Facility 441237
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Rule 908.b(7)C Facility Design and Engineering Data

Piceance Energy LLC
Harrison Creek Water Treatment Facility – DAF Unit

OA Project No. 014-0465

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BASIS OF DESIGN

FOR

Laramie Energy II, LLC

Harrison Creek Water Treatment Facility

Project No. 14130-01

Orig./Lead Eng./Prin. Eng.:	Elie Schuchardt	Date	2/16/2015
Project Engineer Approval:	John Kelly	Date	2/20/2015
Project Manager Approval:	Kevin Mahoney	Date	2/20/2015
Client Approval:		Date	

Rev. No.	By	Revisions	Approval	Date
A	EJS	Issued for Client Approval		2/20/2015

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1.0 INTRODUCTION

This document records the basis for all process work on the Laramie Energy II Harrison Creek Water Treatment Facility. It includes pertinent project information, the basis of design, assumptions and the site data for the project.

2.0 PROJECT INFORMATION

- Client: Laramie Energy II, LLC
- Location: Mesa County, CO
- Project: Harrison Creek Water Treatment Facility
- Samuel Engineering Project Number: 14130-01

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3.0 PROCESS INFORMATION

3.1 PROJECT DESCRIPTION

Laramie Energy has contracted Samuel Engineering, Inc. to design a water treatment facility to clean both flowback and produced water inherent to fracking operations. Laramie Energy plans to expand their drilling program throughout the Collbran Valley, bringing dozens of new wells online within the next several years. To accommodate the increased production of produced water and requisite flowback water, a water treatment facility will be constructed to clean both water species, rendering them usable as recycle frac water for completions.

Natural gas wells are to be drilled on various plots of land owned by Laramie Energy in the Collbran Valley, outside of Grand Junction, Colorado. Wells in relatively close proximity to each other are to be routed to a common separation unit and tank battery. A crude separation of oil, water and natural gas occurs within these facilities. The water cut from this separation is then routed to a large centrally located tank farm in Groundhog Valley before being pumped to the Harrison Creek Water Treatment Facility. In addition, water from wells drilled near the water treatment facility will be gravity drained directly to it. Most water is expected to enter the facility via pipeline. However, water may be trucked in if required to ensure adequate storage space is available to support the active frac job. It is estimated that less than 14% of the water influent to the facility will arrive via trucking, and will be most prevalent in the early stages of the drilling program.

The water treatment facility itself utilizes a combination of residence time and chemical treatment to cleanse the water of residual oil and remove both suspended and settleable solids. The oil recovered is to be sold as condensate, while the solids are concentrated and sent to a disposal land farm. Equipment used to facilitate this separation includes: surge tanks, patented HWSB gunbarrel tanks, flow stabilizing tanks, dissolved air floatation (DAF) units and a belt filter press. The treated water exits the facility and is routed to one of three holding ponds, to be designed by others. High capacity pumps move the water from these ponds to support active frac sites.

This facility is to be designed with the capability to easily expand to accommodate increased production as more wells come online. A nominal design flowrate of 15,000 BPD is to be expected for initial operations, which will most likely increase over time to a nominal flowrate of 30,000 BPD. As such, it is imperative that the facility be designed to accommodate additional equipment.

The table below summarizes the major process inlet and outlet streams. This is not an exhaustive list, omitting utilities and minor process flows.

Table 1
Site/Environment Interface

Inlet		Outlet	
Source	**Average Flow Rate**	**Destination**	**Average Flow Rate**
Groundhog Valley Produced/Flowback Water	15,000 BPD	Treated Water to Frac Supply Ponds	15,000 BPD
Harrison Creek Produced/Flowback Water	15,000 BPD	Condensate Sales	20 BPD
Produced/Flowback Water Truck Offload	2,000 BPD	Dry Solids to Land Farm	1950 LB/DAY

3.2 GENERAL CONDITIONS OF SERVICE

Produced and flowback water constitutes the major influent stream to the Harrison Creek Water Treatment Facility. Produced water is that which is native to the formation and is extracted along with the desired oil and natural gas during well production. Flowback water is the result of injecting water downhole at high pressures to facilitate the hydraulic fracturing of the formation during well completions. General properties for the facility inlet/outlet can be found in the table below. It should be noted that Samuel Engineering's scope does not include the transfer of treated water from the holding ponds to the active frac sites. Olsson Associates is responsible for the design of the frac water supply ponds, auxiliary equipment and all necessary fluid drivers to achieve the required flowrates and pressures to support fracking operations. As such, the facility outlet, pursuant to the scope of this project, is the treated water outlet that feeds these frac supply ponds.

Table 2
General Conditions of Service

	Minimum	Normal	Maximum
Facility Inlet—Groundhog Valley Flowback/Produced Water			
Pressure (psig)	0	500	1,000
Temperature (°F)	40	65	80
Flow Rate (BPD)	0	15,000	30,000
Facility Inlet—Harrison Creek Flowback/Produced Water			
Pressure (psig)	0	--	285
Temperature (°F)	40	65	80
Flow Rate (BPD)	0	15,000	30,000
Facility Inlet—Truck Offload Flowback/Produced Water			
Pressure (psig)	0	15	30
Temperature (°F)	40	65	80
Flow Rate (BPD)	0	1,000	2,000
Facility—Treated Water to Frac Supply Ponds			
Pressure (psig)	--	30	50
Temperature (°F)	40	65	80
Flow Rate (BPD)	--	15,000	30,000

It should be noted that, in the absence of direct sampling of each water species, it is assumed that flowback and produced water entering the facility has an identical chemical makeup. The flowrates of hydrocarbons and solids were based on sampling completed by Baker Hughes, ALS Environmental, eAnalytics Laboratory, ChemSolutions, LLC, and Olsson Associates from June 2013 through October 2014. Averages of each constituent measured were used to derive the general conditions of service listed in the following phase-specific information.

Table 3
Inlet Water Properties

	Units	Minimum	Normal	Maximum
pH		6.0	6.7	7.99
Total Alkalinity	mg/L	540	878	1,208
Turbidity	NTU	3	28	53
Iron	mg/L	0.45	54	93
Chlorides	mg/L	7,605	11,667	24,830
Calcium	mg/L	110	216	281
Magnesium	mg/L	18	26	35
Sodium	mg/L	4,400	10,022	16,324
Potassium	mg/L	54	59	64
Barium	mg/L	20	40	54
Zinc	mg/L	0.15	0.21	0.26
Bicarbonate	mg/L	540	625	710
Boron	mg/L	8.1	8.7	9.4
Strontium	mg/L	30.1	30.25	30.4
Aluminum	mg/L	0.62	0.85	1.07
Copper	mg/L	0	0.34	0.67
Manganese	mg/L	0.26	1.06	1.86
Silicon	mg/L	15.2	18.5	21.8
Silica	mg/L	32.3	39.4	46.4
Fluoride	mg/L	--	2.2	--
Specific Conductance	µmhos/cm	21,000	27,733	32,700
Hydrocarbons	mg/L	1.6	319	900
TDS	mg/L	9,600	15,283	25,760
TSS	mg/L	36	154	371
TOC	cfu/mL	177	183	189
COD	mg/L	585	595	604
5 Day BOD	mg/L	249	270	290
SRB	MPN/mL	0	2.8	6
APB	MPN/mL	0	3.5	6

Condensate entrained in the flowback and produced water was not compositionally analyzed. It is assumed that the condensate that accumulates at the Harrison Creek Water Treatment Facility will closely resemble that of the condensate at the Mega Vega Compressor Station, a nearby asset of Laramie Energy. A sample of this condensate was analyzed by Air Pollution Testing, Inc. in October 2014. Values from this analysis can be found in the following table.

Table 4
Condensate Properties

Parameter	Units	Value
Specific Gravity		0.73
API Gravity	°API	63.1
Molecular Weight	lb/lbmol	97.5
Composition		
Carbon Dioxide	Mol%	0.3644

Table 4 Condensate Properties		
Nitrogen (Air)	Mol%	0.0057
Methane	Mol%	2.9351
Ethane	Mol%	1.3824
Propane	Mol%	1.7063
i-Butane	Mol%	0.8598
n-Butane	Mol%	1.5768
i-Pentane	Mol%	1.6476
n-Pentane	Mol%	1.8832
Cyclopentane	Mol%	0.6246
n-Hexane	Mol%	4.1074
Cyclohexane	Mol%	3.5809
Other Hexanes	Mol%	5.2385
Other Heptanes	Mol%	14.9551
Methylcyclohexane	Mol%	14.4097
2,2,4-Trimethylpentane	Mol%	0.9951
Benzene	Mol%	0.7368
Toluene	Mol%	5.5574
Ethylbenzene	Mol%	0.3130
Xylenes	Mol%	4.5298
Other Octanes	Mol%	20.3606
Nonanes	Mol%	9.1049
Decanes Plus	Mol%	3.0249

3.3 PROPOSED OPERATING PHILOSOPHY

Influent water is to arrive at the Harrison Creek Water Treatment Facility in one of two pipelines. The water entering via pipe from Groundhog Valley shall take a pressure cut at the facility inlet prior to being sent to the inlet surge tanks via a backpressure control valve. Water gravity feeding to the facility from surrounding Harrison Creek wells will be sent directly to the surge tanks. A backpressure control valve will be used to prevent separation within the pipeline. Water being trucked in will be offloaded at one of two available truck bays and sent to the surge tanks. These 3,000 barrel tanks are designed to provide a surge buffer for the facility, while allowing adequate residence time to achieve a rough cut of condensate from the influent water, as well as to allow any settleable solids entering the facility to drop out in the sloped tank bottom. Any free oil that separates out is to be collected in density-dependent pontoon skimmers, designed to sink in oil and float on water. The skimmer is mounted on a vertical guide to allow it to move with the level in the tank. Any condensate collected is sent to condensate tanks via a condensate skim pump. Solids that do settle out in the residence time provided are to be periodically removed with a bottoms solids pump. These concentrated solids are then sent to emulsion holding tanks. Water is removed from the surge tanks at a rate of 15,000 BPD and sent to one of two HWSB gunbarrel tanks, patented by High Tech Consultants, Inc. These tanks serve to polish the influent water, providing surface area for any entrained oil to coalesce into larger droplets and separate out of the bulk water. This condensate is routed to condensate tanks for sales. The polished water overflows from the gunbarrel tanks into one of two 750 barrel DAF holding tanks. These tanks allow the water to equilibrate and homogenize prior to chemical treatment. Upon leaving these tanks, the water is treated with a coagulant to neutralize repulsive charges among the suspended solids. The water is then dosed with a polymer solution, which attracts solids particles to its active sites and binds them together into a larger particle, termed flocculant. Immediately after these chemicals are injected, the water enters a DAF unit. This basin contacts the water with a fine whitewater stream of recycle water and dissolved air introduced via nozzles on the basin floor. The micron-sized bubbles ascend, pushing the flocculated solids to the top of the basin. These float solids are skimmed off with a chain and flight skimmer and collected in a hopper. Solids from this hopper are intermittently drained to one of three existing 1,000 barrel DAF emulsion tanks to await further concentration. Clean water exits the DAF unit and is sent to a 1,000 barrel treated water tank, where it is held briefly before being transported to the frac water supply ponds. Solids collected from the surge tanks and DAF unit are comingled in the DAF emulsion tanks. These concentrated solids are again treated with polymer to create a more tightly bound flocculant. This treated stream is finally sent to a belt filter press. The solids are dewatered and conveyed to a disposal box. Filtrate water pressed from the solids is returned to the inlet surge tanks.

3.4 FUTURE EXPANSION

As new wells come online, it is expected that the nominal flowrate of the facility will increase to 30,000 BPD. As such, it is imperative that efforts be made to ensure the seamless expansion from the initial design rate of 15,000 BPD. All piping within the facility shall be designed to pass 30,000 BPD without unnecessary hydraulic restriction. Additionally, blind flanges and block valves shall be installed at various points in the process where supplementary equipment may be installed at a later date to accommodate higher flowrates.

The following is a summary of the equipment necessary to operate the proposed process. Future additions are highlighted in gray. Design Phase I encompasses the immediate design for 15,000 BPD. Design Phase II will bring the facility to 30,000 BPD. Design Phase III will be undertaken if additional capacity is required, at the client's discretion. It is understood that only Design Phases I and II are within the scope of this project, and as such, accommodations shall be made to ensure the additional required equipment can be easily added. Design Phase III is beyond the scope of this project. It should be noted that this is a preliminary list of required equipment. It is subject to change as detailed project design continues.

Table 5
Process Equipment

Equipment	Tag No.	Size	Capacity	Design Phase
Separation Equipment				
Surge Tank #1	T-110	30'-0" DIA X 24'-0" H	3,000 BBL	I
Surge Tank #2	T-115	30'-0" DIA X 24'-0" H	3,000 BBL	I
Surge Tank #3	T-120	30'-0" DIA X 24'-0" H	3,000 BBL	III
HWSB Gunbarrel #1	T-200	15'-6" DIA X 24'-0" H	750 BBL	I
HWSB Gunbarrel #2	T-205	15'-6" DIA X 24'-0" H	750 BBL	I
HWSB Gunbarrel #3	T-210	15'-6" DIA X 24'-0" H	750 BBL	II
DAF Unit #1	D-400	9'-6" H X 48'-0" L X 8'-0" W	15,000 BPD	I
DAF Unit #2	D-450	9'-6" H X 48'-0" L X 8'-0" W	15,000 BPD	II
DAF Unit #3	D-500	9'-6" H X 48'-0" L X 8'-0" W	15,000 BPD	III
DAF Unit #4	D-550	9'-6" H X 48'-0" L X 8'-0" W	15,000 BPD	III
Filter Press	FP-600	Twin Wire	50 GPM	I
VCU Knockout Vessel	V-700			I

Table 5
Process Equipment

Material Transfer				
Condensate Skim Pump	P-130	Air Operated	15 GPM @ 20 PSIG	I
Surge Tank Emulsion Pump	P-140	5 HP	50 GPM @ 30 PSIG	I
Gunbarrel Feed Pump #1	P-155	15 HP	450 GPM @ 30 PSIG	I
Gunbarrel Feed Pump #2	P-160	15 HP	450 GPM @ 30 PSIG	I
Gunbarrel Feed Pump #3	P-165	15 HP	450 GPM @ 30 PSIG	II
Gunbarrel Emulsion Pump	P-215	5 HP	50 GPM @ 30 PSIG	I
DAF Feed Pump #1	P-260	15 HP	450 GPM @ 30 PSIG	I
DAF Feed Pump #2	P-265	15 HP	450 GPM @ 30 PSIG	I
DAF Feed Pump #3	P-270	15 HP	450 GPM @ 30 PSIG	II
Emulsion Makedown Water Pump	P-305	0.25 HP	1 GPM @ 50 PSIG	I
Filter Press Makedown Water Pump	P-310	0.5 HP	10 GPM @ 50 PSIG	I
DAF Makedown Water Pump #1	P-315	0.5 HP	8 GPM @ 50 PSIG	I
DAF Makedown Water Pump #2	P-316	0.5 HP	8 GPM @ 50 PSIG	III
Emulsion Polymer Pump	P-320	0.25 HP	0.003 GPM @ 50 PSIG	I
Filter Press Polymer Pump	P-330	0.25 HP	0.03 GPM @ 50 PSIG	I
DAF Polymer Pump #1	P-340	0.25 HP	0.02 GPM @ 50 PSIG	I
DAF Polymer Pump #2	P-350	0.25 HP	0.02 GPM @ 50 PSIG	II
DAF Polymer Pump #3	P-360	0.25 HP	0.02 GPM @ 50 PSIG	III
DAF Polymer Pump #4	P-370	0.25 HP	0.02 GPM @ 50 PSIG	III
Coagulant Pump	P-395	0.25 HP	0.09 GPM @ 50 PSIG	I
DAF Recycle Pump #1	P-410	30 HP	150 GPM @ 90 PSIG	I
Bottom Emulsion Pump #1	P-420	Air Operated	15 GPM @ 30 PSIG	I
Float Emulsion Pump #1	P-430	Air Operated	15 GPM @ 30 PSIG	I
Treated Water Pump #1	P-435	15 HP	450 GPM @ 30 PSIG	I
Treated Water Pump #2	P-440	15 HP	450 GPM @ 30 PSIG	I
Treated Water Pump #3	P-445	15 HP	450 GPM @ 30 PSIG	II
DAF Recycle Pump #2	P-460	30 HP	150 GPM @ 90 PSIG	II
Bottom Emulsion Pump #2	P-470	Air Operated	15 GPM @ 30 PSIG	II
Float Emulsion Pump #2	P-480	Air Operated	15 GPM @ 30 PSIG	II
DAF Recycle Pump #3	P-510	30 HP	150 GPM @ 90 PSIG	III
Bottom Emulsion Pump #3	P-520	Air Operated	15 GPM @ 30 PSIG	III
Float Emulsion Pump #3	P-530	Air Operated	15 GPM @ 30 PSIG	III
Treated Water Pump #4	P-535	15 HP	450 GPM @ 30 PSIG	III
Treated Water Pump #5	P-540	15 HP	450 GPM @ 30 PSIG	III
Treated Water Pump #6	P-545	15 HP	450 GPM @ 30 PSIG	III
DAF Recycle Pump #4	P-560	30 HP	150 GPM @ 90 PSIG	III
Bottom Emulsion Pump #4	P-570	Air Operated	15 GPM @ 30 PSIG	III
Float Emulsion Pump #4	P-580	Air Operated	15 GPM @ 30 PSIG	III
Frac Supply Pond Feed Pump #1	P-900	15 HP	450 GPM @ 50 PSIG	I
Frac Supply Pond Feed Pump #2	P-905	15 HP	450 GPM @ 50 PSIG	I
Frac Supply Pond Feed Pump #3	P-910	15 HP	450 GPM @ 50 PSIG	II
Treated Water Makeup Pump	P-915	2 HP	50 GPM 20 PSIG	I
Filter Press Feed Pump	P-950	2 HP	50 GPM @ 20 PSIG	I
Filter Press Discharge Pump	P-605	5 HP	50 GPM @ 30 PSIG	I
VCU Knockout Liquids Pump	P-705	Air Operated	15 GPM @ 20 PSIG	I

Table 5
Process Equipment

Filter Cake Conveyor	B-610	15 HP		I
Storage Units				
Condensate Skim Tank	T-125	Oversized Pipe		I
Condensate Tank #1	T-180	12’-0” DIA x 20’-0”H	400 BBL	I
Condensate Tank #2	T-185	12’-0” DIA x 20’-0”H	400 BBL	I
DAF Holding Tank #1	T-240	15-6” DIA x 24’-0”H	750 BBL	I
DAF Holding Tank #2	T-245	15-6” DIA x 24’-0”H	750 BBL	I
DAF Holding Tank #3	T-250	15-6” DIA x 24’-0”H	750 BBL	III
DAF Holding Tank #4	T-255	15-6” DIA x 24’-0”H	750 BBL	III
Makedown Water Tank	T-300	12’-0” DIA x 20’-0”H	400 BBL	I
Coagulant Tank	T-390	8’-0” DIA x 10’-0”H	90 BBL	I
DAF Emulsion Tank #1	T-922	15’-6” DIA x 30’-6”H	1,000 BBL	Existing
DAF Emulsion Tank #2	T-931	15’-6” DIA x 32’-0”H	1,000 BBL	Existing
DAF Emulsion Tank #3	T-932	15’-6” DIA x 32’-0”H	1,000 BBL	Existing
DAF Emulsion Tank #4	T-933	15’-6” DIA x 32-0”H	1,000 BBL	III
DAF Emulsion Tank #5	T-934	15’-6” DIA x 32’-0”H	1,000 BBL	III
Field Emulsion Tank #1	T-940	12’-0” DIA x 20’-0”H	400 BBL	III
Field Emulsion Tank #2	T-941	12’-0” DIA x 20’-0”H	400 BBL	III
Treated Water Tank (Existing)	T-921	15’-6” DIA x 30’-6”H	1,000 BBL	Existing
Fluid Mixers				
Emulsion Polymer Makedown Mixer	U-325			I
Filter Press Polymer Makedown Mixer	U-335			I
DAF Polymer Makedown Mixer #1	U-345			I
DAF Polymer Makedown Mixer #2	U-355			II
DAF Polymer Makedown Mixer #3	U-365			III
DAF Polymer Makedown Mixer #4	U-375			III
DAF Emulsion Tank #2 Agitator	TA-931			Existing
DAF Emulsion Tank #3 Agitator	TA-932			Existing
DAF Emulsion Tank #4 Agitator	TA-933			III
DAF Emulsion Tank #5 Agitator	TA-934			III
Heat Transfer				
Surge Tank #1 Heater A	H-110	7 KW		I
Surge Tank #1 Heater B	H-111	7 KW		I
Surge Tank #2 Heater A	H-115	7 KW		I
Surge Tank #2 Heater B	H-116	7 KW		I
Surge Tank #3 Heater A	H-120	7 KW		III
Surge Tank #3 Heater B	H-121	7 KW		III
Condensate Tank #1 Heater	H-180	2 KW		I
Condensate Tank #2 Heater	H-185	2 KW		I
HWSB Gunbarrel Heater #1	H-200	7 KW		I
HWSB Gunbarrel Heater #2	H-205	7 KW		I
HWSB Gunbarrel Heater #3	H-210	7 KW		II
DAF Holding Tank #1 Heater	H-240	7 KW		I
DAF Holding Tank #2 Heater	H-245	7 KW		I

Table 5 Process Equipment				
DAF Holding Tank #3 Heater	H-250	7 KW		III
DAF Holding Tank #4 Heater	H-255	7 KW		III
Makedown Water Tank Heater	H-300	4 KW		I
Emulsion Tank #1 Heater	H-922	7 KW		I
Emulsion Tank #2 Heater	H-931	7 KW		I
Emulsion Tank #3 Heater	H-932	7 KW		I
Emulsion Tank #4 Heater	H-933			III
Emulsion Tank #5 Heater	H-934			III
Field Emulsion Tank #1 Heater	H-940			III
Field Emulsion Tank #2 Heater	H-941			III
Treated Water Tank Heater	H-921	7 KW		I
Destruction Units				
Vapor Combustion Unit	X-710		400 MSCFD	I

4.0 SITE DATA

The following tables outline the site conditions and utilities that are or will be available at the Harrison Creek Water Treatment Facility.

Table 6 Civil/Structural	
Elevation	7,456
Atmospheric Pressure	11.16
Ambient Temperature Range	-20°F / 120°F
Frost Depth	36”
Seismic Data	S_{DS}=0.287g, S_{D1}=0.085g, I_e=1.0
Snow Load	70 psf (ground snow), I_s=1.0
Wind	90 mph, Exposure C, I_w=1.0

Table 7 Available Utilities
Electrical
460V / 3 Phase / 60 Hz
Instrument Air
110 SCFM @ 175 PSIG
Fuel Gas
XXX psig

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CAD File: S:\Projects\14130-Laramie_Energy_Wastewater_Plant\CAD\PlantDesign\Drawings\Process Flow Diagrams\0000-PF-100.dwg
Plot Date: Tuesday, March 03, 2015 1:08:55 PM Plotted By: Ken Seals
CTB Used: SE_Std_Color_Full_Size.ctb

REFERENCE DRAWINGS

DWG NO.	DESCRIPTION

REVISIONS

CLIENT	PROJECT MANAGER	PROJECT ENGINEER	CHECK	NO.	DESCRIPTION	DATE	BY
	KM	JMK	EJS	G	ISSUED FOR PERMIT ONLY	03/03/15	KLS
	KM	JMK	EJS	F	REISSUED FOR CLIENT APPROVAL	02/18/15	KLS
	KM	JMK	EJS	E	REISSUED FOR CLIENT APPROVAL	01/29/15	KLS
				D	ISSUED FOR CLIENT APPROVAL	01/22/15	KLS
				C	ISSUED FOR AIR PERMIT	01/19/15	KLS
				B	REISSUED FOR CLIENT REVIEW	01/08/15	KLS
				A	ISSUED FOR CLIENT REVIEW	12/18/14	KLS

		DATE
SCALE:	N.T.S.	
DESIGNED:	E. SCHUCHARDT	12/05/14
DRAWN:	K. SEALS	12/05/14
CHECKED:		
APPROVED:		
APPROVED:		

CLIENT: PICEANCE ENERGY II, LLC

LOCATION: MESA COUNTY

Samuel Engineering
We Provide Solutions
8450 E. Crescent Parkway, Suite 200
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TITLE
HARRISON CREEK
WATER TREATMENT FACILITY
CONCEPTUAL PROCESS FLOW DIAGRAM

PROJECT NO. 14130

DRAWING NUMBER 0000-PF-100

REV. G

PROCESS CONDITIONS

Stream	#	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115
Temperature	°F	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Pressure	PSIG	500	500	20	0	0	0	0	8.3	8.3	8.3	8.3	8.3	30	30	30
Vapor Fraction	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate	gpm/scfm	437.5	437.5	300	437.5	437.5	437.5	437.5	437.5	437.5	437.5	437.5	437.5	437.5	437.5	437.5
Molecular Weight	lb/lbmol	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02
Density	lb/ft^3	62.36	62.36	62.36	62.32	62.32	62.32	62.32	62.32	62.32	62.32	62.32	62.32	62.32	62.32	62.32
Viscosity	cP	1.07	1.07	1.06	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
Solids Content	%	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Notes	#	1,4	1,4	1,4	4	4	1,4	1,4	1,4	1,4	4	4	1,4	4	1,4	4

Stream	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130
Temperature	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Pressure	5.96	5.96	5.96	5.96	20	6.77	6.77	6.77	5.02	5.02	5.02	8.3	8.3	8.3	30
Vapor Fraction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate	15	15	15	15	15	15.02	15.02	15.02	300	300	300	50	50	50	50
Molecular Weight	104.04	104.04	104.04	104.04	104.04	103.96	103.96	103.96	103.96	103.96	103.96	18.02	18.02	18.02	18.02
Density	44.73	44.73	44.73	44.73	44.74	44.73	44.73	44.73	44.73	44.73	44.73	68.87	68.87	68.87	68.87
Viscosity	0.53	0.53	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.52	1.04	1.04	1.04	1.04
Solids Content	0	0	0	0	0	0	0	0	0	0	0	7	7	7	7
Notes	1	1	1	1	1	1	1	1	1	1	1	1,4	1,4	1,4	1,4

Stream	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146
Temperature	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Pressure	9.34	9.34	9.34	0	0	0	0	0	0	0	0	0	0	0	0	20
Vapor Fraction	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
Flow Rate	437.5	437.5	437.5	437.5	437.5	78	78	97	109	5	5	8	117	117	15	15
Molecular Weight	18.02	18.02	18.02	18.02	18.02	30.10	30.10	30.10	30.25	31.62	31.62	31.62	30.34	30.34	51.74	51.74
Density	62.32	62.32	62.32	62.32	62.32	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	47.84	47.85
Viscosity	1.04	1.04	1.04	1.04	1.04	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.59	0.59
Solids Content	0.02	0.02	0.02	0.02	0.02	0	0	0	0	0	0	0	0	0	0	0
Notes	1,4	1,4	1,4	1,4	1,4										1	1

NOTES:
1. INTERMITTENT FLOW.
2. CHEMICALLY TREATED.
3. BY OTHERS.
4. VISCOSITY NOT ADJUSTED FOR SOLIDS.
5. MISSING INFORMATION NOT AVAILABLE.

DWG NO. | DESCRIPTION — REFERENCE DRAWINGS

NO. | DESCRIPTION | DATE | BY — REVISIONS

NO.	DESCRIPTION	DATE	BY	CLIENT	PROJECT MANAGER	PROJECT ENGINEER	CHECK
A	ISSUED FOR CLIENT APPROVAL	02/10/15	KLS	KM	JMK	JM	

REVISIONS

SCALE: N.T.S. — DATE
DESIGNED: E. SCHUCHARDT — 12/18/14
DRAWN: K. SEALS — 12/18/14
CHECKED:
APPROVED:
APPROVED:

CLIENT: PICEANCE ENERGY II, LLC
LOCATION: MESA COUNTY

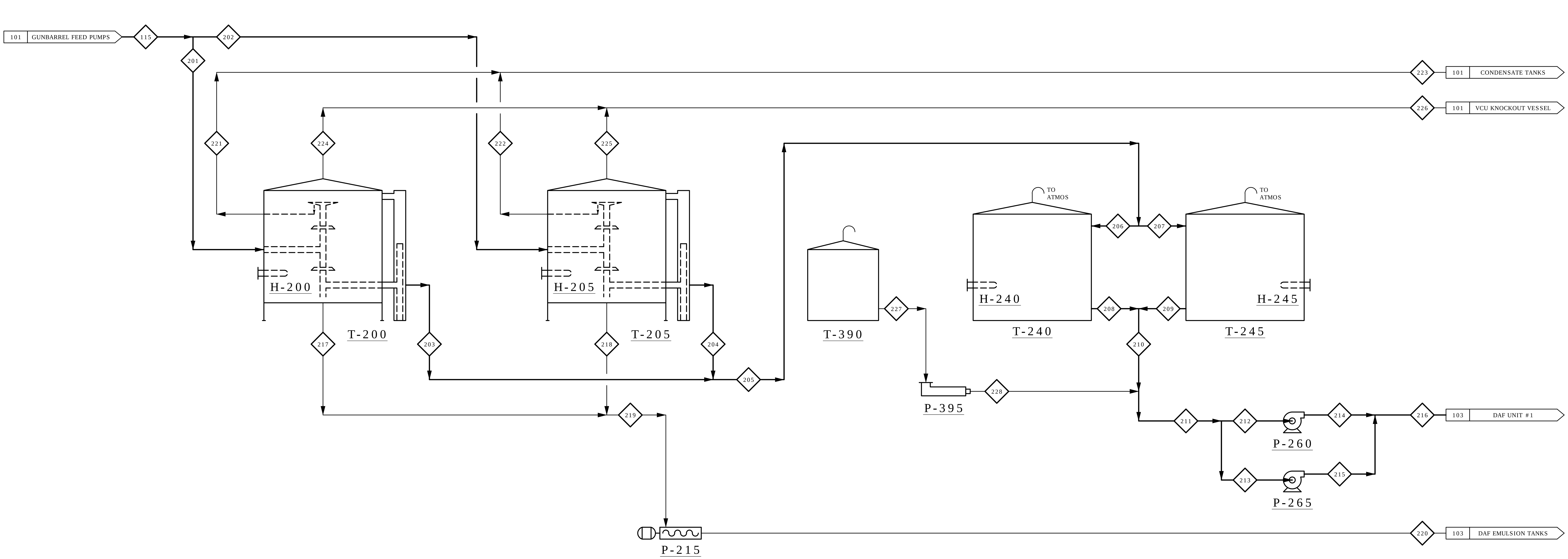
Samuel Engineering
We Provide Solutions
8450 E. Crescent Parkway, Suite 200
Greenwood Village, CO 80111
Phone: 303.714.4840
Fax: 303.714.4800

TITLE
HARRISON CREEK
WATER TREATMENT FACILITY
PROCESS FLOW DIAGRAM
SHEET 1

PROJECT NO. 14130
DRAWING NUMBER 0000-PF-101
REV. A

CAD File: S:\Projects\14130-Laramie_Energy_Wastewater_Plant\CAD\PlantDesign\Design\Drawings\Process Flow Diagrams\0000-PF-101.dwg
Plot Date: Tuesday, February 10, 2015 2:36:22 PM Plotted By: Ken Seals
CTB Used: SE_Std_B&W_Full_Size.ctb

T-200, 205	H-200, 205	P-215	T-390	P-395	T-240, 245	H-240, 245	P-260, 265
HWSB GUNBARRELS 750 BBL	GUNBARREL TANK HEATERS 7 kW	GUNBARREL EMULSION PUMP 50 GPM	COAGULANT TANK 3000 GAL	COAGULANT PUMP 0.9 GPM	DAF HOLDING TANKS 750 BBL	DAF HOLDING TANK HEATERS 7 kW	DAF FEED PUMPS 450 GPM



PROCESS CONDITIONS

Stream	#	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228
Temperature	°F	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Pressure	PSIG	30	30	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	30	30	30	8.3	8.3	8.3	30	6.77	6.77	6.77	0	0	0	2.68	50
Vapor Fraction	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00
Flow Rate	gpm/scfm	437.5	437.5	437.5	437.5	437.5	437.5	437.5	437.5	437.5	437.5	437.6	437.6	437.6	437.6	437.6	437.6	50	50	50	50	0.02	0.02	0.02	6	6	12	0.0875	0.0875
Molecular Weight	lb/lbmol	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	88.19	88.19	88.19	31.46	31.46	31.46	--	--
Density	lb/ft^3	62.32	62.32	62.32	62.32	62.32	62.32	62.32	62.32	62.32	62.32	62.32	62.32	62.32	62.32	62.32	62.32	68.87	68.87	68.87	68.87	50.80	50.80	50.80	0.06	0.06	0.06	83.30	83.30
Viscosity	cP	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	0.53	0.53	0.53	0.01	0.01	0.01	--	--
Solids Content	%	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	7	7	7	7	0	0	0	0	0	0	0	0
Notes	#	1,4	1,4	1,4	1,4	4	1,4	1,4	1,4	1,4	4	2,4	2,4	1,2,4	2,4	1,2,4	2,4	1,4	1,4	1,4	1,4							5	5

NOTES:

1. INTERMITTENT FLOW.
2. CHEMICALLY TREATED.
3. BY OTHERS.
4. VISCOSITY NOT ADJUSTED FOR SOLIDS.
5. MISSING INFORMATION NOT AVAILABLE.

