sediment controls will be installed before any construction activity takes place at the site including any timber and vegetation removal, or any other construction related activity. Temporary sediment basins will be constructed in two locations; near the lower end of the Minesite Facilities Area, and near the location of the proposed sediment pond. The dam embankment will be designed to create a substantial sediment trap behind (upstream from) the temporary dam. At the upsteam end of the temporary dams, a culvert will be fitted with an open riser which will extend vertically and will terminate at an elevation several feet lower than the tip of the temporary dam (refer to Figure 9 for details). This riser will allow any silt-laden runoff water to impound behind the dam. During subsequent construction the vertical riser will function as an emergency spillway in the unlikely event that the precipitation event is large enough to completely fill the impoundment. Outfall from the temporary basins located north of Emery County Road #306 will be routed through the existing culverts installed along the road.

It should be noted that this temporary sediment structure will be required for only a short time during the construction (approximately 1 year) until such time as the permanent sediment pond structures are in place. The temporary sediment pond embankment will be constructed according to the design certified by a registered professional engineer (PE). It will be constructed in lifts and compacted to a 95% density. After the temporary sediment pond has been installed, construction can then begin on the other upstream mine facilities. Once the permanent sediment pond is constructed and is functional and capable of controlling the sediment from the remainder of the construction site, the temporary sediment basins can then be removed (i.e. filled). At this time, the riser spillway can be removed and the bypass culvert below the temporary pond and permanent ponds can be connected

with short segment of culvert. The bypass culvert will then be fully functional and the temporary basins can be filled.

The temporary sediment basins will each have a storage capacity of 0.05 acre-feet below the vertical riser spillways. The calculated sediment contribution for the entire minesite is 0.014 acre-feet per year; therefore, the basins will each have the equivalent of more than 3 years of sediment storage capacity.

DESIGN OF DRAINAGE CONTROL STRUCTURES FOR RECLAMATION

Reclamation Hydrology

4.1 General
4.2 Reclaimed Area Drainage Control
4.3 Restored Channels
4.4 Sediment Pond

Reclamation Hydrology

4.1 General

Prior to construction of the mine site and facilities, it is proposed to only slightly alter the existing side canyon channels to allow for culvert installation. Bypass culverts will be installed and necessary earthwork will be done to construct the mine site.

The County Road is to remain in place after final reclamation. Only the portion of culverts UC-1 through UC-8 beneath the road will be left in place. All other undisturbed culvert portions will be removed and replaced with reclaimed channels sized to carry the runoff from a 100 year - 6 hour storm. All other hydrologic controls, including the sediment pond, will be removed.

Reclaimed channels are noted with an RC-Letter (i.e. RC-BB). Channels are shown on Map 700-4, "Minesite Reclamation".

A typical channel cross-section for each side and main channel is shown on Figure 10. Calculated flows for the applicable storm event were then routed through the channels to determine if reclaimed channel sizes were adequate for the design flows. (See Table 20). In all cases, the channels were adequately sized to safely carry the contributing area runoff.

4.2 Reclaimed Area Drainage Control

During final reclamation, all previously installed drainage controls, including the sediment ponds, will be removed. The reclaimed area will be roughened by discontinuous tilling and/or "gouging" the area with a trackhoe bucket. The roughening will create furrows or depressions at approximately 18"-36" deep throughout the reclaimed area. In addition, straw or wood mulch will be used in final seeding of the area. Roughening will continue throughout the entire reclaimed area. The reclaimed area, including channels will be reseeded

according to the approved plan.

Calculations have been run to estimate the total production from the reclaimed site, and to evaluate the effectiveness of the treatments.

The Universal Soil Loss Equation (USLE) was used to estimate sediment yield from disturbed areas. All soil loss from this area was assumed to be delivered to, and deposited in the main channel.

Erosion rate (A) in tons-per-acre-per-year is determined using the USLE as follows:

$$A = (R)\ (K)\ (LS)\ (CP)$$

where the variables R, K, LS, and CP are defined as follows:

Variable "R" is the rainfall factor which can be estimated from $R = 27P^{2.2}$; where P is the 2-year, 6-hour precipitation value. P for the North Rilda area is 1.04" as shown in Section 2.1. Therefore, the estimated value of "R" for this area is 29.43.

Variable "K" is the soil erodibility factor. For disturbed areas, the "K" value is conservatively estimated to be 0.25. "K" is estimated to be 0.035 for undisturbed areas.

Variable "LS" is the length-slope factor. This figure was determined by applying the slope length and percentage for each sub-drainage area to the chart in Figure 5.15, p. 334, "Applied Hydrology and Sedimentology for Disturbed Areas", Barfield, Warner and Haan, 1983.

Variable"CP" is the control practice factor, which can be divided into a cover and a practice factor. For purposes of these calculations, the following "CP" values were used:

Cover Factor - "C"

Reclaimed Area - Wood Fiber Mulch	- * 0.01
Undisturbed Area - Section 3.2	- 0.15
Disturbed Area - Section 3.2	- 1.20

*Barfield, et. al., 1983, Appendix 5A.

Control Practice Factor - "P"

Assumed equal to 1.0, since the land is not used for crops.

The table on the following page is a summary comparing expected sediment contributions from the proposed disturbed area only, under all three phases of conditions - Undisturbed, Disturbed and Reclaimed.

Note: While this set of calculations assume all sediment production is delivered to the main channel, this is probably not the case. The deep surface gouging on both sides of the channel during reclamation will likely trap most, if not all, of the transported sediment prior to reaching the channel.

The sediment volume is based on a density of 100 pounds per cubic foot of sediment.

Undisturbed/Disturbed/Reclaimed

Sediment Yield Calculations - USLE

(Proposed Disturbed Area Only)

Drainage	R	K	Acres	Slope Length Feet	Slope (%)	LS	CP	A*	Yield**
Unpaved Area - Undisturbed	29.43	0.035	1.85	1400	7.14	3.00	0.15	0.463	0.0004
Unpaved Area - Disturbed	29.43	0.50	1.85	1400	7.14	3.00	*0.38	16.78	0.0142
Unpaved Area - Reclaimed	29.43	0.25	1.85	1400	7.14	3.00	0.01	0.221	0.0002
Mine Site - Undisturbed	29.43	0.035	6.55	1850	6.32	3.10	0.15	0.479	0.0014
Mine Site - Disturbed	29.43	0.50	6.55	1850	6.32	3.10**	0.00	0.000	0.0000
Mine Site - Reclaimed	29.43	0.25	6.55	1850	6.32	3.10	0.01	0.228	0.0007

* Reseeded
** Paved

Total Sediment (Undisturbed State) 0.0018
Total Sediment (Disturbed State) 0.0142
Total Sediment (Reclaimed State) 0.0009

* A = tons/acre-year
** Yield = acre-ft/year

Summary

The above table indicates the sediment contribution from the reclaimed areas of the minesite will be approximately 0.0009 acre feet per year, as compared to 0.0142 acre feet per year for the disturbed area. When the reclaimed areas are calculated as undisturbed, the total minesite sediment contribution increases slightly to 0.0018 acre feet per year, verses the 0.0009 noted in the table above.

This indicates the proposed reclamation process will actually reduce the expected sediment contribution over natural, undisturbed conditions. This is primarily due to the extensive roughening and use of wood fiber mulch to reduce runoff.

4.3 Restored Channels

As mentioned in Section 4.1, undisturbed drainage culverts will be removed, except for the portion beneath the County Road, and replaced with restored channels sized to carry the runoff from a 100 year - 6 hour storm event. The culverts have already been sized to carry this event, as indicated in Table 8.

As shown on Table 22, all channels are adequately sized to carry the projected runoff with at least 1' of freeboard. See Figure 10 for a typical section of the reclaimed channels and summary of flow depths and velocities.

4.4 Sediment Pond

As discussed in Section 4.1, the sediment pond will be removed during final reclamation. Sediment control for the reclamation will be accomplished by extensive roughening/gouging and revegetation of the reclaimed area. See Map 700-4 "Minesite Reclamation" for location and reclamation details.

TABLE 19
FINAL RECLAMATION
DRAINAGE AREAS CONTRIBUTING TO CHANNELS

RC-1	UA-1a, UA-1b
RD-2	UA-2a, UA-2b
RC-3	UA-3a, UA-3b
RC-4	UA-4a, UA-4b
RC-5	UA-5a, UA-5b
RC-6	UA-6a, UA-6b
RC-7	UA-7a, UA-7b
RC-8	UA-8a, UA-8b

Refer to Map 700-1 for drainage areas and Map 700-4 for reclamation channels.

TABLE 20
FINAL RECLAMATION
DRAINAGE STRUCTURE FLOW SUMMARY

Channel	10/6 cfs	100/6 cfs
RC-1	0.23	0.69
RC-2	0.83	2.36
RC-3	0.24	0.73
RC-4	2.32	6.30
RC-5	0.11	0.34
RC-6	0.13	0.41
RC-7	0.14	0.42
RC-8	0.74	2.13

Flows from Table 5, and Table 8.

TABLE 21
FINAL RECLAMATION
RESTORED CHANNEL DESIGN PARAMETERS

Channel	Bottom Width (ft.)	Side Slope H:V	Slope %	Reclaimed Depth (ft.)	Manning's No.
RC-1	2	2:1	5.24	1.5	0.035
RC-2	2	2:1	3.25	1.5	0.035
RC-3	2	2:1	5.24	1.5	0.035
RC-4	4	2:1	8.46	2.0	0.035
RC-5	2	2:1	7.92	1.5	0.035
RC-6	2	2:1	15.38	1.5	0.035
RC-7	2	2:1	17.65	1.5	0.035
RC-8	2	2:1	16.82	1.5	0.035

TABLE 22
FINAL RECLAMATION
RESTORED CHANNEL FLOW CALCULATIONS

Channel	RC-1	RC-2	RC-3
10 yr - 6 hr event (in.)	1.55	1.55	1.55
Peak Flow (cfs)	0.23	0.83	0.24
Velocity (fps)	1.56	2.10	1.36
Req'd Area (ft.^{2})	0.15	0.39	0.18
Flow Depth (ft.)	0.07	0.17	0.08
100 yr - 6 hr event (in.)	2.07	2.07	2.07
Peak Flow (cfs)	0.69	2.36	0.73
Velocity (fps)	2.31	2.95	2.83
Req'd Area (ft.^{2})	0.30	0.80	0.73
Flow Depth (ft.)	0.13	0.31	0.28

TABLE 22 (Continued)
FINAL RECLAMATION
RESTORED CHANNEL FLOW CALCULATIONS

Channel	RC-4	RC-5	RC-6	RC-7	RC-8
10 yr - 6 hr event (in.)	1.55	1.55	1.55	1.55	1.55
Peak Flow (cfs)	2.32	0.11	0.13	0.14	0.74
Velocity (fps)	3.41	1.34	1.76	1.89	3.45
Req'd Area (ft.^{2})	0.68	0.08	0.07	0.07	0.21
Flow Depth (ft.)	0.16	0.04	0.04	0.04	0.10
100 yr - 6 hr event (in.)	2.07	2.07	2.07	2.07	2.07
Peak Flow (cfs)	6.30	0.34	0.41	0.42	2.13
Velocity (fps)	4.86	2.05	2.71	2.85	4.98
Req'd Area (ft.^{2})	1.30	0.17	0.15	0.15	0.43
Flow Depth (ft.)	0.28	0.08	0.07	0.07	0.18

APPENDIX 1

RILDA CANYON PORTAL FACILITIES

COMPUTER BACKUP

WATERSHED RUNOFF

CALCULATIONS

```
Project Title          = RILDA CANYON UA-1a (10/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     1.9 acres
    Hydraulic length          =  605.00 Feet
    Elevation change          =   380.0 feet.
    Concentration time        =    0.02 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     1.9 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.05 cfs
    Discharge volume     =    0.02 acre ft
```

```
Project Title          = RILDA CANYON UA-1a (25/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     1.9 acres
    Hydraulic length          =  605.00 Feet
    Elevation change          =   380.0 feet.
    Concentration time        =    0.02 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     1.9 acres

-- Storm data
    Total precipitation  =     1.9 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.11 cfs
    Discharge volume     =    0.03 acre ft
```

```
Project Title          = RILDA CANYON UA-1a (100/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     1.9 acres
    Hydraulic length          =  605.00 Feet
    Elevation change          =   380.0 feet.
    Concentration time        =    0.02 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     1.9 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.18 cfs
    Discharge volume     =    0.04 acre ft
```

```
Project Title          = RILDA CANYON UA-1a (10/24)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     1.9 acres
    Hydraulic length          =  605.00 Feet
    Elevation change          =   380.0 feet.
    Concentration time        =    0.02 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     1.9 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    0.50 cfs
    Discharge volume     =    0.07 acre ft
```

```
Project Title          = RILDA CANYON UA-1b (10/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     6.0 acres
    Hydraulic length          = 1541.00 Feet
    Elevation change          =  1155.0 feet.
    Concentration time        =    0.05 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     6.0 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.18 cfs
    Discharge volume     =    0.05 acre ft
```

```
Project Title          = RILDA CANYON UA-1b (25/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:         Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     6.0 acres
    Hydraulic length          = 1541.00 Feet
    Elevation change          =  1155.0 feet.
    Concentration time        =    0.05 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     6.0 acres

-- Storm data
    Total precipitation   =     1.9 inches
    Storm type            = SCS 6 hour design storm
    Peak Discharge        =    0.38 cfs
    Discharge volume      =    0.10 acre ft
```

Project Title = RILDA CANYON UA-1b (100/6)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	70.0
Area	=	6.0 acres
Hydraulic length	=	1541.00 Feet
Elevation change	=	1155.0 feet.
Concentration time	=	0.05 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Forested

-- Total Area = 6.0 acres

-- Storm data

Total precipitation	=	2.1 inches
Storm type	=	SCS 6 hour design storm
Peak Discharge	=	0.51 cfs
Discharge volume	=	0.13 acre ft

```
Project Title          = RILDA CANYON UA-1b (10/24)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     6.0 acres
    Hydraulic length          = 1541.00 Feet
    Elevation change          =  1155.0 feet.
    Concentration time        =    0.05 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     6.0 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    1.51 cfs
    Discharge volume     =    0.22 acre ft
```

```
Project Title          = RILDA CANYON UA-2a (10/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     3.2 acres
    Hydraulic length          = 1085.00 Feet
    Elevation change          =   835.0 feet.
    Concentration time        =    0.03 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     3.2 acres

-- Storm data
    Total precipitation   =     1.5 inches
    Storm type            = SCS 6 hour design storm
    Peak Discharge        =    0.09 cfs
    Discharge volume      =    0.03 acre ft
```

```
Project Title          = RILDA CANYON UA-2a (25/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     3.2 acres
    Hydraulic length          = 1085.00 Feet
    Elevation change          =   835.0 feet.
    Concentration time        =    0.03 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     3.2 acres

-- Storm data
    Total precipitation  =     1.9 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.20 cfs
    Discharge volume     =    0.05 acre ft
```

```
Project Title          = RILDA CANYON UA-2a (100/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     3.2 acres
    Hydraulic length          = 1085.00 Feet
    Elevation change          =   835.0 feet.
    Concentration time        =    0.03 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     3.2 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.28 cfs
    Discharge volume     =    0.07 acre ft
```

'roject Title = RILDA CANYON UA-2a (10/24)
/ATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

- Watershed data for watershed # 1
  Curve number = 70.0
  Area = 3.2 acres
  Hydraulic length = 1085.00 Feet
  Elevation change = 835.0 feet.
  Concentration time = 0.03 hours
  Concentration time type = SCS Upland Curves
  Unit hydrograph type = Forested

- Total Area = 3.2 acres

- Storm data
  Total precipitation = 2.5 inches
  Storm type = SCS Type 2 storm, 24 hour storm
  Peak Discharge = 0.81 cfs
  Discharge volume = 0.11 acre ft

'roject Title = RILDA CANYON UA-2b (10/6)
'ATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

- Watershed data for watershed # 1
  Curve number = 70.0
  Area = 24.5 acres
  Hydraulic length = 2522.00 Feet
  Elevation change = 1690.0 feet.
  Concentration time = 0.09 hours
  Concentration time type = SCS Upland Curves
  Unit hydrograph type = Forested

- Total Area = 24.5 acres

- Storm data
  Total precipitation = 1.5 inches
  Storm type = SCS 6 hour design storm
  Peak Discharge = 0.74 cfs
  Discharge volume = 0.20 acre ft

Project Title = RILDA CANYON UA-2b (25/6)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	70.0
Area	=	24.5 acres
Hydraulic length	=	2522.00 Feet
Elevation change	=	1690.0 feet.
Concentration time	=	0.09 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Forested

-- Total Area = 24.5 acres

-- Storm data

Total precipitation	=	1.9 inches
Storm type	=	SCS 6 hour design storm
Peak Discharge	=	1.50 cfs
Discharge volume	=	0.40 acre ft

```
'roject Title          = RILDA CANYON UA-2b (100/6)
/ATERSHED HYDROGRAPH
  Inflow into structure #  1
  Structure type:          Null


-- Watershed data for watershed # 1
   Curve number              =    70.0
   Area                      =    24.5 acres
   Hydraulic length          = 2522.00 Feet
   Elevation change          =  1690.0 feet.
   Concentration time        =    0.09 hours
   Concentration time type   = SCS Upland Curves
   Unit hydrograph type      = Forested

-- Total Area            =    24.5 acres

-- Storm data
   Total precipitation   =     2.1 inches
   Storm type            = SCS 6 hour design storm
   Peak Discharge        =    2.08 cfs
   Discharge volume      =    0.55 acre ft
```

Project Title = RILDA CANYON UA-2b (10/24)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	70.0
Area	=	24.5 acres
Hydraulic length	=	2522.00 Feet
Elevation change	=	1690.0 feet.
Concentration time	=	0.09 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Forested

-- Total Area = 24.5 acres

-- Storm data

Total precipitation	=	2.5 inches
Storm type	=	SCS Type 2 storm, 24 hour storm
Peak Discharge	=	5.68 cfs
Discharge volume	=	0.88 acre ft

```
Project Title          = RILDA CANYON UA-3a (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     1.2 acres
    Hydraulic length          =  362.00 Feet
    Elevation change          =   265.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type    = Forested

-- Total Area            =     1.2 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.03 cfs
    Discharge volume     =    0.01 acre ft
```

Project Title = RILDA CANYON UA-3a (25/6)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	70.0
Area	=	1.2 acres
Hydraulic length	=	362.00 Feet
Elevation change	=	265.0 feet.
Concentration time	=	0.01 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Forested

-- Total Area = 1.2 acres

-- Storm data

Total precipitation	=	1.9 inches
Storm type	=	SCS 6 hour design storm
Peak Discharge	=	0.07 cfs
Discharge volume	=	0.02 acre ft

```
Project Title          = RILDA CANYON UA-3a (100/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     1.2 acres
    Hydraulic length          =  362.00 Feet
    Elevation change          =   265.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     1.2 acres

-- Storm data
    Total precipitation   =     2.1 inches
    Storm type            = SCS 6 hour design storm
    Peak Discharge        =    0.11 cfs
    Discharge volume      =    0.03 acre ft
```

```
Project Title          = RILDA CANYON UA-3a (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     1.2 acres
    Hydraulic length          =  362.00 Feet
    Elevation change          =   265.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     1.2 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    0.31 cfs
    Discharge volume     =    0.04 acre ft
```

```
Project Title          = RILDA CANYON UA-3b (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     7.2 acres
    Hydraulic length          = 1595.00 Feet
    Elevation change          =  1205.0 feet.
    Concentration time        =    0.05 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     7.2 acres

-- Storm data
    Total precipitation   =     1.5 inches
    Storm type            = SCS 6 hour design storm
    Peak Discharge        =    0.21 cfs
    Discharge volume      =    0.06 acre ft
```

```
Project Title          = RILDA CANYON UA-3b (25/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     7.2 acres
    Hydraulic length          = 1595.00 Feet
    Elevation change          =  1205.0 feet.
    Concentration time        =    0.05 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     7.2 acres

-- Storm data
    Total precipitation   =     1.9 inches
    Storm type            = SCS 6 hour design storm
    Peak Discharge        =    0.45 cfs
    Discharge volume      =    0.12 acre ft
```

```
Project Title          = RILDA CANYON UA-3b (100/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     7.2 acres
    Hydraulic length          = 1595.00 Feet
    Elevation change          =  1205.0 feet.
    Concentration time        =    0.05 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     7.2 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.62 cfs
    Discharge volume     =    0.16 acre ft
```

```
Project Title          = RILDA CANYON UA-3b (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     7.2 acres
    Hydraulic length          = 1595.00 Feet
    Elevation change          =  1205.0 feet.
    Concentration time        =    0.05 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     7.2 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    1.81 cfs
    Discharge volume     =    0.26 acre ft
```

Project Title = RILDA CANYON UA-4a (10/6)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	70.0
Area	=	5.9 acres
Hydraulic length	=	1239.00 Feet
Elevation change	=	850.0 feet.
Concentration time	=	0.04 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Forested

-- Total Area = 5.9 acres

-- Storm data

Total precipitation	=	1.5 inches
Storm type	=	SCS 6 hour design storm
Peak Discharge	=	0.17 cfs
Discharge volume	=	0.05 acre ft

```
Project Title          = RILDA CANYON UA-4a (25/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     5.9 acres
    Hydraulic length          = 1239.00 Feet
    Elevation change          =   850.0 feet.
    Concentration time        =    0.04 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     5.9 acres

-- Storm data
    Total precipitation  =     1.9 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.36 cfs
    Discharge volume     =    0.10 acre ft
```

```
Project Title          = RILDA CANYON UA-4a (100/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     5.9 acres
    Hydraulic length          = 1239.00 Feet
    Elevation change          =   850.0 feet.
    Concentration time        =    0.04 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     5.9 acres

-- Storm data
    Total precipitation   =     2.1 inches
    Storm type            = SCS 6 hour design storm
    Peak Discharge        =    0.51 cfs
    Discharge volume      =    0.13 acre ft
```

```
Project Title          = RILDA CANYON UA-4a (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     5.9 acres
    Hydraulic length          = 1239.00 Feet
    Elevation change          =   850.0 feet.
    Concentration time        =    0.04 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     5.9 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    1.49 cfs
    Discharge volume     =    0.21 acre ft
```

```
Project Title          = RILDA CANYON UA-4b (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =    72.9 acres
    Hydraulic length          = 3191.00 Feet
    Elevation change          =  1974.0 feet.
    Concentration time        =    0.11 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =    72.9 acres

-- Storm data
    Total precipitation   =     1.5 inches
    Storm type            = SCS 6 hour design storm
    Peak Discharge        =    2.15 cfs
    Discharge volume      =    0.59 acre ft
```

Project Title = RILDA CANYON UA-4b (25/6)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	70.0
Area	=	72.9 acres
Hydraulic length	=	3191.00 Feet
Elevation change	=	1974.0 feet.
Concentration time	=	0.11 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Forested

-- Total Area = 72.9 acres

-- Storm data

Total precipitation	=	1.9 inches
Storm type	=	SCS 6 hour design storm
Peak Discharge	=	4.16 cfs
Discharge volume	=	1.20 acre ft

```
Project Title          = RILDA CANYON UA-4b (100/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =    72.9 acres
    Hydraulic length          = 3191.00 Feet
    Elevation change          =  1974.0 feet.
    Concentration time        =    0.11 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =    72.9 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    5.79 cfs
    Discharge volume     =    1.63 acre ft
```

```
Project Title          = RILDA CANYON UA-4b (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =    72.9 acres
    Hydraulic length          = 3191.00 Feet
    Elevation change          =  1974.0 feet.
    Concentration time        =    0.11 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =    72.9 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =   14.54 cfs
    Discharge volume     =    2.62 acre ft
```

```
Project Title          = RILDA CANYON UA-5a (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     0.1 acres
    Hydraulic length          =  106.00 Feet
    Elevation change          =    50.0 feet.
    Concentration time        =    0.00 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     0.1 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.00 cfs
    Discharge volume     =    0.00 acre ft
```

```
Project Title          = RILDA CANYON UA-5a (25/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     0.1 acres
    Hydraulic length          =  106.00 Feet
    Elevation change          =    50.0 feet.
    Concentration time        =    0.00 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     0.1 acres

-- Storm data
    Total precipitation  =     1.9 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.01 cfs
    Discharge volume     =    0.00 acre ft
```

```
Project Title          = RILDA CANYON UA-5a (100/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     0.1 acres
    Hydraulic length          =  106.00 Feet
    Elevation change          =    50.0 feet.
    Concentration time        =    0.00 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     0.1 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.01 cfs
    Discharge volume     =    0.00 acre ft
```

```
Project Title          = RILDA CANYON UA-5a (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     0.1 acres
    Hydraulic length          =  106.00 Feet
    Elevation change          =    50.0 feet.
    Concentration time        =    0.00 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     0.1 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    0.03 cfs
    Discharge volume     =    0.00 acre ft
```

```
Project Title          = RILDA CANYON UA-5b (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     3.8 acres
    Hydraulic length          = 1222.00 Feet
    Elevation change          =   780.0 feet.
    Concentration time        =    0.04 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     3.8 acres

-- Storm data
    Total precipitation   =     1.5 inches
    Storm type            = SCS 6 hour design storm
    Peak Discharge        =    0.11 cfs
    Discharge volume      =    0.03 acre ft
```

```
Project Title          = RILDA CANYON UA-5b (25/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     3.8 acres
    Hydraulic length          = 1222.00 Feet
    Elevation change          =   780.0 feet.
    Concentration time        =    0.04 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     3.8 acres

-- Storm data
    Total precipitation  =     1.9 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.24 cfs
    Discharge volume     =    0.06 acre ft
```

Project Title = RILDA CANYON UA-5b (100/6)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	70.0
Area	=	3.8 acres
Hydraulic length	=	1222.00 Feet
Elevation change	=	780.0 feet.
Concentration time	=	0.04 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Forested

-- Total Area = 3.8 acres

-- Storm data

Total precipitation	=	2.1 inches
Storm type	=	SCS 6 hour design storm
Peak Discharge	=	0.33 cfs
Discharge volume	=	0.08 acre ft

Project Title = RILDA CANYON UA-5b (10/24)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	70.0
Area	=	3.8 acres
Hydraulic length	=	1222.00 Feet
Elevation change	=	780.0 feet.
Concentration time	=	0.04 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Forested

-- Total Area = 3.8 acres

-- Storm data

Total precipitation	=	2.5 inches
Storm type	=	SCS Type 2 storm, 24 hour storm
Peak Discharge	=	0.96 cfs
Discharge volume	=	0.14 acre ft

```
Project Title          = RILDA CANYON UA-6a (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     2.0 acres
    Hydraulic length          =  690.00 Feet
    Elevation change          =   445.0 feet.
    Concentration time        =    0.02 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     2.0 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.06 cfs
    Discharge volume     =    0.02 acre ft
```

```
Project Title          = RILDA CANYON UA-6a (25/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     2.0 acres
    Hydraulic length          =  690.00 Feet
    Elevation change          =   445.0 feet.
    Concentration time        =    0.02 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     2.0 acres

-- Storm data
    Total precipitation  =     1.9 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.12 cfs
    Discharge volume     =    0.03 acre ft
```

Project Title = RILDA CANYON UA-6a (100/6)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	70.0
Area	=	2.0 acres
Hydraulic length	=	690.00 Feet
Elevation change	=	445.0 feet.
Concentration time	=	0.02 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Forested

-- Total Area = 2.0 acres

-- Storm data

Total precipitation	=	2.1 inches
Storm type	=	SCS 6 hour design storm
Peak Discharge	=	0.19 cfs
Discharge volume	=	0.05 acre ft

Project Title = RILDA CANYON UA-6a (10/24)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	70.0
Area	=	2.0 acres
Hydraulic length	=	690.00 Feet
Elevation change	=	445.0 feet.
Concentration time	=	0.02 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Forested

-- Total Area = 2.0 acres

-- Storm data

Total precipitation	=	2.5 inches
Storm type	=	SCS Type 2 storm, 24 hour storm
Peak Discharge	=	0.54 cfs
Discharge volume	=	0.07 acre ft

```
Project Title          = RILDA CANYON UA-6b (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     2.4 acres
    Hydraulic length          =  834.00 Feet
    Elevation change          =   545.0 feet.
    Concentration time        =    0.03 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     2.4 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.07 cfs
    Discharge volume     =    0.02 acre ft
```

Project Title = RILDA CANYON UA-6b (25/6)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	70.0
Area	=	2.4 acres
Hydraulic length	=	834.00 Feet
Elevation change	=	545.0 feet.
Concentration time	=	0.03 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Forested

-- Total Area = 2.4 acres

-- Storm data

Total precipitation	=	1.9 inches
Storm type	=	SCS 6 hour design storm
Peak Discharge	=	0.14 cfs
Discharge volume	=	0.04 acre ft

```
Project Title          = RILDA CANYON UA-6b (100/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     2.4 acres
    Hydraulic length          =  834.00 Feet
    Elevation change          =   545.0 feet.
    Concentration time        =    0.03 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     2.4 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.22 cfs
    Discharge volume     =    0.05 acre ft
```

Project Title = RILDA CANYON UA-6b (10/24)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	70.0
Area	=	2.4 acres
Hydraulic length	=	834.00 Feet
Elevation change	=	545.0 feet.
Concentration time	=	0.03 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Forested

-- Total Area = 2.4 acres

-- Storm data

Total precipitation	=	2.5 inches
Storm type	=	SCS Type 2 storm, 24 hour storm
Peak Discharge	=	0.62 cfs
Discharge volume	=	0.09 acre ft

```
Project Title          = RILDA CANYON UA-7a (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     2.0 acres
    Hydraulic length          =  853.00 Feet
    Elevation change          =   565.0 feet.
    Concentration time        =    0.03 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     2.0 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.06 cfs
    Discharge volume     =    0.02 acre ft
```

```
Project Title          = RILDA CANYON UA-7a (25/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     2.0 acres
    Hydraulic length          =  853.00 Feet
    Elevation change          =   565.0 feet.
    Concentration time        =    0.03 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     2.0 acres

-- Storm data
    Total precipitation  =     1.9 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.12 cfs
    Discharge volume     =    0.03 acre ft
```

```
Project Title          = RILDA CANYON UA-7a (100/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     2.0 acres
    Hydraulic length          =  853.00 Feet
    Elevation change          =   565.0 feet.
    Concentration time        =    0.03 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     2.0 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.18 cfs
    Discharge volume     =    0.04 acre ft
```

```
Project Title          = RILDA CANYON UA-7a (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     2.0 acres
    Hydraulic length          =  853.00 Feet
    Elevation change          =   565.0 feet.
    Concentration time        =    0.03 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     2.0 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    0.51 cfs
    Discharge volume     =    0.07 acre ft
```

```
Project Title          = RILDA CANYON UA-7b (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     2.7 acres
    Hydraulic length          = 1051.00 Feet
    Elevation change          =   715.0 feet.
    Concentration time        =    0.04 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     2.7 acres

-- Storm data
    Total precipitation   =     1.5 inches
    Storm type            = SCS 6 hour design storm
    Peak Discharge        =    0.08 cfs
    Discharge volume      =    0.02 acre ft
```

```
Project Title          = RILDA CANYON UA-7b (25/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     2.7 acres
    Hydraulic length          = 1051.00 Feet
    Elevation change          =   715.0 feet.
    Concentration time        =    0.04 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     2.7 acres

-- Storm data
    Total precipitation   =     1.9 inches
    Storm type            = SCS 6 hour design storm
    Peak Discharge        =    0.16 cfs
    Discharge volume      =    0.04 acre ft
```

```
Project Title          = RILDA CANYON UA-7b (100/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     2.7 acres
    Hydraulic length          = 1051.00 Feet
    Elevation change          =   715.0 feet.
    Concentration time        =    0.04 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     2.7 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.24 cfs
    Discharge volume     =    0.06 acre ft
```

```
Project Title          = RILDA CANYON UA-7b (10/24)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     2.7 acres
    Hydraulic length          = 1051.00 Feet
    Elevation change          =   715.0 feet.
    Concentration time        =    0.04 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     2.7 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    0.68 cfs
    Discharge volume     =    0.10 acre ft
```

```
Project Title          = RILDA CANYON UA-8a (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     6.0 acres
    Hydraulic length          = 1280.00 Feet
    Elevation change          =   870.0 feet.
    Concentration time        =    0.04 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     6.0 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.17 cfs
    Discharge volume     =    0.05 acre ft
```

```
Project Title          = RILDA CANYON UA-8a (25/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     6.0 acres
    Hydraulic length          = 1280.00 Feet
    Elevation change          =   870.0 feet.
    Concentration time        =    0.04 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     6.0 acres

-- Storm data
    Total precipitation  =     1.9 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.37 cfs
    Discharge volume     =    0.10 acre ft
```

```
Project Title          = RILDA CANYON UA-8a (100/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     6.0 acres
    Hydraulic length          = 1280.00 Feet
    Elevation change          =   870.0 feet.
    Concentration time        =    0.04 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     6.0 acres

-- Storm data
    Total precipitation   =     2.1 inches
    Storm type            = SCS 6 hour design storm
    Peak Discharge        =    0.52 cfs
    Discharge volume      =    0.13 acre ft
```

```
Project Title          = RILDA CANYON UA-8a (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     6.0 acres
    Hydraulic length          = 1280.00 Feet
    Elevation change          =   870.0 feet.
    Concentration time        =    0.04 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     6.0 acres

-- Storm data
    Total precipitation   =     2.5 inches
    Storm type            = SCS Type 2 storm, 24 hour storm
    Peak Discharge        =    1.51 cfs
    Discharge volume      =    0.22 acre ft
```

```
Project Title          = RILDA CANYON UA-8b (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =    19.0 acres
    Hydraulic length          = 2255.00 Feet
    Elevation change          =  1307.0 feet.
    Concentration time        =    0.08 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =    19.0 acres

-- Storm data
    Total precipitation   =     1.5 inches
    Storm type            = SCS 6 hour design storm
    Peak Discharge        =    0.57 cfs
    Discharge volume      =    0.15 acre ft
```

```
Project Title          = RILDA CANYON UA-8b (25/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =    19.0 acres
    Hydraulic length          = 2255.00 Feet
    Elevation change          =  1307.0 feet.
    Concentration time        =    0.08 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =    19.0 acres

-- Storm data
    Total precipitation  =     1.9 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    1.17 cfs
    Discharge volume     =    0.31 acre ft
```

```
Project Title          = RILDA CANYON UA-8b (100/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =    19.0 acres
    Hydraulic length          = 2255.00 Feet
    Elevation change          =  1307.0 feet.
    Concentration time        =    0.08 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =    19.0 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    1.61 cfs
    Discharge volume     =    0.42 acre ft
```

```
Project Title          = RILDA CANYON UA-8b (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =    19.0 acres
    Hydraulic length          = 2255.00 Feet
    Elevation change          =  1307.0 feet.
    Concentration time        =    0.08 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =    19.0 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    4.46 cfs
    Discharge volume     =    0.68 acre ft
```

```
Project Title          = RILDA CANYON UA-9 (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     3.0 acres
    Hydraulic length          =  779.00 Feet
    Elevation change          =   540.0 feet.
    Concentration time        =    0.03 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     3.0 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.09 cfs
    Discharge volume     =    0.02 acre ft
```

```
Project Title          = RILDA CANYON UA-9 (25/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     3.0 acres
    Hydraulic length          =  779.00 Feet
    Elevation change          =   540.0 feet.
    Concentration time        =    0.03 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     3.0 acres

-- Storm data
    Total precipitation  =     1.9 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.18 cfs
    Discharge volume     =    0.05 acre ft
```

```
Project Title          = RILDA CANYON UA-9 (100/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     3.0 acres
    Hydraulic length          =  779.00 Feet
    Elevation change          =   540.0 feet.
    Concentration time        =    0.03 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     3.0 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.28 cfs
    Discharge volume     =    0.07 acre ft
```

```
Project Title          = RILDA CANYON UA-9 (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    70.0
    Area                      =     3.0 acres
    Hydraulic length          =  779.00 Feet
    Elevation change          =   540.0 feet.
    Concentration time        =    0.03 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Forested

-- Total Area            =     3.0 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    0.79 cfs
    Discharge volume     =    0.11 acre ft
```

```
Project Title          = RILDA CANYON DA-1 (10/6)
WATERSHED HYDROGRAPH
   Inflow into structure #  1
   Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     3.5 acres
    Hydraulic length          = 1050.00 Feet
    Elevation change          =    52.0 feet.
    Concentration time        =    0.07 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     3.5 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    3.27 cfs
    Discharge volume     =    0.31 acre ft
```

