

GENWAL RESOURCES, INC
CRANDALL CANYON MINES
C/015/032

CHANGE TO THE
MINING AND RECLAMATION PLAN
TO INCLUDE

MINE DISCHARGE WATER
IRON TREATMENT FACILITY

AND ABATEMENT ACTION FOR
CITATION 10043

**NOTE: THIS SUBMITTAL IS A RESPONSE TO
DEFICIENCIES TO THE ORIGINAL SUBMITTAL
OF OCTOBER 13, 2009**

TASK #3415

SUBMITTED: DECEMBER 2, 2009

File in:

Confidential

Shelf

Expandable

Refer to Record No. 0064 Date 12/02/2009

In C 0150032 2009 In Closing

For additional information



COPY

P.O. Box 910, East Carbon, Utah 84520 794 North "C" Canyon Rd, East Carbon, Utah 84520
Telephone (435) 888-4000 Fax (435) 888-4002

Daron Haddock
Permit Supervisor
Utah Division of Oil, Gas and Mining
P.O. Box 145801
1594 West North Temple, Suite 1210
Salt Lake City, Utah 84114-5801

December 2, 2009

Re: Crandall Canyon Mines, C/015/032
Mine Water Iron Treatment Facility
Citation 10043, and
Response to Deficiencies, Task 3415

Dear Mr. Haddock:

Enclosed are six (6 ea.) copies of the Response to Deficiencies (Task 3415) to the change to the Mining and Reclamation Plan to include the mine discharge water iron treatment facility, originally submitted on October 13, 2009. This is the same plan that was recently approved by the Division in response to the required actions for abatement of Citation 10043. Indeed, construction of the facility has already commenced, and is scheduled for completion by the end of this month. This change to the MRP also addresses the need to revise the final reclamation plan brought about by the uncertainty of the long-term requirement to treat the water for excessive iron.

If you have any questions or comments regarding this submittal please contact me at 435 888-4017.

Sincerely,

A handwritten signature in blue ink, appearing to read "David Shaver".

David Shaver
Resident Agent

RECEIVED

DEC 09 2009

DIV. OF OIL, GAS & MINING

File in:

- Confidential
 Shelf
 Expandable

Refer to Record No. 0064 Date 12/02/2009
In C 0150032 2009 Incoming
For additional information

APPLICATION FOR PERMIT PROCESSING

<input type="checkbox"/> Permit Change	<input type="checkbox"/> New Permit	<input type="checkbox"/> Renewal	<input type="checkbox"/> Transfer	<input type="checkbox"/> Exploration	<input type="checkbox"/> Bond Release	Permit Number: 015/032
Title of Proposal: Change to MRP to include discharge water iron treatment facility, and abate citation 10043, response to Deficiencies (Task 3415)						Mine: Crandall Canyon Mines
						Permittee: GENWAL Resources, Inc.

Description, include reason for application and timing required to implement:.

Instructions: If you answer yes to any of the first 8 questions (gray), submit the application to the Salt Lake Office. Otherwise, you may submit it to your reclamation specialist.

<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	1. Change in the size of the Permit Area? _____ acres Disturbed Area? _____ acres <input type="checkbox"/> increase <input type="checkbox"/> decrease.
<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	2. Is the application submitted as a result of a Division Order?
<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	3. Does application include operations outside a previously identified Cumulative Hydrologic Impact Area?
<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	4. Does application include operations in hydrologic basins other than as currently approved?
<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	5. Does application result from cancellation, reduction or increase of insurance or reclamation bond?
<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	6. Does the application require or include public notice/publication?
<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	7. Does the application require or include ownership, control, right-of-entry, or compliance information?
<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?
<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	9. Is the application submitted as a result of a Violation?
<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	10. Is the application submitted as a result of other laws or regulations or policies? Explain:
<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	11. Does the application affect the surface landowner or change the post mining land use?
<input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	12. Does the application require or include underground design or mine sequence and timing?
<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	13. Does the application require or include collection and reporting of any baseline information?
<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?
<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	15. Does application require or include soil removal, storage or placement?
<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	16. Does the application require or include vegetation monitoring, removal or revegetation activities?
<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	17. Does the application require or include construction, modification, or removal of surface facilities?
<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	18. Does the application require or include water monitoring, sediment or drainage control measures?
<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	19. Does the application require or include certified designs, maps, or calculations?
<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	20. Does the application require or include subsidence control or monitoring?
<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	21. Have reclamation costs for bonding been provided for?
<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	22. Does application involve a perennial stream, a stream buffer zone or discharges to a stream?
<input type="checkbox"/> Yes	<input type="checkbox"/> No	23. Does the application affect permits issued by other agencies or permits issued to other entities?

Attach 3 complete copies of the application.

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein. (R645-301-123)

[Signature]
Signed - Name - Position - Date *Agent 12/1/09*

Subscribed and sworn to before me this 1st day of December 2009

Notary Public
[Signature]
My Commission Expires: 3.27.13
STATE OF Utah
COUNTY OF Carbon



Received by Oil, Gas & Mining

RECEIVED

DEC 09 2009

DIV. OF OIL, GAS & MINING

ASSIGNED TRACKING NUMBER

Application for Permit Processing Detailed Schedule of Changes to the MRP

COPY

Title of Application: Change to MRP to include discharge water iron treatment facility and abate citation 10043, response to deficiencies (Task 3415)	Permit Number: 015/032
	Mine: CRANDALL CANYON MINES
	Permittee: GENWAL RESOURCES

Provide a detailed listing of all changes to the mining and reclamation plan which will be required as a result of this proposed permit application. Individually list all maps and drawings which are to be added, replaced, or removed from the plan. Include changes of the table of contents, section of the plan, pages, or other information as needed to specifically locate, identify and revise the existing mining and reclamation plan. Include page, section and drawing numbers as part of the description.

			DESCRIPTION OF MAP, TEXT, OR MATERIALS TO BE CHANGED
<input type="checkbox"/> ADD	<input checked="" type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	App 1-9 (Ownership) + Control)
<input type="checkbox"/> ADD	<input type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	
<input type="checkbox"/> ADD	<input checked="" type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	App 1-11 (Violation Information)
<input type="checkbox"/> ADD	<input type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	
<input type="checkbox"/> ADD	<input checked="" type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	Ch 5: pgs 5-33 and 5-34
<input type="checkbox"/> ADD	<input type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	
<input type="checkbox"/> ADD	<input checked="" type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	Ch 7: pgs 7-VII-a
<input type="checkbox"/> ADD	<input type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	pgs 7-46 thru 7-50
<input type="checkbox"/> ADD	<input checked="" type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	
<input type="checkbox"/> ADD	<input type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	Ch 7: Appendix 7-4
<input type="checkbox"/> ADD	<input type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	(Sediment + Drainage Control Plan)
<input type="checkbox"/> ADD	<input type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	
<input checked="" type="checkbox"/> ADD	<input type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	Ch 7: Appendix 7-65
<input type="checkbox"/> ADD	<input type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	(Mine Water Discharge Iron Treatment Facility)
<input type="checkbox"/> ADD	<input type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	
<input type="checkbox"/> ADD	<input checked="" type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	Plate 5-3 (Surface Facility)
<input type="checkbox"/> ADD	<input type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	
<input type="checkbox"/> ADD	<input checked="" type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	Plate 7-5 (Drainage Map)
<input type="checkbox"/> ADD	<input type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	
<input type="checkbox"/> ADD	<input type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	
<input type="checkbox"/> ADD	<input type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	
<input type="checkbox"/> ADD	<input type="checkbox"/> REPLACE	<input type="checkbox"/> REMOVE	

Any other specific or special instructions required for insertion of this proposal into the Mining and Reclamation Plan?

RECEIVED

DEC 09 2009

DIV. OF OIL, GAS & MINING

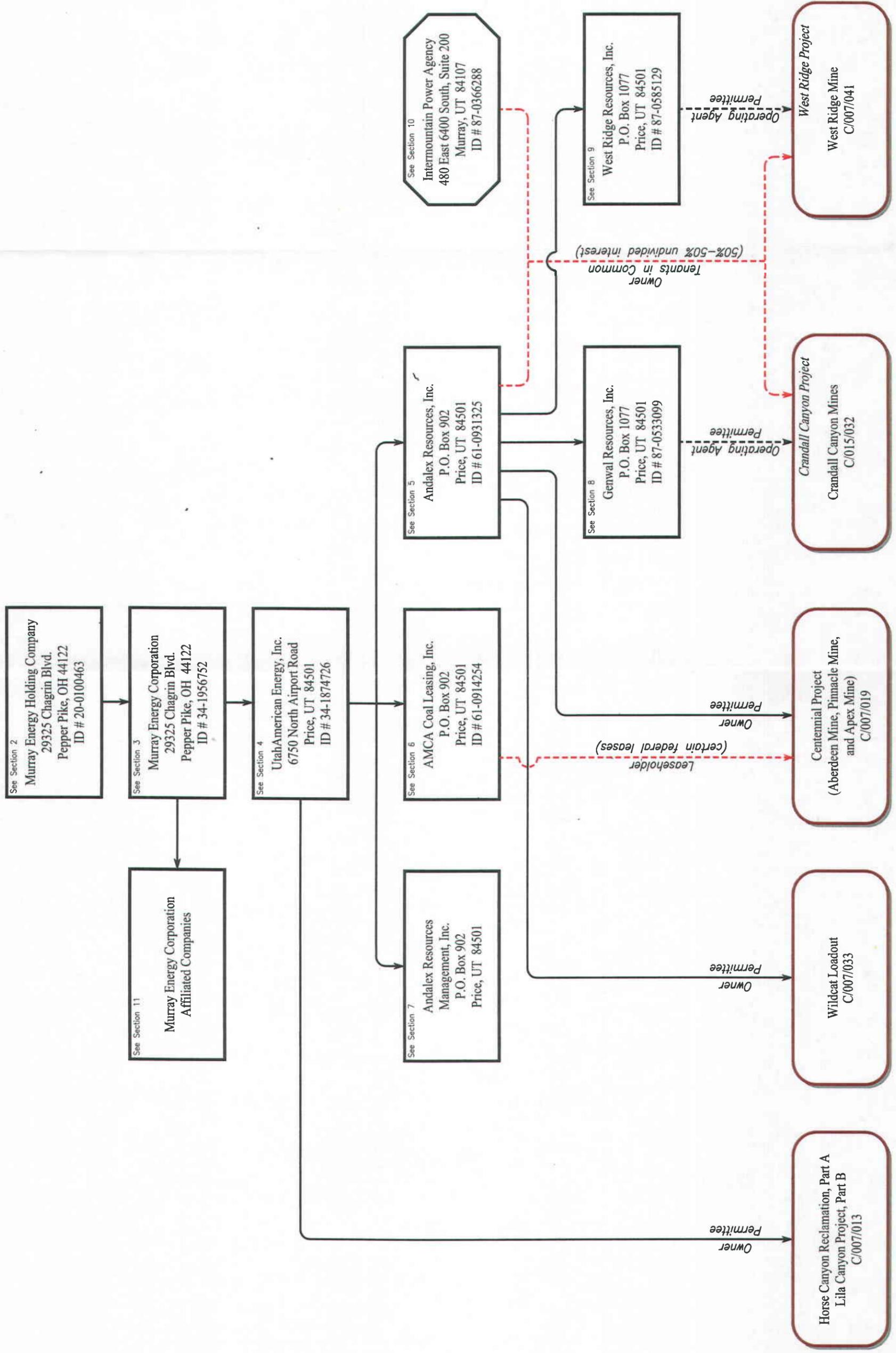
APPENDIX 1-9

OWNERSHIP AND CONTROL

OWNERSHIP AND CONTROL

REVISED 11/2009

OWNERSHIP AND CONTROL



Section 2

MURRAY ENERGY HOLDINGS CO.

29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

Robert E. Murray	President & CEO	6/30/03	11/29/05
Scott Boyle	President & CEO	11/29/05	12/20/05
Michael D. Loiacono	President & CEO	1/10/05	4/23/07
Robert D. Moore	President & CEO	4/23/07	
Michael D. Loiacono	Treasurer	1/10/05	
		6/30/03	
Michael O. McKown	Secretary	6/30/03	

Incorporation Information:

State of Incorporation Delaware;
Charter No. 3676958

Date of Incorporation June 27, 2003

ID # 20-0100463

Shareholders:

Robert Eugene Murray
Robert Edward Murray
Jonathan Robert Murray
Ryan Michael Murray
Fifth Third Bank of
Northeast Ohio, Trustee

Directors:

Robert E. Murray	6/30/03	
Michael D. Loiacono	6/30/03	4/23/07
Michael O. McKown	6/30/03	
Robert D. Moore	4/23/07	

Section 3

MURRAY ENERGY CORPORATION

29325 Chagrin Boulevard, Suite 300

Pepper Pike, Ohio 44122

Appointment of Officers

		<u>Begin</u>	<u>End</u>
Robert E. Murray	Chairman, President & Chief Executive Officer	02/23/01	
John R. Forrelli	Vice President	12/18/03	12/17/04
Robert D. Moore	Vice President & Chief Financial Officer	12/17/04	
P. Bruce Hill	Vice President - Human Resources	04/23/07	
Michael D. Loiacono	Treasurer	12/18/03	11/05/09
Michael D. Loiacono	Chief Financial Officer	02/23/01	
Michael O. McKown	Secretary	12/20/05	04/23/07
		02/23/01	

Incorporation Information:

State of Incorporation	Ohio; Charter No. 1211519
Date of Incorporation	February 23, 2001
ID#	34-1956752

Shareholder:

	<u>Begin</u>	<u>End</u>
Murray Energy Holdings Co. (100%)	10/21/03	
Robert E. Murray	2/23/01	10/21/03

Directors:

Robert E. Murray	02/23/01	
Michael D. Loiacono	12/20/05	04/23/07
Henry W. Fayne	01/28/05	
Richard L. Lawson	01/28/05	
Andrew D. Weissman	10/23/03	
Robert D. Moore	04/23/07	

Section 4

UTAHAMERICAN ENERGY, INC.

P.O. Box 910

East Carbon, Utah 84520

Officers:

		<u>Begin</u>	<u>End</u>
Peter J. Vuljanic	Interim President	11/06/09	
P. Bruce Hill	Chief Executive Officer	08/18/06	11/05/09
P. Bruce Hill	President	12/16/06	11/05/09
Douglas H. Smith	President	08/18/06	12/16/06
Clyde I. Borrell	President	07/31/98	05/19/06
Robert D. Moore	Treasurer	08/18/06	
Michael O. McKown	Secretary	08/18/06	
Marsha Baker Kocinski	Secretary	07/31/98	06/25/02
Barbara Boyce	Secretary	07/31/98	11/01/99
Jay Marshall	Manager	07/31/98	8/18/06

Directors:

Robert E. Murray	07/31/98	
P. Bruce Hill	08/18/06	11/05/09

Owner:¹

Murray Energy Corp.

¹ Coal Resources, Inc. is incorrectly listed as a shareholder the AVS OFT. Coal Resources, Inc has never been a shareholder of UEI.

Section 5

ANDALEX RESOURCES, INC.

P.O. Box 910

East Carbon, Utah 84520

Officers:

		<u>Begin</u>	<u>End</u>
Peter J. Vuljanic	Interim President	11/06/09	
P. Bruce Hill	President and Chief Executive Officer	12/16/06	11/05/09
Douglas H. Smith	President	03/07/94	12/16/06
Robert D. Moore	Treasurer	08/18/06	
Michael O. McKown	Secretary	08/18/06	

Former Officers/Directors:

Peter B. Green	Director	01/05/98	08/18/06
Peter B. Green	CB	05/11/90	08/18/06
Peter B. Green	CEO	05/11/90	08/18/06
Ronald C. Beedie	Director	01/05/88	08/18/06
John Bradshaw	Secretary	02/05/90	08/18/06
John Bradshaw	Vice-President	02/05/90	08/18/06
Douglas H. Smith	Director	03/07/94	08/18/06
Samuel C. Quigley	Vice-President	02/24/95	08/18/06
Andalex Hungary Ltd.	Shareholder	12/28/20	08/18/06
Alexander Harold Samuel Green	Director	01/11/02	08/18/06

Directors:

Robert E. Murray		08/18/06	
P. Bruce Hill		08/18/06	11/05/09

Owner:

UtahAmerican Energy, Inc.	100%	08/18/06	
---------------------------	------	----------	--

MSHA Numbers

Apex Mine	42-01750
Pinnacle Mine	42-01474
Aberdeen Mine	42-02028
Wildcat Loadout	42-01864

Section 6

AMCA COAL LEASING, INC.

P.O. Box 910

East Carbon, Utah 84520

Appointment of Officers:

		<u>Begin</u>	<u>End</u>
Peter J. Vuljanic	Interim President	11/06/09	
P. Bruce Hill	President and Chief Executive Officer	12/16/06	11/05/09
Douglas H. Smith	President	08/18/06	12/16/06
Robert D. Moore	Treasurer	12/16/06	
Michael O. McKown	Secretary	12/16/06	

Directors:

Robert E. Murray	08/18/06	
P. Bruce Hill	08/18/06	11/05/09

Owner:

UtahAmerican Energy, Inc., 100% ownership	08/18/06
---	----------

Section 7

ANDALEX RESOURCES MANAGEMENT, INC.

P.O. Box 910

East Carbon, Utah 84520

Appointment of Officers:

		<u>Begin</u>	<u>End</u>
Peter J. Vuljanic	Interim President	11/06/09	
Douglas H. Smith	President	08/18/06	12/16/06
P. Bruce Hill	President and Chief Executive Officer	12/16/06	11/05/09
Robert D. Moore	Treasurer	12/16/06	
Michael O. McKown	Secretary	12/16/06	

Directors:

Robert E. Murray	08/18/06	
P. Bruce Hill	08/18/06	11/05/09

Shareholders:

UtahAmerican Energy, Inc.	100%	08/18/06
---------------------------	------	----------

Section 8

GENWAL RESOURCES, INC.

P.O. Box 910

East Carbon, Utah 84520

Officers:

		<u>Begin</u>	<u>End</u>
Peter J. Vuljanic	Interim President	11/06/09	
Douglas H. Smith	President	08/18/06	12/16/06
P. Bruce Hill	President and		
	Chief Executive Officer	12/16/06	11/05/09
Robert D. Moore	Treasurer	12/16/06	
Michael O. McKown	Secretary	12/16/06	

Directors:

Robert E. Murray	08/18/06	
P. Bruce Hill	08/18/06	11/05/09

Former Directors:

Peter B. Green		8/9/06
Ronald C. Beedie		8/9/06
Douglas H. Smith		8/18/06
Gordon Ulrich		10/30/96

Former Officers:

Peter B. Green	Chairman & CEO	8/9/06
Samuel C. Quigley	Vice President	8/18/06
John Bradshaw	Vice President	5/17/05
John Bradshaw	Secretary & Treasurer	8/18/06
Douglas H. Smith	President	12/16/06

Owner:

ANDALEX Resources, Inc. is and remains the sole shareholder of Genwal Resources, Inc.¹

MSHA Numbers

Crandall Canyon Mine 42-01715

¹ Intermountain Power Agency holds, as a tenant in common, an undivided 50% interest in certain real property interests regarding the Crandall Canyon Mine.

Section 9

WEST RIDGE RESOURCES, INC.^I

P.O. Box 910

East Carbon, Utah 84520

Officers:

		<u>Begin</u>	<u>End</u>
Peter J. Vuljanic	Interim President	11/06/09	
Douglas H. Smith	President	08/18/06	12/16/06
P. Bruce Hill	President and CEO	12/16/06	11/05/09
Robert D. Moore	Treasurer	12/16/06	
Michael O. McKown	Secretary	12/16/06	

Directors:

Robert E. Murray	08/18/06	
P. Bruce Hill	08/18/06	11/05/09

Owner:

Andalex Resources, Inc.^{II} 100%

<u>Former Directors^{III}</u>	<u>Begin Date</u>	<u>End Date</u>	
Peter B. Green	4/1/98	8/9/06	
Ronald C. Beedie	4/1/98	8/9/06	
Douglas H. Smith	4/1/98	9/18/06	
<u>Former Officers^{IV}</u>	<u>Position</u>	<u>Begin Date</u>	<u>End Date</u>
Peter B. Green	Chairman & CEO	4/15/98	8/9/06
Samuel C. Quigley	Vice President	4/15/98	8/18/06
John Bradshaw	Secretary	4/15/98	8/18/06
Douglas H. Smith	President	4/15/98	12/16/06

MSHA Number

West Ridge Mine 42-022444

^I WEST RIDGE Resources, Inc. ("WRRRI") was formed on March 10, 1998. No actions of WRRRI occurred before that date.

^{II} ANDALEX Resources is (and remains) the sole shareholder of WRRRI. WRRRI and the Intermountain Power Agency hold certain real property interests as tenants in common, each owning a 50% interest therein.

^{III} The initial directors of WRRRI (as shown above) were appointed on April 1, 1998; the "Begin Date[s]" for each such director shown on the OFT form are incorrect.

^{IV} The initial officers of WRRRI (as shown above) were appointed on April 15, 1998; the "Begin Date[s]" for each such officer shown on the OFT form are incorrect. Also, Christopher G. Van Bever never served as an officer of WRRRI; the information shown on the OFT form to the contrary is incorrect.

Section 10

INTERMOUNTAIN POWER AGENCY

(Tenant in Common, 50% undivided interest; West Ridge Mine Permit C/007/041; Crandall Canyon Mine Permit C/015/032)^I

10653 South River Front Parkway, Suite 120
South Jordan, Utah 84095
(801) 938-1333

Appointment of Officers:

Ray Farrell	Chairman	12/1998
R. Leon Bowler	Vice-Chairman	12/1984
Ted L. Olson	Secretary	01/2002
Russell F. Fjeldsted	Treasurer	03/2007

Directors:

	<u>Begin Date</u>	<u>End Date</u>
R. Leon Bowler	06/1977	
Ray Farrell	11/1978	
Clifford C. Michaelis ^{II}	01/1988	6/2007
Ted L. Olson	01/1990	
Russell F. Fjeldsted	01/1992	
Walter Meacham	01/1999	
Gary O. Merrill	01/2002	6/2007
Robert O. Christiansen	06/2007	
Ed Collins	06/2007	

^I Intermountain Power Agency holds, as a tenant in common, an undivided 50% interest in certain real property interests regarding the West Ridge Mine and the Crandall Canyon Mine.

^{II} Replacing controller Dan R. Eldredge, serving from April 11, 1988 to January 1990.

Name and address of IPA's general manager:

Jim Hewlett
Intermountain Power Agency
10653 South River Front Parkway, Suite 120
South Jordan, Utah 84095
Telephone (801) 938-1333
Assumed position December 1, 2007

Resident Agent for IPA:

Mark Buchi
Holme, Roberts, and Owen
299 South Main, Suite 1800
Salt Lake City, Utah 84111
Assumed position January, 1988

IPA Designated representative to the Crandall Canyon Project and West Ridge Project Management Boards:

Nick Kezman
Operating Agent
Los Angeles Department of Water & Power
111 North Hope Street, Room 1263
Los Angeles, California 90012-2694
Telephone (213) 367-0286

Principle Shareholders of IPA:

IPA has no shareholders. IPA is a political subdivision of the State of Utah created under the Interlocal Cooperation Act, Title II, Chapter 13, Utah Code Ann. 1953, as amended, and as such, has not issued stock.

Section 11

MURRAY ENERGY AFFILIATE COMPANIES

- A. AMCOAL HOLDINGS, INC.**
101 Prosperous Place, Suite 125
Lexington, Kentucky 40509
- B. THE AMERICAN COAL COMPANY**
P. O. Box 727
Harrisburg, Illinois 62946
- C. THE AMERICAN COAL SALES COMPANY**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122
- D. AMERICAN COMPLIANCE COAL, INC.**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122
- E. AMERICAN ENERGY CORPORATION**
43521 Mayhugh Hill Road
Township Highway 88
Beallsville, Ohio 43716
- F. ANCHOR LONGWALL AND REBUILD, INC.**
One Industrial Park Drive
Wheeling, West Virginia 26003
- G. AVONMORE RAIL LOADING, INC.**
125 Old Farm Drive,
Pittsburgh, PA 15239
- H. BELMONT COAL, INC.**
P. O. Box 146
Powhatan, Ohio 43942
- I. CANTERBURY COAL COMPANY**
125 Old Farm Drive
Pittsburgh, PA 15239

- J. COAL RESOURCES HOLDINGS CO.**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122
- K. COAL RESOURCES, INC.**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122
- L. CONSOLIDATED LAND COMPANY**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122
- M. ENERGY RESOURCES, INC.**
P. O. Box 259
R. D.#2, Fermantown Road
Brockway, PA 15824
- N. KENAMERICAN RESOURCES, INC.**
101 Prosperous Place, Suite 125
Lexington, Kentucky 40509
- O. MAPLE CREEK MINING, INC.**
981 Route 917
Bentleyville, Pennsylvania 15314
- P. MILL CREEK MINING COMPANY**
P. O. Box 259
R. D. #2, Fermantown Road
Brockway, PA 15824
- Q. MONVALLEY TRANSPORTATION CENTER, INC.**
P. O. Box 135
1060 Ohio Avenue
Glassport, Pennsylvania 15045
- R. OHIOAMERICAN ENERGY INCORPORATED**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

- S. THE OHIO VALLEY COAL COMPANY**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

- T. OHIO VALLEY RESOURCES, INC.**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

- U. THE OHIO VALLEY TRANSLOADING COMPANY**
56854 Pleasant Ridge Road
Alledonia, Ohio 43902

- V. THE OKLAHOMA COAL COMPANY**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

- W. ONEIDA COAL COMPANY, INC.**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

- X. PENNAMERICAN COAL, INC.**
125 Old Farm Drive
Pittsburgh, PA 15239

- Y. PENNAMERICAN COAL LP**
125 Old Farm Drive
Pittsburgh, PA 15239

- Z. PENNSYLVANIA TRANSLOADING, INC.**
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio

- AA. PINSKI CORP.**
125 Old Farm Drive
Pittsburgh, PA 15239

- BB. SPRING CHURCH COAL COMPANY**
125 Old Farm Drive
Pittsburgh, PA 15239

CC. SUNBURST RESOURCES, INC.

586 National Road
Wheeling, West Virginia 26003

DD. TDK COAL SALES, INCORPORATED

P. O. Box 259
R. D. #2, Fermantown Road
Brockway, PA 15824

EE. UMCO ENERGY, INC.

29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

FF. WEST VIRGINIA RESOURCES, INC.

953 National Road, Suite 207
Wheeling, West Virginia 26003

GG. WYAMERICAN ENERGY, INC.

29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

A. AMCOAL HOLDINGS, INC.
101 Prosperous Place, Suite 125
Lexington, Kentucky 40509

Officers:

Robert E. Murray	President	5/23/03
P. Bruce Hill	Vice President – Human Resources	10/01/98
Robert D. Moore	Treasurer	10/01/98
Michael O. McKown	Secretary	3/1/05
Jeffrey L. Cash	Assistant Treasurer	11/01/99

Incorporation Information:

State of Incorporation: Ohio;
Charter No. 1007981

Date of Incorporation: June 12, 1998

ID #34-1867389

Shareholders: Murray Energy Corporation

Directors: Robert E. Murray

Revised 2/14/05

B. THE AMERICAN COAL COMPANY

P. O. Box 727

Harrisburg, Illinois 62946

Officers:

Robert E. Murray	Acting President	11/02/02
John R. Forrelli	Vice President	9/07/04
Michael O. McKown	Vice President, General Counsel and Secretary	3/15/99 3/1/05
Robert D. Moore	Treasurer	10/01/98
Jeffrey L. Cash	Assistant Treasurer and Assistant Secretary	11/01/99 6/01/01

Incorporation Information:

State of Incorporation Delaware;
Charter No. 2881631

Date of Incorporation June 2, 1998

ID #73-1543124

Shareholders: AmCoal Holdings, Inc.

Directors: Robert E. Murray

Revised: 2/14/05

C. THE AMERICAN COAL SALES COMPANY

29325 Chagrin Boulevard, Suite 300

Pepper Pike, Ohio 44122

Officers:

		<u>Begin</u>	<u>End</u>
Robert E. Murray	Chief Executive Officer	11/11/88	
B. J. Cornelius	President	9/08/95	
Edwin D. Lane	Vice President	11/01/99	3/1/05
William E. Hollars	Vice President	3/1/05	
Richard Rice	Vice President	11/11/88	11/01/99
Michael O. McKown	Secretary	3/1/05	
Steven C. Ellis	Secretary	11/10/88	3/1/05
James R. Turner, Jr.	Treasurer and Assistant Secretary	3/1/05	
Duane A. Smith	Assistant Treasurer and Assistant Secretary	6/25/01 6/25/01	
Brenda L. Murray	Assistant Secretary	9/8/95	6/25/01

Incorporation Information:

State of Incorporation Ohio; Charter No. 727836

Date of Incorporation June 29, 1988

ID #34-1603699

Shareholder: Coal Resources, Inc.

Directors: Robert E. Murray 9/08/95

Revised
5/2/07

D. AMERICAN COMPLIANCE COAL, INC.

29325 Chagrin Boulevard, Suite 300

Pepper Pike, Ohio 44122

Officers:

		<u>Begin</u>	<u>End</u>
Stanley T. Piasecki	President	3/1/05	
Charles E. Shestak	Vice President	03/10/03	
Michael O. McKown	Secretary	3/1/05	
Robert D. Moore	Treasurer and	6/25/01	
	Assistant Secretary	6/25/01	
Elmer A. Mottillo	Assistant Treasurer	8/22/03	

Former Officers:

Clyde I. Borrell	President	6/02/97	3/1/05
William W. Taft	Secretary	5/24/94	3/1/05

Incorporation Information:

State of Incorporation Colorado;
Charter No. 19941059260

Date of Incorporation May 24, 1994

ID #34-1797161

Shareholder:

Murray Energy Corporation	6/1/01	
(100%)		
Robert E. Murray	5/24/94	2/23/01

Director:

Robert E. Murray	5/24/94
------------------	---------

Revised
5/2/07

E. AMERICAN ENERGY CORPORATION

43521 Mayhugh Hill Road

Township Highway 88

Beallsville, Ohio 43716

Officers:

		<u>Begin</u>	<u>End</u>
Robert E. Murray	President	12/15/04	
Robert D. Moore	President	6/25/01	12/15/04
Michael O. McKown	Secretary	11/01/99	
James R. Turner, Jr.	Treasurer	3/1/05	
Robert D. Moore	Treasurer	6/25/01	12/15/04
Robert L. Putsock	Assistant Treasurer	1/27/04	

Incorporation Information:

State of Incorporation Ohio;
Charter No. 00842695

Date of Incorporation April 12, 1993
ID #31-1550443

Shareholder: Murray Energy Corporation
(100%)

Director:

Robert E. Murray	12/15/04	
P. Bruce Hill	7/02/01	12/15/04

Revised
3/16/07

F. ANCHOR LONGWALL AND REBUILD, INC.

One Industrial Park Drive
Wheeling, West Virginia 26003

Officers:

		<u>Begin</u>	<u>End</u>
P. Bruce Hill	President and	2/16/99	11/10/06
	Assistant Secretary	2/16/99	
Chad Underkoffler	President	11/10/06	
Michael O. McKown	Secretary	11/01/99	
James R. Turner, Jr.	Treasurer	9/16/05	
Duane A. Smith	Assistant Secretary	11/01/99	

Incorporation Information:

State of Incorporation West Virginia;
Charter No. 00961100093212818

Date of Incorporation April 18, 1996

ID #55-0749933

Shareholder:

I.D. # 34-1586390
Address: 29325 Chagrin
Boulevard
Suite 300
Pepper Pike, OH 44122

Coal Resources, Inc.