REFERENCE DRAWINGS: DWG NO. | DESCRIPTION

REVISIONS: NO. | DESCRIPTION | DATE | BY

NO.	DESCRIPTION	DATE	BY	CLIENT	PROJECT MANAGER	PROJECT ENGINEER	CHECK
A	ISSUED FOR CLIENT APPROVAL	02/10/15	KLS	KM	JMK	JM	

REVISIONS

		DATE
SCALE:	N.T.S.	
DESIGNED:	E. SCHUCHARDT	12/18/14
DRAWN:	K. SEALS	12/18/14
CHECKED:		
APPROVED:		
APPROVED:		

CLIENT: PICEANCE ENERGY II, LLC

LOCATION: MESA COUNTY

Samuel Engineering
We Provide Solutions
8450 E. Crescent Parkway, Suite 200
Greenwood Village, CO 80111
Phone: 303.714.4840
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TITLE

HARRISON CREEK
WATER TREATMENT FACILITY
PROCESS FLOW DIAGRAM
SHEET 2

PROJECT NO. 14130

DRAWING NUMBER 0000-PF-102

REV. A

CAD File: S:\Projects\14130-Laramie_Energy_Wastewater_Plant\CAD\PlantDesign\Drawings\Process Flow Diagrams\0000-PF-102.dwg
Plot Date: Tuesday, February 10, 2015 2:43:07 PM Plotted By: Ken Seals
CTB Used: SE_Std_B&W_Full_Size.ctb

T-300 MAKEDOWN WATER TANK 400 BBL
H-300 MAKEDOWN WATER TANK HEATER 4 kW
P-305 EMULSION MAKEDOWN WATER PUMP 1 GPM
P-310 FILTER PRESS MAKEDOWN WATER PUMP 10 GPM
P-315 DAF MAKEDOWN WATER PUMP 8 GPM
P-320 EMULSION POLYMER PUMP 0.003 GPM
P-330 FILTER PRESS POLYMER PUMP 0.03 GPM
P-340 DAF POLYMER PUMP #1 0.02 GPM
U-325 EMULSION POLYMER MAKEDOWN MIXER
U-335 FILTER PRESS POLYMER MAKEDOWN MIXER
U-345 DAF POLYMER MAKEDOWN MIXER #1
D-400 DAF UNIT #1 450 GPM
P-410 DAF RECYCLE PUMP #1 150 GPM
P-430 FLOAT EMULSION PUMP #1 15 GPM
P-435, 440 TREATED WATER PUMPS 450 GPM
P-420 BOTTOM EMULSION PUMP #1 15 GPM
P-915 TREATED WATER MAKE UP PUMP 50 GPM
T-921 TREATED WATER TANK (EXISTING) 1000 BBL
H-921 TREATED WATER TANK HEATER 7 kW
P-900, 905 FRAC SUPPLY POND FEED PUMP 450 GPM

PROCESS CONDITIONS

Stream	#	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319
Temperature	°F	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	120	66	66
Pressure	PSIG	20	6.92	6.92	6.92	6.92	50	50	50	50	50	50	50	50	50	30	4.12	150	4.12	90
Vapor Fraction	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
Flow Rate	gpm/scfm	300	14.65	1	10	3.65	1	10	3.65	0.003	0.03	0.01	1.003	10.03	3.657	442	150	6	150	150
Molecular Weight	lb/lbmol	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	28.85	18.02	18.02
Density	lb/ft^3	62.32	62.32	62.32	62.32	62.32	62.32	62.32	62.32	66.89	66.89	66.89	62.32	62.32	62.32	62.32	62.31	0.75	62.31	62.31
Viscosity	cP	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	--	--	--	1.06	1.06	1.06	1.04	1.04	0.02	1.04	1.04
Solids Content	%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02	0	0	0	0
Notes	#	1		1	1		1	1		1,4	1,4	4	1	1		2,3				

Stream	#	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339
Temperature	°F	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Pressure	PSIG	4.12	30	4.12	30	4.12	4.12	4.12	30	30	30	30	10.55	10.55	10.55	50	50	50	10.55	20	50
Vapor Fraction	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate	gpm/scfm	15	15	15	15	437.5	437.5	437.5	437.5	437.5	437.5	15	437.5	437.5	437.5	437.5	437.5	437.5	50	50	300
Molecular Weight	lb/lbmol	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02
Density	lb/ft^3	66.99	66.99	66.99	66.99	62.31	62.31	62.31	62.31	62.31	62.31	66.99	62.31	62.31	62.31	62.31	62.31	62.31	62.31	62.31	62.31
Viscosity	cP	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
Solids Content	%	5	5	5	5	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
Notes	#	1,2,3	1,2,3	1,2,3	1,2,3			1		1		1,2,3			1		1		1	1	1

NOTES:
1. INTERMITTENT FLOW.
2. CHEMICALLY TREATED.
3. VISCOSITY NOT ADJUSTED FOR SOLIDS.
4. MISSING INFORMATION NOT AVAILABLE.

REFERENCE DRAWINGS (DWG NO. / DESCRIPTION)

REVISIONS

CLIENT	PROJECT MANAGER	PROJECT ENGINEER	CHECK	NO.	DESCRIPTION	DATE	BY
KM	JMK	EJS	B	REISSUED FOR CLIENT APPROVAL	02/18/15	KLS
KM	JMK	JM	A	ISSUED FOR CLIENT APPROVAL	02/10/15	KLS

SCALE: N.T.S. DATE
DESIGNED: E. SCHUCHARDT 01/05/15
DRAWN: K. SEALS 01/05/15
CHECKED:
APPROVED:
APPROVED:

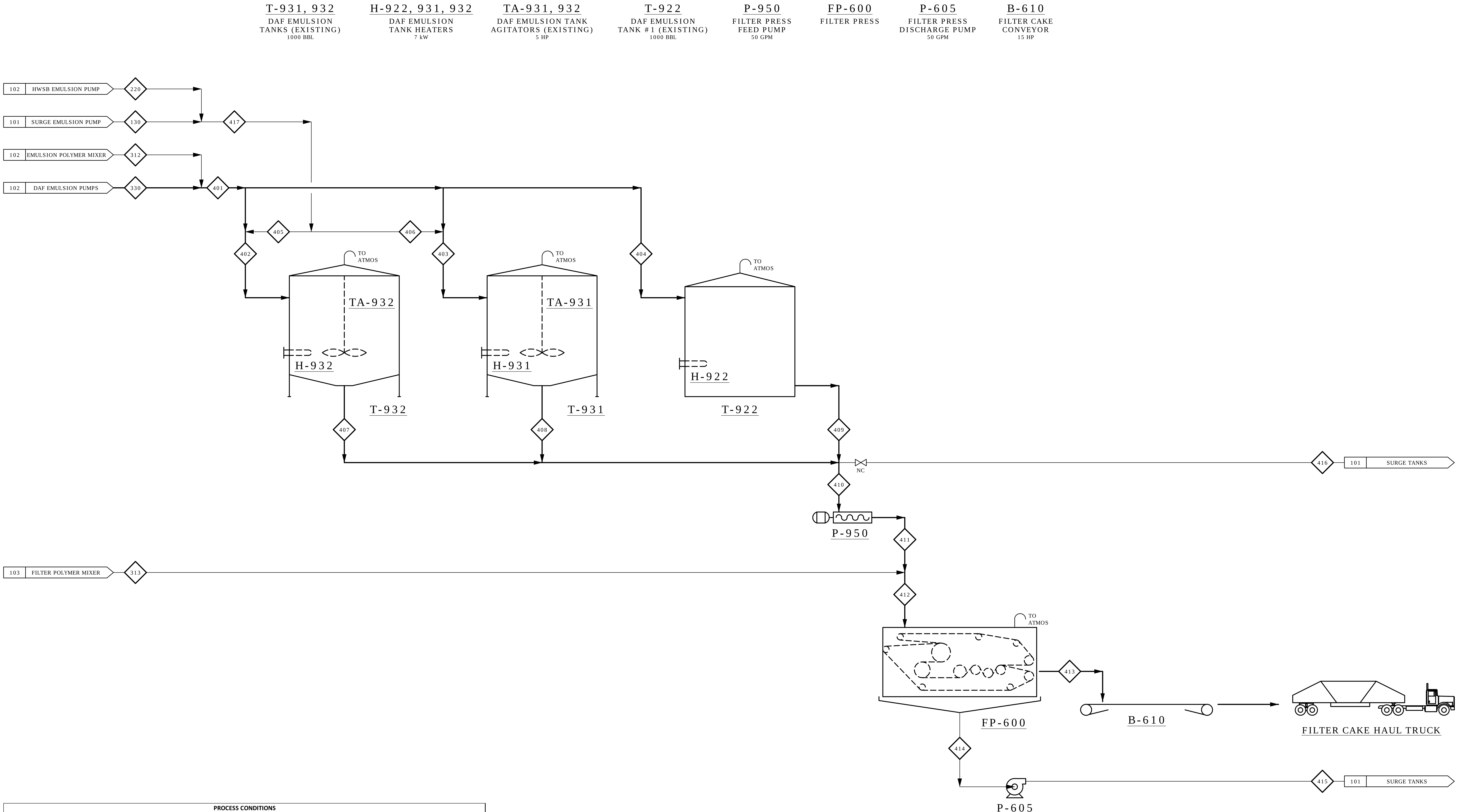
CLIENT: PICEANCE ENERGY II, LLC
LOCATION: MESA COUNTY

Samuel Engineering
We Provide Solutions
8450 E. Crescent Parkway, Suite 200 Greenwood Village, CO 80111
Phone: 303.714.4840 Fax: 303.714.4800

TITLE
HARRISON CREEK
WATER TREATMENT FACILITY
PROCESS FLOW DIAGRAM
SHEET 3

PROJECT NO. 14130
DRAWING NUMBER 0000-PF-103
REV. B

CAD File: S:\Projects\14130-Laramie_Energy_Wastewater_Plant\CAD\PlantDesign\Drawings\Process Flow Diagrams\0000-PF-103.dwg
Plot Date: Wednesday, February 18, 2015 1:17:14 PM Plotted By: Ken Seals
CTB Used: SE_Std_B&W_Full_Size.ctb



PROCESS CONDITIONS																		
Stream	#	**401**	**402**	**403**	**404**	**405**	**406**	**407**	**408**	**409**	**410**	**411**	**412**	**413**	**414**	**415**	**416**	**417**
Temperature	°F	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Pressure	PSIG	30	30	30	30	30	30	11.07	11.07	11.07	11.07	20	20	0	0	30	11.07	30
Vapor Fraction	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate	gpm/scfm	16	16	16	16	50	50	50	50	50	50	50	60.03	12.5	50	50	50	50
Molecular Weight	lb/lbmol	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	--	18.02	18.02	18.02	18.02
Density	lb/ft^3	66.99	66.99	66.99	66.99	68.87	68.87	66.99	66.99	66.99	66.99	66.99	66.99	81.05	62.31	62.31	66.99	68.87
Viscosity	cP	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	--	1.04	1.04	1.04	1.04
Solids Content	%	5	5	5	5	7	7	5	5	5	5	5	5	20	0	0	5	7
Notes	#	1,2,4	1,2,4	1,2,4	1,2,4	1,4	1,4	1,2,4	1,2,4	1,2,4	1,2,4	1,2,4	1,2,4	1,2,5	1	1	1,4	1,4

NOTES:

1. INTERMITTENT FLOW.
2. CHEMICALLY TREATED.
3. BY OTHERS.
4. VISCOSITY NOT ADJUSTED FOR SOLIDS.
5. MISSING INFORMATION NOT AVAILABLE.

DWG NO.	DESCRIPTION
REFERENCE DRAWINGS	

CLIENT	PROJECT MANAGER	PROJECT ENGINEER	CHECK	NO.	DESCRIPTION	DATE	BY
KM	JMK	JM		A	ISSUED FOR CLIENT APPROVAL	02/10/15	KLS

REVISIONS

SCALE:	N.T.S.	DATE
DESIGNED:	E. SCHUCHARDT	01/07/15
DRAWN:	K. SEALS	01/07/15
CHECKED:		
APPROVED:		
APPROVED:		

CLIENT: PICEANCE ENERGY II, LLC

LOCATION: MESA COUNTY

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8450 E. Crescent Parkway, Suite 200
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Phone: 303.714.4840
Fax: 303.714.4800

TITLE

HARRISON CREEK
WATER TREATMENT FACILITY
PROCESS FLOW DIAGRAM
SHEET 4

PROJECT NO. 14130

DRAWING NUMBER 0000-PF-104

REV. A

CAD File: S:\Projects\14130-Laramie_Energy_Wastewater_Plant\CAD\PlantDesign\Drawings\Process Flow Diagrams\0000-PF-104.dwg
Plot Date: Tuesday, February 10, 2015 2:47:20 PM Plotted By: Ken Seals
CTB Used: SE_Std_B&W_Full_Size.ctb

PROCESS CONDITIONS																				
Stream	*#*	**501**	**502**	**503**	**504**	**505**	**506**	**507**	**508**	**509**	**510**	**511**	**512**	**513**	**514**	**515**	**516**	**517**	**518**	**519**
Temperature	*°F*	65	68	65	68	65	68	68	67	67	67	--	65	68	--	--	--	--	--	--
Pressure	*PSIG*	0	1000	0	1000	0	1000	1000	50	50	50	--	0	1000	--	--	--	--	--	--
Vapor Fraction	*%*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--	0.00	0.00	--	--	--	--	--	--
Flow Rate	*gpm/scfm*	1470	1470	1470	1470	1470	1470	1470	437.5	437.5	437.5	--	1470	1470	--	--	--	--	--	--
Molecular Weight	*lb/lbmol*	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	18.02	--	18.02	18.02	--	--	--	--	--	--
Density	*lb/ft^3*	62.31	62.35	62.31	62.35	62.31	62.35	62.35	62.31	62.31	62.31	--	62.31	62.35	--	--	--	--	--	--
Viscosity	*cP*	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	--	1.04	1.04	--	--	--	--	--	--
Solids Content	*%*	0	0	0	0	0	0	0	0	0	0	--	0	0	--	--	--	--	--	--
Notes	*#*	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1	1	1	1,3	1	1	1,3	1,3	3	3	1,3	1,3

NOTES:

1. INTERMITTENT FLOW.
2. CHEMICALLY TREATED.
3. BY OTHERS.
4. VISCOSITY NOT ADJUSTED FOR SOLIDS.
5. MISSING INFORMATION NOT AVAILABLE.

DWG NO.	DESCRIPTION
REFERENCE DRAWINGS	

CLIENT	PROJECT MANAGER	PROJECT ENGINEER	CHECK	NO.	DESCRIPTION	DATE	BY
KM	JMK	JM		A	ISSUED FOR CLIENT APPROVAL	02/10/15	KLS

REVISIONS

SCALE:	N.T.S.	DATE
DESIGNED:	E. SCHUCHARDT	01/09/15
DRAWN:	K. SEALS	01/09/15
CHECKED:		
APPROVED:		
APPROVED:		

CLIENT: PICEANCE ENERGY II, LLC

LOCATION: MESA COUNTY

Samuel Engineering
We Provide Solutions
8450 E. Crescent Parkway, Suite 200
Greenwood Village, CO 80111
Phone: 303.714.4840
Fax: 303.714.4800

TITLE

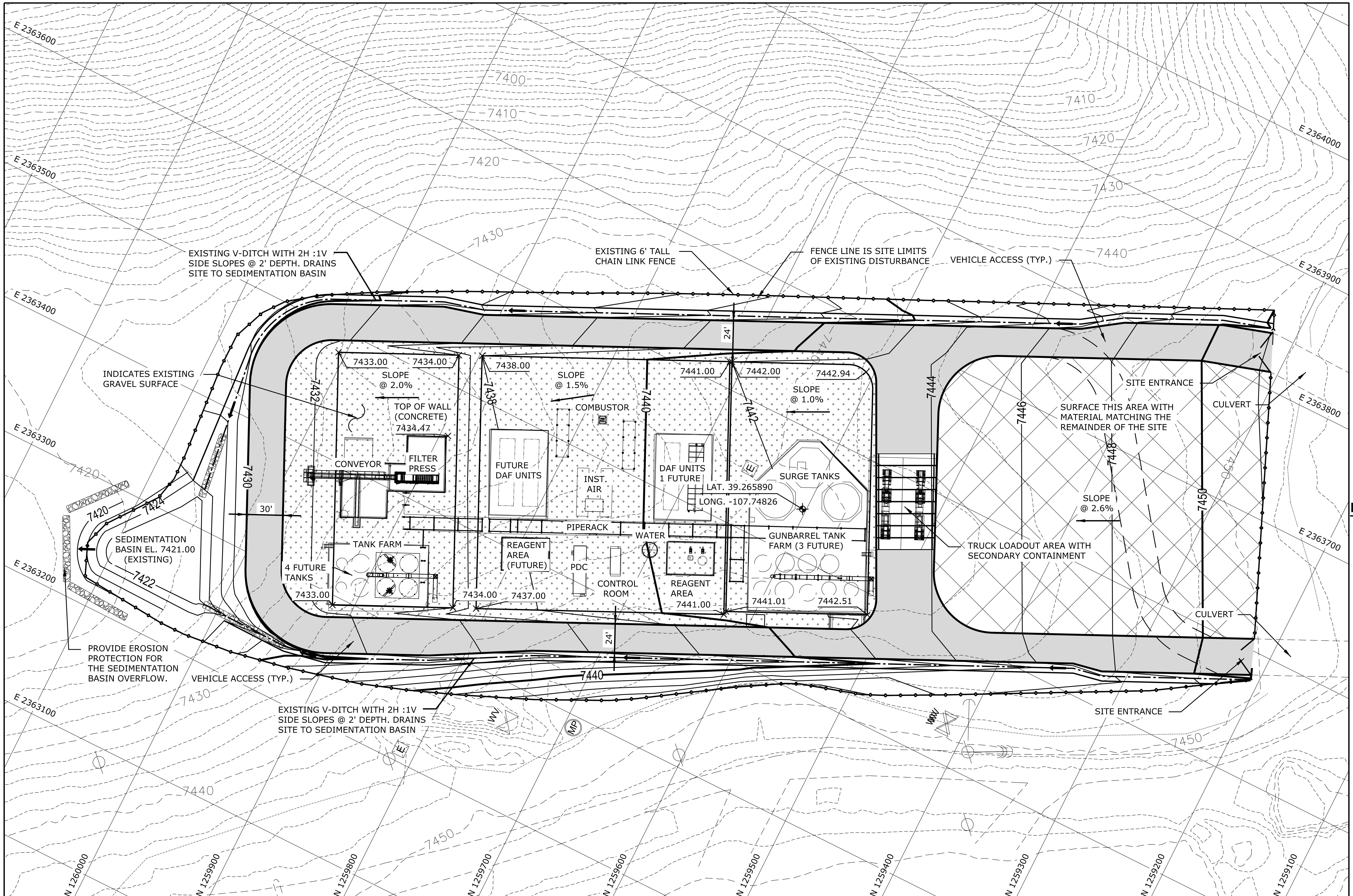
HARRISON CREEK
WATER TREATMENT FACILITY
PROCESS FLOW DIAGRAM
SHEET 5

PROJECT NO. 14130

DRAWING NUMBER 0000-PF-105

REV. A

CAD File: S:\Projects\14130-Laramie_Energy_Wastewater_Plant\CAD\PlantDesign\Drawings\Process Flow Diagrams\0000-PF-105.dwg
Plot Date: Tuesday, February 10, 2015 2:48:44 PM Plotted By: Ken Seals
CTB Used: SE_Std_B&W_Full_Size.ctb



24.49°
TRUE NORTH
PLANT NORTH

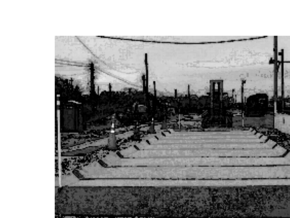
0' 20' 40' 80' 120'
SCALE: 1" = 40'

NOTES

1. THE HARRISON CREEK WATER TREATMENT FACILITY IS LOCATED IN THE NE AND SE 1/4 SECTIONS OF THE NE 1/4 OF SECTION 22, TOWNSHIP 9S, RANGE 67 W 6TH PRINCIPAL MERIDIAN, MESA COUNTY, STATE OF COLORADO.
2. THE PROJECT IS LOCATED AT A LATITUDE OF 39.265890° AND A LONGITUDE OF -107.748264°.
3. SITE GRADING AND SURFACING WAS COMPLETED IN EARLY 2010. EARTHWORK WILL BE LIMITED TO SHAPING AND GENERAL CLEANUP OF THE SITE TO RESTORE TO THE PREVIOUSLY GRADED CONDITION.
4. SITE DRAINAGE WILL FOLLOW THE ORIGINAL DESIGN INTENT WITH ALL SITE DRAINAGE DIRECTED TO THE SEDIMENTATION BASIN LOCATED AT THE NORTH END OF THE SITE.
5. A STATE OF COLORADO DEPARTMENT OF PUBLIC HEALTH CONSTRUCTION ACTIVITIES STORM WATER MANAGEMENT PLAN, PERMIT NUMBER COR03000D, CERTIFICATE NUMBER COR03K454 INCLUDES INFORMATION OF EROSION CONTROL MEASURES USED DURING THE ORIGINAL EARTHWORK CONSTRUCTION. REFER TO THIS PERMIT AND PERFORM MAINTENANCE, REPAIR OR REPLACEMENT OF ALL EXISTING AND PROPOSED SITE EROSION CONTROL MEASURES.
6. NO ADDITIONAL DISTURBANCE IS PLANED FOR THIS SITE.
7. SECONDARY CONTAINMENT FOR EQUIPMENT CONSISTS OF CONCRETE WITH WALLS OF VARYING HEIGHTS DEPENDING ON THE REQUIRED VOLUME OF CONTAINMENT NEEDED.

LEGEND

DENOTES FLOW ARROW
7430 MAJOR CONTOUR (EXISTING)
MINOR CONTOUR (EXISTING)
7440 MAJOR CONTOUR (2010 GRADING)
7446 MINOR CONTOUR (2010 GRADING)
CHAIN LINK FENCE
DITCH CENTERLINE
TYPE L RIP-RAP EROSION CONTROL
CRUSHED GRAVEL OVER GEOTEX 250 ST FABRIC (OR EQUAL) COMPACTED TO 95% S.P.D. (FOR SITE BENCH ROAD PERMANENT SURFACING)
4" CRUSHED GRANITE COMPACTED TO 95% S.P.D. (MATCH EXISTING MATERIALS)
TYPE L RIP-RAP EROSION CONTROL
CRUSHED GRAVEL OVER GEOTEX 250 ST FABRIC (OR EQUAL) COMPACTED TO 95% S.P.D. (FOR SITE BENCH ROAD PERMANENT SURFACING)
4" CRUSHED GRANITE COMPACTED TO 95% S.P.D. (MATCH EXISTING MATERIALS)



PROPOSED TRUCK LOADOUT CONTAINMENT

ISSUED FOR PERMIT
Not For Construction

Know what's below. Call before you dig.

REFERENCE DRAWINGS (DWG NO. / DESCRIPTION / CLIENT / PROJECT MANAGER / PROJECT ENGINEER / CHECK)

REVISIONS (NO. / DESCRIPTION / DATE / BY)

NO.	DESCRIPTION	DATE	BY
C	ISSUED FOR PERMIT (GENERAL TEXT CHANGE.)	03-19-15	MAS
B	ISSUED FOR PERMIT (ADD FUTURE EQUIP.)	02-24-15	MAS
A	ISSUED FOR PERMIT	02-18-15	MAS

REVISIONS

		DATE
SCALE:	1"=40'	
DESIGNED:	E. CURTIS	02-06-15
DRAWN:	M. SKELSKEY	02-18-15
CHECKED:	E. CURTIS	02-18-15
APPROVED:	K. MAHONEY	02-18-15
APPROVED:		

CLIENT: PICEANCE ENERGY II, LLC
LOCATION: MESA COUNTY

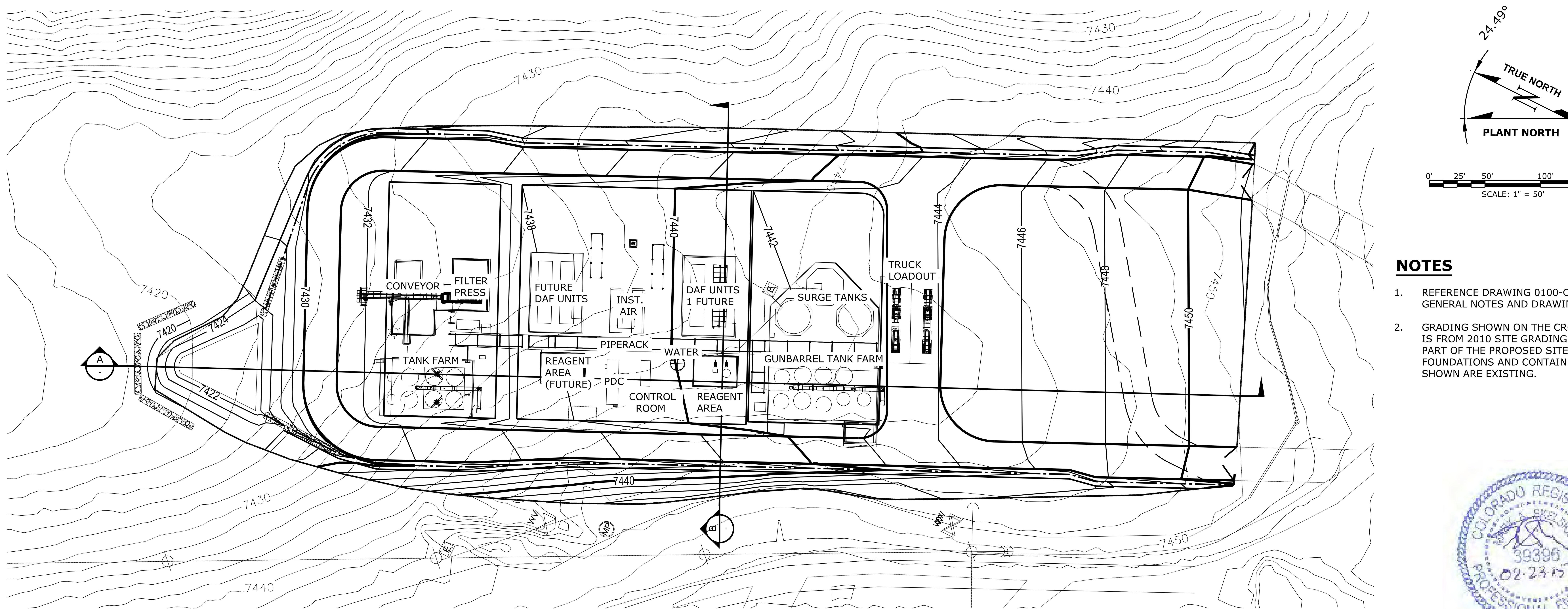
Samuel Engineering
We Provide Solutions
8450 E. Crescent Parkway, Suite 200
Greenwood Village, CO 80111
Phone: 303.714.4840
Fax: 303.714.4800

TITLE
HARRISON CREEK
WATER TREATMENT FACILITY
CIVIL
LAYOUT AND GRADING PLAN

PROJECT NO.
14130

DRAWING NUMBER
0100-CE-101
REV. C

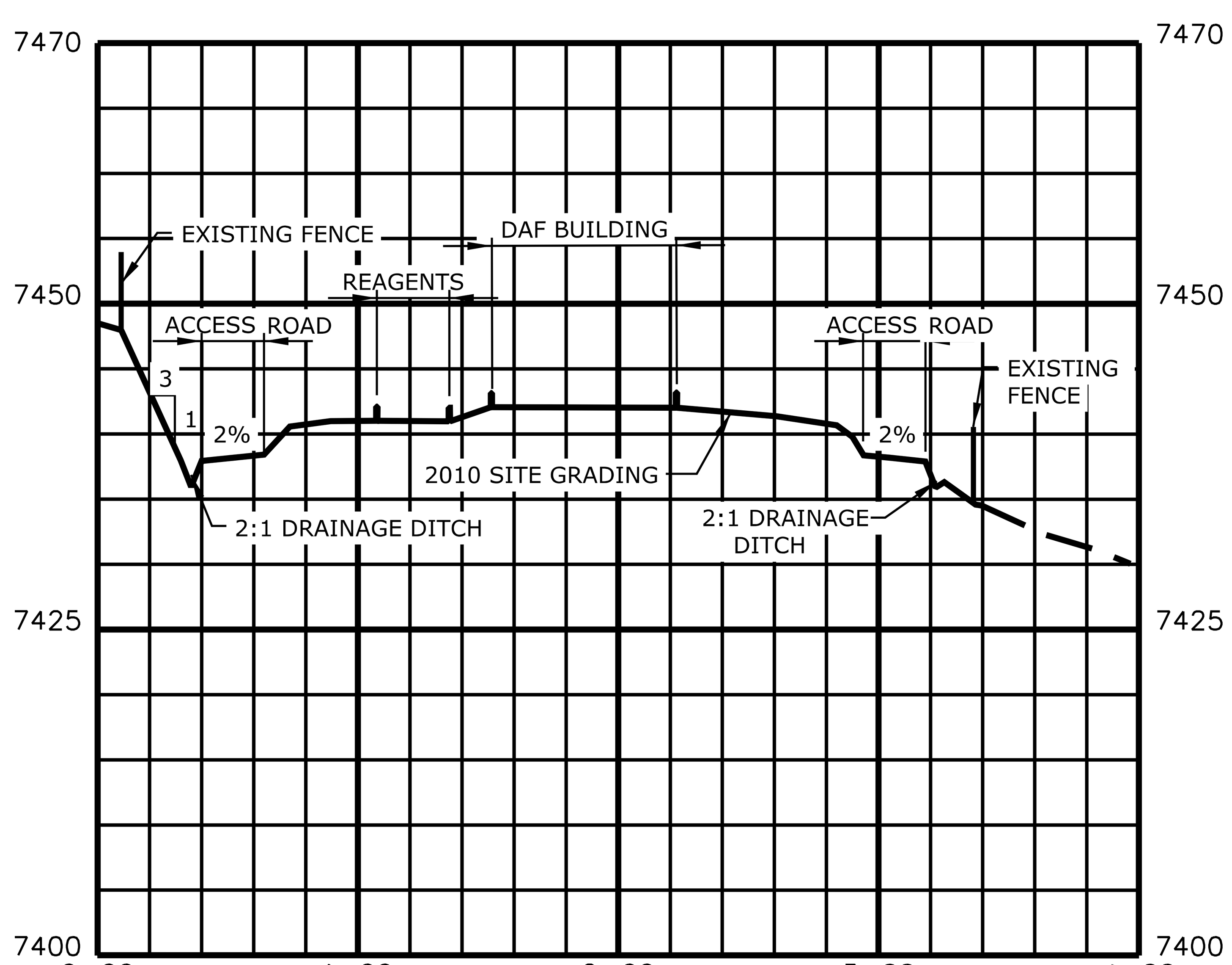
CAD File: S:\Projects\14130-Laramie_Energy_Wastewater_Plant\CAD\Civil\Drawings\0100-CE-101.dgn
Plot Date: 3/18/2015 2:19:17 PM Plotted By: mskelskey



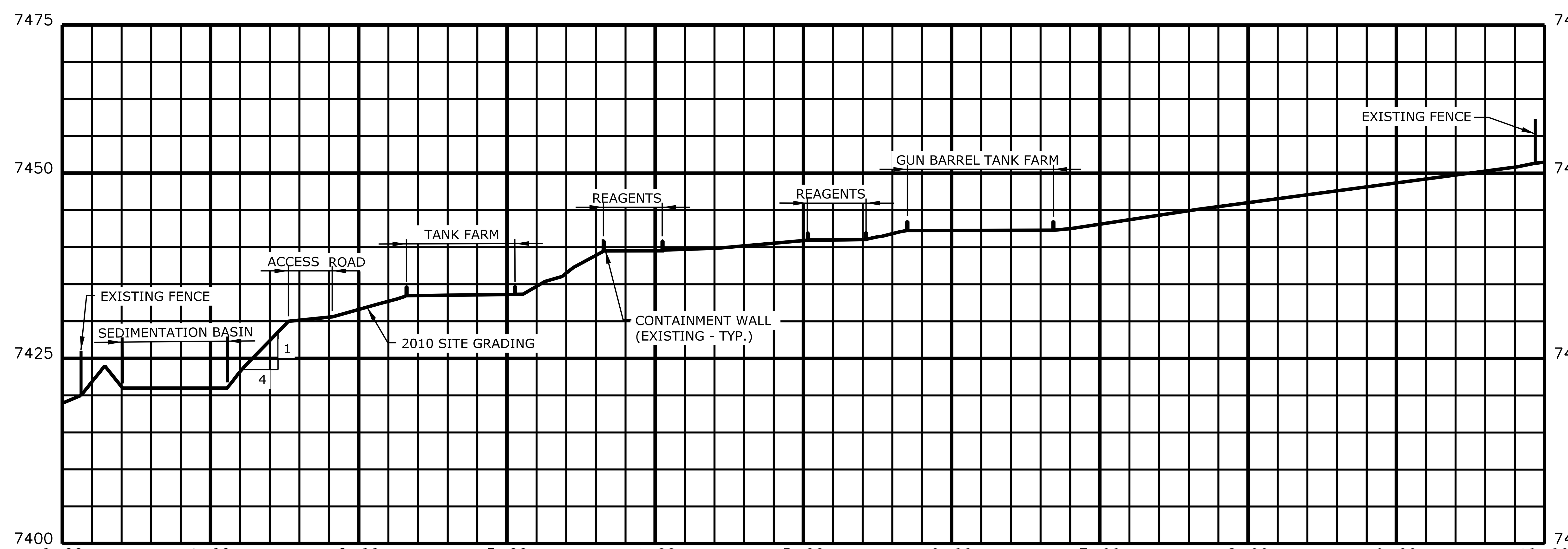
NOTES

1. REFERENCE DRAWING 0100-CE-101 FOR GENERAL NOTES AND DRAWING LEGENDS.
2. GRADING SHOWN ON THE CROSS SECTIONS IS FROM 2010 SITE GRADING AND IS NOT PART OF THE PROPOSED SITE IMPROVEMENTS. FOUNDATIONS AND CONTAINMENT WALLS SHOWN ARE EXISTING.

COLORADO REGISTERED PROFESSIONAL ENGINEER 39396 02-23-15



B SECTION
1"= 50' HORIZ.
1" = 10' VERT.



A SECTION
1"= 50' HORIZ.
1" = 10' VERT.