Project Title = RILDA CANYON DA-1 (25/6)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	95.0
Area	=	3.5 acres
Hydraulic length	=	1050.00 Feet
Elevation change	=	52.0 feet.
Concentration time	=	0.07 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Disturbed

-- Total Area = 3.5 acres

-- Storm data

Total precipitation	=	1.9 inches
Storm type	=	SCS 6 hour design storm
Peak Discharge	=	4.17 cfs
Discharge volume	=	0.40 acre ft

```
Project Title          = RILDA CANYON DA-1 (100/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     3.5 acres
    Hydraulic length          = 1050.00 Feet
    Elevation change          =    52.0 feet.
    Concentration time        =    0.07 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     3.5 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    4.68 cfs
    Discharge volume     =    0.45 acre ft
```

```
Project Title          = RILDA CANYON DA-1 (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     3.5 acres
    Hydraulic length          = 1050.00 Feet
    Elevation change          =    52.0 feet.
    Concentration time        =    0.07 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     3.5 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    5.92 cfs
    Discharge volume     =    0.56 acre ft
```

```
Project Title          = RILDA CANYON DA-2 (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.7 acres
    Hydraulic length          =  170.00 Feet
    Elevation change          =     2.0 feet.
    Concentration time        =    0.02 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     0.7 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.53 cfs
    Discharge volume     =    0.07 acre ft
```

Project Title = RILDA CANYON DA-2 (25/6)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	95.0
Area	=	0.7 acres
Hydraulic length	=	170.00 Feet
Elevation change	=	2.0 feet.
Concentration time	=	0.02 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Disturbed

-- Total Area = 0.7 acres

-- Storm data

Total precipitation	=	1.9 inches
Storm type	=	SCS 6 hour design storm
Peak Discharge	=	0.68 cfs
Discharge volume	=	0.08 acre ft

```
Project Title          = RILDA CANYON DA-2 (100/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.7 acres
    Hydraulic length          =  170.00 Feet
    Elevation change          =     2.0 feet.
    Concentration time        =    0.02 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     0.7 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.76 cfs
    Discharge volume     =    0.10 acre ft
```

```
Project Title          = RILDA CANYON DA-2 (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.7 acres
    Hydraulic length          =  170.00 Feet
    Elevation change          =     2.0 feet.
    Concentration time        =    0.02 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     0.7 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    0.96 cfs
    Discharge volume     =    0.12 acre ft
```

```
Project Title          = RILDA CANYON DA-3 (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.2 acres
    Hydraulic length          =   60.00 Feet
    Elevation change          =     1.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     0.2 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.11 cfs
    Discharge volume     =    0.02 acre ft
```

Project Title = RILDA CANYON DA-3 (25/6)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	95.0
Area	=	0.2 acres
Hydraulic length	=	60.00 Feet
Elevation change	=	1.0 feet.
Concentration time	=	0.01 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Disturbed

-- Total Area = 0.2 acres

-- Storm data

Total precipitation	=	1.9 inches
Storm type	=	SCS 6 hour design storm
Peak Discharge	=	0.14 cfs
Discharge volume	=	0.03 acre ft

```
Project Title          = RILDA CANYON DA-3 (100/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:         Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.2 acres
    Hydraulic length          =   60.00 Feet
    Elevation change          =     1.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type    = Disturbed

-- Total Area           =     0.2 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.16 cfs
    Discharge volume     =    0.03 acre ft
```

```
Project Title          = RILDA CANYON DA-3 (10/24)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.2 acres
    Hydraulic length          =   60.00 Feet
    Elevation change          =     1.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type    = Disturbed

-- Total Area            =     0.2 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    0.20 cfs
    Discharge volume     =    0.04 acre ft
```

```
Project Title          = RILDA CANYON DA-4 (10/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.2 acres
    Hydraulic length          =   60.00 Feet
    Elevation change          =     1.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     0.2 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.12 cfs
    Discharge volume     =    0.02 acre ft
```

```
Project Title          = RILDA CANYON DA-4 (25/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.2 acres
    Hydraulic length          =   60.00 Feet
    Elevation change          =     1.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type    = Disturbed

-- Total Area            =     0.2 acres

-- Storm data
    Total precipitation  =     1.9 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.15 cfs
    Discharge volume     =    0.03 acre ft
```

```
Project Title          = RILDA CANYON DA-4 (100/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.2 acres
    Hydraulic length          =   60.00 Feet
    Elevation change          =     1.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     0.2 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.17 cfs
    Discharge volume     =    0.03 acre ft
```

Project Title = RILDA CANYON DA-4 (10/24)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	95.0
Area	=	0.2 acres
Hydraulic length	=	60.00 Feet
Elevation change	=	1.0 feet.
Concentration time	=	0.01 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Disturbed

-- Total Area = 0.2 acres

-- Storm data

Total precipitation	=	2.5 inches
Storm type	=	SCS Type 2 storm, 24 hour storm
Peak Discharge	=	0.21 cfs
Discharge volume	=	0.04 acre ft

```
Project Title          = RILDA CANYON DA-5 (10/6)
WATERSHED HYDROGRAPH
   Inflow into structure #  1
   Structure type:         Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.3 acres
    Hydraulic length          =   60.00 Feet
    Elevation change          =     1.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     0.3 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.12 cfs
    Discharge volume     =    0.02 acre ft
```

```
Project Title          = RILDA CANYON DA-5 (25/6)
WATERSHED HYDROGRAPH
   Inflow into structure #  1
   Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.3 acres
    Hydraulic length          =   60.00 Feet
    Elevation change          =     1.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     0.3 acres

-- Storm data
    Total precipitation  =     1.9 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.16 cfs
    Discharge volume     =    0.03 acre ft
```

```
Project Title          = RILDA CANYON DA-5 (100/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.3 acres
    Hydraulic length          =   60.00 Feet
    Elevation change          =     1.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     0.3 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.18 cfs
    Discharge volume     =    0.03 acre ft
```

```
Project Title          = RILDA CANYON DA-5 (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.3 acres
    Hydraulic length          =   60.00 Feet
    Elevation change          =     1.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     0.3 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    0.22 cfs
    Discharge volume     =    0.04 acre ft
```

```
Project Title          = RILDA CANYON DA-6 (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.3 acres
    Hydraulic length          =   60.00 Feet
    Elevation change          =     1.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type    = Disturbed

-- Total Area            =     0.3 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.13 cfs
    Discharge volume     =    0.02 acre ft
```

```
Project Title          = RILDA CANYON DA-6 (25/6)
WATERSHED HYDROGRAPH
   Inflow into structure #  1
   Structure type:         Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.3 acres
    Hydraulic length          =   60.00 Feet
    Elevation change          =     1.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     0.3 acres

-- Storm data
    Total precipitation  =     1.9 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.17 cfs
    Discharge volume     =    0.03 acre ft
```

```
Project Title          = RILDA CANYON DA-6 (100/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     0.3 acres
    Hydraulic length          =   60.00 Feet
    Elevation change          =     1.0 feet.
    Concentration time        =    0.01 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type    = Disturbed

-- Total Area            =     0.3 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.19 cfs
    Discharge volume     =    0.03 acre ft
```

Project Title = RILDA CANYON DA-6 (10/24)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1

Curve number	=	95.0
Area	=	0.3 acres
Hydraulic length	=	60.00 Feet
Elevation change	=	1.0 feet.
Concentration time	=	0.01 hours
Concentration time type	=	SCS Upland Curves
Unit hydrograph type	=	Disturbed

-- Total Area = 0.3 acres

-- Storm data

Total precipitation	=	2.5 inches
Storm type	=	SCS Type 2 storm, 24 hour storm
Peak Discharge	=	0.24 cfs
Discharge volume	=	0.04 acre ft

```
Project Title          = RILDA CANYON DA-7 (10/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     1.3 acres
    Hydraulic length          =  390.00 Feet
    Elevation change          =    27.0 feet.
    Concentration time        =    0.02 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     1.3 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.94 cfs
    Discharge volume     =    0.12 acre ft
```

```
Project Title          = RILDA CANYON DA-7 (25/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     1.3 acres
    Hydraulic length          =  390.00 Feet
    Elevation change          =    27.0 feet.
    Concentration time        =    0.02 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     1.3 acres

-- Storm data
    Total precipitation  =     1.9 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    1.20 cfs
    Discharge volume     =    0.15 acre ft
```

```
Project Title          = RILDA CANYON DA-7 (100/6)
WATERSHED HYDROGRAPH
   Inflow into structure #  1
   Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     1.3 acres
    Hydraulic length          =  390.00 Feet
    Elevation change          =    27.0 feet.
    Concentration time        =    0.02 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     1.3 acres

-- Storm data
    Total precipitation  =     2.1 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    1.35 cfs
    Discharge volume     =    0.17 acre ft
```

```
Project Title          = RILDA CANYON DA-7 (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    95.0
    Area                      =     1.3 acres
    Hydraulic length          =  390.00 Feet
    Elevation change          =    27.0 feet.
    Concentration time        =    0.02 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     1.3 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    1.70 cfs
    Discharge volume     =    0.21 acre ft
```

```
Project Title          = RILDA CANYON DA-8 (10/6)
WATERSHED HYDROGRAPH
   Inflow into structure #  1
   Structure type:         Null


-- Watershed data for watershed # 1
    Curve number              =    90.0
    Area                      =     1.9 acres
    Hydraulic length          = 1400.00 Feet
    Elevation change          =   100.0 feet.
    Concentration time        =    0.15 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     1.9 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    1.10 cfs
    Discharge volume     =    0.11 acre ft
```

```
Project Title          = RILDA CANYON DA-8 (25/6)
WATERSHED HYDROGRAPH
   Inflow into structure #  1
   Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    90.0
    Area                      =     1.9 acres
    Hydraulic length          = 1400.00 Feet
    Elevation change          =   100.0 feet.
    Concentration time        =    0.15 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     1.9 acres

-- Storm data
    Total precipitation  =     1.9 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    1.52 cfs
    Discharge volume     =    0.15 acre ft
```

```
Project Title          = RILDA CANYON DA-8 (100/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    90.0
    Area                      =     1.9 acres
    Hydraulic length          = 1400.00 Feet
    Elevation change          =   100.0 feet.
    Concentration time        =    0.15 hours
    Concentration time type   = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     1.9 acres

-- Storm data
    Total precipitation   =     2.1 inches
    Storm type            = SCS 6 hour design storm
    Peak Discharge        =    1.77 cfs
    Discharge volume      =    0.18 acre ft
```

Project Title = RILDA CANYON DA-8 (10/24)
WATERSHED HYDROGRAPH
Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1
Curve number = 90.0
Area = 1.9 acres
Hydraulic length = 1400.00 Feet
Elevation change = 100.0 feet.
Concentration time = 0.15 hours
Concentration time type = SCS Upland Curves
Unit hydrograph type = Disturbed

-- Total Area = 1.9 acres

-- Storm data
Total precipitation = 2.5 inches
Storm type = SCS Type 2 storm, 24 hour storm
Peak Discharge = 2.45 cfs
Discharge volume = 0.23 acre ft

UNDISTURBED DITCH

CALCULATIONS

```
Title of run: UD-1 (10/6)
   Solving for................= Depth Normal
Triangle
   Flow depth (ft)............=    0.13
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.0495
   Manning"s n................=   0.035
   CFS........................=    0.05
   Cross section area (sqft)..=    0.03
   Hydrualic radius...........=    0.06
   fps........................=    1.44
   Froude number..............=    1.04
```

Title of run: UD-1 (10/24)

```
   Solving for................= Depth Normal
Triangle
   Flow depth (ft)............=    0.31
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.0495
   Manning"s n................=   0.035
   CFS........................=    0.50
   Cross section area (sqft)..=    0.20
   Hydrualic radius...........=    0.14
   fps........................=    2.55
   Froude number..............=    1.20
```

Title of run: UD-2 (10/6)

```
   Solving for................= Depth Normal
Triangle
   Flow depth (ft)............=    0.16
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.0495
   Manning"s n................=   0.035
   CFS........................=    0.09
   Cross section area (sqft)..=    0.05
   Hydrualic radius...........=    0.07
   fps........................=    1.66
   Froude number..............=    1.08
```

Title of run: UD-2 (10/24)

Solving for.....=	Depth Normal
Triangle	
Flow depth (ft).....=	0.37
First Side slope.....=	2.0
Second Side slope.....=	2.0
Slope of diversion.....=	0.0495
Manning"s n.....=	0.035
CFS.....=	0.81
Cross section area (sqft)..=	0.28
Hydrualic radius.....=	0.17
fps.....=	2.88
Froude number.....=	1.24

'itle of run: UD-3 (10/6)

```
   Solving for................= Depth Normal
'angle
   Flow depth (ft)............=    0.11
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.0495
   Manning"s n................=   0.035
   CFS........................=    0.03
   Cross section area (sqft)..=    0.02
   Hydrualic radius...........=    0.05
   fps........................=    1.26
   Froude number..............=    1.01
```

'itle of run: UD-3 (10/24)

```
  Solving for................= Depth Normal
  Angle
  Flow depth (ft)............=    0.26
  First Side slope...........=     2.0
  Second Side slope..........=     2.0
  Slope of diversion.........=  0.0495
  Manning"s n................=   0.035
  CFS........................=    0.31
  Cross section area (sqft)..=    0.14
  Hydrualic radius...........=    0.12
  fps........................=    2.27
  Froude number..............=    1.17
```

Title of run: UD-4 (10/6)

```
   Solving for................= Depth Normal
Triangle
   Flow depth (ft)............=    0.21
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.0500
   Manning"s n................=   0.035
   CFS........................=    0.17
   Cross section area (sqft)..=    0.09
   Hydrualic radius...........=    0.09
   fps........................=    1.96
   Froude number..............=    1.13
```

Title of run: UD-4 (10/24)

```
   Solving for................= Depth Normal
Triangle
   Flow depth (ft)............=    0.47
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.0500
   Manning"s n................=   0.035
   CFS........................=    1.49
   Cross section area (sqft)..=    0.44
   Hydrualic radius...........=    0.21
   fps........................=    3.37
   Froude number..............=    1.29
```

Title of run: UD-5 (10/6)

```
   Solving for................= Depth Normal
Triangle
   Flow depth (ft)............=    0.07
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.0692
   Manning"s n................=   0.035
   CFS........................=    0.01
   Cross section area (sqft)..=    0.01
   Hydrualic radius...........=    0.03
   fps........................=    1.09
   Froude number..............=    1.10
```

Title of run: UD-5 (10/24)

Solving for.....= Depth Normal

Triangle

Flow depth (ft).....= 0.10

First Side slope.....= 2.0

Second Side slope.....= 2.0

Slope of diversion.....= 0.0692

Manning"s n.....= 0.035

CFS.....= 0.03

Cross section area (sqft)..= 0.02

Hydrualic radius.....= 0.05

fps.....= 1.43

Froude number.....= 1.18

Title of run: UD-6 (10/6)

```
   Solving for................= Depth Normal
Triangle
   Flow depth (ft)............=    0.13
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.0926
   Manning"s n................=   0.035
   CFS........................=    0.06
   Cross section area (sqft)..=    0.03
   Hydrualic radius...........=    0.06
   fps........................=    1.90
   Froude number..............=    1.41
```

Title of run: UD-6 (10/24)

```
   Solving for................= Depth Normal
Triangle
   Flow depth (ft)............=    0.29
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.0926
   Manning"s n................=   0.035
   CFS........................=    0.54
   Cross section area (sqft)..=    0.16
   Hydrualic radius...........=    0.13
   fps........................=    3.29
   Froude number..............=    1.62
```

Title of run: UD-7 (10/6)

```
   Solving for................= Depth Normal
Triangle
   Flow depth (ft)............=    0.14
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.0536
   Manning"s n................=   0.035
   CFS........................=    0.06
   Cross section area (sqft)..=    0.04
   Hydrualic radius...........=    0.06
   fps........................=    1.55
   Froude number..............=    1.09
```

Title of run: UD-7 (10/24)

```
   Solving for................= Depth Normal
Triangle
   Flow depth (ft)............=    0.31
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.0536
   Manning"s n................=   0.035
   CFS........................=    0.51
   Cross section area (sqft)..=    0.19
   Hydrualic radius...........=    0.14
   fps........................=    2.64
   Froude number..............=    1.25
```

Title of run: UD-8 (10/6)

```
   Solving for................= Depth Normal
Triangle
   Flow depth (ft)............=    0.22
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.0358
   Manning"s n................=   0.035
   CFS........................=    0.17
   Cross section area (sqft)..=    0.10
   Hydrualic radius...........=    0.10
   fps........................=    1.73
   Froude number..............=    0.97
```

Title of run: UD-8 (10/24)

```
   Solving for................= Depth Normal
Triangle
   Flow depth (ft)............=    0.50
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.0358
   Manning"s n................=   0.035
   CFS........................=    1.51
   Cross section area (sqft)..=    0.51
   Hydrualic radius...........=    0.23
   fps........................=    2.98
   Froude number..............=    1.11
```

```
Title of run: UD-9 (10/6)
   Solving for................= Depth Normal
Triangle
   Flow depth (ft)............=    0.14
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.1125
   Manning"s n................=   0.035
   CFS........................=    0.09
   Cross section area (sqft)..=    0.04
   Hydrualic radius...........=    0.06
   fps........................=    2.26
   Froude number..............=    1.59
```

Title of run: UD-9 (10/24)

```
   Solving for................= Depth Normal
Triangle
   Flow depth (ft)............=    0.32
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.1125
   Manning"s n................=   0.035
   CFS........................=    0.79
   Cross section area (sqft)..=    0.20
   Hydrualic radius...........=    0.14
   fps........................=    3.90
   Froude number..............=    1.82
```

UNDISTURED CULVERT

CALCULATIONS

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-1 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0524 ft/ft
Manning's n.....	0.024
Discharge.....	0.23 cfs

Computed Results:

Full Flow Diameter.....	0.33 ft
Full Flow Depth.....	0.33 ft
Velocity.....	2.69 fps
Flow Area.....	0.09 sf
Critical Depth....	0.27 ft
Critical Slope....	0.0527 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.23 cfs
QMAX @.94D.....	0.25 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-1 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0524 ft/ft
Manning's n.....	0.024
Discharge.....	2.01 cfs

Computed Results:

Full Flow Diameter.....	0.74 ft
Full Flow Depth.....	0.74 ft
Velocity.....	4.62 fps
Flow Area.....	0.44 sf
Critical Depth....	0.64 ft
Critical Slope....	0.0482 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	2.01 cfs
QMAX @.94D.....	2.16 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-1 (25/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0524 ft/ft
Manning's n.....	0.024
Discharge.....	0.49 cfs

Computed Results:

Full Flow Diameter.....	0.44 ft
Full Flow Depth.....	0.44 ft
Velocity.....	3.25 fps
Flow Area.....	0.15 sf
Critical Depth....	0.37 ft
Critical Slope....	0.0508 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.49 cfs
QMAX @.94D.....	0.53 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-1 (100/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0524 ft/ft
Manning's n.....	0.024
Discharge.....	0.69 cfs

Computed Results:

Full Flow Diameter.....	0.50 ft
Full Flow Depth.....	0.50 ft
Velocity.....	3.54 fps
Flow Area.....	0.20 sf
Critical Depth....	0.42 ft
Critical Slope....	0.0501 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.69 cfs
QMAX @.94D.....	0.74 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-1

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	1.50 ft
Slope.....	0.0524 ft/ft
Manning's n.....	0.024
Discharge.....	13.02 cfs

Computed Results:

Full Flow Capacity.....	13.02 cfs
Full Flow Depth.....	1.50 ft
Velocity.....	7.37 fps
Flow Area.....	1.77 sf
Critical Depth....	1.35 ft
Critical Slope....	0.0461 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	13.02 cfs
QMAX @.94D.....	14.01 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-2 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0325 ft/ft
Manning's n.....	0.024
Discharge.....	0.83 cfs

Computed Results:

Full Flow Diameter.....	0.58 ft
Full Flow Depth.....	0.58 ft
Velocity.....	3.10 fps
Flow Area.....	0.27 sf
Critical Depth....	0.45 ft
Critical Slope....	0.0375 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.83 cfs
QMAX @.94D.....	0.89 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-2 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0325 ft/ft
Manning's n.....	0.024
Discharge.....	6.49 cfs

Computed Results:

Full Flow Diameter.....	1.26 ft
Full Flow Depth.....	1.26 ft
Velocity.....	5.18 fps
Flow Area.....	1.25 sf
Critical Depth....	1.03 ft
Critical Slope....	0.0331 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	6.49 cfs
QMAX @.94D.....	6.98 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-2 (25/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0325 ft/ft
Manning's n.....	0.024
Discharge.....	1.70 cfs

Computed Results:

Full Flow Diameter.....	0.76 ft
Full Flow Depth.....	0.76 ft
Velocity.....	3.70 fps
Flow Area.....	0.46 sf
Critical Depth....	0.60 ft
Critical Slope....	0.0357 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	1.70 cfs
QMAX @.94D.....	1.83 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-2 (100/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0325 ft/ft
Manning's n.....	0.024
Discharge.....	2.36 cfs

Computed Results:

Full Flow Diameter.....	0.86 ft
Full Flow Depth.....	0.86 ft
Velocity.....	4.02 fps
Flow Area.....	0.59 sf
Critical Depth....	0.68 ft
Critical Slope....	0.0350 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	2.36 cfs
QMAX @.94D.....	2.54 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-2

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	2.00 ft
Slope.....	0.0325 ft/ft
Manning's n.....	0.024
Discharge.....	22.09 cfs

Computed Results:

Full Flow Capacity.....	22.09 cfs
Full Flow Depth.....	2.00 ft
Velocity.....	7.03 fps
Flow Area.....	3.14 sf
Critical Depth....	1.68 ft
Critical Slope....	0.0312 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	22.09 cfs
QMAX @.94D.....	23.76 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-3 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0524 ft/ft
Manning's n.....	0.024
Discharge.....	0.24 cfs

Computed Results:

Full Flow Diameter.....	0.34 ft
Full Flow Depth.....	0.34 ft
Velocity.....	2.72 fps
Flow Area.....	0.09 sf
Critical Depth....	0.27 ft
Critical Slope....	0.0526 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.24 cfs
QMAX @.94D.....	0.26 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-3 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0524 ft/ft
Manning's n.....	0.024
Discharge.....	2.12 cfs

Computed Results:

Full Flow Diameter.....	0.76 ft
Full Flow Depth.....	0.76 ft
Velocity.....	4.68 fps
Flow Area.....	0.45 sf
Critical Depth....	0.66 ft
Critical Slope....	0.0481 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	2.12 cfs
QMAX @.94D.....	2.28 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-3 (25/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0524 ft/ft
Manning's n.....	0.024
Discharge.....	0.52 cfs

Computed Results:

Full Flow Diameter.....	0.45 ft
Full Flow Depth.....	0.45 ft
Velocity.....	3.29 fps
Flow Area.....	0.16 sf
Critical Depth....	0.37 ft
Critical Slope....	0.0507 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.52 cfs
QMAX @.94D.....	0.56 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-3 (100/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0524 ft/ft
Manning's n.....	0.024
Discharge.....	0.73 cfs

Computed Results:

Full Flow Diameter.....	0.51 ft
Full Flow Depth.....	0.51 ft
Velocity.....	3.59 fps
Flow Area.....	0.20 sf
Critical Depth....	0.43 ft
Critical Slope....	0.0500 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.73 cfs
QMAX @.94D.....	0.79 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-3

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	1.50 ft
Slope.....	0.0524 ft/ft
Manning's n.....	0.024
Discharge.....	13.02 cfs

Computed Results:

Full Flow Capacity.....	13.02 cfs
Full Flow Depth.....	1.50 ft
Velocity.....	7.37 fps
Flow Area.....	1.77 sf
Critical Depth....	1.35 ft
Critical Slope....	0.0461 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	13.02 cfs
QMAX @.94D.....	14.01 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-4 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0846 ft/ft
Manning's n.....	0.024
Discharge.....	2.32 cfs

Computed Results:

Full Flow Diameter.....	0.72 ft
Full Flow Depth.....	0.72 ft
Velocity.....	5.73 fps
Flow Area.....	0.40 sf
Critical Depth....	0.67 ft
Critical Slope....	0.0732 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	2.32 cfs
QMAX @.94D.....	2.50 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-4 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0846 ft/ft
Manning's n.....	0.024
Discharge.....	16.03 cfs

Computed Results:

Full Flow Diameter.....	1.48 ft
Full Flow Depth.....	1.48 ft
Velocity.....	9.29 fps
Flow Area.....	1.73 sf
Critical Depth....	1.42 ft
Critical Slope....	0.0735 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	16.03 cfs
QMAX @.94D.....	17.24 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-4 (25/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0846 ft/ft
Manning's n.....	0.024
Discharge.....	4.52 cfs

Computed Results:

Full Flow Diameter.....	0.92 ft
Full Flow Depth.....	0.92 ft
Velocity.....	6.77 fps
Flow Area.....	0.67 sf
Critical Depth....	0.87 ft
Critical Slope....	0.0731 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	4.52 cfs
QMAX @.94D.....	4.86 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-4 (100/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0846 ft/ft
Manning's n.....	0.024
Discharge.....	6.30 cfs

Computed Results:

Full Flow Diameter.....	1.04 ft
Full Flow Depth.....	1.04 ft
Velocity.....	7.36 fps
Flow Area.....	0.86 sf
Critical Depth....	0.99 ft
Critical Slope....	0.0732 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	6.30 cfs
QMAX @.94D.....	6.78 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-4

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	2.00 ft
Slope.....	0.0846 ft/ft
Manning's n.....	0.024
Discharge.....	35.64 cfs

Computed Results:

Full Flow Capacity.....	35.64 cfs
Full Flow Depth.....	2.00 ft
Velocity.....	11.35 fps
Flow Area.....	3.14 sf
Critical Depth....	1.93 ft
Critical Slope....	0.0739 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	35.64 cfs
QMAX @.94D.....	38.34 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-5 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0792 ft/ft
Manning's n.....	0.024
Discharge.....	0.11 cfs

Computed Results:

Full Flow Diameter.....	0.23 ft
Full Flow Depth.....	0.23 ft
Velocity.....	2.61 fps
Flow Area.....	0.04 sf
Critical Depth....	0.20 ft
Critical Slope....	0.0724 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.11 cfs
QMAX @.94D.....	0.12 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-5 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0792 ft/ft
Manning's n.....	0.024
Discharge.....	0.99 cfs

Computed Results:

Full Flow Diameter.....	0.53 ft
Full Flow Depth.....	0.53 ft
Velocity.....	4.52 fps
Flow Area.....	0.22 sf
Critical Depth....	0.48 ft
Critical Slope....	0.0691 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.99 cfs
QMAX @.94D.....	1.06 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-5 (25/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0792 ft/ft
Manning's n.....	0.024
Discharge.....	0.25 cfs

Computed Results:

Full Flow Diameter.....	0.32 ft
Full Flow Depth.....	0.32 ft
Velocity.....	3.20 fps
Flow Area.....	0.08 sf
Critical Depth....	0.28 ft
Critical Slope....	0.0708 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.25 cfs
QMAX @.94D.....	0.27 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-5 (100/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0792 ft/ft
Manning's n.....	0.024
Discharge.....	0.34 cfs

Computed Results:

Full Flow Diameter.....	0.35 ft
Full Flow Depth.....	0.35 ft
Velocity.....	3.46 fps
Flow Area.....	0.10 sf
Critical Depth....	0.32 ft
Critical Slope....	0.0703 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.34 cfs
QMAX @.94D.....	0.37 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-5

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	1.50 ft
Slope.....	0.0792 ft/ft
Manning's n.....	0.024
Discharge.....	16.01 cfs

Computed Results:

Full Flow Capacity.....	16.01 cfs
Full Flow Depth.....	1.50 ft
Velocity.....	9.06 fps
Flow Area.....	1.77 sf
Critical Depth....	1.42 ft
Critical Slope....	0.0686 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	16.01 cfs
QMAX @.94D.....	17.22 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-6 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.1538 ft/ft
Manning's n.....	0.024
Discharge.....	0.13 cfs

Computed Results:

Full Flow Diameter.....	0.22 ft
Full Flow Depth.....	0.22 ft
Velocity.....	3.49 fps
Flow Area.....	0.04 sf
Critical Depth....	0.21 ft
Critical Slope....	0.1333 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.13 cfs
QMAX @.94D.....	0.14 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-6 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.1538 ft/ft
Manning's n.....	0.024
Discharge.....	1.16 cfs

Computed Results:

Full Flow Diameter.....	0.49 ft
Full Flow Depth.....	0.49 ft
Velocity.....	6.03 fps
Flow Area.....	0.19 sf
Critical Depth....	0.48 ft
Critical Slope....	0.1356 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	1.16 cfs
QMAX @.94D.....	1.25 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-6 (25/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.1538 ft/ft
Manning's n.....	0.024
Discharge.....	0.26 cfs

Computed Results:

Full Flow Diameter.....	0.28 ft
Full Flow Depth.....	0.28 ft
Velocity.....	4.15 fps
Flow Area.....	0.06 sf
Critical Depth....	0.27 ft
Critical Slope....	0.1339 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.26 cfs
QMAX @.94D.....	0.28 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-6 (100/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.1538 ft/ft
Manning's n.....	0.024
Discharge.....	0.41 cfs

Computed Results:

Full Flow Diameter.....	0.34 ft
Full Flow Depth.....	0.34 ft
Velocity.....	4.65 fps
Flow Area.....	0.09 sf
Critical Depth....	0.32 ft
Critical Slope....	0.1343 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.41 cfs
QMAX @.94D.....	0.44 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-6

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	1.50 ft
Slope.....	0.1538 ft/ft
Manning's n.....	0.024
Discharge.....	22.31 cfs

Computed Results:

Full Flow Capacity.....	22.31 cfs
Full Flow Depth.....	1.50 ft
Velocity.....	12.63 fps
Flow Area.....	1.77 sf
Critical Depth....	1.48 ft
Critical Slope....	0.1398 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	22.31 cfs
QMAX @.94D.....	24.00 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-7 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.1765 ft/ft
Manning's n.....	0.024
Discharge.....	0.14 cfs

Computed Results:

Full Flow Diameter.....	0.22 ft
Full Flow Depth.....	0.22 ft
Velocity.....	3.74 fps
Flow Area.....	0.04 sf
Critical Depth....	0.21 ft
Critical Slope....	0.1541 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.14 cfs
QMAX @.94D.....	0.15 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-7 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.1765 ft/ft
Manning's n.....	0.024
Discharge.....	1.19 cfs

Computed Results:

Full Flow Diameter.....	0.49 ft
Full Flow Depth.....	0.49 ft
Velocity.....	6.39 fps
Flow Area.....	0.19 sf
Critical Depth....	0.48 ft
Critical Slope....	0.1573 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	1.19 cfs
QMAX @.94D.....	1.28 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-7 (25/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.1765 ft/ft
Manning's n.....	0.024
Discharge.....	0.28 cfs

Computed Results:

Full Flow Diameter.....	0.28 ft
Full Flow Depth.....	0.28 ft
Velocity.....	4.45 fps
Flow Area.....	0.06 sf
Critical Depth....	0.27 ft
Critical Slope....	0.1550 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.28 cfs
QMAX @.94D.....	0.30 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-7 (100/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.1765 ft/ft
Manning's n.....	0.024
Discharge.....	0.42 cfs