Director:

Charles E. Shestak	11/01/99
P. Keith McGilton	11/01/99

Revised
3/6/07

G. AVONMORE RAIL LOADING, INC.

125 Old Farm Drive,
Pittsburgh, PA 15239

Officers:

VACANT	President	
Robert D. Moore	Treasurer	6/25/01
Michael O. McKown	Secretary	3/1/05
Robert L. Putsock	Assistant Treasurer	1/02/03
Elmer A. Mottillo	Assistant Secretary	1/02/03

Incorporation Information:

State of Incorporation	Delaware; Charter No. 0798860
Date of Incorporation Qualified	February 19, 1974 May 6, 1974 Pennsylvania; PA Entity #000302999
ID #25-1253970	

Shareholder: Mill Creek Mining Company

Director: Charles E. Shestak

Revised: 2/14/05

H. BELMONT COAL, INC.

P. O. Box 146

Powhatan, Ohio 43942

Officers:

		<u>Begin</u>	<u>End</u>
Robert D. Moore	President	6/25/01	
Maynard St. John	Vice-President	1/02/02	6/26/02
James R. Turner, Jr.	Secretary/Treasurer	9/16/05	
Kristi D. Brown	Secretary/Treasurer	11/08/01	9/16/05

Incorporation Information:

State of Incorporation Ohio;
Charter No. 00842697

Date of Incorporation April 12, 1993

ID #31-1536602

Shareholder:

Murray Energy Corporation (100%)	6/1/01	
Robert E. Murray	4/19/93	6/1/01

Director:

Duane A. Smith	4/12/93	12/15/06
Robert D. Moore	12/15/06	

Revised
3/6/07

I. CANTERBURY COAL COMPANY

125 Old Farm Drive
Pittsburgh, PA 15239

Officers:

Robert D. Moore	President & Treasurer	05/26/07
Michael O. McKown	Secretary	05/26/07
Robert L. Putsock	Asst Treasurer	01/2/03
James R. Turner, Jr.	Asst Secretary	06/1/08

Incorporation Information:

State of Incorporation Pennsylvania;
PA Entity #000055242

Date of Incorporation July 26, 1963

ID #25-1127473

Shareholder: Mill Creek Mining Company
(100%)

Director: Charles E. Shestak

Revised
3/6/07

J. COAL RESOURCES HOLDINGS CO.

29325 Chagrin Boulevard, Suite 300

Pepper Pike, Ohio 44122

Officers:

		<u>Begin</u>	<u>End</u>
Robert E. Murray	President and CEO	6/27/03	
Michael D. Loiacono	Treasurer	6/27/03	
	CFO	12/20/05	04/23/07
Robert D. Moore	CFO	04/23/07	
Scott A. Boyle	Chief Financial Officer	10/29/05	12/20/05
P. Bruce Hill	Secretary	3/1/05	11/01/05
Michael O. McKown	Secretary	11/01/05	
Robert L. Putsock	Assistant Secretary and Assistant Treasurer	6/25/01	
		6/25/01	

Incorporation Information:

State of Incorporation Delaware;
Charter No. 3676954

Date of Incorporation June 27, 2003

ID #20-0100479

Shareholder:

Robert E. Murray (Class A Shares
100%)

Robert Eugene Murray (Class B
Shares 20%)

Robert Edward Murray (Class B
Shares 20%)

Ryan Michael Murray (Class B
Shares 20%)

Jonathan Robert Murray (Class B
Shares 20%)

Fifth Third Bank of Northeast
Ohio, Trustee (Class B Shares
20%)

Director:

Revised

5/10/07

Robert E. Murray

6/27/03

K. COAL RESOURCES, INC.
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

		<u>Begin</u>	<u>End</u>
Robert E. Murray	Chairman, President and Chief Executive Officer	3/1/05	
Michael D. Loiacono	Treasurer	1/28/05	
	CFO	12/20/05	04/23/07
Robert D. Moore	CFO	04/23/07	
Scott A. Boyle	Chief Financial Officer	10/17/05	12/20/05
P. Bruce Hill	Secretary	3/1/05	11/01/05
Michael O. McKown	Secretary	11/01/05	
Robert L. Putsock	Assistant Secretary and Assistant Treasurer	6/25/01	6/25/01

Incorporation Information:

State of Incorporation: Ohio;
Charter No. 717546

Date of Incorporation: January 29, 1988

ID #34-1586390

Shareholder:

Coal Resources Holdings Co.	10/21/03	
Robert E. Murray	1/29/88	10/21/03

Directors:

Robert E. Murray		
Henry W. Fayne		
Andrew Weissman		
Richard L. Lawson		
Michael D. Loiacono	12/20/05	04/23/07
Robert D. Moore	04/23/07	

Revised
5/10/07

L. CONSOLIDATED LAND COMPANY

29325 Chagrin Boulevard, Suite 300

Pepper Pike, Ohio 44122

Officers:

Robert D. Moore	President	8/11/04
Robert D. Moore	Treasurer and Assistant Secretary	6/25/01 6/25/01
Michael O. McKown	Secretary	3/1/05
Elmer A. Mottillo	Assistant Secretary	8/22/03

Incorporation Information:

State of Incorporation Ohio;
Charter No. 00842696

Date of Incorporation April 12, 1993

ID #34-1769562

Shareholder: Murray Energy Corporation 6/1/01
(100%)

Director: Robert D. Moore 8/11/04

Revised
3/6/07

M. ENERGY RESOURCES, INC.

P. O. Box 259

R. D.#2, Fermantown Road

Brockway, PA 15824

Officers:

Stanley T. Piasecki	President and Chief Executive Officer	8/11/04
Elmer A. Mottillo	Treasurer	8/22/03
Michael O. McKown	Secretary	3/1/05
Charles E. Shestak	Assistant Secretary	4/30/93

Incorporation Information:

State of Incorporation Pennsylvania;
PA Entity #762734

Date of Incorporation September 14, 1982

ID #31-1044044

Shareholder: Mill Creek Mining Company

Director: Stanley T. Piasecki 8/11/04

Revised 2/14/05

N. KENAMERICAN RESOURCES, INC.

101 Prosperous Place, Suite 125
Lexington, Kentucky 40509

Officers:

		<u>Begin</u>	<u>End</u>
Robert N. Sandidge	President	12/16/06	
Dennis W. Bryant	President/Manager	10/1/05	12/16/06
B. J. Cornellius	Senior Vice-President--Sales	11/1/05	
James R. Turner, Jr.	Treasurer	3/1/05	
Robert D. Moore	Assistant Treasurer	3/1/05	
Michael O. McKown	Secretary	2/13/06	

Incorporation Information:

State of Incorporation Kentucky;
 Charter No. 0331655

Date of Incorporation June 9, 1994

ID #61-1264385

Shareholder: Mill Creek Mining Company

Director: Robert E. Murray 6/1/05

Revised
3/6/07

O. MAPLE CREEK MINING, INC.

981 Route 917

Bentleyville, Pennsylvania 15314

Officers:

		<u>Begin</u>	<u>End</u>
Paul B. Piccolini	President	4/28/06	
Ronnie D. Dietz	Vice President and Treasurer	3/1/05	
Michael B. Gardner	Secretary	3/1/05	5/01/07
VACANT			
Roberta K. Heil	Assistant Secretary	11/01/99	

Incorporation Information:

State of Incorporation Pennsylvania;
PA Entity #2607113

Date of Incorporation November 9, 1994

ID #25-1755305

Shareholder: Sunburst Resources, Inc. 1/11/95

Director: Robert E. Murray

P. MILL CREEK MINING COMPANY

P. O. Box 259
R. D. #2, Fermantown Road
Brockway, PA 15824

Officers:

		<u>Begin</u>	<u>End</u>
Charles E. Shestak	President	8/18/98	
James R. Turner, Jr.	Treasurer	3/1/05	
Robert D. Moore	Treasurer	6/25/01	3/1/05
Robert D. Moore	Assistant Treasurer	3/1/05	
Michael O. McKown	Secretary	3/1/05	
Michael E. Elliott	Secretary	8-18-98	3/1/05
Robert L. Putsock	Assistant Secretary and Assistant Treasurer	6/25/01 6/25/01	

Incorporation Information:

State of Incorporation Pennsylvania;
PA Entity #0007447787

Date of Incorporation December 1, 1981

Certificate of Amendment July 7, 1988;
#8854525

ID #31-1040986

Shareholder: Coal Resources, Inc.

Director: Robert E. Murray 5/14/04

Revised
3/6/07

Q. MONVALLEY TRANSPORTATION CENTER, INC.

P. O. Box 135

1060 Ohio Avenue

Glassport, Pennsylvania 15045

Officers:

Paul B. Piccolini President 4/28/06

James R. Turner, Jr. Secretary and
Treasurer 3/1/05

Incorporation Information:

State of Incorporation Pennsylvania;
PA Entity #856918

Date of Incorporation February 15, 1985

ID #25-1490495

Shareholders: Pennsylvania Transloading, Inc.

Directors: Robert E. Murray and
Michael D. Loiacono 11/01/99

R. OHIOAMERICAN ENERGY INCORPORATED

29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

D. Michael Jamison	President	5/1/05
Michael O. McKown	Secretary	5/1/05
Robert D. Moore	Treasurer	5/1/05
Elmer A. Mottillo	Assistant Treasurer	6/30/06

Incorporation Information:

State of Incorporation	Ohio
Date of Incorporation	February 1, 2005
ID # 20-3044610	Ohio Charter No. 1518533

Director: Robert E. Murray 5/1/05

Shareholder: Murray Energy Corporation 5/1/05

Revised
3/6/07

S. THE OHIO VALLEY COAL COMPANY

29325 Chagrin Boulevard, Suite 300

Pepper Pike, Ohio 44122

Officers:

		<u>Begin</u>	<u>End</u>
Vacant	President	11/4/05	
Paul B. Piccolini	Vice President	1/1/07	
Ronnie D. Dietz	Treasurer,	3/1/05	
	Assistant Secretary and		
	Corporate Comptroller		
Michael B. Gardner	Secretary	3/1/05	5/01/07
Roberta K. Heil	Assistant Secretary	11/01/99	
Bonnie M. Froehlich	Assistant Secretary and	6/25/01	
	Assistant Treasurer	6/25/01	

Incorporation Information:

State of Incorporation Ohio;
Charter No. 384971

Date of Incorporation June 6, 1969

Certificate of Amendment October 4, 1988;
#201274

ID #34-1041310

Shareholder: Ohio Valley Resources, Inc.

Director: Robert E. Murray

Revised
5/2/07

T. OHIO VALLEY RESOURCES, INC.

29325 Chagrin Boulevard, Suite 300

Pepper Pike, Ohio 44122

Officers:

		<u>Begin</u>	<u>End</u>
Paul B. Piccolini	President	4/28/06	
John Forrelli	President	11/1/99	4/28/06
Ronnie D. Dietz	Treasurer, Assistant Secretary and Corporate Comptroller	3/1/05	
Michael D. Loiacono	Treasurer, Assistant Secretary and Corporate Comptroller	3/10/95	4/28/06
VACANT	Secretary	3/1/05	05/01/07
Stephen Ellis	Secretary	3/10/95	3/1/05

Incorporation Information:

State of Incorporation Ohio;
Charter No. 721514

Date of Incorporation March 29, 1988

ID #34-1586391

Shareholders:

Murray Energy Corporation	6/1/01	
(100%)		
Robert E. Murray	3/10/95	6/1/01

Director:

Robert E. Murray

Revised
3/6/07

U. **THE OHIO VALLEY TRANSLOADING COMPANY**

56854 Pleasant Ridge Road

Alledonia, Ohio 43902

Officers:

		<u>Begin</u>	<u>End</u>
Vacant	President	11/4/05	
Paul B. Piccolini	Vice-President	1/1/07	
Ronnie D. Dietz	Treasurer, Assistant Secretary and Corporate Comptroller	3/1/05	
Michael B. Gardner	Secretary	3/1/05	05/01/07
Roberta K. Heil	Assistant Secretary	9/01/00	

Incorporation Information:

State of Incorporation Ohio;
Charter No. 727835

Date of Incorporation June 29, 1988

ID #34-1611209

Shareholder: Ohio Valley Resources, Inc.

Director: Robert E. Murray 4/06/93

Revised
3/6/07

V. THE OKLAHOMA COAL COMPANY

29325 Chagrin Boulevard, Suite 300

Pepper Pike, Ohio 44122

Officers:

		<u>Begin</u>	<u>End</u>
Paul B. Piccolini	President	4/28/06	
Gregory C. Smith	President	11/1/99	4/28/06
Michael O. McKown	Secretary	3/1/05	
Gregory A. Gorospe	Secretary	9/15/94	11/1/99
James R. Turner, Jr.	Treasurer and Assistant Secretary	3/1/05	
Kathleen Bednarek	Treasurer	6/20/00	6/26/00
Robert L. Putsock	Assistant Secretary	1/10/03	
Kathleen Bednarek	Assistant Secretary	9/3/96	6/26/00

Incorporation

Information:

State of Incorporation Oklahoma;
Charter No. DB00477836

Date of Incorporation April 17, 1989

Licensed in Ohio February 27, 1991;
FL 790739

ID #34-1673480

Shareholder: The American Coal Sales Company

Director: Robert E. Murray

Revised
3/6/07

X. PENNAMERICAN COAL, INC.

125 Old Farm Drive
Pittsburgh, PA 15239

Officers:

Robert D. Moore	President, Treasurer and Secretary	6/25/01 6/25/01
Robert L. Putsock	Assistant Secretary	6/25/01

Incorporation Information:

State of Incorporation Pennsylvania;
PA Entity #2545905

Date of Incorporation September 13, 1993

ID #25-1722115

Shareholder: Mill Creek Mining Co. 11/08/93

Director: Robert E. Murray

Revised 2/14/05

Y. **PENNAMERICAN COAL LP**

125 Old Farm Drive
Pittsburgh, PA 15239

Partners:

Pinski Corp.	Managing Partner	8/19/96
PennAmerican Coal, Inc.	Limited Partner	7/8/98

EIN# 25-1800809
Partnership Effective 7/8/98

Revised
3/6/07

Z. PENNSYLVANIA TRANSLOADING, INC.

29325 Chagrin Boulevard, Suite 300

Pepper Pike, Ohio 44122

Officers:

Paul B. Piccolini	President	4/28/06
James R. Turner, Jr.	Treasurer	3/1/05
Michael O. McKown	Secretary	3/1/05

Incorporation Information:

State of Incorporation Ohio;
Charter No. 736747

Date of Incorporation November 18, 1988

Qualified: Pennsylvania;
December 28, 1988

Certificate of Authority No. 8898868

ID #34-1603748

Shareholder: Sunburst Resources, Inc. 04/01/96
(100%)

Director: Robert E. Murray

I

Revised
5/10/07

¹ Sunburst Resources, Inc. has always been a shareholder and has no relation to Consolidated Land Company.

AA. PINSKI CORP.
125 Old Farm Drive
Pittsburgh, PA 15239

Officers:

VACANT	President and General Manager	
Robert D. Moore	Treasurer and Secretary	6/25/01 6/25/01
Robert L. Putsock	Assistant Treasurer and Assistant Secretary	6/25/01 6/25/01

Incorporation Information:

State of Incorporation	Pennsylvania; PA Entity #002710766
Date of Incorporation	August 19, 1996
ID #25-1800870	

Shareholder: PennAmerican Coal, Inc.

Director: Charles E. Shestak

Revised 2/14/05

BB. SPRING CHURCH COAL COMPANY

125 Old Farm Drive
Pittsburgh, PA 15239

Officers:

Robert D. Moore	President	05/26/07
Robert S. Moore	Treasurer	06/25/01
Michael O. McKown	Secretary	05/26/07
Robert L. Putsock	Asst Treasurer	01/02/03
James R. Turner, Jr.	Asst Secretary	06/01/08

Incorporation Information:

State of Incorporation Pennsylvania;
PA Entity #000696663

Date of Incorporation November 2, 1979

ID #25-1372128

Shareholder: Mill Creek Mining Company

Director: Charles E. Shestak

Revised: 2/14/05

CC. SUNBURST RESOURCES, INC.

586 National Road

Wheeling, West Virginia 26003

Officers:

		<u>Begin</u>	<u>End</u>
Paul B. Piccolini	President	4/28/06	
Ronnie D. Dietz	Treasurer	3/1/05	
Michael B. Gardner	Secretary	3/1/05	05/01/07

Incorporation Information:

State of Incorporation Pennsylvania;
PA Entity #2616384

Date of Incorporation January 10, 1995

ID #25-1766427

Shareholder: Ohio Valley Resources, 4/01/97
Inc.

Director: Robert E. Murray

Revised

3/7/07

DD. TDK COAL SALES, INCORPORATED

P. O. Box 259

R. D. #2, Fermantown Road

Brockway, PA 15824

Officers:

Stanley T. Piasecki	President and Chief Executive Officer	8/11/04
Elmer A. Mottillo	Treasurer	8/22/03
Michael O. McKown	Secretary	3/1/05
Charles E. Shestak	Assistant Secretary	2/01/99

Incorporation Information:

State of Incorporation Pennsylvania;
PA Entity #00758582

Date of Incorporation June 28, 1982

ID #25-1422374

Shareholder: Energy Resources, Inc.

Director: Stanley T. Piasecki 8/11/04

Revised: 02/14/05

EE. UMCO ENERGY, INC.
29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

		<u>Begin</u>	<u>End</u>
Paul B. Piccolini	President	4/28/06	
Ronnie D. Dietz	Treasurer and Assistant Secretary	3/1/05	
Michael B. Gardner	Secretary	3/1/05	05/01/07
	Vice-President	5/3/06	

Incorporation Information:

State of Incorporation Pennsylvania;
PA Entity #1072295

Date of Incorporation December 29, 1988

ID #52-1615668

Shareholder: Maple Creek Mining, Inc.
and Toni J. Southern

Director: Robert E. Murray

Revised
3/6/07

FF. WEST VIRGINIA RESOURCES, INC.

953 National Road, Suite 207

Wheeling, West Virginia 26003

Officers:

		<u>Begin</u>	<u>End</u>
Neil Kok	President	10/2/06	
Robert D. Moore	President	10/20/00	10/20/00
Robert E. Murray	President, CEO	12/27/91	10/20/00
Anne Besece	Treasurer and Secretary	10/2/06	
Robert L. Putsock	Treasurer and Assistant Secretary	6/25/01 6/25/01	10/2/06
Robert E. Murray	Treasurer	12/27/91	6/25/01
Michael O. McKown	Secretary	3/1/05	10/2/06
Anthony Carl Laplaca	Secretary	12/27/91	3/1/05

Incorporation Information:

State of Incorporation: West Virginia;
Charter No.
00913610154813604

Date of Incorporation: December 27, 1991

ID #55-0713676

Shareholder: Mill Creek Mining Company 12/27/91
(100%)

Director: Robert E. Murray

Revised
3/6/07

GG. WYAMERICAN ENERGY, INC.

29325 Chagrin Boulevard, Suite 300
Pepper Pike, Ohio 44122

Officers:

Robert D. Moore	President, Treasurer and Secretary	5/3/06
-----------------	---------------------------------------	--------

Incorporation Information:

State of Incorporation	Wyoming; Charter No. 1998003378171
------------------------	---------------------------------------

Date of Incorporation	September 22, 1998
-----------------------	--------------------

ID #34-1875051

<u>Shareholder:</u>	Murray Energy Corporation
---------------------	---------------------------

<u>Director:</u>	Robert E. Murray
------------------	------------------

Revised
3/7/07

APPENDIX 1-11

VIOLATION INFORMATION

VIOLATION INFORMATION

Information updated to November 25 , 2009

Name of Operation	Identifying number for operation	Federal or State Permit Number	MSHA ID Number
Centennial		007/019	42-01750 42-01474 42-02028 42-01864

Date issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
9/27/2006	10000	DOG M			Failure to renew	9/29/2006	terminated	N
10/6/2006	10002	DOG M			Failure to submit fan plan	12/4/2006	terminated	N
2/7/2007	10003	DOG M			Non coal Waste	2/12/2007	terminated	N
7/6/2007	10007	DOG M			Vehicle in ditch	7/06/07	terminated	N
8/27/2007	10008	DOG M			vehicle in ditch	8/28/2007	terminated	N
8/27/2007	10009	DOG M			no sed pond inspection	8/27/07	terminated	N
6/18/2007	10024	DOG M			non coal waste	6/18.08	terminated	N
10/28/2008	10030	DOG M			guard shack		terminated	N

1/21/09 10032 DOG M Rocks in ditch Term N

7/2/09 10040 DOG M Failure to maintain sediment control, GVH Term N

Name of Operation		Identifying number for operation	Federal or State Permit Number	MSHA ID Number
Crandall			015/032	42-01715

Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term, etc.)	Abatement Action	Appeal Y or N
8/19/2004	Nov4-49-4-1	DOGM			Parking in Forest	Term	moved vehicle	N
9/13/2004	Nov4-49-5-1	DOGM			non-coal waste	Term	moved waste	N
9/8/2005	Nov5-49-2-1	DOGM			Failure annual subsidence	Term		N
10/4/2006	#10001	DOGM			Culvert Plugged	TErm	Unplugged	N
9/6/2007	10014	DOGM			no sed pond inspection	TERM	Inspected	N
9/10/2007	10015	DOGM			plugged culvert	term	unplugged	N
1/14/2008	10016	DOGM			mine water stored in pond	Term	rerouted water	N
1/14/2008	10017	DOGM			grvity flow fro m portals	Term	stopped flow	N
2/06/2008	10019	DOGM			failure to request permit renewal	Term	submitted renewal	N

5/28/2008	10021	DOGM			Plugged culverts	Term	Unplugged	N
5/28/2008	10022	DOGM			Failure to maintain silt fence	Term	Cleaned fence	N
8/10/2009	10043	DOGM			High iron discharge in Crandall Creek			N
8/10/2009	10044	DOGM			No macroinvertebrate studies			N
10/29/2009	10046	DOGM			Failure to clean out sediment pond			N

Name of Operation		Identifying number for operation	Federal or State Permit Number	MSHA ID Number
West Ridge			007/041	42-02233

Date issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
1/22/2004	Nov4-49-1-1	DOGM			Failure to request renewal	Term		N
4/6/2005	Nov5-39-1-1	DOGM			Failure to submit 4qtr water	Term		N
7/31/2008	10025	DOGM			coal pushed on topsoil	Term		N
1/29/2009	10033	DOGM			sediment in stream	Pending		N

Name of Operation			Identifying number for operation				Federal or State Permit Number	MSHA ID Number
Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
UMCO								
			74645				PA 63921301	3608375
9/1/2004	426787	DMRM		63921301	86.13	No resolution	No resolution	N
9/3/2004	426786	DMRM		63921301	89.142a(b)	No resolution		N
9/20/2004	427936	DMRM		63921301	89.142a(b)	No resolution		N
1/4/2005	445603	Air Quality		63921301	25.127.25	ADM. Close Out	ADM. Close Out	N
1/13/2005	445603	Air Quality		63921301	25.127.25	ADM. Close Out	ADM. Close Out	N
3/18/2005	445603	Air Quality		63921301	25.127.25	ADM. Close Out	ADM. Close Out	N
6/10/2005	466153	DEP		63921301	25.89.21	No resolution		N
7/15/2005	448412	DEP		63921301	25.89.68	Abated		N
7/15/2005	448413	DEP		63921301	25.89.83(a)	Abated		N
10/10/2006	499479	PADDP		63921301	89.142a(f)	No resolution		Y

Name of Operation		Identifying number for operation			Federal or State Permit Number	MSHA ID Number		
Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number			Brief Description of Violation	Status (Abated, Term. etc.)
Maple Creek		4244			63723707		36-00970	
5/7/2004	394440	MCM		63841302	89.142A.F.1	Abated		N
5/12/2004	394880	MCM		63841302	89.142A.F.1	No resolution		N
5/13/2004	395344	MCM		63841302	89.142A.F.1	No resolution		N
5/13/2004	395345	MCM		63841302	89.142A.F.1V	No resolution		N
5/13/2004	395346	MCM		63841302	89.142A.E	Abated		N
5/7/2004	394440	MCM		63841302	89.142A.F.1	Abated		N
7/7/2004	401714	MCM		63841302	89.142A.F.1	No resolution		N
7/30/2004	421806	MCM		63841302	SMCRA, 18.6	Abated		N
8/26/2004	425804	MCM		63841302	89.142A.F.1	No resolution		N
8/13/2004	426148	MCM		63723707	86.13	Abated		N
9/8/2004	427302	MCM		63723707	90.102	Abated		N
9/10/2004	427564	MCM		63723707	90.102	Abated		N
9/13/2004	427565	MCM		63723707	90.102	Abated		N
9/14/2004	427566	MCM		63723707	90.102	Abated		N
9/14/2004	427567	MCM		63723707	90.112	Abated		N
10/19/2004	432068	MCM		63723707	90.102	Abated		N
7/29/2005	469866	DEP		63723707	89.142a(b)(1)(iii)	No Resolution		N
12/1/2005	478486	PADEP		63841302	89.145a(b)	No Resolution		N
12/1/2005	478487	PADEP		63841302	89.145a(f)(1)(v)	No Resolution		N
12/1/2005	478488	PADEP		63841302	89.145a(b)	No Resolution		N
1/9/2006	480660	PADEP		63841302	1396.18(f)	Abated		N
6/12/2006	491619	PADEP		6381302	89.142a(e)	No Resolution		Y

Name of Operation		Identifying number for operation		Federal or State Permit Number	MSHA ID Number			
Ohio American Coal, Inc.		N/A		N/A	3304550/3304569			
Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
8/9/2006	21861	ODNR	OAEI	D-2180	outside of permit bndry	Abadted	IBR	N
3/1/2007	13101	ODNR	OAEI	D-2291	mining without a permit	Abadted	Permit issued	N

Kim Betcher

Name of Operation		Identifying number for operation	Federal or State Permit Number	MSHA ID Number				
Energy Resources, Inc.		470	License # 1465	360 269 5				
Charlie Shestak								
Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
5/11/2004	143258	PaDEP	ERI	24010101	87.147	Abated	Corrected	N
8/26/2004	167665	PaDEP	ERI	24010101	87.140	Abated	Corrected	N
8/30/2004	168590	PaDEP	ERI	24970102	87.147	Abated	Corrected	N
7/6/2004	147120	PaDEP	ERI	33901602	89.52	Abated	Corrected	N
7/31/2006	211989	PaDEP	ERI	17841607	86.152	Abated	Corrected	N
4/11/2006	486936	PaDEP	ERI	17930120	87.157	Abated	Corrected	N

Name of Operation		Identifying number for operation			Federal or State Permit Number	MSHA ID Number		
Belmont Coal Company					D-0241/D-1020	33-04397/33-03048		
Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
2/24/2004	24541	DMR	Mine	D-0241	Gullies exis in regraded	Terminated	regraded	N

David Bartsch

Name of Operation		Identifying number for operation			Federal or State Permit Number	MSHA ID Number		
The Ohio Valley Coal Co.		Powhatan No. 6 Mine			State - D-33-01159 0360			
Date Issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action	Appeal Y or N
8/2/2004	19662	DMRM	Mine D-0360		Failure to maintain sediment control	Terminated	Cleaned Ditch	N
5/23/2006	19656	DMRM	Mine D-0360		Failure to maintain the perimeter of diversion ditch	Terminated	Cleaned Ditch	N
11/30/2006	28473	DMRM	Mine D-0360		Undirected Drainage	Terminated	Cleaned Ditch	N
11/30/2006	28484	DMRM	Mine D-0360		Coal Blocking Diversion Ditch	Terminated	Cleaned Ditch	N

David Bartsch

Name of Operation			Identifying number for operation					Federal or State Permit Number	MSHA ID Number
American Energy Corp			Violation Number	Name of Issuing Agency	Person Issued To	Permit Number	Brief Description of Violation	Status (Abated, Term. etc.)	Appeal Y or N
1/25/2005	21807	ODNR		D-0425		subsidized residnet ran out of water	Terminated	filled tank with water	N
4/27/2005	19696	ODNR		D-0425		Coal located outside stockpile area	Terminated	cleaned coal	N
4/29/2005	19695	ODNR		D-0425		Maintenance on pond 018	Terminated	cleaned out pond	N
4/27/2005	19697	ODNR		D-0425		drainage from property not entering sumps	Terminated	construct sumps	N
10/3/2005	21871	ODNR		D-0425		Failure to sub specific repairs (landowner)	Active		N
6/15/2006	21860	ODNR		D-1159		Segregate Prim Farmland soils	Active	Waiting on ODNR, All information submitted	N
Aug-05	CO-1726	ODNR		D-0425		Uncontrolled discharge (Slurry)	Avtive	Will submit revised Plan Mid Month	N

Name of Operation		Identifying number for operation			Federal or State Permit Number	MSHA ID Number			
Date issued	Violation Number	Name of Issuing Agency	Person Issued To	Permit Number			Brief Description of Violation	Status (Abated, Term. etc.)	Abatement Action
					Galatia Mine & Millennium Portal				
9/27/2004	37-1-04	IDNR	DeNeal	Permit #2	Failure to submit groundwater report on schedule	Terminated			N
4/13/2005	37-01-05	IDNR	DeNeal	Permit #2	Failure to submit u/g mining maps	Terminated			N
5/12/2005	37-02-05	IDNR	DeNeal	Shadow Area 9	failure to complete subsidence mitigation in contemporaneous manner.	Modified			N
6/1/2005	37-03-05	IDNR	DeNeal	352	broken waterline-failure to prevent minepumpage from passing through sediment pond before going offsite	Terminated			N

The following companies either did not have any violations in the last three years or do not have permits.

Oklahoma Coal Company

KenAmerican Resources, Inc.

Onieda Coal, Inc.

MonValley Transportation Center, Inc.

Mill Creek Mining Co.

Pinski Corp

American Compliance Coal Inc.

Coal Resources Inc.

PA Transloading, Inc.

West Virginia Resources Inc.

WildCat Loadout

American Coal Sales Co.

Hocking Valley Resources Co..

In the fall of 2009 the company constructed a facility on the surface to treat the excessive iron content in the mine discharge water. Details of this facility can be found in Appendix 7-65.

5.26.21 Utility Installation and Protection

All coal mining and reclamation operations will be conducted in a manner which minimizes damage, destruction, or disruption of services provided by oil, gas, and water wells; oil, gas, and coal slurry pipelines, railroads; public utilities; etc. which pass over, under, or through the permit area, unless otherwise approved by the owner of those facilities and the Division.

5.26.22 Operation of Support Facilities

Support facilities will be operated in accordance with a permit issued for the mine to which it is incident or from which its operation results.