ISSUED FOR PERMIT
Not For Construction

811 Know what's below. Call before you dig.

CAD File: S:\Projects\14130-Laramie_Energy_Wastewater_Plant\CAD\Civil\Drawings\0100-CE-102.dgn
Plot Date: 2/26/2015 9:04:31 AM Plotted By: mskelskey

DWG NO.	DESCRIPTION
REFERENCE DRAWINGS	

NO.	DESCRIPTION	DATE	BY
A	ISSUED FOR PERMIT	02-24-15	MAS

REVISIONS

SCALE:	AS-NOTED	DATE
DESIGNED:	M. SKELSKEY	02-23-15
DRAWN:	M. SKELSKEY	02-23-15
CHECKED:		
APPROVED:		
APPROVED:		

CLIENT: PICEANCE ENERGY II, LLC
LOCATION: MESA COUNTY

Samuel Engineering
We Provide Solutions
8450 E. Crescent Parkway, Suite 200
Greenwood Village, CO 80111
Phone: 303.714.4840
Fax: 303.714.4800

TITLE
HARRISON CREEK
WATER TREATMENT FACILITY
CIVIL
SECTIONS

PROJECT NO. 14130
DRAWING NUMBER 0100-CE-102
REV. A

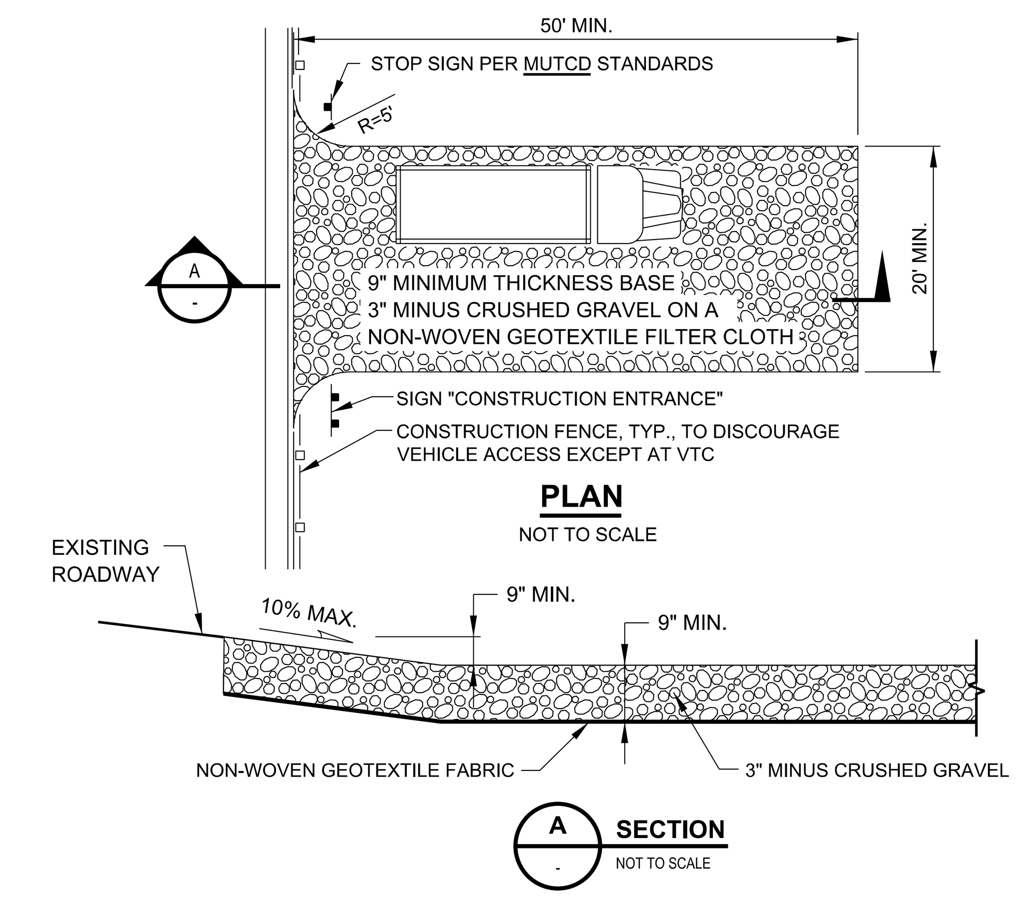
CONSTRUCTION BEST MANAGEMENT PRACTICES NOTES

1. EROSION AND SEDIMENT CONTROL DEVICES SHALL BE INSTALLED AND INSPECTED PRIOR TO ANY LAND DISTURBANCE ON SITE.
2. THE PERMITTEE AND/OR CONTRACTOR SHALL REMOVE ALL SEDIMENT, MUD, CONSTRUCTION DEBRIS, OR OTHER POTENTIAL POLLUTANTS THAT MAY HAVE BEEN DISCHARGED TO OR, ACCUMULATE IN, THE FLOW LINES, STORM DRAINAGE APPURTENANCES, AND PUBLIC RIGHTS OF WAYS OF THE LOCAL GOVERNING ATUHORITY AS A RESULT OF CONSTRUCTION ACTIVITIES ASSOCIATED WITH THIS SITE DEVELOPMENT OR CONSTRUCTION PROJECT. SAID REMOVAL SHALL BE CONDUCTED IN A TIMELY MANNER.
3. THE CONTRACTOR SHALL PREVENT SEDIMENT, DEBRIS AND ALL OTHER POLLUTANTS FROM ENTERING THE STORM SEWER SYSTEM DURING ALL DEMOLITION, EXCAVATION, TRENCHING, BORING, GRADING, OR OTHER CONSTRUCTION OPERATIONS THAT ARE PART OF THIS PROJECT. THE CONTRACTOR SHALL BE HELD RESPONSIBLE FOR REMEDIATION OF ANY ADVERSE IMPACTS TO THE MUNICIPAL STORM SEWER SYSTEM, RECEIVING WATERS, WATERWAYS, WETLANDS, AND OR OTHER PUBLIC OR PRIVATE PROPERTIES, RESULTING FROM WORK DONE AS PART OF THIS PROJECT.
4. SOIL STABILIZATION MEASURES SHALL BE IMPLEMENTED WITHIN FOURTEEN (14) DAYS FOLLOWING COMPLETION OF GRADING ACTIVITIES. STABILIZATION OF DISTURBED AREAS ADJACENT TO RECEIVING WATERS OR WITH SLOPES 3 TO 1 OR GREATER SHALL BE COMPLETED WITHIN SEVEN (7) DAYS FOLLOWING COMPLETION OF GRADING ACTIVITIES. NOTE: FEDERAL AND STATE REGULATIONS MAY SOON REQUIRE STABILIZATION WITHIN SEVEN (7) DAYS OF COMPLETION OF GRADING ACTIVITIES. IN SUCH CASES, THE SHORTER SHALL APPLY.
5. THE DEVELOPER, CONTRACTOR, GRADING CONTRACTOR AND/OR THEIR AUTHORIZED AGENTS SHALL INSURE THAT ALL LOADS OF CUT AND FILL MATERIAL IMPORTED TO OR EXPORTED FROM THIS SITE SHALL BE PROPERLY COVERED TO PREVENT LOSS OF THE MATERIAL DURING TRANSPORT ON PUBLIC RIGHTS OF WAY.
6. THE USE OF REBAR, TO ANCHOR BEST MANAGEMENT PRACTICES IS PROHIBITED. STEEL FENCE POSTS MAY BE USED ON A CASE BY CASE BASIS AND REQUIRES APPROVAL FROM THE LOCAL GOVERNING ATUHORITY SWMP REVIEWER OR THE STORMWATER ENFORCEMENT INVESTIGATOR PRIOR TO INSTALLATION.
7. SOILS THAT WILL BE STOCKPILED FOR MORE THEN THIRTY (30) DAYS SHALL BE PROTECTED FROM WIND AND WATER EROSION WITHIN FOURTEEN (14) DAYS OF STOCKPILE CONSTRUCTION. STABILIZATION OF STOCKPILES LOCATED WITHIN 100 FEET OF RECEIVING WATERS, OR WITH SLOPES 3 TO 1 OR GREATER SHALL BE COMPLETED WITHIN SEVEN (7) DAYS FOLLOWING STOCKPILE CONSTRUCTION. STABILIZATION AND PROTECTION OF THE STOCKPILE MAY BE ACCOMPLISHED BY ANY OF THE FOLLOWING: MULCHING, TEMPORARY/PERMANENT REVEGETATION OPERATIONS, OR EROSION CONTROL MATTING/GEOTEXTILES. IF STOCKPILES ARE LOCATED WITHIN 100 FEET OF RECEIVING WATERS, A DRAINAGE WAY OR THE SITE PERIMETER, ADDITIONAL SEDIMENT CONTROLS SHALL BE REQUIRED.
8. APPROVED EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES SHALL BE MAINTAINED AND KEPT IN GOOD REPAIR FOR THE DURATION OF THIS PROJECT. AT A MINIMUM, THE PERMITTEE OR CONTRACTOR SHALL PRODUCE AND RETAIN WEEKLY WRITTEN INSPECTION RECORDS FOR ALL BMPS AND AFTER SIGNIFICANT PRECIPITATION EVENTS. ALL NECESSARY MAINTENANCE AND REPAIR SHALL BE COMPLETED IMMEDIATELY. ADDITIONALLY, STREET SWEEPING IS TO BE COMPLETED BY THE CLOSE OF BUSINESS DAY OR (AND) ON AN AS NEEDED BASIS THROUGHOUT THE DAY.
9. WATER USED IN THE CLEANING OF CEMENT TRUCK DELIVERY CHUTES SHALL BE DISCHARGED INTO A PREDEFINED, CONCRETE WASHOUT AREA ON THE JOB SITE. BERMED CONTAINMENT OR COMMERCIALLY AVAILABLE CONCRETE WASHOUT DEVICES THAT FULLY CONTAIN ALL WASH WATER ARE ACCEPTABLE. WASH WATER DISCHARGED INTO THE CONTAINMENT AREA OR DEVICE SHALL BE ALLOWED TO INFILTRATE OR EVAPORATE AND OR BE DISPOSED OF IN ACCORDANCE WITH APPLICABLE REGULATIONS. DRIED CEMENT WASTE IS TO BE REMOVED FROM THE CONTAINMENT AREA AND PROPERLY DISPOSED OF.
10. SHOULD THE USE OF A PREDEFINED BERMED CONTAINMENT AREA OR APPROVED WASHOUT DEVISE BE TECHNICALLY INFEASIBLE DUE TO THE PROJECT SIZE, OR LACK OF AN AREA WITH A SUITABLE GROUND SURFACE FOR ESTABLISHING A CONTAINMENT, PROPER DISPOSAL OF CONCRETE WASHOUT AND WASH WATER AT THE JOB SITE SHALL CONFORM TO THE APPROVED TECHNIQUES AND PRACTICES IDENTIFIED IN THE COLORADO DEPARTMENT OF PUBLIC HEALTH & ENVIRONMENTS' TRAINING VIDEO ENTITLED "BUILDING FOR A CLEANER ENVIRONMENT, READY MIX WASHOUT TRAINING" AND ITS ACCOMPANYING MANUAL ENTITLED, "READY MIX WASHOUT GUIDEBOOK, VEHICLE AND EQUIPMENT WASHOUT AT CONSTRUCTION SITES."
11. THE DIRECT OR INDIRECT DISCHARGE OF WATER CONTAINING WASTE CEMENT TO THE STORM SEWER SYSTEM IS PROHIBITED.
12. THE CONTRACTOR SHALL PROTECT ALL STORM SEWER FACILITIES ADJACENT TO ANY LOCATION WHERE PAVEMENT CUTTING OPERATIONS INVOLVING WHEEL CUTTING, SAW CUTTING, OR ABRASIVE WATER JET CUTTING ARE TO TAKE PLACE.
13. THE CONTRACTOR SHALL REMOVE AND PROPERLY DISPOSE OF ALL WASTE PRODUCTS GENERATED BY SAID CUTTING OPERATIONS ON A DAILY BASIS OR AS NEEDED THROUGHOUT THE DAY.
14. THE DISCHARGE OF ANY WATER CONTAMINATED BY WASTE PRODUCTS FROM CUTTING OPERATIONS TO THE STORM SEWER SYSTEM IS PROHIBITED.
15. PAVED AND IMPERVIOUS SURFACES WHICH ARE ADJACENT TO CONSTRUCTION SITES MUST BE SWEPT ON A DAILY BASIS OR AS NEEDED DURING DAY WHEN SEDIMENT AND OTHER MATERIAL ARE TRACKED OR DISCHARGED ONTO THEM. EITHER SWEEPING BY HAND OR USE OF STREET SWEEPERS IS ACCEPTABLE. STREET SWEEPERS USING WATER WHILE SWEEPING IS PREFERRED IN ORDER TO MINIMIZE DUST. FLUSHING OF PAVED SURFACES WITH WATER IS PROHIBITED.

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT AIR POLLUTION CONTROL NOTES

1. ALL UNPAVED ROADS AND OTHER DISTURBED SURFACE AREAS ON SITE MUST BE WATERED AS NECESSARY TO PREVENT OFF-PROPERTY TRANSPORT OF VISIBLE FUGITIVE PARTICULATE EMISSIONS.
2. VEHICLE SPEED ON ALL UNPAVED ROADS AND DISTURBED AREAS SHALL NOT EXCEED A MAXIMUM OF 30 MPH. SPEED LIMIT SIGNS SHALL BE POSTED.
3. NO EARTHWORK ACTIVITIES SHALL BE PERFORMED WHEN THE WIND SPEED EXCEEDS 30 MPH.
4. ALL DISTURBED SURFACE AREAS SHALL BE REVEGETATED WITHIN ONE YEAR AND ACCORDING TO THE INFORMATION SUBMITTED BY THE APPLICANT WITH THE PERMIT APPLICATION.
5. GRAVEL ENTRYWAYS SHALL BE UTILIZED TO PREVENT MUD AND DIRT CARRYOUT ONTO PAVED SURFACES. ANY MUD AND DIRT CARRYOUT ONTO PAVED SURFACES SHALL BE CLEANED UP DAILY.

*EROSION CONTROL DETAILS ARE FROM URBAN DRAINAGE AND FLOOD CONTROL DISTRICT, DRAINAGE CRITERIA MANUAL, VOLUME 3 - CONSTRUCTION BEST MANAGEMENT PRACTICES. INSTALLATION AND MAINTENANCE OF SITE BMP'S IS TO ADHERE TO MESA COUN TY OR STATE OF COLORADO LATEST STANDARDS AND REQUIREMENTS.



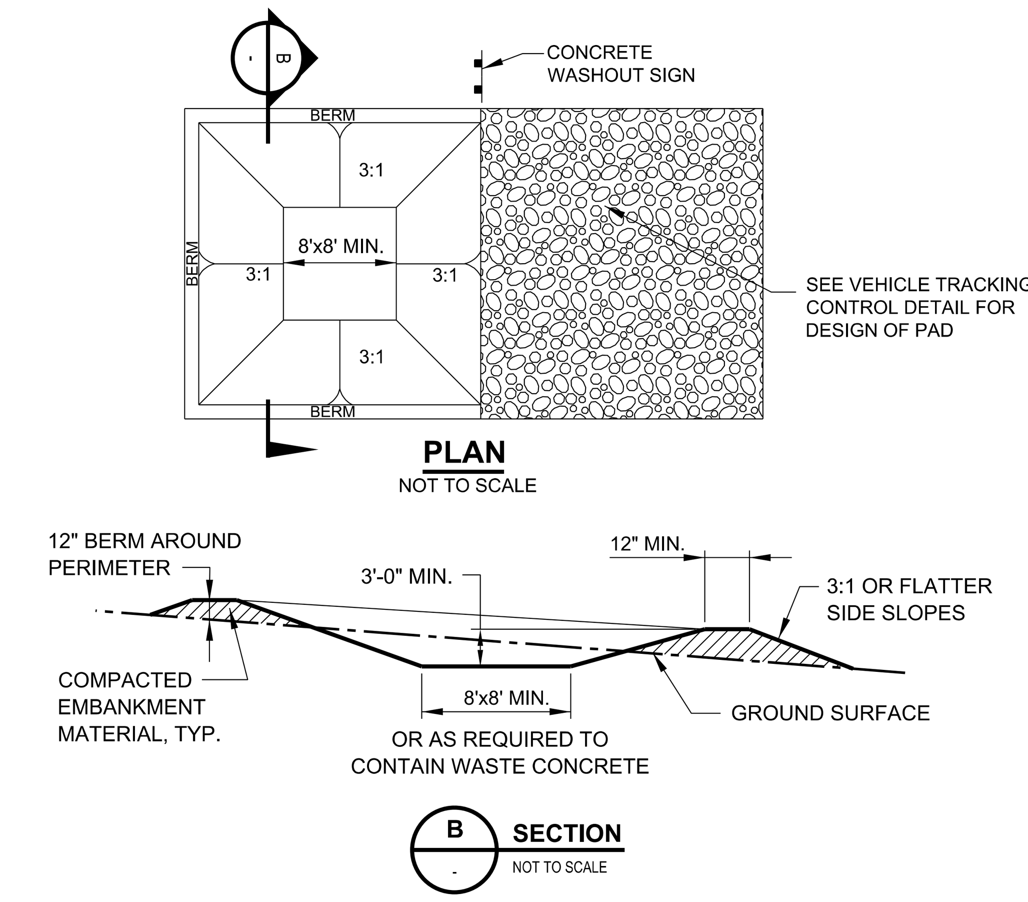
VEHICLE TRACKING CONTROL INSTALLATION NOTES

1. VEHICLE TRACKING CONTROL PADS SHALL BE INSTALLED AT EVERY ACCESS POINT TO SITE.
2. VEHICLE TRACKING CONTROL PADS SHALL CONSIST OF HARD, DENSE, DURABLE STONE, ANGULAR IN SHAPE AND RESISTANT TO WEATHERING. ROUNDED STONE OR BOULDERS WILL NOT BE ACCEPTABLE. THE STONES SHALL BE 3" MINUS.
3. A STOP SIGN INSTALLED IN ACCORDANCE WITH THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD), AS AMENDED, SHALL BE INSTALLED FOR EXITING TRAFFIC AT THE VTC.

VEHICLE TRACKING CONTROL MAINTENANCE NOTES

1. THE EROSION CONTROL SUPERVISOR SHALL INSPECT VEHICLE TRACKING CONTROL DAILY. GRAVEL SURFACE SHALL BE CLEAN AND LOOSE ENOUGH TO RUT SLIGHTLY UNDER WHEEL LOADS AND CAUSE LOOSE GRAVEL TO DISLODGE MUD FROM TIRES. WHEN GRAVEL BECOMES COMPACTED OR FILLED WITH SEDIMENT SO THAT THE EFFECTIVENESS OF THE PAD IS DIMINISHED, CONTRACTOR SHALL RIP, TURN OVER, OR OTHERWISE LOOSEN GRAVEL, PLACE ADDITIONAL NEW GRAVEL, OR REPLACE WITH NEW GRAVEL AS NECESSARY TO RESTORE EFFECTIVENESS.
2. VEHICLE TRACKING CONTROL SHALL BE REMOVED AT THE END OF CONSTRUCTION, THE GRAVEL MATERIAL REMOVED OR, IF APPROVED, USED ON SITE, AND TOPSOIL ADDED TO THE AREA, DRILL SEEDED AND CRIMP MULCHED OR OTHERWISE STABILIZED.

VTC **VEHICLE TRACKING CONTROL**



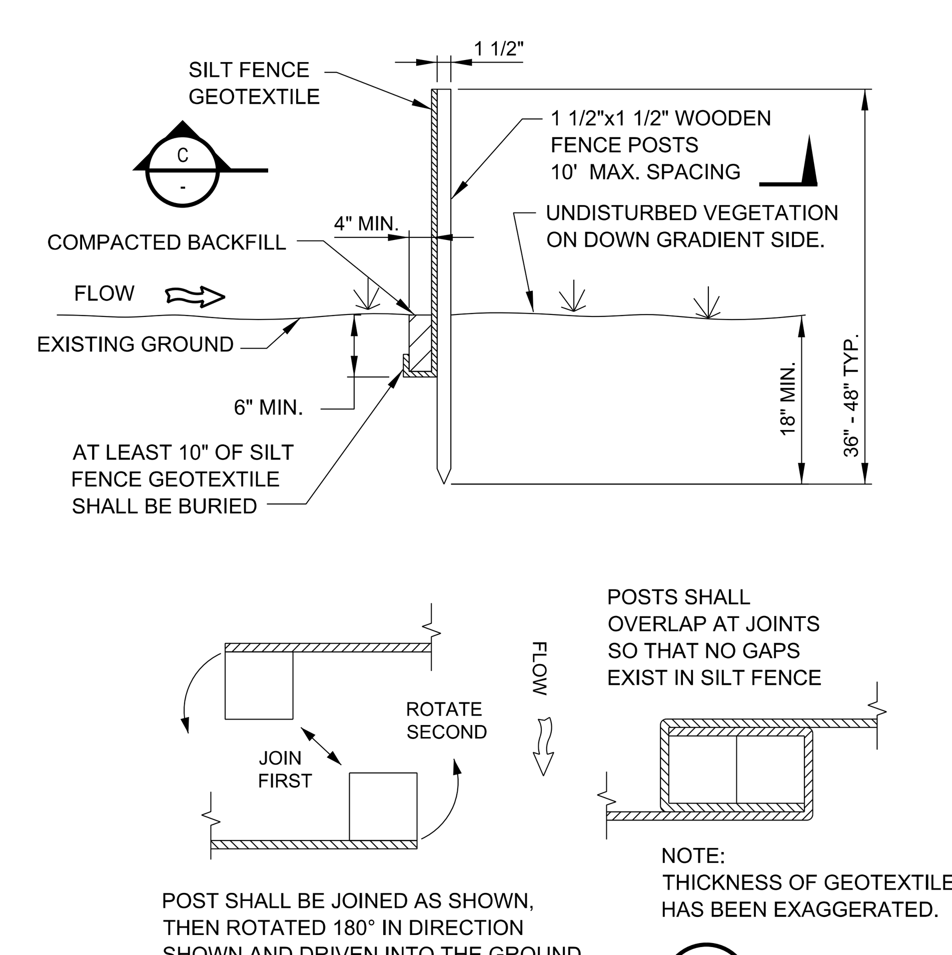
CONCRETE WASHOUT AREA INSTALLATION NOTES

1. SEE PLAN VIEW FOR LOCATIONS OF CONCRETE WASHOUT AREA.
2. THE CONCRETE WASHOUT AREA SHALL BE INSTALLED PRIOR TO ANY CONCRETE PLACEMENT ON SITE.
3. VEHICLE TRACKING CONTROL IS REQUIRED AT THE ACCESS POINT SLOPED AT 2% TOWARDS THE CWA.
4. SIGNS SHALL BE PLACED AT THE CONSTRUCTION ENTRANCE, AT THE WASHOUT AREA, AND ELSEWHERE AS NECESSARY TO CLEARLY INDICATE THE LOCATION OF THE CONCRETE WASHOUT AREA TO OPERATORS OF THE CONCRETE TRUCKS AND PUMP RIGS.
5. EXCAVATED MATERIAL SHALL BE UTILIZED IN PERIMETER BERM CONSTRUCTION.

CONCRETE WASHOUT AREA MAINTENANCE NOTES

1. THE CONCRETE WASHOUT AREA SHALL BE REPAIRED AND ENLARGED OR CLEANED OUT AS NECESSARY TO MAINTAIN CAPACITY FOR WASTED CONCRETE. CONCRETE MATERIALS SHALL BE REMOVED ONCE THE MATERIALS HAVE REACHED A DEPTH OF 2'.
2. AT THE END OF THE CONSTRUCTION PROJECT, ALL CONCRETE SHALL BE REMOVED FROM THE SITE AND DISPOSED OF AT AN APPROVED WASTE SITE.
3. WHEN THE CONCRETE WASHOUT AREA IS REMOVED, COVER THE DISTURBED AREA WITH TOP SOIL, DRILL SEED AND CRIMP MULCH OR OTHERWISE STABILIZE IN A MANNER APPROVED BY THE CITY OF FT. LUPTON AND/OR WELD COUNTY.
4. INSPECT WEEKLY AND DURING AND AFTER ANY STORM EVENT.

CWA **CONCRETE WASHOUT AREA**



SILT FENCE INSTALLATION NOTES

1. SEE PLAN VIEW FOR:
   - LOCATION AND LENGTH OF FENCE.
2. ANCHOR TRENCH SHALL BE EXCAVATED WITH TRENCHER, OR WITH SILT FENCE INSTALLATION MACHINE; NO ROAD GRADERS, BACKHOES, ETC. SHALL BE USED. TRENCH SHALL BE COMPACTED BY HAND, WITH "JUMPING JACK", OR BY WHEEL ROLLING. COMPACTION SHALL BE SUCH THAT SILT FENCE RESISTS BEING PULLED OUT OF ANCHOR TRENCH BY HAND.
3. SILT FENCE GEOTEXTILE SHALL MEET THE FOLLOWING REQUIREMENTS:
   - 6-TO 12-GALLONS PER MINUTE PER SQUARE FOOT FLOW CAPACITY.
   - 90 LB. TENSILE STRENGTH PER ASTM D4622.
   - UV DESIGN AT 500 HRS MIN. 70% STRENGTH RETAINED PER ASTM D 4355.
4. SILT FENCE INDICATED ON THE EROSION CONTROL PLAN SHALL BE INSTALLED PRIOR TO ANY LAND-DISTURBING ACTIVITIES.

SILT FENCE MAINTENANCE NOTES

1. INSPECT SILT FENCE DAILY, DURING AND AFTER ANY STORM EVENT AND MAKE REPAIRS OR CLEAN OUT UPSTREAM SEDIMENT AS NECESSARY.
2. SEDIMENT ACCUMULATED UPSTREAM OF SILT FENCE SHALL BE REMOVED WHEN THE UPSTREAM SEDIMENT REACHES A DEPTH OF ½H.
3. SILT FENCE SHALL BE REMOVED WHEN THE UPSTREAM DISTURBED AREA IS STABILIZED AND GRASS COVER HAS BEEN ESTABLISHED. IF ANY DISTURBED AREA EXISTS AFTER REMOVAL, IT SHALL BE SEEDED AND MULCHED OR OTHERWISE STABILIZED.

—SF——SF— SF **SILT FENCE**

ISSUED FOR PERMIT
Not For Construction

NO.	DESCRIPTION	DATE	BY
A	ISSUED FOR PERMIT	02-19-15	MAS

REVISIONS — KM

SCALE:	AS-NOTED	DATE
DESIGNED:	M SKELSKEY	02-19-15
DRAWN:	M SKELSKEY	02-19-15
CHECKED:	K MAHONEY	02-19-15
APPROVED:	K MAHONEY	
APPROVED:		

CLIENT: PICEANCE ENERGY II, LLC
LOCATION: MESA COUNTY

Samuel Engineering
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8450 E. Crescent Parkway, Suite 200, Greenwood Village, CO 80111
Phone: 303.714.4840 Fax: 303.714.4800

TITLE: HARRISON CREEK WATER TREATMENT FACILITY EROSION CONTROL DETAILS SHEET 1 OF 2

PROJECT NO. 14130
DRAWING NUMBER 0100-CE-401
REV. A

CAD File: S:\Projects\14130-Laramie_Energy_Wastewater_Plant\CAD\Civil\Drawings\0100-CE-401.dgn
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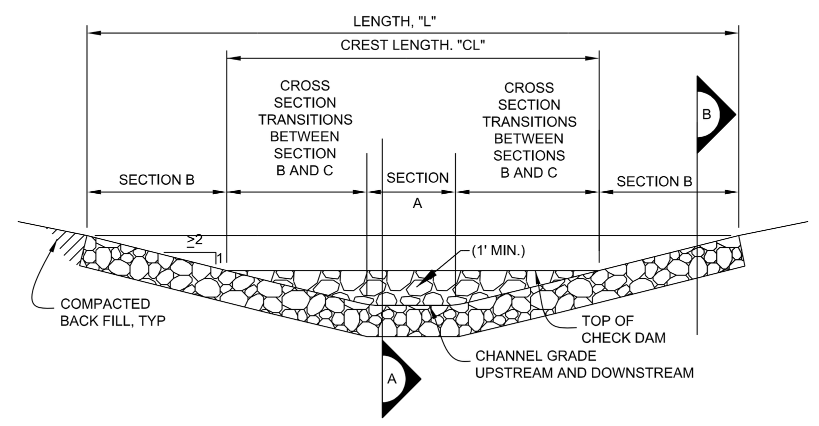
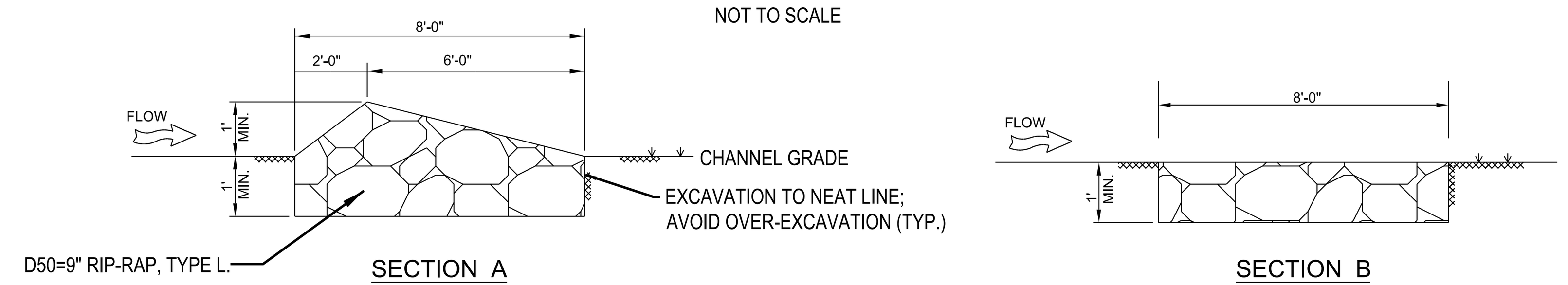


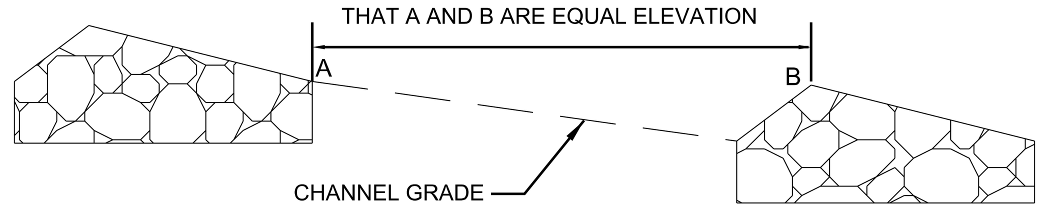
ELEVATION

NOT TO SCALE



SECTION A
NOT TO SCALE

SECTION B
NOT TO SCALE



CHECK DAM INSTALLATION NOTES

1. SEE PLAN VIEW FOR:
   - -LOCATIONS OF CHECK DAMS.
   - -CHECK DAM TYPE (CHECK DAM OR REINFORCED CHECK DAM).
   - -LENGTH, "L", CREST LENGTH, "CL", AND DEPTH, "D".
2. CHECK DAMS INDICATED ON INITIAL EROSION CONTROL PLAN SHALL BE INSTALLED AFTER CONSTRUCTION FENCE, BUT PRIOR TO ANY UPSTREAM LAND DISTURBING ACTIVITIES.
3. RIP-RAP UTILIZED FOR CHECK DAMS SHALL HAVE A D50 MEDIAN STONE SIZE OF 9".
4. RIP-RAP PAD SHALL BE TRENCHED INTO THE GROUND A MINIMUM OF 1'.
5. THE ENDS OF THE CHECK DAM SHALL BE A MINIMUM OF 1' HIGHER THAN THE CENTER OF THE CHECK DAM.

CHECK DAM MAINTENANCE NOTES

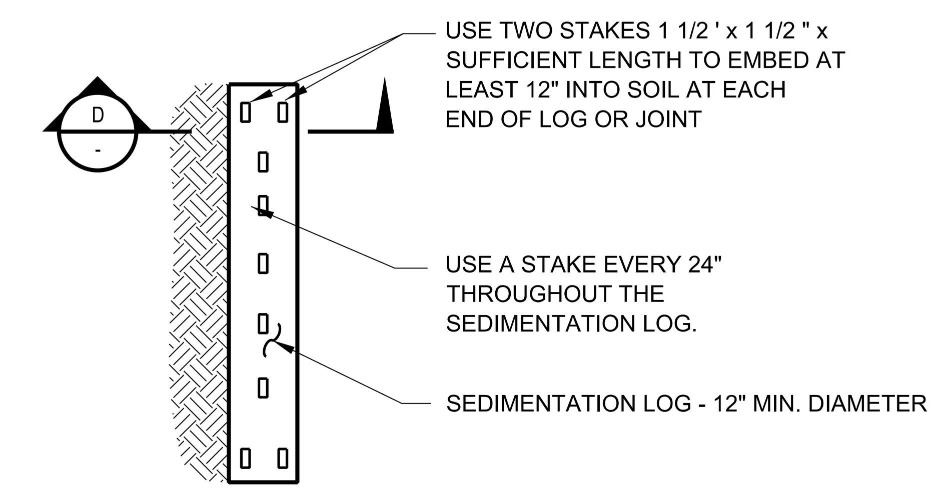
1. THE SWMP MANAGER SHALL INSPECT CHECK DAMS WEEKLY, DURING AND AFTER ANY STORM EVENT AND MAKE REPAIRS OR CLEAN OUT AS NECESSARY.
2. SEDIMENT ACCUMULATED UPSTREAM OF CHECK DAMS SHALL BE REMOVED WHEN THE SEDIMENT DEPTH UPSTREAM OF CHECK DAM IS WITHIN 1/2 OF THE HEIGHT OF THE CREST.
3. CHECK DAMS ARE TO REMAIN IN PLACE UNTIL THE UPSTREAM DISTURBED AREA IS STABILIZED AND GRASS COVER IS APPROVED BY THE CITY OR COUNTY.
4. WHEN CHECK DAMS ARE REMOVED, EXCAVATIONS SHALL BE FILLED WITH SUITABLE COMPACTED BACK FILL. ANY DISTURBED AREA SHALL BE SEEDED AND MULCHED AND COVERED WITH EROSION CONTROL BLANKET OR OTHERWISE STABILIZED IN A MANNER APPROVED BY THE CITY OF FT. LUPTON AND/OR WELD COUNTY.

CD **CHECK DAM**

STATE OF COLORADO
STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION
(RIPRAP GRADATION)

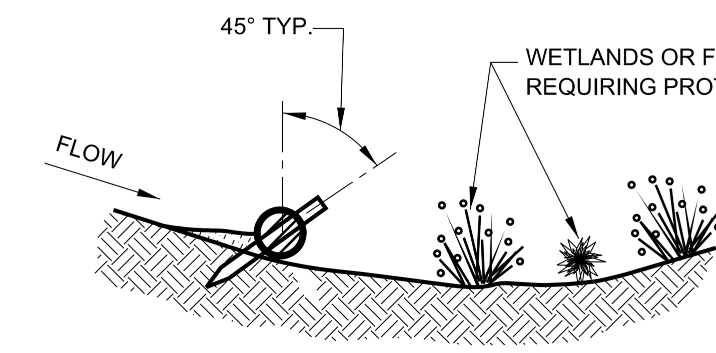
PAY ITEM	STONE SIZE D50 (INCHES)	% OF MATERIAL SMALLER THAN TYPICAL STONE % PASSING	TYPICAL STONE DIMENSIONS (INCHES)	TYPICAL STONE WEIGHT (POUNDS)	METRIC SIZE OF STONE	TYPE
RIPRAP	6	70 to 100 50 to 70 35 to 50 2 to 10	12 9 6 2	85 35 10 0.4	150mm	VL
RIPRAP	9	70 to 100 50 to 70 35 to 50 2 to 10	15 12 9 3	160 85 35 1.3	225mm	L

*EROSION CONTROL DETAILS ARE FROM URBAN DRAINAGE AND FLOOD CONTROL DISTRICT, DRAINAGE CRITERIA MANUAL, VOLUME 3 - CONSTRUCTION BEST MANAGEMENT PRACTICES. INSTALLATION AND MAINTENANCE OF SITE BMP'S IS TO ADHERE TO MESA COUN TY OR STATE OF COLORADO LATEST STANDARDS AND REQUIREMENTS.