Computed Results:

Full Flow Diameter.....	0.33 ft
Full Flow Depth.....	0.33 ft
Velocity.....	4.92 fps
Flow Area.....	0.09 sf
Critical Depth....	0.32 ft
Critical Slope....	0.1556 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.42 cfs
QMAX @.94D.....	0.45 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-7

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	1.50 ft
Slope.....	0.1765 ft/ft
Manning's n.....	0.024
Discharge.....	23.90 cfs

Computed Results:

Full Flow Capacity.....	23.90 cfs
Full Flow Depth.....	1.50 ft
Velocity.....	13.53 fps
Flow Area.....	1.77 sf
Critical Depth....	1.48 ft
Critical Slope....	0.1622 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	23.90 cfs
QMAX @.94D.....	25.71 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-8 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.1682 ft/ft
Manning's n.....	0.024
Discharge.....	0.74 cfs

Computed Results:

Full Flow Diameter.....	0.41 ft
Full Flow Depth.....	0.41 ft
Velocity.....	5.57 fps
Flow Area.....	0.13 sf
Critical Depth....	0.40 ft
Critical Slope....	0.1486 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.74 cfs
QMAX @.94D.....	0.80 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-8 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.1682 ft/ft
Manning's n.....	0.024
Discharge.....	5.97 cfs

Computed Results:

Full Flow Diameter.....	0.90 ft
Full Flow Depth.....	0.90 ft
Velocity.....	9.39 fps
Flow Area.....	0.64 sf
Critical Depth....	0.88 ft
Critical Slope....	0.1519 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	5.97 cfs
QMAX @.94D.....	6.42 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-8 (25/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.1682 ft/ft
Manning's n.....	0.024
Discharge.....	1.54 cfs

Computed Results:

Full Flow Diameter.....	0.54 ft
Full Flow Depth.....	0.54 ft
Velocity.....	6.69 fps
Flow Area.....	0.23 sf
Critical Depth....	0.53 ft
Critical Slope....	0.1497 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	1.54 cfs
QMAX @.94D.....	1.66 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-8 (100/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.1682 ft/ft
Manning's n.....	0.024
Discharge.....	2.13 cfs

Computed Results:

Full Flow Diameter.....	0.61 ft
Full Flow Depth.....	0.61 ft
Velocity.....	7.26 fps
Flow Area.....	0.29 sf
Critical Depth....	0.60 ft
Critical Slope....	0.1502 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	2.13 cfs
QMAX @.94D.....	2.29 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT UC-8

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	2.00 ft
Slope.....	0.1682 ft/ft
Manning's n.....	0.024
Discharge.....	50.26 cfs

Computed Results:

Full Flow Capacity.....	50.26 cfs
Full Flow Depth.....	2.00 ft
Velocity.....	16.00 fps
Flow Area.....	3.14 sf
Critical Depth....	1.98 ft
Critical Slope....	0.1551 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	50.26 cfs
QMAX @.94D.....	54.06 cfs
Froude Number.....	FULL

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DISTURBED DITCH

CALCULATIONS

'itle of run: DD-1 (10/6)
Solving for.....= Depth Normal
'riangle
Flow depth (ft).....= 0.46
First Side slope.....= 2.0
Second Side slope.....= 2.0
Slope of diversion.....= 0.0495
Manning"s n.....= 0.015
CFS.....= 3.27
Cross section area (sqft)..= 0.42
Hydrualic radius.....= 0.21
fps.....= 7.71
Froude number.....= 2.99

'itle of run: DD-1 (10/24)

```
  Solving for................= Depth Normal
'angle
  Flow depth (ft)............=    0.58
  First Side slope...........=     2.0
  Second Side slope..........=     2.0
  Slope of diversion.........=  0.0495
  Manning"s n................=   0.015
  CFS........................=    5.92
  Cross section area (sqft)..=    0.66
  Hydrualic radius...........=    0.26
  fps........................=    8.94
  Froude number..............=    3.11
```

'itle of run: DD-2 (10/6)

```
  Solving for................= Depth Normal
'riangle
  Flow depth (ft)............=    0.64
  First Side slope...........=     2.0
  Second Side slope..........=     2.0
  Slope of diversion.........=  0.0118
  Manning"s n................=   0.015
  CFS........................=    3.80
  Cross section area (sqft)..=    0.81
  Hydrualic radius...........=    0.29
  fps........................=    4.67
  Froude number..............=    1.54
```

'itle of run: DD-2 (10/24)
Solving for.....= Depth Normal
'riangle
Flow depth (ft).....= 0.80
First Side slope.....= 2.0
Second Side slope.....= 2.0
Slope of diversion.....= 0.0118
Manning"s n.....= 0.015
CFS.....= 6.88
Cross section area (sqft)..= 1.27
Hydrualic radius.....= 0.36
fps.....= 5.42
Froude number.....= 1.60

'itle of run: DD-3 (10/6)

```
   Solving for................= Depth Normal
'angle
   Flow depth (ft)............=    0.60
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.0167
   Manning"s n................=   0.015
   CFS........................=    3.91
   Cross section area (sqft)..=    0.73
   Hydrualic radius...........=    0.27
   fps........................=    5.36
   Froude number..............=    1.82
```

'itle of run: DD-3 (10/24)

Solving for.....= Depth Normal

'ngle

low depth (ft).....= 0.75

First Side slope.....= 2.0

Second Side slope.....= 2.0

Slope of diversion.....= 0.0167

Manning"s n.....= 0.015

CFS.....= 7.08

Cross section area (sqft)..= 1.14

Hydrualic radius.....= 0.34

fps.....= 6.22

Froude number.....= 1.89

'itle of run: DD-4 (10/6)

```
   Solving for................= Depth Normal
'angle
   Flow depth (ft)............=    0.61
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Slope of diversion.........=  0.0167
   Manning"s n................=   0.015
   CFS........................=    4.03
   Cross section area (sqft)..=    0.75
   Hydrualic radius...........=    0.27
   fps........................=    5.40
   Froude number..............=    1.82
```

'itle of run: DD-4 (10/24)

```
  Solving for................= Depth Normal
'hangle
  Flow depth (ft)............=    0.76
  First Side slope...........=     2.0
  Second Side slope..........=     2.0
  Slope of diversion.........=  0.0167
  Manning"s n................=   0.015
  CFS........................=    7.29
  Cross section area (sqft)..=    1.16
  Hydrualic radius...........=    0.34
  fps........................=    6.27
  Froude number..............=    1.89
```

'itle of run: DD-5 (10/6)

Solving for.....=	Depth Normal

'riangle

Flow depth (ft).....=	0.62
First Side slope.....=	2.0
Second Side slope.....=	2.0
Slope of diversion.....=	0.0167
Manning"s n.....=	0.015
CFS.....=	4.15
Cross section area (sqft)..=	0.76
Hydrualic radius.....=	0.28
fps.....=	5.44
Froude number.....=	1.83

'itle of run: DD-5 (10/24)

```
  Solving for................= Depth Normal
'angle
  Flow depth (ft)............=    0.77
  First Side slope...........=     2.0
  Second Side slope..........=     2.0
  Slope of diversion.........=  0.0167
  Manning"s n................=   0.015
  CFS........................=    7.51
  Cross section area (sqft)..=    1.19
  Hydrualic radius...........=    0.34
  fps........................=    6.31
  Froude number..............=    1.89
```

'itle of run: DD-6 (10/6)

```
  Solving for................= Depth Normal
'angle
  Flow depth (ft)............=    0.62
  First Side slope...........=     2.0
  Second Side slope..........=     2.0
  Slope of diversion.........=  0.0167
  Manning"s n................=   0.015
  CFS........................=    4.28
  Cross section area (sqft)..=    0.78
  Hydrualic radius...........=    0.28
  fps........................=    5.49
  Froude number..............=    1.83
```

'itle of run: DD-6 (10/24)

```
  Solving for................= Depth Normal
'riangle
  Flow depth (ft)............=    0.78
  First Side slope...........=     2.0
  Second Side slope..........=     2.0
  Slope of diversion.........=  0.0167
  Manning"s n................=   0.015
  CFS........................=    7.75
  Cross section area (sqft)..=    1.22
  Hydrualic radius...........=    0.35
  fps........................=    6.36
  Froude number..............=    1.90
```

```
itle of run: DD-7 (10/6)
  Solving for................= Depth Normal
'triangle
  Flow depth (ft)............=    0.52
  First Side slope...........=     2.0
  Second Side slope..........=     2.0
  Slope of diversion.........=  0.0692
  Manning"s n................=   0.015
  CFS........................=    5.22
  Cross section area (sqft)..=    0.53
  Hydrualic radius...........=    0.23
  fps........................=    9.82
  Froude number..............=    3.61
```

itle of run: DD-7 (10/24)

```
  Solving for................= Depth Normal
angle
  low depth (ft)............=    0.64
  First Side slope..........=     2.0
  Second Side slope.........=     2.0
  Slope of diversion........=  0.0692
  Manning"s n...............=   0.015
  CFS.......................=    9.45
  Cross section area (sqft)..=    0.83
  Hydrualic radius..........=    0.29
  fps.......................=   11.40
  Froude number.............=    3.74
```

'itle of run: DD-8 (10/6)

```
  Solving for................= Depth Normal
'riangle
  Flow depth (ft)............=    0.39
  First Side slope...........=     2.0
  Second Side slope..........=     2.0
  Slope of diversion.........=  0.0714
  Manning"s n................=   0.035
  CFS........................=    1.10
  Cross section area (sqft)..=    0.31
  Hydrualic radius...........=    0.18
  fps........................=    3.57
  Froude number..............=    1.50
```

'itle of run: DD-8 (10/24)
Solving for.....= Depth Normal
'riangle
Flow depth (ft).....= 0.53
First Side slope.....= 2.0
Second Side slope.....= 2.0
Slope of diversion.....= 0.0714
Manning"s n.....= 0.035
CFS.....= 2.45
Cross section area (sqft)..= 0.56
Hydrualic radius.....= 0.24
fps.....= 4.36
Froude number.....= 1.58

DISTURBED CULVERT

CALCULATIONS

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-1 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	3.27 cfs

Computed Results:

Full Flow Diameter.....	0.51 ft
Full Flow Depth.....	0.51 ft
Velocity.....	15.76 fps
Flow Area.....	0.21 sf
Critical Depth....	0.51 ft
Critical Slope....	0.9780 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	3.27 cfs
QMAX @.94D.....	3.52 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-1 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	5.92 cfs

Computed Results:

Full Flow Diameter.....	0.64 ft
Full Flow Depth.....	0.64 ft
Velocity.....	18.29 fps
Flow Area.....	0.32 sf
Critical Depth....	0.64 ft
Critical Slope....	0.9795 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	5.92 cfs
QMAX @.94D.....	6.37 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-1

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	1.50 ft
Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	56.90 cfs

Computed Results:

Full Flow Capacity.....	56.90 cfs
Full Flow Depth.....	1.50 ft
Velocity.....	32.20 fps
Flow Area.....	1.77 sf
Critical Depth....	1.50 ft
Critical Slope....	0.9846 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	56.90 cfs
QMAX @.94D.....	61.21 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-2 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	3.80 cfs

Computed Results:

Full Flow Diameter.....	0.54 ft
Full Flow Depth.....	0.54 ft
Velocity.....	16.37 fps
Flow Area.....	0.23 sf
Critical Depth....	0.54 ft
Critical Slope....	0.9784 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	3.80 cfs
QMAX @.94D.....	4.09 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-2 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	6.88 cfs

Computed Results:

Full Flow Diameter.....	0.68 ft
Full Flow Depth.....	0.68 ft
Velocity.....	18.99 fps
Flow Area.....	0.36 sf
Critical Depth....	0.68 ft
Critical Slope....	0.9799 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	6.88 cfs
QMAX @.94D.....	7.40 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-2

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	1.50 ft
Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	56.90 cfs

Computed Results:

Full Flow Capacity.....	56.90 cfs
Full Flow Depth.....	1.50 ft
Velocity.....	32.20 fps
Flow Area.....	1.77 sf
Critical Depth....	1.50 ft
Critical Slope....	0.9846 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	56.90 cfs
QMAX @.94D.....	61.21 cfs
Froude Number.....	FULL

Open Channel Flow Module, Version 3.43 (c) 1991
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-3 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	3.91 cfs

Computed Results:

Full Flow Diameter.....	0.55 ft
Full Flow Depth.....	0.55 ft
Velocity.....	16.49 fps
Flow Area.....	0.24 sf
Critical Depth....	0.55 ft
Critical Slope....	0.9785 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	3.91 cfs
QMAX @.94D.....	4.21 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-3 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	7.08 cfs

Computed Results:

Full Flow Diameter.....	0.69 ft
Full Flow Depth.....	0.69 ft
Velocity.....	19.12 fps
Flow Area.....	0.37 sf
Critical Depth....	0.69 ft
Critical Slope....	0.9800 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	7.08 cfs
QMAX @.94D.....	7.62 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-3

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	1.50 ft
Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	56.90 cfs

Computed Results:

Full Flow Capacity.....	56.90 cfs
Full Flow Depth.....	1.50 ft
Velocity.....	32.20 fps
Flow Area.....	1.77 sf
Critical Depth....	1.50 ft
Critical Slope....	0.9846 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	56.90 cfs
QMAX @.94D.....	61.21 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-4 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	4.03 cfs

Computed Results:

Full Flow Diameter.....	0.56 ft
Full Flow Depth.....	0.56 ft
Velocity.....	16.61 fps
Flow Area.....	0.24 sf
Critical Depth....	0.56 ft
Critical Slope....	0.9785 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	4.03 cfs
QMAX @.94D.....	4.34 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-4 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	7.29 cfs

Computed Results:

Full Flow Diameter.....	0.69 ft
Full Flow Depth.....	0.69 ft
Velocity.....	19.26 fps
Flow Area.....	0.38 sf
Critical Depth....	0.69 ft
Critical Slope....	0.9801 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	7.29 cfs
QMAX @.94D.....	7.84 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-4

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	1.50 ft
Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	56.90 cfs

Computed Results:

Full Flow Capacity.....	56.90 cfs
Full Flow Depth.....	1.50 ft
Velocity.....	32.20 fps
Flow Area.....	1.77 sf
Critical Depth....	1.50 ft
Critical Slope....	0.9846 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	56.90 cfs
QMAX @.94D.....	61.21 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-5 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	4.15 cfs

Computed Results:

Full Flow Diameter.....	0.56 ft
Full Flow Depth.....	0.56 ft
Velocity.....	16.73 fps
Flow Area.....	0.25 sf
Critical Depth....	0.56 ft
Critical Slope....	0.9786 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	4.15 cfs
QMAX @.94D.....	4.46 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-5 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	7.51 cfs

Computed Results:

Full Flow Diameter.....	0.70 ft
Full Flow Depth.....	0.70 ft
Velocity.....	19.41 fps
Flow Area.....	0.39 sf
Critical Depth....	0.70 ft
Critical Slope....	0.9801 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	7.51 cfs
QMAX @.94D.....	8.08 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-5

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	1.50 ft
Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	56.90 cfs

Computed Results:

Full Flow Capacity.....	56.90 cfs
Full Flow Depth.....	1.50 ft
Velocity.....	32.20 fps
Flow Area.....	1.77 sf
Critical Depth....	1.50 ft
Critical Slope....	0.9846 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	56.90 cfs
QMAX @.94D.....	61.21 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-6 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	4.28 cfs

Computed Results:

Full Flow Diameter.....	0.57 ft
Full Flow Depth.....	0.57 ft
Velocity.....	16.86 fps
Flow Area.....	0.25 sf
Critical Depth....	0.57 ft
Critical Slope....	0.9787 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	4.28 cfs
QMAX @.94D.....	4.60 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-6 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	7.75 cfs

Computed Results:

Full Flow Diameter.....	0.71 ft
Full Flow Depth.....	0.71 ft
Velocity.....	19.56 fps
Flow Area.....	0.40 sf
Critical Depth....	0.71 ft
Critical Slope....	0.9802 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	7.75 cfs
QMAX @.94D.....	8.34 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-6

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	1.50 ft
Slope.....	1.0000 ft/ft
Manning's n.....	0.024
Discharge.....	56.90 cfs

Computed Results:

Full Flow Capacity.....	56.90 cfs
Full Flow Depth.....	1.50 ft
Velocity.....	32.20 fps
Flow Area.....	1.77 sf
Critical Depth....	1.50 ft
Critical Slope....	0.9846 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	56.90 cfs
QMAX @.94D.....	61.21 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-7 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0714 ft/ft
Manning's n.....	0.024
Discharge.....	5.22 cfs

Computed Results:

Full Flow Diameter.....	1.00 ft
Full Flow Depth.....	1.00 ft
Velocity.....	6.59 fps
Flow Area.....	0.79 sf
Critical Depth....	0.93 ft
Critical Slope....	0.0619 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	5.22 cfs
QMAX @.94D.....	5.62 cfs
Froude Number.....	FULL

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-7 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0714 ft/ft
Manning's n.....	0.024
Discharge.....	9.45 cfs

Computed Results:

Full Flow Diameter.....	1.26 ft
Full Flow Depth.....	1.26 ft
Velocity.....	7.64 fps
Flow Area.....	1.24 sf
Critical Depth....	1.17 ft
Critical Slope....	0.0617 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	9.45 cfs
QMAX @.94D.....	10.17 cfs
Froude Number.....	FULL

Open Channel Flow Module, Version 3.43 (c) 1991
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: RILDA CANYON

Comment: CULVERT DC-7

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	1.50 ft
Slope.....	0.0714 ft/ft
Manning's n.....	0.024
Discharge.....	15.20 cfs

Computed Results:

Full Flow Capacity.....	15.20 cfs
Full Flow Depth.....	1.50 ft
Velocity.....	8.60 fps
Flow Area.....	1.77 sf
Critical Depth....	1.41 ft
Critical Slope....	0.0617 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	15.20 cfs
QMAX @.94D.....	16.35 cfs
Froude Number.....	FULL

Open Channel Flow Module, Version 3.43 (c) 1991
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RESTORED CHANNELS

Title of run: RC-1 (10/6)

Solving for.....= Depth Normal

Trapedeziod

Flow depth (ft).....= 0.07

First Side slope.....= 2.0

Second Side slope.....= 2.0

Bottom width (ft).....= 2.00

Slope of diversion.....= 0.0524

Manning"s n.....= 0.035

CFS.....= 0.23

Cross section area (sqft)..= 0.15

Hydrualic radius.....= 0.06

fps.....= 1.56

Froude number.....= 1.09

'itle of run: RC-1 (100/6)

Solving for.....= Depth Normal

'rapedeziod

Flow depth (ft).....= 0.13

First Side slope.....= 2.0

Second Side slope.....= 2.0

Bottom width (ft).....= 2.00

Slope of diversion.....= 0.0524

Manning"s n.....= 0.035

CFS.....= 0.69

Cross section area (sqft)..= 0.30

Hydrualic radius.....= 0.12

fps.....= 2.31

Froude number.....= 1.20

'itle of run: RC-2 (10/6)

```
  Solving for................= Depth Normal
'rapedeziod
  Flow depth (ft)............=    0.17
  First Side slope...........=     2.0
  Second Side slope..........=     2.0
  Bottom width (ft)..........=    2.00
  Slope of diversion.........=  0.0325
  Manning"s n................=   0.035
  CFS........................=    0.83
  Cross section area (sqft)..=    0.39
  Hydrualic radius...........=    0.14
  fps........................=    2.10
  Froude number..............=    0.98
```

Title of run: RC-2 (100/6)

```
   Solving for................= Depth Normal
Trapedeziod
   Flow depth (ft)............=    0.31
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Bottom width (ft)..........=    2.00
   Slope of diversion.........=  0.0325
   Manning"s n................=   0.035
   CFS........................=    2.36
   Cross section area (sqft)..=    0.80
   Hydrualic radius...........=    0.24
   fps........................=    2.95
   Froude number..............=    1.06
```

```
Title of run: RC-3 (10/6)
   Solving for................= Depth Normal
Trapedeziod
   Flow depth (ft)............=    0.08
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Bottom width (ft)..........=    2.00
   Slope of diversion.........=  0.0325
   Manning"s n................=   0.035
   CFS........................=    0.24
   Cross section area (sqft)..=    0.18
   Hydrualic radius...........=    0.07
   fps........................=    1.36
   Froude number..............=    0.88
```

```
Title of run: RC-3 (100/6)
   Solving for................= Depth Normal
Trapedeziod
   Flow depth (ft)............=    0.28
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Bottom width (ft)..........=    2.00
   Slope of diversion.........=  0.0325
   Manning"s n................=   0.035
   CFS........................=    2.07
   Cross section area (sqft)..=    0.73
   Hydrualic radius...........=    0.22
   fps........................=    2.83
   Froude number..............=    1.05
```

Title of run: RC-4 (10/6)

Solving for.....= Depth Normal

Trapedeziod

Flow depth (ft).....= 0.16

First Side slope.....= 2.0

Second Side slope.....= 2.0

Bottom width (ft).....= 4.00

Slope of diversion.....= 0.0846

Manning"s n.....= 0.035

CFS.....= 2.32

Cross section area (sqft)..= 0.68

Hydrualic radius.....= 0.14

fps.....= 3.41

Froude number.....= 1.58

Title of run: RC-4 (100/6)

Solving for.....= Depth Normal

Trapedeziod

Flow depth (ft).....= 0.28

First Side slope.....= 2.0

Second Side slope.....= 2.0

Bottom width (ft).....= 4.00

Slope of diversion.....= 0.0846

Manning"s n.....= 0.035

CFS.....= 6.30

Cross section area (sqft)..= 1.30

Hydrualic radius.....= 0.25

fps.....= 4.86

Froude number.....= 1.73

Title of run: RC-5 (10/6)

```
   Solving for................= Depth Normal
   Bedeziod
   Flow depth (ft)............=    0.04
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Bottom width (ft)..........=    2.00
   Slope of diversion.........=  0.0792
   Manning"s n................=   0.035
   CFS........................=    0.11
   Cross section area (sqft)..=    0.08
   Hydrualic radius...........=    0.04
   fps........................=    1.34
   Froude number..............=    1.22
```

```
Title of run: RC-5 (100/6)
   Solving for................= Depth Normal
Trapedeziod
   Flow depth (ft)............=    0.08
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Bottom width (ft)..........=    2.00
   Slope of diversion.........=  0.0792
   Manning"s n................=   0.035
   CFS........................=    0.34
   Cross section area (sqft)..=    0.17
   Hydrualic radius...........=    0.07
   fps........................=    2.05
   Froude number..............=    1.36
```

Title of run: RC-6 (10/6)

```
   Solving for................= Depth Normal
Trapedeziod
   Flow depth (ft)............=    0.04
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Bottom width (ft)..........=    2.00
   Slope of diversion.........=  0.1538
   Manning"s n................=   0.035
   CFS........................=    0.13
   Cross section area (sqft)..=    0.07
   Hydrualic radius...........=    0.03
   fps........................=    1.76
   Froude number..............=    1.68
```

Title of run: RC-6 (100/6)

Solving for.....= Depth Normal

Trapedeziod

Flow depth (ft).....= 0.07

First Side slope.....= 2.0

Second Side slope.....= 2.0

Bottom width (ft).....= 2.00

Slope of diversion.....= 0.1538

Manning"s n.....= 0.035

CFS.....= 0.41

Cross section area (sqft)..= 0.15

Hydrualic radius.....= 0.07

fps.....= 2.71

Froude number.....= 1.87

Title of run: RC-7 (10/6)

Solving for.....= Depth Normal

Trapedeziod

Flow depth (ft).....= 0.04

First Side slope.....= 2.0

Second Side slope.....= 2.0

Bottom width (ft).....= 2.00

Slope of diversion.....= 0.1765

Manning"s n.....= 0.035

CFS.....= 0.14

Cross section area (sqft)..= 0.07

Hydrualic radius.....= 0.03

fps.....= 1.89

Froude number.....= 1.80

Title of run: RC-7 (100/6)

Solving for.....= Depth Normal

Trapedeziod

Flow depth (ft).....= 0.07

First Side slope.....= 2.0

Second Side slope.....= 2.0

Bottom width (ft).....= 2.00

Slope of diversion.....= 0.1765

Manning"s n.....= 0.035

CFS.....= 0.42

Cross section area (sqft)..= 0.15

Hydrualic radius.....= 0.06

fps.....= 2.85

Froude number.....= 1.99

Title of run: RC-8 (10/6)

Solving for.....= Depth Normal

Trapedeziod

Flow depth (ft).....= 0.10

First Side slope.....= 2.0

Second Side slope.....= 2.0

Bottom width (ft).....= 2.00

Slope of diversion.....= 0.1682

Manning"s n.....= 0.035

CFS.....= 0.74

Cross section area (sqft)..= 0.21

Hydrualic radius.....= 0.09

fps.....= 3.45

Froude number.....= 2.05

Title of run: RC-8 (100/6)

```
   Solving for................= Depth Normal
Trapedeziod
   Flow depth (ft)............=    0.18
   First Side slope...........=     2.0
   Second Side slope..........=     2.0
   Bottom width (ft)..........=    2.00
   Slope of diversion.........=  0.1682
   Manning"s n................=   0.035
   CFS........................=    2.13
   Cross section area (sqft)..=    0.43
   Hydrualic radius...........=    0.15
   fps........................=    4.98
   Froude number..............=    2.25
```

ASCA
CALCULATIONS

```
Project Title          = ASCA-1 (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    90.0
    Area                      =     1.7 acres
    Hydraulic length          =   20.00 Feet
    Elevation change          =    10.0 feet.
    Concentration time        =    0.00 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     1.7 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.43 cfs
    Discharge volume     =    0.10 acre ft
```

```
Project Title          = ASCA-1 (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    90.0
    Area                      =     1.7 acres
    Hydraulic length          =   20.00 Feet
    Elevation change          =    10.0 feet.
    Concentration time        =    0.00 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     1.7 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    0.91 cfs
    Discharge volume     =    0.21 acre ft
```

```
Project Title          = ASCA-2 (10/6)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    90.0
    Area                      =     0.1 acres
    Hydraulic length          =   30.00 Feet
    Elevation change          =    10.0 feet.
    Concentration time        =    0.00 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     0.1 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    0.03 cfs
    Discharge volume     =    0.01 acre ft
```

```
Project Title          = ASCA-2 (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    90.0
    Area                      =     0.1 acres
    Hydraulic length          =   30.00 Feet
    Elevation change          =    10.0 feet.
    Concentration time        =    0.00 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     0.1 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    0.06 cfs
    Discharge volume     =    0.01 acre ft
```

```
Project Title          = ASCA-3 (10/6)
WATERSHED HYDROGRAPH
     Inflow into structure #  1
     Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    90.0
    Area                      =     3.1 acres
    Hydraulic length          =  950.00 Feet
    Elevation change          =    76.0 feet.
    Concentration time        =    0.09 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     3.1 acres

-- Storm data
    Total precipitation  =     1.5 inches
    Storm type           = SCS 6 hour design storm
    Peak Discharge       =    2.07 cfs
    Discharge volume     =    0.19 acre ft
```

```
Project Title          = ASCA-3 (10/24)
WATERSHED HYDROGRAPH
    Inflow into structure #  1
    Structure type:          Null


-- Watershed data for watershed # 1
    Curve number              =    90.0
    Area                      =     3.1 acres
    Hydraulic length          =  950.00 Feet
    Elevation change          =    76.0 feet.
    Concentration time        =    0.09 hours
    Concentration time type = SCS Upland Curves
    Unit hydrograph type      = Disturbed

-- Total Area            =     3.1 acres

-- Storm data
    Total precipitation  =     2.5 inches
    Storm type           = SCS Type 2 storm, 24 hour storm
    Peak Discharge       =    4.51 cfs
    Discharge volume     =    0.39 acre ft
```

GEOMORPHOLOGY EVALUATION OF THE RILDA CANYON STREAM CHANNEL

ENERGY WEST MINING COMPANY
Huntington, Utah

August 2004

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GEOMORPHOLOGY EVALUATION OF THE RILDA CANYON STREAM CHANNEL

CHAPTER 1

INTRODUCTION

Energy West Mining Company has proposed construction of new portal facilities in Rilda Canyon to allow more efficient access of their Deer Creek Mine coal reserves. At the request of the Utah Division of Oil, Gas and Mining (the "Division"), a stream channel morphology study was conducted within and adjacent to areas to be disturbed by the new portal. The purpose of this study was to define baseline geomorphic conditions in the vicinity of the portals to assist in future reclamation decisions. Specifically, this study involved the following scope of work:

- Establish permanent benchmarks and cross sections at six locations along Rilda Canyon.
- Survey channel cross sections and gradients at the established locations, in accordance with guidelines established by the U.S. Forest Service (Harrelson et al., 1994).
- Classify the stream sections in accordance with procedures established by Rosgen (1996).
- Prepare drawings showing surveyed cross section and profile data.
- Evaluate data collected from existing piezometers and prior soil surveys in Rilda Canyon concerning:
    - Water table fluctuations relative to the elevation of the adjacent stream channel
    - Stratification of alluvial sediment within the stream corridor
    - Composition of stream bank material
    - Identification of zones of seasonally saturated and infrequently saturated soils.
- Evaluate historic streamflow data collected from Rilda Canyon.
- Calculate flood-flow magnitudes based on regional regression equations.
- Prepare maps, if possible, based on soil and vegetation data collected within the canyon, showing the riparian zone, bank zone, overbank zone, and upland zone.
- Prepare a report transmitting the above information.

The purpose of this document is to present the results of the above-outlined study. It is divided into four chapters, including this introduction. Chapter 2 discusses the field methods used in this investigation, with the results of the work presented in Chapter 3. References are cited in Chapter 4.

CHAPTER 2

FIELD DATA COLLECTION METHODS

Reference sites were established in Rilda Canyon at the locations shown on Plate 1. All reference sites were established in general conformance with the recommendations of Harrelson et al. (1994). The work involved the following:

- Benchmarks were installed at each site by drilling an 8-inch diameter hole to a depth of approximately 3 feet using a portable power auger. Each hole was filled with concrete and the monument was identified with a brass marker stamped with the site number. Photographs were taken and descriptions provided to allow others to return to the sites in the future. Photographs are presented in Appendix A.
- Each benchmark position and elevation was determined in the field by Energy West using ground survey methods. Table 1 presents the benchmark coordinates.
- Monumented cross sections were established at each site. The endpoints of the cross sections were marked with 3-foot long, 1/2-inch diameter steel reinforcing bars that were driven approximately 2.5 feet into the ground. The bars were capped with plastic survey end caps marked with the cross-section number.
- The locations of the cross section endpoints with respect to the benchmarks were measured, using a tape and Brunton compass, with the measurements noted in the field log book (see Appendix B).
- The channel cross section was surveyed at each site. A measuring tape was attached to one of the cross section monuments and stretched tight and level across the stream to the other monument. Surveying was performed using a Sokkia survey level and rod. Elevations were shot at each important feature or change in elevation (e.g., slope breaks, channel banks, bankfull stages, etc.). The survey was closed by re-shooting the station benchmark. The readings were recorded in the field log book (see Appendix B).
- The longitudinal profile of the stream channel was surveyed at each site. The profiles extend a distance of at least 20 times the channel width (half upstream and half downstream from the cross section location). Data were collected to indicate the elevation of the channel bottom, the water surface, indications of bankfull stage, and the top of the stream bank. Measurements were collected on intervals at least equal to the channel width. Data were collected using a survey level and rod, with the location of the starting and endpoints being measured as noted above. Data readings were recorded in the field log book (see Appendix B).

CHAPTER 3

RESULTS SUMMARY

3.1 Channel Descriptions

Surveys of the channel cross section and longitudinal profile were conducted at each reference site as discussed in Chapter 2. Field data collected from these surveys are presented in Appendix B. Data and plots of the channel cross sections and profiles are provided in Appendix C. Table 2 presents a summary of the channel data for each reference site.

The hydraulic slope of the Rilda Canyon channel varies from about 4 to 6% within the reach adjacent to the area of planned disturbance (i.e., between reference sites RC-1 and RC-5). The slope decreases to 2.6% at RC-6, approximately 1,200 feet downstream from RC-5. This slope reduction in the downstream direction is typical of mountain streams. The channel in the main portion of the canyon below the confluence of Left and Right Forks is deeply entrenched, with steep, eroded streambanks. As indicated by the photographs contained in Appendix A, vegetative cover density along the stream channel is high. Collins (2004) reported that the sum of the overstory and understory cover exceeds 100% along the stream channel. The Appendix A photographs also indicate that significant quantities of woody debris exist in the stream channel at several locations.

As indicated in Table 2, within the area of investigation Rilda Canyon is classified as an A4 or A5 stream type. According to Rosgen (1996), these streams are generally deeply entrenched into a steep, confined channel. Woody debris commonly occurs in such streams, and their banks are typically steep and eroded. The primary difference between the two is that A4 streams contain a greater amount of coarse bed material than A5 streams. It should be noted that reference reaches RC-1 and RC-2 were classified as A5 streams even though they are not deeply entrenched. The channel slope and sinuosity at RC-1 and RC-2 preclude their classification as

type C or E streams (which are generally only slightly entrenched), prompting their classification as type A5 streams.

3.2 Groundwater Conditions

Energy West has collected water-level data since 1993 from the four piezometers in Rilda Canyon noted on Plate 1. The data thus collected are provided in Appendix D and summarized in Figure 1. Water levels measured in piezometers P-1 and P-5 have not shown significant fluctuations with time during the period of record. These piezometers were constructed by West Appa Coal Company prior to acquisition of the property by Energy West. No details concerning the construction of these wells are available; it is presumed that they were completed only within the upper portion of the colluvial surface material (water table) based upon electric water level measurements. Given the lack of water-level fluctuations in P-1 and P-5, it is possible that the well screens have become plugged, suggesting that the wells likely provide a general indication of water levels, but are slow to respond to fluctuations.