5.26.3 Water Pollution Control

See "Waste Disposal Plans" under the Mining Operation section of this chapter.

In the fall of 2009 the company constructed a facility on the surface to treat the excessive iron content in the mine discharge water. Details of this facility can be found in Appendix 7-65

5.26.4 Air Pollution Control

Coal mining and reclamation activities will be conducted in accordance with R645-301-420 and the Air Quality Approval Order issued by the Utah Division of Air Quality (Appendix 4-7).

5.27 Transportation Facilities

The coal from the mine will be transported to the rail loadout or final destination by truck. The trucks are typical 45 ton tandem trailer coal haulers used in the Utah coal fields. GENWAL uses a loading site on the Utah Railway located at Mohrland, Utah, a loading facility on the Southern Pacific Railway in Wellington, Utah, and other independently owned loadouts within the Carbon/Emery county area.

The Forest Development Road from Huntington Creek to the truck turn around area was constructed under the definition of a class one road and will be maintained as a primary road, in compliance with the road use permit issued by the U. S. Forest Service, Manti-La Sal National Forest. The forest access road will remain as part of the post mining land use in accordance with the Forest Service Permit (Appendix 1-2). The Forest Service Access Road, upgraded under the definition of a class two road, is maintained as a primary road. The road connects the main pad area, the truck turn around area, and the Forest Service Parking/Turnaround to the Huntington Canyon

Road (State Route 31). The road is designed, maintained and will be restored in accordance with the Forest Service road use permit.

The road from the lower pad area to the upper pad area was built under the definition of a class two road and is maintained as a primary road. It is designed (as shown on Plate 5-10), maintained and restored in accordance with R645-301-527.120. The Ancillary road to the portal area was built under the definition of a class three road and was designed (as Shown on Plate 5-10), is maintained and restored in accordance with R645-527.130.

The Forest Service Development road has been designed and was approved by the USFS prior to construction. The design drawings are on file with the Manti-La Sal National Forest in Price, Utah. During the 1991 construction season GENWAL Resources Inc. improved and asphalted the Forest Service Development road and surface facilities area of the Crandall Canyon Mine (as shown on Plate 5-3). The improvement information covering the haul road and facilities area is addressed in Appendices 5-15, 5-16, and 5-17.

The Forest Service road (primary road) is utilized by coal haul trucks, mining equipment (on a limited basis), support vehicles, employees, and recreational users (public). The two roads located on the permit area, the portal pad road and the access road to the main pad, are utilized by both surface and underground mining equipment, support vehicles, and employee vehicles. The ancillary road to the portal area is utilized by service vehicles on a very limited basis. The ancillary road to the upper unused area has been reseeded.

The forest parking area past the mine site was preserved for recreational/forest service parking and with verbal approval for the short term storage of mine equipment being unloaded/offloaded or moved as a part of upgrading or retrofitting.

Because of the limited space available at the existing site, snow removal and storage is now a problem. Currently, under agreement with the Forest Service, limited snow storage is allowed in the Forest Service trailhead parking area. This practice is less than ideal however. Snow storage in this area limits the amount of available public parking. Snow melt and runoff from the snowpiles often makes the parking area muddy in the springtime and makes sediment control into nearby Crandall Creek more challenging. The expanded operations area should relieve congestion at the site and free up both the parking area and the Forest Service road and make snow storage in the parking area unnecessary. Snow storage will become available in the area of the existing loadout facilities once these facilities have been removed and the area cleaned up properly as part of the overall site expansion project. Snowmelt from this new storage area will be able to report directly to the sediment pond located nearby. There will be absolutely no snow storage in the sediment pond itself.

After construction of the surface expansion is completed, the Forest Development Road 50248 will be returned to double lane width through the permit area to the Forest Service trailhead parking area. This will be accomplished by the following:

a) The existing loadout facilities will be removed and cleaned up and the road will be widened, realigned, and repaved through this area.

- 7-56 Investigation of Potential for Little Bear Spring Recharge
- 7-57 Determination of Recharge Location of Little Bear Spring (Dye Tracing)
- 7-58 Summary of Hydro logic Baseline Information, South Crandall Lease
- 7-59 Little Bear Spring Study (Initial study, 1998) AquaTrack
- 7-60 Little Bear Spring Study (Expanded Study, 1999) AquaTrack
- 7-61 Mill Fork Resistivity Study, 2001 AquaTrack
- 7-62 Little Bear Spring (2nd Expanded Study, 2001) AquaTrack
- 7-63 Hydrology/Geology Map of Little Bear Watershed
- 7-64 Baseline Information for the U-68082 Lease Mod Area
- 7-65 Mine Discharge Water Iron Treatment Facility

Note: Bold number plates and appendices are included with this submittal.

3. Diverting runoff using protected channels or pipes through disturbed areas so as not to cause additional erosion;
4. Using straw dikes, riprap, check dams, mulches, vegetative sediment filters, dugout ponds and other measures that reduce overland flow velocities, reduce runoff volumes or trap sediment;
5. Treating with chemicals/paving;
6. For the purposes of UNDERGROUND COAL MINING AND RECLAMATION ACTIVITIES, treating mine drainage in underground sumps.

7.42.20 Siltation Structures

7.42.21 General Requirements

Additional contributions of suspended solids and sediment to stream flow or runoff outside the permit area will be prevented to the extent possible using the best technology currently available.

Alternate Sediment Control Areas and Small Area Exemptions

There are seven ASCA sites associated with this property. All ASCA's are maintained to minimize additional contributions of suspended solids and sediment to stream flow or runoff outside the permit area. Details on the ASCA's are included in Appendix 7-4.

As a result of the Crandall Canyon Mine disaster of August 6, 2007, the mine has been deactivated and the portals have been sealed. Mine water inflow has built up to the extent that water is now discharging from the portals and is discharged through a 12" pipe into Crandall Creek under UPDES permit UT0024368. The mine is presently discharging approximately 400-500 gallons per minute, with the flow fluctuating with barometric pressure and seasons. In early 2009 the iron concentrations in the water began to exceed UPDES limits. Because there is no way to treat the water underground the company constructed an aeration treatment system located on the surface in the "old loadout" area, immediately below the portal bench. Complete details of the treatment facility can be found in Appendix 7-65. While the facility is neither an ASCA nor a small area exemption, it represents a small area within the disturbed area wherein runoff is treated along with the mine discharge water and discharges through an approved UPDES outfall point, and therefore does not drain to the sediment pond.

A suitably constructed barricade has been constructed between the treatment facility and the road which prevents any disturbed area drainage from entering the treatment facility area, and similarly prevents any of the mine discharge water from running over the adjacent disturbed area and reporting to the sediment pond. See Plate 5-3 for the location of the facility

At the lower end of the treatment facility, the treated minewater water is collected into a buried pipeline which crosses underneath the road and connects to the existing discharge line. In this manner the treated water ends up reporting to the Crandall Canyon drainage (by way of the main bypass culvert) at the existing approved UPDES outfall point.

There is every reason to believe that water will permanently discharge from the Crandall Mine portals. The iron level of the mine water historically was very low, and began rising only after the water began to build up and impound within the mine workings following the mine collapse of 2007. It is now the consensus that the elevated iron concentration will be a permanent situation, and that the reclamation plan must provide for a permanent means of treating the discharge water so as to meet UPDES requirements, even subsequent to final reclamation. To address this situation, the company commits to revising the reclamation plan in the near future. Additional baseline data will be incorporated into this revised reclamation plan. This data will include: 1) flow quantities from the seep in the sandstone ledge above the treatment facility, 2) historical data concerning the iron concentration levels in the mine discharge water, and 3) performance data demonstrating the effectiveness of the existing treatment system methodology, i.e., oxidation/settling, as opposed to other treatment methods such as reverse-osmosis, fine-element filtration, chemical coagulants/flocculants, etc. Based on recent input from various state and federal agencies (Div. Oil, Gas and Mining, Forest Service, BLM, Div Water Resources, Div. Wildlife Resources) a conceptual treatment plan was agreed upon. This plan would utilize a passive aeration system (modifying the existing portal access road into a long, cascading, open-air aeration waterway), emptying out into a set of large settling basins to be constructed in the area presently occupied by the shop/warehouse building, in accordance with the agreed-upon passive concept, so that the revised reclamation plan can be approved by August 1, 2010. This plan will include not only the facility design but also projected operating and maintenance costs for long-term (perpetual) bonding considerations. In light of the long-term treatment requirements for final reclamation, the existing treatment facility is considered temporary (i.e., operational) and will be removed at the time of final reclamation after the permanent (post-reclamation) facility is constructed.

7.42.22 Sedimentation Pond

Design

The sedimentation pond located in Crandall Canyon has been redesigned to control the additional storm runoff from the pad extension and from the designated undisturbed drainage areas above the pad extension associated with the proposed culvert expansion. The topography and watershed boundaries are shown on Plate 7-5 and 7-5C. Cross sections of the pond design are shown on Plate 7-3.

Runoff- and Sediment-Control Facilities

Results of analyses to determine the required size and hydraulics of the sedimentation pond are included in Appendix 7-4. Details of the sedimentation pond required for compliance with 30 CFR 77.216-1 and 30 CFR 77.216-2 are contained in Appendix 7-8. Permanent disposal of the sediment removed during cleanout will be in accordance with Section 535.

Prior to any discharges through the decant system on the sedimentation pond, a sample will be collected to determine total suspended solids, settleable solids, total dissolved solids, oil and grease, total iron, total manganese concentrations, and pH. The sample will be collected by opening the gate valve on the dewatering device, allowing water to flow from the pond through the primary spillway for a sufficient time to collect a sample of the water, and then immediately shutting the gate valve to prevent further dewatering. This sample will then be submitted to a laboratory for analyses of the indicated parameters.

After receipt of analytical results from the laboratory, if the pH and concentrations of total suspended solids, settleable solids, total dissolved solids, oil and grease, total iron, and total manganese are within the acceptable limits, water will be discharged from the pond through the dewatering device. If the parameters of concern are not within the acceptable limits, no water will be discharged through the device.

During discharge of water to Crandall Creek from the sedimentation pond, samples of the water will be collected at the discharge point at the beginning and end of the discharge time. These samples will be sent to a laboratory following the discharge period for analyses of total suspended solids, settleable solids, total dissolved solids, total iron, total manganese, oil and grease, and pH. Analytical results will be submitted to the Division with the subsequent quarterly report.

The emergency spillway discharges onto the boulder-covered slope adjacent to the sedimentation pond. Boulders that cover this slope were blasted from the cut above the pond during construction of the mine-access road. Due to the large size of the boulders, laboratory size-fraction analyses could not be conducted. However, the boulders are visually estimated to range in size up to at least 10 feet in diameter. It is further estimated that approximately 80 percent of the coarse rock on the slope is finer than 8 feet in diameter, 30 percent is finer than 5 feet in diameter, and 10 percent is finer than 3 feet in diameter.

The blasted rock has an approximate thickness of 15 to 20 feet at the top of the slope and 5 to 6 feet at the bottom of the slope. The soil that underlies the rock is a silty sand. Size-fraction analyses presented by Delta Geotechnical Consultants (1982) indicate that this soil is 70 percent sand and 30 percent silt and clay (the latter being minus 200 mesh).

The emergency spillway is lined with riprap and a filter blanket to reduce erosion potential. A concrete cutoff has also been installed immediately downstream of the inlet. The concrete cutoff ensures that the emergency spillway will not erode during a discharge event. Grading of the riprap, filter blanket, and embankment materials are shown in Figure 7-10. The spillway will discharge directly onto the boulder-covered slope. Due to the extreme thickness of the boulders and cobbles on the slope, additional erosion protection below the emergency-spillway outflow will not be required.

All new fill required to modify the embankment will be placed in 6-inch lifts. This new fill will be compacted in place by repeated passes of a front-end loader or equivalent prior to placing the next lift. Compaction will continue until the density of the material is at least 90 percent of Proctor density (as determined by sandcone density tests in the field).

As included in the original design, the interior of the pond will be lined with a 12-inch thick local, compacted clay to reduce seepage from the pond and, thereby, increase the stability of the embankment. The clay liner will be placed in 6-inch lifts and compacted during placement by at least four passes of a front end loader or equivalent. The initial layer will be disk-harrowed into the bottom of the pond prior to completion.

After pond cleanout, the thickness of the clay liner will be sampled by means of a bucket auger at 8 locations. Three holes will be placed along the ingress/egress route and five additional holes will be randomly selected from the remaining pond area. If any of the holes penetrate less than 10 inches of clay, additional clay will be compacted into the deficient areas of the pond.

Flow conditions in Crandall Creek adjacent to the sedimentation pond were examined to determine if flood flows may erode the downstream toe (see Appendix 7-5). As noted, the peak flow from the 100-year, 24-hour precipitation event will encroach 0.6 foot above the toe of the embankment. Thus, a riprap protective layer (with a median rock diameter of 12.5 inches) was placed along the lower 2.0 feet of the embankment as shown in Plate 7-4. Placement of this riprap will serve an incidental purpose of increasing the stability of the dam by placing additional weight on the downstream toe (Figure 7-10).

Following construction of the sedimentation pond as designed herein, all disturbed areas associated with pond construction (with the exception of the interior of the pond) will be revegetated with the temporary seed mixture. This mixture was developed in consultation with Lynn Kunzler of the Division and Walt Nowak of the U.S. Forest Service. This mixture provides rapid growth species, sod-forming species, and species that are compatible with other plants.

Seeding will be done in the late fall, just prior to the first heavy snowfall of the year (Plummer et al., 1968). Seeding will be accomplished by hydroseeder. Mulch will be placed after seeding. The mulch, which consists of two tons of straw or grass hay per acre of disturbed area, will be spread over the area to be planted by hydromulcher.

Following seeding, the revegetated outslopes of the pond will be inspected during normal pond inspections to determine the effectiveness of the seeding. Straw-bale dikes will be added as necessary to control excessive gullying on the dam face. These dikes will be installed as noted by Figure 7-11.

7.42.30 Diversions

Diversion UD-1 is a 42" culvert placed along the western edge of the site at the location shown on Plate 7-5 to divert water from a 95-acre undisturbed watershed around the yard area. Analyses and design information associated with this and other diversions associated with the site are contained in Appendix 7-4. (Table 10)

Two additional diversions were designed to convey water from undisturbed areas away from the disturbed site. One (UD-2) was constructed in the northwest portion of the site along the proposed substation pad. UD-2 is an open ditch diversion. UD-3 is a 24" culvert diversion located in the northeastern portion of the site to convey water away from the portal area. Design details are presented in Tables 8 and 10 respectively in Appendix 7-4.

As a result of the Crandall Canyon Mine disaster of August 6, 2007, the mine has been deactivated and the portals have been sealed. During the process of constructing the seals much of the UD-3 culvert diversion structure was damaged beyond repair. Upon further evaluation it was determined that the undisturbed drainage from WSUD-3 above the portals could be diverted into the existing surface drainage ditches rather than try to re-establish it back across the portals as it had been previously. The drainage from WSUD-3 is now proposed to report to disturbed drainage ditch DD-8, then to culvert C-1, then to ditch DD-5, then culvert C-12, and ultimately into the sediment pond. As shown in Tables 3, 5, 6 and 7 of Appendix 7-4, all ditches and culverts are presently sized to adequately handle the additional runoff from the undisturbed area. Also, as shown in Table 11 of Appendix 7-4, the sediment pond is also adequately sized to handle this additional contribution. The existing inlet structure to culvert UD-3 is a substantially constructed concrete box located about 20' above the intake portal. This structure will remain in place. The existing culvert is an 18" PVC pipe, which is undamaged in the area immediately above the portal. This pipe will be cut off about 10' below the inlet structure and fitted with a PVC 90 degree elbow. From this elbow a new segment of 12" HDPE pipe will be routed over and around the intake portal and allowed to discharge into the existing disturbed drainage ditch DD-8 which runs along the portal access road. Due to the short length and steepness of this new segment, calculations show that use of a 12" pipe will easily handle the anticipated flow. This HDPE pipe will be supported by cables anchored into the concrete inlet box, and by an existing steel lamp-post located above the portal. The semi-flexible nature of the replacement pipe will allow it to be directed around the portal to ditch DD-8. Details of the pipe sizing and schematic drawings of the installation plans for this re-routed culvert can be found in Figures 13A and 13B of Appendix 7-4.

The existing culverts in the mine yard were examined to determine their adequacy with respect to passing the peak flow. Details of these designs are provided in Appendix 7-4.

Similarly, ditches within the disturbed area are designed to pass the peak flow from the 10-year, 6-hour storm. Typical cross sections and design calculations are contained in Appendix 7-4 for these ditches. Ditches have been evaluated for adequacy in passing the 10 year-24 hour storm and found to be of adequate size (see Appendix 7-4).

A berm was placed around the (un-used) power substation area to prevent runoff water that accumulates thereon from flowing across the remainder of the site. A small channel on the

APPENDIX 7-4

SEDIMENTATION AND DRAINAGE
CONTROL PLAN

APPENDIX 7-4

*CRANDALL CANYON MINE
SEDIMENTATION AND DRAINAGE CONTROL PLAN*

*PREPARED BY: DAN W. GUY, P.E.
BLACKHAWK ENGINEERING, INC.
1056 WEST 2060 NORTH
HELPER, UT. 84526*

REVISED: NOVEMBER 2009



*CRANDALL CANYON MINE
SEDIMENTATION AND DRAINAGE CONTROL PLAN*

TABLE OF CONTENTS

<i>SECTION</i>	<i>PAGE NUMBER</i>
<i>1- Introduction:</i>	<i>1</i>
<i>2- Design of Drainage Control Structures:</i>	<i>3</i>
<i>2.1 Precipitation</i>	<i>4</i>
<i>2.2 Flow</i>	<i>5</i>
<i>2.3 Velocity</i>	<i>6</i>
<i>2.4 Drainage Areas</i>	<i>6</i>
<i>2.5 Slope/Lengths</i>	<i>6</i>
<i>2.6 Runoff</i>	<i>7</i>
<i>2.7 Runoff Curve Numbers</i>	<i>7</i>
<i>2.8 Culvert Sizing</i>	<i>9</i>
<i>2.9 Culverts</i>	<i>9</i>
<i>2.10 Ditches</i>	<i>12</i>
<i>2.11 Main Canyon Culvert</i>	<i>14</i>
<i>2.12 Main Canyon Culvert Inlet Structure</i>	<i>16</i>
<i>2.13 Main Canyon Culvert Outlet Structure</i>	<i>16</i>
<i>3- Design of Sediment Control Structures:</i>	
<i>3.1 Design Specification for Expanded Sediment Pond</i>	<i>29</i>
<i>3.2 Sediment Yield</i>	<i>30</i>
<i>3.3 Sediment Pond Volume</i>	<i>32</i>
<i>3.4 Sediment Pond Summary</i>	<i>36</i>
<i>3.5 Alternate Sediment Control Area (ASCA's)</i>	<i>37</i>

4-	<i>Design of Drainage Control Structures for Reclamation:</i>	
4.1	<i>General (Phase I)</i>	39
4.2	<i>General (Phase II)</i>	40
4.3	<i>Reclamation - Disturbed Drainage Control</i>	41
4.4	<i>Restored Channels</i>	41
4.5	<i>Sediment Pond</i>	42
4.6	<i>Calculations</i>	43

Tables:

Table 1	<i>Watershed Summary</i>
Table 2	<i>Watershed Parameters</i>
Table 3	<i>Runoff Summary - Undisturbed Diversions</i>
Table 4	<i>Runoff Summary - Drainage to Sediment Pond</i>
Table 5	<i>Runoff Control Structure Watershed Summary</i>
Table 6	<i>Runoff Control Structure Flow Summary</i>
Table 7	<i>Disturbed Ditch Design Summary</i>
Table 8	<i>Undisturbed Ditch Design Summary</i>
Table 9	<i>Disturbed Culvert Design Summary</i>
Table 10	<i>Undisturbed Culvert Design Summary</i>
Table 11	<i>Sediment Pond Design</i>
Table 12	<i>Sediment Pond Stage Volume Data</i>
Table 13	<i>Sediment Pond Stage Discharge Data</i>
Table 14	<i>Reclamation - Phase I Runoff Summary Drainage to Sediment Pond</i>
Table 15	<i>Reclamation - Phase I Runoff Control Structure / Watershed Summary</i>
Table 16	<i>Reclamation - Phase I Runoff Control Structure / Flow Summary</i>
Table 17	<i>Reclamation - Phase I Reclaimed Ditch Design Summary</i>

Figures:

- Figure 1 Culvert Nomograph*
- Figure 2 Rip Rap Chart*
- Figure 3 Undisturbed and Disturbed Ditch Typical Section*
- Figure 4 Soil Erodibility Chart - Disturbed Areas*
- Figure 5 Soil Erodibility Chart - Undisturbed/Reclaimed Areas*
- Figure 6 Sediment Pond Stage-Volume Curve*
- Figure 7 Sediment Pond Stage-Discharge Curve*
- Figure 8 Reclamation Ditch RD-1 Typical Section*
- Figure 9 Runoff Curve Numbers for Forest Range*
- Figure 10 Main Canyon Culvert Inlet / Trash Barriers*
- Figure 11 Main Canyon Culvert Outlet*
- Figure 12 Typical Underdrain Construction*
- Figure 13A Installation of Re-Routed Culvert UD-3 (Front View)*
- Figure 13B Installation of Re-Routed Culvert UD-3 (Side View)*

1. Introduction

The Sedimentation and Drainage Control Plan for the Crandall Canyon Mine has been designed according to the State of Utah R645- Coal Mining Rules, November 1, 1996. All design criteria and construction will be certified by a Utah Registered Professional Engineer.

This plan has been divided into the following three sections:

- 1) *Design of Drainage Control Structures for the Proposed Construction*
- 2) *Design of Sediment Control Structures*
- 3) *Design of Drainage Control Structures for Reclamation*

The general surface water control plan for this project will consist of the following:

- (a) *The proposed pad expansion will necessitate modifications of a number of existing hydrologic structures on the site. In an effort to clarify the new plan, the entire sedimentation and drainage control plan has been re-evaluated for the site and presented in this Appendix.*
- (b) *The general plan for the pad expansion is to divert undisturbed drainage from Crandall Canyon above the minesite through a 6' diameter CMP culvert beneath the expansion area and discharge below the disturbed area. As a result of the expansion, existing culverts C-2, C-8, C-10 and Ditch DD-9 will be removed. 2 new ditches (DD-12 & DD-13) and 3 new culverts (Main Canyon, C-11 and C-11A) will be added to provide for drainage control for the expanded facility. The existing sediment pond will also be expanded to contain additional runoff from the expansion area. All other existing drainage controls will remain unchanged. All minesite drainage controls are shown on Plate 7-5 "Drainage Map".*
- (c) *The main canyon culvert is sized to safely pass the runoff from a 100 year - 6*

hour precipitation event. All other undisturbed diversions, disturbed ditches and culverts are sized to safely convey runoff from a 10 year - 24 hour precipitation event. The sediment pond is sized to contain runoff from a 10 year - 24 hour precipitation event, as required.

- (d) The crescent-shaped area below the portals will be utilized as a water treatment facility for the mine water discharging from the mine and seeping from the slope below the portals. The plan is to divert all mine water into this area, where it will be treated with an aeration system and settling pond to reduce the iron content. Once treated, the mine water will flow into the main canyon culvert at the UPDES #002 discharge location. Calculations show a minimum 12" pipeline at a minimum grade of 3 % is more than adequate to carry the expected maximum discharge of 800 gpm or 1.78 cfs. A larger pipeline may be used. This system will be isolated from the rest of the minesite drainage by topography and jersey-barriers, and will no longer flow to the sediment pond. The location and drainage plans are shown on Plate 7-5. As a result of constructing this facility, the volume of runoff reporting to the sediment pond actually decreases by a small amount, estimated at about 0.05 ac/ft. However, since the facility may not be permanent and could be removed in the future, the runoff calculations for the affected ditches, culverts and sediment pond have not been changed to reflect any resulting decrease.*
- (e) When the Crandall Canyon Mine Portals were sealed as a result of the 2007 disaster, culvert system UD-3 which diverts undisturbed drainage area WSUD-3, was damaged beyond repair. Therefore it was decided to re-route UD-3 as shown on Figures 13A and 13B. Culvert UD-3 now reports to Disturbed Ditch DD-8, Culvert C-1, Disturbed Ditch DD-5, Culvert C-12 and ultimately into the Sediment Pond. Calculations show that all affected ditches, culverts and the Sediment Pond are adequately sized to handle the increased flow from WSUD-3 (See Tables 3, 5, 6, 7 and 11).*

DESIGN OF DRAINAGE CONTROL STRUCTURES

Design Parameters:

- 2.1 *Precipitation*
- 2.2 *Flow*
- 2.3 *Velocity*
- 2.4 *Drainage Areas*
- 2.5 *Slopes, Lengths*
- 2.6 *Runoff*
- 2.7 *Runoff Curve Numbers*
- 2.8 *Culvert Sizing*
- 2.9 *Culverts*
- 2.10 *Ditches*

Tables:

- Table 1 *Watershed Summary*
- Table 2 *Watershed Parameters*
- Table 3 *Runoff Summary - Undisturbed Diversions*
- Table 4 *Runoff Summary - Drainage to Sediment Pond*
- Table 5 *Runoff Control Structure Watershed Summary*
- Table 6 *Runoff Control Structure Flow Summary*
- Table 7 *Disturbed Ditch Design Summary*
- Table 8 *Undisturbed Ditch Design Summary*
- Table 9 *Disturbed Culvert Design Summary*
- Table 10 *Undisturbed Culvert Design Summary*

Design Parameters:

2.1 Precipitation

The precipitation-frequency values for the area were taken from the existing plan which lists Miller, et.al. (1973) as the sources.

<u>Frequency - Duration</u>	<u>Precipitation</u>
10 year-6 hour	1.55"
10 year-24 hour	2.50"
25 year-6 hour	1.90"
100 year-6 hour	2.40"
100 year-24 hour	3.70"

2.2 Flow

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

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

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

where:

t_C	=	Time of Concentration (hrs.)
t_L	=	Lag Time (hrs.) = 0.6 t_C
L	=	Hydraulic Length of Watershed (ft.)
Y	=	Average Land Slope (%)
S	=	$\frac{1000}{CN} - 10$

2.3 Velocity

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

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

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

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

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

<i>Structure</i>	<i>Manning's n</i>
<i>Culverts (cmp)</i>	<i>0.020</i>
<i>Unlined Disturbed Area Ditches</i>	<i>0.035</i>

2.4 Drainage Areas

All drainage areas were planimetered directly from Plate 7-5, Drainage Map, and Plate 7-5C, Watershed Boundaries.

2.5 Slopes, Lengths

All slopes and lengths were measured directly from the topography on Plate 7-5, Drainage Map, and Plate 7-5C, Watershed Boundaries.

2.6 Runoff

Runoff was calculated using the SCS Formula for Type II Storms; using the Storm Version 6.21 computer program:

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

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

2.7 Runoff Curve Numbers

Two curve numbers were utilized for the undisturbed areas. Average curve numbers for the north facing and south facing slopes were determined from curves presented in Figure 7-3 (Chapter 7), using measured cover densities as reported in Chapter 3 and the northern half of lease area SL 062648, assuming a hydrologic soil group of C. Curve numbers of 60 and 69 were obtained for the north facing and south facing undisturbed areas, respectively, using Chart A for Oak-Aspen and ground cover densities of 45 and 26 for north facing and south facing areas, respectively. The above referenced Figure 7-3 (Chapter 7) is included in this Appendix as Figure 9.

Runoff curve numbers for reclaimed, disturbed and paved areas were selected based on comparison with Table 2.20 (p. 82, Barfield, et al, 1983) and numbers previously approved in the M.R.P. A conservative number of 75 was used for reclaimed areas within the disturbed boundary. Curve numbers of 90 and 95 were used for all disturbed areas and paved areas, respectively. See Plates 7-5 and 7-5C for referenced areas.

CRANDALL CANYON MINE
SEDIMENTATION AND DRAINAGE CONTROL PLAN

The following is a summary of runoff curve numbers used in these calculations:

<i>Watershed</i>	<i>Runoff CN</i>
<i>Undisturbed (North Facing):</i>	<i>60</i>
<i>Undisturbed (South Facing):</i>	<i>69</i>
<i>Reclaimed:</i>	<i>75</i>
<i>Disturbed:</i>	<i>90</i>
<i>Paved:</i>	<i>95</i>

2.8 Culvert Sizing

Minimum culvert sizing is based on the following Manning's Equation; using the Haestad Methods, Flowmaster I, Version 3.42 computer program:

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

where: D = Required Diameter (feet)
 Q = QP = Peak Discharge (cfs)
 n = Roughness Factor (0.020 for cmp)
 S = Slope (ft. Per ft.)

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

2.9 Culverts

As indicated in Section 1, the proposed pad expansion will necessitate modifications of a number of existing hydrologic structures on the site, including culverts. As a result of the expansion, existing culverts C-2, C-8 and C-10 will be removed. Two new culverts (Main Canyon, C-11) were added to provide drainage control for the expanded facility during phase I of the surface expansion. One more (C-11A) will be added during the phase II south portal construction. All other existing culverts on the site will remain unchanged.

Culverts have been sized according to the calculations previously described, and are summarized on the following tables. The culverts are shown on Plate 7-5, Drainage Map.

All undisturbed diversions are labeled with a UD number (i.e. UD-1). One of these diversions is a culvert (UD-1), and is clearly marked on Plate 7-5. Contributing watersheds for undisturbed diversions are labeled with a WSUD number, (i.e. WSUD-1) as shown on Plates 7-5 and 7-5C. All undisturbed diversion culverts will be fitted with trash racks to minimize plugging by rocks or other debris.

The proposed Main Canyon culvert is sized to carry runoff from a 100 year - 6 hour precipitation event for the Crandall Canyon area above the minesite. A 6' diameter C.M.P. culvert is proposed to carry the Crandall Canyon runoff beneath the expanded pad area and discharge below the minesite. Calculations in Table 10 show the proposed 6' diameter culvert to be more than adequate to carry the expected peak flow. The culvert will be equipped with an inlet headwall and trash rack and a properly sized outlet apron and energy dissipator for erosion protection. Runoff characteristics, flow and culvert design are presented in this Appendix.

The remaining undisturbed culverts on the site (UD-1 and UD-3) are existing. These culverts are adequate for the required 10 year - 6 hour precipitation event, as shown on Table 10 of this Appendix.

Culverts carrying disturbed drainage are designed with a C number (i.e. C-1). Contributing watersheds for disturbed area culverts (and ditches) are designated with a WSDD number (i.e. WSDD-1) shown on Plate 7-5. All disturbed area drainage culverts have been designed to carry the runoff from a 10 year - 24 hour precipitation event. All calculations and design criteria are included in this Appendix.

CRANDALL CANYON MINE
SEDIMENTATION AND DRAINAGE CONTROL PLAN

Existing culverts C-2, C-8 and C-10 will be removed during the pad extension, and therefore are not included in this Appendix. These culverts are shown on Plate 7-5C, dated 03/21/91.

All culverts will be inspected regularly, and cleaned as necessary to provide for passage of design flows. Inlets and outlets shall also be maintained to prevent plugging, undue restriction of water flow and erosion. Culvert outlets will be rip-rapped where necessary to protect from erosion.