TYPICAL STAKE INSTALLATION

NOT TO SCALE



5 **SECTION**
NOT TO SCALE

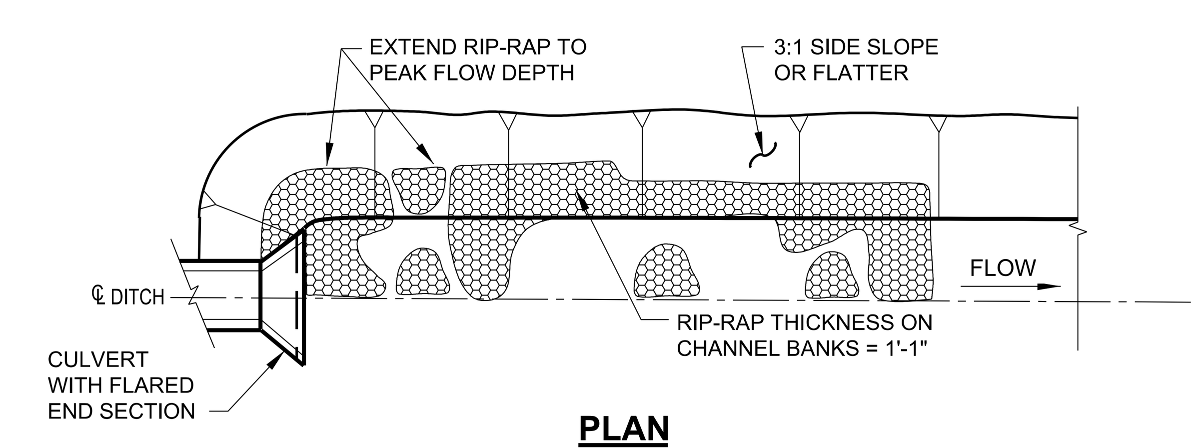
SEDIMENT CONTROL LOG INSTALLATION NOTES

1. SEE SEDIMENTATION (EROSION) CONTROL PLAN FOR LOCATION AND LENGTH OF SEDIMENT CONTROL LOG.
2. SEDIMENT CONTROL LOGS INDICATED ON INITIAL EROSION CONTROL PLAN SHALL BE INSTALLED PRIOR TO ANY LAND-DISTURBING ACTIVITIES.
3. SEDIMENT CONTROL LOGS SHALL CONSIST OF STRAW, COMPOST, EXCELSIOR OR COCONUT FIBER.
4. NOT FOR USE IN CONCENTRATED FLOW AREAS.
5. THE SEDIMENT CONTROL LOG SHALL BE TRENCHED INTO THE GROUND A MINIMUM OF 2"

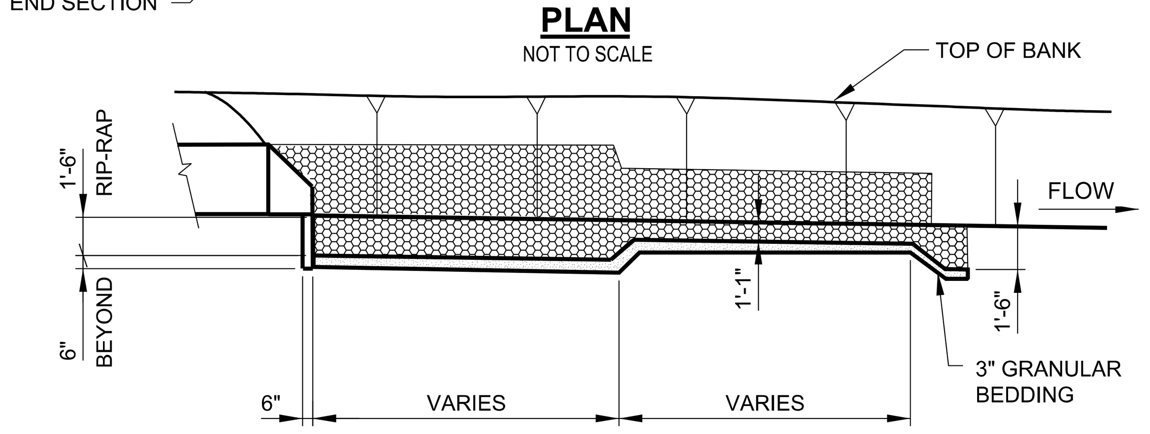
SEDIMENT CONTROL LOG MAINTENANCE NOTES

1. THE SWMP MANAGER SHALL INSPECT SEDIMENT CONTROL LOGS DAILY, DURING AND AFTER ANY STORM EVENT AND MAKE REPAIRS OR CLEAN OUT UPSTREAM SEDIMENT AS NECESSARY.
2. SEDIMENT ACCUMULATED UPSTREAM OF SEDIMENT CONTROL LOGS SHALL BE REMOVED WHEN THE UPSTREAM SEDIMENT DEPTH IS WITHIN ½ THE HEIGHT OF THE CREST OF THE LOG.
3. SEDIMENT CONTROL LOG SHALL BE REMOVED AT THE END OF CONSTRUCTION. IF ANY DISTURBED AREA EXISTS AFTER REMOVAL, IT SHALL BE COVERED WITH TOP SOIL, DRILL SEEDED AND CRIMP MULCHED OR OTHERWISE STABILIZED IN A MANNER APPROVED BY THE CITY OF FT. LUPTON AND/OR WELD COUNTY.

SCL **SEDIMENT CONTROL LOG**



PLAN
NOT TO SCALE



PROFILE
NOT TO SCALE

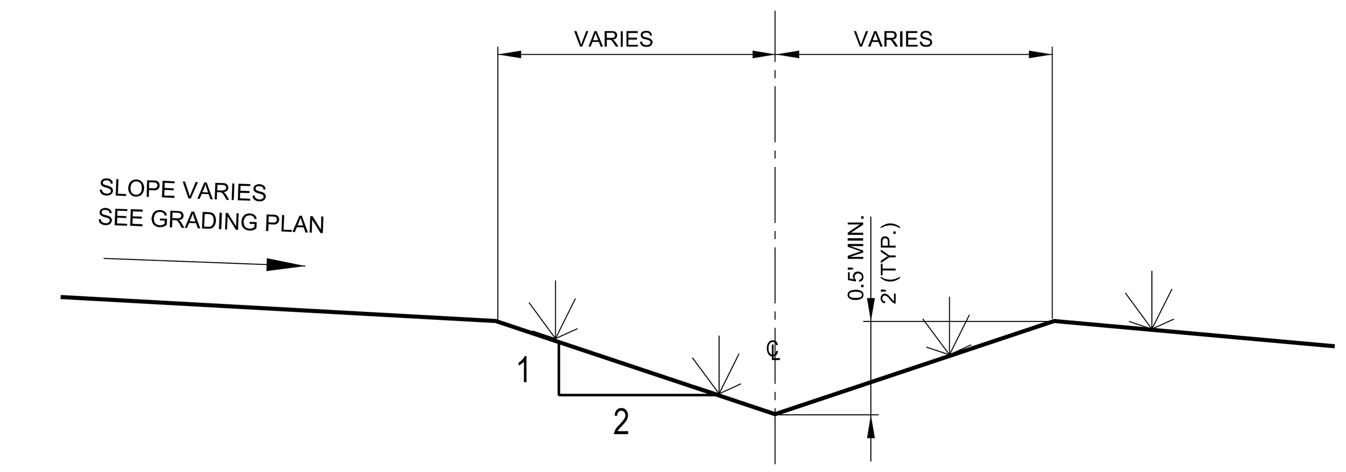
NOTES

1. FLARED END SECTION REQUIRED AT ALL CULVERT OUTLETS.
3. PROVIDE JOINT FASTENERS FOR FLARED END SECTIONS FOR SLOPES GREATER THAN 5%.
4. INSTALL MIRAFI 140N FILTER FABRIC (OR EQUAL) BELOW ALL RIP-RAP.

CULVERT AND OUTLET EROSION PROTECTION

OP

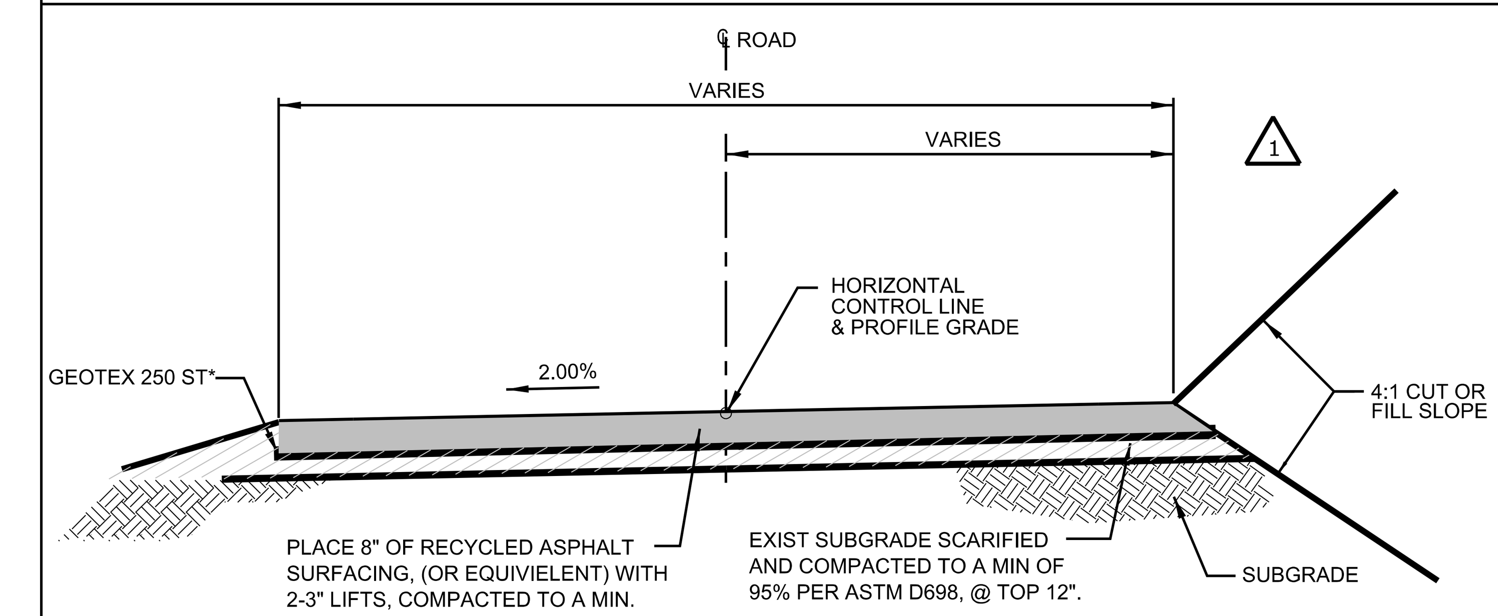
NOT TO SCALE



TYPICAL DRAINAGE DITCH

NOT TO SCALE

6 **SECTION**
NOT TO SCALE



* GEOTEX 250 ST WOVEN GEOTEXTILE FABRIC AS MANUFACTURED BY PROPEX (OR EQUIVALEN
OVERLAP ALL SEAMS 1.5' MINIMUM OR AS RECOMMENDED BY THE MANUFACTURER

7 **TYPICAL ACCESS ROAD SECTION**
NOT TO SCALE

COLORADO REGISTERED PROFESSIONAL ENGINEER 39396 02-23-15

ISSUED FOR PERMIT
Not For Construction

REFERENCE DRAWINGS (DWG NO. / DESCRIPTION / CLIENT / PROJECT MANAGER / PROJECT ENGINEER / CHECK)

REVISIONS (NO. / DESCRIPTION / DATE / BY / CLIENT / PROJECT MANAGER / PROJECT ENGINEER / CHECK)

NO.	DESCRIPTION	DATE	BY
A	ISSUED FOR PERMIT	02-19-15	MAS

KM

		DATE
SCALE:	AS-NOTED	
DESIGNED:	M SKELSKEY	02-19-15
DRAWN:	M SKELSKEY	02-19-15
CHECKED:	K MAHONEY	02-19-15
APPROVED:	K MAHONEY	
APPROVED:		

CLIENT: PICEANCE ENERGY II, LLC
LOCATION: MESA COUNTY

Samuel Engineering
We Provide Solutions
8450 E. Crescent Parkway, Suite 200
Greenwood Village, CO 80111
Phone: 303.714.4840
Fax: 303.714.4800

TITLE
HARRISON CREEK
WATER TREATMENT FACILITY
EROSION CONTROL DETAILS
SHEET 2 OF 2

PROJECT NO. 14130
DRAWING NUMBER 0100-CE-402
REV. A

CAD File: S:\Projects\14130-Laramie_Energy_Wastewater_Plant\CAD\Civil\Drawings\0100-CE-402.dgn
Plot Date: 2/19/2015 2:12:54 PM Plotted By: mskelskey

OLSSON
ASSOCIATES

March 18, 2015

Matthew Hall, PE
Piceance Energy LLC
1512 Larimer Street, Suite 1000
Denver, CO 80202

Dear Mr. Hall,

Olsson Associates (Olsson) has reviewed the *Drainage Report for Harrison Creek Produced Water Recycling Facility Mesa County, Colorado* prepared by Rhino Engineering, Inc. Revised June 25, 2009 (Report). Additionally, Olsson has reviewed the Harrison Creek Water Treatment Facility Civil Layout and Grading Plan prepared by Samuel Engineering, signed and sealed March 18, 2015 (Grading Plan). The purpose of the review is to determine whether the Grading Plan is in general conformance with the Report. Calculations and study is not included with this review.

The Grading Plan illustrates the site. The site is generally comprised of the following:

- Drainage conveyance around the perimeter
- Internal roadways around the perimeter
- Treatment equipment within the interior

The Report and Grading Plan are of the same site. Drainage patterns discussed within the Report appear to be reflected within the Grading Plan. Items to note include:

- Existing Sedimentation Basin located along the northern portion of the site
- Existing V- Ditch (2:1 side slopes with 2 feet of depth) for conveyance to the sedimentation basin along the east side of the site
- Existing V- Ditch (2:1 side slopes with 2 feet of depth) for conveyance to the sedimentation basin along the west side of the site
- Drainage from the interior roadways is out towards the conveyance ditches
- Drainage within the equipment area generally sheet flows from south to north towards the sedimentation basin

There are a few items of note that require some additional verification between the Grading Plan and the Report:

- The Report indicates there are two 18" CMP culverts on the south end of the site
  - The culverts convey the existing irrigation ditch under the perimeter access roads
  - The Grading Plan identifies culverts, however, the size is not indicated
- The Report indicates an 18" CMP culvert within the conveyance swale along the west side of the site

  - The Grading Plan does not indicate the culvert, however, it shows the V-ditch along the entire length
- The Report indicates that the Sedimentation Basin shown within the grading plan is a detention basin
  - The Report indicates there is a 12" HDPE outlet pipe, however, the Grading Plan does not indicate that there is an outlet pipe
  - Additionally, the Report indicates the pond bottom to have an elevation of 7411 feet with a top elevation of 7415 feet, however, the Grading Plan indicates the pond bottom elevation is 7421 feet and it appears the top elevation may be 7425 feet

In conclusion, the Grading Plan appears to be in general conformance with the Report with two exceptions:

1. The detention pond described within the Report appears to be of similar volume, similar side slopes, and similar depth, however, it does not appear to function as designed. The Report designed the pond to release the flow through an outlet pipe. The Grading Plan appears to treat the pond as a sedimentation basin and does not allow for an outflow. The outflow would require overtopping the pond.

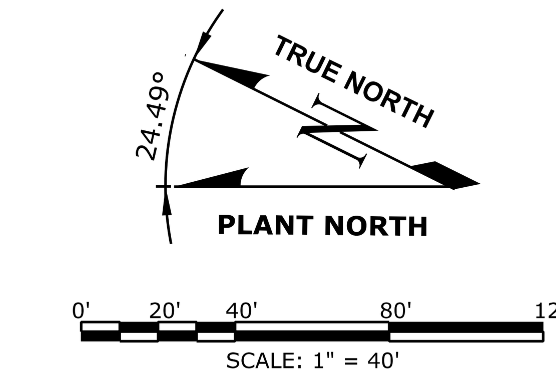
   It is recommended that the detention pond be modified to include the outlet pipe as designed within the Report. Alternatively, the existing pond could be modified to include a weir outfall to meet the intent of the pond release designed within the Report.

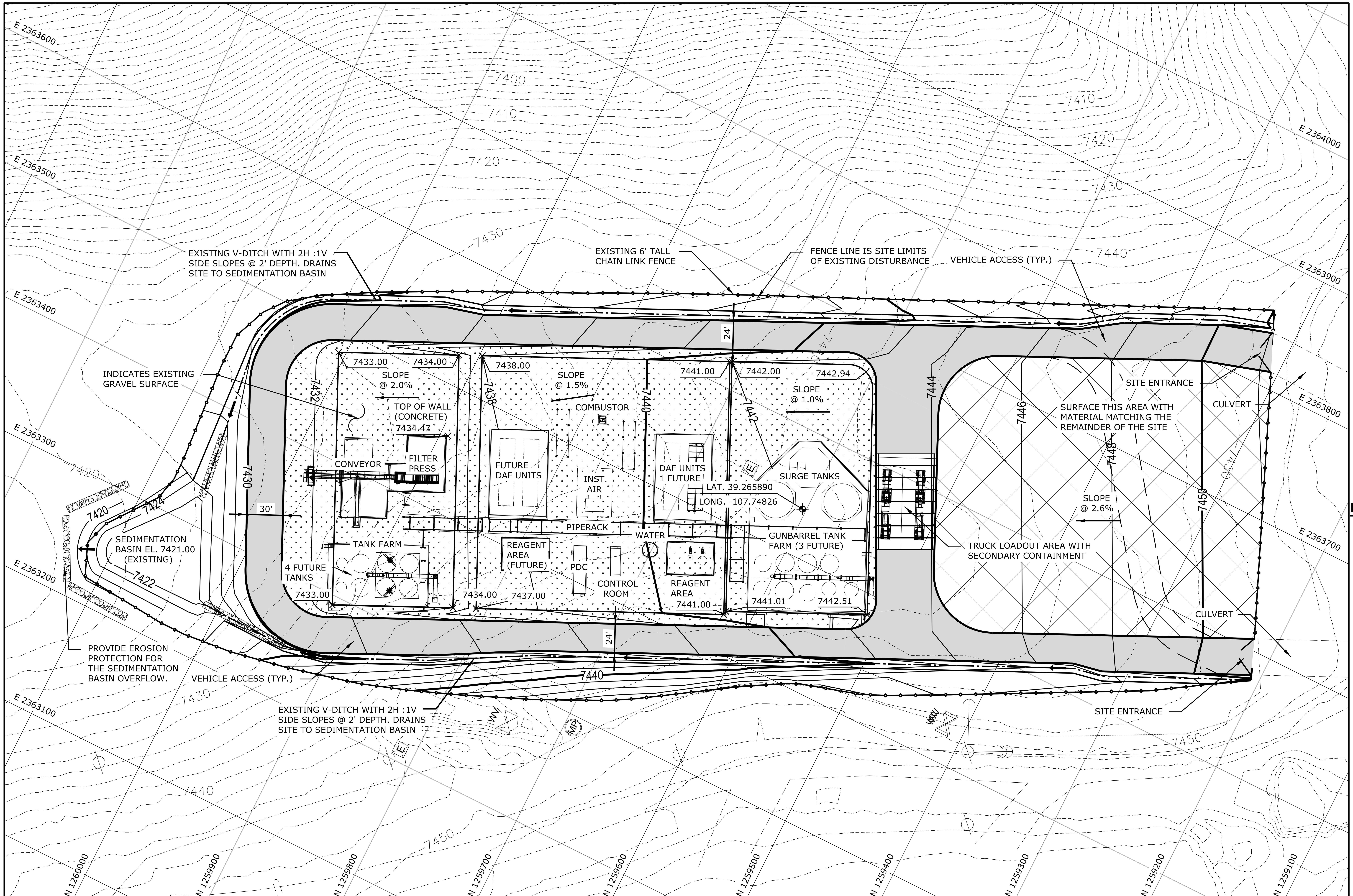
2. The west conveyance ditch is designed within the Report to include a culvert in a portion of the ditch. This appears to have been included due to grading constraints that would prevent an open channel ditch.

   It is recommended that this area be investigated further to determine that the ditch section is maintained throughout the area and verify that the grading anticipated within the Report was modified to allow for an open channel. Alternatively, a culvert may need to be installed to meet the design intent of the Report should additional verification confirm that the channel section does not meet the intent of the design of the Report.

Sincerely,

Wyatt E. Popp
Olsson Associates



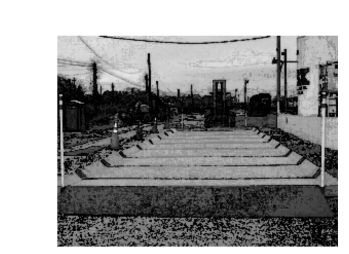


NOTES

1. THE HARRISON CREEK WATER TREATMENT FACILITY IS LOCATED IN THE NE AND SE 1/4 SECTIONS OF THE NE 1/4 OF SECTION 22, TOWNSHIP 9S, RANGE 67 W 6TH PRINCIPAL MERIDIAN, MESA COUNTY, STATE OF COLORADO.
2. THE PROJECT IS LOCATED AT A LATITUDE OF 39.265890° AND A LONGITUDE OF -107.748264°.
3. SITE GRADING AND SURFACING WAS COMPLETED IN EARLY 2010. EARTHWORK WILL BE LIMITED TO SHAPING AND GENERAL CLEANUP OF THE SITE TO RESTORE TO THE PREVIOUSLY GRADED CONDITION.
4. SITE DRAINAGE WILL FOLLOW THE ORIGINAL DESIGN INTENT WITH ALL SITE DRAINAGE DIRECTED TO THE SEDIMENTATION BASIN LOCATED AT THE NORTH END OF THE SITE.
5. A STATE OF COLORADO DEPARTMENT OF PUBLIC HEALTH CONSTRUCTION ACTIVITIES STORM WATER MANAGEMENT PLAN, PERMIT NUMBER COR03000D, CERTIFICATE NUMBER COR03K454 INCLUDES INFORMATION OF EROSION CONTROL MEASURES USED DURING THE ORIGINAL EARTHWORK CONSTRUCTION. REFER TO THIS PERMIT AND PERFORM MAINTENANCE, REPAIR OR REPLACEMENT OF ALL EXISTING AND PROPOSED SITE EROSION CONTROL MEASURES.
6. NO ADDITIONAL DISTURBANCE IS PLANED FOR THIS SITE.
7. SECONDARY CONTAINMENT FOR EQUIPMENT CONSISTS OF CONCRETE WITH WALLS OF VARYING HEIGHTS DEPENDING ON THE REQUIRED VOLUME OF CONTAINMENT NEEDED.

LEGEND

DENOTES FLOW ARROW
7430 MAJOR CONTOUR (EXISTING)
MINOR CONTOUR (EXISTING)
7440 MAJOR CONTOUR (2010 GRADING)
7446 MINOR CONTOUR (2010 GRADING)
CHAIN LINK FENCE
DITCH CENTERLINE
TYPE L RIP-RAP EROSION CONTROL
CRUSHED GRAVEL OVER GEOTEX 250 ST FABRIC (OR EQUAL) COMPACTED TO 95% S.P.D. (FOR SITE BENCH ROAD PERMANENT SURFACING)
4" CRUSHED GRANITE COMPACTED TO 95% S.P.D. (MATCH EXISTING MATERIALS)
TYPE L RIP-RAP EROSION CONTROL
CRUSHED GRAVEL OVER GEOTEX 250 ST FABRIC (OR EQUAL) COMPACTED TO 95% S.P.D. (FOR SITE BENCH ROAD PERMANENT SURFACING)
4" CRUSHED GRANITE COMPACTED TO 95% S.P.D. (MATCH EXISTING MATERIALS)



PROPOSED TRUCK LOADOUT CONTAINMENT

ISSUED FOR PERMIT
Not For Construction

Know what's below. Call before you dig.

REFERENCE DRAWINGS (DWG NO. / DESCRIPTION) — none listed

REVISIONS

NO.	DESCRIPTION	DATE	BY
C	ISSUED FOR PERMIT (GENERAL TEXT CHANGE.)	03-19-15	MAS
B	ISSUED FOR PERMIT (ADD FUTURE EQUIP.)	02-24-15	MAS
A	ISSUED FOR PERMIT	02-18-15	MAS

		DATE
SCALE:	1"=40'	
DESIGNED:	E. CURTIS	02-06-15
DRAWN:	M. SKELSKEY	02-18-15
CHECKED:	E. CURTIS	02-18-15
APPROVED:	K. MAHONEY	02-18-15
APPROVED:		

CLIENT: PICEANCE ENERGY II, LLC
LOCATION: MESA COUNTY

Samuel Engineering
We Provide Solutions
8450 E. Crescent Parkway, Suite 200
Greenwood Village, CO 80111
Phone: 303.714.4840
Fax: 303.714.4800

TITLE
HARRISON CREEK
WATER TREATMENT FACILITY
CIVIL
LAYOUT AND GRADING PLAN

PROJECT NO. 14130
DRAWING NUMBER 0100-CE-101
REV. C

CAD File: S:\Projects\14130-Laramie_Energy_Wastewater_Plant\CAD\Civil\Drawings\0100-CE-101.dgn
Plot Date: 3/18/2015 2:19:17 PM Plotted By: mskelskey

DRAINAGE REPORT

for

HARRISON CREEK PRODUCED WATER RECYLCING FACILITY
MESA COUNTY, COLORADO

SUBMITTED TO:

MESA COUNTY PLANNING AND DEVELOPMENT
750 MAIN STREET
GRAND JUNCTION, COLORADO 81501

PREPARED FOR:

Delta Petroleum Corp.
c/o Cordilleran Compliance Services, a division of Olsson Associates
826 21 ½ Road
Grand Junction, CO 81505

PREPARED BY:

Rhino Engineering, Inc.
1229 North 23rd Street, Suite 201
Grand Junction, Colorado 81501

December 9, 2008
Revised June 25, 2009

RE Project No. 28046.02

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"I hereby certify that this Final Drainage Report for the design of the Harrison Creek Produced Water Recycling Facility located in the NE ¼ of Section 22, Township 9S, Range 93W of the 6th Principal Meridian in Mesa County, Colorado, was prepared by me or under my direct supervision in accordance with the provisions of the Stormwater Management Manual for the owners thereof. I understand that Mesa County does not and will not assume liability for drainage facilities designed by others."

John Emil Kornfeld, P.E.
Registered Professional Engineer
State of Colorado No. 33064

Report Prepared by:
Jennie E. DeFrank, E.I.
Project Engineer

"I Delta Petroleum (*Name of Developer*) hereby certify that the drainage facilities for Harrison Creek Produced Water Recycling Facility shall be constructed according to the design presented in this report. I understand that Mesa County does not and will not assume liability for the drainage facilities designed and/or certified by my engineer. I understand that Mesa County reviews drainage plans but cannot, on behalf of Harrison Creek Produced Water Recycling Facility, guarantee that final drainage design review will absolve Delta Petroleum (*Name of Developer*) and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the Final Plat and/or Final Development Plan does not imply approval of my engineer's drainage design.

Delta Petroleum Corp.
Name of Developer

[signature] 4/29/09
Authorized Signature Date

John R. Wallace
President and COO

TABLE OF CONTENTS

APPENDICES

EXHIBITS

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1.0 LOCATION AND DESCRIPTION OF PROPERTY

A. Background

This drainage report for the Harrison Creek Produced Water Recycling Facility was prepared by Rhino Engineering, Inc. in response to review comments provided by Mesa County on February 9, 2009. The purpose of this report is to evaluate the impact (or change) to the existing drainage pattern and peak runoff from the addition to the site.

B. Property Location

The facility will be located south of Mesa County Road 330, east of Collbran on property owned by Delta Petroleum Corporation. The site is accessed by an unpaved access road connected to County Road 330.

By legal description, the property is located in the NE ¼ of Section 22, Township 9S, Range 93W of the 6th Principal Meridian in Mesa County. Refer to Figure 1 – General Location Map.

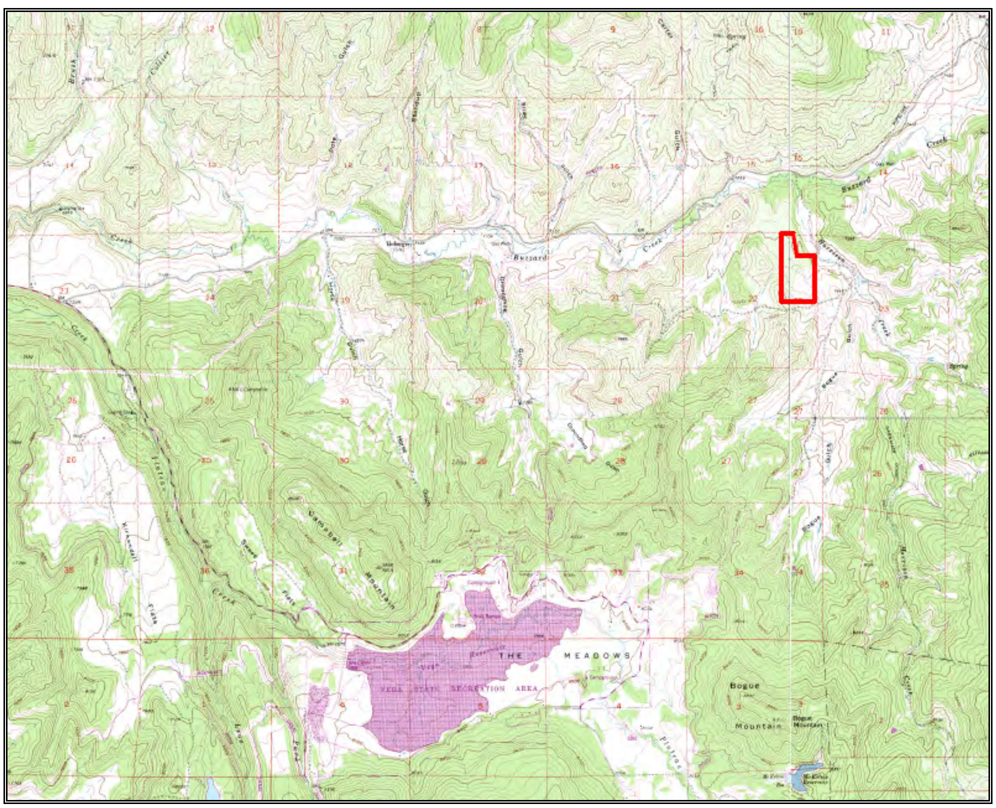


Figure 1- General Location Map

C. Description of Property

The property is situated in a remote area located east of Collbran and south of Highway 330. The approximately 8.1 acre disturbance area for the proposed facility will be located just east of the existing compressor station.

Current vegetation onsite is sagebrush and desert shrub with fair to good ground cover. The general area slopes to the north/northeast. The existing compressor station has a stormwater ditch around the perimeter to collect runoff. There is also an earthern irrigation ditch that flows in a northwesterly direction which is located to the south and west of the proposed facility.

According to the Natural Resource Conservation Service (NRCS), the soils in this area consist mostly of Hesperus-Empedrado Complex and Pagoda-Hesperus Complex Soils which are Hydrologic Group B and Hydrologic Group C soils respectively. These soils are well drained and are comprised of loam and clay loam soils. Refer to Appendix A for the soils map and further information.

D. Previous Investigations

The project site is not included in any known master drainage plan nor is it located in a FEMA designated floodplain. A previous report prepared for a similar compressor site northeast of Collbran was used as a reference for this report.

2.0 DRAINAGE SYSTEM DESCRIPTION

A. Existing Drainage Conditions

The topography of the surrounding area is fairly mountainous. Slopes across the footprint area range from about 2%-10%. There is a sharp drop off into Harrison Creek located east of the site. Refer to Exhibit 1 – Major Drainage Basin Map.

The total disturbance area for the new facility is approximately 8.1 acres. Current vegetation is desert shrub and sagebrush in fair to good condition. Rational method coefficients for 0% imperviousness on Type ‘B’ soils are 0.02, 0.15, and 0.35 for the 2-year, 10-year and 100-year storms. The time of concentration is:

$$t_t = \frac{1.8(1.1-0.15)\times 300^{1/2}}{8^{1/3}} = 14.8\,\text{min}$$

$$t_s = \frac{665\,ft}{7 \times 0.03^{0.5}} = 548s = 9.1\min$$

$$t_c = t_t + t_s = 14.8\min + 9.1\min = 23.9\min$$

Table 1 – Existing Peak Runoff Rates

Drainage Basin	Area (Ac)	2-Year Peak Runoff (cfs)	10-year Peak Runoff (cfs)	100-year Peak Runoff (cfs)
Existing Site	8.1	0.2	2.6	8.7

B. Master Drainage Plan

There are no known master drainage plans or adjacent developments which affect the site.

C. Offsite Tributary Area

The area is located in the Harrison Creek Watershed. Harrison Creek drains northerly into Buzzard Creek which is a tributary to Plateau Creek. There is very little development in the drainage basin. Vegetation consists mostly of desert shrub and sagebrush.

The site is affected by offsite runoff from an area to the south of about 67 acres. An SCS Curve Number of 63 was used for offsite conditions. Runoff rates are presented in Table 2. Offsite runoff from this basin should be re-directed to the northwest by the existing irrigation ditch and elevated access road. Very little, if any offsite runoff should overtop the road and affect the location of the new pad.

Table 2 – Offsite Runoff

Drainage Basin	Area (Ac)	2-year Peak Runoff (cfs)	10-year Peak Runoff (cfs)	100-year Peak Runoff (cfs)
Offsite	67	0.0	1.3	16.5

$$t_t = \frac{1.8(1.1 - 0.15) \times 300^{1/2}}{14^{1/3}} = 12.4\min$$

$$t_t = \frac{3200\,ft}{7\times 0.14^{0.5}} = 1222s = 20.4\,\text{min}$$

$$t_c = 12.4 + 20.4 = 32.8\ \text{min}$$

D. Proposed Drainage System Description

The new facility will be situated to the east of the existing compressor station and access road. A drainage ditch will be constructed around the outside perimeter of the road to collect runoff from the site and route it to the sand filter detention basin. This ditch will have a top width of approximately 8-feet with 2:1 side slopes and a depth of 2-feet. Assuming an average slope of 2.5%, the normal flow depth in the ditch is about 1-foot for a flow of 9.2 cfs. This ditch cross section will provide adequate capacity and freeboard to convey 100-year flows from offsite flows and the facility to the detention pond. Additionally, the full flow capacity of the ditch at a depth of 1.5-feet (with the minimum 0.5-feet of freeboard) is about 27.1 cfs which should convey any offsite flows around the site. Refer to Appendix C for developed drainage calculations and Exhibit 3 – Post-Development Drainage Map for details.