The maximum annual water-level fluctuation in P-6 and P-7 occurred in 1995, with a maximum change of 10.9 feet in P-6 and 27.6 feet in P-7. These wells were each drilled by Energy West to a depth of 80 feet and completed with casing and screen at a depth of 70 feet into the Star Point Sandstone.

Table 3 provides a comparison of water levels measured in the stream at the reference sites during this investigation and groundwater levels projected from the potentiometric surface provided by Hansen, Allen & Luce (1991, see Plate 1). As indicated, groundwater in bedrock is estimated to be 35 to 70 feet below the water level in the stream at all locations except RC-5, where groundwater is projected to be only about 5 feet below the stream surface. Even with the maximum water-level fluctuations measured in P-6 and P-7, it is likely that the Rilda Canyon is a losing stream throughout the area of investigation, with the possible exception of the area near

RC-5, where the stream may be gaining during periods of high groundwater levels (i.e., late spring/early summer).

Larsen (2004) installed a soil test pit in a relatively flat area about 100 feet south of the stream between RC-5 and RC-6 (his location S7). The soil at this location was mottled at a depth of about 30 inches, indicating a periodic high water table at that depth. Given the similarities in topography and geomorphology from that approximate location to downstream areas, it is probable that this depth of mottling is typical of the vicinity of RC-6 and areas about 600 to 800 feet upstream therefrom. However, based on field observations of the streambank, the deeply entrenched nature of the channel between RC-3 and RC-5, and other soil test pits installed in the area by Furst (1991), Larsen (2004), and Nyenhuis (2004), the seasonally high water table in the alluvium of this reach is likely below the bottom of the channel.

3.3 Description of Alluvial Material

The extent of alluvial fill within the study area, as mapped by Energy West, is noted on Plate 1. According to Nyenhuis (2004), the soil that comprises this alluvial fill is "very deep (>60" to bedrock), well to somewhat poorly drained. . . . Soil textures are primarily sandy loam or sandy clay loam. Coarse fragment content is generally less than 15% in the surface layer, and increases to about 20% or more in the subsoil and substratum. Stones and boulders are scattered on the soil surface."

A test pit installed by Nyenhuis (2004) in Right Fork of Rilda Canyon just upstream from its confluence with Left Fork (his test pit RC2) consisted of the following profile:

0- 6 inches	Very dark grayish brown (10YR 3/2, dry) sandy loam
6-18 inches	Brown (10YR 4/3, dry) sandy clay loam
18-30 inches	Brown (10YR 5/3, dry) sandy loam
30-66 inches	Brown (10YR5/3, dry) sandy loam

Furst (1991) installed a test pit very near stream reference site RC-2 as part of an earlier soils investigation of the area. This test pit encountered the following soil profile:

0- 8 inches	Very dark brown (10YR 2/1) sandy loam; moderate, fine subangular blocky structure parting to moderate, fine granular structure; very friable; effervesces slightly; many fine roots; clear, smooth boundary.
8-19 inches	Very dark grayish brown (10YR 3/2) sandy loam; weak, fine subangular blocky structure; friable; effervesces strongly; few, fine roots; clear, smooth boundary.
19-30 inches	Dark brown (10YR 3/4) sandy loam; weak, medium subangular blocky structure; friable; effervesces violently; few, fine roots; smooth boundary.
30-43 inches	Brown (10YR 5/4) sandy loam; weak, medium subangular blocky structure; friable; effervesces violently; few, sine roots; gradual, smooth boundary.
43-60 inches	Brown (10YR 5/4) sandy loam; massive; firm; effervesces violently; few, fine roots.

From these profile descriptions it is evident that only limited stratification exists in the alluvial soils. This conclusion was verified elsewhere within the area of this investigation through observations of the eroded streambank. Consistent with the test pit profile, the streambank throughout the area of investigation consists of silty clay, with minor coarse fragments and varying amounts of organic matter.

3.4 Streamflow Conditions

Monthly streamflow data have been collected for several years from flumes and a weir installed in Rilda Canyon at the locations noted on Figure 2. These data, which are included in Appendix E and summarized in Figure 3, indicate that significant seasonal and annual variations in streamflow occur in Rilda Canyon. Peak flows generally occur in the late spring or early summer, with periods of low to no flow being common during other seasons of the year.

Temporal trends in flow were compared with the Palmer Hydrologic Drought Index ("PHDI") to assess the effects of climatic change on the magnitude of streamflow issuing from

Rilda Canyon. The PHDI, which is generated by the National Climatic Data Center, is a monthly index value used to quantify the hydrologic impacts of drought and gives an indication of the severity of a drought or a period of excess precipitation. PHDI data included on Figure 3 were obtained from the National Climatic Data Center web site at http://www.ncdc.noaa.gov/oa/climate/onlineprod/drought/main.html. As would be expected, Rilda Canyon streamflow responds directly to drought, with higher flow during periods of excess precipitation and lower flow during periods of drought.

Table 4 summarizes the contribution of various areas within Rilda Canyon to the total streamflow of the canyon for 1998 (within a period of positive PHDI) and 2003 (within a period of negative PHDI). As indicated, the contribution of Right Fork to the total flow of Rilda Canyon (as measured at location RCF1) varies significantly from year to year, with approximately half of the total flow coming from Right Fork in 1998 and nearly 90% of the total flow issuing from that for in 2003. The contribution of Left Fork (RCLF1 and RCLF2) to the total flow of the canyon is relatively minor, being less than 5% in 1998 and contributing no flow in 2003.

Peak flow estimates for various return periods were calculated using the regional flood-flow equations of Thomas and Lindskov (1983). These estimates were calculated for watersheds at the mouth of Right Fork and the mouth of Left Fork (i.e., both being upstream from the proposed disturbed area) as well as at reference site RC-5 (i.e., downstream from the proposed disturbed area). Results of these calculations are provided in Appendix F and summarized in Table 5. Given the lack of entrenchment at reference sites RC-1 and RC-2, the 100-year peak flow is expected to overflow the active channel at these locations and spread onto the floodplain. However, the 100-year peak flow will be contained entirely within the deeply entrenched channel at RC-5. Given the entrenched conditions of the main Rilda Canyon channel downstream from the confluence of Left and Right Forks, it is anticipated that the 100-year peak flow will be contained within the active channel along the length of the proposed disturbed area.

3.5 Streambank Zones

The extent of alluvium in Rilda Canyon adjacent to the proposed disturbed area is shown on Plate 1. The stream channel is sufficiently entrenched from the confluence of Left and Right Forks through the area of adjacent proposed disturbance that streambank zones cannot be plotted at the scale of Plate 1. Riparian zones were of insufficient extent adjacent to the area of proposed disturbance to warrant their identification as a separate plant community by Collins (2004).

A small floodplain (typically a few feet wide) exists in discontinuous sections along the area evaluated for this investigation. Given the degree of entrenchment, the main channel generally transitions abruptly from active water surface to upland zone.

CHAPTER 4

REFERENCES

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Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology. Pagosa Springs, Colorado.

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TABLE 1

Rilda Canyon Benchmark Coordinates

Reference Site	Northing (ft)	Easting (ft)	Elevation (ft)
RC-1	390,101.780	2,097,428.079	7715.74
RC-2	389,894.365	2,097,558.487	7714.65
RC-3	390,017.989	2,097,719.928	7688.91
RC-4	389,994.342	2,098,417.687	7643.61
RC-5	389,983.249	2,100,808309	7474.71
RC-6	389,974.927	2,101,779.088	7417.44

TABLE 2

Summary of Channel Data

Reference Site	Entrenchment Ratio			Width/Depth Ratio			Sinuosity	Hydraulic Slope (ft/ft)	Bed Material	Stream Class
	W_{fpa}[a] (ft)	W_{bkf}[b] (ft)	Ratio	W_{bkf}[b] (ft)	D_{bkf}[c] (ft)	Ratio				
RC-1	85.2	7.2	11.8	7.2	0.61	11.8	Low	0.045	Sandy gravel	A5[d]
RC-2	5.7	1.4	4.1	1.4	0.20	7.0	Low	0.049	Sand	A5[d]
RC-3	5.8	4.3	1.3	4.3	0.86	5.0	Low	0.042	Sandy gravel	A4
RC-4	4.9	3.9	1.3	3.9	0.90	4.3	Low	0.059	Sandy gravel	A4
RC-5	10.6	8.0	1.3	8.0	1.37	5.8	Low	0.051	Sandy gravel	A4
RC-6	10.3	7.1	1.5	7.1	0.73	9.7	Low	0.026	Gravelly sand	A5

[a] Width of the floodplain at a depth of twice the bankfull depth
[b] Width of flow at bankfull depth
[c] Depth of flow at bankfull stage
[d] Classification based primarily on factors other than the entrenchment ratio

TABLE 3

Stream and Potentiometric Water Level Comparisons

Reference Site	Stream Water Surface Elevation[a] (ft)	Projected Groundwater Elevation[b] (ft)	Approximate Difference (ft)
RC-1	7715.17	7645	70
RC-2	7708.95	7645	65
RC-3	7679.80	7630	50
RC-4	7636.11	7600	35
RC-5	7469.90	7465	5
RC-6	7415.45	7350	65

[a] Measured in Rilda Canyon on 21 Jan 2004
[b] Based on December 1990 potentiometric surface map of Hansen, Allen & Luce (1991), projected to reference site locations

TABLE 4

Contribution of Subwatersheds to Total Rilda Canyon Flow

Measurement Location	Percent of Total Flow	
	1998	2003
RCLF1	4.6	0.0
RCLF2	4.4	0.0
RCF1	47.4	89.6
RCF2	65.2	55.2
RCF3	80.1	90.2
RCW4	100.0	100.0

TABLE 5

Estimated Peak Flows at Selected Rilda Canyon Locations

Parameter[a]	Reference Site		
	RC-1[b]	RC-2[c]	RC-5
Q_2 (cfs)	28	20	48
Q_5 (cfs)	61	45	99
Q_{10} (cfs)	84	66	139
Q_{25} (cfs)	120	99	198
Q_{50} (cfs)	150	128	250
Q_{100} (cfs)	183	160	306
D_{100} (ft)	0.86	1.45	3.31

[a] Q_n = peak flow at a return period of "n" years (Thomas and Lindskov [1983] method)
D_n = flow depth at a peak flow of Q_n, measured relative to the channel bottom
[b] Based on estimates for the mouth of Right Fork
[c] Based on estimated for the mouth of Left Fork

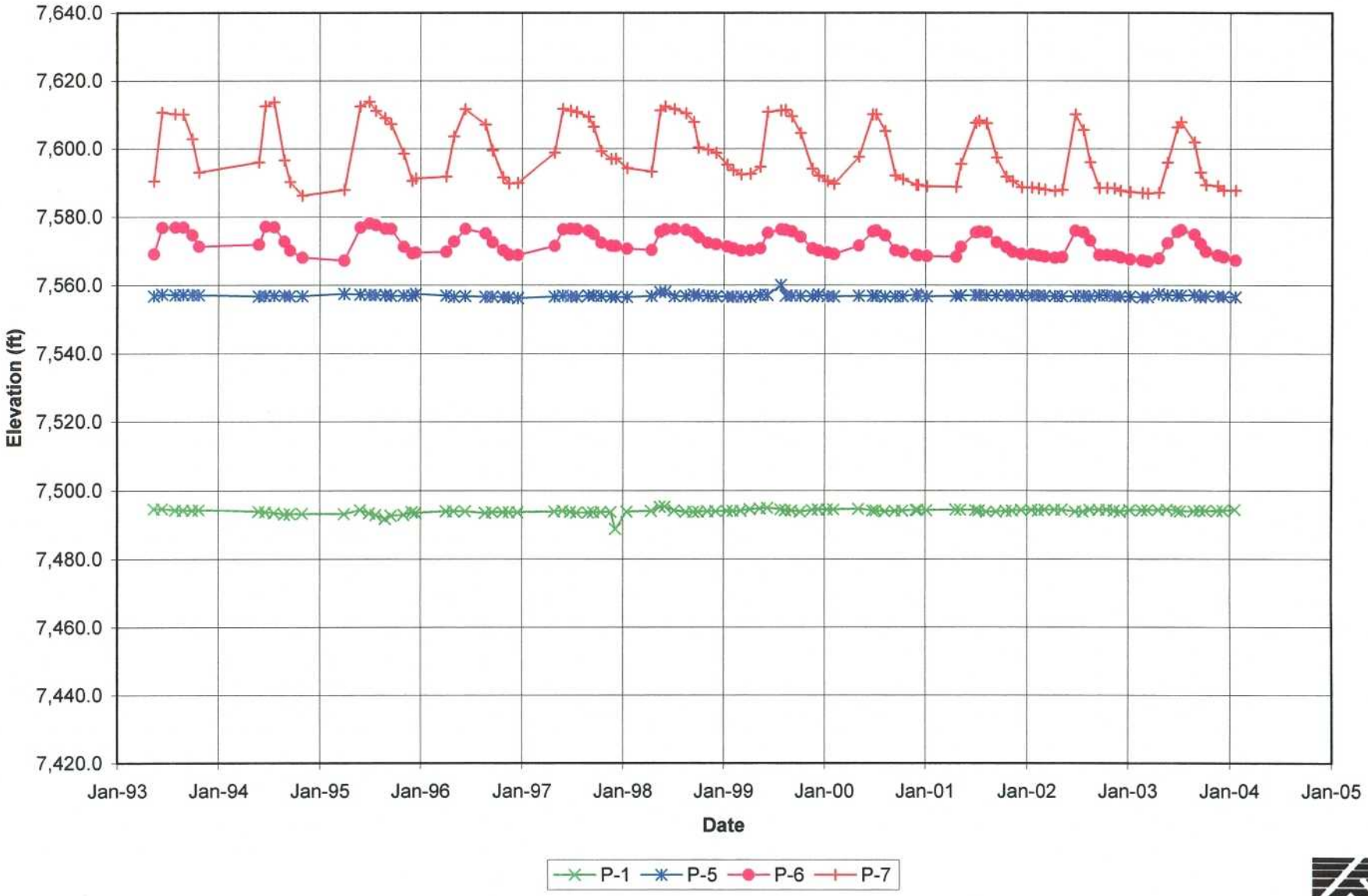

FIGURE 1. RILDA CANYON GROUNDWATER LEVEL DATA

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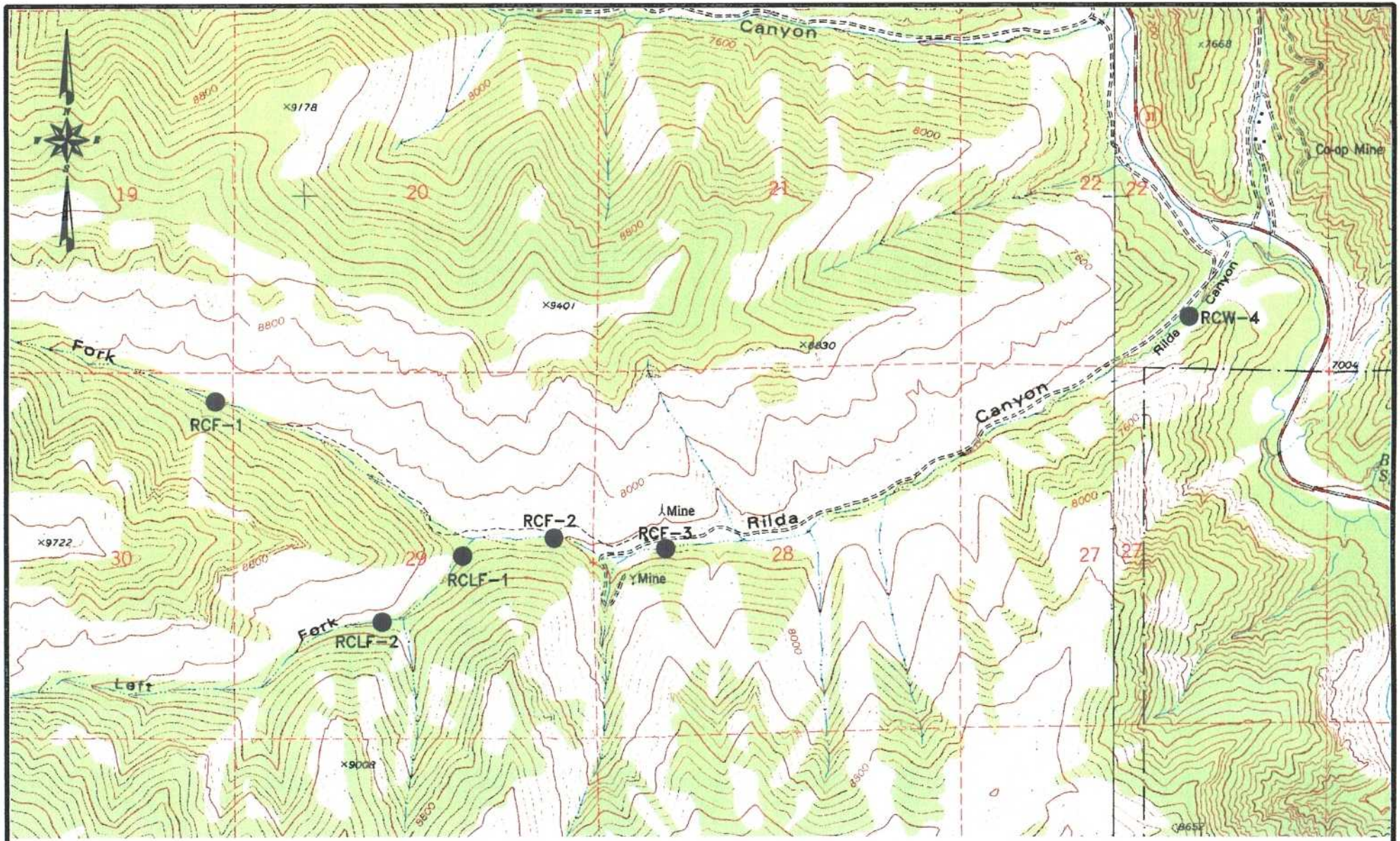

BASE MAP: RILDA CANYON, UTAH 7.5 MINUTE QUADRANGLE
HIAWATHA, UTAH 7.5 MINUTE QUADRANGLE

0' 2000'

FIGURE 2. STREAMFLOW MEASUREMENT LOCATIONS

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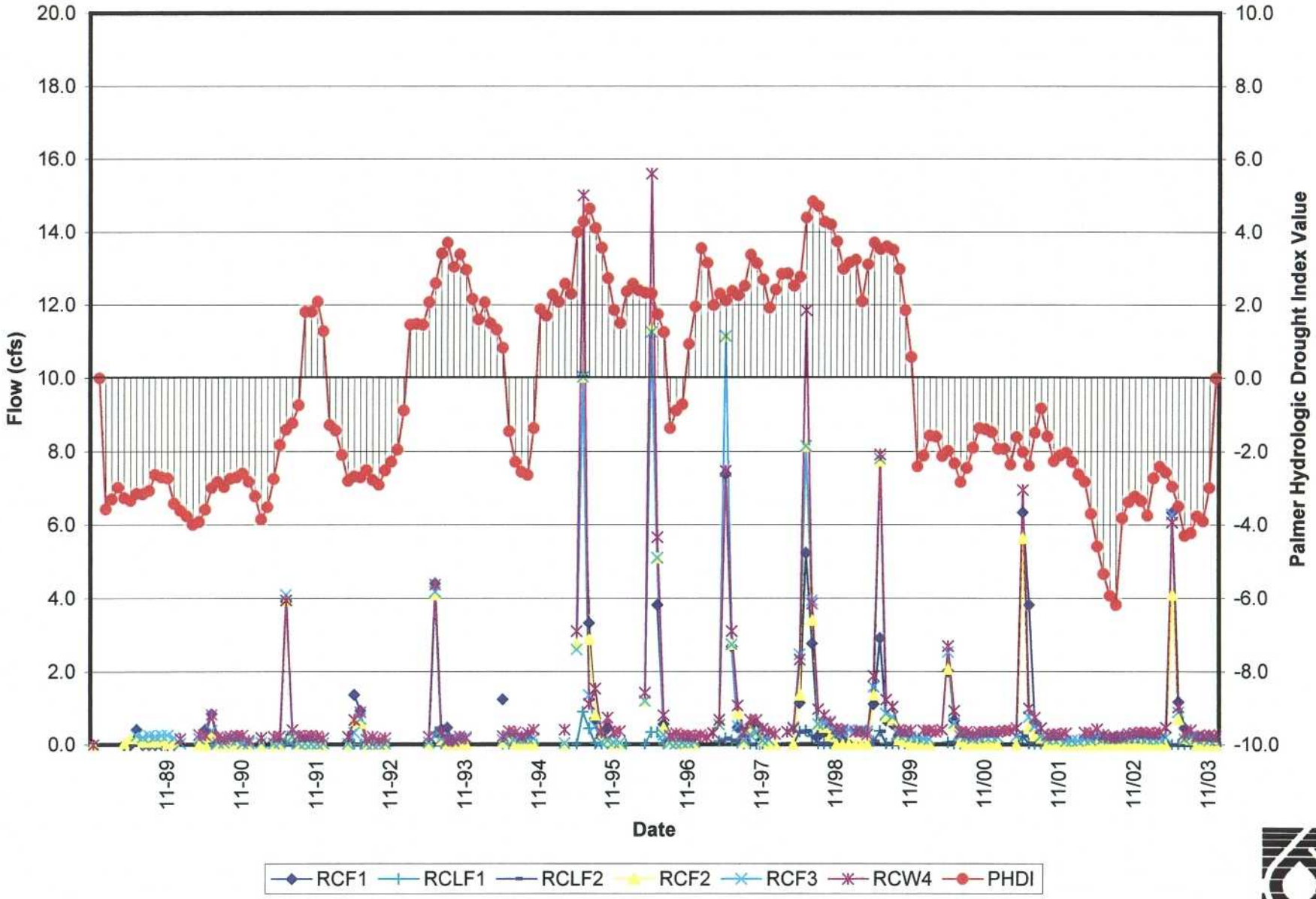

FIGURE 3. RILDA CANYON STREAMFLOW SUMMARY

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APPENDIX A

Reference Site Photographs

RC-1 Cross Section

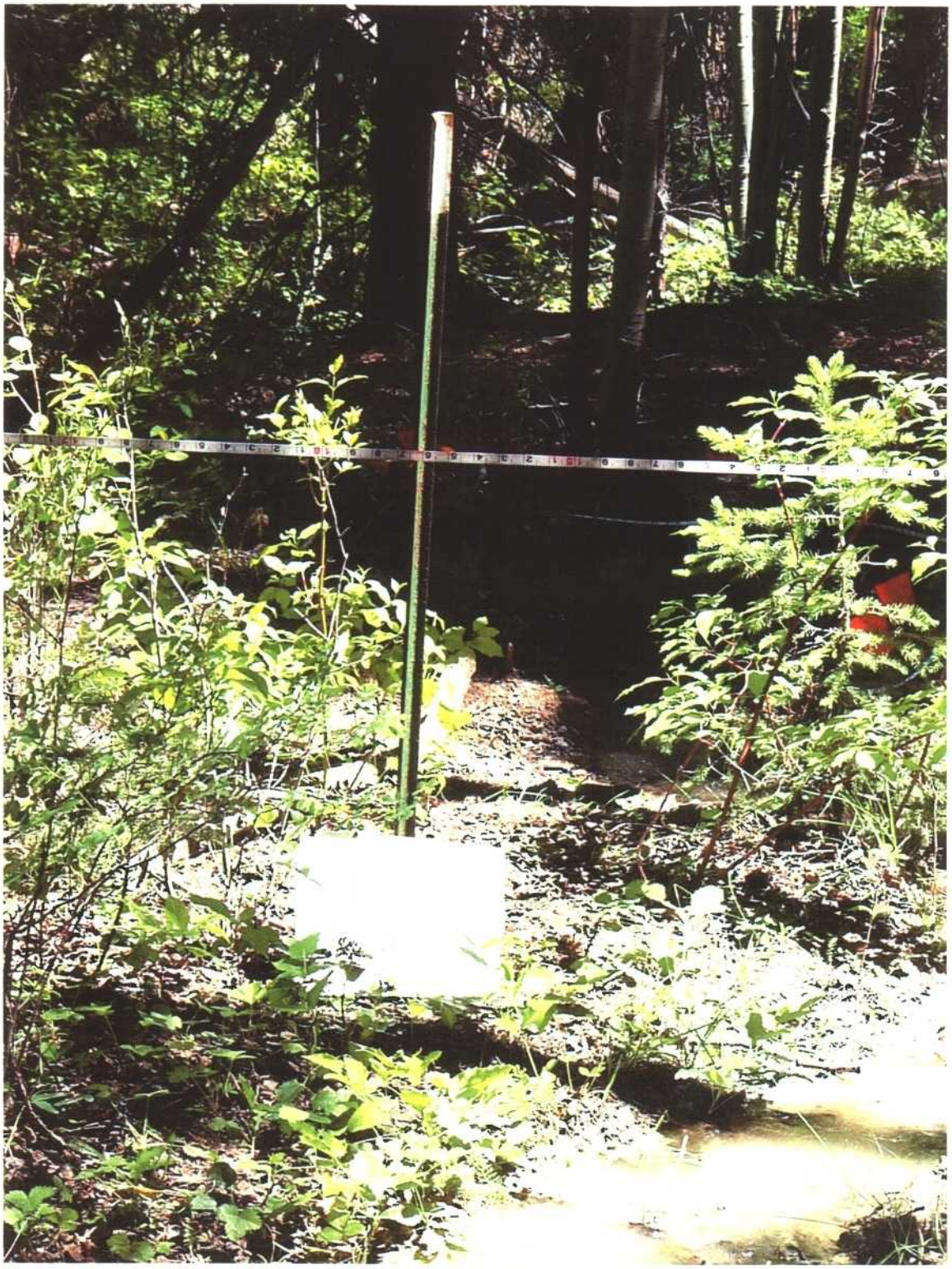
RC-1 cross section (close up)

RC-1 downstream view

RC-1 upstream view

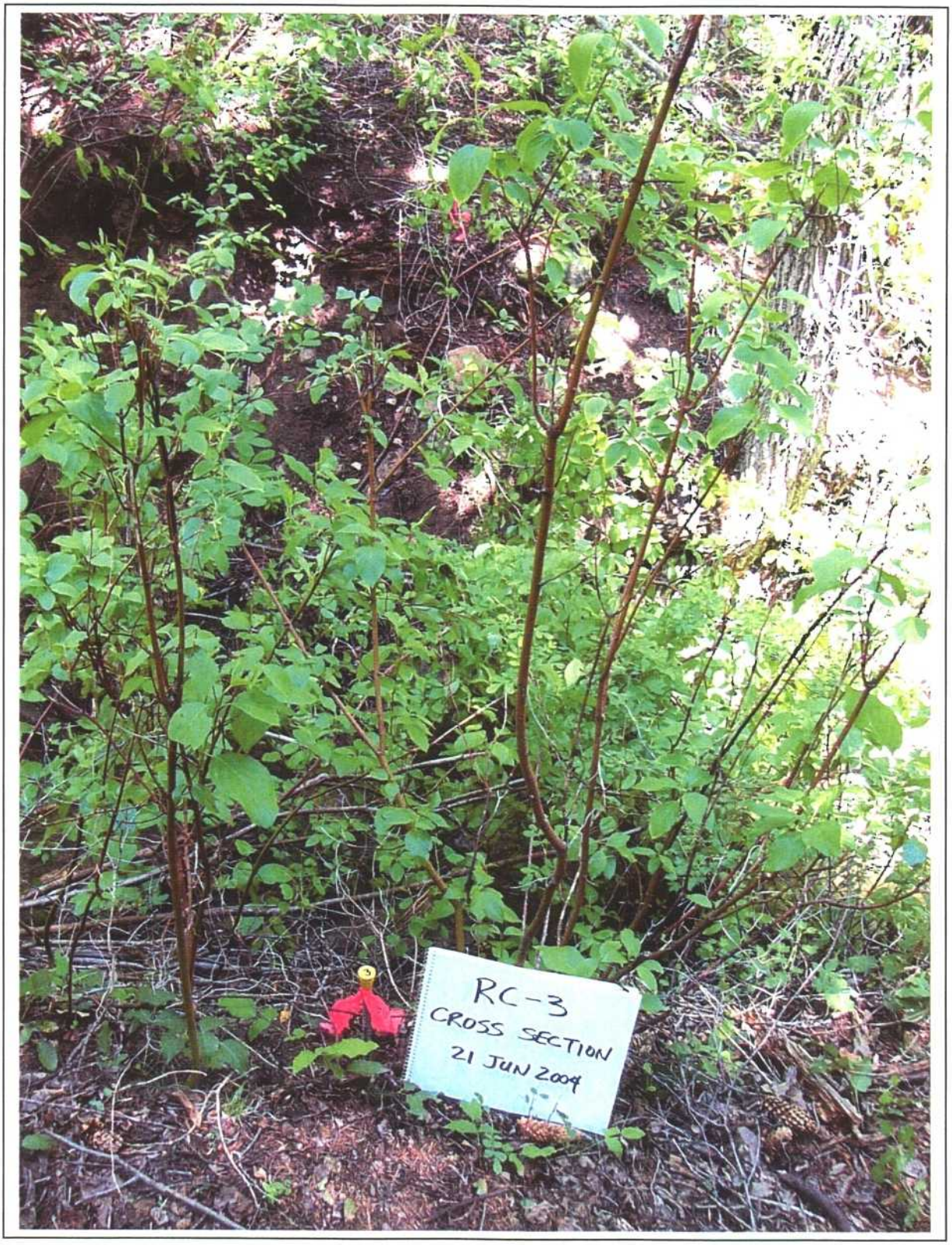
RC-2 cross section

RC-2 cross section (close up)