One culvert, UD-1, is considered a permanent diversion, and will remain in place after reclamation. This culvert is sized to carry runoff in-excess of a 100 year - 6 hour storm. Justification for leaving it in place is provided in the Reclamation Hydrology Section 4.1, of this Appendix.

All other culverts are considered temporary, and will be removed upon final reclamation, with the exception of the lower 300' of the Main Canyon Culvert. This portion of the culvert will be left in place until the sediment pond is removed during Phase II Reclamation. The remaining portion of the culvert will be removed at that time.

2.10 Ditches

The proposed pad expansion will necessitate modifications to hydrologic structures, including ditches. As a result of the expansion, existing ditch DD-9 will be eliminated. Two new ditches (DD-12 and DD-13) will be added to provide drainage control for the expanded facility. All other existing ditches on the site will remain unchanged.

Undisturbed diversions are designated with a UD number (i.e. UD-2). There is only one undisturbed diversion ditch - (UD-2). This ditch is existing. Contributing watersheds for the undisturbed diversion are labelled with a WSUD number (i.e. WSUD-2), and are shown on Plate 7-5C.

Disturbed diversions (ditches) are designated with a DD number (i.e. DD-1). Contributing watersheds for disturbed diversions are labelled with a WSDD number (i.e. WSDD-1) as shown on Plates 7-5 and 7-5C. All disturbed diversions carry runoff which ultimately goes to the sediment pond.

All ditches are designed to carry the expected runoff from respective watersheds from a 10 year - 6 hour precipitation event, with a minimum freeboard of 0.3'. Ditches were assumed to be unlined with a Manning's No. of 0.035. All ditches have been conservatively evaluated for size using the computer program "Office of Surface Mining Watershed Model," Storm, Version 6.21, by Gary E. McIntosh, to calculate peak flows, which were then routed into triangular shaped channels with 1:1 side slopes. This evaluation shows conditions which are not uncommon at minesites and which tend to maximize required flow depths. All ditches are designed with the steeper (1:1) side slopes to allow for maintenance by road grading or other equipment. Actual side slopes may vary in the field; however, as long as the ditch has the required depth and cross-sectional area to carry the flow with required

CRANDALL CANYON MINE
SEDIMENTATION AND DRAINAGE CONTROL PLAN

freeboard, the ditch is adequate.

Ditches with flow velocities of 5 fps or greater will be lined with properly sized rip-rap or other controls to protect from erosion.

All ditch slopes and lengths were taken from Plate 7-5, "Drainage Map".

A typical ditch section, as well as a summary of flow depths and sizes is provided in Figure 3 of this Appendix.

All ditches will be inspected regularly, constructed and maintained to the minimum dimensions to provide adequate capacity for the design flow. All ditches are temporary and will be removed during final reclamation.

Note: Ditches were also evaluated for adequacy to carry runoff from the 10 year - 24 hour precipitation event.

2.11 Main Canyon Culvert

The proposed main canyon culvert will be placed to closely approximate the existing stream alignment. In an effort to protect the natural channel, the area will be covered with a filter fabric (geotextile material). An underdrain will then be installed on the fabric, consisting of an 18" perforated drain pipe surrounded by a bed of clean 2" drain drainrock. The underdrain will be covered by a second layer of fabric which in turn will be covered with a layer of marker material used to facilitate visibility during final reclamation. A layer of bedding material will then be placed over the marker material. The proposed 72" cnp culvert will then be installed on the bedding material and backfilled and compacted throughout the length of the mine site - approximately 1500'.

The culvert has been sized to safely carry the runoff from a 100 year - 6 hour precipitation event for all of Crandall Canyon above the minesite. The 100 year - 6 hour flow has been calculated at 222.79 cfs, as shown on Table 3. This flow can be carried by a 3.75' minimum diameter culvert, as calculated by the Manning's Equation and shown in Table 10; therefore, the proposed 6' diameter culvert is more than adequate.

There have been some questions raised as to previous main canyon flow calculations which showed the expected runoff from the 100 year - 6 hour storm to be as high as 431 cfs. It appears this number was generated by using a computer program called "Peak", using slightly different parameters than those used in this report.

The runoff numbers in this Appendix were calculated using the "Office of Surface Mining Watershed Model", Storm Version 6.21, by Gary E. McIntosh. All flows were based on the SCS-TR55 Method for Type II storms. This program has been supplied to the operators by the Division, and results have been consistently accepted

CRANDALL CANYON MINE
SEDIMENTATION AND DRAINAGE CONTROL PLAN

by the agencies.

In an effort to make the runoff values more conservative, yet realistic, for design purposes, some parameters, such as concentration time and SCS Upland Curve numbers were placed on the conservative side in the program. Based on these numbers, a very conservative flow of 222.79 cfs was obtained. It should be noted that this flow agrees closely with a previous calculation using the equation of Thomas and Lindskov (1983), which estimates the 100 year - 6 hour flow for the main canyon at 272 cfs.

Summary: It is obvious that the final number on the main channel flow is entirely dependent upon which computer program or method is used. Since the OSM Storm program has been used throughout calculations for this plan, and since it is a widely accepted method, the more conservative figure of 222.79 cfs has been used in design calculations for this plan.

2.12 Main Canyon Culvert Inlet Structure

The culvert inlet will be protected by an inlet section and trash rack, along with a rip-rapped headwall. An additional trash rack will be installed upstream of the inlet at a location convenient for maintenance and cleanout, as shown on Figure 10. Based on the Culvert Nomograph, Figure 1, the expected flow will enter the culvert at slightly over 1 diameter of head; therefore, additional headwall protection will be provided for a minimum of 5' above and around the inlet structure. Headwall protection will be of 18" D_{50} rip-rap, as shown on Figure 10.

A small side drainage enters Crandall Creek just west of the bypass culvert inlet. As the drainage calculations took into consideration the runoff from this side canyon, the bypass culvert and inlet riprap are adequately sized to handle drainage from this side canyon. The riprap has been extended up this drainage for a short distance (see Map 5-3) in order to protect the culvert inlet.

2.13 Main Canyon Culvert - Outlet Structure

The outlet of the 6' diameter main canyon culvert has been designed to flow into a rip-rap apron to protect against scouring and for energy dissipation. The rip-rap apron is designed to fit the natural channel configuration as closely as possible, and will allow runoff to re-enter the natural channel at a reduced velocity which is no greater than natural flow conditions. Runoff from the 100 year - 6 hour precipitation event in the canyon above the minesite has been calculated at 222.79 cfs.

CRANDALL CANYON MINE
SEDIMENTATION AND DRAINAGE CONTROL PLAN

The rip-rap apron design is based on Figure 7-26, Design of Outlet Protection - Maximum Tailwater Condition, "Applied Hydrology and Sedimentology for Disturbed Areas", Barfield, Warner and Haan, 1983. Based on the figure, the apron should be a minimum of 22' in length, widening from 6' to 15', with a 0% slope. The proposed length has been increased to 30', with an 18' width, to ensure adequate time for velocity reduction. The slope is kept at 0%. Rip-rap size is conservatively placed at 30" D_{50} . Rip-rap will be placed to a depth of 1.5 D_{50} and will be embedded in a 12" layer of 2" drain rock filter. Rip-rap will also be placed on 1:1 side slopes to the height of the culvert (6') at the culvert outlet tapering to 3' at the outlet of the apron. This rip rap apron has been sized and designed to adequately dissipate energy from flow velocities of a 100 year, 24 hour precipitation event and resist dislodgement. The drain rock filter bed will also serve to secure the rip rap boulders firmly in place, to add an additional element of stability, and prevent scouring underneath the boulder bed.

The natural channel below the proposed outlet has been measured from field surveys to have a bottom width of approximately 17' at the proposed apron outlet, with side slopes approximately 1:1. When the flow is routed from the culvert across the apron to the natural channel, the velocity is reduced from 21.70 fps at the culvert outlet to 10.83 fps at the outlet of the apron. Refer to 72" Culvert Outlet Rip-Rap Apron Flow Velocity Calculations in Section 4.6. Based on actual field measurements, the natural channel flow velocity would be approximately 11.02 fps at this location with the same flow of 222.79 cfs. Therefore, the velocity of the stream flow exiting the rip rap apron will be less than the velocity in the naturally existing stream bed, at that location, under similar conditions.

CRANDALL CANYON MINE
 SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 1
 WATERSHED SUMMARY

<i>Watershed</i>	<i>Type</i>	<i>CN</i>	<i>Acres</i>	<i>Drains To</i>	<i>Final</i>
<i>Crandall</i>	<i>Undisturbed</i>	<i>69</i>	<i>3480.00</i>	<i>Main Culvert</i>	<i>- Crandall Creek</i>
<i>WSUD-1</i>	<i>Undisturbed</i>	<i>69</i>	<i>84.88</i>	<i>Culvert UD-1</i>	<i>- Crandall Creek</i>
<i>WSUD-2</i>	<i>Undisturbed</i>	<i>69</i>	<i>1.39</i>	<i>Ditch UD-2</i>	<i>- Culvert UD-1</i>
<i>WSUD-3</i>	<i>Undisturbed</i>	<i>69</i>	<i>8.66</i>	<i>Culvert UD-3</i>	<i>- Sediment Pond</i>
<i>WSDD-1</i>	<i>Undisturbed</i>	<i>69</i>	<i>0.14</i>	<i>Ditch DD-1</i>	<i>- Sediment Pond</i>
<i>WSDD-1</i>	<i>Reclaimed</i>	<i>75</i>	<i>0.08</i>	<i>Ditch DD-1</i>	<i>- Sediment Pond</i>
<i>WSDD-2</i>	<i>Reclaimed</i>	<i>75</i>	<i>0.15</i>	<i>Ditch DD-1</i>	<i>- Sediment Pond</i>
<i>WSDD-3</i>	<i>Undisturbed</i>	<i>69</i>	<i>0.13</i>	<i>Ditch DD-3</i>	<i>- Sediment Pond</i>
<i>WSDD-3</i>	<i>Reclaimed</i>	<i>75</i>	<i>0.15</i>	<i>Ditch DD-3</i>	<i>- Sediment Pond</i>
<i>WSDD-3</i>	<i>Disturbed</i>	<i>90</i>	<i>0.26</i>	<i>Ditch DD-3</i>	<i>- Sediment Pond</i>
<i>WSDD-3</i>	<i>Paved</i>	<i>95</i>	<i>0.33</i>	<i>Ditch DD-3</i>	<i>- Sediment Pond</i>
<i>WSDD-4</i>	<i>Paved Road</i>	<i>95</i>	<i>0.11</i>	<i>Ditch DD-4</i>	<i>- Sediment Pond</i>
<i>WSDD-4</i>	<i>Disturbed</i>	<i>90</i>	<i>0.08</i>	<i>Ditch DD-4</i>	<i>- Sediment Pond</i>
<i>WSDD-5</i>	<i>Undisturbed</i>	<i>69</i>	<i>0.12</i>	<i>Ditch DD-5</i>	<i>- Sediment Pond</i>
<i>WSDD-5</i>	<i>Reclaimed</i>	<i>75</i>	<i>0.33</i>	<i>Ditch DD-5</i>	<i>- Sediment Pond</i>
<i>WSDD-5</i>	<i>Paved Road</i>	<i>95</i>	<i>0.33</i>	<i>Ditch DD-5</i>	<i>- Sediment Pond</i>
<i>WSDD-7</i>	<i>Undisturbed</i>	<i>69</i>	<i>0.18</i>	<i>Ditch DD-7</i>	<i>- Sediment Pond</i>
<i>WSDD-7</i>	<i>Disturbed</i>	<i>90</i>	<i>0.17</i>	<i>Ditch DD-7</i>	<i>- Sediment Pond</i>
<i>WSDD-7</i>	<i>Paved Road</i>	<i>95</i>	<i>0.09</i>	<i>Ditch DD-7</i>	<i>- Sediment Pond</i>
<i>WSDD-8</i>	<i>Undisturbed</i>	<i>69</i>	<i>3.59</i>	<i>Ditch DD-8</i>	<i>- Sediment Pond</i>
<i>WSDD-8</i>	<i>Reclaimed</i>	<i>75</i>	<i>0.15</i>	<i>Ditch DD-8</i>	<i>- Sediment Pond</i>
<i>WSDD-8</i>	<i>Disturbed</i>	<i>90</i>	<i>0.37</i>	<i>Ditch DD-8</i>	<i>- Sediment Pond</i>
<i>WSDD-8</i>	<i>Paved Road</i>	<i>95</i>	<i>0.25</i>	<i>Ditch DD-8</i>	<i>- Sediment Pond</i>
<i>WSDD-10</i>	<i>Undisturbed</i>	<i>69</i>	<i>0.07</i>	<i>Ditch DD-10</i>	<i>- Sediment Pond</i>
<i>WSDD-10</i>	<i>Reclaimed</i>	<i>75</i>	<i>0.12</i>	<i>Ditch DD-10</i>	<i>- Sediment Pond</i>
<i>WSDD-10</i>	<i>Disturbed</i>	<i>90</i>	<i>0.61</i>	<i>Ditch DD-10</i>	<i>- Sediment Pond</i>
<i>WSDD-10</i>	<i>Paved Road</i>	<i>95</i>	<i>0.27</i>	<i>Ditch DD-10</i>	<i>- Sediment Pond</i>
<i>WSDD-11</i>	<i>Undisturbed</i>	<i>69</i>	<i>2.09</i>	<i>Ditch DD-11</i>	<i>- Sediment Pond</i>
<i>WSDD-11</i>	<i>Reclaimed</i>	<i>75</i>	<i>0.15</i>	<i>Ditch DD-11</i>	<i>- Sediment Pond</i>
<i>WSDD-11</i>	<i>Disturbed</i>	<i>90</i>	<i>0.04</i>	<i>Ditch DD-11</i>	<i>- Sediment Pond</i>
<i>WSDD-12</i>	<i>Undisturbed</i>	<i>60</i>	<i>8.82</i>	<i>Ditch DD-12</i>	<i>- Sediment Pond</i>
<i>WSDD-12</i>	<i>Disturbed</i>	<i>90</i>	<i>2.29</i>	<i>Ditch DD-12</i>	<i>- Sediment Pond</i>
<i>WSDD-13</i>	<i>Undisturbed</i>	<i>60</i>	<i>17.72</i>	<i>Ditch DD-13</i>	<i>- Sediment Pond</i>
<i>WSDD-13</i>	<i>Disturbed</i>	<i>90</i>	<i>3.70</i>	<i>Ditch DD-13</i>	<i>- Sediment Pond</i>
<i>WSDD-13</i>	<i>Paved</i>	<i>95</i>	<i>0.27</i>	<i>Ditch DD-13</i>	<i>- Sediment Pond</i>
<i>WSDD-14</i>	<i>Disturbed</i>	<i>90</i>	<i>0.89</i>	<i>Sediment Pond</i>	<i>- Sediment Pond</i>
<i>WSDD-14</i>	<i>Undisturbed</i>	<i>60</i>	<i>0.78</i>	<i>Sediment Pond</i>	<i>- Sediment Pond</i>
<i>WSDD-14</i>	<i>Paved</i>	<i>95</i>	<i>0.02</i>	<i>Sediment Pond</i>	<i>- Sediment Pond</i>
<i>WSDD-15</i>	<i>Paved</i>	<i>95</i>	<i>0.09</i>	<i>Ditch DD-7</i>	<i>- Sediment Pond</i>

CRANDALL CANYON MINE
 SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 2
 WATERSHED PARAMETERS

<i>Watershed</i>	<i>Type</i>	<i>CN</i>	<i>Acres</i>	<i>Hyd. Length(ft.)</i>	<i>Land Slope(%)</i>	<i>Elev.Change(ft.)</i>
<i>Crandall</i>	<i>Und.</i>	<i>69</i>	<i>3480.00</i>	<i>16,500</i>	<i>17.58</i>	<i>2900</i>
<i>WSUD-1</i>	<i>Und.</i>	<i>69</i>	<i>84.88</i>	<i>3,100</i>	<i>53.55</i>	<i>1660</i>
<i>WSUD-2</i>	<i>Und.</i>	<i>69</i>	<i>1.39</i>	<i>320</i>	<i>78.13</i>	<i>250</i>
<i>WSUD-3</i>	<i>Und.</i>	<i>69</i>	<i>8.66</i>	<i>1300</i>	<i>70.77</i>	<i>920</i>
<i>WSDD-1</i>	<i>Und.</i>	<i>69</i>	<i>0.14</i>	<i>100</i>	<i>40.00</i>	<i>40</i>
<i>WSDD-1</i>	<i>Recl.</i>	<i>75</i>	<i>0.08</i>	<i>120</i>	<i>25.00</i>	<i>30</i>
<i>WSDD-2</i>	<i>Recl.</i>	<i>75</i>	<i>0.15</i>	<i>200</i>	<i>25.00</i>	<i>50</i>
<i>WSDD-3</i>	<i>Und.</i>	<i>69</i>	<i>0.13</i>	<i>80</i>	<i>50.00</i>	<i>40</i>
<i>WSDD-3</i>	<i>Recl.</i>	<i>75</i>	<i>0.15</i>	<i>100</i>	<i>48.00</i>	<i>48</i>
<i>WSDD-3</i>	<i>Dist.</i>	<i>90</i>	<i>0.26</i>	<i>125</i>	<i>56.00</i>	<i>70</i>
<i>WSDD-3</i>	<i>Paved</i>	<i>95</i>	<i>0.33</i>	<i>100</i>	<i>3.00</i>	<i>3</i>
<i>WSDD-4</i>	<i>Paved</i>	<i>95</i>	<i>0.11</i>	<i>250</i>	<i>8.33</i>	<i>20</i>
<i>WSDD-4</i>	<i>Dist.</i>	<i>90</i>	<i>0.08</i>	<i>100</i>	<i>10.00</i>	<i>10</i>
<i>WSDD-5</i>	<i>Und.</i>	<i>69</i>	<i>0.12</i>	<i>60</i>	<i>50.00</i>	<i>30</i>
<i>WSDD-5</i>	<i>Recl.</i>	<i>75</i>	<i>0.33</i>	<i>80</i>	<i>50.00</i>	<i>40</i>
<i>WSDD-5</i>	<i>Paved</i>	<i>95</i>	<i>0.33</i>	<i>300</i>	<i>8.33</i>	<i>25</i>
<i>WSDD-7</i>	<i>Und.</i>	<i>69</i>	<i>0.18</i>	<i>100</i>	<i>78.00</i>	<i>78</i>
<i>WSDD-7</i>	<i>Dist.</i>	<i>90</i>	<i>0.17</i>	<i>120</i>	<i>66.67</i>	<i>80</i>
<i>WSDD-8</i>	<i>Und.</i>	<i>69</i>	<i>3.59</i>	<i>700</i>	<i>65.71</i>	<i>460</i>
<i>WSDD-8</i>	<i>Recl.</i>	<i>75</i>	<i>0.15</i>	<i>80</i>	<i>62.50</i>	<i>50</i>
<i>WSDD-8</i>	<i>Dist.</i>	<i>90</i>	<i>0.37</i>	<i>60</i>	<i>65.71</i>	<i>39</i>
<i>WSDD-8</i>	<i>Paved</i>	<i>95</i>	<i>0.25</i>	<i>560</i>	<i>5.36</i>	<i>30</i>
<i>WSDD-10</i>	<i>Und.</i>	<i>69</i>	<i>0.07</i>	<i>45</i>	<i>62.22</i>	<i>28</i>
<i>WSDD-10</i>	<i>Recl.</i>	<i>75</i>	<i>0.12</i>	<i>50</i>	<i>72.00</i>	<i>36</i>
<i>WSDD-10</i>	<i>Dist.</i>	<i>90</i>	<i>0.61</i>	<i>120</i>	<i>62.50</i>	<i>75</i>
<i>WSDD-10</i>	<i>Paved</i>	<i>95</i>	<i>0.27</i>	<i>335</i>	<i>5.37</i>	<i>18</i>
<i>WSDD-11</i>	<i>Und.</i>	<i>69</i>	<i>2.09</i>	<i>570</i>	<i>64.91</i>	<i>370</i>
<i>WSDD-11</i>	<i>Recl.</i>	<i>75</i>	<i>0.15</i>	<i>30</i>	<i>66.67</i>	<i>20</i>
<i>WSDD-11</i>	<i>Dist.</i>	<i>90</i>	<i>0.04</i>	<i>35</i>	<i>66.67</i>	<i>23</i>
<i>WSDD-12</i>	<i>Und.</i>	<i>60</i>	<i>8.82</i>	<i>1600</i>	<i>42.50</i>	<i>680</i>
<i>WSDD-12</i>	<i>Dist.</i>	<i>90</i>	<i>2.29</i>	<i>80</i>	<i>72.73</i>	<i>58</i>
<i>WSDD-13</i>	<i>Und.</i>	<i>60</i>	<i>17.72</i>	<i>2100</i>	<i>53.81</i>	<i>1130</i>
<i>WSDD-13</i>	<i>Dist.</i>	<i>90</i>	<i>3.70</i>	<i>650</i>	<i>9.09</i>	<i>59</i>
<i>WSDD-13</i>	<i>Paved</i>	<i>95</i>	<i>0.27</i>	<i>40</i>	<i>4.00</i>	<i>2</i>
<i>WSDD-14</i>	<i>Dist.</i>	<i>90</i>	<i>0.89</i>	<i>140</i>	<i>16.11</i>	<i>23</i>
<i>WSDD-14</i>	<i>Und.</i>	<i>60</i>	<i>0.78</i>	<i>380</i>	<i>64.41</i>	<i>245</i>
<i>WSDD-14</i>	<i>Paved</i>	<i>95</i>	<i>0.02</i>	<i>30</i>	<i>3.00</i>	<i>1</i>
<i>WSDD-15</i>	<i>Paved</i>	<i>95</i>	<i>0.09</i>	<i>150</i>	<i>3.33</i>	<i>5</i>

CRANDALL CANYON MINE
 SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 3
 RUNOFF SUMMARY
 UNDISTURBED DIVERSIONS

<i>Diversion</i>	<i>Main Culvert</i>	<i>UD-1</i>	<i>UD-2</i>	<i>UD-3</i>
<i>Watershed</i>	<i>Crandall Canyon</i>	<i>WSUD-1</i>	<i>WSUD-2</i>	<i>WSUD-3</i>
<i>Area (Acres)</i>	3480.0	84.88	1.39	8.66
<i>Runoff CN</i>	69	69	69	69
<i>10 year/6 hour Rainfall (in.)</i>	1.55	1.55	1.55	1.55
<i>Peak Flow 10/6 (cfs)</i>	N/A	1.91	0.04	0.23
<i>25 year/6 hour Rainfall (in.)</i>	1.90	1.90	1.90	1.90
<i>Peak Flow 25/6 (cfs)</i>	N/A	3.68	0.08	0.43
<i>100 year/6 hour Rainfall (in.)</i>	2.40	2.40	2.40	2.40
<i>Peak Flow 100/6 (cfs)</i>	222.79	6.81	0.21	0.89
<i>10 year/24 hour Rainfall (in.)</i>	N/A	2.50	2.50	2.50
<i>Runoff Volume 10/24 (ac.ft.)</i>	N/A	2.98	0.05	0.30

CRANDALL CANYON MINE
 SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 4
 RUNOFF SUMMARY
 DRAINAGE TO SEDIMENT POND

<i>Watershed</i>	<i>Type</i>	<i>10 year/24 hour Volume-ac.ft.</i>	<i>10 year/24 hour Peak Flow-cfs</i>	<i>10 year/6 hour Peak Flow-cfs</i>	<i>25 year/6 hour Peak Flow-cfs</i>
WSDD-1	Undisturbed	0.02	0.10	0.04	0.06
WSDD-1	Reclaimed	0.01	0.04	0.01	0.01
WSDD-2	Reclaimed	0.01	0.06	0.01	0.03
WSDD-3	Undisturbed	0.00	0.03	0.00	0.01
WSDD-3	Reclaimed	0.01	0.05	0.01	0.02
WSDD-3	Disturbed	0.03	0.18	0.08	0.12
WSDD-3	Paved	0.05	0.32	0.17	0.22
WSDD-4	Paved	0.02	0.12	0.07	0.09
WSDD-4	Disturbed	0.01	0.08	0.04	0.05
WSDD-5	Undisturbed	0.00	0.03	0.00	0.01
WSDD-5	Reclaimed	0.02	0.10	0.02	0.04
WSDD-5	Paved	0.05	0.39	0.21	0.27
WSDD-7	Undisturbed	0.01	0.05	0.00	0.01
WSDD-7	Disturbed	0.02	0.12	0.05	0.07
WSUD-3	Undisturbed	0.30	1.40	0.23	0.43
WSDD-8	Undisturbed	0.13	0.75	0.10	0.20
WSDD-8	Reclaimed	0.01	0.05	0.01	0.02
WSDD-8	Disturbed	0.05	0.23	0.10	0.14
WSDD-8	Paved	0.04	0.37	0.20	0.26
WSDD-10	Undisturbed	0.00	0.03	0.00	0.01
WSDD-10	Reclaimed	0.01	0.03	0.01	0.01
WSDD-10	Disturbed	0.08	0.42	0.19	0.27
WSDD-10	Paved	0.04	0.35	0.19	0.24
WSDD-11	Undisturbed	0.07	0.47	0.06	0.12
WSDD-11	Reclaimed	0.01	0.04	0.01	0.02
WSDD-11	Disturbed	0.01	0.06	0.03	0.04
WSDD-12	Undisturbed	0.13	0.25	0.04	0.16
WSDD-12	Disturbed	0.29	3.33	1.51	2.10
WSDD-13	Undisturbed	0.26	0.49	0.07	0.30
WSDD-13	Disturbed	0.47	5.39	2.44	3.39
WSDD-13	Paved	0.04	0.20	0.11	0.14
WSDD-14	Disturbed	0.11	0.78	0.35	0.49
WSDD-14	Undisturbed	0.01	0.03	0.00	0.02
WSDD-14	Paved	0.02	0.07	0.04	0.05
WSDD-15	Paved	0.02	0.11	0.06	0.08
Totals		2.36	16.53	6.46	9.50

CRANDALL CANYON MINE
 SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 5
 RUNOFF CONTROL STRUCTURE
 WATERSHED SUMMARY

<i>Structure</i>	<i>Type</i>	<i>Contributing Watersheds</i>
<i>Main Culvert</i>	<i>Culvert</i>	<i>Crandall Canyon Above Mine</i>
<i>UD-1</i>	<i>Culvert</i>	<i>WSUD-1</i>
<i>UD-2</i>	<i>Culvert</i>	<i>WSUD-2</i>
<i>UD-3</i>	<i>Culvert</i>	<i>WSUD-3</i>
<i>DD-1</i>	<i>Ditch</i>	<i>WSDD-1, WSDD-2</i>
<i>DD-3</i>	<i>Ditch</i>	<i>WSDD-1, WSDD-2, WSDD-3</i>
<i>DD-4</i>	<i>Ditch</i>	<i>WSDD-1, WSDD-2, WSDD-3, WSDD-4, WSDD-8, WSDD-12</i>
<i>DD-5</i>	<i>Ditch</i>	<i>WSDD-1, WSDD-2, WSDD-3, WSDD-4, WSDD-5, WSDD-8, WSDD-12</i>
<i>DD-7</i>	<i>Ditch</i>	<i>WSDD-7, WSDD-11</i>
<i>DD-8</i>	<i>Ditch</i>	<i>WSDD-8, WSUD-3</i>
<i>DD-10</i>	<i>Ditch</i>	<i>WSDD-10 + Mine Water</i>
<i>DD-11</i>	<i>Ditch</i>	<i>WSDD-11</i>
<i>DD-12</i>	<i>Ditch</i>	<i>WSDD-12</i>
<i>DD-13</i>	<i>Ditch</i>	<i>WSDD-13</i>
<i>DD-14</i>	<i>Sheet Flow</i>	<i>WSDD-14</i>
<i>C-1</i>	<i>Culvert</i>	<i>WSDD-1, WSDD-2, WSDD-3, WSDD-8</i>
<i>C-3</i>	<i>Culvert</i>	<i>WSDD-7, WSDD-11, WSDD-15</i>
<i>C-4</i>	<i>Culvert</i>	<i>WSDD-10 + Mine Water</i>
<i>C-5</i>	<i>Culvert</i>	<i>WSDD-11</i>
<i>C-6</i>	<i>Culvert</i>	<i>WSUD-2</i>
<i>C-7</i>	<i>Culvert</i>	<i>WSDD-1, WSDD-2, WSDD-3</i>
<i>C-9</i>	<i>Culvert</i>	<i>WSDD-4, WSDD-12</i>
<i>C-11</i>	<i>Culvert</i>	<i>WSDD-12</i>
<i>C-11A</i>	<i>Culvert</i>	<i>WSDD-12</i>
<i>C-12</i>	<i>Culvert</i>	<i>WSDD-1, 2, 3, 4, 5, 8, 12</i>
<i>C-13</i>	<i>Culvert</i>	<i>WSDD-13</i>
<i>C-14</i>	<i>Slot Culvert</i>	<i>WSDD-4</i>
<i>C-15</i>	<i>Slot Culvert</i>	<i>WSDD-15</i>
<i>C-16</i>	<i>Culvert</i>	<i>WSDD-13</i>
<i>C-17</i>	<i>Culvert</i>	<i>WSDD-13</i>
<i>Sediment Pond</i>	<i>Pond</i>	<i>WSDD-1, 2, 3, 4, 5, 7, 8, 10, 11, 12, 13, 14, WSUD-3</i>

CRANDALL CANYON MINE
 SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 6
 RUNOFF CONTROL STRUCTURE
 FLOW SUMMARY

Structure	Type	10 year/6 hour Peak Flow-cfs	10 year/24 hour Peak Flow-cfs	25 year/6 hour Peak Flow-cfs	100 year/6 hour Peak Flow-cfs
Main Culvert	Culvert	-	-	-	222.79
UD-1	Culvert	1.91	-	3.68	6.81
UD-2	Ditch	0.04	-	0.08	0.21
UD-3	Culvert	0.23	-	0.43	0.89
DD-1	Ditch	0.06	0.20	0.10	-
DD-3	Ditch	0.32	0.78	0.47	-
DD-4	Ditch	2.39	5.96	3.49	-
DD-5	Ditch	2.85	7.88	4.24	-
DD-7	Ditch	0.21	0.85	0.34	-
DD-8	Ditch	0.64	2.80	1.05	-
DD-10	Ditch	2.62	3.06	2.76	-
DD-11	Ditch	0.10	0.57	0.18	-
DD-12	Ditch	1.55	3.58	2.26	-
DD-13	Ditch	2.62	6.08	3.83	-
DD-14	Sht Flw	0.39	0.88	0.56	-
C-1	Culvert	0.96	3.58	1.52	-
C-3	Culvert	0.21	0.85	0.34	-
C-4	Culvert	2.62	3.06	2.76	-
C-5	Culvert	0.10	0.57	0.18	-
C-6	Culvert	0.04	-	0.08	-
C-7	Culvert	0.32	0.78	0.47	-
C-9	Culvert	0.11	0.20	0.14	-
C-11	Culvert	1.55	3.58	2.26	-
C-11A	Culvert	1.55	3.58	2.26	-
C-12	Culvert	2.85	7.36	3.92	-
C-13	Culvert	2.62	6.08	3.83	-
C-14	Slot Cul.	0.11	0.20	0.14	-
C-15	Slot Cul.	0.06	0.11	0.08	-
C-16	Culvert	2.62	6.08	3.83	-
C-17	Culvert	2.62	6.08	3.83	-
Sediment Pond	Pond	6.46	16.53	9.50	-

CRANDALL CANYON MINE
 SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 7
 DISTURBED DITCH DESIGN SUMMARY

<i>Ditch</i>	<i>DD-1</i>	<i>DD-3</i>	<i>DD-4</i>	<i>DD-5</i>	<i>DD-7</i>	<i>DD-8</i>	<i>DD-10</i>
<i>Slope (%)</i>	30.77	3.00	11.91	4.50	3.33	3.59	3.33
<i>Length (ft.)</i>	130	75	168	628	142	557	70
<i>Manning's No.</i>	0.035	0.035	0.035	0.035	0.035	0.035	0.035
<i>Side Slope (H:V)</i>	1:1	1:1	1:1	1:1	1:1	1:1	1:1
<i>*Bottom Width (ft.)</i>	0	0	0	0	0	0	0
<i>Peak Flow 10/6 (cfs)</i>	0.06	0.32	2.39	2.85	0.21	0.64	2.62**
<i>Peak Flow 10/24 (cfs)</i>	0.20	0.78	5.96	7.88	0.85	2.80	3.06**
<i>Flow Depth (ft.) 10/6</i>	0.14	0.40	0.66	0.84	0.33	0.50	0.86
<i>Flow Depth (ft.) 10/24</i>	0.22	0.56	0.92	1.23	0.57	0.87	0.92
<i>Flow Area (ft²)10/6</i>	0.02	0.16	0.43	0.71	0.11	0.25	0.75
<i>Flow Area (ft²)10/24</i>	0.05	0.31	0.85	1.52	0.32	0.76	0.84
<i>Velocity (fps)10/6</i>	3.15	2.00	5.55	4.02	1.87	2.55	3.51
<i>Velocity (fps) 10/24</i>	4.26	2.50	6.97	5.19	2.66	3.68	3.65
<i>Rip-Rap Req'd (Y/N)</i>	N	N	Y	N	N	N	N
<i>Rip-Rap D₅₀</i>	-	-	6"	-	-	-	-

* All ditches are triangular.