The total disturbance area is approximately 8.1 acres. All of this area is on hydrologic group 'B' soils. Land use breakdown in this area is:

Gravel Access Road:	1.5 Ac	40% Impervious (Table 701)
Pad Area:	3.5 Ac	80 % Impervious (Table 701)
Remaining Area:	3.1 Ac	0% Impervious

The overall site impervious value is: $\frac{(1.5Ac\times 0.40)+(3.5Ac\times 0.80)}{8.1Ac} \approx 42\%$

Using Table 702 in the Mesa County SWMM Manual, the 2-year, 10-year, and 100-year Rational Method coefficients for a percent imperviousness of 41% on Type 'B' soils are: 0.24, 0.36, and 0.50.

Time of Concentration for Basin A

$$t_t = \frac{1.8(1.1-0.31)\times 300^{1/2}}{6^{1/3}} = 13.6\,\text{min}$$

$$t_t = \frac{130\,ft}{20\times 0.046^{0.5}} = 30s = 0.5\,\text{min}$$

$$t_t = \frac{750\,ft}{20\times 0.022^{0.5}} = 253s = 4.2\,\text{min}$$

$$t_c = 13.6 + 0.5 + 4.2 = 18.3\ \text{min}$$

Time of Concentration for Basin B

$$t_t = \frac{1.8(1.1-0.31)\times 300^{1/2}}{6^{1/3}} = 13.6\,\text{min}$$

$$t_t = \frac{290\,ft}{20\times 0.028^{0.5}} = 87s = 1.5\,\text{min}$$

$$t_t = \frac{700\,ft}{20\times 0.022^{0.5}} = 236s = 3.9\,\text{min}$$

$$t_c = 13.6 + 1.5 + 3.9 = 19.0\ \text{min}$$

Table 3 – Post-Development Site Runoff

Drainage Basin	Area (Ac)	2-year Peak Runoff (cfs)	10-year Peak Runoff (cfs)	100-year Peak Runoff (cfs)
Basin A	4.2	1.7	3.8	7.6
Basin B	3.6	1.4	3.1	6.4
A & B Combined	**7.8**	**3.0**	**6.8**	**13.7**

The minimum detention storage system was calculated using Equations 1402 through 1404 based on the total site imperviousness.

$$K_{10} = (0.95P - 1.90)\,{}^{X_{10}}\!/_{1000} = (0.95\times 42 - 1.90)\times {}^{0.26}\!/_{1000} = 0.00988$$
$$V_{10} = 0.00988 \times 8.1Ac = 0.08AF \approx 3{,}485\ cf$$
$$K_{100} = (1.78P - 0.002P^2 - 3.56)\,{}^{X_{100}}\!/_{900} = (1.78\times 42 - 0.002\times 42^2 - 3.56)\times {}^{0.42}\!/_{900} = 0.03158$$
$$V_{100} = 0.03158 \times 8.1Ac = 0.2558AF \approx 11{,}140\ cf$$

Maximum Release Rate

$$Q_{100}\ Max = 0.43 \times A = 0.43 \times 8.1Ac = 3.5\ cfs$$

A sand filter detention basin will provide 22,000 cubic feet of storage and will provide release rates less than the maximum allowable. The basin will be 4-feet deep with 4:1 side slopes. No groundwater was found in borings performed for the geotechnical engineering report for the neighboring MVS Compressor Station at 22 feet and 33 feet. Therefore groundwater should not be an issue with construction of the detention basin. The outlet design will consist of a small area inlet with an overflow grate for volumes greater than the water quality capture volume. The water quality capture volume was determined using a 40-hour drain time.

$$WQCV = K\{a(0.91\times I^3 - 1.19\times I^2 + 0.78I)\} = 0.65\{1.0(0.91\times 0.42^3 - 1.19\times 0.42^2 + 0.78\times 0.42)\} = 0.120$$

$$\mathrm{Re}\,q\ WQCV\ \ Storage = 1.2\left(\frac{0.120}{12}\right)\times 8.1Ac = 0.097Ac - ft \approx 4{,}225\ cf$$

Table 4 – Detention Parameters

Parameter	WQCV	10yr Storm	100yr Storm
Max Storage (cf)	6,030	8,000	15,000
Max Release (cfs)	N/A	2.4	3.5
Capacity of Pond	27%	36%	68%

Rip-rap protection at the 12-inch detention outlet is based on the 10-year design with a normal flow depth of 0.55 feet and velocity of 5.4 ft/s. These values were calculated with Urban Drainage and Flood Control District spreadsheets. Refer to Appendix C for printouts. Rip-rap pad dimensions were calculated as follows:

Length $L_a = \frac{3Q}{D_o^{1.5}} + 7D_o = \frac{3 \times 2.4}{1^{1.5}} + (7 \times 1) = 14.2 \rightarrow 15\ ft$

Width $W = 3(D_o) + 0.4L_a = 3(1) + 0.4(14.2) = 8.7 \rightarrow 10\ ft$

Median Stone Size $D_{50} = \frac{0.02(Q)^{1.33}}{TW(D_o)} = \frac{0.02(2.4)^{1.33}}{0.55 \times 1} = 0.12 ft = 1.4\ in \rightarrow use\ 6\ in$

The rip-rap pad at the outlet of the 18-inch CMP culvert which will convey site drainage in the proposed ditch on the west side of the pad was sized based on a 10-year design normal flow depth of 0.47 feet and a velocity of 3.4 ft/s.

Length $L_a = \frac{1.8Q}{D_o^{1.5}} + 7D_o = \frac{1.8 \times 1.6}{1.5^{1.5}} + (7 \times 1.5) = 12.1 \rightarrow 12\ ft$

Width: Bottom and Sides of Channel up to a depth of 1.5 feet above flowline

Median Stone Size $D_{50} = \frac{0.02(Q)^{1.33}}{TW(D_o)} = \frac{0.02(1.6)^{1.33}}{0.47 \times 1.5} = 0.05 ft = 0.6\ in \rightarrow use\ 6\ in$

E. Drainage Facility Maintenance

Routine (yearly) maintenance will include trimming/removal of vegetation overgrowth in proposed ditches and cleaning of trash debris and sediment buildup in detention outlet and culverts. Approximately once every five years, the top 1-2 inches of sand at the bottom of the sand filter basin should removed as pollutants accumulate and clog the layer. After several layers have been removed, all the sand should be replaced with a new 10-inch layer. Maintenance will be the responsibility of Delta Petroleum Corporation.

3.0 DRAINAGE ANALYSIS AND DESIGN CRITERIA

A. Regulations

The analysis and design outlined in this report were prepared in accordance with the provision of the Mesa County Stormwater Management Manual.

B. Development Criteria

There are no drainage constraints placed on the project by major drainage or floodplain studies or adjacent developments.

C. Hydrologic Criteria

Peak runoff rates were determined using the Rational Method. Coefficients were used per the guidelines listed in Table 702 of the Mesa County SWMM Manual. Times of concentration were calculated using Equations 701 through 703. Intensity-duration-frequency data were identified using the Federal Highway Administration's Hydrain program since the Collbran area is outside the Grand Valley. Refer to Appendix B for program output. The 10-year and 100-year storms were considered "minor" and "major" events respectively.

D. Hydraulic Criteria

The Denver Urban Drainage and Flood Control District's Sewer and Culvert Hydraulics and Open Channel Flow software was used to size and calculate capacities of culverts and ditches. The detention basin area was calculated using the average end area method.

4.0 POST CONSTRUCTION STORMWATER MANAGEMENT

A. Stormwater Quality Control Measures

A sand filter detention basin will be utilized for stormwater quality control. The basin will be 4-feet deep with 4:1 side slopes and will provide about 22,000 cubic feet of storage. A minimum 1-foot of freeboard will be maintained. 4-inch perforated plastic pipe will be placed beneath the pond bottom to collect and route infiltrated stormwater to the outlet box. An overflow grate will intercept all flows exceeding the stormwater quality control volume. A 12-inch outlet from the concrete outlet box will discharge treated stormwater from the pond to Harrison Creek.

B. Calculations

$$WQCV = K\{a(0.91 \times I^3 - 1.19 \times I^2 + 0.78I)\} = 0.65\{1.0(0.91 \times 0.42^3 - 1.19 \times 0.42^2 + 0.78 \times 0.42)\} = 0.120$$

$$\text{Re}q\ WQCV\ \ Storage = 1.2\left(\frac{0.120}{12}\right) \times 8.1Ac = 0.097Ac - ft \approx 4{,}225\ cf$$

The storage volume is based on 120% of the required water quality capture volume to account for sediment storage. Actual provided water quality capture volume based on the detention design is 6,030 cubic feet.

5.0 CONCLUSIONS

A. Compliance with Manual

This drainage report complies with the 2008 Mesa County SWMM Manual.

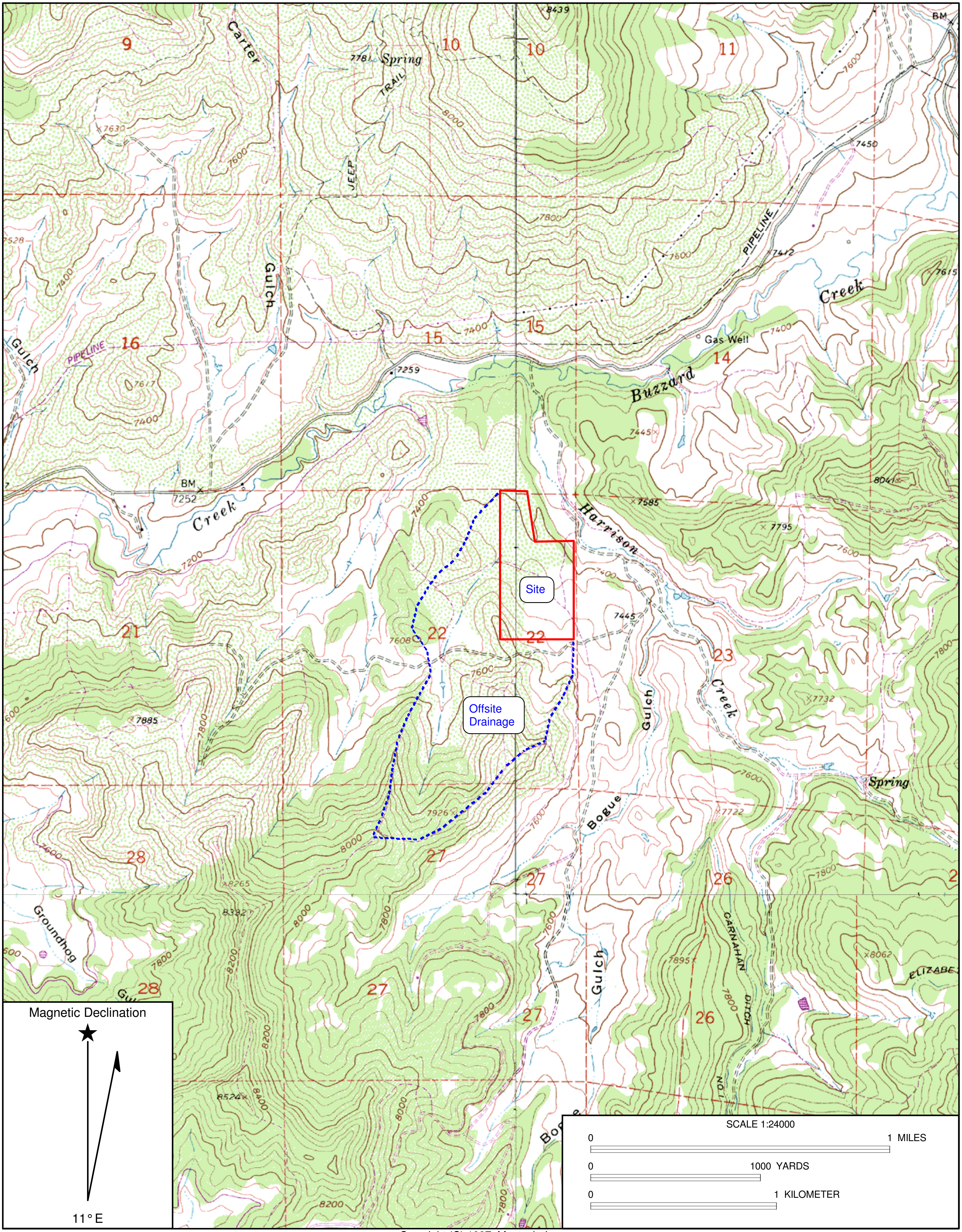
B. Design Effectiveness

The drainage facilities outlined in this report including detention, culverts, and ditches were designed to effectively control impacts of storm runoff to adjacent properties.

6.0 REFERENCES

The following manuals, computer programs, and engineering reports were used as references in the preparation of this report.

- Stormwater Management Manual, City of Grand Junction and Mesa County, May 2008.
- The NRCS method Technical Release 55 entitled “Urban Hydrology for Small Watersheds” was used to calculate times of concentration.
- Hydraflow Hydragraphs 2004 Software was used to calculate runoff volumes and for detention routing
- Denver Urban Drainage and Flood Control District Open Channel Design Version 1.01, April 2004
- Geotechnical Engineering Study Proposed Delta Petroleum Mega Vega Compressor Station South of County Road 330, Kumar and Associates, Inc. April 2008


Site
Offsite Drainage
Carter
Gulch
Spring
TRAIL
JEEP
PIPELINE
Gas Well
Buzzard
Creek
Harrison
Creek
Bogue
Gulch
Groundhog
GARNAHAN
DITCH
NO 1
Spring
Magnetic Declination
11° E
SCALE 1:24000
0
1 MILES
0
1000 YARDS
0
1 KILOMETER

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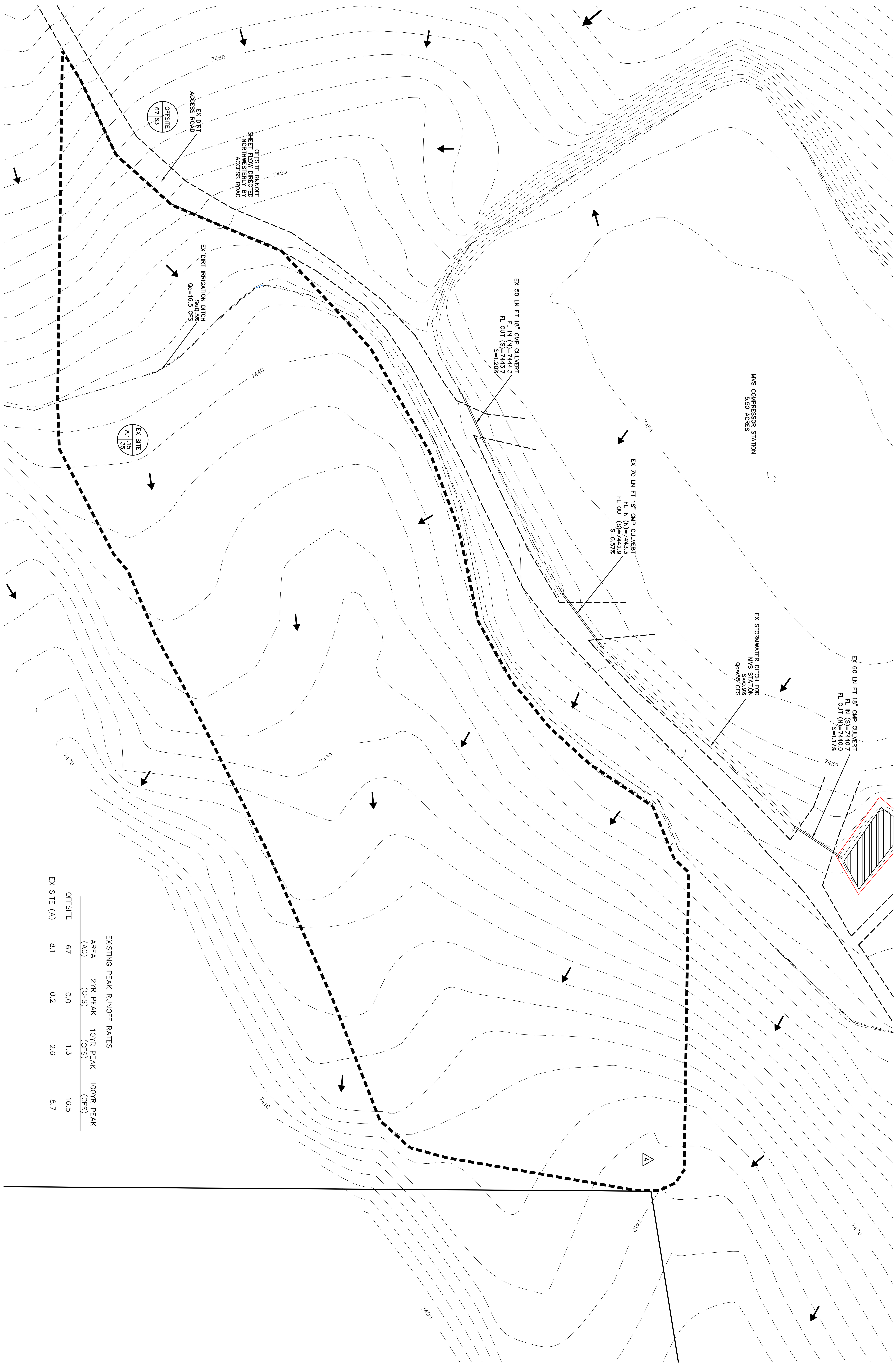


GRAPHIC SCALE

0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

EXISTING PEAK RUNOFF RATES

	AREA (AC)	2YR PEAK (CFS)	10YR PEAK (CFS)	100YR PEAK (CFS)
OFFSITE	67	0.0	1.3	16.5
EX SITE (A)	8.1	0.2	2.6	8.7

LEGEND

- DITCH FLOWLINE
- DRAINAGE BASIN BOUNDARY
- DIRECTION OF DRAINAGE
- CONCENTRATION PT
- A BASIN
- B AREA (AC)
- C 10YR RATIONAL COEFFICIENT
- D 100YR RATIONAL COEFFICIENT

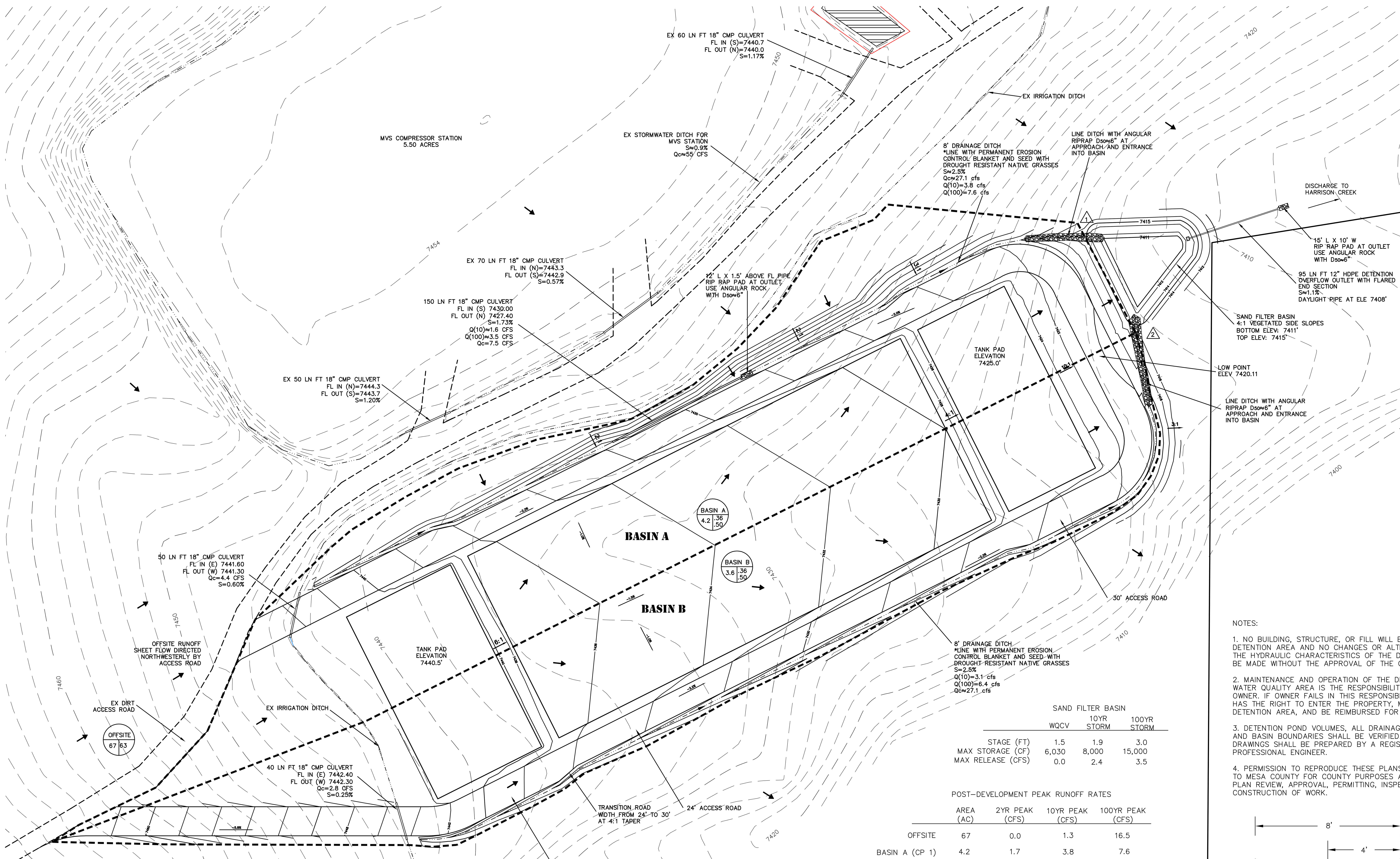
BENCHMARK
E ¼ CORNER SECTION 22
TOWNSHIP 9S, RANGE 93W
N 7575.37
E 8975.40
ELEV 7503.70

RHINO ENGINEERING, INC.
1229 N 23RD ST SUITE 201
GRAND JUNCTION, CO 81501
970.241.6027 fax 970.256.7992

EXHIBIT 2
EXISTING DRAINAGE MAP
HARRISON CREEK PRODUCED
WATER RECYCLING FACILITY
MESA COUNTY, COLORADO

REVISION	DATE	DESCRIPTION	BY	CK
1	4/16/09	RO. 1 COMMENTS	JED	JEK
2	6/25/09	COGCC COMMENTS	JED	JEK

REVIEWED BY JEK
PREPARED BY JED
DATE 12/9/08
SCALE 1" =50'
PROJECT NO 28046.02
SHEET NO 1



SAND FILTER BASIN

	WQCV	10YR STORM	100YR STORM
STAGE (FT)	1.5	1.9	3.0
MAX STORAGE (CF)	6,030	8,000	15,000
MAX RELEASE (CFS)	0.0	2.4	3.5

POST-DEVELOPMENT PEAK RUNOFF RATES

	AREA (AC)	2YR PEAK (CFS)	10YR PEAK (CFS)	100YR PEAK (CFS)
OFFSITE	67	0.0	1.3	16.5
BASIN A (CP 1)	4.2	1.7	3.8	7.6
BASIN B (CP 2)	3.6	1.4	3.1	6.4
A & B COMBINED	7.8	3.0	6.8	13.7

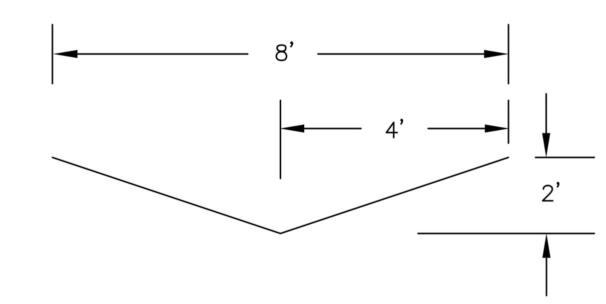
NOTES:

1. NO BUILDING, STRUCTURE, OR FILL WILL BE PLACED IN THE DETENTION AREA AND NO CHANGES OR ALTERATIONS AFFECTING THE HYDRAULIC CHARACTERISTICS OF THE DETENTION AREA WILL BE MADE WITHOUT THE APPROVAL OF THE COUNTY.

2. MAINTENANCE AND OPERATION OF THE DETENTION AND WATER QUALITY AREA IS THE RESPONSIBILITY OF THE PROPERTY OWNER. IF OWNER FAILS IN THIS RESPONSIBILITY, THE COUNTY HAS THE RIGHT TO ENTER THE PROPERTY, MAINTAIN THE DETENTION AREA, AND BE REIMBURSED FOR COST INCURRED.

3. DETENTION POND VOLUMES, ALL DRAINAGE APPURTENANCES, AND BASIN BOUNDARIES SHALL BE VERIFIED. AS BUILT DRAWINGS SHALL BE PREPARED BY A REGISTERED PROFESSIONAL ENGINEER.

4. PERMISSION TO REPRODUCE THESE PLANS IS HEREBY GIVEN TO MESA COUNTY FOR COUNTY PURPOSES ASSOCIATED WITH PLAN REVIEW, APPROVAL, PERMITTING, INSPECTION AND CONSTRUCTION OF WORK.



8-FOOT DRAINAGE DITCH DETAIL

MAGNETIC

GRAPHIC SCALE

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

LEGEND

- DITCH FLOWLINE
- DRAINAGE BASIN BOUNDARY
- DIRECTION OF DRAINAGE
- CONCENTRATION PT
- A BASIN
- B AREA (AC)
- C 10YR RATIONAL COEFFICIENT
- D 100YR RATIONAL COEFFICIENT

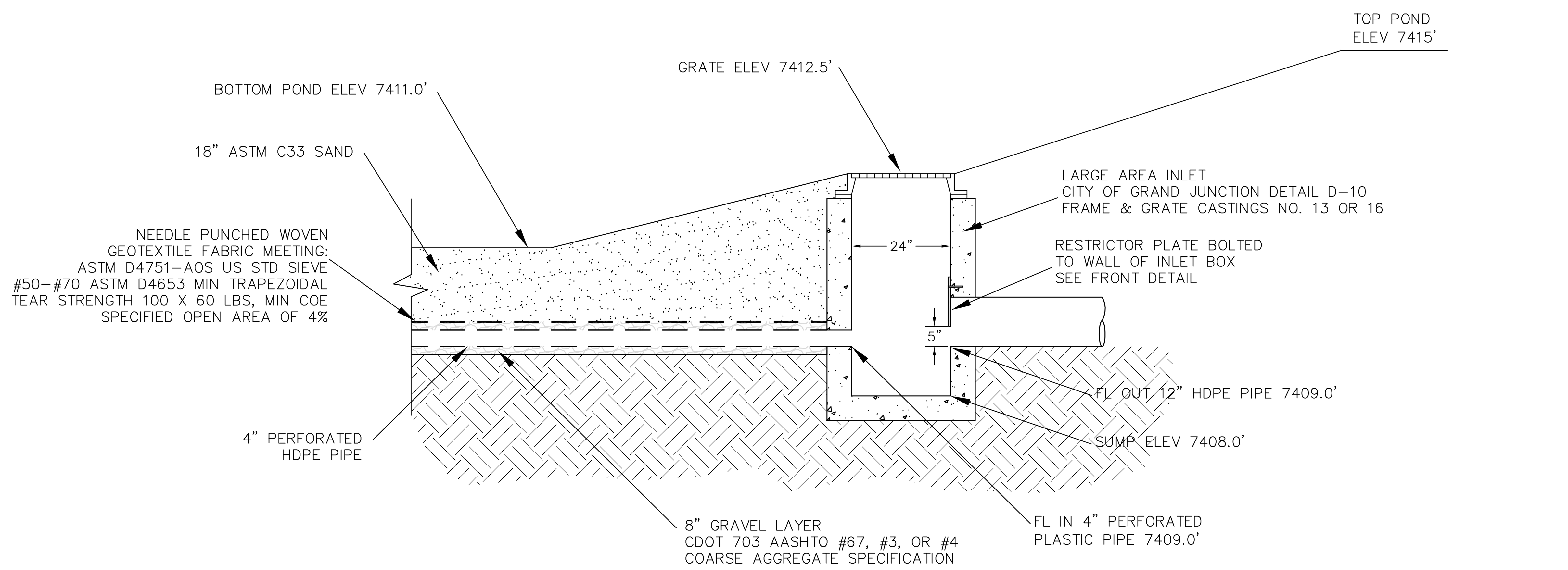
BENCHMARK
E ¼ CORNER SECTION 22
TOWNSHIP 9S, RANGE 93W
N 7575.37
E 8975.40
ELEV 7503.70

REVISION	DATE	DESCRIPTION	BY	CK
1	4/16/09	RO. 1 COMMENTS	JED	JEK
2	6/25/09	COGCC COMMENTS	JED	JEK

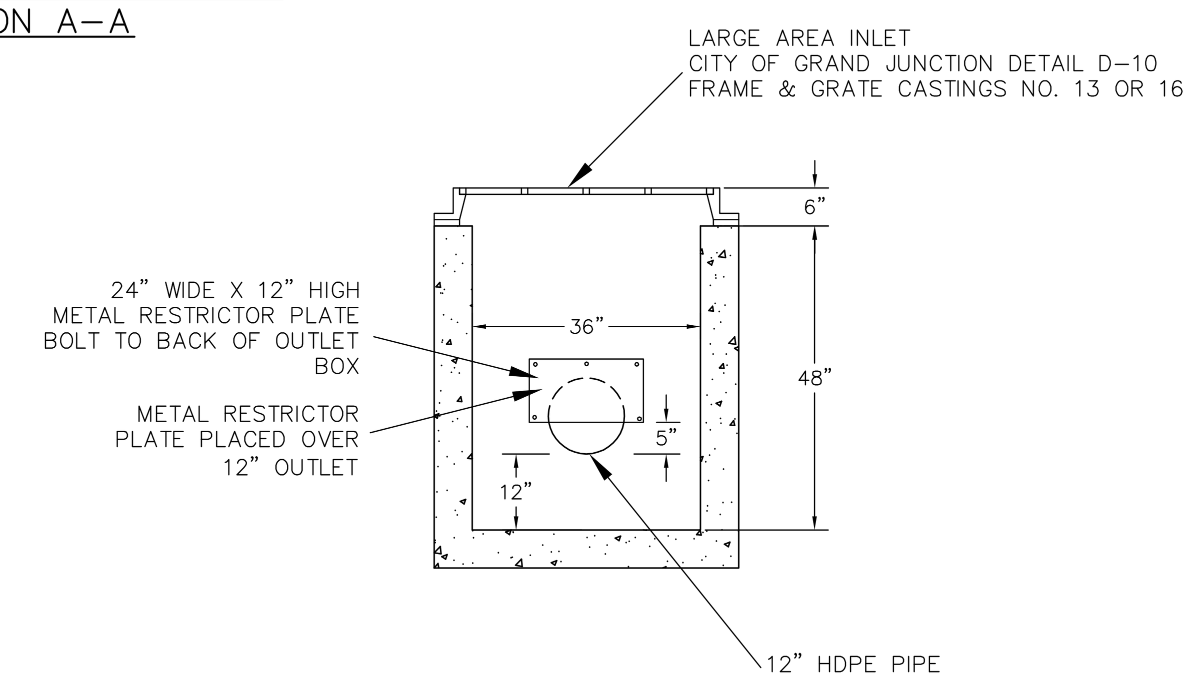
EXHIBIT 3
POST-DEVELOPMENT DRAINAGE MAP
HARRISON CREEK PRODUCED
WATER RECYCLING FACILITY
MESA COUNTY, COLORADO

RHINO ENGINEERING, INC.
1229 N 23RD ST SUITE 201
GRAND JUNCTION, CO 81501
970.241.6027 fax 970.256.7992

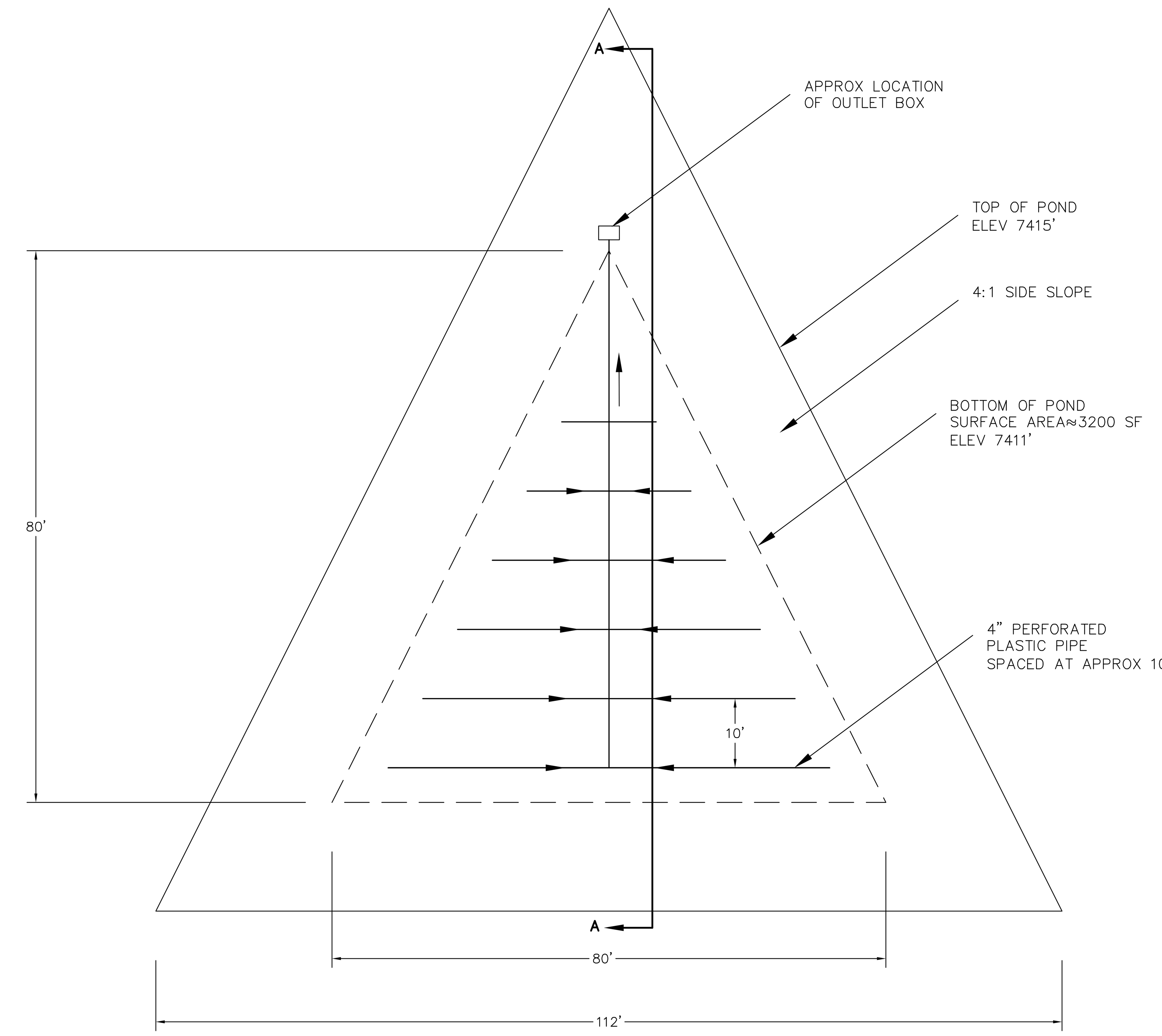
REVIEWED BY: JEK
PREPARED BY: JED
DATE: 12/9/08
SCALE: 1" =50'
PROJECT NO: 28046.02
SHEET NO: 2