RC-2 downstream view

RC-2 upstream view

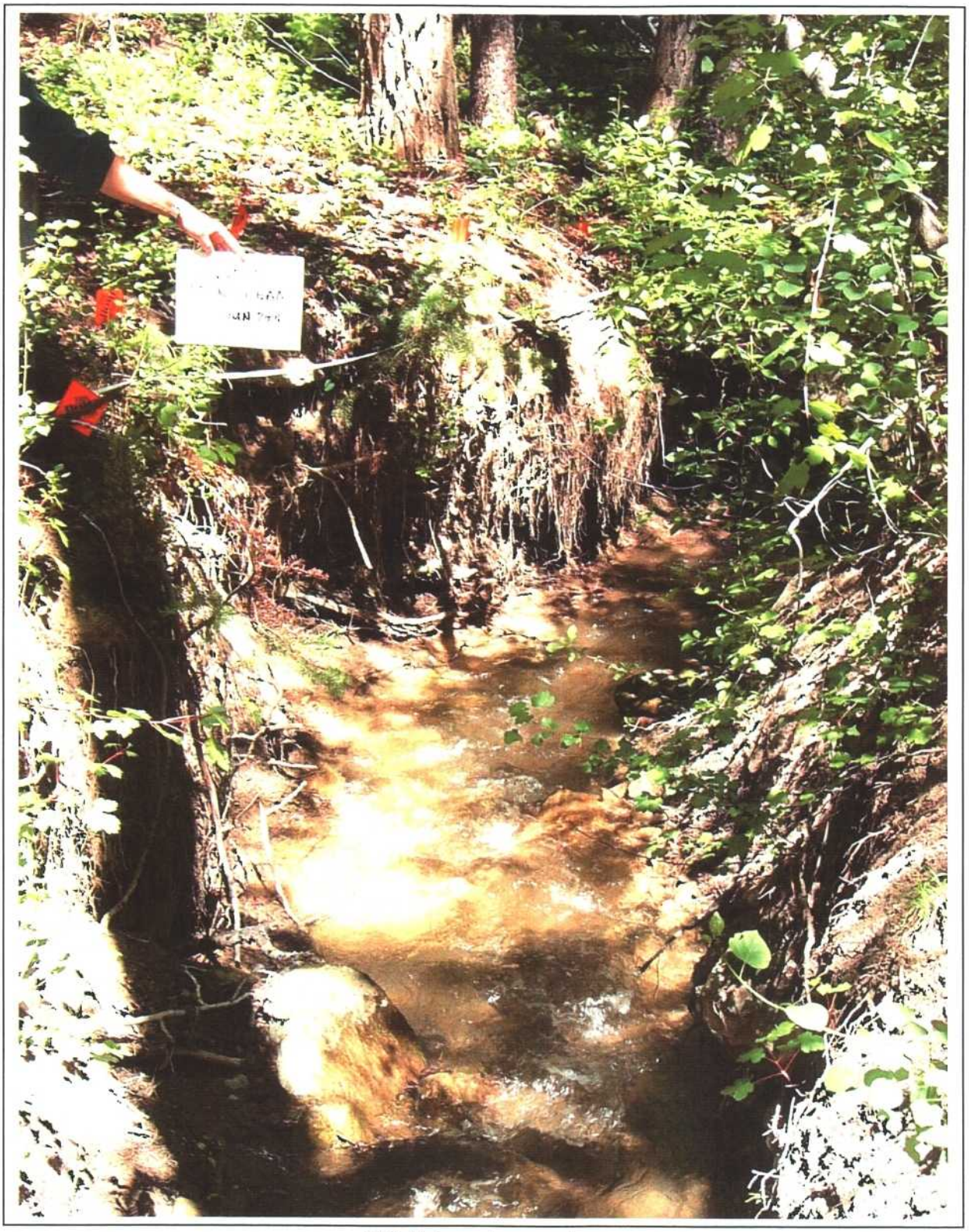


RC-3 cross section

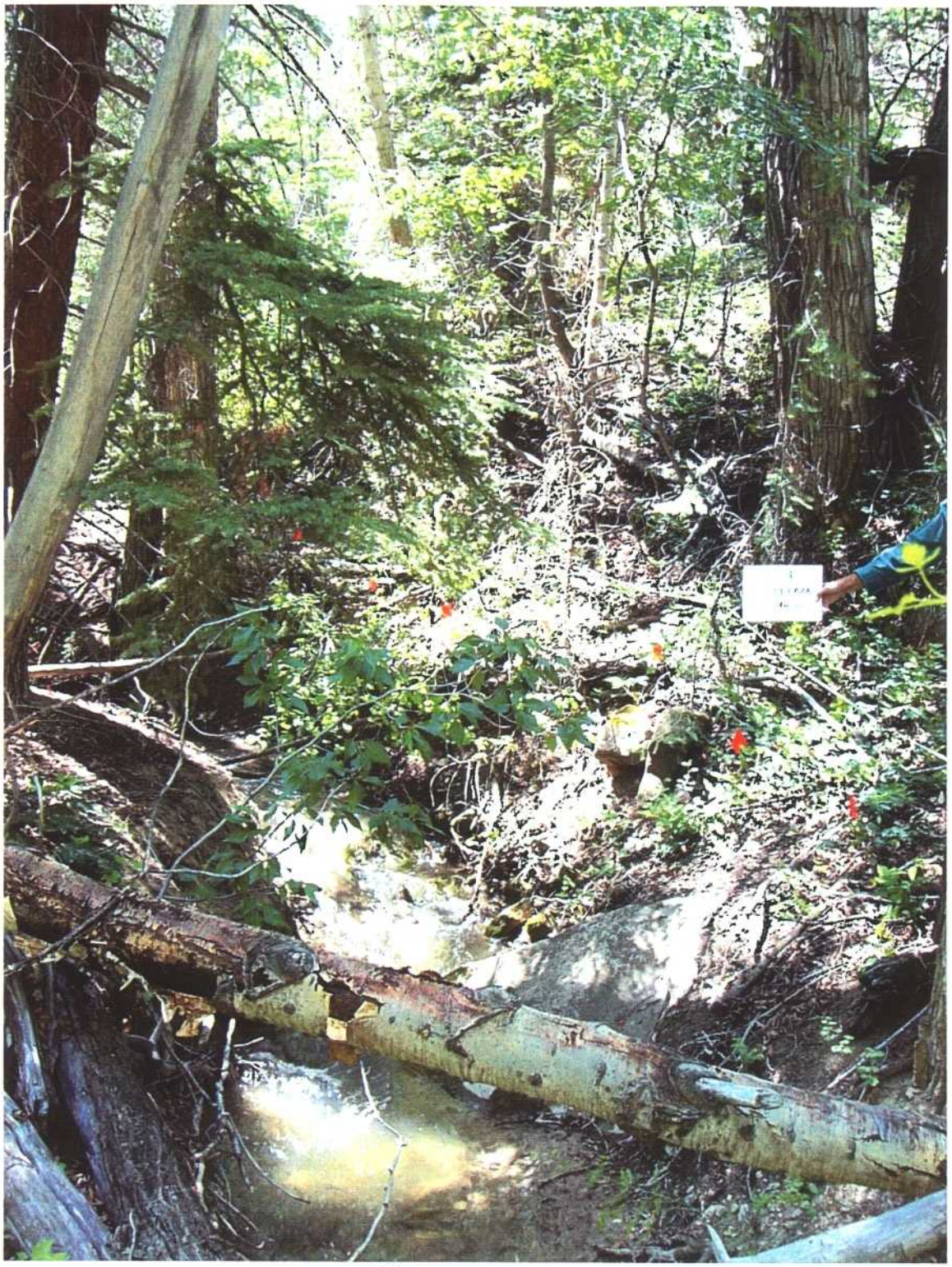
RC-3 downstream view

RC-3 upstream view

RC-4 cross section

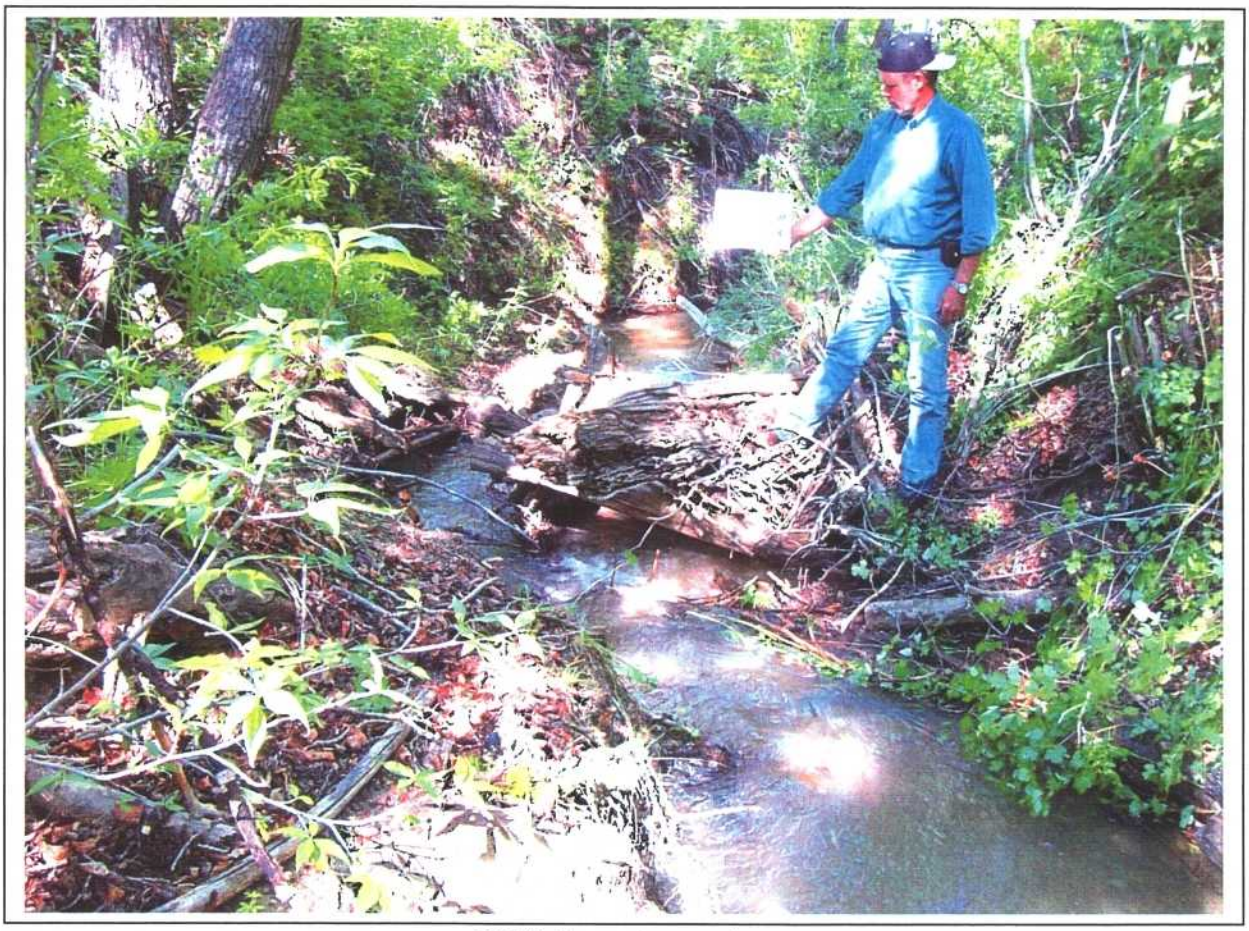


RC-4 downstream view



RC-4 upstream view

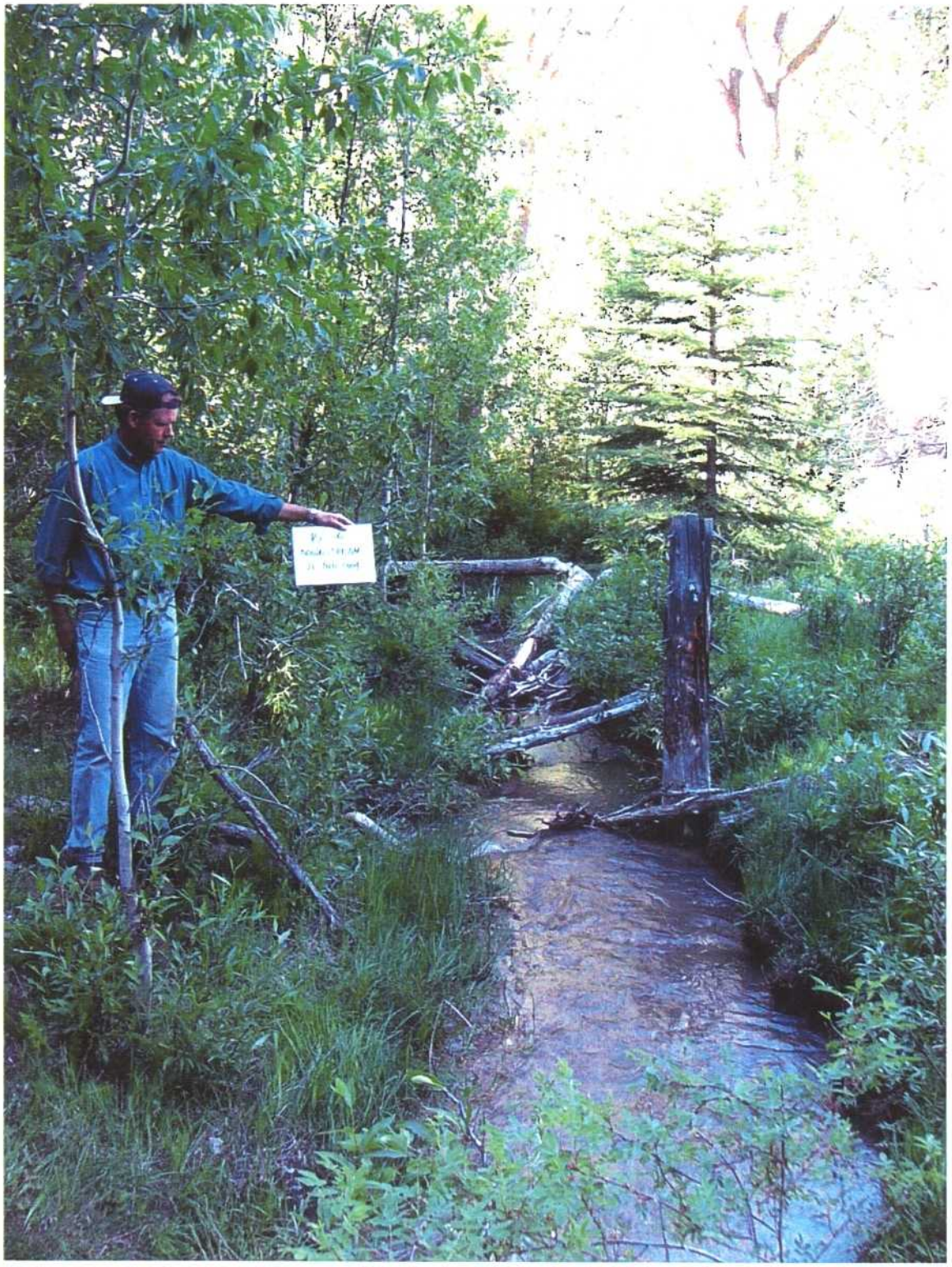
RC-5 cross section



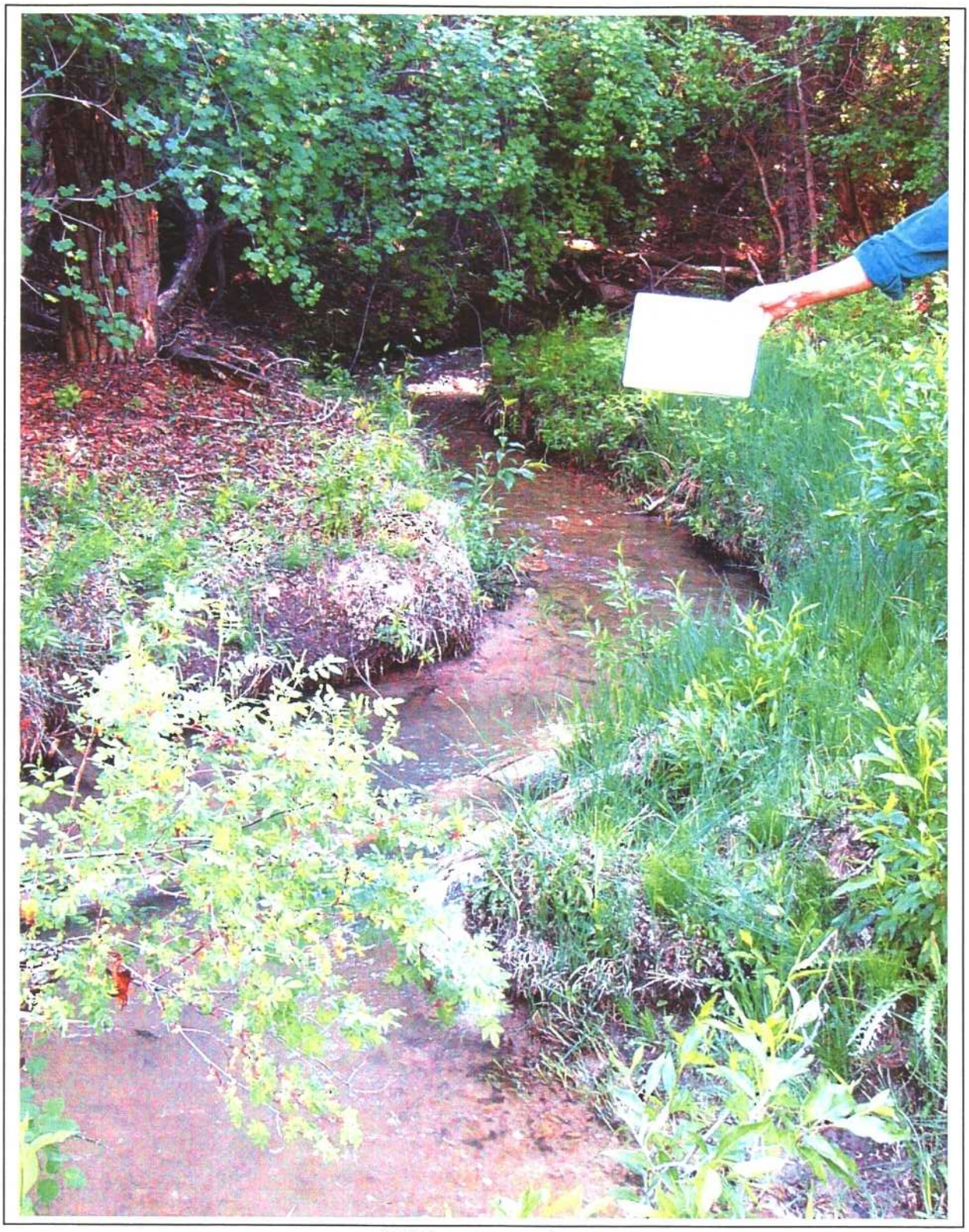
RC-5 downstream view

RC-5 upstream view

RC-6 cross section



RC-6 downstream view



RC-6 upstream view

Typical cross section marker

Typical benchmark

APPENDIX B

Field Notes

CONTENTS

PAGE	REFERENCE	DATE

UC-936

17 Jun 2004

08:45 – Arrived on site, Raining

RC-1 – Rt hand tributary

* Installed benchmark as follows:
  - Excavated 8" diameter ~36" deep w/ power auger
  - Poured in concrete mix, added water, mixed in hole.
  - Installed brass cap w/ stamped site number
* Installed cross section markers as follows:
  - Drove ½" rebar (3' long) into soil, leaving 3-6" above ground.
  - Installed yellow plastic survey caps on rebar

RC-2 – Left hand tributary

Installed as above

RC-3 – Main canyon across from proposed portals

Installed as above.

RC-4 – Main canyon across from proposed bath house

Installed as above

RC-5 – Downstream from seed pond outlet

Installed as above

RC-6 – Downstream end of study area

Installed as above.

16:00 – Soaked to the bone. Headed home

21 Jun 2004

RC-1 Cross section

Sta	Elev	Comment
–	4.73	BM
0+00	5.20	Left stk
0+05	5.86	
0+28	5.39	Top left bank
0+45	4.98	
0+46	5.31	WS @ left bank
0+47	5.67	
0+50	5.52	
0+51	5.31	WS @ rt bank
0+53	4.98	Top rt bank
0+61	4.87	
0+64	5.45	
0+71	5.64	
0+80	5.28	
0+81	4.67	rt stk
–	4.73	BM close

All stations relative to upstream view.

RC-1 profile

Sta	Top Bank Left	Bankfull left	Water surf.	Bottom	Top Bank Right
0+00	1.36	3.94	4.41	5.44	—
0+05	3.64	4.72	4.80	5.39	1.12
0+10	3.88	4.73	4.86	5.46	1.98
0+15	4.06	4.70	4.91	5.49	2.87
0+20	—	—	4.98	5.27	3.08
0+25	—	—	5.02	5.28	3.74
0+30	—	—	5.13	5.69	4.00
0+35	4.41	—	5.15	5.56	4.66
0+40	4.58	5.07	5.19	5.88	4.75
0+45	4.88	5.01	5.27	5.93	4.82
0+50	4.98	5.10	5.30	5.71	4.83
0+55	5.05	5.34	5.34	5.66	4.88
0+60	5.09	5.45	5.54	5.74	5.03
0+65	5.14	5.56	5.68	6.71	4.94
0+70	5.46	5.83	5.90	6.67	4.96
0+75	5.71	6.36	6.58	7.03	5.88
0+80	6.21	6.62	6.79	7.48	5.45
0+85	6.74	7.00	7.10	7.96	—
0+90	6.92	7.38	7.75	8.54	5.96
0+95	6.98	8.38	8.92	9.94	7.28
1+00	—	—	8.92	9.56	7.53

BM close = 4.73

RC-1 channel bottom:
Sand and gravel (typ ½-1")
Occasional cobble

RC-1 bank: silty clay

Left x section stake
71.8' S 10°W from BM

Rt x section stake
11.6' N 45°E from BM

Took photos

RC-2 cross section

Sta	Elev.	Comments
—	0.55	BM
0+00	3.16	Left stk
0+03	4.70	
0+07	5.82	
0+13	6.15	Left top of bank
0+14	6.28	Left bankfull
0+15	6.47	Channel bottom
0+16	6.21	Rt bankfull top
0+18	5.98	
0+26	6.21	
0+34	3.42	Rt stk
—	0.55	BM close

RC-2 profile

Sta	Top Bank Left	Bankfull Left	WS	Bottom	Top Bank Rt
0+00	4.46	4.59	4.59	4.86	4.47
0+03	4.58	4.71	4.73	4.86	4.65
0+06	4.73	4.91	4.91	5.68	4.92
0+09	4.70	5.14	5.32	5.50	4.88
0+12	4.71	5.36	5.36	5.60	4.94
0+15	5.05	5.69	5.69	6.06	5.13
0+18	5.39	5.74	5.74	5.91	5.38
0+21	5.33	6.12	6.12	6.34	4.83
0+24	5.98	6.14	6.14	6.33	5.67
0+27	5.97	6.17	6.19	6.42	6.10
0+30	6.14	6.25	6.25	6.45	6.07
0+33	6.22	6.39	6.39	6.49	6.23
0+36	6.13	6.59	6.63	6.83	6.28
0+39	6.26	6.65	6.66	6.80	6.25
0+42	6.54	6.81	6.85	6.94	6.51
0+45	6.72	7.09	7.09	7.39	6.68
0+48	6.72	7.23	7.28	7.44	7.01
0+51	6.81	7.29	7.26	7.48	7.01
0+54	—	—	—	—	—
0+57	7.10	7.38	7.41	7.69	7.09
0+60	7.23	7.34	7.53	7.75	7.21

BM close = 0.53

RC-2. channel bottom - med. to fine sand.

Banks - Clayey silt w/ high OM content

Dist to X sec stakes from BM:

Left: 9.2' S 75° W

Right: 38.6' N 55° W

RC-3 cross section

Sta	Elev.	Comment
—	1.31	BM
0+00	3.58	Top left stk
0+06	~~12.06~~ 10.43	Lft bank
0+08	~~12.48~~ 11.02	Channel bottom
0+10	~~11.97~~ 10.46	Rt bank (WS)
0+14	6.04	
0+15	4.70	Top right stake

BM close = 1.31

RC-3 Profile

Sta	Top Left	Bankfull	WS	Bottom	Top Right
0+00	2.25	7.70	7.70	8.24	1.00
0+05	2.44	7.92	8.27	8.71	1.67
0+10	2.46	8.13	8.28	8.85	2.08
0+15	2.22	—	9.43	10.40	2.60
0+20	2.39	—	9.49	10.28	2.49
0+25	2.84	9.11	9.52	10.09	2.67
0+30	3.46	—	9.74	10.26	2.68
0+35	3.60	—	—	—	3.24
0+40	3.62	—	10.16	10.60	—
0+45	2.99	—	10.33	10.94	3.67
0+50	3.58	—	10.42	11.02	4.70
0+55	4.38	—	10.50	11.10	5.21
0+60	4.60	10.39	10.57	11.25	4.98
0+65	5.13	10.71	10.83	11.25	4.83
0+70	5.96	10.63	10.94	11.51	6.06
0+75	6.20	10.96	11.13	11.69	8.90
0+80	6.71	10.82	11.33	11.99	9.13
0+85	6.57	—	11.39	11.96	9.50
0+90	7.45	—	11.59	12.12	9.80
0+95	7.86	—	11.76	12.16	10.33
1+00	8.53	—	11.94	12.43	

BM close → 1.31

RC-3 channel bottom: sandy gravel w/ abundant cobbles
Bank: Silty clay

Location of x sec stakes w/ respect to BM:
Left: 36.0' Due east
Right: 45.5' S 70° E

RC-4 Cross section

Sta	Elev.	Comment
—	2.18	BM
0+00	5.48	Left stake
0+03	6.11	Top of bank
0+04	10.26	Bottom of bank
0+05	10.51	Bottom of channel
0+07	10.23	Bottom of rt bank
0+08	9.32	
0+10	5.90	Top of rt bank
0+13	5.42	Rt stake
—	2.18	BM close

RC-4 profile

Sta	Top Left	Bankful	WS	Bottom	Top Right
0+00	4.99	7.08	7.22	7.71	3.55
0+04	5.06	7.38	7.38	7.90	4.27
0+08	5.11	—	7.39	7.99	4.32
0+12	5.37	7.57	7.70	8.20	4.67
0+16	5.40	7.52	7.72	8.53	4.32
0+20	5.55	—	8.32	8.85	5.19
0+24	5.72	8.12	8.40	9.23	5.35
0+28	5.48	—	8.39	8.89	5.65
0+32	—	—	—	—	—
0+36	—	—	9.58	11.17	5.69
0+40	6.11	9.61	9.68	10.51	5.90
0+44	6.01	9.08	9.66	10.53	5.62
0+48	5.92	9.68	10.31	10.76	5.65
0+52	5.83	—	10.47	11.14	6.04
0+56	5.65	—	10.60	11.34	6.02
0+60	5.64	—	10.90	11.46	5.94
0+64	6.01	10.85	10.91	11.54	6.56
0+68	7.16	—	11.00	11.41	6.98
0+72	7.16	—	11.14	11.65	7.19
0+76	6.78	—	11.38	11.85	7.55
0+80	7.14	11.30	11.93	12.55	7.69

RC-4 channel bottom: As above

Bank: As above

X sect stake location (relative to BM):

Left: 17.3' N 70°E

Right: 25.6' N 40°E

RC-5 cross section

Sta	Elev.	Comment
—	3.68	BM
0+00	5.40	Left stake
0+04	5.44	Top left bank
0+07	8.49	WS
0+09	8.93	Bottom
0+13	8.56	Rt toe
0+17	4.32	Rt stake
—	3.68	BM close

RC-5 profile

Sta	Top Left	Bankfull	WS	Bottom	Top Right
0+00	4.27	5.05	6.11	6.82	4.33
0+05	4.07	6.02	6.16	6.66	4.12
0+10	1.66	5.87	6.81	7.45	4.45
0+15	1.60	6.41	7.24	7.71	4.70
0+20	1.35	7.28	7.41	7.87	5.09
0+25	2.74	7.21	7.59	7.86	4.93
0+30	3.99	7.02	7.75	8.20	4.28
0+35	4.37	7.67	7.89	8.46	3.68
0+40	4.15	—	8.37	9.43	5.31
0+45	5.47	—	8.39	9.35	4.60
0+50	5.40	—	8.49	8.93	4.32
0+55	7.39	8.98	9.30	10.35	6.19
0+60	7.46	—	9.32	10.00	6.39
0+65	6.96	—	9.44	10.20	7.72
0+70	8.25	—	9.91	10.87	9.43
0+75	8.23	—	10.46	11.70	8.83
0+80	9.38	10.33	10.69	11.16	9.40
0+85	—	10.48	10.66	12.30	—
0+90	10.28	—	11.10	11.55	7.23
0+95	10.26	—	11.13	11.66	8.98
1+00	—	—	11.23	11.80	8.12

BM close = 3.68

RC-5 channel bottom: As above, but slightly coarser

Bank: As above

Location from BM of X section stakes:

Left: 27.0' N 85° E

Rt: 32.0' N 50° E

RC-6 cross section

Sta	Elev.	Comment
—	5.15	BM
0+00	4.60	Left stake
0+07	5.95	
0+11	5.38	
0+18	5.18	Top left bank
0+21	5.52	
0+24	7.14	WS
0+24	7.45	Channel at left toe
0+26	7.56	Bottom
0+29	7.10	Channel edge
0+31	6.48	Top right
0+34	5.43	
0+37	5.07	
0+39	4.75	Rt stake
—	5.15	BM close

RC-6 profile

Sta	Top Left	Bankful	WS	Bottom	Top Rt
0+00	4.36	—	6.36	7.04	4.75
0+05	4.96	—	6.46	6.87	4.65
0+10	4.60	—	6.46	6.85	4.82
0+15	4.81	6.42	6.62	7.17	5.00
0+20	5.05	6.35	6.63	7.53	5.13
0+25	4.83	6.29	6.65	7.57	5.27
0+30	5.06	6.53	6.74	7.36	5.65
0+35	4.61	6.69	6.77	7.23	5.10
0+40	5.87	—	7.09	7.73	6.44
0+45	5.96	—	7.11	7.63	6.61
0+50	5.52	—	7.14	7.56	6.48
0+55	6.67	—	7.16	7.67	6.49
0+60	5.86	6.98	7.12	7.71	6.17
0+65	5.76	—	8.48	9.62	5.65
0+70	5.98	—	8.63	9.19	5.63
0+75	6.67	—	8.64	9.85	5.76
0+80	7.47	—	8.82	10.29	6.80
0+85	7.67	—	8.87	9.58	6.14
0+90	6.98	—	8.90	10.66	8.30
0+95	7.54	—	8.92	10.04	8.24
1+00	7.88	—	8.92	10.03	8.35

BM close = 5.15

RC-6 channel bottom: Gravelly sand
(well compacted)
Bank: Silty clay
Location x sect stakes w/ respect to B/M:
Left: 19.2' N 85° E
Right: 21.5' N 55° W

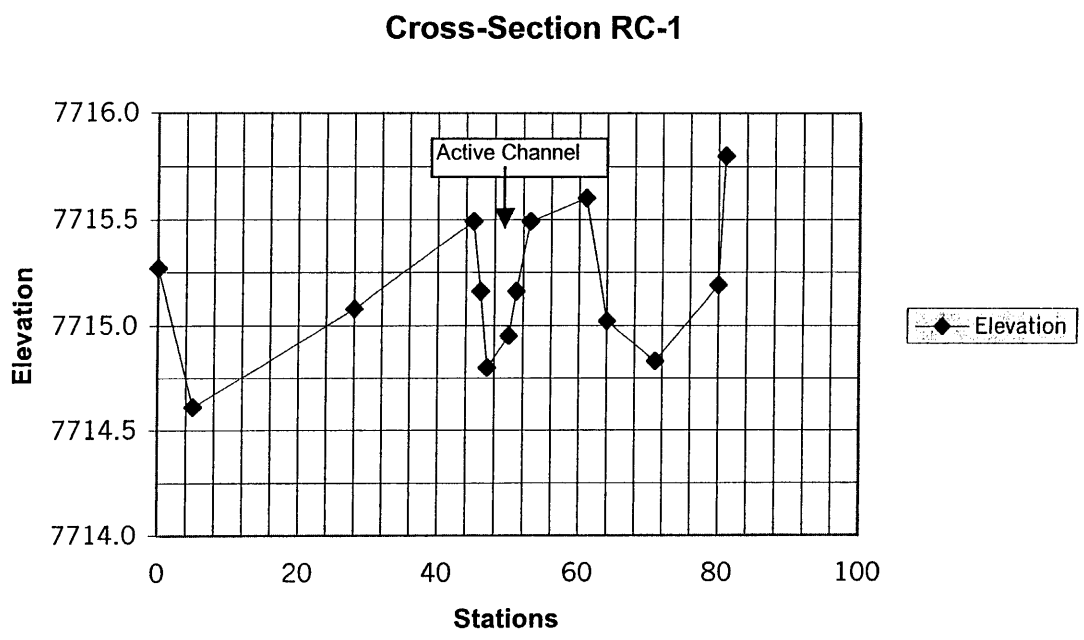
APPENDIX C

Rilda Canyon Cross Sections and Profiles

Cross Section: RC-1

Benchmark elevation: 7715.74
BenchMark Rod Reading: 4.73

Station	Rod Reading	Elevation
0	5.20	7715.27
5	5.86	7714.61
28	5.39	7715.08
45	4.98	7715.49
46	5.31	7715.16
47	5.67	7714.80
50	5.52	7714.95
51	5.31	7715.16
53	4.98	7715.49
61	4.87	7715.60
64	5.45	7715.02
71	5.64	7714.83
80	5.28	7715.19
81	4.67	7715.80


Cross-Section RC-1
Active Channel
7716.0
7715.5
7715.0
7714.5
7714.0
Elevation
0
20
40
60
80
100
Stations
Elevation

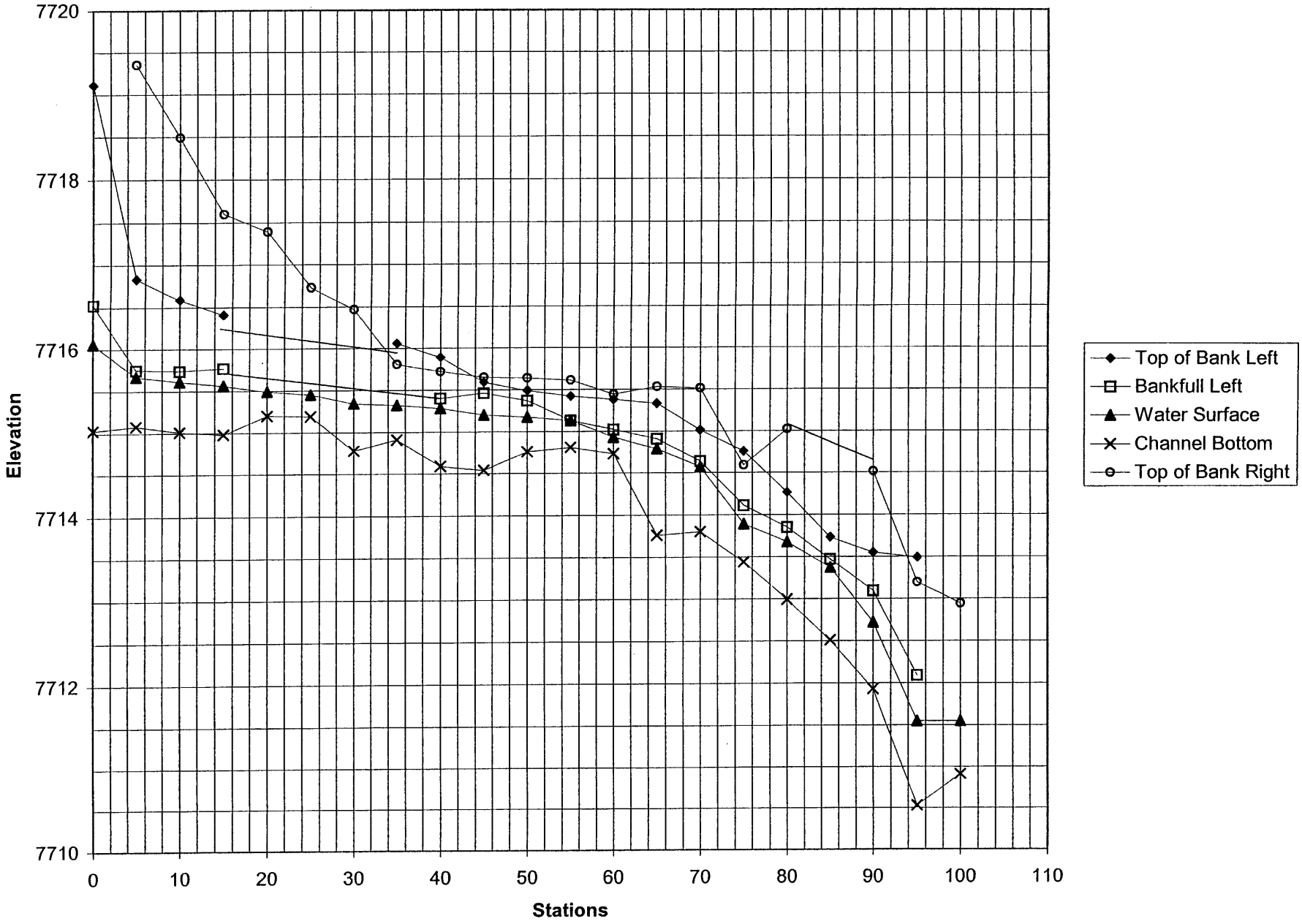
Profile: RC-1

Benchmark elevation (ft): 7715.74
Rod reading at Benchmark (f 4.73

	Top of Bank Left		Bankfull Left		Water Surface		Channel Bottom		Top of Bank Right	
Station	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation
0	1.36	7719.11	3.94	7716.53	4.41	7716.06	5.44	7715.03		
5	3.64	7716.83	4.72	7715.75	4.80	7715.67	5.39	7715.08	1.12	7719.35
10	3.88	7716.59	4.73	7715.74	4.86	7715.61	5.46	7715.01	1.98	7718.49
15	4.06	7716.41	4.70	7715.77	4.91	7715.56	5.49	7714.98	2.87	7717.60
20					4.98	7715.49	5.27	7715.20	3.08	7717.39
25					5.02	7715.45	5.28	7715.19	3.74	7716.73
30					5.13	7715.34	5.69	7714.78	4.00	7716.47
35	4.41	7716.06			5.15	7715.32	5.56	7714.91	4.66	7715.81
40	4.58	7715.89	5.07	7715.40	5.19	7715.28	5.88	7714.59	4.75	7715.72
45	4.88	7715.59	5.01	7715.46	5.27	7715.20	5.93	7714.54	4.82	7715.65
50	4.98	7715.49	5.10	7715.37	5.30	7715.17	5.71	7714.76	4.83	7715.64
55	5.05	7715.42	5.34	7715.13	5.34	7715.13	5.66	7714.81	4.86	7715.61
60	5.09	7715.38	5.45	7715.02	5.54	7714.93	5.74	7714.73	5.03	7715.44
65	5.14	7715.33	5.56	7714.91	5.68	7714.79	6.71	7713.76	4.94	7715.53
70	5.46	7715.01	5.83	7714.64	5.90	7714.57	6.67	7713.80	4.96	7715.51
75	5.71	7714.76	6.36	7714.11	6.58	7713.89	7.03	7713.44	5.88	7714.59
80	6.21	7714.26	6.62	7713.85	6.79	7713.68	7.48	7712.99	5.45	7715.02
85	6.74	7713.73	7.00	7713.47	7.10	7713.37	7.96	7712.51		
90	6.92	7713.55	7.38	7713.09	7.75	7712.72	8.54	7711.93	5.96	7714.51
95	6.98	7713.49	8.38	7712.09	8.92	7711.55	9.94	7710.53	7.28	7713.19
100					8.92	7711.55	9.56	7710.91	7.53	7712.94