** Flows include 1000 gpm (2.23 cfs) Mine Water Flow.

Note: Slope/Lengths from Plate 7-5.

CRANDALL CANYON MINE
 SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 7 (Continued)
 DISTURBED DITCH DESIGN SUMMARY

<i>Ditch</i>	<i>DD-11</i>	<i>DD-12</i>	<i>DD-13</i> <i>(MIN.)</i>	<i>DD-13</i> <i>(MAX.)</i>
<i>Slope (%)</i>	3.00	3.29	1.79	50.00
<i>Length (ft.)</i>	173	50	280	80
<i>Manning's No.</i>	0.035	0.035	0.035	0.035
<i>Side Slope (H:V)</i>	1:1	1:1	1:1	2:1
<i>Bottom Width (ft.)</i>	0	0	0	2
<i>Peak Flow 10/6 (cfs)</i>	0.10	1.55	2.62	2.62
<i>Peak Flow 10/24 (cfs)</i>	0.57	3.58	6.08	6.08
<i>Flow Depth (ft.) 10/6</i>	0.26	0.71	0.97	0.15
<i>Flow Depth (ft.) 10/24</i>	0.50	0.97	1.33	0.24
<i>Flow Area (ft²) 10/6</i>	0.07	0.50	0.94	0.34
<i>Flow Area (ft²) 10/24</i>	0.25	0.94	1.77	0.60
<i>Velocity (fps) 10/6</i>	1.50	3.07	2.79	7.66
<i>Velocity (fps) 10/24</i>	2.31	3.79	3.44	10.12
<i>Rip-Rap Req'd (Y/N)</i>	N	N	N	Y
<i>Rip-Rap D₅₀</i>	-	-	-	9"

**All ditches are triangular.*

Note: Slope/Lengths from Plate 7-5.

Note: DD-12 is shortened due to construction of the south portal access ramp/fan pad.

TABLE 8
UNDISTURBED DITCH DESIGN SUMMARY

<i>Ditch</i>	<i>UD-2</i>
<i>Slope (%)</i>	12.5
<i>Length (ft.)</i>	400
<i>Manning's No.</i>	0.035
<i>Side Slope (H:V)</i>	1:1
<i>Bottom Width (ft.)</i>	0
<i>Peak Flow-10/6 (cfs)</i>	0.04
<i>Flow Depth (ft.)</i>	0.14
<i>Flow Area (ft²)</i>	0.02
<i>Velocity (fps)</i>	2.03
<i>Lined (Y/N)</i>	N
<i>Rip-Rap Req'd (Y/N)</i>	N

Note: Slope/Lengths from Plate 7-5.

KANDALL CANYON MINE
SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 9
DISTURBED CULVERT DESIGN SUMMARY

Culvert	C-1	C-3	C-4	C-5	C-6	C-7	C-9	C-11	C-11A	C-12	C-13	C-14	C-15	C-16	C-17
Slope (%)	16.67	8.00	25.07	57.14	17.20	3.00	3.50	3.50	1.50	4.50	3.00	1.00	1.00	25.00	20.00
Length (ft.)	60	360	69	120	12	80	18	30	60	330	100	40	30	40	60
Manning's No.	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
Peak Flow 10/6 (cfs)	0.96	0.21	2.62*	0.10	0.04	0.32	0.11	1.55	1.55	2.85	2.62	0.11	0.06	2.62	2.62
Peak Flow 10/24 (cfs)	3.58	0.85	3.06*	0.57	N/A	0.78	0.20	3.58	3.58	7.36	6.08	0.20	0.11	6.08	6.08
Min. Diam. Req'd (ft.) 10/6	0.42	0.28	0.57	0.14	0.13	0.39	0.25	0.68	0.80	0.82	0.85	0.32	0.25	0.57	0.60
Min. Diam. Req'd (ft.) 10/24	0.69	0.46	0.61	0.28	N/A	0.54	0.32	0.93	1.09	1.16	1.17	0.40	0.32	0.79	0.82
Diam. Installed (ft.)	1.50	2.00	2.00	1.00	1.00	1.00	1.00	1.50	1.50	2.00	2.00	1.00	1.00	1.67	1.50
Velocity (fps) 10/6	6.80	3.53	10.18	6.13	3.11	2.71	2.20	4.27	3.10	5.46	4.59	1.38	1.18	10.17	9.35
Velocity (fps) 10/24	9.44	5.01	10.58	9.47	N/A	3.39	2.56	5.26	3.83	6.92	5.67	1.60	1.38	12.55	11.5
Rip-Rap D_{50}	12"	-	12"	6"	-	-	-	-	-	6"	-	-	-	12"	12"

* Includes 1000 gpm (2.23 cfs) Mine Water Flow.

Note: Slope/Lengths from Plate 7-5.

Source: (Haestad Methods, Flowmaster I, Version 3.42)

TABLE 10
 UNDISTURBED CULVERT DESIGN SUMMARY

<i>Culvert</i>	<i>*Main Canyon</i>	<i>UD-1</i>	<i>UD-3</i>
<i>Slope (%)</i>	8.00	23.33	30.00
<i>Length (ft.)</i>	1500	270	50'
<i>Manning's No.</i>	0.02	0.02	0.02
<i>Peak Flow 100/6 (cfs)</i>	222.79	-	-
<i>Peak Flow 10/6 (cfs)</i>	-	1.91	0.23
<i>Min. Diam. Req'd (ft.)</i>	3.75	0.52	0.22
<i>Diam. Installed (ft.)</i>	6.00	3.50	1.00
<i>Velocity (fps)</i>	20.14	9.16	5.93

** Culvert to be installed under expansion plan.
 All other undisturbed culverts are existing.*

Note: Slope/Lengths from Plate 7-5.

Source: (Haestad Methods, Flowmaster I, Version 3.43)

DESIGN OF SEDIMENT CONTROL STRUCTURES

Design Specifications:

- 3.1 *Design Specification for Expanded Sedimentation Pond*
- 3.2 *Sediment Yield*
- 3.3 *Sediment Pond Volume*

Tables:

- Table 11 *Sediment Pond Design*
- Table 12 *Sediment Pond Stage Volume Data*
- Table 13 *Sediment Pond Stage Discharge Data*

- 3.4 *Sediment Pond Summary*

Figures:

- Figure 4 *Soil Erodibility Chart - Disturbed Areas*
- Figure 5 *Soil Erodibility Chart - Undisturbed/Reclaimed Areas*
- Figure 6 *Sediment Pond Stage-Volume Curve*
- Figure 7 *Sediment Pond Stage-Discharge Curve*

3.1 Design Specification for Expanded Sediment Pond

The sedimentation pond located in Crandall Canyon has been redesigned and reconstructed to control the additional storm runoff from the pad extension and from the undisturbed drainage areas above the pad extension. The "As-Constructed" topography and cross sections of the pond design are shown on Plate 7-3.

The pond has been sized to meet the requirements of R645-301-742.221.33 (DOGM), which stipulates that sedimentation ponds be capable of containing or treating the 10-year 24-hour precipitation event. According to Miller, et al (1973), the 10-year, 24-hour design storm for Crandall Canyon is 2.5 inches. The design storm calculations for the sedimentation pond are presented in Table 4 of this Appendix. These calculations include the proposed pad extension, the additional watersheds above the pad extension, the existing pad and reclaimed areas, and the undisturbed watersheds above the existing pad.

As required by R645-301-742.223, the 25 year-6 hour precipitation event was routed through the sedimentation pond to determine the adequacy of the spillway. Overflow from the pond is discharged to Crandall Creek. Total precipitation from the 25 year-6 hour storm is 1.9 inches (Miller, et al, 1973). The 25 year-6 hour flow is calculated at 9.07 cfs. Based on the calculations, the primary spillway is more than adequate to carry the expected runoff from a 25 year-6 hour event.

3.2 Sediment Yield

The Universal Soil Equation (USLE) was used to estimate sediment yield from all drainage areas contributing to the pond. All soil loss from this area was assumed to be delivered to, and deposited in the sedimentation pond.

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

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

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

Variable "R" is the rainfall factor which can be estimated from $R = 27P^{2.2}$; where P is the 2-year, 6-hour precipitation value. P for the Crandall Canyon area is estimated at 1.00" based on Figure 5.4, page 315, Barfield, et.al. 1983. Therefore, the estimated value of "R" for this area is 27.00.

Variable "K" is the soil erodibility factor. For disturbed areas, the "K" value is taken as 0.06 as determined from soils samples and shown on the soil erodibility chart, Figure 4. K is estimated to be 0.15 for undisturbed and reclaimed areas, based on soils data and the soil erodibility chart, Figure 5.

Variable "LS" is the length-slope factor. This figure was determined by calculating a weighted average slope length and percentage for the undisturbed, reclaimed and disturbed areas, respectively. The slope length and percentage were then substituted into the following equation to determine the LS Factor:

$$\left(\frac{\pi}{72.6} \right)^m \left(\frac{430 x^2 + 30 x + 0.6613}{6.613} \right)$$

where:

π	=	Field slope length in feet;
m	=	0.5 if S is 5% or greater;
x	=	$\sin \theta$
θ	=	Angle of slope in degrees.

Variable "CP" is the control practice factor, which can be divided into a cover and practice factor. Values were determined from Appendix 5A, Barfield, et.al., 1983.

Site	CP Factor
Disturbed Areas	1.20
Reclaimed Areas	0.100
Undisturbed Areas	0.003

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

SEDIMENT YIELD CALCULATIONS - USLE

Drainage	R	K	Acres	Slope Length		LS	CP	A*	Yield**
				Feet	%				
Undisturbed	27.00	0.15	42.25	1700	53	79.60	0.003	00.967	0.019
Reclaimed	27.00	0.15	1.22	90	52	17.81	0.10	07.213	0.004
Disturbed	27.00	0.06	8.92	350	26	11.69	1.200	22.725	0.093

Total Sediment 1 year (ac.ft.) 0.116

Total Sediment 3 years (ac. ft.) 0.348

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

3.3 Sediment Pond Volume

The volumes shown in Table 11 are from the volumes calculated from the precipitation, runoff and sediment yield for a 10 year-24 hour precipitation event. The volumes were calculated based on the disturbed areas (and contributing undisturbed areas) runoff values, developed using the design parameters described in this section.

The sediment pond has been reconstructed, and the sediment pond volumes on Table 11, Table 12 and Figure 6 all represent the "As-Constructed" pond.

Mine Water

There may be times that the mine water oxidizer must be shut down for repair or cleaning, at which time the mine discharge water will need to bypass the treatment system. In such a case, the water will be directed to temporarily run down the road around the outside of the basin, and into the sediment pond through ditch DD-10 and existing culvert C-4 located below the treatment facility. Assuming the sediment level in the pond is below the approved clean-out level (7769'), and assuming the pond has been previously decanted under approved UPDES discharge criteria, the remaining capacity in the sediment pond is 3.22 ac. ft., as described in Table 12. The required freeboard for a 10 year -24 hour event is 2.452 ac. ft. (2.36 ac. ft. runoff + 0.092 ac. ft. direct precipitation) leaving a usable volume of 0.771 ac. ft. for the purpose of the above bypass. This equates to approximately 251,000 gallons. At an average flow rate of 500 gpm from the mine, the sediment pond could theoretically contain 8.37 hours worth of by-passed mine water in addition to the required 10 year - 24 hour storm event. The maximum amount of by-passed mine water storage would occur at a volume of 1.061 ac. ft. (0.290 acre-feet sediment level plus 0.771 acre-feet of mine water). As shown on Table 12, this volume would occur at elevation of 7773.2.

TABLE 11
SEDIMENT POND DESIGN

1. Use 2.50" for 10 year-24 hour event.
2. Runoff Volume (from Table 4, 10 yr/24 hr) = 2.360 ac. ft.
3. Sediment Storage Volume

USLE 0.116 ac.ft./yr. x 3 yrs. = 0.348 ac. ft.
4. Direct Precipitation into Pond

0.441 acres x 2.50" / 12 in./ft. = 0.092 ac. ft.
5. Total Required Pond Volume

 $2.360 + 0.348 + 0.092 =$ 2.800 ac. ft.
6. * Peak Flow (25 yr. - 6 hr. event) = 9.500 cfs
7. Pond Design Volume @ Principle Spillway =
(See Table 12) 3.513 ac. ft.

* Peak Flow values from Table 4.

CRANDALL CANYON MINE
 SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 12
 SEDIMENT POND
 STAGE / VOLUME DATA

<i>Elev.</i>	<i>Area</i>	<i>Volume</i>	<i>Acc. Volume</i> <i>(ac.ft.)</i>	<i>Remarks</i>
7766	1756.67	.0000	.0000	<i>Bottom of Pond</i>
7767	3706.92	2731.80	0.063	
7768	5119.14	4413.03	0.164	
7769	5857.00	5488.07	0.290	<i>Sediment Cleanout Level</i>
7770	6949.54	6403.32	0.437	<i>Maximum Sediment Level</i>
7771	7806.54	7378.14	0.606	
7772	8894.51	8350.53	0.798	
7773	9905.02	9399.77	1.014	
7773.2	-	-	1.061	<i>Max. Elev. of Mine Water</i>
7774	11055.91	10480.47	1.254	
7775	12153.06	11604.49	1.520	
7776	13120.22	12636.64	1.810	
7777	14084.05	13602.14	2.123	
7778	15043.33	14563.69	2.457	
7779	15984.66	15514.00	2.813	
7780	16934.94	16459.15	3.191	
7780.81	17669.26	14014.70	3.513	<i>Principal Spillway</i>
7781	17868.13	3376.05	3.591	
7781.81	18661.53	15028.20	3.936	<i>Emergency Spillway</i>
7782	18848.42	3430.08	4.012	
7783	19886.14	19367.28	4.457	
7784	21113.55	20499.85	4.927	
7785	22110.39	21611.97	5.423	<i>Top of Embankment</i>

TABLE 13
 SEDIMENT POND
 STAGE / DISCHARGE DATA

Head (ft.)	Q (cfs) Weir Controlled	Q (cfs) Orifice Controlled	Q (cfs) Pipe Flow Controlled
0.0	-	-	-
0.2	1.69	6.77	17.14
0.4	4.77	9.57	17.32
0.6	8.76	11.72	17.50
0.8	13.49	13.53	17.68
1.0	18.85	15.13	17.86

Note: 1- 25 year-6 hour flow = 9.500 cfs.
 2- Flow will be weir controlled at a head of 0.64' over riser inlet.

Weir Controlled

$Q = CLH^{1.5}$; where : $C = 3.0$, $L = \text{Circumference of Riser} = 6.2832'$

Orifice Controlled

$Q = C'a (2gH)^{0.5}$; where : $C = 0.6$, $a = \text{Area of Riser} = 3.1416 \text{ ft}^2$, $g = 32.2 \text{ ft/sec}^2$

Pipe Flow Controlled

$Q = \frac{a (2gH')^{0.5}}{(1+K_e+K_b+K_cL)^{0.5}}$; where

- $a = \text{Area of Pipe} = 1.77 \text{ ft}^2$
- $H' = \text{Head} = H + 9.1 \text{ (At outlet of Riser)}$
- $K_e = 1.0$
- $K_b = 0.5$
- $K_c = 0.043$
- $L = 90'$

3.4 Sediment Pond Summary

- a) *The sedimentation pond has been designed to contain the disturbed area (and contributing undisturbed area) runoff from a 10 year-24 hour precipitation event, along with 3 years of sediment storage capacity. Runoff to the pond will be directed by various ditches and culverts as described in the plan.*
- b) *The required volume for the sediment pond is calculated at 2,800 acre feet, including 3 years of sediment storage. The existing sediment pond size is 3,513 acre feet (at the principle spillway), which is more than adequate.*
- c) *The pond will meet a theoretical detention time of 24 hours. It is equipped with a decant, a culvert principle spillway and an open-channel emergency spillway. Any discharge from the pond will be in accordance with the approved UPDES Permit.*
- d) *The pond inlets will be protected from erosion, and the spillway will discharge into the main Crandall Canyon drainage.*
- e) *The pond is temporary, and will be removed upon final reclamation of the property.*
- f) *The pond expansion will be constructed according to the regulations and under supervision of a Registered, Professional Engineer.*

- g) *The pond volume has been increased at the request of the Forest Service to provide a greater level of protection for forest resources located down stream from the minesite. The enlarged pond capacity (3.513 acre ft.) is over-designed by nearly 25% to contain the 10 year-24 hour design event.*

<i>Storm Event</i>	<i>Pond Volume Required</i>	<i>Pond Capacity Provided</i>
<i>10 yr./24 hr.</i>	<i>2.800 acre ft.</i>	<i>125%</i>

3.5 Alternate Sediment Control Areas (ASCA's)

ASCA-2 (consisting of 0.34 acre) exists at the northwest corner of the site. This area was initially constructed as a substation pad but was never utilized as such. A 12-inch CMP culvert was installed to act as a discharge into UD-1. A silt fence and strawbale dike have been placed to trap the sediment and prevent erosion. (Refer to Plates 7-5)

ASCA-5, ASCA-6, ASCA-7 and ASCA-11 consist of the topsoil stockpiles #1, #2, #3, and #4 respectfully. These stockpiles are located on the north and south side of the access road as shown on Plate 2-3. Disturbed areas associated with the topsoil stockpiles are 0.20 acres, 0.22 acres, 0.62 acres and 0.65 acres for ASCA-5, ASCA-6, ASCA-7, and ASCA-11, respectively. All topsoil stockpiles have been protected from erosion by a combination of dikes, silt-fencing, berms, and a vegetative cover. (Refer to Plate 2-3)

ASCA-9 (0.15 acres) is the outslope of the sediment pond; ASCA-10 (0.02 acres) is the headwall of the inlet of the main by-pass culvert. The drainage from these areas can not be directed to the sediment pond and are too close to the creek to construct separate sediment ponds. Therefore GENWAL has used alternate sediment control methods such as silt fences, straw bale dikes and vegetation. (Refer to Plate 7-5)

Note: ASCA's 1, 3, 4 and 8 have been eliminated through previous permitting actions.

A 0.30 acre water treatment facility is located within WSDD-10. This facility contains a settling basin for treating mine discharge water. The treated water is then piped directly to a UPDES outfall into Crandall Creek. Therefore, surface runoff from this facility does not report to the sediment pond.

*DESIGN OF DRAINAGE CONTROL STRUCTURES
FOR
RECLAMATION*

Reclamation Hydrology:

- 4.1 General (Phase I)*
- 4.2 General (Phase II)*
- 4.3 Reclamation - Disturbed Drainage Control*
- 4.4 Restored Channels*
- 4.5 Sediment Pond*
- 4.6 Calculations*

Tables:

- Table 14 Reclamation - Phase I Runoff Summary Drainage to Sediment Pond*
- Table 15 Reclamation - Phase I Runoff Control Structure / Watershed Summary*
- Table 16 Reclamation - Phase I Runoff Control Structure / Flow Summary*
- Table 17 Reclamation - Phase I Reclaimed Ditch Design Summary*

Figures:

- Figure 8 Reclamation Channel RD-1 Typical Section*

Reclamation Hydrology

4.1 General (Phase I)

During Phase I of reclamation, all disturbed area culverts and ditches will be removed except as shown on Plate 5-16. Undisturbed diversion UD-2 will also be removed, and the drainage from that area will be directed to the sediment pond. Undisturbed diversion UD-1 will remain in place as a permanent structure for the following reasons:

- (1) The diversion is necessary to continue to divert runoff from the reclaimed site, the U.S. Forest Service turnaround area and beneath the U.S. Forest Service Road;*
- (2) The 10 year-24 hour storm runoff from WSUD-1 is approximately 2.98 acre feet, which combined with runoff from the reclaimed site, exceeds the holding capacity of the sediment pond;*
- (3) The existing diversion is a 42" full-round C.M.P. pipe, which is well in excess of the size required to carry runoff from a 100 year-6 hour storm event for the area (See Table 10).*

The main canyon 72" culvert will also be removed during Phase I reclamation, except for the lower approximately 300', which will be left in place to divert undisturbed and treated runoff beneath the sediment pond. Once the main canyon culvert is removed, Crandall Creek will be directed back to the original drainage channel through the area. Silt fences will be installed on both sides of the restored channel to treat runoff from the reclaimed pad areas, as shown on Plate 5-16.

The U.S. Forest Service Road will be left as a permanent feature. A berm and ditch (RD-1) will be established along the road. This ditch will direct all runoff from areas above the road to the sediment pond. The sediment pond will remain in place until Phase II of reclamation.

Watersheds are shown on Plates 7-5 and 7-5C. Reclamation drainage details are shown on Plates 5-16 and 5-17.

4.2 General (Phase II)

Once the criteria for Phase II Bond Release are met, the sediment pond will be removed and, the area recontoured and reseeded according to the plan. The remaining 300' of the main canyon 72" culvert will also be removed at this time. At the discretion of the U.S. Forest Service, the berm along the road can also be removed at this time, or left in place. If the berm is left in place, reclaimed ditch RD-1 will be extended through the reclaimed pond area to the main channel.

4.3 Reclamation - Disturbed Drainage Control

Drainage from all contributing watersheds above the U.S. Forest Service Road, except WSUD-1, will be collected in a reclamation ditch (RD-1) and diverted into the sediment pond during Phase I reclamation. Drainage from the reclaimed areas and contributing watersheds below the road, will be treated through silt fences along the restored natural main channel, during Phase I reclamation.

Approximately 300' of the main canyon culvert will remain in place beneath the sediment pond area during Phase I.

Upon Phase II reclamation, the sediment pond will be removed and the area restored. The remaining portion of the main canyon culvert will also be removed at this time. Silt fences along the previously reclaimed channel section may also be removed during Phase II; however, additional silt fences will be installed along the 300' section of culvert removal channel restoration.

4.4 Restored Channels

Upon final reclamation, the main canyon drainage will be returned to the natural channel. During construction, this channel is to be covered by filter fabric and an underdrain system. The culvert will then be placed over the protected channel. Upon removal of the culvert, filter fabric will also be removed, exposing the natural channel. Construction in this manner will have a temporary effect on the riparian vegetation; however, this can readily be restored upon reclamation. Flow characteristics, bedding and other natural features of the natural channel will not be changed appreciably; therefore, no actual channel reconstruction or reclamation (beyond revegetation) is proposed.

No other channels are proposed to be restored within the reclaimed minesite.

4.5 Sediment Pond

The sediment pond will remain in place during Phase I reclamation. The pond will be removed during Phase II and all drainage will be returned to the Main Crandall Canyon channel at that time.

Calculations show the sediment pond to be adequately sized to contain the runoff from contributing watersheds from a 10 year-24 hour precipitation event, along with a minimum of 3 years of sediment storage. The principle and emergency spillways are each capable of passing the runoff from a 25 year-6 hour event, as required.

4.6 Calculations

For ease of calculation and to ensure a conservative runoff requirement for sediment pond adequacy, no curve numbers for contributing watersheds were changed for reclamation purposes. Contributing watershed characteristics and flows were taken from Tables 1 through 4 of this report. Watersheds and pre-reclamation drainage control are shown on Plates 7-5 and 7-5C. Phase I and Phase II drainage control are shown on Plates 5-16 and 5-17, respectively.

TABLE 14

RECLAMATION - PHASE I
 RUNOFF SUMMARY
 DRAINAGE TO SEDIMENT POND

<i>Watershed</i>	<i>10 year/24 hour Volume-ac.ft.</i>	<i>10 year/ 6 hour Peak Flow-cfs</i>	<i>25 year/6 hour Peak Flow-cfs</i>
WSUD-2	0.05	0.04	0.08
WSUD-3	0.30	0.23	0.43
WSDD-1	0.03	0.05	0.07
WSDD-2	0.01	0.01	0.03
WSDD-3	0.09	0.26	0.37
WSDD-4	0.03	0.11	0.14
WSDD-5	0.07	0.23	0.32
WSDD-7	0.05	0.11	0.16
WSDD-8	0.23	0.41	0.62
WSDD-10	0.13	0.39	0.53
WSDD-11	0.09	0.10	0.18
WSDD-14	0.13	0.39	0.56
<i>Totals</i>	1.21	2.33	3.49

Note: Volumes and flows are totals from respective watersheds on Tables 3 and 4 of this report.