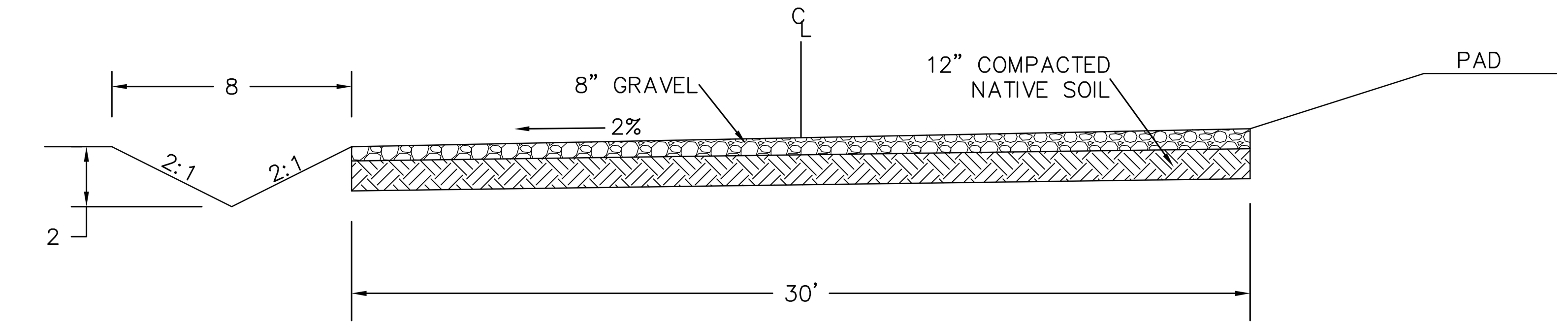
SAND FILTER BASIN SIDE VIEW
SECTION A–A



OUTLET BOX FRONT VIEW



SAND FILTER BASIN DIMENSIONS PLAN VIEW



ACCESS ROAD SECTION

REVISION	DATE	DESCRIPTION	BY	CK
1	4/16/09	RO. 1 COMMENTS	JED	JEK
2	6/25/09	COGCC COMMENTS	JED	JEK

EXHIBIT 4
DRAINAGE DETAILS
HARRISON CREEK PRODUCED
WATER RECYCLING FACILITY
MESA COUNTY, COLORADO

RHINO ENGINEERING, INC.
1229 N 23RD ST SUITE 201
GRAND JUNCTION, CO 81501
970.241.6027 fax 970.256.7992

REVIEWED BY JEK
PREPARED BY JED
DATE 12/9/08
SCALE 1" =50'
PROJECT NO 28046.02
SHEET NO 3

APPENDIX A
NRCS SOILS DATA

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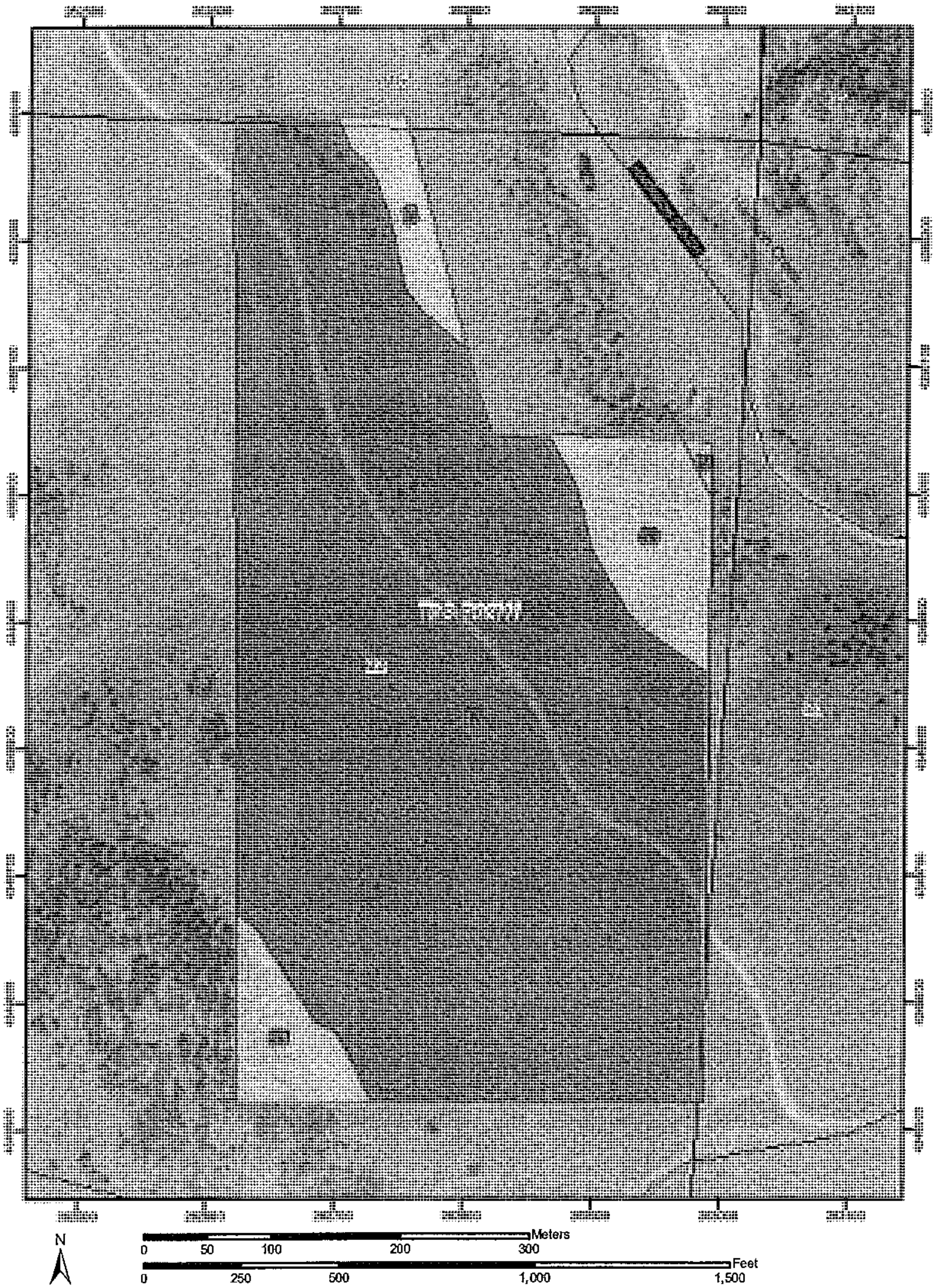

Appendix A-1

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Soil Ratings
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Political Features

Public Land Survey
- Township and Range
- Section

Municipalities
- Cities
- Urban Areas

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails

Roads
- Interstate Highways
- US Routes
- State Highways
- Local Roads
- Other Roads

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 13N

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Douglas-Plateau Area, Colorado, Parts of Garfield and Mesa Counties
Survey Area Data: Version 5, Feb 1, 2008

Date(s) aerial images were photographed: 1993

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

Appendix A-2

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Douglas-Plateau Area, Colorado, Parts of Garfield and Mesa Counties				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
19	Cerro silty clay loam, 6 to 12 percent slopes	C	0.1	0.2%
47	Hesperus-Empedrado, moist-Pagoda complex 5 to 35 percent slopes	B	50.2	87.2%
53	Pagoda-Hesperus complex, 12 to 40 percent slopes	C	7.2	12.6%
Totals for Area of Interest (AOI)			57.6	100.0%

Description

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

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

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

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

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

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

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

Map Unit: 47—Hesperus-Empedrado, moist-Pagoda complex 5 to 35 percent slopes

Component: Hesperus (35%)

The Hesperus component makes up 35 percent of the map unit. Slopes are 5 to 35 percent. This component is on mountainsides. The parent material consists of residuum weathered from sandstone and shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 4 percent. This component is in the R048AY238CO Brushy Loam ecological site. Nonirrigated land capability classification is 6e. This soil does not meet hydric criteria.

Component: Empedrado, moist (30%)

The Empedrado, moist component makes up 30 percent of the map unit. Slopes are 5 to 35 percent. This component is on benches. The parent material consists of colluvium derived from sandstone and shale and/or residuum weathered from sandstone and shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. This component is in the R048AY238CO Brushy Loam ecological site. Nonirrigated land capability classification is 6e. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 8 percent.

Component: Pagoda (20%)

The Pagoda component makes up 20 percent of the map unit. Slopes are 5 to 35 percent. This component is on benches, mountains. The parent material consists of colluvium derived from shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R048AY238CO Brushy Loam ecological site. Nonirrigated land capability classification is 6e. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 10 percent.

Map Unit: 53—Pagoda-Hesperus complex, 12 to 40 percent slopes

Component: Pagoda (50%)

Appendix A-4

The Pagoda component makes up 50 percent of the map unit. Slopes are 12 to 40 percent. This component is on mudflows. The parent material consists of alluvium derived from shale and/or colluvium derived from shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R048AY238CO Brushy Loam ecological site. Nonirrigated land capability classification is 7e. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 10 percent.

Component: Hesperus (20%)

The Hesperus component makes up 20 percent of the map unit. Slopes are 12 to 40 percent. This component is on hills. The parent material consists of alluvium derived from shale and/or colluvium derived from shale. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 4 percent. This component is in the R048AY238CO Brushy Loam ecological site. Nonirrigated land capability classification is 7e. This soil does not meet hydric criteria.

Data Source Information

Soil Survey Area: Douglas-Plateau Area, Colorado, Parts of Garfield and Mesa Counties
Survey Area Data: Version 5, Feb 1, 2008

Appendix A-6

Soils that have profiles that are almost alike make up a *soil series*. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Additional information about the map units described in this report is available in other soil reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the soil reports define some of the properties included in the map unit descriptions.

Report—Map Unit Description

Douglas-Plateau Area, Colorado, Parts of Garfield and Mesa Counties Version date: 2/1/2008 9:53:18 AM

19—Cerro silty clay loam, 6 to 12 percent slopes

Map Unit Setting

Elevation: 6,600 to 7,000 feet
Frost-free period: 80 to 90 days

Map Unit Composition

Cerro and similar soils: 70 percent

Description of Cerro

Setting

Landform: Hills
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Marine shales of the wasatch formation colluvium and/or marine shales of the wasatch formation residuum

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 10.7 inches)

Interpretive groups

Land capability (nonirrigated): 4e
Ecological site: Deep Clay Loam (R048AY247CO)

Typical profile

0 to 7 inches: Silty clay loam
7 to 12 inches: Silty clay loam
12 to 35 inches: Silty clay
35 to 60 inches: Silty clay loam

28—Cumulic Haploborolls, 1 to 3 percent slopes

Map Unit Setting

Elevation: 5,800 to 7,400 feet
Mean annual precipitation: 12 to 18 inches
Mean annual air temperature: 40 to 46 degrees F
Frost-free period: 80 to 110 days

Map Unit Composition

Cumulic haploborolls and similar soils: 90 percent

Description of Cumulic Haploborolls

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Wasatch shale formation alluvium and/or green river shale formation alluvium

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 36 to 72 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 4.0 mmhos/cm)
Available water capacity: Low (about 4.6 inches)

Interpretive groups

Land capability (nonirrigated): 4e
Ecological site: Foothill Swale (R048AY285CO)

Typical profile

0 to 8 inches: Gravelly sandy clay loam
8 to 20 inches: Very channery sandy clay loam
20 to 28 inches: Clay loam
28 to 60 inches: Stratified very gravelly sand to extremely gravelly loamy sand

47—Hesperus-Empedrado, moist-Pagoda complex 5 to 35 percent slopes

Map Unit Setting

Elevation: 6,200 to 8,500 feet
Mean annual precipitation: 18 to 20 inches
Mean annual air temperature: 42 to 44 degrees F
Frost-free period: 85 to 100 days

Map Unit Composition

Hesperus and similar soils: 35 percent
Empedrado, moist, and similar soils: 30 percent
Pagoda and similar soils: 20 percent

Description of Hesperus

Setting

Landform: Mountainsides
Landform position (three-dimensional): Mountainflank
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Residuum weathered from sandstone and shale

Properties and qualities

Slope: 5 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)

Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very high (about 21.2 inches)

Interpretive groups

Land capability (nonirrigated): 6e
Ecological site: Brushy Loam (R048AY238CO)

Typical profile

0 to 7 inches: Loam
7 to 60 inches: Clay loam, loam

Description of Empedrado, Moist

Setting

Landform: Benches
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium derived from sandstone and shale and/or residuum weathered from sandstone and shale

Properties and qualities

Slope: 5 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 9.7 inches)

Interpretive groups

Land capability (nonirrigated): 6e
Ecological site: Brushy Loam (R048AY238CO)

Typical profile

0 to 10 inches: Loam
10 to 21 inches: Clay loam
21 to 28 inches: Gravelly sandy clay loam
28 to 60 inches: Loam

Description of Pagoda

Setting

Landform: Benches, mountains
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear, concave
Across-slope shape: Linear
Parent material: Colluvium derived from shale

Properties and qualities

Slope: 5 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Very high (about 18.7 inches)

Interpretive groups
Land capability (nonirrigated): 6e
Ecological site: Brushy Loam (R048AY238CO)

Typical profile
0 to 6 inches: Clay loam
6 to 17 inches: Clay loam
17 to 27 inches: Clay loam, clay
27 to 60 inches: Clay loam, clay

53—Pagoda-Hesperus complex, 12 to 40 percent slopes

Map Unit Setting
Elevation: 7,400 to 8,000 feet
Mean annual precipitation: 18 to 22 inches
Frost-free period: 75 to 85 days

Map Unit Composition
Pagoda and similar soils: 50 percent
Hesperus and similar soils: 20 percent

Description of Pagoda

Setting
Landform: Mudflows
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Alluvium derived from shale and/or colluvium derived from shale

Properties and qualities
Slope: 12 to 40 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Very high (about 18.7 inches)

Interpretive groups
Land capability (nonirrigated): 7e
Ecological site: Brushy Loam (R048AY238CO)

Appendix A-11

Typical profile

0 to 6 inches: Clay loam
6 to 17 inches: Clay loam
17 to 27 inches: Clay loam, clay
27 to 60 inches: Clay loam, clay

Description of Hesperus

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear

Properties and qualities

Slope: 12 to 40 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very high (about 21.2 inches)

Interpretive groups

Land capability (nonirrigated): 7e
Ecological site: Brushy Loam (R048AY238CO)

Typical profile

0 to 7 inches: Loam
7 to 60 inches: Clay loam, loam

Data Source Information

Soil Survey Area: Douglas-Plateau Area, Colorado, Parts of Garfield and Mesa Counties
Survey Area Data: Version 5, Feb 1, 2008

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APPENDIX B
EXISTING DRAINAGE CALCULATIONS

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IDF Curve for Various Return Periods

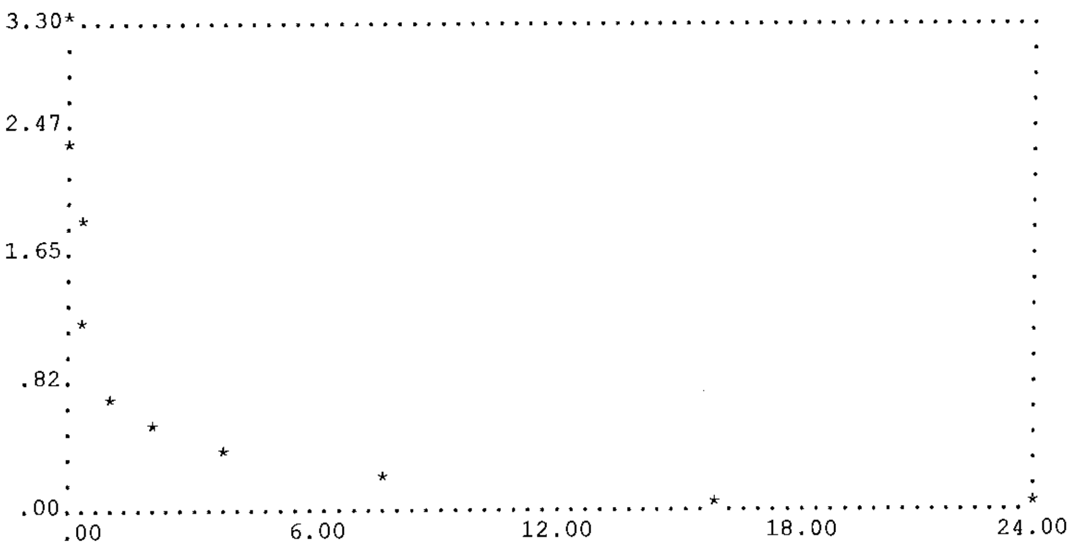
Intensities (in/h)

Duration	2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
5 min	3.296	4.014	4.461	5.043	5.467	5.871
10 min	2.436	3.044	3.430	3.943	4.322	4.688
15 min	1.839	2.370	2.715	3.179	3.527	3.866
30 min	1.171	1.559	1.817	2.171	2.441	2.707
60 min	.697	.951	1.122	1.362	1.546	1.730
120 min	.450	.613	.724	.878	.998	1.116
4 h	.263	.358	.423	.513	.583	.652
8 h	.143	.196	.231	.280	.318	.356
16 h	.075	.102	.121	.147	.167	.186
24 h	.051	.069	.082	.099	.113	.126

VEGA RESERVOIR

Intensity Curve for 2 Year Return Period

Rainfall Intensity (in/h) versus Duration (h)



Appendix B-1

Hydrograph Plot

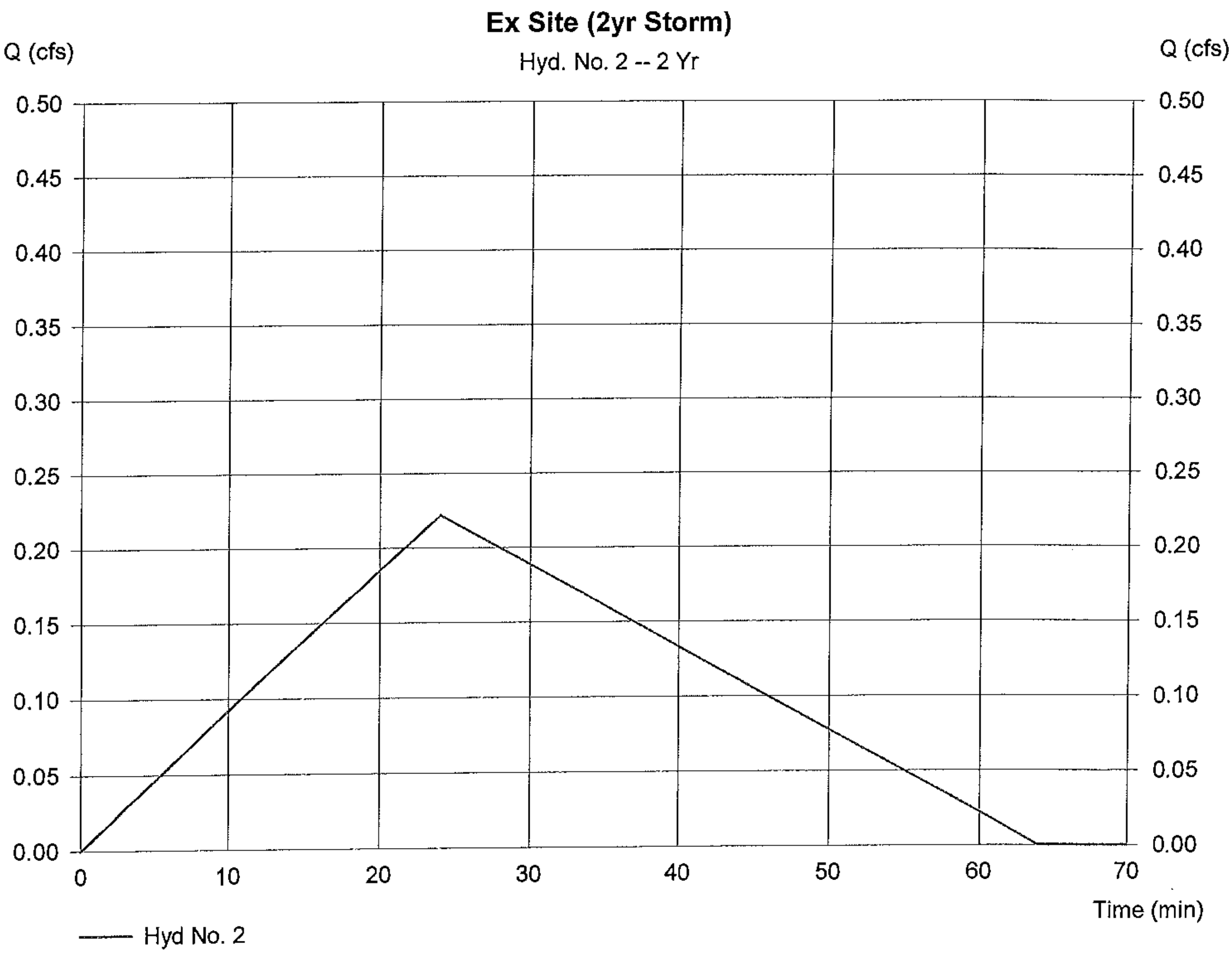
Hydraflow Hydrographs by Intelisolve — Tuesday, Apr 28 2009, 9:32 AM

Hyd. No. 2

Ex Site (2yr Storm)

Hydrograph type	= Rational	Peak discharge	= 0.22 cfs
Storm frequency	= 2 yrs	Time interval	= 1 min
Drainage area	= 8.100 ac	Runoff coeff.	= 0.02
Intensity	= 1.370 in/hr	Tc by User	= 24.00 min
IDF Curve	= Rifle IDF 25&100only.IDF	Asc/Rec limb fact	= 1/1.67

Hydrograph Volume = 427 cuft



Appendix B-2

Hydrograph Plot

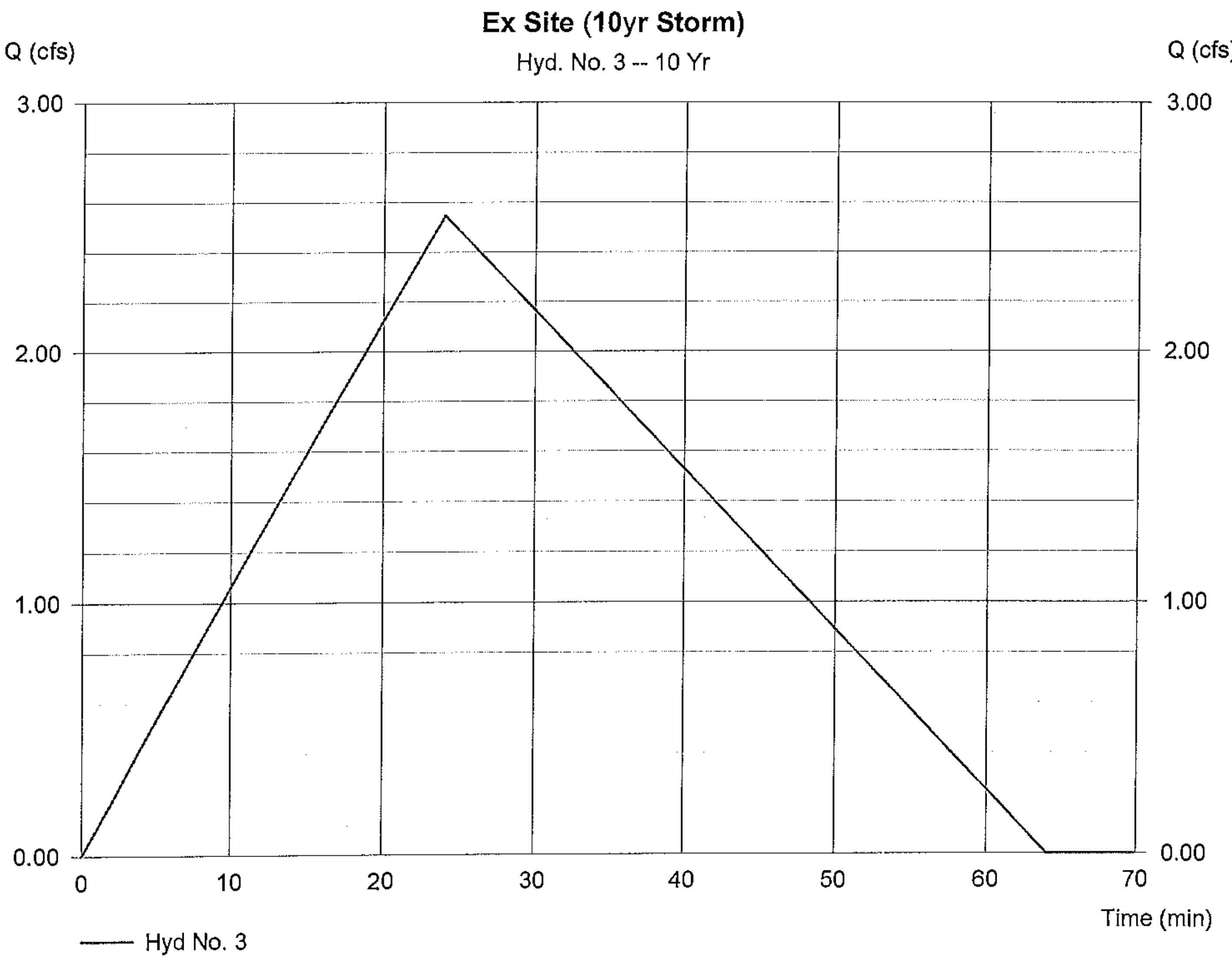
Hydraflow Hydrographs by Intelisolve | Tuesday, Apr 28 2009, 9:32 AM

Hyd. No. 3

Ex Site (10yr Storm)

Hydrograph type	= Rational	Peak discharge	= 2.55 cfs
Storm frequency	= 10 yrs	Time interval	= 1 min
Drainage area	= 8.100 ac	Runoff coeff.	= 0.15
Intensity	= 2.096 in/hr	Tc by User	= 24.00 min
IDF Curve	= Rifle IDF 25&100only.IDF	Asc/Rec limb fact	= 1/1.67

Hydrograph Volume = 4,895 cuft



Appendix B-3

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

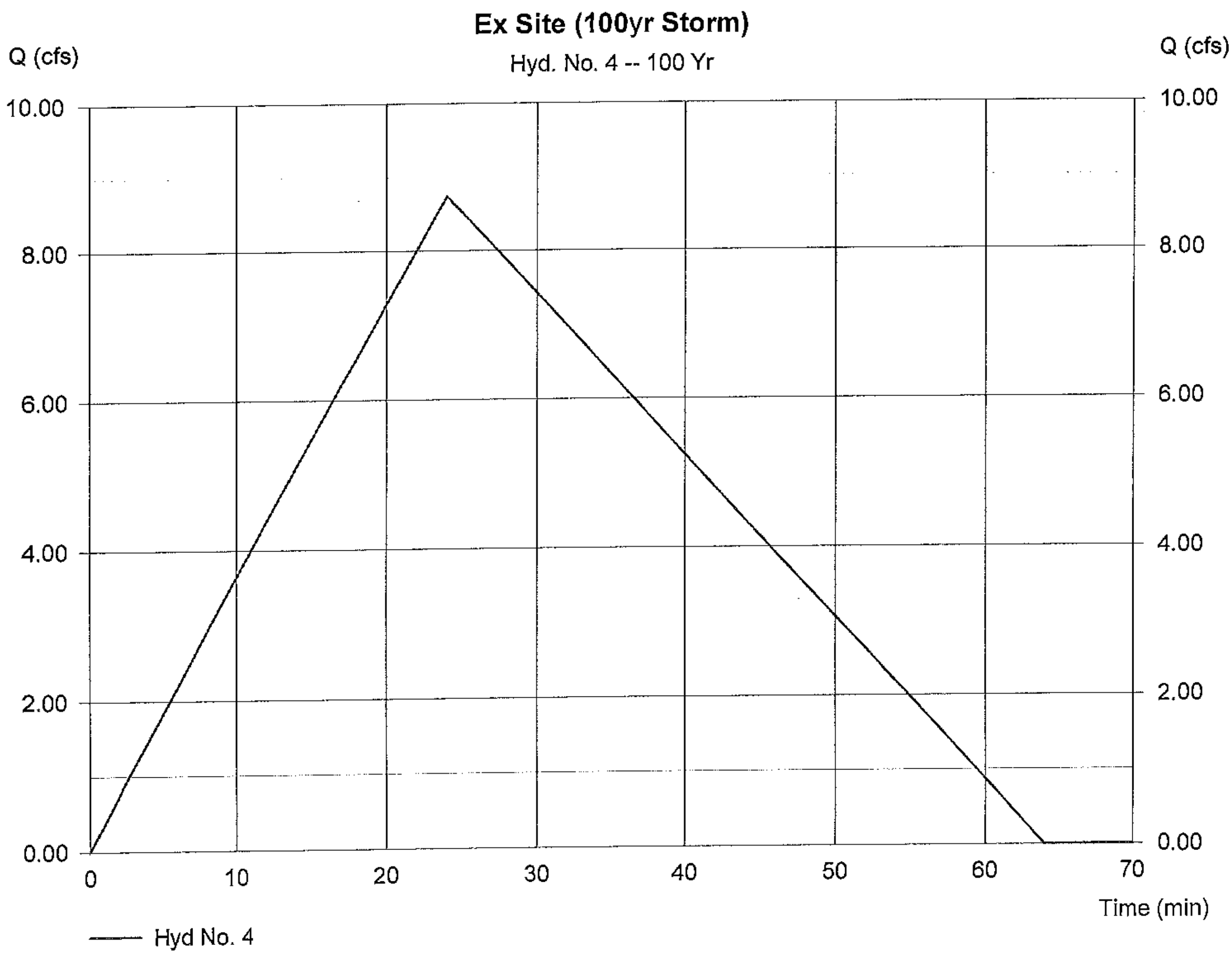
Tuesday, Apr 28 2009, 9:33 AM

Hyd. No. 4

Ex Site (100yr Storm)

Hydrograph type	= Rational	Peak discharge	= 8.73 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 8.100 ac	Runoff coeff.	= 0.35
Intensity	= 3.081 in/hr	Tc by User	= 24.00 min
IDF Curve	= Rifle IDF 25&100only.IDF	Asc/Rec limb fact	= 1/1.67

Hydrograph Volume = 16,791 cuft



Appendix B-4

APPENDIX C
POST-DEVELOPMENT DRAINAGE CALCULATIONS

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Hydrograph Plot

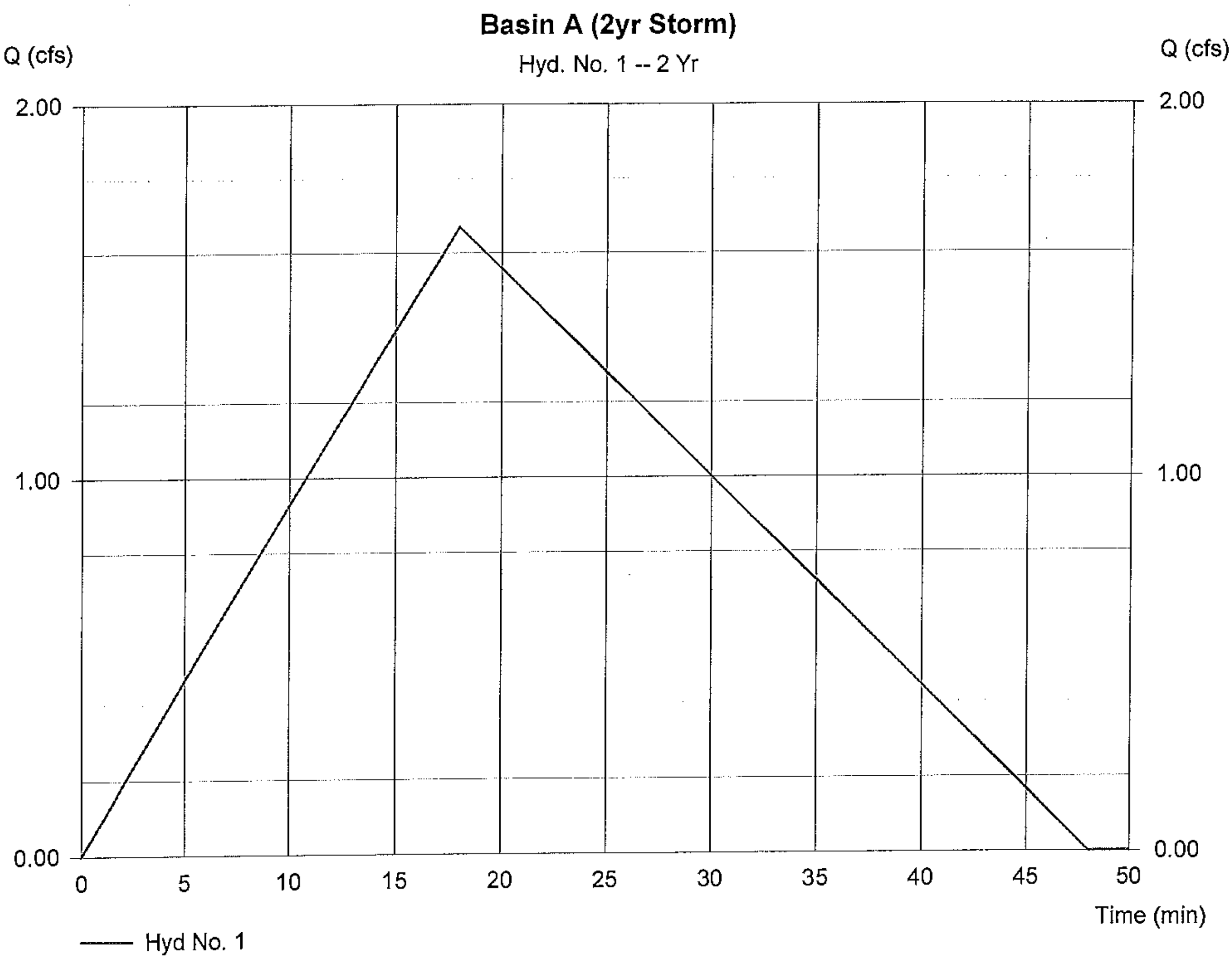
Hydraflow Hydrographs by Intelisolve — Monday, Apr 27 2009, 9:50 AM