Max. Water Surface Slope (fraction): 0.234
Min. Water Surface Slope (fraction): 0.000
Avg. Water Surface Slope (fraction): 0.045

Profile RC-1

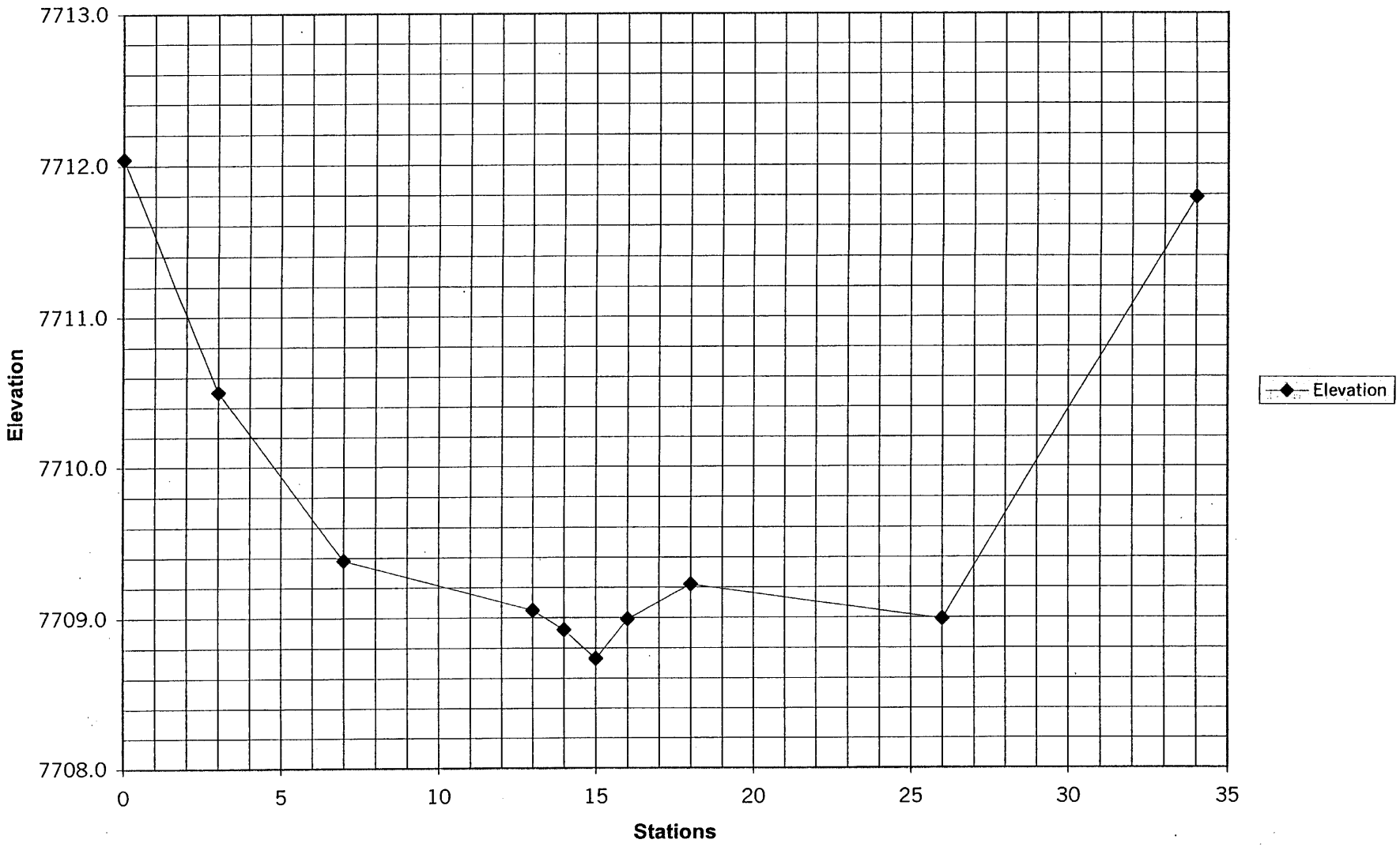

7720
7718
7716
7714
7712
7710
Elevation
0
10
20
30
40
50
60
70
80
90
100
110
Stations
Top of Bank Left
Bankfull Left
Water Surface
Channel Bottom
Top of Bank Right

Cross Section: RC-2

Benchmark elevation: 7714.65
BenchMark Rod Reading: 0.55

Station	Rod Reading	Elevation
0	3.16	7712.04
3	4.70	7710.50
7	5.82	7709.38
13	6.15	7709.05
14	6.28	7708.92
15	6.47	7708.73
16	6.21	7708.99
18	5.98	7709.22
26	6.21	7708.99
34	3.42	7711.78

Cross-Section RC-2

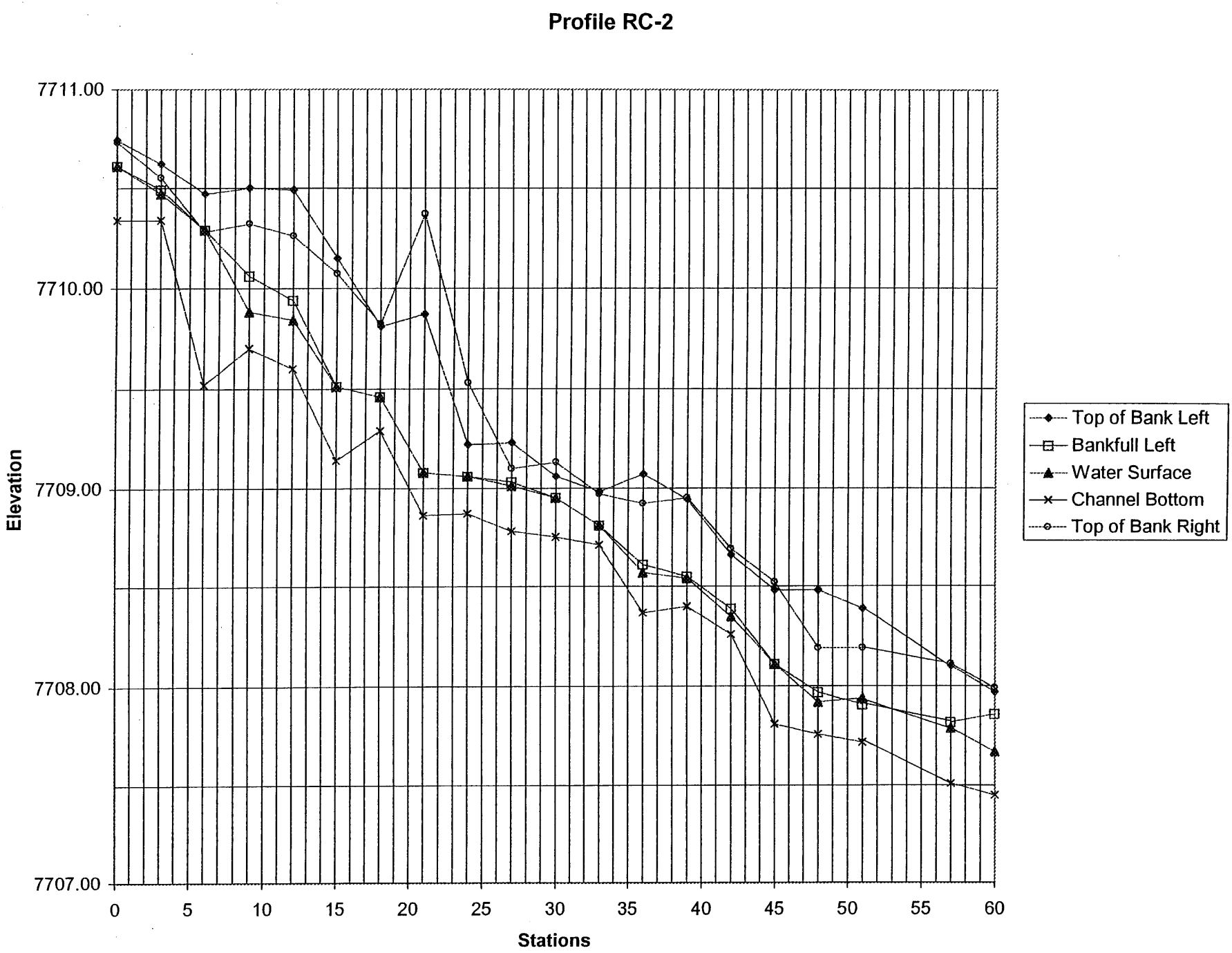


Profile: RC-2

Benchmark elevation (ft): 7714.65
Rod reading at Benchmark (f 0.55

	Top of Bank Left		Bankfull Left		Water Surface		Channel Bottom		Top of Bank Right	
Station	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation
0	4.46	7710.74	4.59	7710.61	4.59	7710.61	4.86	7710.34	4.47	7710.73
3	4.58	7710.62	4.71	7710.49	4.73	7710.47	4.86	7710.34	4.65	7710.55
6	4.73	7710.47	4.91	7710.29	4.91	7710.29	5.68	7709.52	4.92	7710.28
9	4.70	7710.50	5.14	7710.06	5.32	7709.88	5.50	7709.70	4.88	7710.32
12	4.71	7710.49	5.26	7709.94	5.36	7709.84	5.60	7709.60	4.94	7710.26
15	5.05	7710.15	5.69	7709.51	5.69	7709.51	6.06	7709.14	5.13	7710.07
18	5.39	7709.81	5.74	7709.46	5.74	7709.46	5.91	7709.29	5.38	7709.82
21	5.33	7709.87	6.12	7709.08	6.12	7709.08	6.34	7708.86	4.83	7710.37
24	5.98	7709.22	6.14	7709.06	6.14	7709.06	6.33	7708.87	5.67	7709.53
27	5.97	7709.23	6.17	7709.03	6.19	7709.01	6.42	7708.78	6.10	7709.10
30	6.14	7709.06	6.25	7708.95	6.25	7708.95	6.45	7708.75	6.07	7709.13
33	6.22	7708.98	6.39	7708.81	6.39	7708.81	6.49	7708.71	6.23	7708.97
36	6.13	7709.07	6.59	7708.61	6.63	7708.57	6.83	7708.37	6.28	7708.92
39	6.26	7708.94	6.65	7708.55	6.66	7708.54	6.80	7708.40	6.25	7708.95
42	6.54	7708.66	6.81	7708.39	6.85	7708.35	6.94	7708.26	6.51	7708.69
45	6.72	7708.48	7.09	7708.11	7.09	7708.11	7.39	7707.81	6.68	7708.52
48	6.72	7708.48	7.23	7707.97	7.28	7707.92	7.44	7707.76	7.01	7708.19
51	6.81	7708.39	7.29	7707.91	7.26	7707.94	7.48	7707.72	7.01	7708.19
57	7.10	7708.10	7.38	7707.82	7.41	7707.79	7.69	7707.51	7.09	7708.11
60	7.23	7707.97	7.34	7707.86	7.53	7707.67	7.75	7707.45	7.21	7707.99

Max. Water Surface Slope (fraction): 0.137
Min. Water Surface Slope (fraction): -0.007
Avg. Water Surface Slope (fraction): 0.050

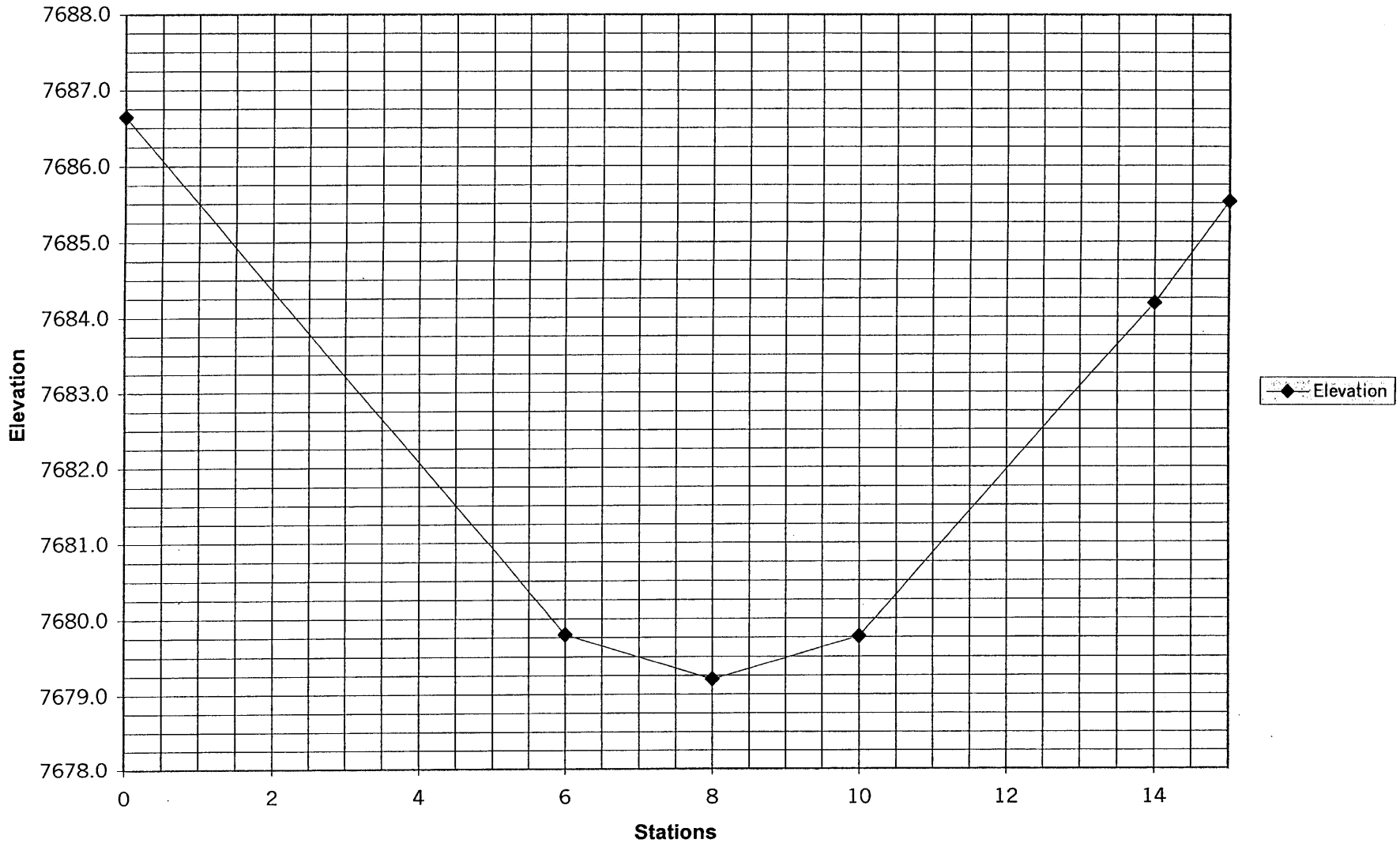

Profile RC-2
7711.00
7710.00
7709.00
7708.00
7707.00
Elevation
0
5
10
15
20
25
30
35
40
45
50
55
60
Stations
Top of Bank Left
Bankfull Left
Water Surface
Channel Bottom
Top of Bank Right

Cross Section: RC-3

Benchmark elevation: 7688.91
BenchMark Rod Reading: 1.31

Station	Rod Reading	Elevation
0	3.58	7686.64
6	10.43	7679.79
8	11.02	7679.20
10	10.46	7679.76
14	6.04	7684.18
15	4.70	7685.52

Cross-Section RC-3



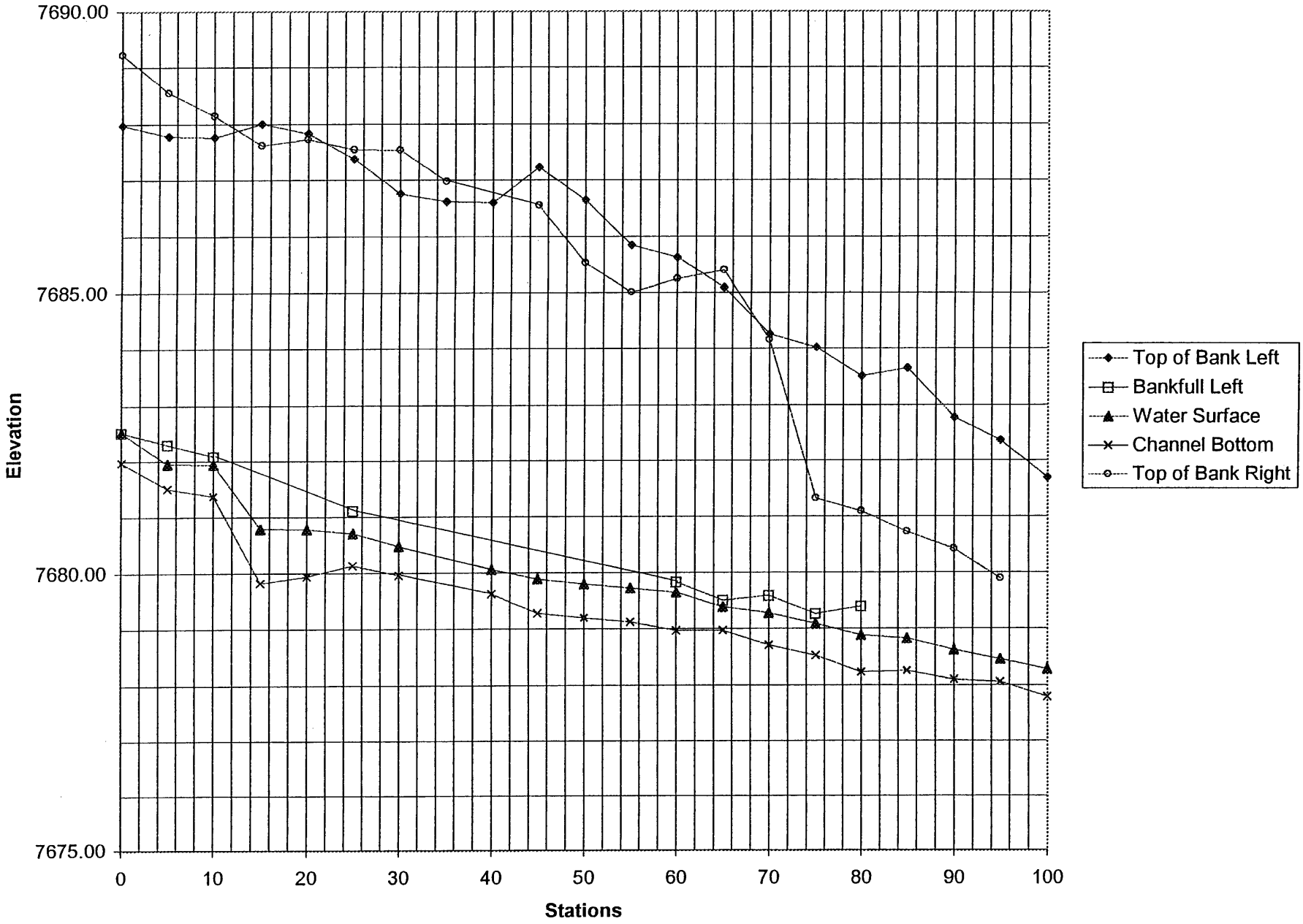
Profile: RC-3

Benchmark elevation (ft): 7688.91
Rod reading at Benchmark (f 1.31

	Top of Bank Left		Bankfull Left		Water Surface		Channel Bottom		Top of Bank Right	
Station	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation
0	2.25	7687.97	7.70	7682.52	7.70	7682.52	8.24	7681.98	1.00	7689.22
5	2.44	7687.78	7.92	7682.30	8.27	7681.95	8.71	7681.51	1.67	7688.55
10	2.46	7687.76	8.13	7682.09	8.28	7681.94	8.85	7681.37	2.08	7688.14
15	2.22	7688.00			9.43	7680.79	10.40	7679.82	2.60	7687.62
20	2.39	7687.83			9.44	7680.78	10.28	7679.94	2.49	7687.73
25	2.84	7687.38	9.11	7681.11	9.52	7680.70	10.09	7680.13	2.67	7687.55
30	3.46	7686.76			9.74	7680.48	10.26	7679.96	2.68	7687.54
35	3.60	7686.62							3.24	7686.98
40	3.62	7686.60			10.16	7680.06	10.60	7679.62		
45	2.99	7687.23			10.33	7679.89	10.94	7679.28	3.67	7686.55
50	3.58	7686.64			10.42	7679.80	11.02	7679.20	4.70	7685.52
55	4.38	7685.84			10.50	7679.72	11.10	7679.12	5.21	7685.01
60	4.60	7685.62	10.39	7679.83	10.57	7679.65	11.25	7678.97	4.98	7685.24
65	5.13	7685.09	10.71	7679.51	10.83	7679.39	11.25	7678.97	4.83	7685.39
70	5.96	7684.26	10.63	7679.59	10.94	7679.28	11.51	7678.71	6.06	7684.16
75	6.20	7684.02	10.96	7679.26	11.13	7679.09	11.69	7678.53	8.90	7681.32
80	6.71	7683.51	10.82	7679.40	11.33	7678.89	11.99	7678.23	9.13	7681.09
85	6.57	7683.65			11.39	7678.83	11.96	7678.26	9.50	7680.72
90	7.45	7682.77			11.59	7678.63	12.12	7678.10	9.80	7680.42
95	7.86	7682.36			11.76	7678.46	12.16	7678.06	10.33	7679.89
100	8.53	7681.69			11.94	7678.28	12.43	7677.79		

Max. Water Surface Slope (fraction): 0.230
Min. Water Surface Slope (fraction): 0.002
Avg. Water Surface Slope (fraction): 0.042

Profile RC-3

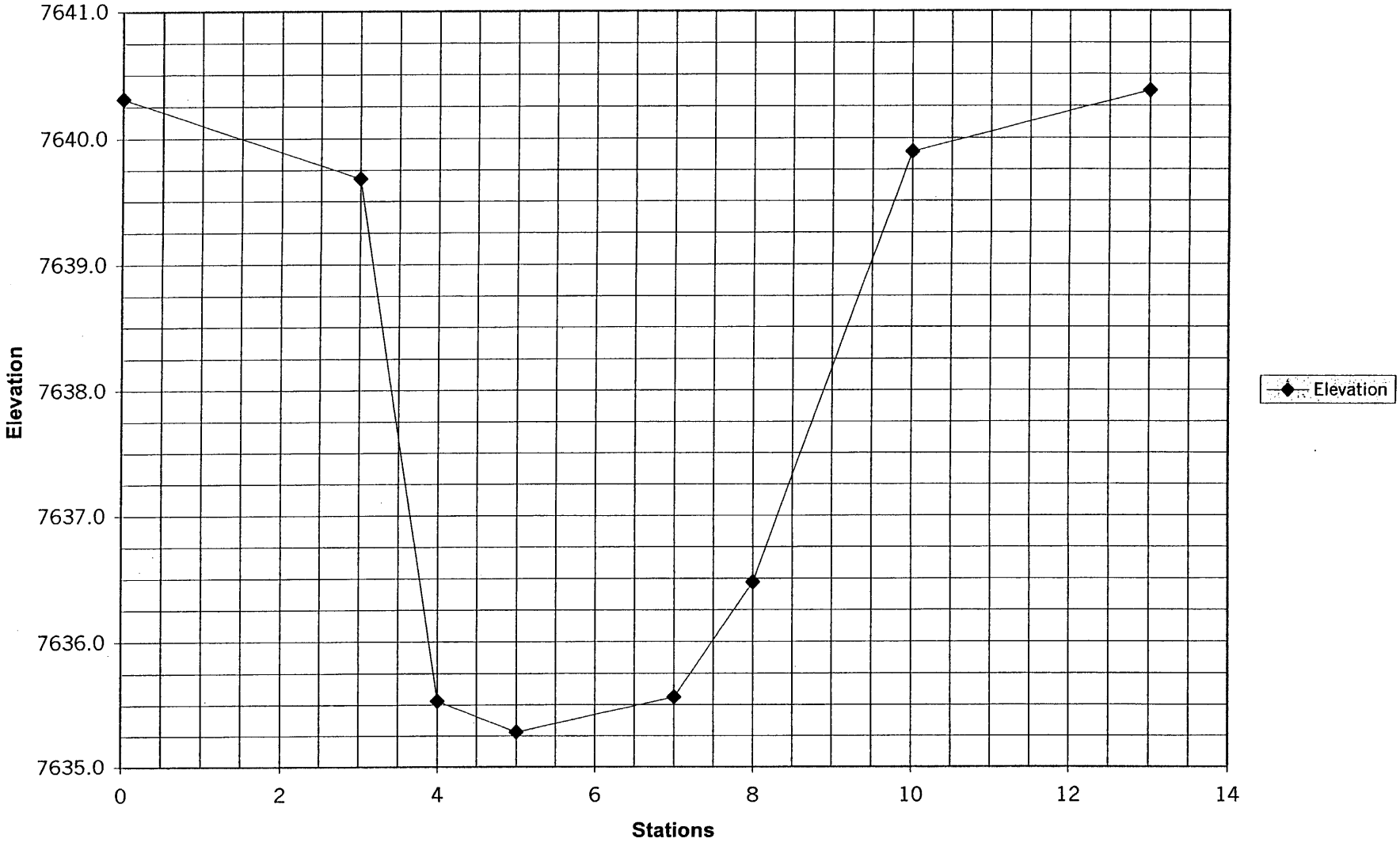

7690.00
7685.00
7680.00
7675.00
Elevation
0
10
20
30
40
50
60
70
80
90
100
Stations
Top of Bank Left
Bankfull Left
Water Surface
Channel Bottom
Top of Bank Right

Cross Section: RC-4

Benchmark elevation: 7643.61
BenchMark Rod Reading: 2.18

Station	Rod Reading	Elevation
0	5.48	7640.31
3	6.11	7639.68
4	10.26	7635.53
5	10.51	7635.28
7	10.23	7635.56
8	9.32	7636.47
10	5.90	7639.89
13	5.42	7640.37

Cross-Section RC-4



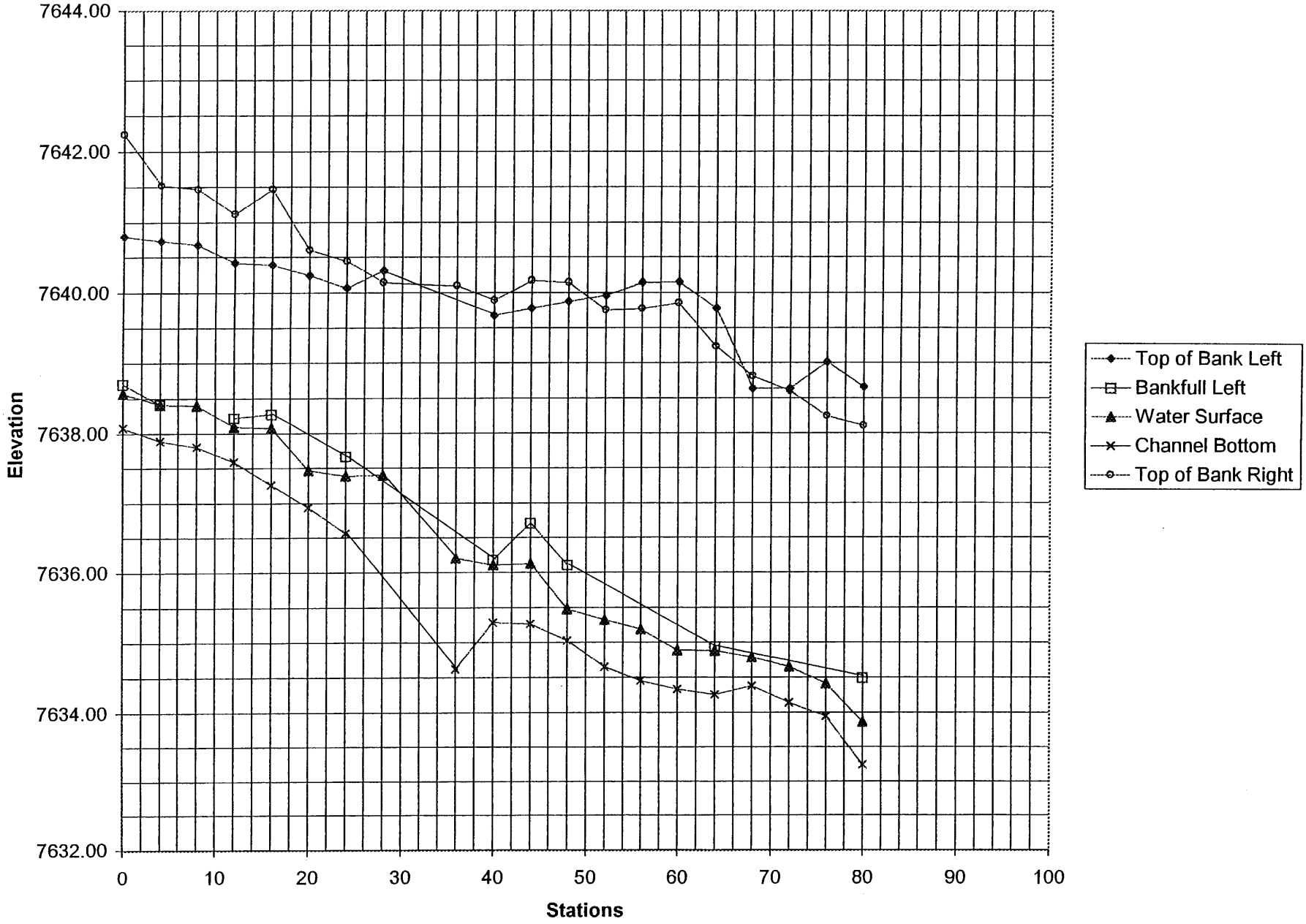
Profile: RC-4

Benchmark elevation (ft): 7643.61
Rod reading at Benchmark (f 2.18

	Top of Bank Left		Bankfull Left		Water Surface		Channel Bottom		Top of Bank Right	
Station	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation
0	4.99	7640.80	7.08	7638.71	7.22	7638.57	7.71	7638.08	3.55	7642.24
4	5.06	7640.73	7.38	7638.41	7.38	7638.41	7.90	7637.89	4.27	7641.52
8	5.11	7640.68			7.39	7638.40	7.99	7637.80	4.32	7641.47
12	5.37	7640.42	7.57	7638.22	7.70	7638.09	8.20	7637.59	4.67	7641.12
16	5.40	7640.39	7.52	7638.27	7.72	7638.07	8.53	7637.26	4.32	7641.47
20	5.55	7640.24			8.32	7637.47	8.85	7636.94	5.19	7640.60
24	5.72	7640.07	8.12	7637.67	8.40	7637.39	9.23	7636.56	5.35	7640.44
28	5.48	7640.31			8.39	7637.40	8.89	7636.90	5.65	7640.14
36					9.58	7636.21	11.17	7634.62	5.69	7640.10
40	6.11	7639.68	9.61	7636.18	9.68	7636.11	10.51	7635.28	5.90	7639.89
44	6.01	7639.78	9.08	7636.71	9.66	7636.13	10.53	7635.26	5.62	7640.17
48	5.92	7639.87	9.68	7636.11	10.31	7635.48	10.76	7635.03	5.65	7640.14
52	5.83	7639.96			10.47	7635.32	11.14	7634.65	6.04	7639.75
56	5.65	7640.14			10.60	7635.19	11.34	7634.45	6.02	7639.77
60	5.64	7640.15			10.90	7634.89	11.46	7634.33	5.94	7639.85
64	6.01	7639.78	10.85	7634.94	10.91	7634.88	11.54	7634.25	6.56	7639.23
68	7.16	7638.63			11.00	7634.79	11.41	7634.38	6.98	7638.81
72	7.16	7638.63			11.14	7634.65	11.65	7634.14	7.19	7638.60
76	6.78	7639.01			11.38	7634.41	11.85	7633.94	7.55	7638.24
80	7.14	7638.65	11.30	7634.49	11.93	7633.86	12.55	7633.24	7.69	7638.10