TABLE 15

RECLAMATION - PHASE I
RUNOFF CONTROL STRUCTURE
WATERSHED SUMMARY

<i>Structure</i>	<i>Type</i>	<i>Contributing Watersheds</i>
<i>Main Channel</i>	<i>Silt Fence</i>	<i>WSDD-12, WSDD-13</i>
<i>UD-1</i>	<i>Culvert</i>	<i>WSUD-1</i>
<i>RD-1</i>	<i>Ditch</i>	<i>WSUD-2, WSUD-3, WSDD-1 thru WSDD-11</i>
<i>Sediment Pond</i>	<i>Pond</i>	<i>WSUD-2, WSUD-3, WSDD-1 thru WSDD-11 and WSDD-14</i>

TABLE 16

RECLAMATION - PHASE I
 RUNOFF CONTROL STRUCTURE
 FLOW SUMMARY

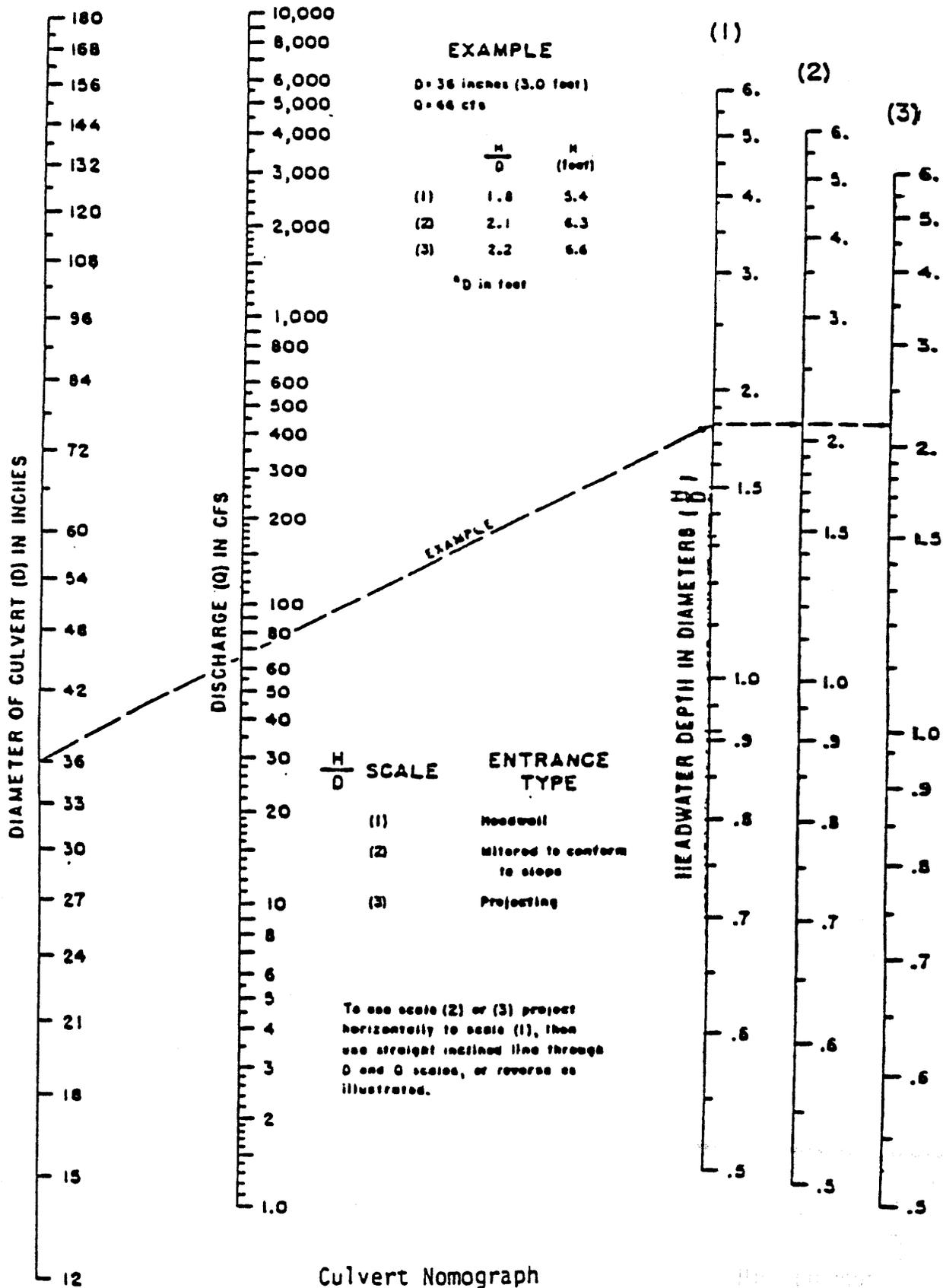
<i>Structure</i>	<i>Type</i>	<i>10 year/6 hour Peak Flow (cfs)</i>	<i>25 year/6 hour Peak Flow (cfs)</i>	<i>100 year/6 hour Peak Flow (cfs)</i>
<i>Main Channel</i>	<i>Silt Fence</i>	<i>3.73</i>	<i>5.44</i>	<i>-</i>
<i>UD-1</i>	<i>Culvert</i>	<i>1.91</i>	<i>3.68</i>	<i>6.81</i>
<i>RD-1</i>	<i>Ditch</i>	<i>1.94</i>	<i>2.93</i>	<i>-</i>
<i>Sediment Pond</i>	<i>Pond</i>	<i>2.33</i>	<i>3.49</i>	<i>-</i>

TABLE 17

RECLAMATION - PHASE 1
RECLAIMED DITCH/CULVERT DESIGN SUMMARY

<i>Ditch</i>	<i>RD-1</i>
<i>Slope (%)</i>	<i>10.10</i>
<i>Length (ft.)</i>	<i>990</i>
<i>Manning's No.</i>	<i>0.035</i>
<i>Side Slope (H:V)</i>	<i>1.5:1</i>
<i>Bottom Width (ft.)</i>	<i>0</i>
<i>Peak Flow 10/6 (cfs)</i>	<i>1.94</i>
<i>Flow Depth (ft.)</i>	<i>0.52</i>
<i>Flow Area (ft²)</i>	<i>0.40</i>
<i>Velocity (fps)</i>	<i>4.85</i>
<i>Lined (Y/N)</i>	<i>N</i>
<i>Rip Rap Req'd (Y/N)</i>	<i>N</i>

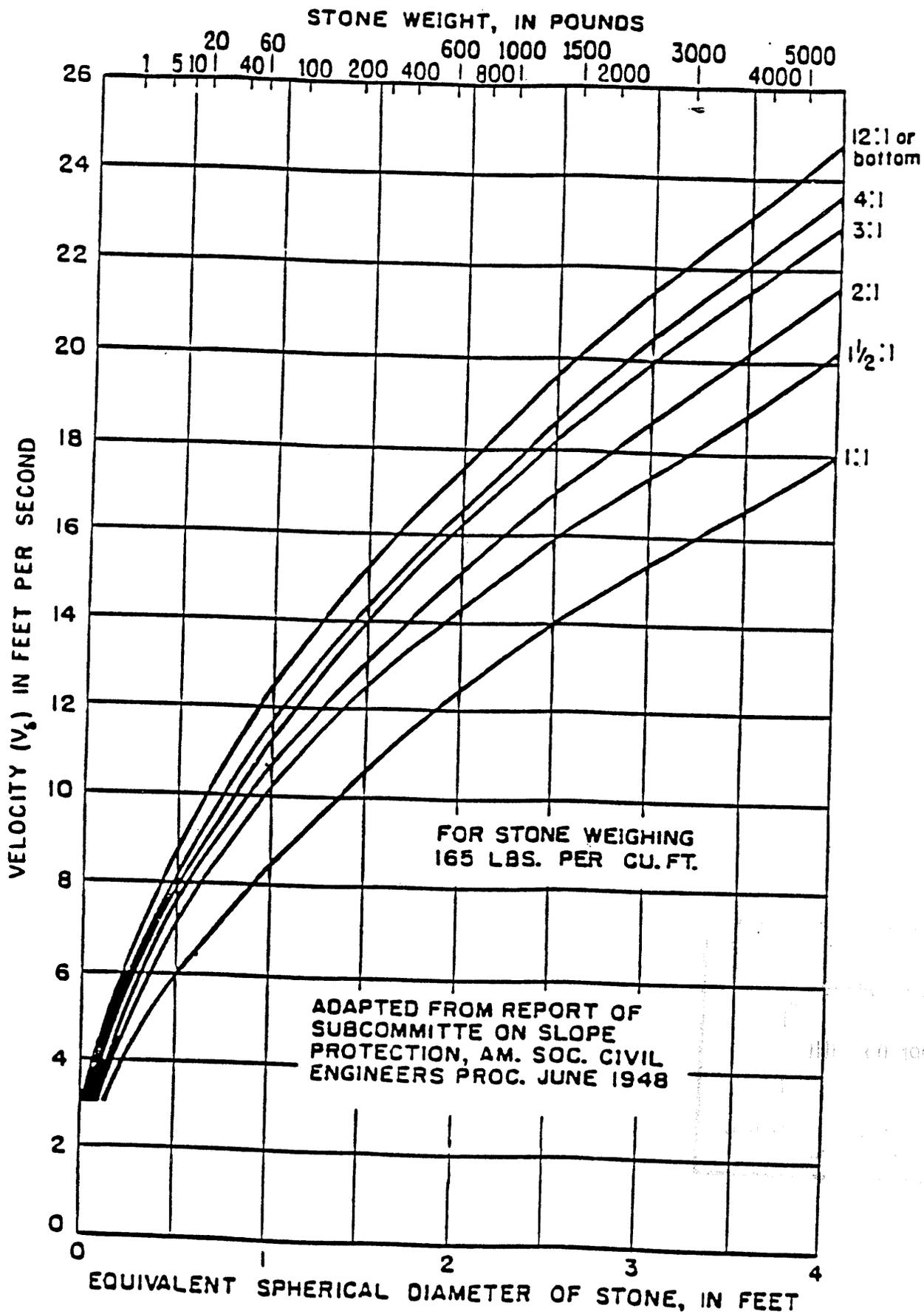
Note: Slope / Length from Plate 5-16



Headwater depth for corrugated-metal pipe culverts with entrance control. (U.S. Bureau of Public Roads.) 138-D-2909.

FIGURE 1

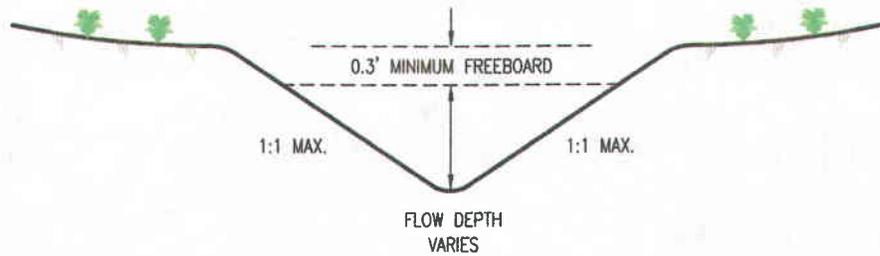
RIP-RAP CHART



SIZE OF STONE THAT WILL RESIST DISPLACEMENT
FOR VARIOUS VELOCITIES AND SIDE SLOPES

FIGURE 2

UNDISTURBED AND DISTURBED DITCH
TYPICAL SECTION



DITCH SIZING					
10 YEAR 6 HOUR STORM			* 10 YEAR 24 HOUR STORM		
DITCH	FLOW DEPTH	FLOW AREA	DITCH	FLOW DEPTH	FLOW AREA
UD-2	0.14	0.02	UD-2	—	—
DD-1	0.14	0.02	DD-1	0.22	0.05
DD-3	0.40	0.16	DD-3	0.56	0.31
DD-4	0.66	0.43	DD-4	0.92	0.85
DD-5	0.84	0.71	DD-5	1.23	1.52
DD-7	0.33	0.11	DD-7	0.57	0.32
DD-8	0.50	0.25	DD-8	0.87	0.76
DD-10	0.86	0.75	DD-10	0.92	0.84
DD-11	0.26	0.07	DD-11	0.50	0.25
DD-12	0.71	0.50	DD-12	0.97	0.94
DD-13	0.56	0.32	DD-13	0.77	0.59

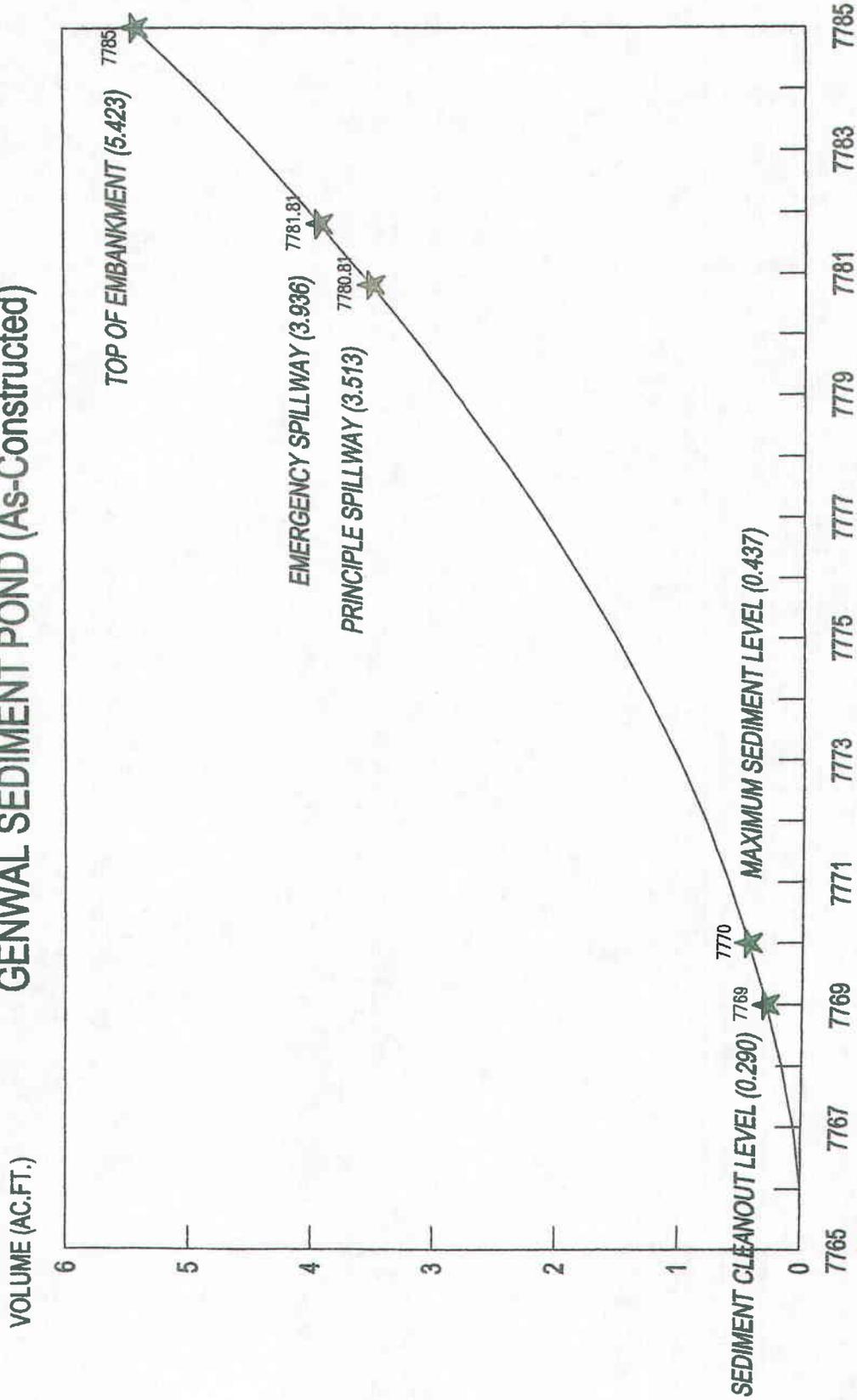
NOTE:

DITCH CONFIGURATIONS MAY VARY IN FIELD; HOWEVER, MINIMUM FLOW DEPTHS AND AREAS WILL BE MAINTAINED.

* FOR REFERENCE ONLY.

FIGURE 3

STAGE-VOLUME GENWAL SEDIMENT POND (As-Constructed)



— STAGE (Elev. - Ft.)
 — STAGE-VOLUME CURVE

INCORPORATED
FEB 03 2006
 DIV OF OIL GAS & MINING

FIGURE 6

SEDIMENT POND
STAGE-DISCHARGE CURVE

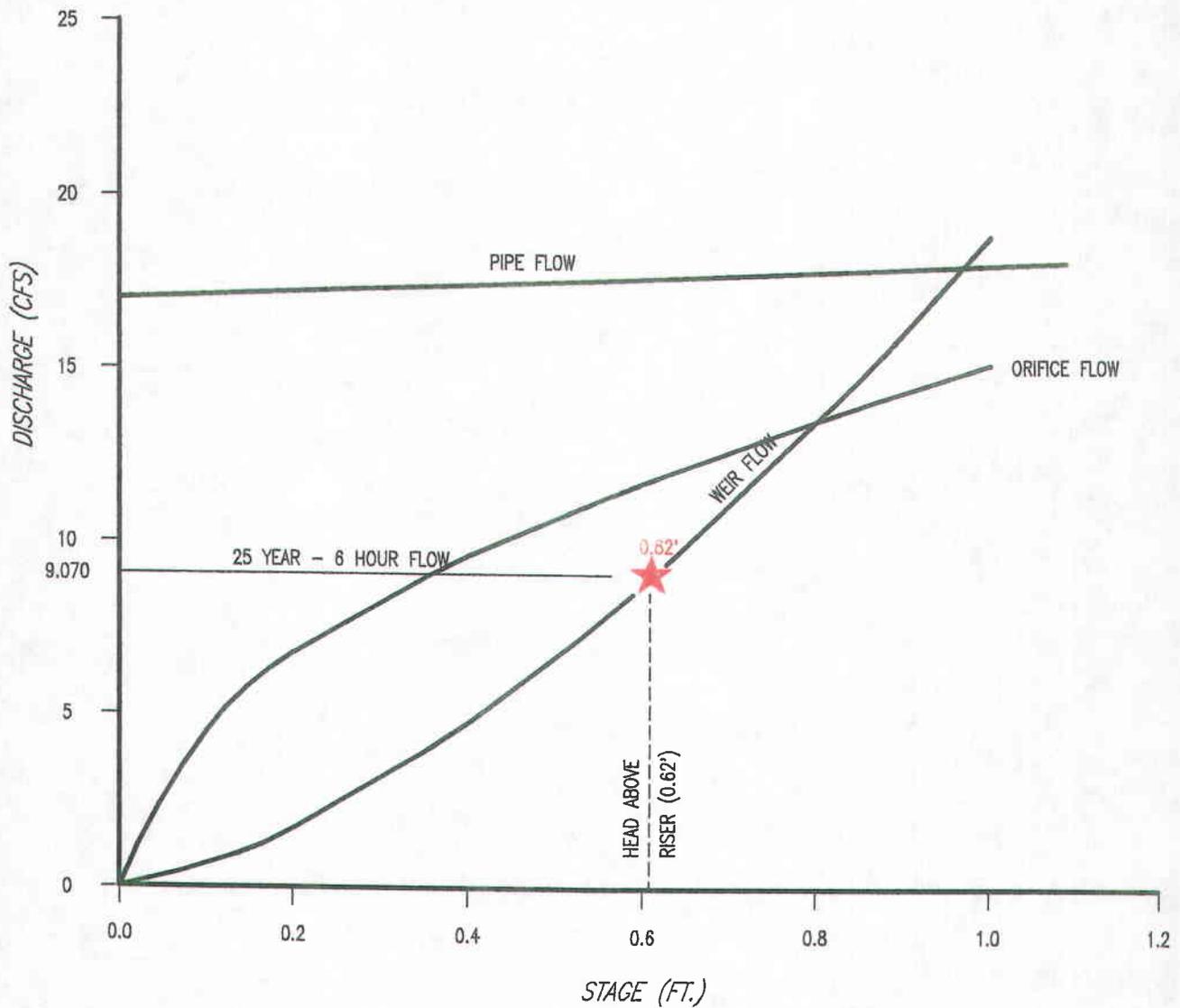
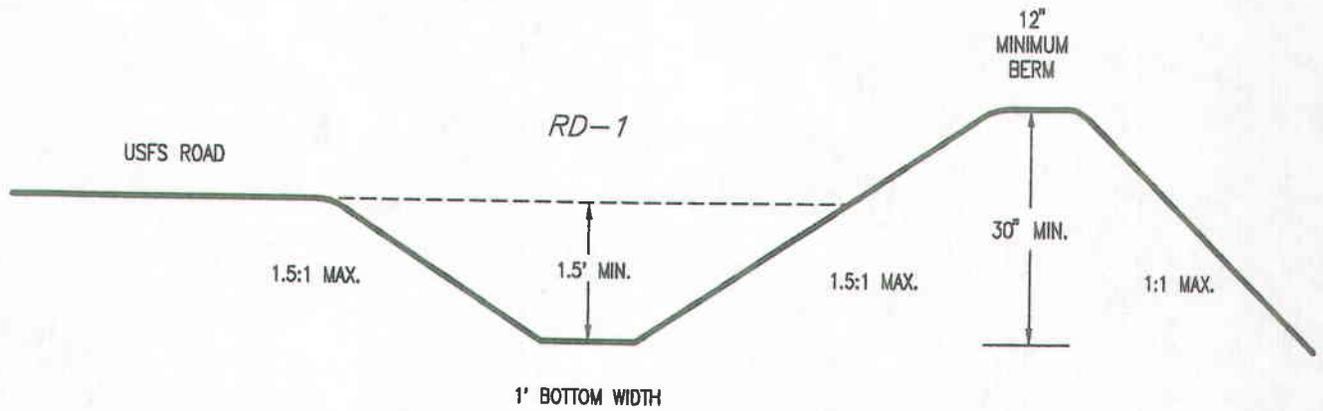


FIGURE 7

RECLAMATION DITCH RD-1
TYPICAL SECTION



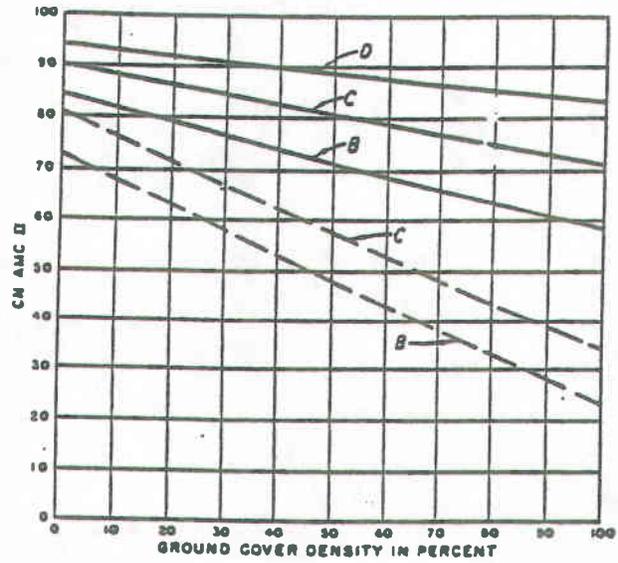
<i>DITCH SIZING</i>		
<i>DITCH</i>	<i>FLOW DEPTH</i>	<i>FLOW AREA</i>
<i>RD-1</i>	<i>0.52</i>	<i>0.40</i>

JUL 30 1987
 (Faint red text and stamp details)

NOTE:

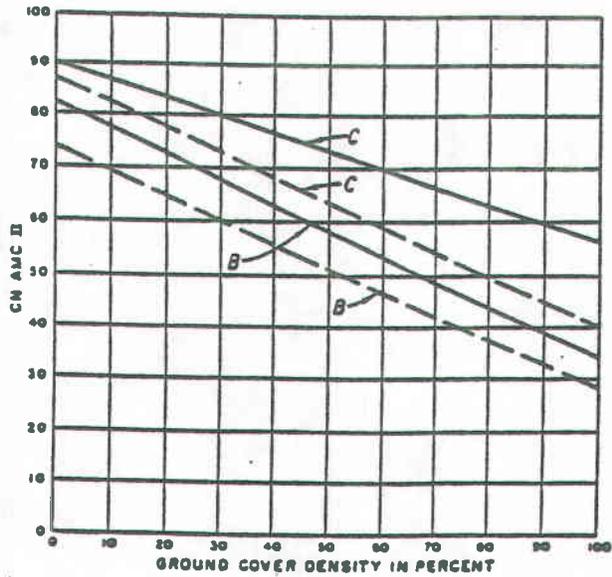
DITCH CONFIGURATIONS MAY VARY IN FIELD; HOWEVER, MINIMUM FLOW DEPTHS AND AREAS WILL BE MAINTAINED.

FIGURE 8



———— HERBACEOUS
 - - - - OAK-ASPEN
 B, C, D: SOIL GROUPS

(A)



———— JUNIPER GRASS
 - - - - SAGE-GRASS
 B, C: SOIL GROUP

(B)

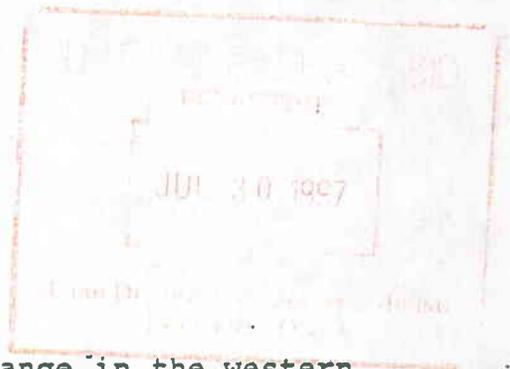


Figure 7-3. Runoff curve numbers for forest-range in the western U.S. (from U.S. Bureau of Reclamation, 1977).

MAIN CULVERT INLET AND TRASH BARRIERS

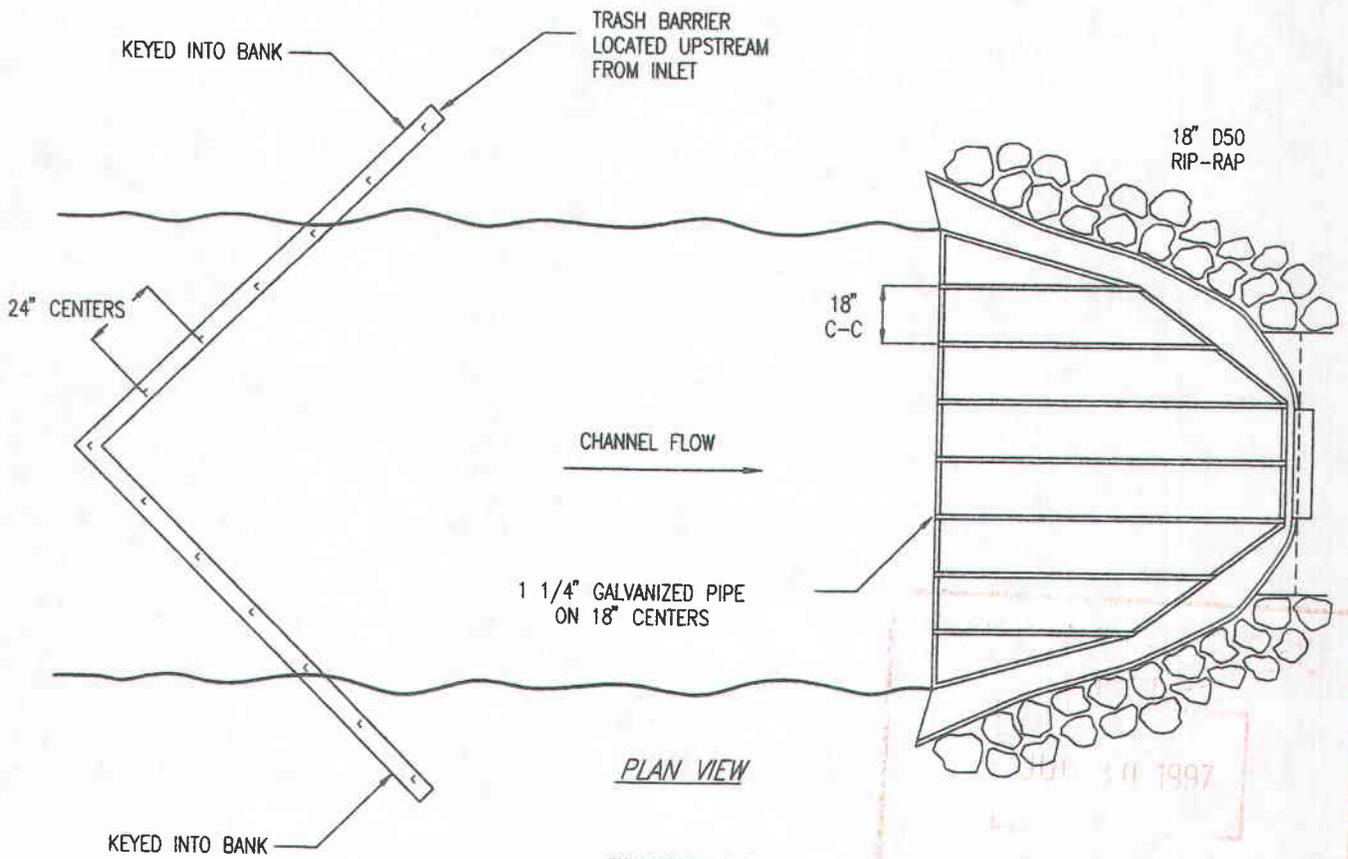
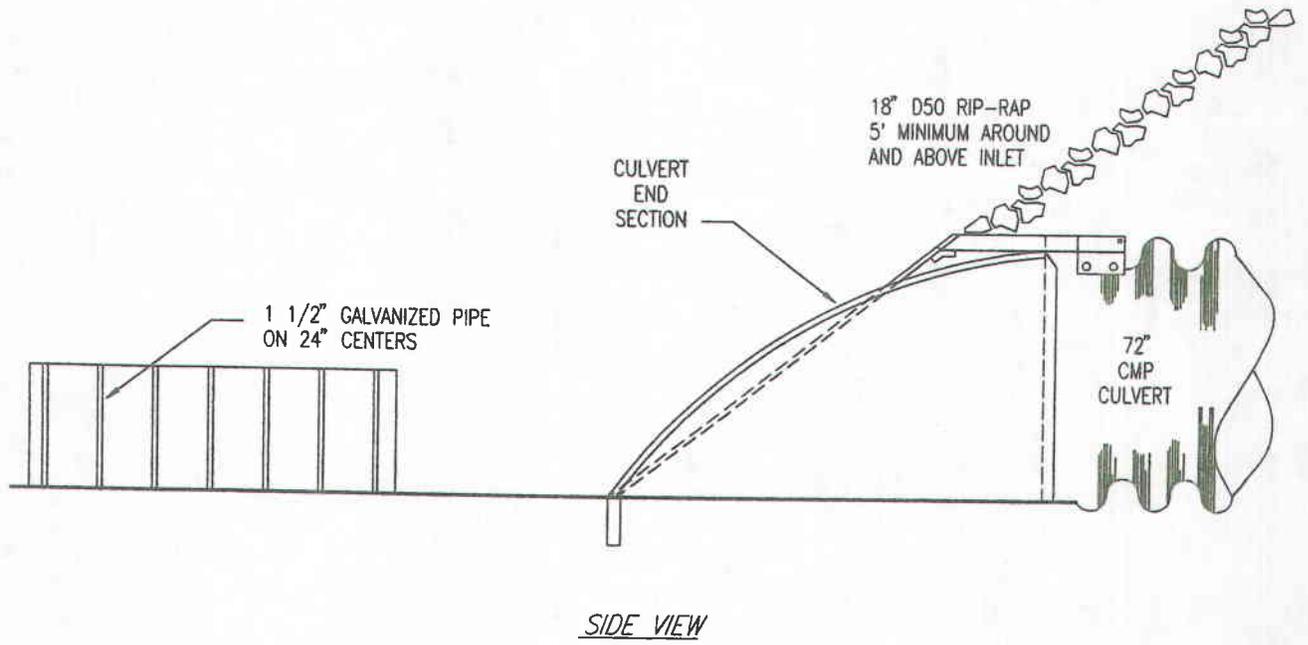
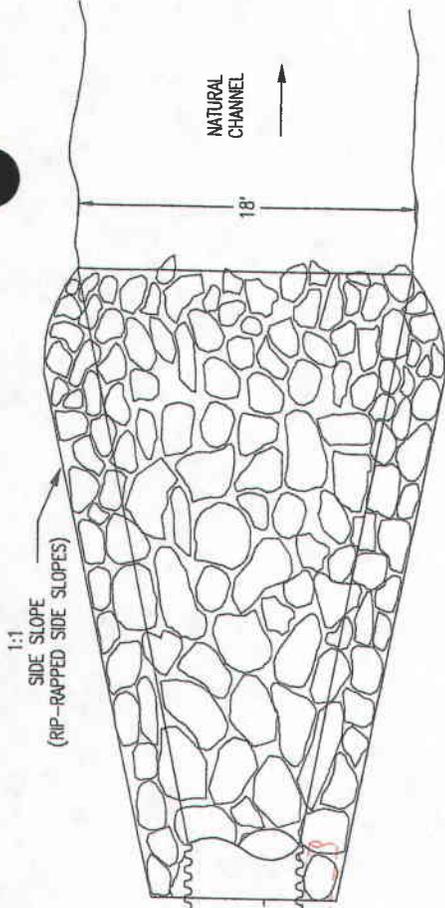


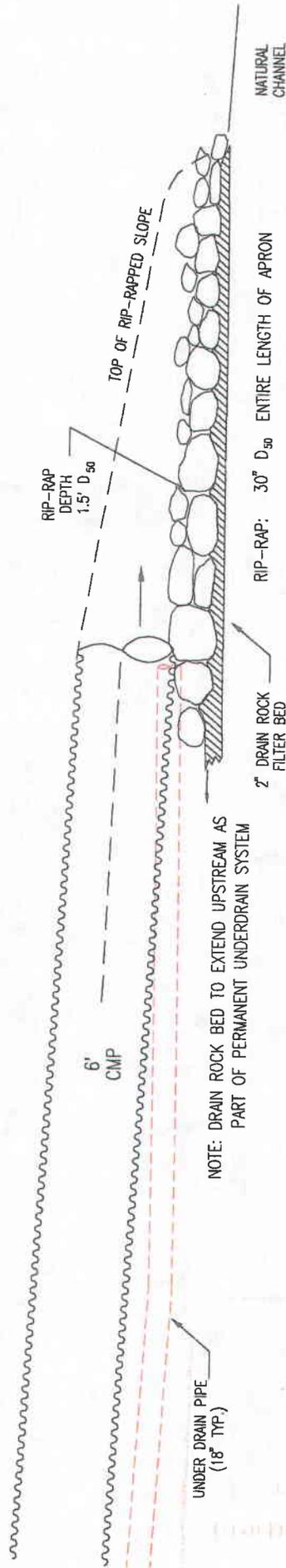
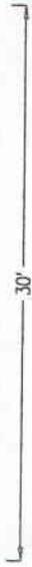
FIGURE 10

**MAIN CANYON
CULVERT OUTLET**



TOP VIEW

RIP-RAP: 30" D₅₀ ENTIRE LENGTH OF APRON



NOTE: DRAIN ROCK BED TO EXTEND UPSTREAM AS PART OF PERMANENT UNDERDRAIN SYSTEM

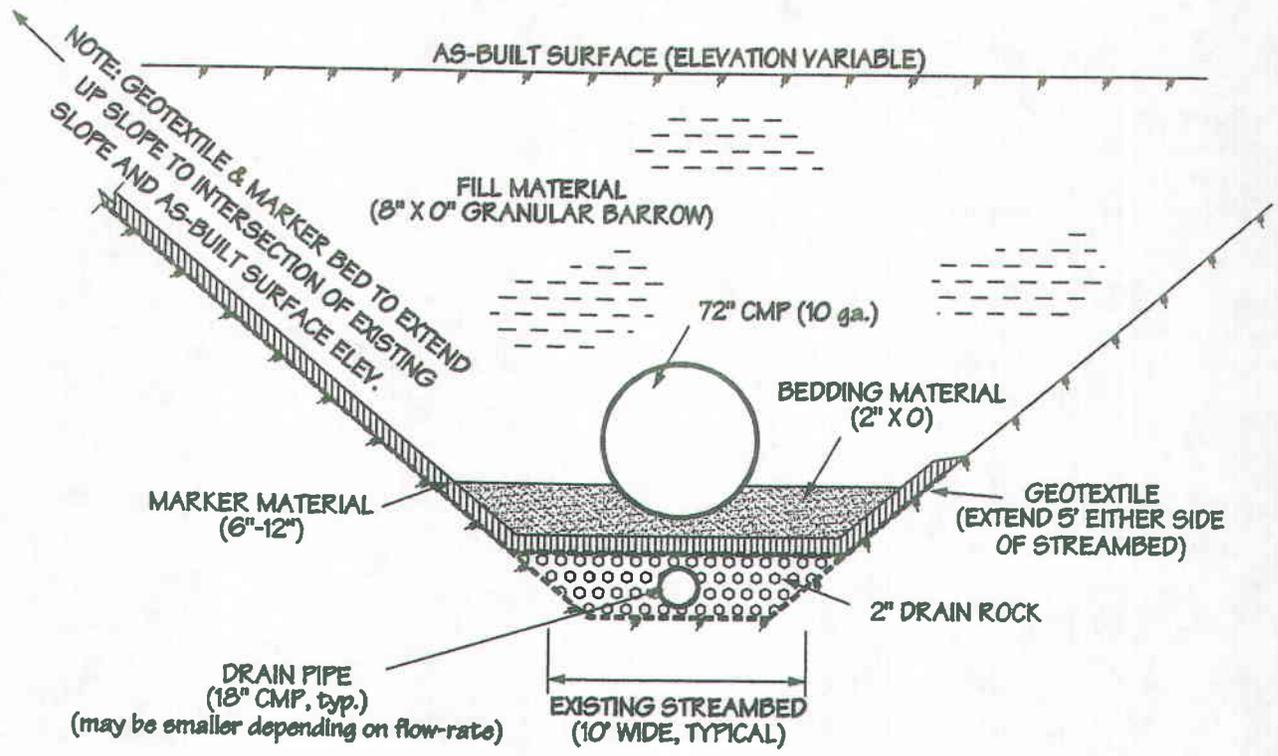
SECTION VIEW

* DESIGN BASED ON FIGURE 7-26, DESIGN OF OUTLET PROTECTION - MAXIMUM TAILWATER CONDITION,
"APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS", BARFIELD, WARNER & HAAN, 1983.