Hyd. No. 1

Basin A (2yr Storm)

Hydrograph type	= Rational	Peak discharge	= 1.67 cfs
Storm frequency	= 2 yrs	Time interval	= 1 min
Drainage area	= 4.200 ac	Runoff coeff.	= 0.24
Intensity	= 1.656 in/hr	Tc by User	= 18.00 min
IDF Curve	= Rifle IDF 25&100only.IDF	Asc/Rec limb fact	= 1/1.67

Hydrograph Volume = 2,407 cuft



Appendix C-1

Hydrograph Plot

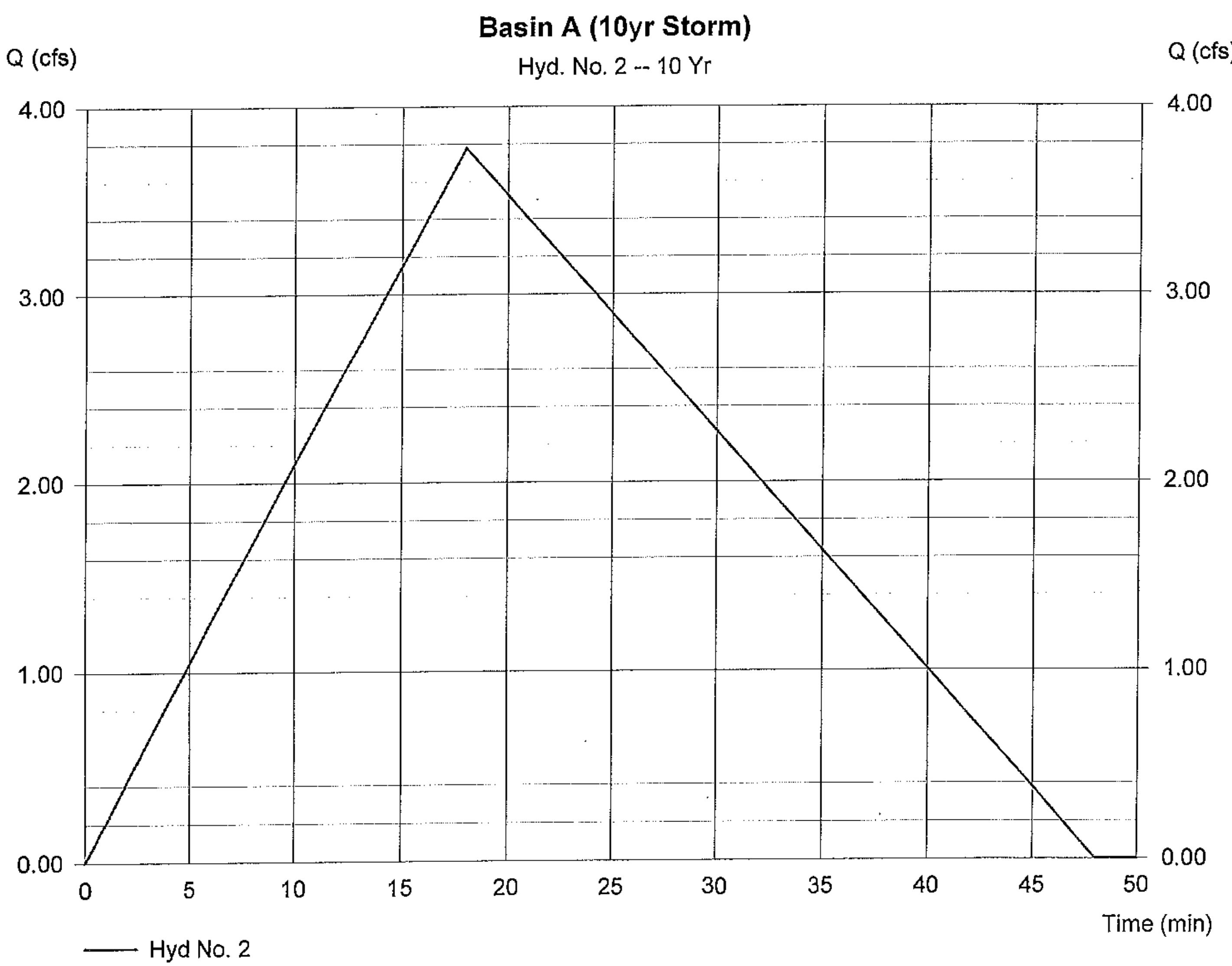
Hydraflow Hydrographs by Intelisolve — Monday, Apr 27 2009, 9:51 AM

Hyd. No. 2

Basin A (10yr Storm)

Hydrograph type	= Rational	Peak discharge	= 3.78 cfs
Storm frequency	= 10 yrs	Time interval	= 1 min
Drainage area	= 4.200 ac	Runoff coeff.	= 0.36
Intensity	= 2.498 in/hr	Tc by User	= 18.00 min
IDF Curve	= Rifle IDF 25&100only.IDF	Asc/Rec limb fact	= 1/1.67

Hydrograph Volume = 5,445 cuft



Appendix C-2

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

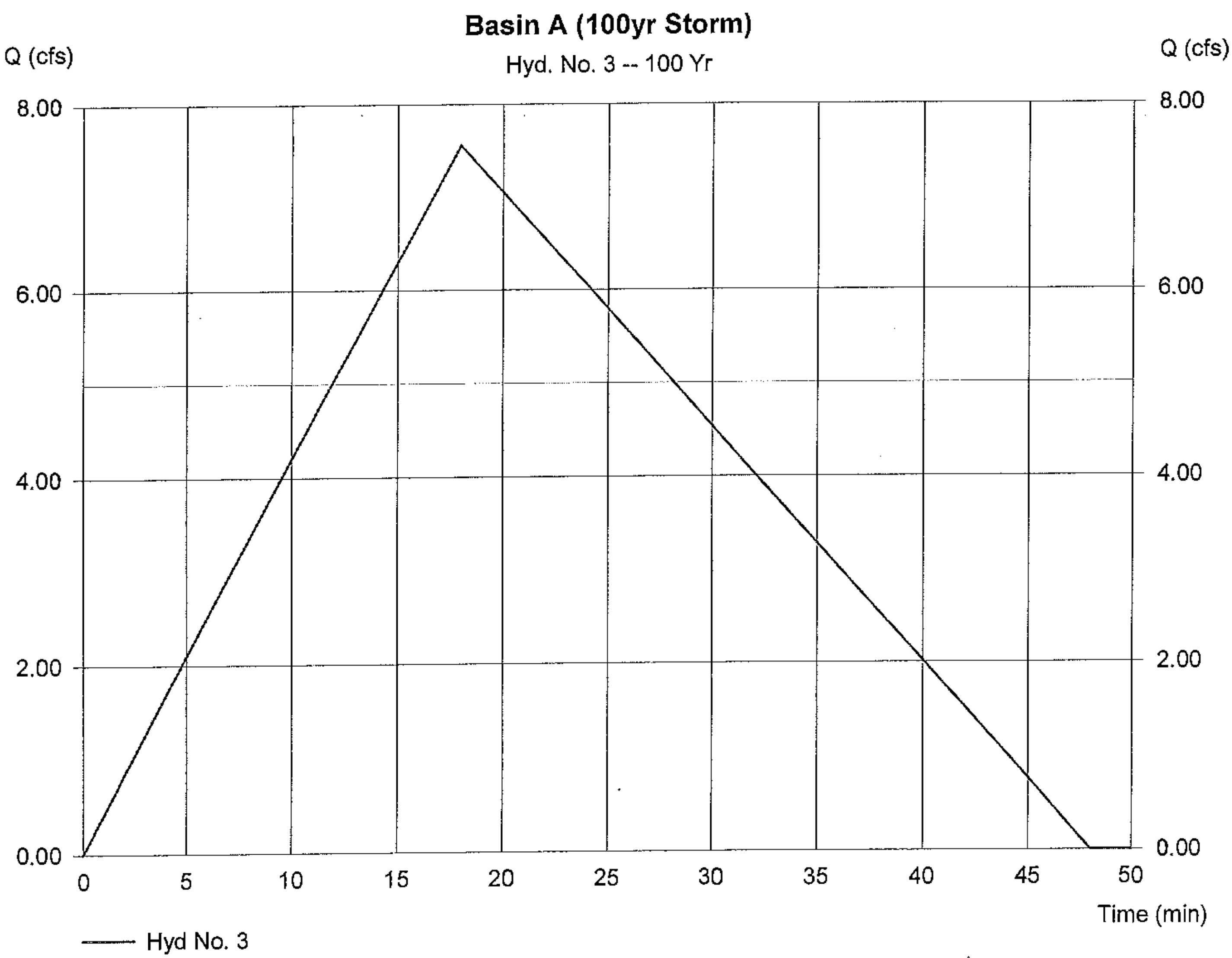
Monday, Apr 27 2009, 9:52 AM

Hyd. No. 3

Basin A (100yr Storm)

Hydrograph type	= Rational	Peak discharge	= 7.56 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 4.200 ac	Runoff coeff.	= 0.5
Intensity	= 3.599 in/hr	Tc by User	= 18.00 min
IDF Curve	= Rifle IDF 25&100only.IDF	Asc/Rec limb fact	= 1/1.67

Hydrograph Volume = 10,896 cuft



Appendix C-3

Hydrograph Plot

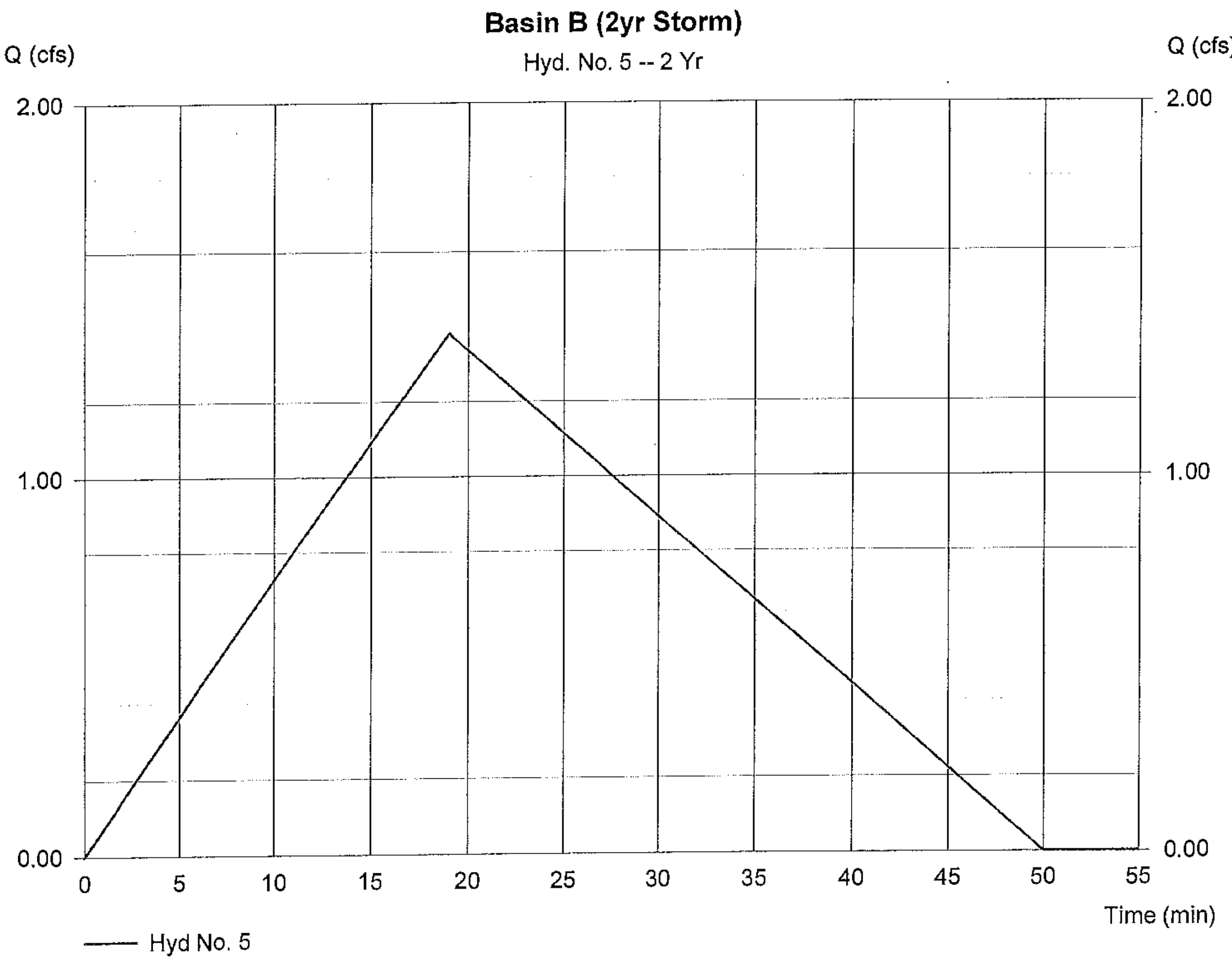
Hydraflow Hydrographs by Intelisolve — Monday, Apr 27 2009, 9:53 AM

Hyd. No. 5

Basin B (2yr Storm)

Hydrograph type	= Rational	Peak discharge	= 1.38 cfs
Storm frequency	= 2 yrs	Time interval	= 1 min
Drainage area	= 3.600 ac	Runoff coeff.	= 0.24
Intensity	= 1.599 in/hr	Tc by User	= 19.00 min
IDF Curve	= Rifle IDF 25&100only.IDF	Asc/Rec limb fact	= 1/1.67

Hydrograph Volume = 2,102 cuft



Appendix C-4

Hydrograph Plot

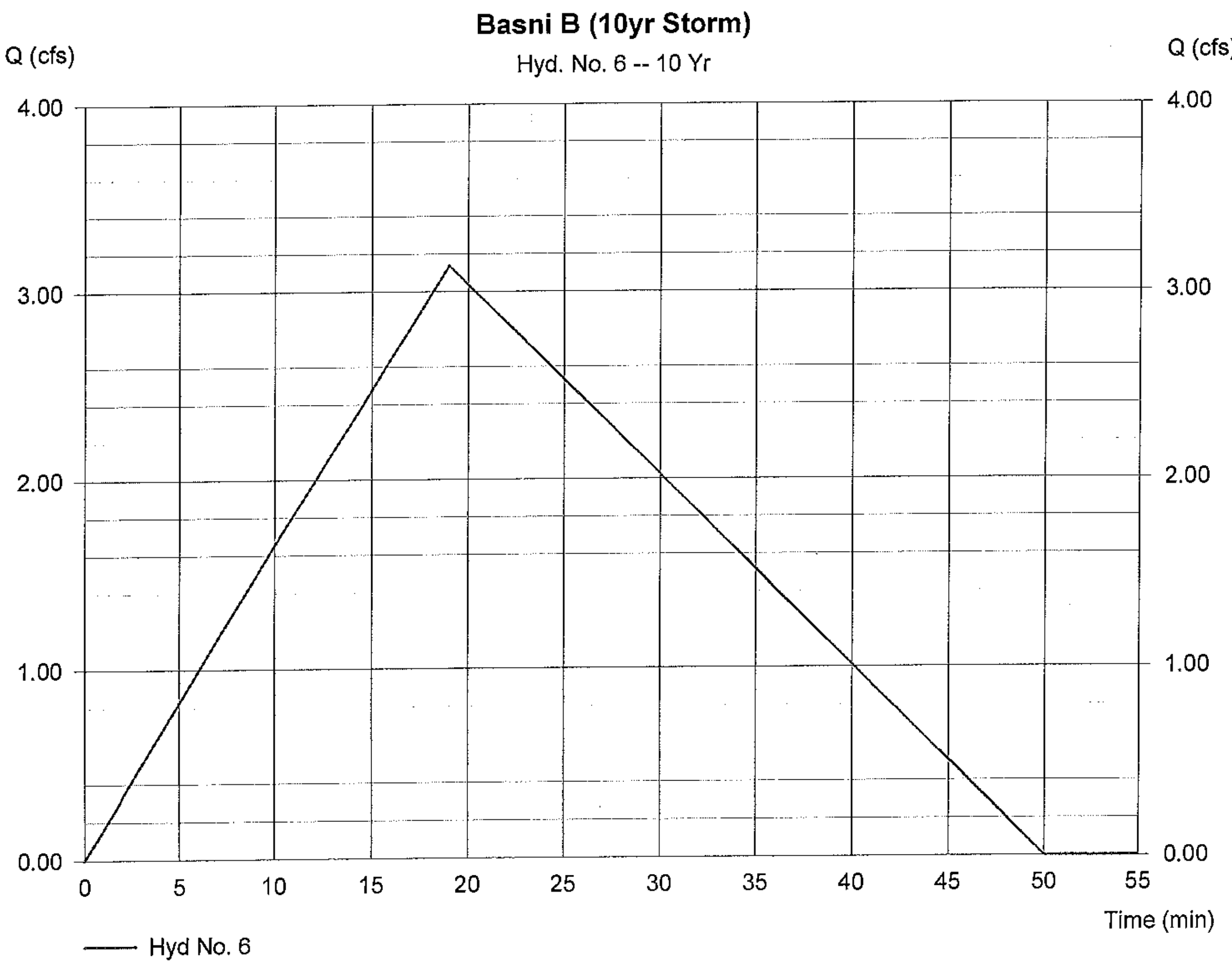
Hydraflow Hydrographs by Intelisolve — Monday, Apr 27 2009, 9:54 AM

Hyd. No. 6

Basni B (10yr Storm)

Hydrograph type	= Rational	Peak discharge	= 3.14 cfs
Storm frequency	= 10 yrs	Time interval	= 1 min
Drainage area	= 3.600 ac	Runoff coeff.	= 0.36
Intensity	= 2.420 in/hr	Tc by User	= 19.00 min
IDF Curve	= Rifle IDF 25&100only.IDF	Asc/Rec limb fact	= 1/1.67

Hydrograph Volume = 4,774 cuft



Appendix C-5

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

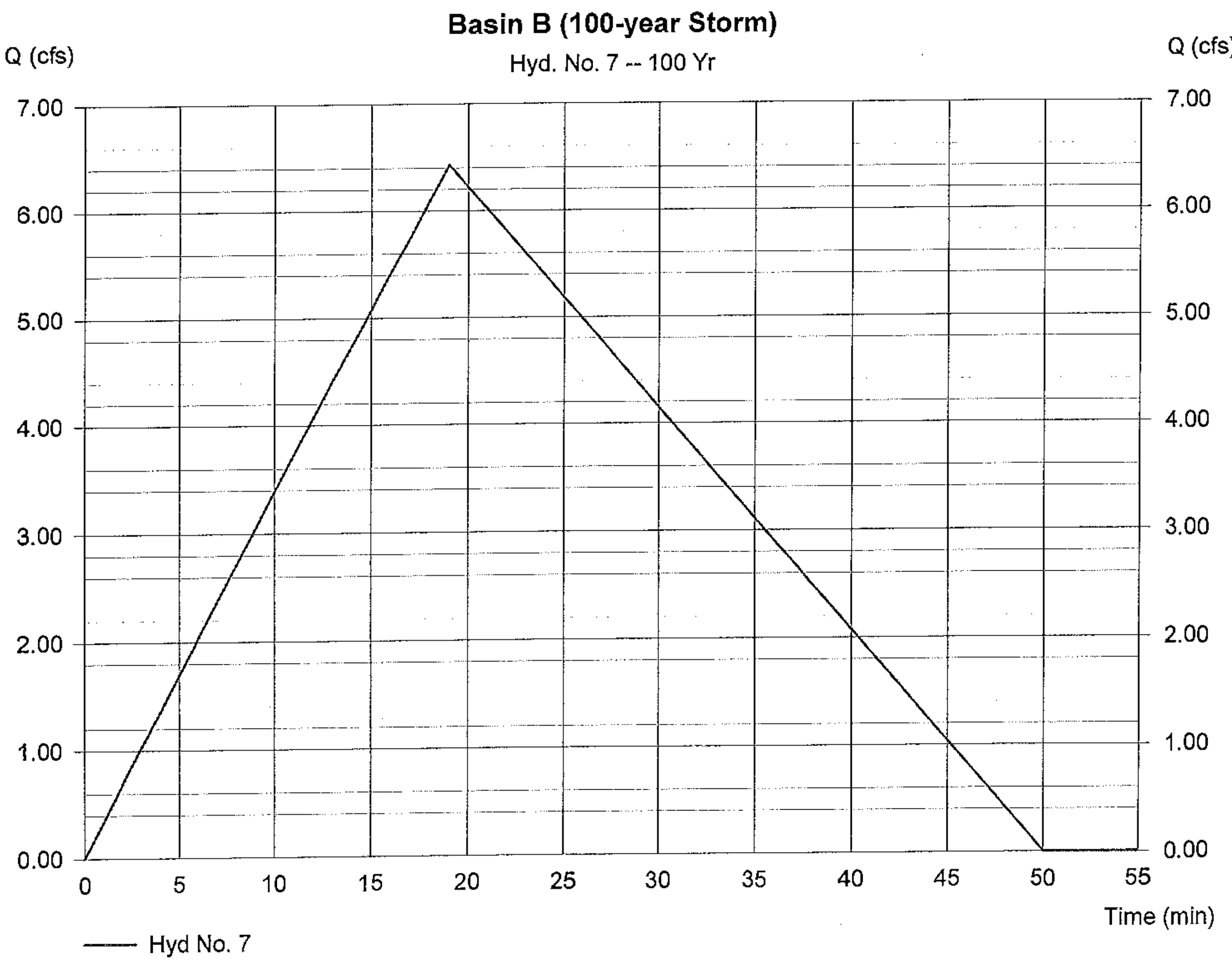
Monday, Apr 27 2009, 9:55 AM

Hyd. No. 7

Basin B (100-year Storm)

Hydrograph type	= Rational	Peak discharge	= 6.43 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 3.600 ac	Runoff coeff.	= 0.51
Intensity	= 3.500 in/hr	Tc by User	= 19.00 min
IDF Curve	= Rifle IDF 25&100only.IDF	Asc/Rec limb fact	= 1/1.67

Hydrograph Volume = 9,780 cuft



Appendix C-5

Hydrograph Plot

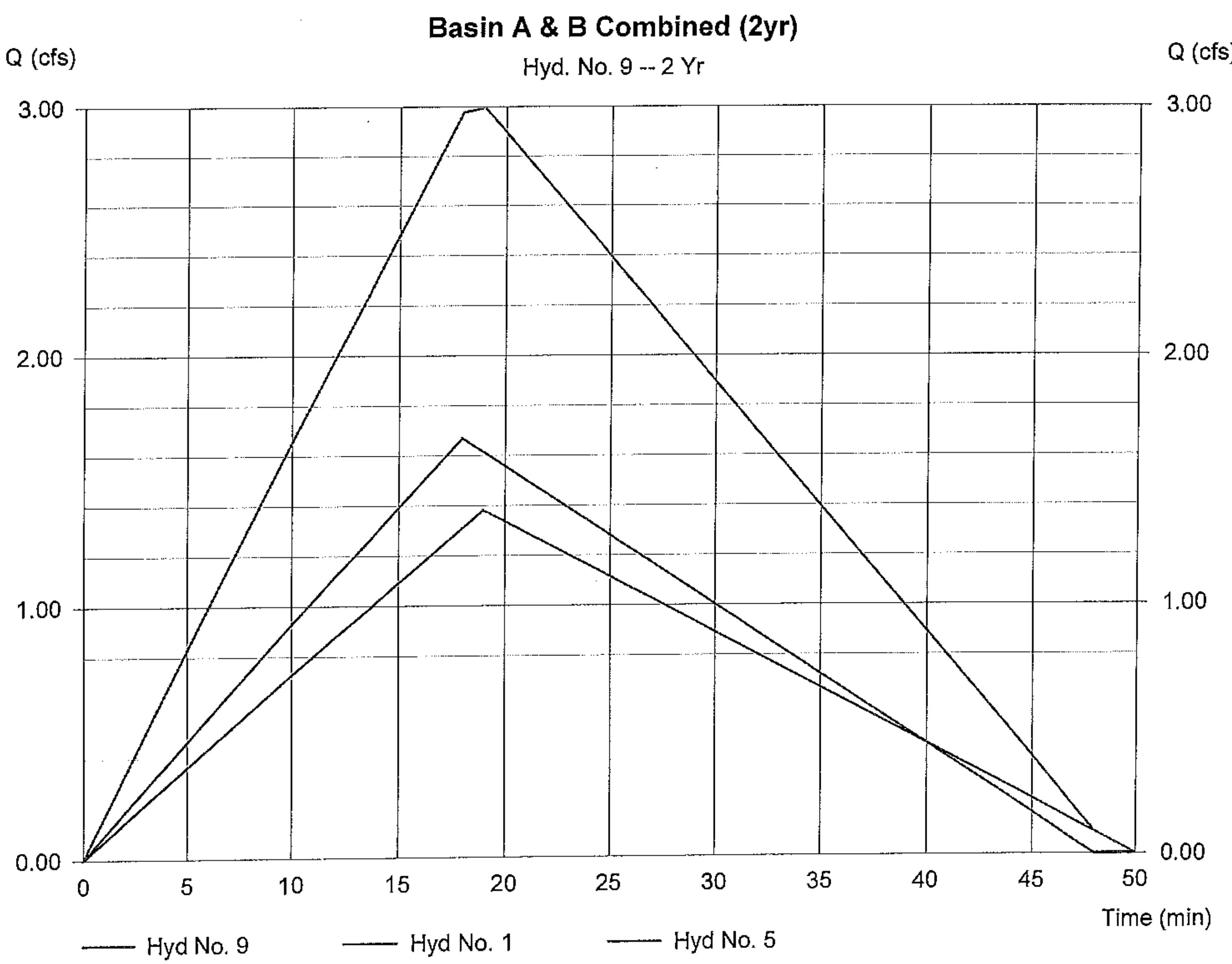
Hydraflow Hydrographs by Intelisolve — Tuesday, Apr 28 2009, 8:7 AM

Hyd. No. 9

Basin A & B Combined (2yr)

Hydrograph type	= Combine	Peak discharge	= 2.99 cfs
Storm frequency	= 2 yrs	Time interval	= 1 min
Inflow hyds.	= 1, 5		

Hydrograph Volume = 4,476 cuft



Appendix C-6

Hydrograph Plot

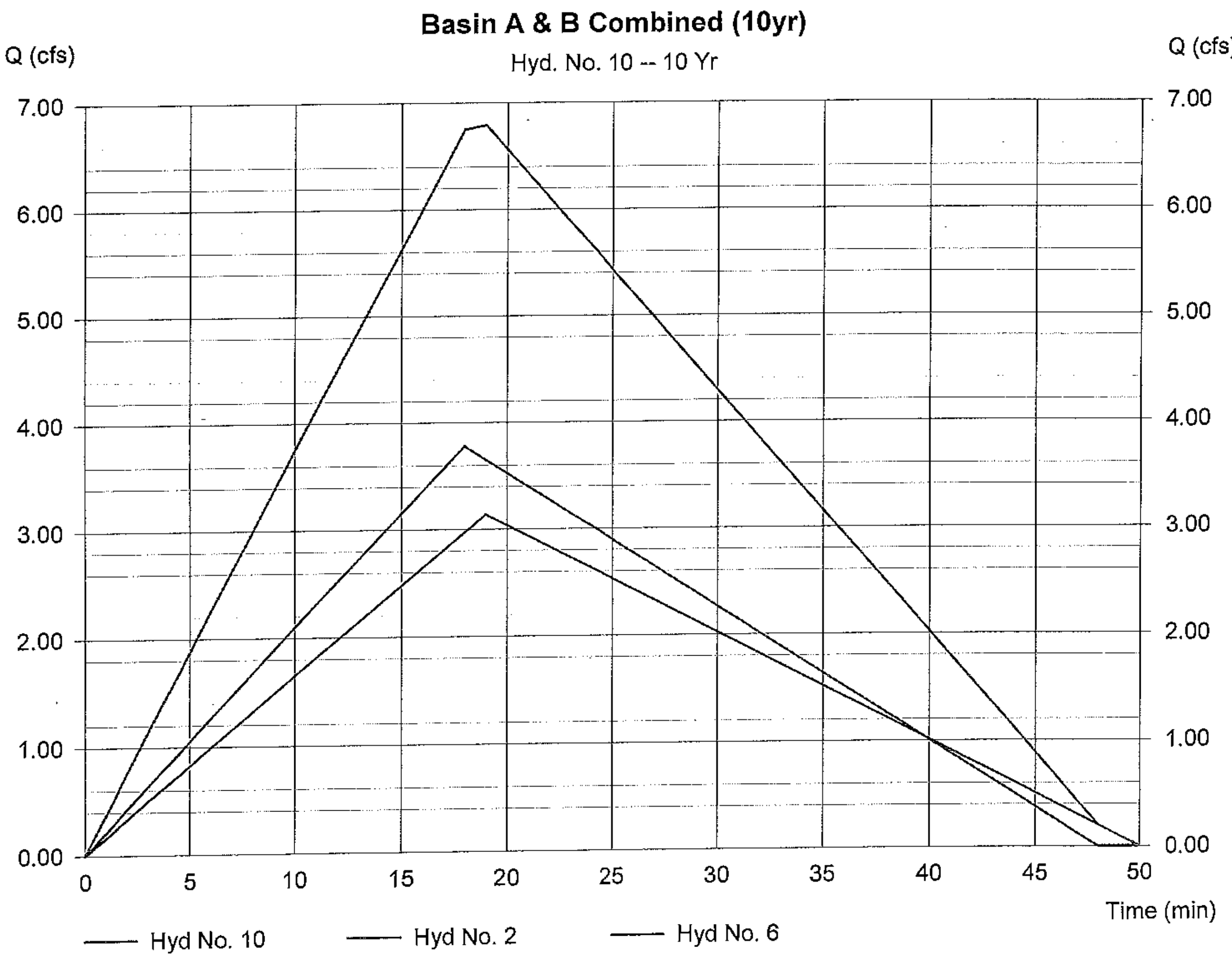
Hydraflow Hydrographs by Intelisolve — Tuesday, Apr 28 2009, 8:8 AM

Hyd. No. 10

Basin A & B Combined (10yr)

Hydrograph type	= Combine	Peak discharge	= 6.79 cfs
Storm frequency	= 10 yrs	Time interval	= 1 min
Inflow hyds.	= 2, 6		

Hydrograph Volume = 10,144 cuft



Appendix C-7

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve | Tuesday, Apr 28 2009, 8:10 AM

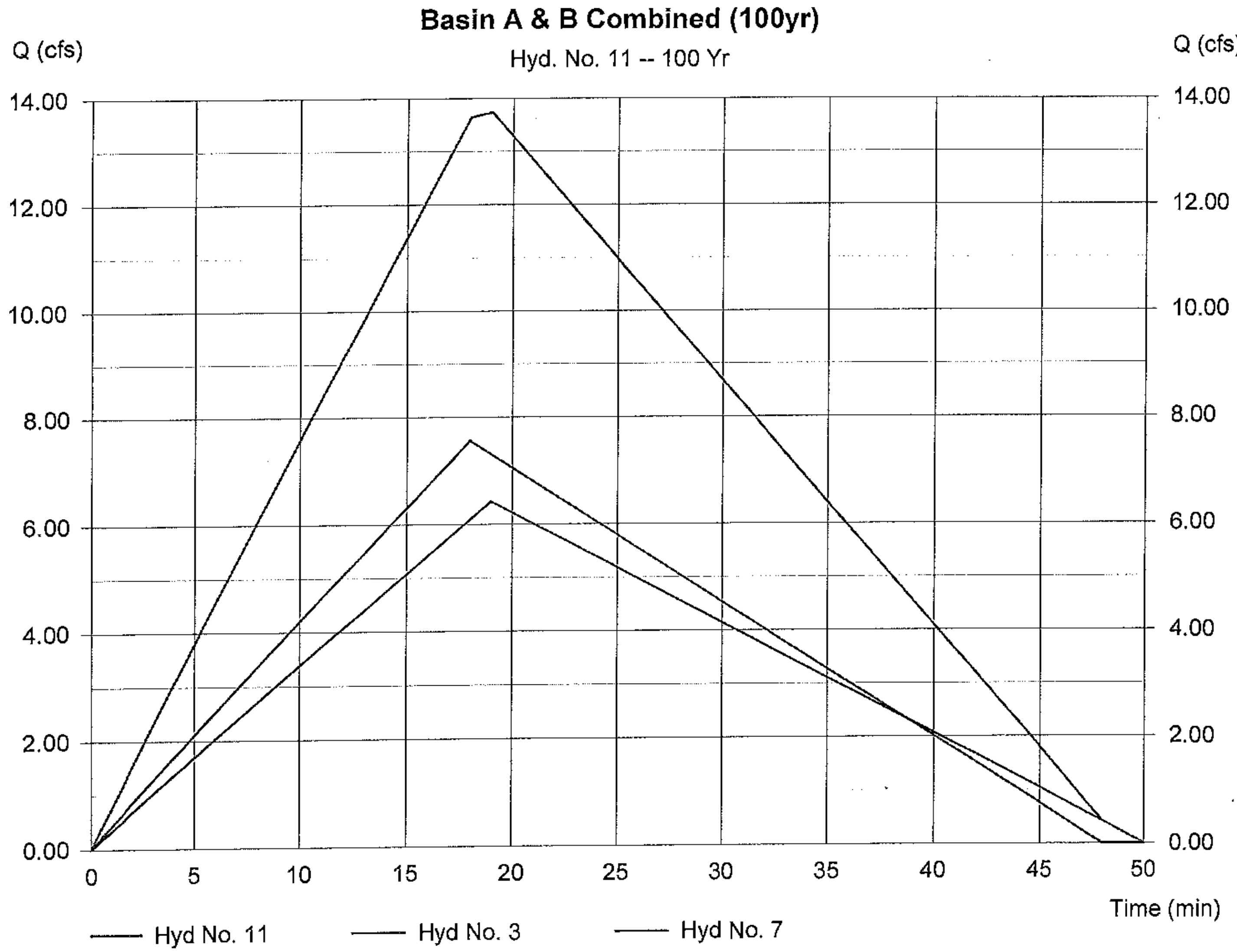
Hyd. No. 11

Basin A & B Combined (100yr)

Hydrograph type = Combine
Storm frequency = 100 yrs
Inflow hyds. = 3, 7

Peak discharge = 13.73 cfs
Time interval = 1 min

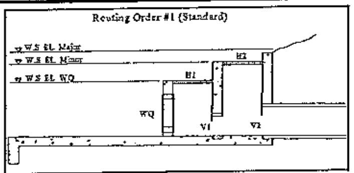
Hydrograph Volume = 20,522 cuft

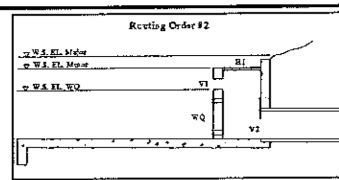


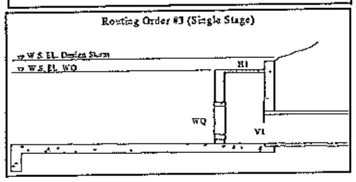
Appendix C-8

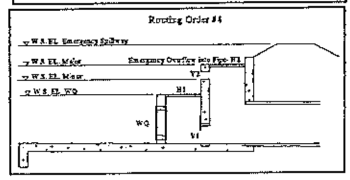
STAGE-DISCHARGE SIZING OF THE WEIRS AND ORIFICES (INLET CONTROL)

Project: Harrison Creek Produced Water Recycling Facility
Basin ID: Sand Filter Detention Basin









Current Routing Order is #3

Design Information (Input):

			#1 Horiz.	#2 Horiz.	#1 Vert.	#2 Vert.	
Circular Opening:	Diameter in Inches	Dia. =					Inches
OR							
Rectangular Opening:	Width in Feet	W =	3.00		0.78		ft.
	Length (Height for Vertical)	L or H =	2.00		0.41		ft.
	Percentage of Open Area After Trash Rack Reduction	% open =	100		100		%
	Orifice Coefficient	C_o =	0.65		0.65		
	Weir Coefficient	C_w =	2.65				
	Orifice Elevation (Bottom for Vertical)	E_o =	7412.50		7,409.00		ft.