Max. Water Surface Slope (fraction): 0.163
Min. Water Surface Slope (fraction): -0.005
Avg. Water Surface Slope (fraction): 0.054

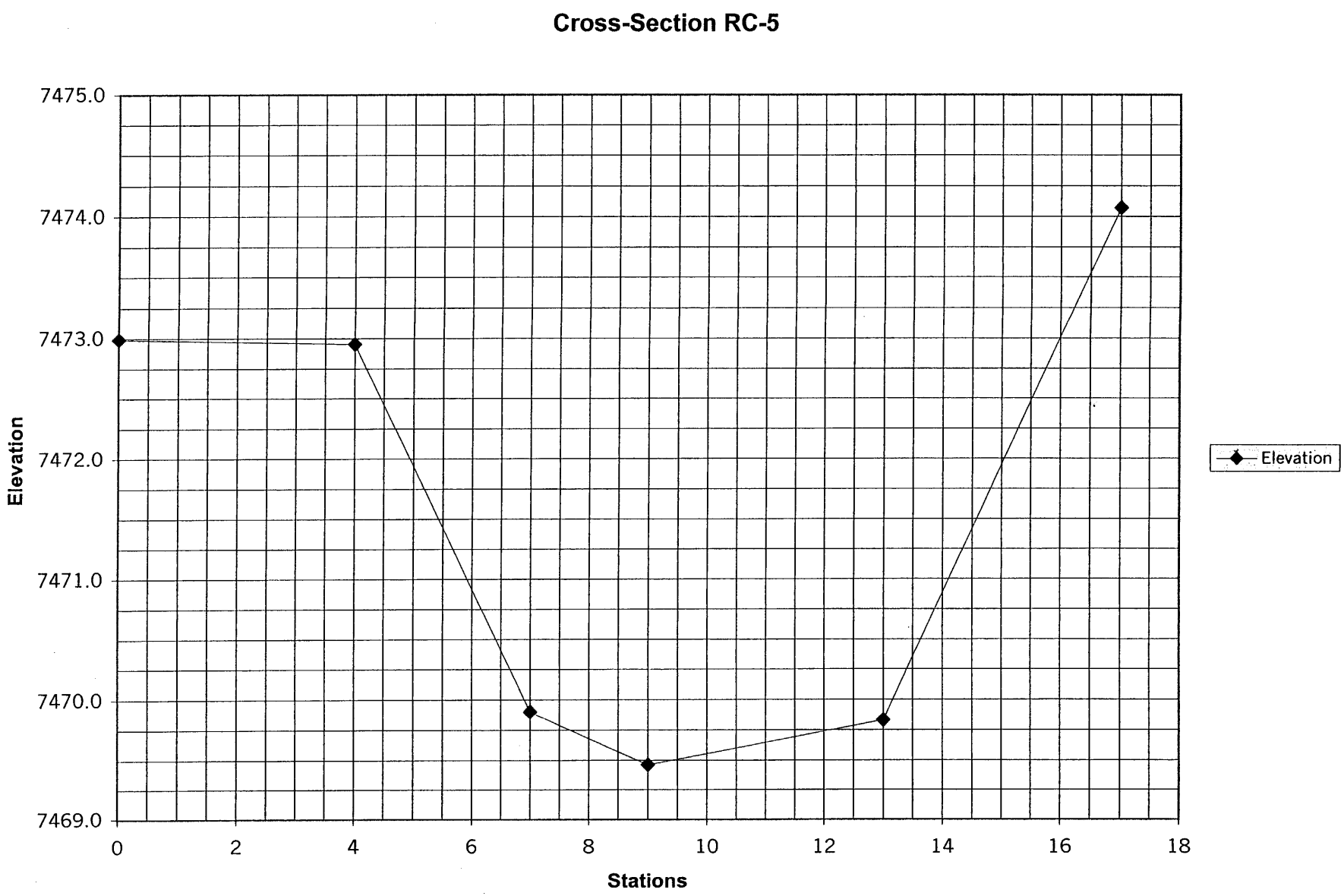
Profile RC-4


7644.00
7642.00
7640.00
7638.00
7636.00
7634.00
7632.00
Elevation
0
10
20
30
40
50
60
70
80
90
100
Stations
Top of Bank Left
Bankfull Left
Water Surface
Channel Bottom
Top of Bank Right

Cross Section: RC-5

Benchmark elevation: 7474.71
BenchMark Rod Reading: 3.68

Station	Rod Reading	Elevation
0	5.40	7472.99
4	5.44	7472.95
7	8.49	7469.90
9	8.93	7469.46
13	8.56	7469.83
17	4.32	7474.07

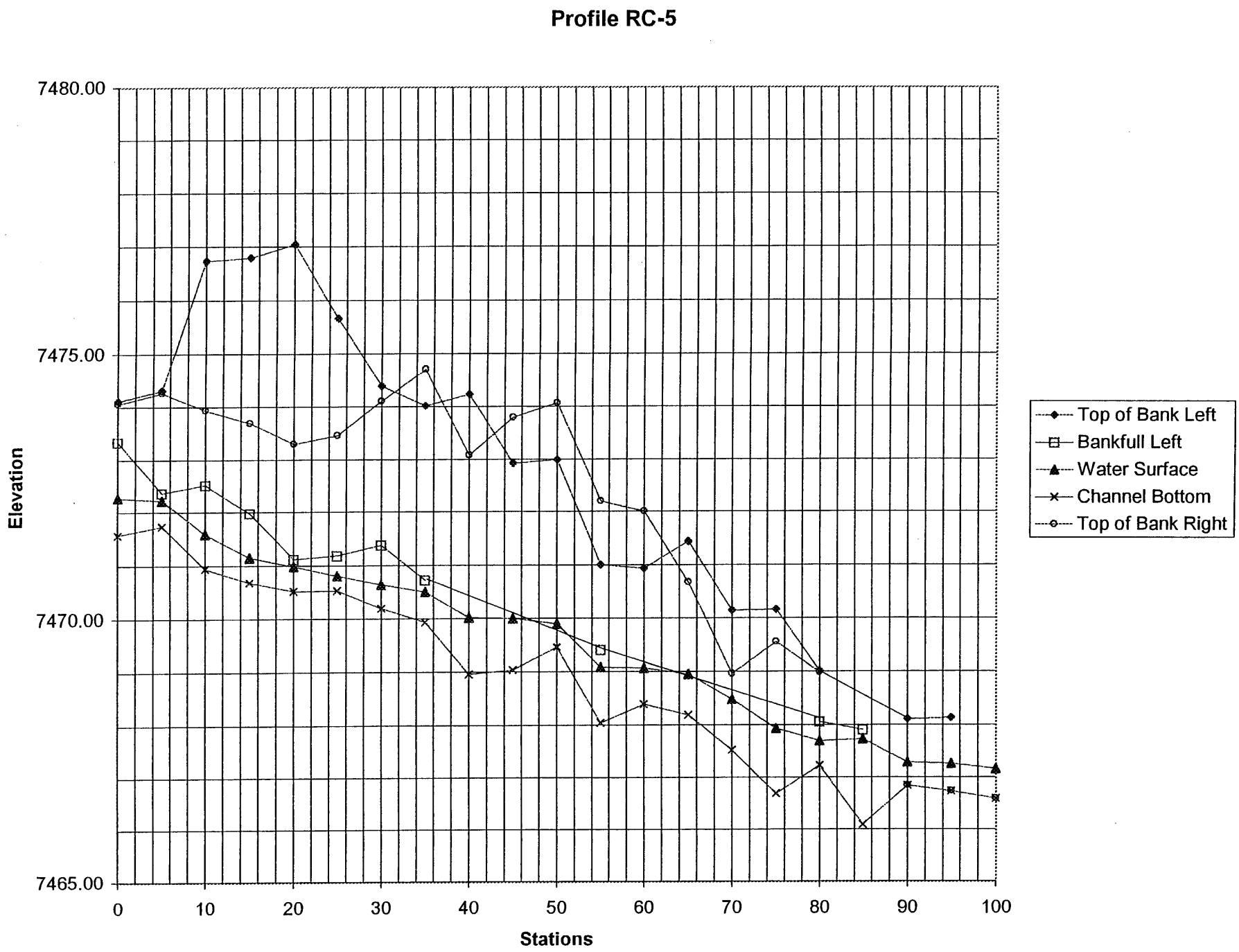

Cross-Section RC-5
7475.0
7474.0
7473.0
7472.0
7471.0
7470.0
7469.0
Elevation
0
2
4
6
8
10
12
14
16
18
Stations
Elevation

Profile: RC-5

Benchmark elevation (ft): 7474.71
Rod reading at Benchmark (ft): 3.68

	Top of Bank Left		Bankfull Left		Water Surface		Channel Bottom		Top of Bank Right	
Station	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation
0	4.27	7474.12	5.05	7473.34	6.11	7472.28	6.82	7471.57	4.33	7474.06
5	4.07	7474.32	6.02	7472.37	6.16	7472.23	6.66	7471.73	4.12	7474.27
10	1.66	7476.73	5.87	7472.52	6.81	7471.58	7.45	7470.94	4.45	7473.94
15	1.60	7476.79	6.41	7471.98	7.24	7471.15	7.71	7470.68	4.70	7473.69
20	1.35	7477.04	7.28	7471.11	7.41	7470.98	7.87	7470.52	5.09	7473.30
25	2.74	7475.65	7.21	7471.18	7.59	7470.80	7.86	7470.53	4.93	7473.46
30	3.99	7474.40	7.02	7471.37	7.75	7470.64	8.20	7470.19	4.28	7474.11
35	4.37	7474.02	7.67	7470.72	7.89	7470.50	8.46	7469.93	3.68	7474.71
40	4.15	7474.24			8.37	7470.02	9.43	7468.96	5.31	7473.08
45	5.47	7472.92			8.39	7470.00	9.35	7469.04	4.60	7473.79
50	5.40	7472.99			8.49	7469.90	8.93	7469.46	4.32	7474.07
55	7.39	7471.00	8.98	7469.41	9.30	7469.09	10.35	7468.04	6.19	7472.20
60	7.46	7470.93			9.32	7469.07	10.00	7468.39	6.39	7472.00
65	6.96	7471.43			9.44	7468.95	10.20	7468.19	7.72	7470.67
70	8.25	7470.14			9.91	7468.48	10.87	7467.52	9.43	7468.96
75	8.23	7470.16			10.46	7467.93	11.70	7466.69	8.83	7469.56
80	9.38	7469.01	10.33	7468.06	10.69	7467.70	11.16	7467.23	9.40	7468.99
85			10.48	7467.91	10.66	7467.73	12.30	7466.09		
90	10.28	7468.11			11.10	7467.29	11.55	7466.84	11.55	7466.84
95	10.26	7468.13			11.13	7467.26	11.66	7466.73	11.66	7466.73
100					11.23	7467.16	11.80	7466.59	11.80	7466.59

Max. Water Surface Slope (fraction): 0.162
Min. Water Surface Slope (fraction): -0.006
Avg. Water Surface Slope (fraction): 0.051

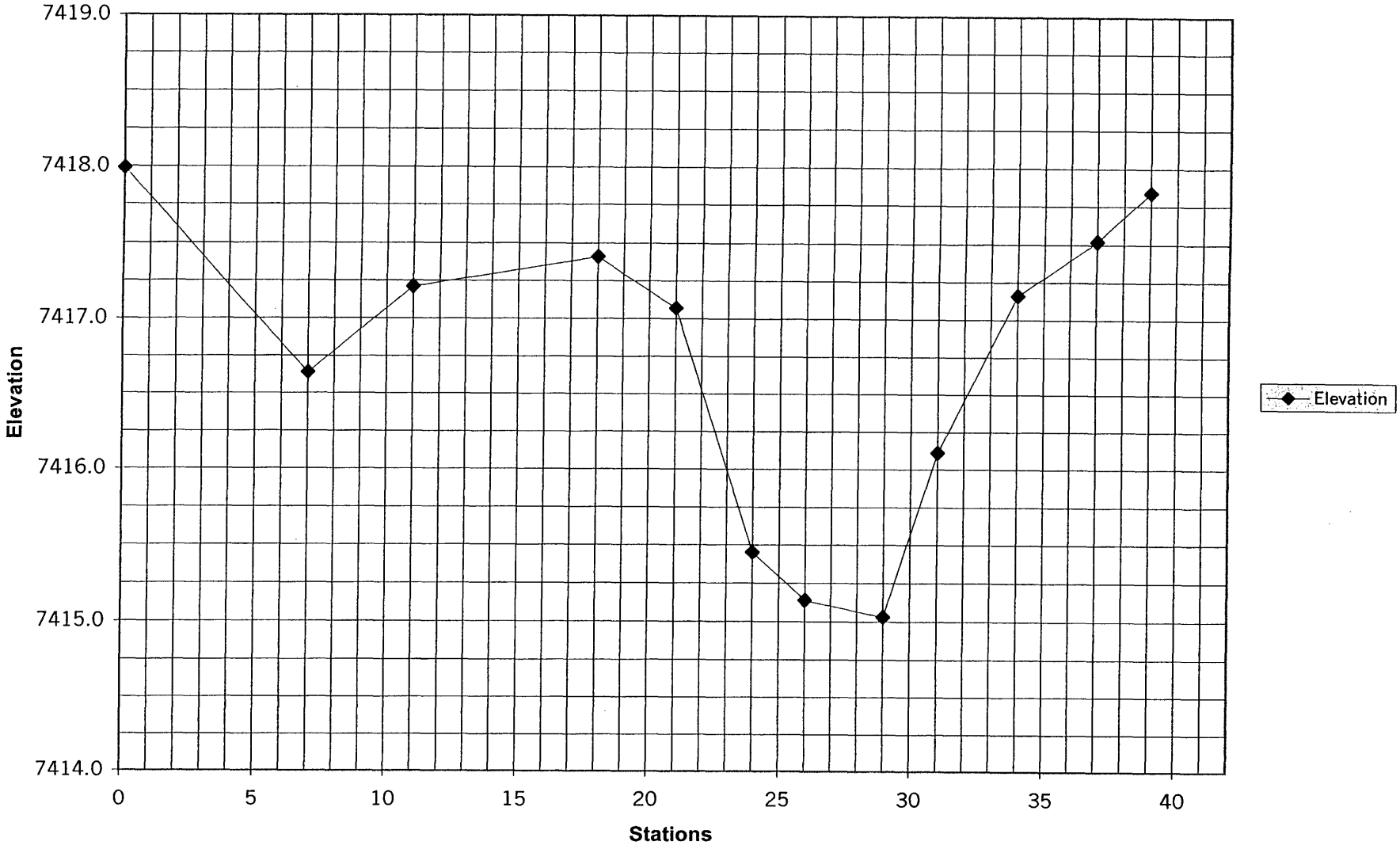

Profile RC-5
7480.00
7475.00
7470.00
7465.00
Elevation
0
10
20
30
40
50
60
70
80
90
100
Stations
Top of Bank Left
Bankfull Left
Water Surface
Channel Bottom
Top of Bank Right

Cross Section: RC-6

Benchmark elevation: 7417.44
BenchMark Rod Reading: 5.15

Station	Rod Reading	Elevation
0	4.60	7417.99
7	5.95	7416.64
11	5.38	7417.21
18	5.18	7417.41
21	5.52	7417.07
24	7.14	7415.45
26	7.45	7415.14
29	7.56	7415.03
31	6.48	7416.11
34	5.43	7417.16
37	5.07	7417.52
39	4.75	7417.84

Cross-Section RC-6



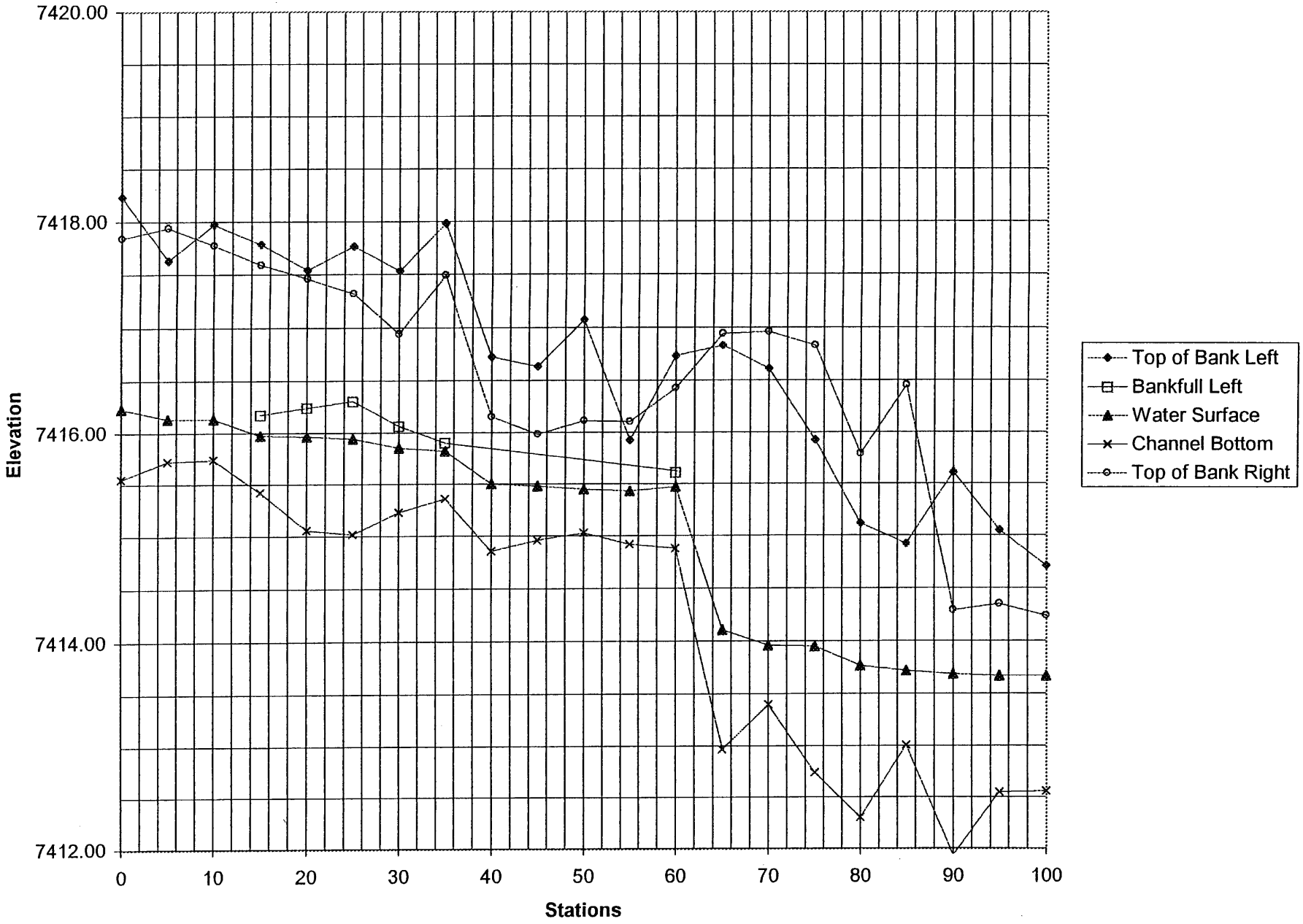
Profile: RC-6

Benchmark elevation (ft): 7417.44
Rod reading at Benchmark (ft): 5.15

	Top of Bank Left		Bankfull Left		Water Surface		Channel Bottom		Top of Bank Right	
Station	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation
0	4.36	7418.23			6.36	7416.23	7.04	7415.55	4.75	7417.84
5	4.96	7417.63			6.46	7416.13	6.87	7415.72	6.87	7415.72
10	4.62	7417.97			6.46	7416.13	6.85	7415.74	6.85	7415.74
15	4.81	7417.78	6.42	7416.17	6.62	7415.97	7.17	7415.42	7.17	7415.42
20	5.05	7417.54	6.35	7416.24	6.63	7415.96	7.53	7415.06	7.53	7415.06
25	4.83	7417.76	6.29	7416.30	6.65	7415.94	7.57	7415.02	7.57	7415.02
30	5.06	7417.53	6.53	7416.06	6.74	7415.85	7.36	7415.23	7.36	7415.23
35	4.61	7417.98	6.69	7415.90	6.77	7415.82	7.23	7415.36	7.23	7415.36
40	5.87	7416.72			7.09	7415.50	7.73	7414.86	7.73	7414.86
45	5.96	7416.63			7.11	7415.48	7.63	7414.96	7.63	7414.96
50	5.52	7417.07			7.14	7415.45	7.56	7415.03	7.56	7415.03
55	6.67	7415.92			7.16	7415.43	7.67	7414.92	7.67	7414.92
60	5.86	7416.73	6.98	7415.61	7.12	7415.47	7.71	7414.88	7.71	7414.88
65	5.76	7416.83			8.48	7414.11	9.62	7412.97	9.62	7412.97
70	5.98	7416.61			8.63	7413.96	9.19	7413.40	9.19	7413.40
75	6.67	7415.92			8.64	7413.95	9.85	7412.74	9.85	7412.74
80	7.47	7415.12			8.82	7413.77	10.29	7412.30	10.29	7412.30
85	7.67	7414.92			8.87	7413.72	9.58	7413.01	9.58	7413.01
90	6.98	7415.61			8.90	7413.69	10.66	7411.93	10.66	7411.93
95	7.54	7415.05			8.92	7413.67	10.04	7412.55	10.04	7412.55
100	7.88	7414.71			8.92	7413.67	10.03	7412.56	10.03	7412.56

Max. Water Surface Slope (fraction): 0.272
Min. Water Surface Slope (fraction): -0.008
Avg. Water Surface Slope (fraction): 0.026

Profile RC-6


7420.00
7418.00
7416.00
7414.00
7412.00
Elevation
0
10
20
30
40
50
60
70
80
90
100
Stations
Top of Bank Left
Bankfull Left
Water Surface
Channel Bottom
Top of Bank Right

APPENDIX D

Groundwater Level Data Collected from
Rilda Canyon Piezometers

PACIFICORP
TECHNICAL SERVICES - HYDROLOGIC MONITORING

SURFACE PIEZOMETRIC DATA
RILDA CANYON

	Rilda Canyon (EM-47)		P - 1		P - 4		P - 5		P - 6		P - 7	
Collar Elevation	8,059.0		7,516.8		7,579.3		7,564.8		7,615.5		7,634.9	
Date	Reading	Level	Reading	Level	Reading	Level	Reading	Level	Reading	Level	Reading	Level
JAN 93	inaccessible >											
FEB	inaccessible >											
MAR	inaccessible >											
APR	inaccessible >											
05-13-93	inaccessible		22.1	7,494.7	DAMP		8.0	7,556.8	46.3	7,569.2	44.4	7,590.5
06-11-93	208.1	7,850.9	22.1	7,494.7	DAMP		7.5	7,557.3	38.6	7,576.9	24.1	7,610.8
07-29-93	205.1	7,853.9	22.5	7,494.3	DAMP		7.7	7,557.1	38.5	7,577.0	24.6	7,610.3
08-27-93	208.6	7,850.4	22.5	7,494.3	DAMP		7.5	7,557.3	38.5	7,577.0	24.7	7,610.2
09-28-93	213.1	7,845.9	22.6	7,494.2	DAMP		7.6	7,557.3	40.8	7,574.7	31.9	7,603.0
10-22-93	216.4	7,842.6	22.4	7,494.4	DAMP		7.7	7,557.2	44.1	7,571.4	41.8	7,593.1
11-19-93	inaccessible		22.5	7,494.3	DAMP		7.8	7,557.0	45.3	7,570.2	inaccessible	
DEC	inaccessible >											
JAN 94	inaccessible >											
FEB	inaccessible >											
MAR	inaccessible >											
APR	inaccessible >											
05-24-94	221.6	7,837.4	22.8	7,494.0	DAMP		8.0	7,556.8	43.5	7,572.0	38.8	7,596.1
06-16-94	208.5	7,850.5	23.1	7,493.8	DAMP		7.9	7,557.0	38.2	7,577.3	22.3	7,612.6
07-18-94	207.3	7,851.8	23.3	7,493.5	DAMP		7.9	7,556.9	38.4	7,577.1	21.1	7,613.8
08-24-94	212.9	7,846.2	23.7	7,493.1	DAMP		7.8	7,557.0	42.7	7,572.8	38.2	7,596.7
09-13-94	216.6	7,842.4	23.6	7,493.2	DAMP		8.0	7,556.8	45.3	7,570.2	44.6	7,590.3
10-28-94	220.9	7,838.1	23.5	7,493.3	DAMP		8.0	7,556.8	47.3	7,568.2	48.6	7,586.3
NOV 94	inaccessible >											
DEC 94	inaccessible >											
JAN 95	inaccessible >											
FEB 95	inaccessible >											
03-29-95	inaccessible		23.6	7,493.2	DAMP		7.3	7,557.5	48.2	7,567.3	46.9	7,588.0
APR 95	inaccessible >											
05-26-95	inaccessible		22.5	7,494.4	DAMP		7.5	7,557.3	38.6	7,576.9	22.4	7,612.5
06-28-95	206.7	7,852.3	23.4	7,493.4	DAMP		7.6	7,557.2	37.3	7,578.2	21.0	7,613.9
07-21-95	205.5	7,853.5	23.9	7,493.0	DAMP		7.7	7,557.1	37.9	7,577.6	23.7	7,611.2
08-24-95	210.5	7,848.5	25.0	7,491.8	DAMP		7.6	7,557.2	38.8	7,576.7	25.8	7,609.1
09-15-95	213.0	7,846.0	24.1	7,492.7	DAMP		7.9	7,556.9	38.9	7,576.6	27.5	7,607.4
10-31-95	214.8	7,844.2	23.8	7,493.0	DAMP		7.8	7,557.0	44.2	7,571.3	36.3	7,598.6
11-30-95	Inaccessible		23.1	7,493.7	DAMP		7.9	7,556.9	46.1	7,569.4	44.3	7,590.6
12-14-95	Inaccessible		23.2	7,493.6	DAMP.		7.3	7,557.5	45.8	7,569.7	43.6	7,591.3
1/1/1996	Inaccessible											
2/1/1996	Inaccessible											
4/2/1996	Inaccessible		22.8	7,494.0	DAMP		7.8	7,557.0	45.7	7,569.8	43.0	7,591.9
4/30/1996	Inaccessible		22.8	7,494.0	DAMP		8.1	7,556.7	42.6	7,572.9	31.2	7,603.7
6/11/1996	206.5	7,852.5	22.8	7,494.0	DAMP		8.0	7,556.8	38.9	7,576.6	23.2	7,611.7
7/9/1996	207.2	7,851.8								7,615.5		
7/23/1996			23.2	7,493.6	DAMP		8.1	7,556.7		7,615.5		
7/25/1996									39.4	7,576.1	24.8	7,610.1
8/21/1996	211.2	7,847.8	23.3	7,493.5	DAMP		8.2	7,556.6	40.2	7,575.3	27.7	7,607.2
9/16/1996	213.8	7,845.2	23.1	7,493.7	DAMP		8.1	7,556.7	42.8	7,572.7	35.3	7,599.6
10/23/1996	217.2	7,841.8	23.1	7,493.7	DAMP		8.2	7,556.6	45.2	7,570.3	43.3	7,591.7
11/14/1996	217.6	7,841.4	23.1	7,493.7	DAMP		8.3	7,556.5	46.5	7,569.0	45.0	7,589.9
12/16/1996	Inaccessible		23.1	7,493.7	DAMP		8.5	7,556.3	46.6	7,568.9	44.9	7,590.0
1/24/1997	Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible	
2/14/1997	Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible	
3/19/1997	Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible	

PACIFICORP
TECHNICAL SERVICES - HYDROLOGIC MONITORING

SURFACE PIEZOMETRIC DATA
RILDA CANYON

	Rilda Canyon (EM-47)		P - 1		P - 4		P - 5		P - 6		P - 7	
Collar Elevation	8,059.0		7,516.8		7,579.3		7,564.8		7,615.5		7,634.9	
Date	Reading	Level	Reading	Level	Reading	Level	Reading	Level	Reading	Level	Reading	Level
4/28/1997	Inaccessible		22.9	7,493.9	DAMP		8.1	7,556.7	43.9	7,571.6	36.0	7,598.9
5/29/1997	204.7	7,854.3	22.6	7,494.2	DAMP		7.8	7,557.0	39.1	7,576.4	23.1	7,611.8
6/26/1997	203.3	7,855.7	22.9	7,493.9	DAMP		8.0	7,556.8	38.9	7,576.6	23.6	7,611.3
7/17/1997	205.6	7,853.4	23.2	7,493.6	DAMP		8.2	7,556.6	39.0	7,576.5	24.0	7,610.9
8/28/1997	208.3	7,850.7	23.2	7,493.6	DAMP		7.8	7,557.0	39.4	7,576.1	25.5	7,609.4
9/15/1997	209.5	7,849.5	23.1	7,493.7	DAMP		7.8	7,557.0	40.4	7,575.1	28.4	7,606.5
10/13/1997	210.9	7,848.1	23.0	7,493.8	DAMP		7.9	7,556.9	43.0	7,572.5	35.6	7,599.3
11/18/1997	211.5	7,847.5	23.0	7,493.8	DAMP		8.1	7,556.7	43.9	7,571.6	37.8	7,597.1
12/4/1997	Inaccessible		28.0	7,488.8	DAMP		8.1	7,556.7	44.0	7,571.5	37.7	7,597.2
1/15/1998	Inaccessible		22.9	7,493.9	DAMP		8.3	7,556.6	44.8	7,570.7	40.6	7,594.3
2/23/1998	Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible	
3/11/1998	Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible	
4/14/1998	Inaccessible		22.7	7,494.1	DAMP		8.0	7,556.8	45.2	7,570.3	41.6	7,593.3
5/15/1998	204.9	7,854.1	21.5	7,495.3	DAMP		6.8	7,558.0	39.7	7,575.8	23.5	7,611.4
6/2/1998			21.4	7,495.4	DAMP		6.8	7,558.0	39.1	7,576.4	22.4	7,612.5
6/8/1998	203.6	7,855.4								7,615.5		
7/6/1998	203.0	7,856.0	22.6	7,494.2	DAMP		8.0	7,556.8	39.0	7,576.5	23.2	7,611.7
8/17/1998	205.0	7,854.0	23.0	7,493.8	DAMP		8.0	7,556.8	39.2	7,576.3	24.4	7,610.5
9/14/1998	206.8	7,852.2	23.0	7,493.8	DAMP		7.5	7,557.3	40.0	7,575.5	27.0	7,607.9
10/1/1998	207.4	7,851.6	22.9	7,493.9	DAMP		7.8	7,557.0	41.4	7,574.1	34.4	7,600.5
11/4/1998	210.4	7,848.6	22.8	7,494.0	DAMP		7.9	7,556.9	43.0	7,572.5	35.0	7,599.9
12/3/1998	210.5	7,848.5	22.8	7,494.0	DAMP		8.0	7,556.8	43.4	7,572.1	36.0	7,598.9
1/12/1999	210.2	7,848.8	22.7	7,494.1	DAMP		8.1	7,556.7	44.1	7,571.4	39.5	7,595.4
2/2/1999	Inaccessible		22.7	7,494.1	DAMP		8.2	7,556.6	44.6	7,570.9	41.2	7,593.7
3/3/1999	Inaccessible		22.6	7,494.2	DAMP		8.1	7,556.7	45.3	7,570.2	42.4	7,592.5
4/5/1999	Inaccessible		22.2	7,494.6	DAMP		8.1	7,556.7	45.2	7,570.3	42.2	7,592.7
5/11/1999	205.6	7,853.4	22.0	7,494.8	DAMP		7.6	7,557.2	44.7	7,570.9	40.1	7,594.8
6/7/1999	203.3	7,855.7	21.9	7,494.9	DAMP		7.6	7,557.2	40.1	7,575.4	24.0	7,610.9
7/26/1999	202.0	7,857.1	22.3	7,494.5	DAMP		4.7	7,560.1	39.1	7,576.4	23.5	7,611.4
8/12/1999	202.4	7,856.6	22.5	7,494.3	DAMP		7.9	7,556.9	39.2	7,576.3	23.4	7,611.5
9/3/1999	204.9	7,854.1	22.6	7,494.2	DAMP		7.8	7,557.0	39.6	7,575.9	25.3	7,609.6
10/5/1999	206.0	7,853.0	22.9	7,493.9	DAMP		7.9	7,557.0	41.3	7,574.2	30.2	7,604.7
11/17/1999	207.9	7,851.1	22.4	7,494.4	DAMP		8.0	7,556.8	44.6	7,570.9	40.7	7,594.2
12/9./1999	208.1	7,850.9	22.3	7,494.5	DAMP		7.5	7,557.3	45.3	7,570.2	42.8	7,592.2
1/11/2000	Inaccessible		22.3	7,494.6	DAMP		8.0	7,556.8	45.9	7,569.6	44.3	7,590.6
2/3/2000	Inaccessible		22.3	7,494.5	DAMP		8.0	7,556.8	46.3	7,569.2	45.1	7,589.8
3/9/2000	Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible	
4/5/2000	Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible	
5/3/2000	205.9	7,853.1	22.1	7,494.7	DAMP		7.9	7,556.9	43.9	7,571.7	37.2	7,597.7
6/23/2000	203.2	7,855.8	22.5	7,494.3	DAMP		7.9	7,556.9	39.6	7,575.9	24.7	7,610.2
7/6/2000	203.6	7,855.4	22.6	7,494.2	DAMP		7.9	7,556.9	39.4	7,576.1	24.7	7,610.2
8/7/2000	204.7	7,854.3	22.9	7,493.9	DAMP		8.1	7,556.7	40.8	7,574.7	29.6	7,605.3
9/13/2000	205.6	7,853.4	22.7	7,494.1	DAMP		8.0	7,556.8	45.2	7,570.3	42.7	7,592.2
10/10/2000	208.2	7,850.8	22.6	7,494.2	DAMP		8.0	7,556.8	45.7	7,569.8	43.8	7,591.1
11/28/2000	Inaccessible		22.4	7,494.4	DAMP		7.4	7,557.4	46.6	7,568.9	45.4	7,589.5
12/5/2000	Inaccessible		22.4	7,494.4	DAMP		8.0	7,556.9	46.6	7,568.9	45.4	7,589.5
1/5/2001	Inaccessible		22.5	7,494.3	DAMP		8.0	7,556.8	46.9	7,568.6	45.8	7,589.1
2/5/2001	Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible	
3/13/2001	Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible	
4/20/2001	Inaccessible		22.3	7,494.5	DAMP		7.9	7,556.9	47.1	7,568.4	46.1	7,588.9
5/7/2001	211.6	7,847.4	22.3	7,494.5	DAMP		7.8	7,557.1	44.2	7,571.4	39.4	7,595.5
6/29/2001	207.5	7,851.5	22.5	7,494.3	DAMP		7.6	7,557.2	39.9	7,575.6	27.2	7,607.7