FIGURE 11

SCALE: 1" = 10'

TYPICAL UNDERDRAIN CONSTRUCTION



SCALE: 1" = 15'

Note: Culvert installation will generally follow the existing stream alignment, but may vary slightly to accommodate accepted engineering and installation standards.

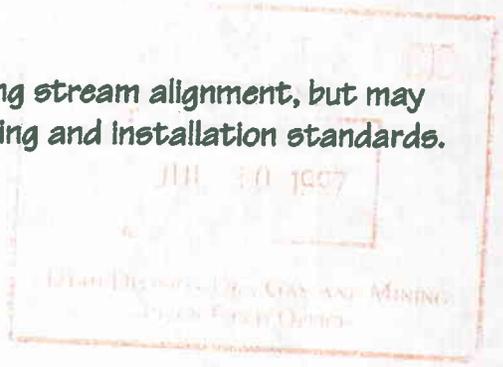


FIGURE 12

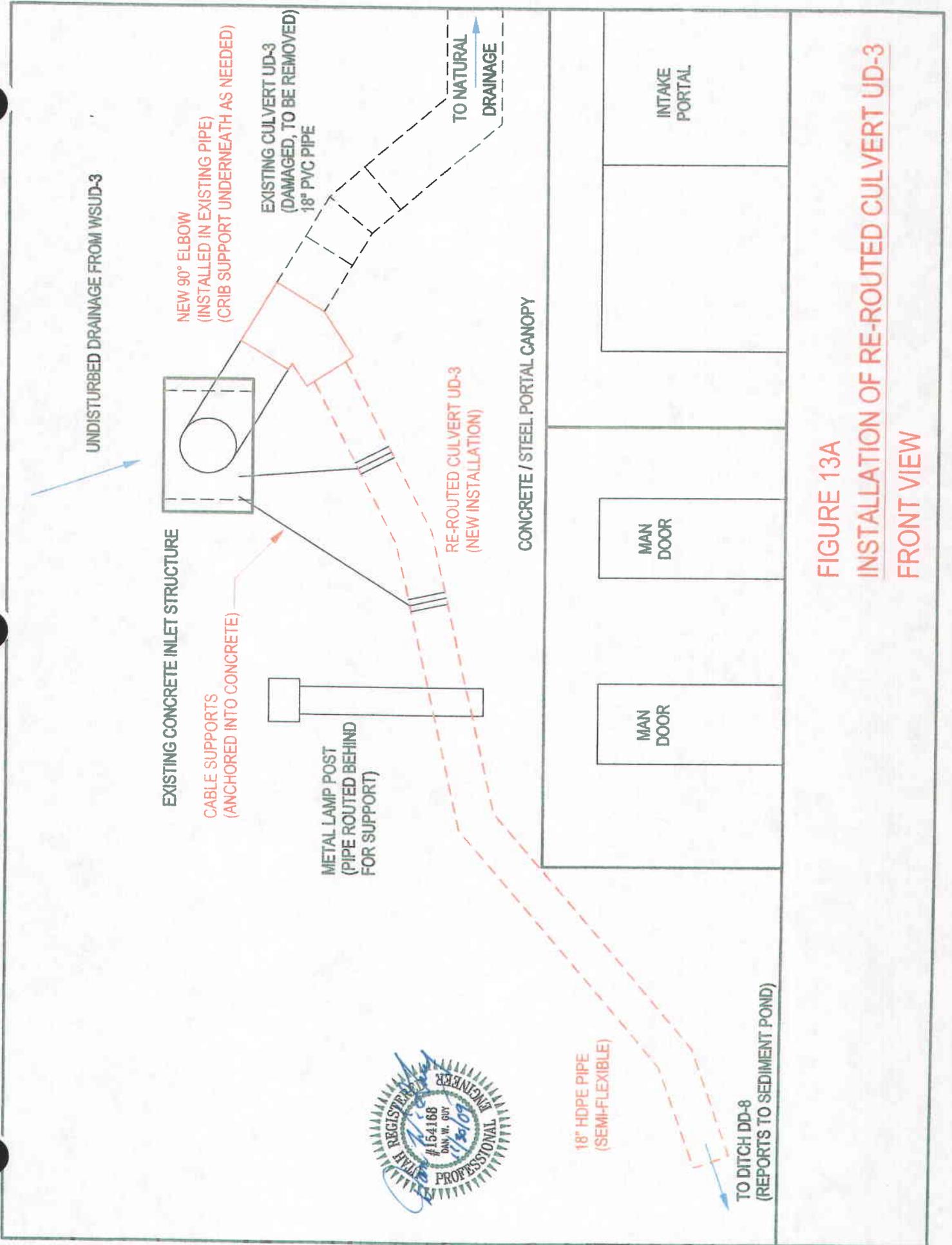


FIGURE 13A
INSTALLATION OF RE-ROUTED CULVERT UD-3
FRONT VIEW

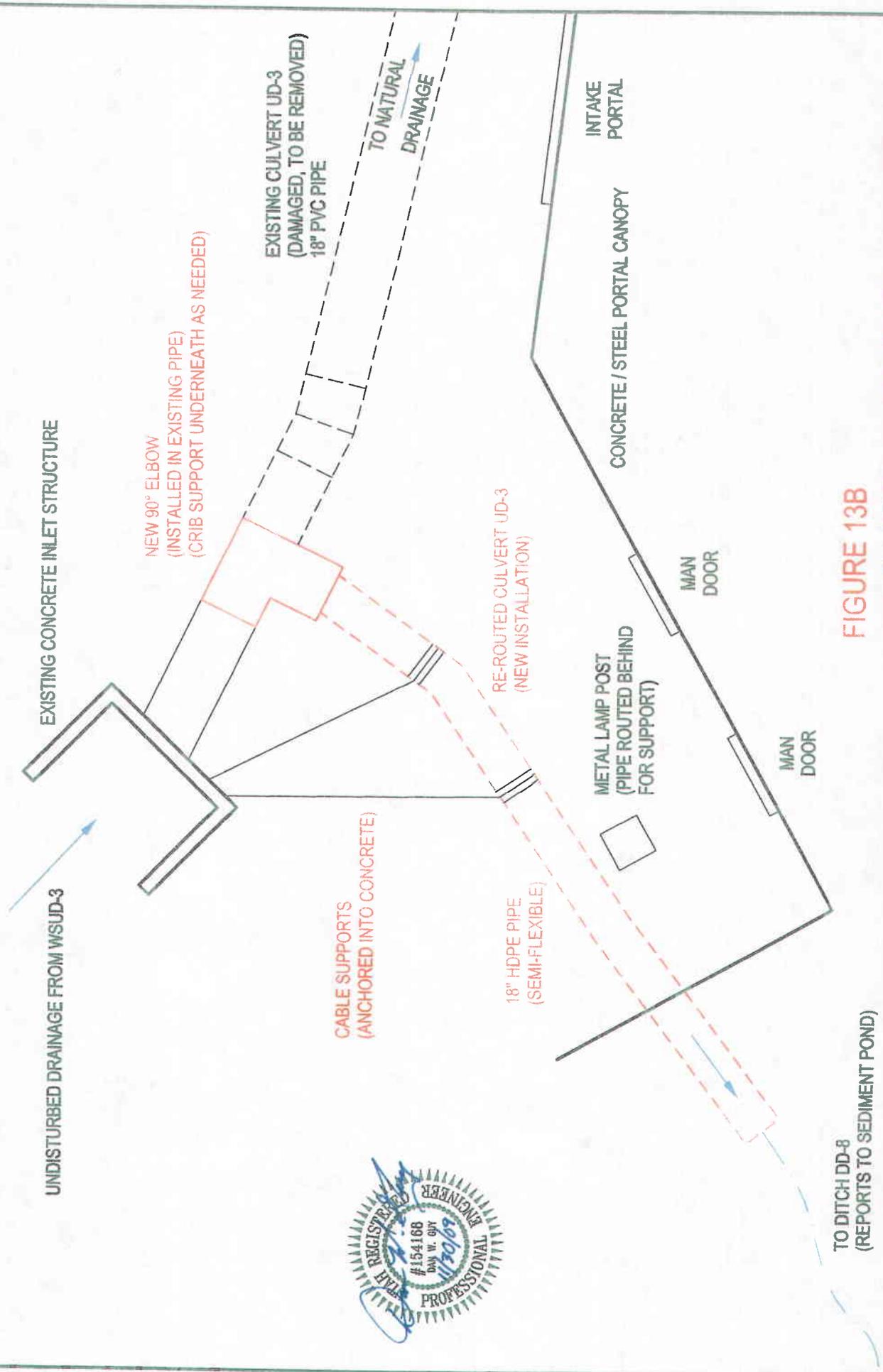


FIGURE 13B
INSTALLATION OF RE-ROUTED CULVERT UD-3
SIDE VIEW



TO DITCH DD-8
 (REPORTS TO SEDIMENT POND)

DITCH FLOW CALCULATIONS

Title of run: DITCH DD-5 (10/6)
 Solving for.....= Depth Normal
 Triangle
 Flow depth (ft).....= 0.84
 First Side slope.....= 1.0
 Second Side slope.....= 1.0
 Slope of diversion.....= 0.0450
 Manning"s n.....= 0.035
 CFS.....= 2.85
 Cross section area (sqft)..= 0.71
 Hydrualic radius.....= 0.30
 fps.....= 4.02
 Froude number.....= 1.30

Title of run: DITCH DD-5 (10/24)
Solving for.....= Depth Normal
Triangle
Flow depth (ft).....= 1.23
First Side slope.....= 1.0
Second Side slope.....= 1.0
Slope of diversion.....= 0.0450
Manning"s n.....= 0.035
CFS.....= 7.88
Cross section area (sqft)..= 1.52
Hydraulic radius.....= 0.44
fps.....= 5.19
Froude number.....= 1.39

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

Solving for.....= Depth Normal
Triangle

Flow depth (ft).....=	0.50
First Side slope.....=	1.0
Second Side slope.....=	1.0
Slope of diversion.....=	0.0359
Manning"s n.....=	0.035
CFS.....=	0.64
Cross section area (sqft).....=	0.25
Hydrualic radius.....=	0.18
fps.....=	2.55
Froude number.....=	1.07

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

Solving for.....= Depth Normal Triangle

Flow depth (ft).....=	0.87
First Side slope.....=	1.0
Second Side slope.....=	1.0
Slope of diversion.....=	0.0359
Manning"s n.....=	0.035
CFS.....=	2.80
Cross section area (sqft).....=	0.76
Hydraulic radius.....=	0.31
fps.....=	3.68
Froude number.....=	1.17

CULVERT FLOW CALCULATIONS

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: UNDISTURBED CULVERT UD-3 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.3000 ft/ft
Manning's n.....	0.020
Discharge.....	0.23 cfs

Computed Results:

Full Flow Diameter.....	0.22 ft
Full Flow Depth.....	0.22 ft
Velocity.....	5.93 fps
Flow Area.....	0.04 sf
Critical Depth....	0.22 ft
Critical Slope....	0.2806 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.23 cfs
QMAX @.94D.....	0.25 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: CULVERT C-1 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.1667 ft/ft
Manning's n.....	0.020
Discharge.....	0.96 cfs

Computed Results:

Full Flow Diameter.....	0.42 ft
Full Flow Depth.....	0.42 ft
Velocity.....	6.80 fps
Flow Area.....	0.14 sf
Critical Depth....	0.42 ft
Critical Slope....	0.1518 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	0.96 cfs
QMAX @.94D.....	1.03 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: CULVERT C-1 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.1667 ft/ft
Manning's n.....	0.020
Discharge.....	3.58 cfs

Computed Results:

Full Flow Diameter.....	0.69 ft
Full Flow Depth.....	0.69 ft
Velocity.....	9.44 fps
Flow Area.....	0.38 sf
Critical Depth....	0.69 ft
Critical Slope....	0.1537 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	3.58 cfs
QMAX @.94D.....	3.85 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: CULVERT C-12 (10/6)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0450 ft/ft
Manning's n.....	0.020
Discharge.....	2.85 cfs

Computed Results:

Full Flow Diameter.....	0.82 ft
Full Flow Depth.....	0.82 ft
Velocity.....	5.46 fps
Flow Area.....	0.52 sf
Critical Depth....	0.74 ft
Critical Slope....	0.0395 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	2.85 cfs
QMAX @.94D.....	3.07 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: CULVERT C-12 (10/24)

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0450 ft/ft
Manning's n.....	0.020
Discharge.....	7.36 cfs

Computed Results:

Full Flow Diameter.....	1.16 ft
Full Flow Depth.....	1.16 ft
Velocity.....	6.92 fps
Flow Area.....	1.06 sf
Critical Depth....	1.07 ft
Critical Slope....	0.0391 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	7.36 cfs
QMAX @.94D.....	7.92 cfs
Froude Number.....	FULL

APPENDIX 7-65

MINE DISCHARGE WATER
IRON TREATMENT FACILITY

APPENDIX 7-65

CRANDALL CANYON MINE MINE DISCHARGE WATER IRON TREATMENT FACILITY

Discussion

Attachment 1

Attachment 2

Attachment 3

Attachment 4

Attachment 5

Attachment 6

Attachment 7

Attachment 8

Maelstrom Oxidizer Unit

Iron Treatment Bench Test Results, and
Settling Basin Volume Determination

Pit Liner Information

Wildcat Sediment Pond C Volume Determination

Settling Basin Clean-up Volume Estimation

Drainage Information

Safety Factor Determination

Construction Specifications and Drawings

DISCUSSION

BACKGROUND

As a result of the Crandall Canyon Mine disaster of August 6, 2007, the mine has been de-activated and the portals have been sealed. Mine water inflow has built up to the extent that water is now discharging from the portals and is discharged through a 12" pipe into Crandall Creek under UPDES permit UT0024368. The mine is presently discharging approximately 500 gallons per minute, with the flow fluctuating with barometric pressure and seasons. In early 2009 the iron concentrations in the water began to exceed UPDES limits. By the summer of 2009, Crandall Creek below the mine began to display an orange discoloration from the iron staining, resulting in violations from both DOGM and Division of Water Quality. Because there is no way to treat the water underground the company has constructed an aeration treatment system located on the surface in the "old loadout" area, immediately below the portal bench. In concept, the facility consists of two basic components; 1) an aeration devise which allows atmospheric oxygen to chemically react with the dissolved iron in the water, thereby creating iron particulates, and 2) a settling basin which allows the iron particulates to settle out of the water. (See Attachment 8 for the construction specifications and engineering drawings for the facility.)

CONSTRUCTION

A new 12" HDPE pipeline has been tapped into the existing discharge line from the mine near the upper portals and extends to the new facility. It is equipped with shutoff valves, which allows the flow of mine water to be routed down to the treatment facility, or bypassed directly to the existing UPDES outfall. This line is supported by cables attached to bolts drilled into the ledgerock and epoxied in place.

The settling basin is contained on three sides by an earthen berm constructed from a structural granular borrow material. The berm was constructed in 8" lifts and compacted to 90% density using vibratory sheeps-foot mechanical compacting equipment, and the embankments do not exceed 2.5H/1V sideslopes. *As shown in Attachment 7, the berm has been designed and constructed to achieve a 1.3 safety factor. Attachment 7 also includes geotechnical information about the granular borrow material used for construction of the berm. The settling basin and berm are constructed in the area previously referred to as the "Old Loadout Area". To make room for this old loadout, a large enclave was blasted out of the solid ledgerock in the past. This blasted rock was then used as fill material to extend the loadout area, and to construct the adjacent Forest Service road. This area was originally compacted for construction purposes, but was also compacted even more through many years of loading operations involving loaded trucks and front-end loaders operating on the site. Prior to constructing the settling basin berm all loose material was removed from the site, revealing the underlying compacted rock subsurface. Therefore, the foundational material for the berm and basin is either the solid sandstone bedrock from the original ledge, or else the highly compacted rock material located next to it. Refer to*

Figure 1 of Attachment 8, which shows the extent of the solid bedrock underlying the basin and berm. It should also be noted that the inner portion of the basin containment is constructed from a pre-existing concrete wall. This wall is a massive 12" thick, reinforced concrete structure which was part of the original "old loadout" system.

The berm is ringed on top with a double row of concrete Jersey barriers placed side-by-side with the intervening space filled with earthen material for added stability. The remaining side of the basin is constructed from the 12' thick pre-existing concrete wall mentioned above. The Jersey barriers on the earth berm, along with the existing concrete wall left over from the old loadout, define the limits of the settling basin. The barriers also provide public safety by keeping vehicular traffic, foot traffic and animals from entering the basin area.

The interior of the basin is lined with a pit liner similar to that used for containing drilling fluids in drilling operations. (See Attachment 3 for additional information on the liner material.) The pit liner is secured around the perimeter by tucking it into the space between the barrier walls and backfilling with earth material. A felt underlining was also placed down before (below) the pit liner to provide protection against damage. A chain link fence is installed around the basin atop the barriers to provide additional public security.

The outslopes of the berm have been covered with a layer of gravel to help prevent erosion and maintain stability. Also, the outer toe of the berm located adjacent to the Forest Service road has been armored with concrete jersey barriers sufficient to prevent potential erosion from surface runoff along the road.

Prior to constructing the berm and placing the pit-liner, an underdrain system was installed in the area of the basin. This underdrain system consists of cleaned drain rock and perforated drainpipe placed in a trench running along the upper toe of the berm at the lower (down-dip) end of the basin. The drain is then routed in a buried 4" pipe to the main discharge line. This underdrain system is designed to carry any water, possibly coming from pin-hole leaks in the pit liner, directly out from the basin so that it cannot saturate any portion of the berm. The pit liner is fabricated and fused as a single piece and is not expected to leak, but the underdrain system was installed as a measure of added insurance. As mentioned previously, the berm has been constructed on the site of the old loadout which was constructed on both solid rock blasted out of the ledge, and on previously compacted structural fill material.

OPERATION

The treatment facility consists of a manufactured mechanical aeration device known as the "Maelstrom Oxidizer Unit". (See Attachment 1 for additional information regarding this unit.) This oxidizer unit consists of a pre-fabricated high-density plastic structure equipped with a series of baffles and a 20 hp blower. The mine water is fed into one end of the unit where it then travels a serpentine route over and under the baffles, and at the same time, a large volume of air is forced through the water by way of a number of nozzles located in the bottom of the unit. The unit has been sized according to the anticipated flow rate, such that the dissolved oxygen in the water as it exits from the unit is nearly 100%. The high oxygen content then reacts

chemically to change the dissolved iron from the ferrous state to the ferric state, which forms iron precipitates which can then be settled out. Samples of the Crandall mine water were sent to the factory for bench testing and the results were very encouraging, showing treated water well within UPDES compliance levels. (Results of the bench test are included in Attachment 2.)

While the bench testing indicates that the iron should settle in 5.5 hours sufficient to meet UPDES compliance levels, the option remains open to treat the water with chemical flocculants as well if needed to enhance the settling rate. Previous bench tests conducted by Nalco Chemical showed that particle settling rates can be greatly accelerated through the application of a small amount of chemical additives. Electric power has been installed to the unit which could be utilized in the future for a chemical pumping/injection system. However, a simpler and perhaps more dependable system would involve the use of chemical gel-logs. These logs are designed to be immersed in to stream flow after aeration and dissolve at a predetermined rate in order to add the proper amount of chemical flocculant to the discharge water ahead of the settling basin. Typically, such gel-log applications can operate for several weeks without requiring attendance. The oxidizer unit has been constructed such that if, in the future, iron levels in the mine-water increase sufficiently to the extent that chemical treatment is required in addition to the oxidization, either a chemical injection system or gel-log chamber can easily be fitted to the unit.

The treated water from the oxidizer unit is then sent to a settling basin. This basin is constructed within a compacted earthen berm. Iron precipitates generated in the oxidizer unit will drop out of suspension and accumulate in the settling basin. The basin has been designed with **nearly** twice the volume (i.e., retention time) recommended from the bench testing in order to maximize the potential for meeting UPDES compliance level (see Attachment 2 for details). The treated water exits the basin through a spillway, dropping into an inlet structure to a discharge pipe which is buried under the road and connects to the existing discharge line leading to the designated UPDES outfall point. A flow meter has also been installed in the line. The UPDES water samples are taken at the outlet of the basin prior to entering the pipe leading to the outfall. This is similar to the manner and location in which the UPDES monitoring was previously conducted, and is agreeable to Division of Water Quality.

CLEAN-OUT

Precipitated iron will be allowed to settle and accumulate in the settling basin. **Because of the newness of this type of facility it is not known at this time the exact nature of the iron precipitate material that is expected to accumulate in the settling basin as a result of the oxidizer treatment. It is assumed that the accumulations will be visible as they begin to settle out in the bottom of the basin, because the water is generally clear and inherently devoid of suspended solids. Also regular sampling of the water at the approved UPDES outfall will provide a good indication that the settling mechanism is functioning properly. By utilizing both visual observations and sampling results it should become apparent when the basin is ready to be cleaned. Since the rate of accumulations is expected to be consistent (unlike a sediment pond that fills up in response to often violent precipitation events), the cleaning process can be anticipated well in advance. Also, due to the slow rate of accumulation, the accumulation level should be easy to monitor. A series of floating booms will be strung across the basin to slow**

down and spread out the flow of water through the basin, in order to maximize retention time and to help direct the pattern of material accumulation within the bottom of the basin.

As indicated by the calculations appearing in Attachment 5, the basin should be capable of holding several years of accumulation before cleaning is required. However, in order to be safe, the company commits to cleaning the basin when accumulations have reached the 7812' level, which would be about 3' deep at the deepest part of the basin. As explained in Attachment 5, this still leaves ample pond volume above the accumulation level to achieve the 5.5 hour settling time recommended by the bench testing. Several staff gauges (sediment markers) will be installed in the deepest areas of the basin to serve as a visual aid in determining when the basin should be cleaned. The company proposes to use the accumulation level of 7812' for the initial cleaning. However, based on operational experience, this level may be changed to reflect actual (versus hypothetical) accumulation rates, refinements in clean-out techniques, topographic and spatial patterns of accumulations within the basin, and other operational dynamics.

After the accumulated material has reached the 7812' level (which is 4' below the surface level), the clean-out will begin. Without prior operational experience it is difficult at this time to predict the exact nature of the precipitated iron accumulation material that will have to be cleaned out of the bottom of the basin. However, based on input from Division staff, literature on treatment systems for mining sites suggest that solids content in the accumulation material is about 5%. This consistency of material would allow removal by vacuum methods. Vacuum tanker trucks will be positioned along the road next to the basin in preparation for clean-up. The semi-flexible 4" suction inlet line will be lowered into the deepest part of the basin, which is located at the lower (outlet) end of the facility, where iron accumulations are expected to be deepest, and the material will be sucked up into the waiting trucks. Care will be taken during the clean-out process to minimize stirring up the accumulations so that suspended iron particles do not begin to flow out of the pond. Visual observations and sampling of the water will be made at the spillway (i.e., UPDES monitoring point) to make certain that stirred up iron material is not exiting the basin. If needed, cleaning operations will be delayed until sufficient time is allowed to re-settle any stirred up material. Experience will help refine the cleaning technique. For example, it may be determined that using a perforated suction line that allows multiple access points for material entry along the length of the pipe is more effective than a single entry point. It may also be determined that several cleanup suction lines can be left permanently in place at designated locations within the basin to make future clean-out efforts quicker and easier. Experience will tell.

Prior to cleaning operation a sample of the iron material will be taken and analyzed for RCRA hazardous constituents. If the RCRA analysis shows the material to be hazardous, it will be disposed of at an approved, licensed hazardous waste disposal facility. However, if the results of this RCRA analysis show the material to be non-hazardous, the iron precipitate material from the basin clean-out will be hauled to the company-owned Wildcat Loadout where it will be disposed of in Sediment Pond C. There it can dry out and remain in-place until buried at final reclamation, or if the volume is excessive, it can be scooped out and moved to the approved refuse disposal pile located at the loadout. Under the currently approved Mining and Reclamation Plan for the Wildcat Loadout (C/007/033), this refuse pile will be buried under at least 4' of

earthen material upon final reclamation. (As shown in Attachment 4, Sediment Pond C is a very large pond with ample capacity to contain more than 2.5 acre-ft (108,900 cu. ft.) of material and still have sufficient volume to contain a 10-year/24-hour precipitation event. This is far more volume than is expected to be needed to accommodate the iron clean-out material, as explained in Attachment 5. However, under no circumstance will the pond level be allowed to exceed the 10-year/24-hour design capacity level. Additional information about Wildcat Sediment Pond C and the refuse disposal pile can be found in Mining & Reclamation Plan C/007/033 on file with the Division.

MAINTENANCE

There may be times during required maintenance that the oxidizer must be shut down for repair or cleaning, at which time the mine discharge water will need to bypass the treatment system. By opening the by-pass valve located ahead of the oxidizer unit, the water will be directed to temporarily run down the road around the outside of the basin, and into the main sediment pond through the existing culvert C-4 located immediately below the treatment facility. The toe of the slope of the basin berm has been lined with concrete Jersey barriers where it joins the roadway. The purpose of these barriers is to prevent erosion of the toe of the slope at such times as the discharge water is bypassed during maintenance.

Without the benefit of prior experience, it is difficult at this time to predict how long the maintenance process will take until the mine-water can then be routed back into the treatment facility. Assuming the sediment level in the pond is below the approved clean-out level, and assuming the pond has been previously decanted under approved UPDES discharge criteria, the remaining capacity in the sediment pond is 3.22 acre-ft, as shown on Plate 7-3. (*Note: The sediment pond was completely cleaned in December of 2009, immediately prior to putting the iron treatment facility into operation.*) Since the required freeboard for a 10yr-24hr event is 2.45 acre-ft, this leaves a usable volume of 0.77 acre-ft for the purpose of maintenance bypass. This equates to 251,000 gallons. At an average flow rate of 500 gpm from the mine, the sediment pond could theoretically contain over 8 hours worth of by-passed discharge flow. In other words, this could allow more than 8 hours of time to perform maintenance work on the treatment facility before the sediment pond was filled to within the 10/24 freeboard level. This should provide sufficient time for most routine or emergency maintenance procedures, especially in light of the mechanical simplicity of the system. Details of the sediment pond capacity for this scenario can be found in Appendix 7-4.

DRAINAGE

The "old loadout area" is depicted on Plate 7-5 and in Appendix 7-4 (Sedimentation and Drainage Control Plan) as disturbed drainage area WSDD-10. Much of this area is now dedicated to the installation of the iron treatment facility. The treated minewater, along with any direct precipitation falling into the settling basin, is discharged into Crandall Creek via the original approved UPDES outfall point. Therefore, part of this treatment area is now excluded from draining into the sediment pond as disturbed area drainage. The basin berm, which supports the concrete barrier wall, serves to effectively separate the settling basin from the

disturbed area drainage around it. Effectively, all surface drainage now bypasses the treatment facility area, and there is no co-mingling of storm surface runoff with the mine discharge water undergoing treatment. Relevant drainage information from Appendix 7-4 is included in Attachment 6 for ease of reference. This attachment also contains information that shows the adequacy of the basin spillway and the discharge pipe to handle the combined flow of the mine water and a 10 year/24 hour precipitation event on the surface.

While the facility is neither an ASCA nor a small area exemption, it represents a small area within the disturbed area wherein runoff is treated along with the mine discharge water and discharges through an approved UPDES outfall point, and therefore does not drain to the sediment pond. Also, the outer toe of the berm located adjacent to the Forest Service road has been armored with concrete jersey barriers sufficient to prevent potential erosion from surface runoff along the road, and to route surface drainage around the basin into drainage ditch DD-10, thence into culvert C-4, and thence into the sediment pond. Calculations in Appendix 7-4 show that these drainage structures are adequately sized to handle the bypass flow (at a peak of 1000 gpm) in addition to the 10 yr-25 hr precipitation event design flow.

FINAL RECLAMATION

There is every reason to believe that water will permanently discharge from the Crandall Mine portals. The iron level of the mine water historically was very low, and began rising only after the water began to build up and impound within the mine workings following the mine collapse of 2007. It is now the consensus that the elevated iron concentration will be a permanent situation, and that the reclamation plan must provide for a permanent means of treating the discharge water so as to meet UPDES requirements, even subsequent to final reclamation. To address this situation, the company commits to revising the reclamation plan in the near future.