Calculation of Collection Capacity:

		#1 Horiz.	#2 Horiz.	#1 Vert.	#2 Vert.	
Net Opening Area (after Trash Rack Reduction)	A_o =	6.00		0.31		sq. ft.
OPTIONAL: User-Overide Net Opening Area	A_o =					sq. ft.
Perimeter as Weir Length	L_w =	10.00	ft.			
OPTIONAL: User-Overide Weir Length	L_w =			ft.		
Top Elevation of Vertical Orifice Opening, Top =				7409.41		ft.
Center Elevation of Vertical Orifice Opening, Cen =				7409.21		ft.

Routing 3: Single Stage - Water flows through WQCV plate and #1 horizontal opening into #1 vertical opening. This flow will be applied to culvert sheet (#2 vertical & horizontal openings is not used).

			Horizontal Orifices				Vertical Orifices			
Labels for WQCV, Minor, & Major Storage W.S. Elevations (input)	Water Surface Elevation ft (linked)	WQCV Plate/Riser Flow cfs (User-linked)	#1 Horiz. Weir Flow cfs (output)	#1 Horiz. Orifice Flow cfs (output)	#2 Horiz. Weir Flow cfs (output)	#2 Horiz. Orifice Flow cfs (output)	#1 Vert. Collection Capacity cfs (output)	#2 Vert. Collection Capacity cfs (output)	Total Collection Capacity cfs (output)	Target Volumes for WQCV, Minor, & Major Storage Volumes (link for goal seek)
	7411.00	0.00	0.00	0.00	0.00	0.00	2.17	0.00	0.00	
	7411.50	0.00	0.00	0.00	0.00	0.00	2.45	0.00	0.00	
	7412.00	0.00	0.00	0.00	0.00	0.00	2.70	0.00	0.00	
	7412.50	0.00	0.00	0.00	0.00	0.00	2.94	0.00	0.00	
	7413.00	0.00	9.37	22.13	0.00	0.00	3.15	0.00	3.15	
	7413.50	0.00	26.50	31.30	0.00	0.00	3.35	0.00	3.35	
	7414.00	0.00	48.68	38.33	0.00	0.00	3.54	0.00	3.54	
	7414.50	0.00	74.95	44.26	0.00	0.00	3.72	0.00	3.72	
	7415.00	0.00	104.75	49.49	0.00	0.00	3.89	0.00	3.89	
		0.00	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		0.00	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
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		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
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		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	#N/A	

Pond Report

Hydraflow Hydrographs by Intelisolve

Tuesday, Apr 28 2009, 8:22 AM

Pond No. 3 - Surface Detention

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	7411.00	3,228	0	0
0.50	7411.50	3,738	1,742	1,742
1.00	7412.00	4,282	2,005	3,747
1.50	7412.50	4,860	2,286	6,032
2.00	7413.00	5,473	2,583	8,615
2.50	7413.50	6,120	2,898	11,514
3.00	7414.00	6,801	3,230	14,744
3.50	7414.50	7,516	3,579	18,323
4.00	7415.00	8,266	3,946	22,269

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	0.00
N-Value	= .000	.000	.000	.000
Orif. Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 0.00	0.00	0.00	0.00
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfiltration = 0.000 in/hr (Wet area) Tailwater Elev. = 0.00 ft

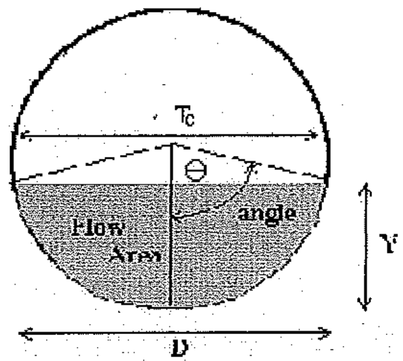
Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control.

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Total cfs
0.00	0	7411.00	---	---	---	---	---	---	---	---	---	0.00
0.50	1,742	7411.50	---	---	---	---	---	---	---	---	---	0.00
1.00	3,747	7412.00	---	---	---	---	---	---	---	---	---	0.00
1.50	6,032	7412.50	---	---	---	---	---	---	---	---	---	0.00
2.00	8,615	7413.00	---	---	---	---	---	---	---	---	---	3.20
2.50	11,514	7413.50	---	---	---	---	---	---	---	---	---	3.40
3.00	14,744	7414.00	---	---	---	---	---	---	---	---	---	3.50
3.50	18,323	7414.50	---	---	---	---	---	---	---	---	---	3.70
4.00	22,269	7415.00	---	---	---	---	---	---	---	---	---	3.90

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: Harrison Creek Produced Water Recycling Facility
Pipe ID: Sand Filter Detention Outlet (10-year Release)



Design Information (Input)			
Pipe Invert Slope	So =	0.0110	ft/ft
Pipe Manning's n-value	n =	0.0120	
Pipe Diameter	D =	12.00	inches
Design discharge	**Q =**	**2.40**	**cfs**

Full-flow Capacity (Calculated)			
Full-flow area	Af =	0.79	sq ft
Full-flow wetted perimeter	Pf =	3.14	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	**Qf =**	**4.06**	cfs

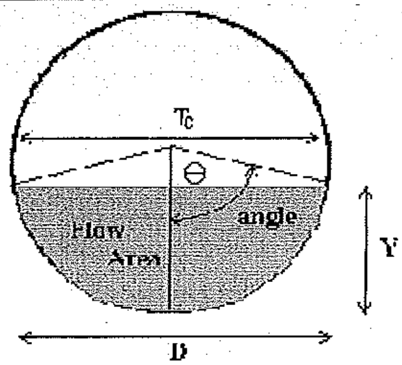
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.68	radians
Flow area	An =	0.45	sq ft
Top width	Tn =	0.99	ft
Wetted perimeter	Pn =	1.68	ft
Flow depth	Yn =	0.55	ft
Flow velocity	Vn =	5.38	fps
Discharge	**Qn =**	**2.40**	**cfs**
Percent Full Flow	**Flow =**	**59.11%**	**of full flow**
Normal Depth Froude Number	**Fr_n =**	**1.42**	**supercritical**

Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.90	radians
Critical flow area	Ac =	0.55	sq ft
Critical top width	Tc =	0.95	ft
Critical flow depth	**Yc =**	**0.66**	**ft**
Critical flow velocity	Vc =	4.34	fps
Critical Depth Froude Number	Fr_c =	1.00	

Appendix C-11

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: Harrison Creek Produced Water Recycling Facility
Pipe ID: 18-inch CMP Culvert in Drainage Ditch (10-year Flow)



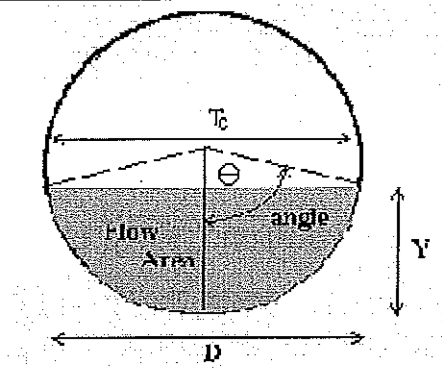
Design Information (Input)			
Pipe Invert Slope	So =	0.0173	ft/ft
Pipe Manning's n-value	n =	0.0240	*
Pipe Diameter	D =	18.00	inches
Design discharge	**Q =**	**1.60**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	**Qf =**	**7.50**	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.19	radians
Flow area	An =	0.47	sq ft
Top width	Tn =	1.39	ft
Wetted perimeter	Pn =	1.78	ft
Flow depth	Yn =	0.47	ft
Flow velocity	Vn =	3.38	fps
Discharge	**Qn =**	**1.60**	**cfs**
Percent Full Flow	**Flow =**	**21.33%**	**of full flow**
Normal Depth Froude Number	**Fr_n =**	**1.02**	**supercritical**
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.20	radians
Critical flow area	Ac =	0.48	sq ft
Critical top width	Tc =	1.40	ft
Critical flow depth	**Yc =**	**0.48**	**ft**
Critical flow velocity	Vc =	3.33	fps
Critical Depth Froude Number	Fr_c =	1.00	

*** Unexpected value for Manning's n**

Appendix C-12

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: Harrison Creek Produced Water Recycling Facility
Pipe ID: Sand Filter Detention Outlet (100-year Release)

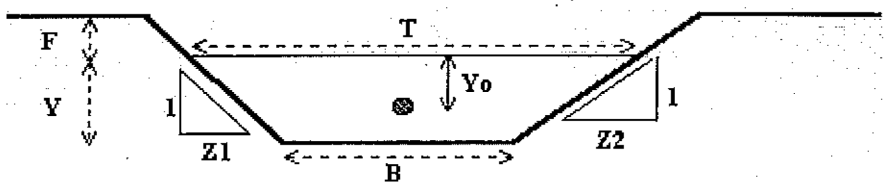


Design Information (Input)			
Pipe Invert Slope	So =	0.0110	ft/ft
Pipe Manning's n-value	n =	0.0120	
Pipe Diameter	D =	12.00	inches
Design discharge	**Q =**	**3.50**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	0.79	sq ft
Full-flow wetted perimeter	Pf =	3.14	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	**Qf =**	**4.06**	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	2.02	radians
Flow area	An =	0.60	sq ft
Top width	Tn =	0.90	ft
Wetted perimeter	Pn =	2.02	ft
Flow depth	Yn =	0.72	ft
Flow velocity	Vn =	5.81	fps
Discharge	**Qn =**	**3.50**	**cfs**
Percent Full Flow	**Flow =**	**86.21%**	**of full flow**
Normal Depth Froude Number	**Fr_n =**	**1.25**	**supercritical**
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.21	radians
Critical flow area	Ac =	0.67	sq ft
Critical top width	Tc =	0.80	ft
Critical flow depth	**Yc =**	**0.80**	**ft**
Critical flow velocity	Vc =	5.20	fps
Critical Depth Froude Number	Fr_c =	1.00	

Appendix C-13

Normal Flow Analysis - Trapezoidal Channel

Project: Harrison Creek Produced Water Recycling Facility
Channel ID: Stormwater Ditch for 212 Pad @ 1-foot Depth



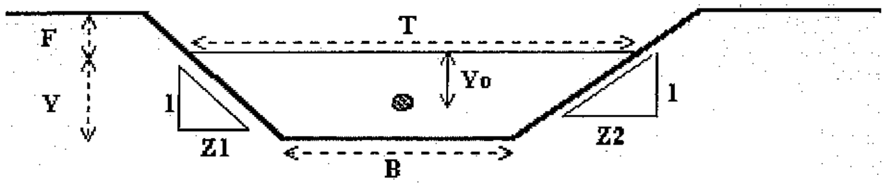
Design Information (Input)			
Channel Invert Slope	So =	0.0200	ft/ft
Channel Manning's N	N =	0.040	
Bottom Width	B =	0.0	ft
Left Side Slope	Z1 =	2.0	ft/ft
Right Side Slope	Z2 =	2.0	ft/ft
Freeboard Height	F =	1.0	ft
Design Water Depth	Y =	1.00	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**6.2**	cfs
Froude Number	**Fr =**	**0.77**	
Flow Velocity	**V =**	**3.1**	fps
Flow Area	A =	2.0	sq ft
Top Width	T =	4.0	ft
Wetted Perimeter	P =	4.5	ft
Hydraulic Radius	R =	0.4	ft
Hydraulic Depth	D =	0.5	ft
Specific Energy	Es =	1.1	ft
Centroid of Flow Area	Yo =	0.3	ft
Specific Force	Fs =	0.1	kip

Appendix C-14

Normal Flow Analysis - Trapezoidal Channel

Project: Harrison Creek Produced Water Recycing Facility
Channel ID: Stormwater Ditch for 212 Pad @ Full Flow Capacity

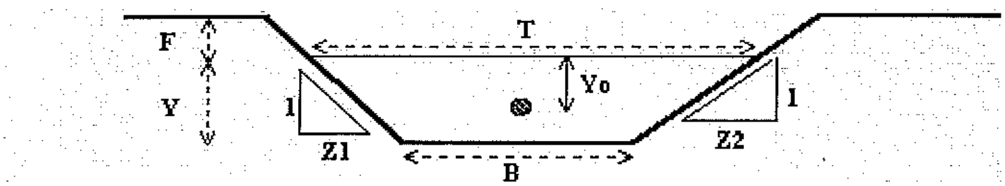


Design Information (Input)			
Channel Invert Slope	So =	0.0200	ft/ft
Channel Manning's N	N =	0.040	
Bottom Width	B =	0.0	ft
Left Side Slope	Z1 =	2.0	ft/ft
Right Side Slope	Z2 =	2.0	ft/ft
Freeboard Height	F =	0.0	ft
Design Water Depth	Y =	2.00	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	39.1	cfs
Froude Number	**Fr =**	0.86	
Flow Velocity	**V =**	4.9	fps
Flow Area	A =	8.0	sq ft
Top Width	T =	8.0	ft
Wetted Perimeter	P =	8.9	ft
Hydraulic Radius	R =	0.9	ft
Hydraulic Depth	D =	1.0	ft
Specific Energy	Es =	2.4	ft
Centroid of Flow Area	Yo =	0.7	ft
Specific Force	Fs =	0.7	kip

Normal Flow Analysis - Trapezoidal Channel

Project: Harrison Creek Produced Water Recycing Facility
Channel ID: Existin g Irrigation Ditch @ Full Flow Capacity

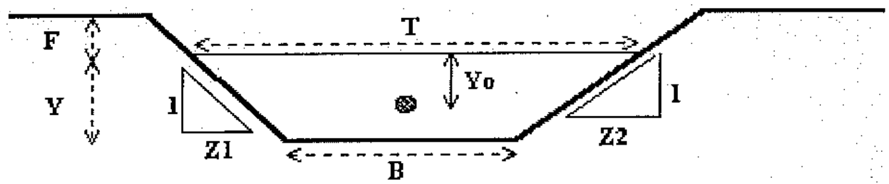


Design Information (Input)			
Channel Invert Slope	So =	0.0050	ft/ft
Channel Manning's N	N =	0.030	
Bottom Width	B =	0.0	ft
Left Side Slope	Z1 =	2.7	ft/ft
Right Side Slope	Z2 =	2.7	ft/ft
Freeboard Height	F =	0.0	ft
Design Water Depth	Y =	1.50	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	16.5	cfs
Froude Number	**Fr =**	0.56	
Flow Velocity	**V =**	2.8	fps
Flow Area	A =	6.0	sq ft
Top Width	T =	8.0	ft
Wetted Perimeter	P =	8.5	ft
Hydraulic Radius	R =	0.7	ft
Hydraulic Depth	D =	0.8	ft
Specific Energy	Es =	1.6	ft
Centroid of Flow Area	Yo =	0.5	ft
Specific Force	Fs =	0.3	kip

Normal Flow Analysis - Trapezoidal Channel

Project: Harrison Creek Produced Water Recycing Facility
Channel ID: Existing Ditch for MVS Station @ Full Flow Capacity



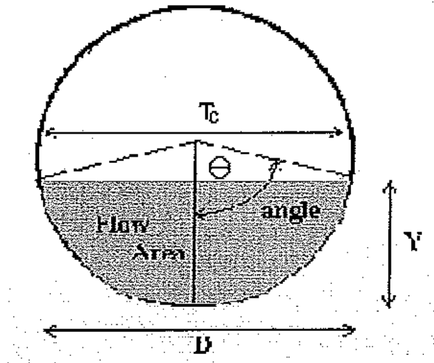
Design Information (Input)			
Channel Invert Slope	So =	0.0090	ft/ft
Channel Manning's N	N =	0.030	
Bottom Width	B =	0.0	ft
Left Side Slope	Z1 =	3.0	ft/ft
Right Side Slope	Z2 =	3.0	ft/ft
Freeboard Height	F =	0.0	ft
Design Water Depth	Y =	2.00	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	54.6	cfs
Froude Number	**Fr =**	0.80	
Flow Velocity	**V =**	4.5	fps
Flow Area	A =	12.0	sq ft
Top Width	T =	12.0	ft
Wetted Perimeter	P =	12.6	ft
Hydraulic Radius	R =	0.9	ft
Hydraulic Depth	D =	1.0	ft
Specific Energy	Es =	2.3	ft
Centroid of Flow Area	Yo =	0.7	ft
Specific Force	Fs =	1.0	kip

Appendix C-17

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: Harrison Creek Produced Water Recycling Facility
Pipe ID: 18 inch CMP at East Irrigation Ditch Crossing



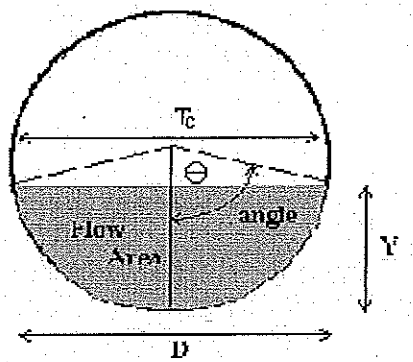
Design Information (Input)			
Pipe Invert Slope	So =	0.0025	ft/ft
Pipe Manning's n-value	n =	0.0240	*
Pipe Diameter	D =	18.00	inches
Design discharge	**Q =**	**2.80**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	**Qf =**	**2.85**	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	2.22	radians
Flow area	An =	1.52	sq ft
Top width	Tn =	1.19	ft
Wetted perimeter	Pn =	3.33	ft
Flow depth	Yn =	1.21	ft
Flow velocity	Vn =	1.84	fps
Discharge	**Qn =**	**2.80**	**cfs**
Percent Full Flow	**Flow =**	**98.25%**	**of full flow**
Normal Depth Froude Number	**Fr_n =**	**0.29**	**subcritical**
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.42	radians
Critical flow area	Ac =	0.71	sq ft
Critical top width	Tc =	1.48	ft
Critical flow depth	**Yc =**	**0.64**	**ft**
Critical flow velocity	Vc =	3.93	fps
Critical Depth Froude Number	Fr_c =	1.00	

*** Unexpected value for Manning's n**

Appendix C-18

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: Harrison Creek Produced Water Recycling Facility
Pipe ID: 18 inch CMP at West Irrigation Ditch Crossing



Design Information (Input)			
Pipe Invert Slope	So =	0.0060	ft/ft
Pipe Manning's n-value	n =	0.0240	*
Pipe Diameter	D =	18.00	inches
Design discharge	**Q =**	**4.40**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	**Qf =**	**4.42**	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	2.25	radians
Flow area	An =	1.54	sq ft
Top width	Tn =	1.16	ft
Wetted perimeter	Pn =	3.38	ft
Flow depth	Yn =	1.22	ft
Flow velocity	Vn =	2.85	fps
Discharge	**Qn =**	**4.40**	**cfs**
Percent Full Flow	**Flow =**	**99.55%**	**of full flow**
Normal Depth Froude Number	**Fr_n =**	**0.44**	**subcritical**
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.64	radians
Critical flow area	Ac =	0.97	sq ft
Critical top width	Tc =	1.50	ft
Critical flow depth	**Yc =**	**0.80**	**ft**
Critical flow velocity	Vc =	4.56	fps
Critical Depth Froude Number	Fr_c =	1.00	

*** Unexpected value for Manning's n**

Appendix C-19

APPENDIX D
SWMM MANUAL CHECKLISTS

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Table 302
Stormwater Management Manual
Drainage Report Checklist

Final Drainage Report April 16, 2009

Instructions:

1. Applicant to identify with a "check-mark" if information is provided with report. If applicant believes information is not required, indicate with "n/a" and attach separate sheet with explanation
2. The reviewer will determine if information labeled "n/a" is required and whether information must be submitted.
3. Those items noted with an "asterisk" are not required for conceptual report.
4. Submit three (3) copies of report and include copy of check list bound with report.

TITLE PAGE

A. Type of report (Conceptual/Preliminary or Final Drainage Report).
B. Project Name.
C. Preparer name, firm, address, number, and date.
D. Professional Engineers seal of preparer.
E. Certifications (see SWMM Section 303.1)

I. INTRODUCTION

A. Background
- ✓ 1. Identify report preparer and purpose.
- ✓ 2. Identify date of letter with previous County comments.

B. Project Location
- ✓ 1. Identify Township, Range, and Section.
- NA 2. Identify adjacent street and subdivision names.
- ✓ 3. Reference to General Location Map.

C. Property Description
- ✓ 1. Identify area in acres of entire contiguous ownership.
- ✓ 2. Describe existing ground cover, vegetation, soils, topography and slopes.
- ✓ 3. Describe existing drainage facilities, such as channels, detention areas, or structures.
- ✓ 4. Describe existing irrigation facilities, such as ditches, head-gates, or diversions.
- ✓ 5. Identify proposed types of land use and encumbrances.

D. Previous Investigations
- NA 1. Identify drainage master plans that include the project area, including floodplain studies.
- NA 2. Identify drainage reports for adjacent development.

II. DRAINAGE SYSTEM DESCRIPTION

A. Existing Drainage Conditions
- ✓ 1. Describe existing topography and provide map with contours extending a minimum of 100-feet beyond property limits.
- ✓ 2. Identify major drainageway or outfall drainageway and describe map showing location of proposed development within the drainageways.
- ✓ 3. Identify pre-developed drainage patterns and describe map showing pre-developed sub-basins and concentrated discharge locations. Provide calculations of pre-developed peak flows entering and leaving the site.

B. Master Drainage Plan
- NA 1. Describe location of the project relative to a previously prepared master drainage plan, including drainage plans prepared for adjacent development.

C. Offsite Tributary Area
- ✓ 1. Identify all offsite drainage basins that are tributary to the project.
- 2. Identify assumptions regarding existing and future land use and effects of offsite

Appendix D-1

______ detention on peak flows.

D. Proposed Drainage System Description

✓ 1. Identify how offsite stormwater is collected and conveyed through the site and ultimately to the receiving water(s).

✓ 2. Identify sub-basins and describe, in general terms, how onsite storm water is collected and conveyed through the site for each location where storm water is discharged from the site.

✓ * 3. Describe detention volumes, release rates and pool elevations.

✓ * 4. Identify the difference in elevation between pond invert and the groundwater table.

✓ 5. Describe how stormwater is discharged from the site, including both concentrated and dispersed discharges.

✓ 6. Describe stormwater quality facilities.

✓ * 7. Describe maintenance access aspects of design.

NA * 8. Describe easements and tracts for drainage purposes, including limitation on use.

E. Drainage Facility Maintenance

✓ * 1. Identify responsible parties for maintenance of each drainage and water quality facility.

✓ * 2. Identify general maintenance activities and schedules.

III. DRAINAGE ANALYSIS AND DESIGN CRITERIA

A. Regulations

✓ 1. Identify that analysis and design was prepared in accordance with the provisions of the Manual.

✓ 2. Identify other regulations or criteria which have been used to prepare analysis and design.

B. Development Criteria

NA 1. Identify drainage constraints placed on the project, such as by a major drainage study, floodplain study or other drainage reports relevant to the project.

NA 2. Identify drainage constraints placed on the project, such as from major street alignments, utilities, existing structures, and other developments.

C. Hydrologic Criteria

(If Manual was followed without deviation, then a statement to that effect is all that is required. Otherwise provide the following information where the criteria used deviates from the Manual.)

✓ 1. Identify how storm runoff peak flows and volumes were determined, including rainfall intensity or design storm.

✓ 2. Identify which storm events were used for minor and major flood analysis and design.

NA 3. Identify how and why any other deviations from the Manual occurred.

D. Hydraulic Criteria

(If Manual was followed without deviation, then a statement to that effect is all that is required. Otherwise provide the following information where the criteria used deviates from the Manual.)

NA * 1. Identify type(s) of streets within and adjacent to development and source for allowable street capacity.

NA * 2. Identify which type(s) of storm inlets were analyzed or designed and source for allowable capacity.

NA * 3. Identify which type of storm sewers which were analyzed or designed and Manning's n-values used.

✓ * 4. Identify which method was used to determine detention volume requirements and how allowable release rates were determined.

✓ * 5. Identify how the capacity of open channels and culverts were determined.

NA * 6. Identify any special analysis or design requirements not contained with the Manual.

NA 7. Identify how and why any other deviations from the Manual occurred.

E. Variance from Criteria

NA 1. Identify which provisions of the Manual a variance is requested.

NA 2. Identify pre-existing conditions which cause the variance request.

***IV. POST CONSTRUCTION STORMWATER MANAGEMENT. See Manual Section 1600 for requirements.**

Note: This section of the Final Drainage Report identifies additional information required by Mesa County's, City of Grand Junction's, and Town of Palisade's, Permit for Stormwater Discharges Associated with Municipal Separate Storm Sewer Systems (MS4s), permit No. COR-090000. The Final Drainage Plan and the Construction SWMP (see SWMM Section 1500) meets the requirements of the MS4s Permit. In general, this section identifies permanent BMP practices to control the discharge of pollutants after construction is complete.

*A. Stormwater Quality Control Measures

✓ * 1. Describe the post-construction BMPs to control discharge of pollutants from the project site.

NA * 2. If compensating detention is provided, discuss practices to address water quality from area not tributary to detention area.

NA * 3. If underground detention is proposed, discuss how water quality facilities will be provided on the surface.

NA 4. If proprietary BMP's are proposed, provide the justification and sizing requirements (see SWMM Section 1603.3).

*B. Calculations

✓ 1. Provide methods and calculations for WQCV, sediment storage, and water quality outlet structure.

V. CONCLUSIONS

A. Compliance with Manual

✓ Compliance with Manual and other approved documents, such as drainage plans and floodplain studies.

B. Design Effectiveness

✓ Effectiveness of drainage design to control impacts of storm runoff.

C. Areas in Flood Hazard Zone

NA Meet requirements of Floodplain Regulations: Mesa County Land Development Code, Section 7.13; City of Grand Junction Zoning and Development Code, Section 7.1.

D. Variances from Manual

NA Applicant shall identify any requested variances and provide basis for approving variance. If no variances are requested, applicant shall state that none are requested.

VII. REFERENCES

✓ Provide a reference list of all criteria, master plans, drainage reports, and technical information used.

TABLES

✓ Include copy of all tables prepared for report.

FIGURES

✓ A. General Location Map (See Section 303.2a)

NA B. Flood Plain Information

✓ C. Drainage Plan (See Section 303.2b)

✓ D. Other pertinent figures.

APPENDICIES

✓ A. DESIGN CHARTS
1. Provide copy of all design charts (i.e.: tables, figures, charts from other criteria) used for the report.

✓ B. HYDROLOGIC CALCULATIONS (see Manual Sections 600 and 700)
✓ 1. Land use assumptions for off-site runoff calculations.
✓ 2. Time of concentration and runoff coefficients for pre-existing and post development conditions.
✓ 3. Pre-developed hydrologic computations.
✓ 4. Developed conditions hydrologic computations.

C. HYDRAULIC CALCULATIONS
✓ 1. Capacity of existing channels, streets, storm sewers, inlets, culverts and other facilities.
NA 2. Calculations for existing storm sewer and open channel.
✓ 3. Irrigation ditch flows and ditch system capacity.
✓ * 4. Detention pond design (see Manual, Section 1400 for requirements).
✓ * a. Storage volume, release rates, and pool elevations for 10-year and 100-year storm.
✓ * b. Outlet structure dimensions, orifice diameter, weir lengths, pipe headwater and other data.
✓ * c. Outlet velocity and energy dissipation requirements.
NA * d. Routing of outlet flows and emergency spillway flows.
NA * 5. Street capacity calculations, if data in Manual not used (see Section 1100).
NA * 6. Storm inlet capacity calculations, if data in Manual not used (see Section 1100).
NA * 7. Storm sewer capacity calculations, if data in Manual not used (see Section 1000).
✓ * 8. Channel capacity calculations, if data in Manual not used (see Section 800).
✓ * 9. Culvert capacity calculations (see Manual, Section 1200).
NA * 10. Other hydraulic structure calculations (see Manual, Section 900).

D. STORMWATER QUALITY CALCULATIONS
✓ 1. Water Quality Capture Volume (WQCV).
✓ * 2. Storage volume for sediment volume and pool elevations for WQCV.
NA * 3. Outlet calculations for required area per row, diameter of individual holes, number of holes per row, and number of holes per column.

✓ **CERTIFICATION – PROFESSIONAL ENGINEER'S SEAL AND SIGNATURE**

✓ **ACKNOWLEDGEMENTS**

Drainage Report checklist was prepared by Jennie DeFrank

Table 303
Mesa County Stormwater Management Manual
Drainage Plan Checklist

Instructions:
1. Applicant to identify with a "check-mark" if information is provided. If applicant believes information is not required, indicate with "n/a".
2. County will determine if information labeled "n/a" is required and whether information must be submitted.

I. EXISTING FACILITIES

- ✓ A. Contours at two foot intervals, based on USGS datum. Contours to extend at least 50 feet past property line.
- ✓ B. Location and elevation of ~~USGS~~ benchmarks or benchmarks referenced to USGS.
- ✓ C. Property lines.
- NA D. Drainage easements.
- NA E. Street names.
- NA F. Major and minor channels and floodplains.

II. PROPOSED FACILITIES

- ✓ A. Contours at two foot intervals, based on USGS datum.
- ✓ B. Property lines.
- NA C. Drainage easements.
- NA D. Street names and grades.
- NA E. Right of way and easement.
- NA F. Finished floor elevations for protection from major storm run-off.
- ✓ G. Detention pond information:
  - ✓ 1. Location of each detention pond with site at 1"=50' scale or larger with 2-foot contour intervals.
  - ✓ 2. Inlet and outlet structure, and trickle channel design details.
  - NA 3. Details of emergency spillway and channel.
  - ✓ 4. Landscape information, including side slopes, vegetation and planting requirements.
  - ✓ 5. Details of water quality outlet structure.
- H. Channel Information:
  - NA 1. Profiles with existing and proposed grades.
  - NA 2. Cross sections on 100-foot stations showing existing and proposed topography and required rights of way.
  - NA 3. Locations and size of all existing and proposed structures.
  - NA 4. Locations and profiles of adjacent utilities.
  - ✓ 5. Typical channel section and lining details.
- I. Storm sewer information:
  - NA 1. Alignment and location of manholes, inlets, and outlet structures.
  - NA 2. Profile of invert and pipe crown.
  - NA 3. Invert elevations at manholes and inlets.
  - NA 4. Lengths and grades between manholes and inlets.
  - NA 5. Locations and elevations of utilities adjacent to and crossing storm sewer.
  - NA 6. Easement and other O&M access geometry.
  - NA 7. Outlet details, such as end sections, headwall and wingwalls, erosion control, and vegetation.
- NA J. Street cross sections with design 100-year flood depth.
- NA K. Other drainage related structures and facilities, including under drains and sump pump discharge lines.
- NA L. Other permanent BMP measures to control pollutant discharges to the County's MS4 system.

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III. **HYDRAULIC AND HYDROLOGIC INFORMATION**

✓ A. Routing and accumulative runoff peaks at upstream and downstream ends of the site and at various critical points onsite for initial and major storms. Inflow and outflow from each subbasin shall be shown for both initial and major storms.

NA B. Street cross sections showing 100-year flood levels.

NA C. Major and minor channels and floodplains.

✓ D. Detention pond data:

✓ 1. Release rates for 10- and 100-year storm events.

✓ 2. Required and provided volumes for 10- and 100-year storm events.

✓ 3. Design depths for 10- and 100-year storm events.

✓ 4. Water quality capture volume and pool elevation.

E. Channel data:

NA 1. Water surface profiles.

NA 2. Representative 100-year flow velocity and Froude number.

F. Storm sewer data:

NA 1. Profile of water surface for design flow rate.

NA 2. Peak flows for design flow, 5-year and 100-year storm events.

IV. **STANDARD NOTES**

✓ A. No building, structure, or fill will be placed in the detention areas and no changes or alterations affecting the hydraulic characteristics of the detention areas will be made without the approval of the County.

✓ B. Maintenance and operation of the detention and water quality areas is the responsibility of property owner. If owner fails in this responsibility, the County has the right to enter the property, maintain the detention areas, and be reimbursed for costs incurred.

✓ C. Detention pond volumes, all drainage appurtenances, and basin boundaries shall be verified. As-built drawings shall be prepared by a registered professional engineer prior to issuance of certificate of occupancy for any structure within the development.

✓ D. Permission to reproduce these plans is hereby given to Mesa County for County purposes associated with plan review, approval, permitting, inspection and construction of work.

✓ V. **PROFESSIONAL ENGINEERS SEAL AND SIGNATURE**

VI. **OTHER**

✓ A. Horizontal and vertical control information and ties to existing and proposed features.

ACKNOWLEDGEMENTS

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