PACIFICORP
TECHNICAL SERVICES - HYDROLOGIC MONITORING

SURFACE PIEZOMETRIC DATA
RILDA CANYON

	Rilda Canyon (EM-47)		P - 1		P - 4		P - 5		P - 6		P - 7	
Collar Elevation	8,059.0		7,516.8		7,579.3		7,564.8		7,615.5		7,634.9	
Date	Reading	Level	Reading	Level	Reading	Level	Reading	Level	Reading	Level	Reading	Level
7/11/2001	206.7	7,852.3	22.6	7,494.2	DAMP		7.7	7,557.1	39.8	7,575.7	26.5	7,608.4
8/7/2001	206.1	7,852.9	22.9	7,493.9	DAMP		7.8	7,557.0	39.9	7,575.6	27.4	7,607.5
9/12/2001	208.5	7,850.5	22.9	7,493.9	DAMP		7.8	7,557.0	42.9	7,572.6	37.4	7,597.5
10/17/2001	211.2	7,847.8	22.7	7,494.1	DAMP		7.8	7,557.1	44.3	7,571.2	43.0	7,591.9
11/9/2001	Inaccessible		22.7	7,494.1	DAMP		7.9	7,556.9	45.7	7,569.8	44.4	7,590.5
12/12/2001	Inaccessible		22.4	7,494.4	DAMP		7.8	7,557.1	46.3	7,569.2	46.1	7,588.8
1/17/2002	Inaccessible		22.4	7,494.4	DAMP		7.8	7,557.0	46.4	7,569.1	46.2	7,588.7
2/11/2002	Inaccessible		22.6	7,494.2	DAMP		7.8	7,557.0	46.7	7,568.8	46.5	7,588.4
3/6/2002	Inaccessible		22.4	7,494.5	DAMP		7.9	7,556.9	47.1	7,568.5	46.8	7,588.1
4/11/2002	Inaccessible		22.4	7,494.4	DAMP		7.9	7,556.9	47.4	7,568.1	47.2	7,587.7
5/7/2002	223.1	7,835.9	22.4	7,494.5	DAMP		8.0	7,556.8	47.2	7,568.3	46.9	7,588.0
6/24/2002	211.9	7,847.1	22.9	7,494.0	DAMP		7.9	7,556.9	39.4	7,576.1	24.7	7,610.2
7/22/2002	211.1	7,847.9	23.0	7,493.8	DAMP		7.9	7,556.9	40.0	7,575.5	29.3	7,605.6
8/16/2002	218.8	7,840.2	22.4	7,494.5	DAMP		8.1	7,556.7	42.4	7,573.1	38.8	7,596.1
9/18/2002	220.2	7,838.8	22.4	7,494.4	DAMP		7.7	7,557.1	46.6	7,568.9	46.4	7,588.6
10/16/2002	223.3	7,835.7	22.4	7,494.4	DAMP		7.7	7,557.1	46.6	7,568.9	46.4	7,588.6
11/12/2002	224.3	7,834.7	22.5	7,494.3	DAMP		7.9	7,556.9	46.7	7,568.8	46.4	7,588.5
12/3/2002	225.1	7,833.9	22.9	7,493.9	DAMP		8.0	7,556.8	47.3	7,568.2	47.1	7,587.8
1/7/2003	225.9	7,833.1	22.5	7,494.3	DAMP		8.1	7,556.7	47.9	7,567.6	47.5	7,587.4
2/20/2003	226.2	7,832.8	22.5	7,494.3	DAMP		8.3	7,556.5	48.1	7,567.4	47.8	7,587.1
3/12/2003	227.3	7,831.7	22.5	7,494.3	DAMP		8.2	7,556.6	48.5	7,567.0	48.0	7,586.9
4/21/2003	228.1	7,830.9	22.4	7,494.4	DAMP		7.3	7,557.5	47.5	7,568.0	47.8	7,587.2
5/22/2003	224.9	7,834.1	22.3	7,494.5	DAMP		7.8	7,557.0	43.1	7,572.4	38.9	7,596.0
6/26/2003	217.1	7,841.9	22.6	7,494.2	DAMP		7.7	7,557.1	39.8	7,575.7	28.5	7,606.4
7/10/2003	213.1	7,845.9	22.8	7,494.0	DAMP		7.8	7,557.0	39.2	7,576.3	27.0	7,607.9
8/26/2003	213.4	7,845.6	22.8	7,494.0	DAMP		7.6	7,557.2	40.5	7,575.0	32.9	7,602.0
9/17/2003	213.3	7,845.8	22.6	7,494.2	DAMP		8.3	7,556.5	43.2	7,572.3	41.8	7,593.1
10/6/2003	220.3	7,838.7	22.6	7,494.2	DAMP		7.9	7,557.0	45.6	7,569.9	45.4	7,589.5
11/17/2003	222.4	7,836.6	22.7	7,494.1	DAMP		8.0	7,556.8	46.7	7,568.8	45.7	7,589.2
12/8/2003	222.4	7,836.6	22.6	7,494.2	DAMP		8.1	7,556.7	47.2	7,568.3	47.1	7,587.8
1/20/2004	222.7	7,836.3	22.4	7,494.4	DAMP		8.2	7,556.6	48.1	7,567.4	47.1	7,587.9
2/27/2004	Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible		Inaccessible	
	Max.	7,857.1	Max.	7,495.4			Max.	7,560.1	Max.	7,615.5	Max.	7,613.9
	Min.	7,830.9	Min.	7,488.8			Min.	7,556.3	Min.	7,567.0	Min.	7,586.3
	Avg.	7,847.1	Avg.	7,494.0			Avg.	7,557.0	Avg.	7,573.5	Avg.	7,598.7

APPENDIX E

Rilda Canyon Streamflow Data

RILDA CANYON
MONTHLY FLOW DATA

FLOW (GPM)

MONTH	RCF1	RCLF1	RCLF2	RCF2	RCF3	RCW4
1-89						
2-89						
3-89						
4-89	0	0		19.06		
5-89	0	0		78.02		
6-89	189.9	78.02		78.02	114.9	
7-89	0	0		35.4	93.4	
8-89	0	0		45.08	114.9	
9-89	0	0		35.6	103.9	
10-89	0	0		55.4	117.8	
11-89	0	0		12.2	117.8	
12-89	0	0		26.9	85.1	
1-90					19	74
2-90						
3-90						
4-90	0	0		0	78	125
5-90	193	0		0	117	118
6-90	380	0		117	177	373
7-90	0	0		0	27	97
8-90	0	0		0	27	74
9-90	0	0		0	66	104
10-90	0	0		0	55	115
11-90	0	0		0	19	115
12-90	0	0		0	19	54
1-91						
2-91				0	27	85
3-91						
4-91				0	19	97
5-91	0	0		0	27	104
6-91	1755	65		1766	1838	1770
7-91	134	5.5		117	103	184
8-91	24	0		2	19	115
9-91	58	0		20	19	104
10-91	46	0		0	12	115
11-91				0	12	104
12-91				0	19	79
1-92						
2-92						
3-92						

RILDA CANYON
MONTHLY FLOW DATA

FLOW (GPM)

MONTH	RCF1	RCLF1	RCLF2	RCF2	RCF3	RCW4
4-92				0	12	97
5-92	614	0		300	146	305
6-92	419	0		262	319	402
7-92	15	0		0	7	63
8-92	0	0		0	7	97
9-92	0	0		0	7	54
10-92	0	0		0	12	79
11-92						
12-92						
1-93						
2-93						
3-93						
4-93						
5-93		0		0	27	97
6-93	1975	150		1838	1874	1960
7-93	190	0		55	78	157
8-93	210	0		0	36	60
9-93	20	0		0	66	48
10-93	30	0		0	66	100
11-93				0	90	75
12-93						
1-94						
2-94						
3-94						
4-94						
5-94	556	0		27	55	104
6-94		0		90.3	103.3	165.7
7-94	0	0		0	78.02	150
8-94	0	0		0	78.02	100
9-94	0	0		0	78.02	144
10-94	0	0		0	78.02	183.9
11-94						
12-94						
1-95						
2-95						
3-95		0		0	19	184
4-95						
5-95		0		1227	1165	1388
6-95	4500	400		4500	4500	6732

RILDA CANYON
MONTHLY FLOW DATA

FLOW (GPM)

MONTH	RCF1	RCLF1	RCLF2	RCF2	RCF3	RCW4
7-95	1490	198		1291	608	500
8-95	320	8.7		359	227	687
9-95	116	0		117	27	149
10-95	200	0		50	50	331
11-95		0		0	27	149
12-95		0		0	25	165
1-96		0				
2-96						
3-96						
4-96		0		536	536	636
5-96		150		5100	5050	7000
6-96	1712	150		2290	2290	2538
7-96	252	2.53		209	117	359
8-96	20	0		20	20	110
9-96	30	0		20	15	140
10-96	20	0		0	25	111
11-96	10	0		0	25	111
12-96		0		0	30	100
1-97						117
2-97						90
3-97						140.5
4-97		40	40	288	244	305.1
5-97	3316	75	75	5000	5000	3350
6-97	1200	50	50	1227	1227	1388
7-97	210	20	20	380	227	481.4
8-97	50	0	0	30	50	149.5
9-97	200	0.2	0.2	193	117	305
10-97	250	0.1	0.1	150	150	300
11-97	60	0	0	50	50	193.4
12-97		0	0	0	60	157
1/98		0	0	0		129.1
2/98						
3/98						157
4/98		0	0	0	209	193.4
5/98	512	160	150	608	1104	1040
6/98	2347	175	165	3657	3657	5317
7/98	1240	100	95	1522	1766	1726
8/98	101	10	9	244	251	433
9/98	152	2.6	3	209	262	358.6

RILDA CANYON
MONTHLY FLOW DATA

FLOW (GPM)

MONTH	RCF1	RCLF1	RCLF2	RCF2	RCF3	RCW4
10/98	117	0.86	0.8	103	262	280.4
11/98	95	2.6	1.7	0	131	193.4
12/98	50	0	0	0	146	183.9
1/99	0	0	0	0	176	
2/99				0	161	157
3/99				0	176	157
4/99		0	0	0	161	125.1
5/99	499	38	37.5	608	709	840
6/99	1303	165	160	3474	3500	3550
7/99	296	12	10	339	380	551
8/99	252	11	9.2	300	339	464.8
9/99	101	0	0	55.36	120	183.9
10/99	78	0	0	36	120	157
11/99	0	0	0	0	95	174.7
12/99	0	0	0	0	90	
1/00				0	70	175
2/00				0	65	175
3/00						157
4/00						183.9
5/00	902	27	25	927	1134	1207
6/00	296	5.7	7.5	227	262	417
7/00	90	0	0	35.5	103	157
8/00	15	0	0	0	103	157
9/00	0	0	0	0	78	125
10/00	10	0	0	0	90	157
11/00		0	0	0	100	157
12/00		0	0	0	103	157
1/01		0	0	0	90	157
2/01						174
3/01						175
4/01		0	0	0	103	203
5/01	2842	100	104	2529	3118	3117
6/01	1712	13.6	14.6	209	339	448
7/01	274	5	8	103	227	331
8/01	60	0	0	78	103	203
9/01	36	0	0	0	64	117
10/01	71.5	0	0	0	75	132
11/01		0	0	0	77	124
12/01				0	48	140.5

RILDA CANYON
MONTHLY FLOW DATA

FLOW (GPM)

MONTH	RCF1	RCLF1	RCLF2	RCF2	RCF3	RCW4
1/02				0	50	
2/02				0	48	
3/02				0	65	150
4/02		0	0	0	60	141
5/02	80	0	0	0	90	193
6/02	85	0	0	0	78	125
7/02	0	0	0	0	78	97.4
8/02	0	0	0	0	79	91
9/02	0	0	0	0	79	110
10/02	0	0	0	0	90	132
11/02	0	0	0	0	90	148
12/02	0	0	0	0	90	157
1/03	0	0	0	0	78	148
2/03	0	0	0	0	78	140
3/03	0	0	0	0	78	157
4/03	0	0	0	0	90	213
5/03	2842	0	0	1838	2818	2722
6/03	527	0	0	319	401	464
7/03	210	0	0	80	72	140
8/03	78	0	0	65	103	183
9/03	40	0	0	0	78	110
10/03	38	0	0	0	78	110
11/03	0	0	0	0	60	125
12/03	0	0	0	0	60	103

APPENDIX F

Peak Flow Calculations

Rilda Canyon Flood-Flow Magnitudes
Based on the regional equations of Thomas and Lindskov (1983)

Parameter	Right Fork at mouth	Left Fork at mouth	Main Canyon at RC-5
Basin parameters			
Area (mi2)	3.33	2.18	6.37
Mean Elev. (ft)	9560	9210	9290
Peak flow estimates			
Q2 (cfs)	28	20	48
Q5 (cfs)	61	45	99
Q10 (cfs)	84	66	139
Q25 (cfs)	120	99	198
Q50 (cfs)	150	128	250
Q100 (cfs)	183	160	306

Table
Rating Table for Irregular Channel

Project Description	
Worksheet	RC-1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data	
Slope	0.045000 ft/ft

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

Attribute	Minimum	Maximum	Increment
Water Surface Elevation (ft)	7,719.68	7,721.60	0.20

Water Surface Elevation (ft)	Discharge (cfs)	Velocity (ft/s)	Flow Area (ft²)	Wetted Perimeter (ft)	Top Width (ft)
7,719.68	N/A	N/A	N/A	N/A	N/A
7,719.88	1.28	1.13	1.1	11.55	11.53
7,720.08	10.22	1.70	6.0	37.69	37.61
7,720.28	36.81	2.39	15.4	55.59	55.41
7,720.48	84.92	3.06	27.8	68.76	68.44
7,720.68	156.00	3.63	42.9	83.81	83.39
7,720.88	265.52	4.44	59.8	85.80	85.30
7,721.08	398.20	5.17	77.0	87.73	87.16
7,721.28	552.49	5.84	94.7	89.67	89.02
7,721.48	727.39	6.46	112.7	91.61	90.88

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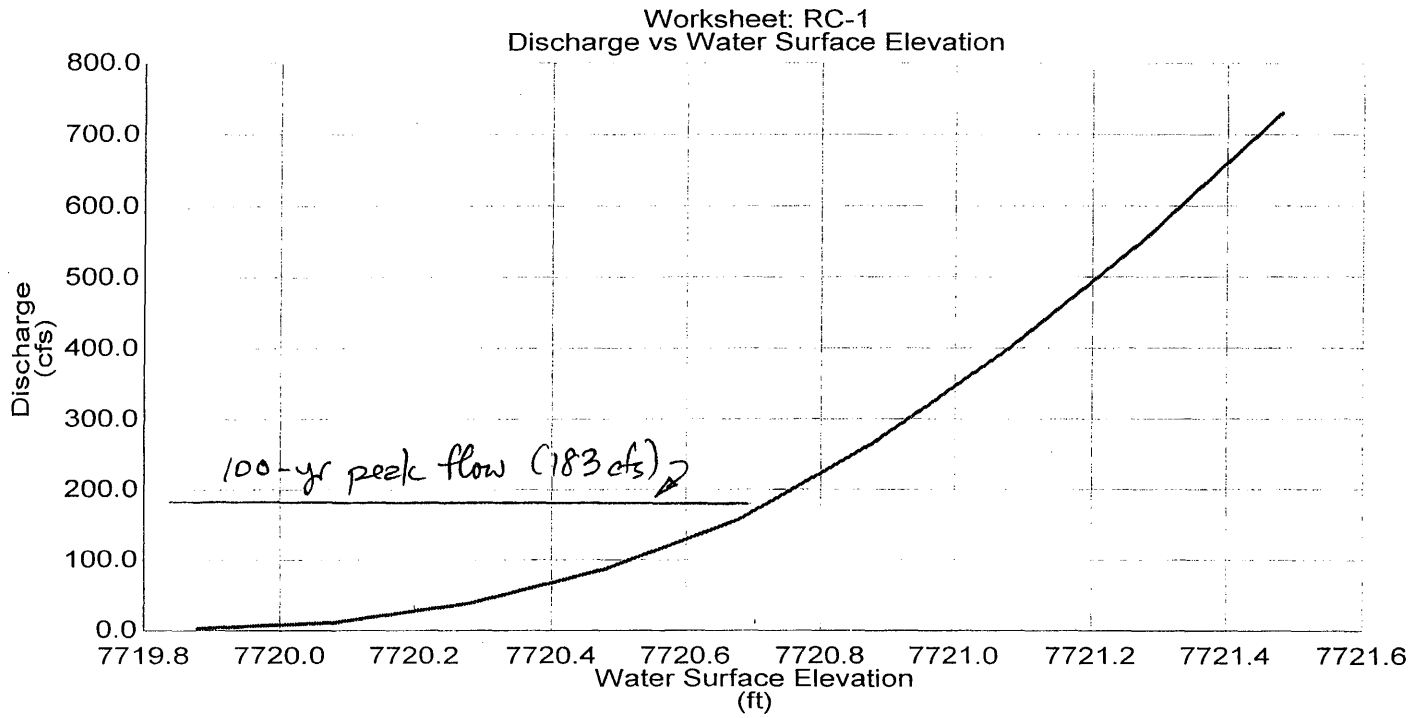
Curve
Plotted Curves for Irregular Channel

Project Description	
Worksheet	RC-1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data	
Slope	0.045000 ft/ft

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

Attribute	Minimum	Maximum	Increment
Water Surface Elevation (ft)	7,719.68	7,721.60	0.20



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	RC-1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficient	0.056	
Slope	0.045000	ft/ft
Water Surface Elevation	7,720.73	ft
Elevation Range	7,719.68 to 7,721.60	
Discharge	181.11	cfs

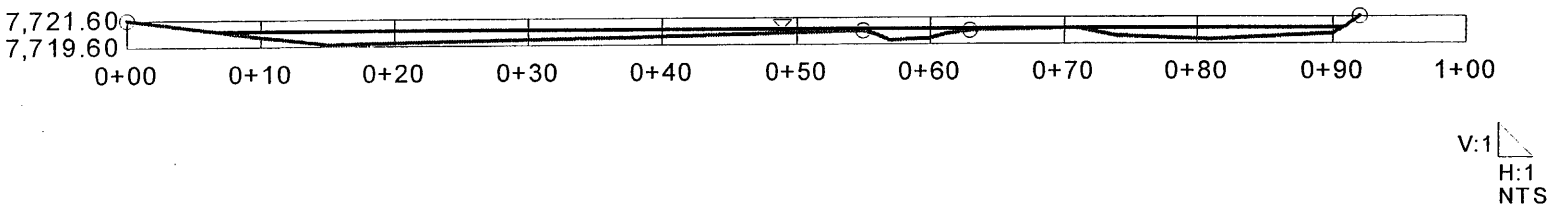


Table
Rating Table for Irregular Channel

Project Description	
Worksheet	RC-2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data	
Slope	0.049000 ft/ft

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

Attribute	Minimum	Maximum	Increment
Water Surface Elevation (ft)	7,708.73	7,711.78	0.20

Water Surface Elevation (ft)	Discharge (cfs)	Velocity (ft/s)	Flow Area (ft²)	Wetted Perimeter (ft)	Top Width (ft)
7,708.73	N/A	N/A	N/A	N/A	N/A
7,708.93	0.42	2.31	0.2	1.89	1.85
7,709.13	2.03	1.65	1.2	11.04	10.94
7,709.33	14.57	3.27	4.4	19.21	19.07
7,709.53	36.25	4.26	8.5	21.28	21.08
7,709.73	66.27	5.15	12.9	22.63	22.37
7,709.93	103.82	5.94	17.5	23.98	23.66
7,710.13	148.60	6.66	22.3	25.33	24.95
7,710.33	200.44	7.30	27.4	26.68	26.24
7,710.53	259.42	7.90	32.8	27.98	27.47
7,710.73	326.20	8.49	38.4	29.03	28.44
7,710.93	399.75	9.04	44.2	30.07	29.40
7,711.13	480.01	9.57	50.2	31.12	30.36
7,711.33	566.95	10.06	56.3	32.16	31.33
7,711.53	660.56	10.53	62.7	33.21	32.29
7,711.73	760.84	10.99	69.3	34.25	33.25

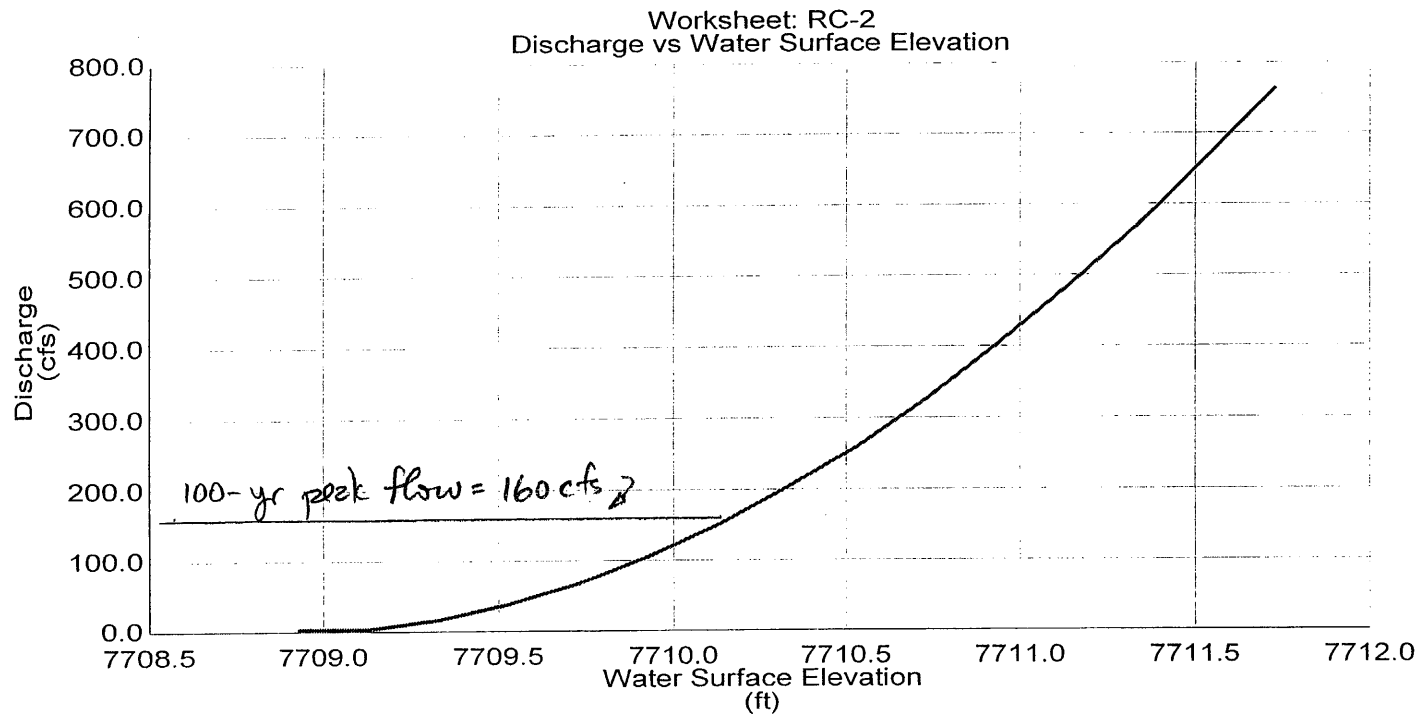
Curve
Plotted Curves for Irregular Channel

Project Description	
Worksheet	RC-2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data	
Slope	0.049000 ft/ft

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

Attribute	Minimum	Maximum	Increment
Water Surface Elevation (ft)	7,708.73	7,711.78	0.20



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	RC-2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficient	0.046	
Slope	0.049000	ft/ft
Water Surface Elevation	7,710.18	ft
Elevation Range	7,708.73 to 7,712.04	
Discharge	160.90	cfs

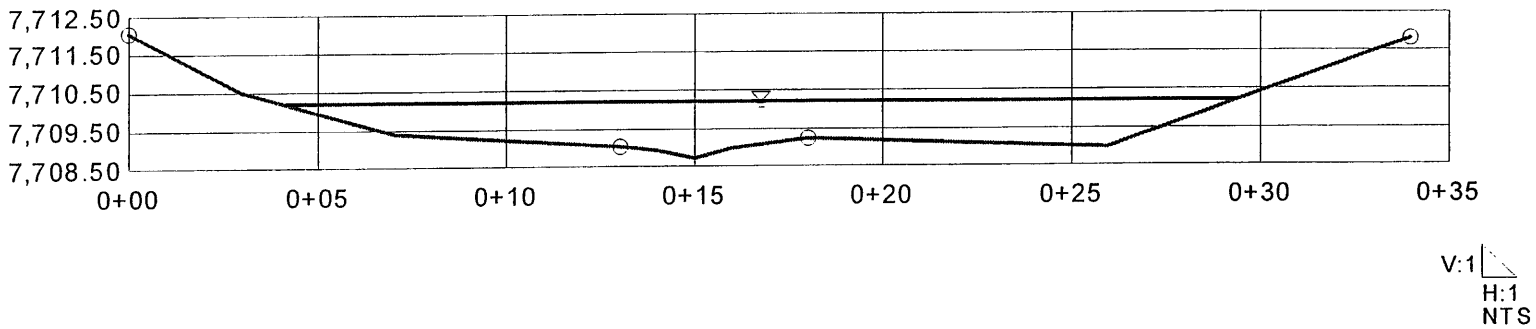


Table
Rating Table for Irregular Channel

Project Description	
Worksheet	RC-5
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data	
Slope	0.051000 ft/ft

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

Attribute	Minimum	Maximum	Increment
Water Surface Elevation (ft)	7,469.46	7,474.00	0.50

Water Surface Elevation (ft)	Discharge (cfs)	Velocity (ft/s)	Flow Area (ft²)	Wetted Perimeter (ft)	Top Width (ft)
7,469.46	N/A	N/A	N/A	N/A	N/A
7,469.96	5.97	3.26	1.8	6.33	6.18
7,470.46	29.44	5.70	5.2	7.72	7.15
7,470.96	66.29	7.39	9.0	9.11	8.11
7,471.46	115.72	8.72	13.3	10.49	9.07
7,471.96	177.82	9.85	18.0	11.88	10.04
7,472.46	252.97	10.85	23.3	13.27	11.00
7,472.96	319.95	11.01	29.1	15.65	12.95
7,473.46	387.92	10.43	37.2	20.00	16.89
7,473.96	523.22	11.40	45.9	21.39	17.86

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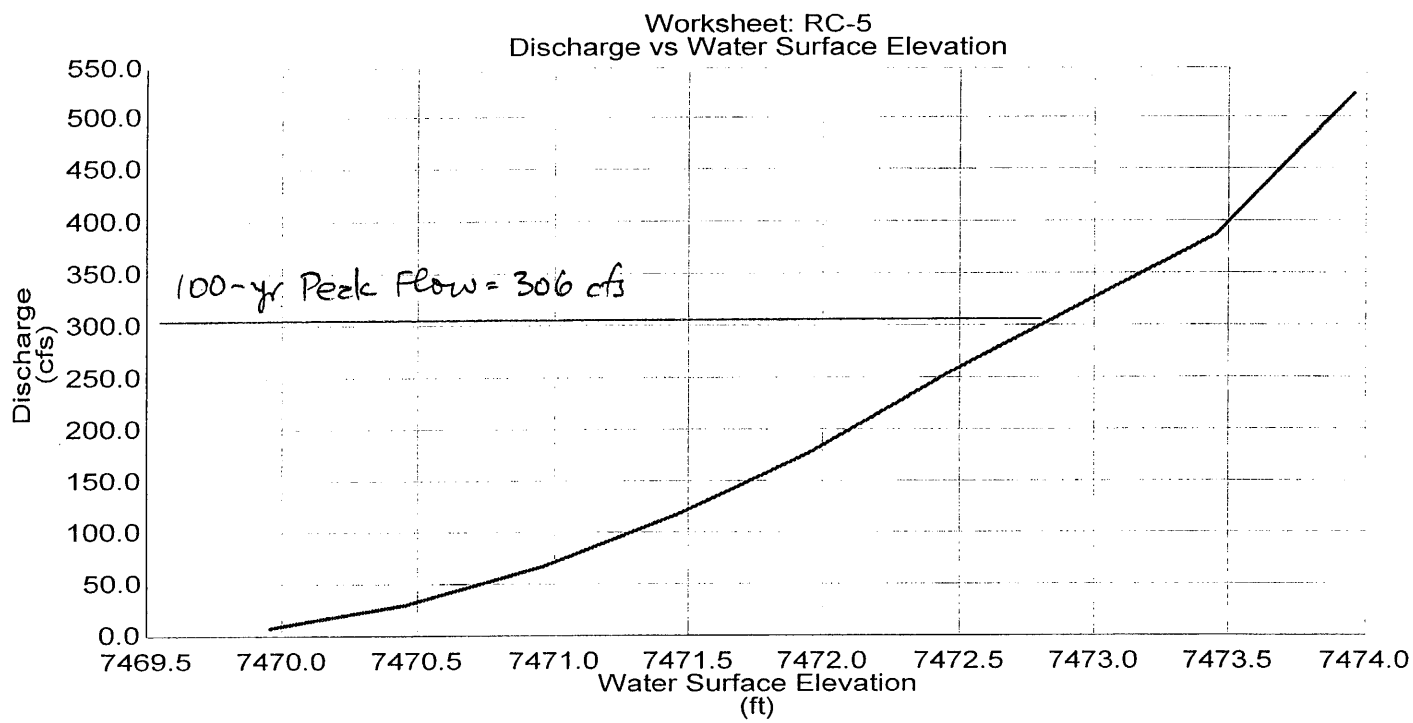
Curve
Plotted Curves for Irregular Channel

Project Description	
Worksheet	RC-5
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

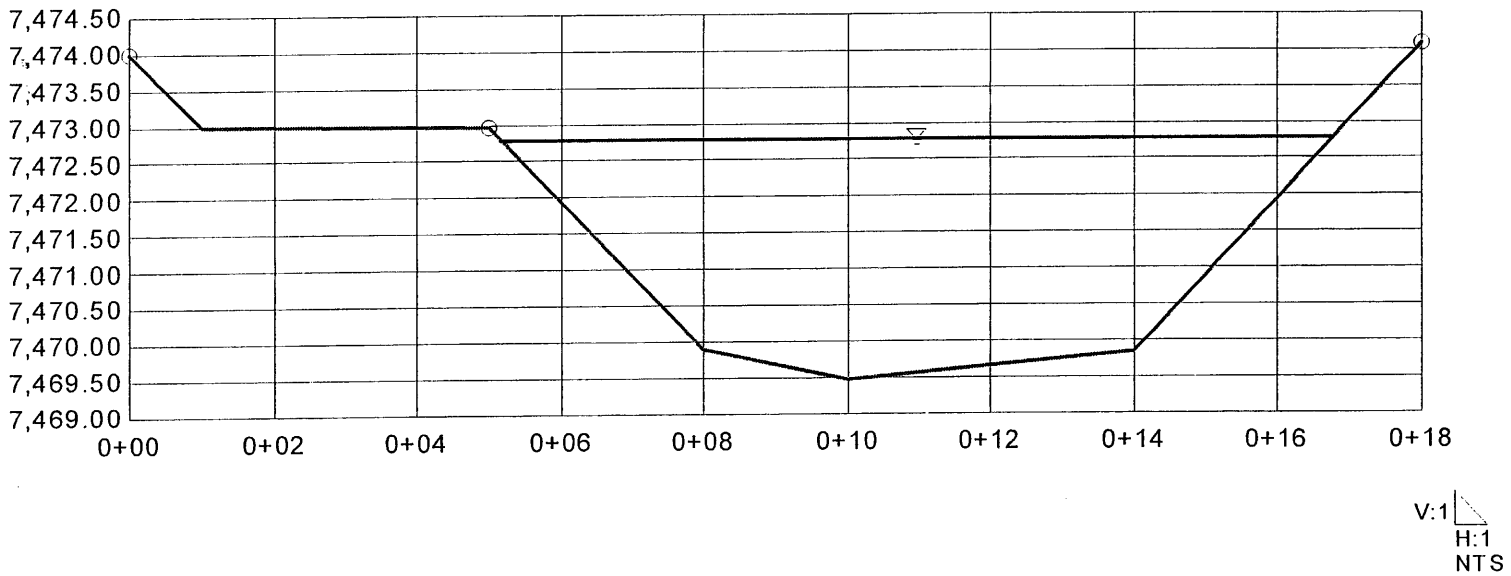
Input Data	
Slope	0.051000 ft/ft

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

Attribute	Minimum	Maximum	Increment
Water Surface Elevation (ft)	7,469.46	7,474.00	0.50



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	RC-5
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficient	0.045	
Slope	0.051000	ft/ft
Water Surface Elevation	7,472.77	ft
Elevation Range	7,469.46 to 7,474.07	
Discharge	306.34	cfs