Based on recent input from various state and federal agencies (Div. Oil, Gas and Mining, Forest Service, BLM, Div Water Resources, Div. Wildlife Resources) a conceptual treatment plan for final reclamation was agreed upon. This plan would utilize a passive aeration system (modifying the existing portal access road into a long, cascading, open-air aeration waterway), emptying out into a set of large settling basins to be constructed in the area presently occupied by the shop/warehouse building. The company commits to collecting the necessary baseline data, consulting with the appropriate agencies, and revising the reclamation plan in accordance with the agreed-upon passive concept, so that the revised reclamation plan can be approved by August 1, 2010. This plan will include not only the facility design but also projected operating and maintenance costs for long-term (perpetual) bonding considerations. In light of the long-term treatment requirements for final reclamation, the existing treatment facility is now considered temporary (i.e., short-term, operational) and will be removed at the time of final reclamation after the permanent (post-reclamation) passive facility is constructed.

BASELINE MONITORING

Additional baseline data will be incorporated into the revised reclamation plan referenced above. This data will include: 1) flow quantities from the seep in the sandstone ledge above the

treatment facility, 2) historical data concerning the iron concentration levels in the mine discharge water, and 3) performance data demonstrating the effectiveness of the existing treatment system methodology of oxidation/settling, as opposed to other treatment methods such as reverse-osmosis, fine-element filtration, chemical coagulants/flocculants, etc.

1) Ledge seep water flow: The treatment area is separated from the portal bench above by a massive sandstone ledge of bare sandstone rock. There are several seeps emanating from this ledge and this seep water drains down the ledge toward the area of the settling basin. Based on previous measurements, the flow is minimal (approximately 1-2 gpm), but constant. A concrete trough has been poured behind the existing retaining wall (between the ledge rock and the back of the wall) to collect this seepage water and route it through a 4" PVC pipe to the settling basin overflow culvert inlet. In this manner the seepage water is contained, can be monitored, and is also subject to treatment thru dilution. The flow data collected from monitoring this seep will be provided to the Division and will assist in determining the most appropriate geotechnical method for future reclamation of this area, i.e., final reclamation. Monitoring will be conducted monthly, although freeze/thaw conditions in winter months will have to be factored into interpreting the data. The monitoring information will be provided to the Division (via email) prior to the end of each month and will continue until the Division determines that it is no longer necessary, and at a minimum, until such time the revised final reclamation plan (see discussion below) has been approved, since this information will be needed in order to properly design the approximate-original-contour requirements for the "old loadout area".

The location of the seep water discharge pipe into the basin overflow culvert inlet provides safe and convenient access for collection of this data. It should also be noted that much of the seep water seems to be coming from underneath the concrete pad of the old crusher building sitting on top of the ledge. Since this building, and its concrete floor, will be removed during final reclamation, there is a high probability that muc of the seep water can be isolated and contained at time of final reclamation. This issue will be addressed in greater detail in the preparation of the revised final reclamation plan. Details of this seep collection system can be found in the engineering drawings in Attachment 8.

2) Mine discharge water quality: This data is essentially the monthly UPDES sampling and monitoring that is presently on-going.

3) Operational performance data: In addition to the normal UPDES data (item 2), the company commits to gathering data to reflect on the effectiveness of the oxidation/settling methodology employed in the existing system. This data will facilitate the design of a final reclamation treatment system that will include perpetual treatment of the mine-water discharge. This data will be collected monthly and will be provided to the Division via email. Samples will be collected from the 12" HDPE pipeline prior to the oxidizer unit, and at the UPDES sampling point at the outlet of the settling basin. The analytical parameters will include the following:

- Iron (total, dissolved, and ferrous)
- Manganese (total and dissolved)
- Aluminum (total and dissolved)

Alkalinity
Sulfate
pH
Dissolved Oxygen

BONDING

As described above (under FINAL RECLAMATION) this facility is to be considered as a short-term, operational facility, designed to treat to the discharge water up until the time of final reclamation, but not thereafter. Because the facility has been constructed using non-permanent structures it will be easy to reclaim. For example, the earthen berm has been constructed out of less than 700 cubic yards of granular borrow which can easily be hauled off or used as backfill material during final reclamation. The oxidizer unit is a pre-fabricated unit that can be removed with a fork-lift. The Jersey barriers can be removed with a backhoe and hauled off to be re-used elsewhere. There is no concrete to be removed and disposed of. The only concrete associated with the facility is a small amount which was poured behind the existing retaining wall which will remain in place during final reclamation. Because all components can easily be dismantled and removed (i.e., are not permanent), any increased costs for reclamation should be negligible. Indeed, if the iron concentrations of the mine water come back into compliance naturally, as they have always been in the past, the treatment facility might no longer be needed and could be disassembled prior to final reclamation of the minesite. Based on discussions with Division, in light of the short-term, non-permanent nature of construction of the facility, the cost of reclamation would be less than \$3000, which include demolition and disposal costs. Also, the projected operating costs for the treatment facility are as follows:

1) Daily inspection: This would involve one man inspecting the facility one time per day, 365 days per year. Each inspection would involve 2 hours per day, including 45 minutes travel to the mine from Price, 30 minutes to inspect, perform minor maintenance, and fill out the necessary reports, and 45 minutes for the return trip back to Price. The system is mechanically quite simple, consisting of a blower direct-coupled to a 20 hp electrical motor. Routine maintenance would consist of checking to see if the motor/blower assembly was running properly, greasing the blower weekly, and checking to see that the water flow is uninterrupted through the oxidizer unit and the basin spillway. Inspection reports would be filled out daily, logging the time and date of inspection, weather conditions, and general notes about the mechanical condition of the system. The existing contractor rate (as of December, 2009) for mining services in the Carbon-Emery County (Utah) area is less than \$20 / hour. $365 \text{ days/year} \times 2 \text{ hours per day} \times \$20 \text{ per hour} = \$14,600 \text{ per year}$.

2) Travel: Mileage from Price to the mine is 35 miles, or 70 miles round trip. Assuming \$0.55 per mile, the mileage cost would be $\$0.55 \text{ per mile} \times 70 \text{ miles per day} \times 365 \text{ days per year} = \$14,052 \text{ per year}$.

3) Replacement parts: According to the manufacturer, the replacement cost of the blower/motor assembly is \$3500. Units typically last for 10-15 years, but conservatively it is estimated to be replaced every five years. Therefore the annual replacement cost would be \$700.

4) Power: According to the manufacturer, the annual power (electricity) cost is about \$2500. Since the unit runs constantly the power cost is comprised entirely of energy cost, with no demand cost component.

5) Sampling analysis: This involves pre and post treatment sampling as defined in the monitoring discussion above, and assumes \$250/month x 12 months = \$3000/year

6) Cleaning costs: As demonstrated in Attachment 5, the estimated yearly volume of iron accumulation material is conservatively estimated at 8,200 cubic feet, based on a slurry ratio of 5% solids to 95% water. This equates to 61,300 gallons of slurry. Also, the company has committed to cleaning out the basin when the slurry level reaches the 7812' level, which should represent slightly over one year's worth of accumulation. Therefore, the annualized operating costs assume that the basin would be cleaned once per year. The proposed method of cleaning is by vacuuming the slurry out of the bottom of the basin directly into 6000 gallon tanker trucks. The estimated time to fill each tanker is 40 minutes. The estimated time to haul the slurry to the Wildcat Loadout is 90 minutes, the time to unload to slurry into Sediment Pond C is 30 minutes, and the return trip is 60 minutes, for a total cycle time of 220 minutes, or 3.67 hours (assume 4 hours to be safe). At 61,300 gallons of slurry, total clean-out would require eleven (11 each) truckloads. This could easily be accomplished in two 8-hour shifts utilizing four (4 each) tanker trucks, and two (2 each) laborers at the site to handle to suction line. Therefore, the projected annual operating costs are as follows:

a) truck costs	11 truckloads/yr x 4 hr/truckload x \$85/hr	\$3,740
b) labor costs	2 laborers x 16 hrs/yr x \$28/ hour	<u>\$896</u>
	Total cleaning cost	\$4,636

The total estimated yearly operating cost are as follows:

Labor	\$14,600
Travel	\$14,052
Replacement parts	\$700
Power	\$2,500
Sampling analysis	\$3,000
Clean-out cost	<u>\$4,636</u>

TOTAL \$39,488/yr = \$3,291/month

It should also be noted that at the present time (November, 2009), the Crandall Canyon Mines reclamation bond contains positive coverage for the following reasons:

1) The East Mountain Drillpads have been reclaimed and the ivision has determined that the site now qualifies for Phase 1 bond release. This bond is presently posted at \$286,196. Phase 1 release would free up 60% of this amount, or \$171,717 which could be transferred to apply to any increase resulting from the treatment facility.

2) Due to the construction of the Crandall Canyon Memorial, the upper end of the mineyard has been deeded over to Emery County, and will not be reclaimed as reflected in the current mine reclamation bond. Based on estimates previously submitted to the Division (Task #3092, April 6, 2009, reprint available on request), this should result in a reduction of the reclamation costs of the minesite by about estimated amount of \$77,798. This positive bonding re-adjustment could also be utilized to cover any increase resulting from the installation of the treatment facility.

As stated previously, the company is committed, under Division Order DO09A, to revising the final reclamation plan to include a permanent, passive treatment facility which will replace the existing one. This revised reclamation plan will include a major re-evaluation of the overall reclamation costs of the Crandall Canyon minesite, and subsequent bond re-adjustments. In light of this pending revision, and the relatively minor reclamation and operating costs associated with the existing facility, and the existing bonding excess presently in place, the company requests that bonding considerations for this existing facility be delayed temporarily and worked into the upcoming "permanent facility" revised reclamation plan and bond.

OFF-SITE IMPACTS

In early 2009 the iron concentrations in the water began to exceed UPDES limits. By the summer of 2009, Crandall Creek below the mine began to display an orange discoloration from the iron staining, resulting in violations from both DOGM and Division of Water Quality. Therefore, the company commits to perform an on-site inspection of the Crandall Creek drainage with the appropriate regulatory agencies once access is possible (late spring/early summer 2010). The purpose of the inspection will be to assess the extent of the total iron accumulations within Crandall Creek. Following the site-visit, the Division (with concurrence with the Forest Service, and consultation from other agencies) will make a determination as to what clean-up measures, if any, should be taken to remove the iron accumulations from the stream channel.

ATTACHMENT 1

MAELSTROM OXIDIZER UNIT

Home Page Accelerate Oxidation Manganese Penn Allegh Mine Sulfite Charts [Links](#)
Environmental Solutions Contact Information | E-mail |

Home / Contact Us / E-Mail /

Environmental SolutionsBreathing Life Into Polluted Water



Home Page
About The Company
Maelstrom Oxidizer
SES
Accelerate Oxidation
Penn Allegh Mine
Sulfite Charts
ROLE OF
ACCELERATED
OXIDATION FOR
REMOVAL OF METALS
FROM MINE
DRAINAGE

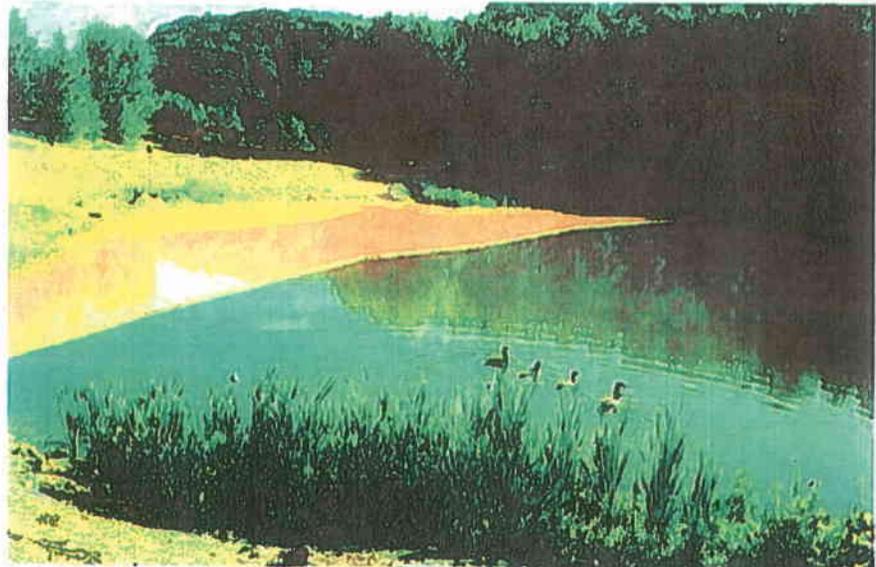
Arsenic Removal
Wilson Run
PROCESS TO
ACCELERATE THE
OXIDATION
Innovative Method to
Reduce Land Area and
Cost in the Treatment
of Acid mine Drainage

CASE HISTORY
Maelstrom Oxidizer
Sulfite Elimination
System
Maelstrom Oxidizer
Advantage for the
Treatment of
Manganese
Links

Index
No Limitations
Maelstrom Oxidizer
Canterbury Mine
Maple Creek Mine

Environmental Solutions

Breathing Life Into Polluted Waters



Environmental Solutions LLC has patents on an apparatus and method for transferring mass quantities of oxygen into a liquid to oxidize and precipitate metals. This apparatus, the Maelstrom Oxidizer, will precipitate all hazardous metals of concern. Iron, lead, zinc, cadmium, manganese, magnesium and copper are examples. Arsenic can also be removed. The process can be used wherever oxygen transfer into liquids is necessary for cost effective treatment. The process is also effective for removal of gasses such as carbon dioxide and Ammonia Nitrogen and for conversion of sulfite into sulfate.

Individual Maelstrom Oxidizer systems are designed specifically for volume of flow and metals content. Size and system requirements are determined by on site testing. On occasion, modifications and catalysts are required for economical treatment. This is also determined by on site testing.

There are no limitations on volume of flow or metals content

Home Page **AMD Treat** **Oxidation** **Manganese** **Penn Allegheny** **Water** **Land** **Money**
Charts **Graphs** **and**
Pictures

Maelstrom Oxidizer
Canterbury Mine

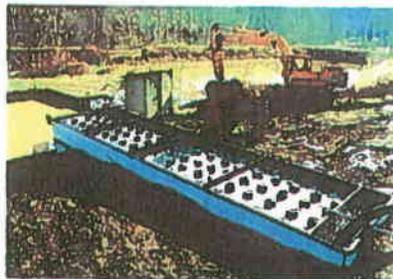
©2009 Environmental
Solutions

These Valuable resources are being squandered needlessly in the treatment of Acid Mine Drainage.

Treated water can be purer; land area can be smaller; costs can be lower.

Oxidation is the means to conserve these resources. Oxidation precipitates metals from the Acid Mine Drainage at a lower pH. Ferrous iron is precipitated as ferric hydroxide rather than ferrous hydroxide. Sludge is denser; less voluminous.

The Maelstrom Oxidizer is an apparatus and method for mass transfer of oxygen into a liquid to strip carbon dioxide and to oxidize and precipitate metals.



Photos are of an installation that's treats 720,000 gallons per day of net alkaline Acid Mine Drainage that contains 105 mg/l of iron. Effluent meets NPDES and Pa. DEP discharge limitations. No chemicals are used in the treatment. Land area is twenty times smaller than recommended for passive systems.

Life Cycle Costs (25 years), calculated with the computer program AMDTreat, are 69% lower than for a passive aerobic wetland. This program was developed jointly by the US Office of Surface Mining (OSM), Pa. DEP and the W. Virginia DEP.

Acidic water can be treated by the system by combining it with an anoxic limestone drain. Chemical reagent can also be introduced and mixed within the system chambers. The Maelstrom is a gravity flow system. There are no limitations on flow volume, total acidity or metals content. The system can be designed for new systems or can be retrofitted into existing systems.

WATER-----Effluent meets federal and state regulations.

LAND-----Treatment area can be reduced by a factor of 10 or more

[Home Page](#) [Accelerate Oxidation](#) [Manganese](#) [Penn Allegh Mine](#) [Sinks](#) [Links](#) **MONEY - Costs can be reduced 50% or more**

Don Budelt, Environmental Solutions LLC

314 Polo Club Drive; Moon Township, Pa. 15108----412 262-2606

environmentalsolutions@comcast.net

The Maelstrom Oxidizer is a proven innovative process

Penn Allegh Mine---Pennsylvania

Net alkaline pH 6.5 water containing 105 mg/l iron

Effluent is 0.6 mg/l in all seasons without chemical addition

Settling area is 13 to 26 times less than required for passive treatment

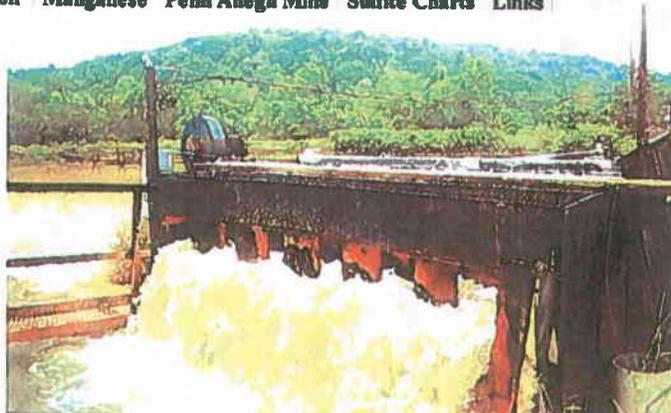
Maelstrom Oxidizer system monitored by Pa. DEP for six years

Never in violation of NPDES Permits

This installation was documented in a paper titled "Innovative Method to Reduce Land area and Cost in the Treatment of Acid Mine Drainage" presented at the National Association of Abandoned Mine Lands Conference at Ohio University 2001.

Canterbury Mine---Pennsylvania

This mine site owned by Murray Energy has near alkaline water but contains both Iron and Manganese. The Maelstrom Oxidizer replaced an existing aeration system. Chemical costs were reduced 41%. The system transferred oxygen in an initial chamber prior to chemical addition in a subsequent chamber. This degassing of carbon dioxide raised the pH and resulted in additional chemical savings.



Maple Creek Mine—Pennsylvania

This Pennsylvania Mine has acidic water with a pH of 3.1. Total iron is 1800 milligrams per liter. The treatment flow is 1850 liters per minute (500 gallons) per minute. Oxygen saturation had to be replenished 28 times every minute to oxidize all of the iron to meet discharge limitations. The 15 horse power blower supplied the oxygen demand of 64 pounds per hour. This relates to more than 4 pounds of oxygen per horse power hour. Sodium Hydroxide was used to increase pH. In Figure 1, the water is turning green in the first reaction chamber. As it leaves the second reaction chamber 15 seconds later, it is already brown from the oxidation of the iron.

Figure 1 Maple Creek Mine Maelstrom Oxidizer.

ATTACHMENT 2

- 1) IRON TREATMENT BENCH TEST RESULTS
- 2) SETTLING BASIN VOLUME DETERMINATION

Environmental Solutions LLC receive raw water from the Utah site on Saturday August 29. These are the results of our testing of that water.

Raw water

6.97 pH

Dissolved Iron 0.79 mg/l

Total Iron 2.16 mg/l

This water was processed through a Maelstrom Oxidizer test unit with results as follows:

pH 8.17

5.5 hour settle time

Dissolved Iron 0.00 mg/l

Total Iron 0.52 mg/l

The increase from 6.97 mg/l to 8.17 mg/l was due to the out gassing of carbon dioxide in the Maelstrom Oxidizer. The pH increase was within one minute of processing. It is important in the treatment of mine drainage because each .5 increase in pH increases the oxidation rate of iron 10 times. A full point increases the oxidation rate 100 times. Any dissolved iron remaining in water cannot precipitate and is discharged as total iron.

These results are without the addition of chemical reagents or polymers.

Currently the raw water contains low amounts of iron but the amount seems to be steadily increasing. The proposed Maelstrom Oxidizer is capable of treating your maximum flows with iron in the hundreds of mg/l.

Don Budeit, President

Environmental Solutions LLC

Dave Shaver:

I have previously sent you the results of our in house testing. Water from the Crandall Canyon site was processed through a Maelstrom Oxidizer test unit. You will note that the raw water pH increased from 6.97 pH to 8.17 pH without the addition of any chemical reagent. The increase was due to out gassing of carbon dioxide in the Maelstrom Oxidizer unit. Each 0.5 increase in pH will increase the oxidation rate of iron ten times. A 1 point increase in pH increases the oxidation rate 100 times. Any dissolved iron in the raw water will be oxidized and precipitated in 36 seconds. In our in house testing, all iron was oxidized and settled out in 5.5 hours. Water leaving the oxidizer unit should settle out in the pond area as shown on your plan. You show an area of approximately 38,500 cubic feet equal to 288,000 gallons. At a treatment flow of 600 gallons per minute, retention time in your pond will be approximately 8 hours. According to in house testing, the area should be adequate for your flows.

Don Budeit, President

Environmental Solutions LLC

environmentalsolutions@comcast.net

412 262 2606

Cell 412 606 8283

SETTLING BASIN VOLUME DETERMINATION

1) Continuous flow readings from September 9, 2009 through October 27, 2009 have been taken on a daily basis. The cumulative flow over this 48 day time period was 33,249,830 gallons. This equates to 692,704 gal/day = 481 gal/min. The instantaneous readings ranged between a low of 314 gpm to a high of 1033 gpm. The average instantaneous reading was 491 gpm, which agrees closely with the cumulative average of 481 gpm. Therefore, the design parameter for the treatment facility was chosen at 500 gpm.

2) Based on the bench test conducted by the manufacturer of the oxidizer unit (see Attachment 2) compliance levels of iron reduction was achieved with a 5.5 hr retention (settling) time, without the use of chemical flocculants or coagulants.

3) Therefore, the manufacturer's recommended settling basin volume is:

$$5.5 \text{ hrs} \times 500 \text{ gal/min} \times 60 \text{ min/hr} = 165,000 \text{ gal}$$

4) Based on computer generated volumetrics, the proposed settling basin has a volume of 288,000 gallons. Therefore, the settling basin is $288,000/165,000 = 1.75$ times bigger than the manufacturer's recommendation. Actual usable settling volume (freeboard) will gradually decrease as accumulation material settles in the bottom of the basin.

5) However, if during operation of the facility, it is determined that additional settling is needed, a chemical coagulant and/or flocculant can be added. The oxidizer unit has been modified to allow easy addition of a chemical injection system in the future. These chemicals dramatically increase the settling rate of the iron particulates.

ATTACHMENT 3

PIT LINER INFORMATION

NOVA-THENE[®]

WOVEN POLYOLEFIN FABRICS

RB8-6

DATA SHEET

A heavy duty fabric designed for protective covers, haystack covers, pit and pond liners and pool covers.

FABRIC SPECIFICATIONS

WEAVE Woven black HDPE scrim using 1600 denier tapes
COATING 1.75 mil average, two sides (41 g/m², two sides)
COLOUR Black or coloured coatings available
silver/black available from stock
WEIGHT 6.0 oz/yd² (203 g/m²) +/- 10%

PERFORMANCE

GRAB TENSILE	Warp 210 lb 933 N	Weft 180 lb 801 N	ASTM D5094
TONGUE TEAR	Warp 70 lb 311 N	Weft 70 lb 311 N	ASTM D2261
MULLEN BURST	370 psi 2553 kPa		ASTM D3786
ACCELERATED UV WEATHERING ¹	> 80 % strength after 2000 hrs		ASTM G53

¹ Q.U.V. [A-340 Lamps]: 8 hrs UV @ 60° C, 4 hrs condensation @ 50° C

ROLL SPECIFICATIONS

CORES 4 inch (101.6 mm) or 5 inch (127 mm) I.D.
WIDTH Up to 150 inches (-0, +0.5) as ordered, 3.81 m (-0, +12 mm), 144" (3.66 m)
available from stock
LENGTH Minimum 500 yds/roll (457 m); up to 1000 yds/roll (914 m)

These values are typical data and are not intended as limiting specifications.

DM2005(RB8-6)
Rev 5 01/01/05

intertape polymer group

P.O. Box 868, 50 Abbey Avenue, Truro, Nova Scotia, Canada B2N 5G6 Tel: 800-565-2000 Fax: 902 893-0220

ATTACHMENT 4

WILDCAT SEDIMENT POND C
VOLUME DETERMINATION



From: Dan Guy
Subject: Excess Volume in Pond C at the Wildcat Loadout
Date: June 2, 2009

Per your request, I have checked the required and actual volumes for Pond C at the Wildcat Loadout. I have also evaluated the Stage-Volume information to determine the maximum level to which the pond could be filled and still retain the required volume for the 10-year, 24-hour storm event. All information is based on the attached Tables 9 and 17, which represent the latest information on this pond.

Based on Table 9, the required pond volume for Pond C is 1.836 ac. ft., and the actual pond volume is 4.732 ac. ft., leaving an excess volume of 2.896 ac. ft. at the principle spillway. On Table 17 (Stage-Volume), the principle spillway is at an elevation of 6137.0. Based on the stage-volume information, the pond could be filled to within 3' of the principle spillway, to an elevation of 6134.0, and still have 2.155 ac. ft. of capacity or 0.319 ac. ft. in excess of that required for the 10-year, 24-hour event. This would allow for placement of approximately 2.577 ac. ft. of material into the pond. This is the maximum elevation I would recommend for adding material to the pond, since it still provides a safety factor for the design storm.



TABLE 9
SEDIMENT POND "C" DESIGN

1-	Use 1.85" for 10 year - 24 hour event.		
2-	Disturbed Area Draining to Pond = 18.43 acres.		
3-	Runoff Curve Number = CN = 90 (Disturbed)		
4-	Disturbed Area Runoff = (From Table 2, 10 yr./24 hr.)	=	<u>1.490 ac.ft.</u>
5-	Sediment Storage Volume USLE - 0.213	=	<u>0.213 ac.ft.</u>
6-	Direct Precipitation into Pond 0.86 acres x 1.85" / 12 in./ft.	=	<u>0.133 ac.ft.</u>
7-	Total Required Pond Volume 1.490 + 0.213 + 0.133	=	<u>1.836 ac.ft.</u>
*8-	Pond Actual Volume at Principal Spillway	=	<u>4.732 ac.ft.</u>
9-	Peak Flow (25 year - 6 hour event)	=	<u>10.99 cfs</u>

* Existing.

TABLE 17
SEDIMENT POND "C"
STAGE VOLUME DATA (AS-CONSTRUCTED)

Elevation	Area (ft²)	Volume (ac. ft.)	Acc. Volume (ac. ft.)	Remarks
6127.7	804.3	0	0	Bottom of Pond
6130.0	18,075.7	0.498	0.498	
6131.5	-	0.700	1.198	Sediment Cleanout Level
6132.0	22,596.8	0.234	1.432	
6134.0	27,274.0	1.145	2.577	
6136.0	32,557.0	1.374	3.951	
6137.0	35,481.1	0.781	4.732	Principal Spillway
6138.0	38,405.1	0.848	5.580	Emergency Spillway
6140.0	45,286.6	1.921	7.501	Crest of Dam

ATTACHMENT 5

SETTLING BASIN CLEAN-UP VOLUME
ESTIMATION

SETTLING BASIN CLEAN-UP VOLUME ESTIMATION

Based on history of non-compliance the iron level has been about 2 to 3 mg/liter (spiking on occasion to 8 mg/liter), with compliance level being 1 mg/liter. Therefore, to achieve compliance could require the removal of up to 7 mg/liter of iron

Removal of 7 mg/liter of iron from a 500 gal/min flow would result in 21 kg/day iron removal, or 33.4 k/day of iron oxide. Assuming the accumulation material which settles at the bottom of the basin is in a semi-liquid (slurry) form of 5% solids (iron oxide)-95% water, the yearly volume of accumulated sludge material would be approximately 8,200 cubic feet. The stage volumes for the settling basin are as follows:

<u>elevation</u>	<u>cumulative volume(cu ft)</u>	<u>years of storage</u>
7810'	1,487	0.18
7811'	4,429	0.54
7812'	9,105	1.11
7813'	15,856	1.93
7814'	23,241	2.83
7815'	31,055	3.78
7816' (water level)	39,135	4.77

Based on the manufacturer's bench testing, 5.5 hours of settling time is sufficient to bring the treated mine-water into UPDES compliance. Five and one half hours of discharge is equivalent to 165,000 gallons or 22,059 cubic feet. Since the total basin volume at the spillway level is 39,135 cubic feet, the available capacity of basin volume for iron accumulation over 17,000 cubic feet. As indicated by the figures above, this equates to an estimated two years of storage. Although these estimates are conservative and subject to speculative variables at this time, it seems safe to assume that the basin can hold sufficient iron accumulations to allow for a regular scheduled clean-out program.

Cleaning out the basin when the accumulations have reached a depth of 3' (i.e., at elevation 7812') would leave sufficient freeboard for adequate settling volume above the accumulations. At this level, clean-out could be expected about once per year.

According to Attachment 4, "Wildcat Pond C Volume Determination" (attached hereto), Pond C has excess capacity to store 2.577 ac-ft of material while still retaining sufficient free-board capacity for a 10-year, 24-hour storm event.

$$2.577 \text{ ac-ft} \times \frac{43560 \text{ cu ft}}{\text{ac-ft}} \times \frac{\text{year}}{8200 \text{ cu ft}} = 13.7 \text{ years}$$

Since Wildcat Loadout Sediment Pond C is in a very dry environment, it is safe to assume that the iron material will dry out soon after it is put in the pond. In this case, assuming the accumulation

material is 5% solids-95% water, the pond could hold more than 250 years worth of material. The purpose of this "quick-and-dirty" calculation is to demonstrate that there is ample reason to conclude that the volume of Wildcat Sediment Pond C is more than capable of containing the iron accumulation material from the Crandall Mine for a very long time.

ATTACHMENT 6

DRAINAGE INFORMATION

NOTE: The following pages are taken from:

APPENDIX 7-4

CRANDALL CANYON MINE, SEDIMENTATION AND
DRAINAGE CONTROL PLAN

and relate directly to the installation of the

MINE WATER DISCHARGE
IRON TREATMENT FACILITY

References are bold and underlined

*CRANDALL CANYON MINE
SEDIMENTATION AND DRAINAGE CONTROL PLAN*

TABLE OF CONTENTS

<i>SECTION</i>	<i>PAGE NUMBER</i>
<i>1- Introduction:</i>	<i>1</i>
<i>2- Design of Drainage Control Structures:</i>	<i>3</i>
<i>2.1 Precipitation</i>	<i>4</i>
<i>2.2 Flow</i>	<i>5</i>
<i>2.3 Velocity</i>	<i>6</i>
<i>2.4 Drainage Areas</i>	<i>6</i>
<i>2.5 Slope/Lengths</i>	<i>6</i>
<i>2.6 Runoff</i>	<i>7</i>
<i>2.7 Runoff Curve Numbers</i>	<i>7</i>
<i>2.8 Culvert Sizing</i>	<i>9</i>
<i>2.9 Culverts</i>	<i>9</i>
<i>2.10 Ditches</i>	<i>12</i>
<i>2.11 Main Canyon Culvert</i>	<i>14</i>
<i>2.12 Main Canyon Culvert Inlet Structure</i>	<i>16</i>
<i>2.13 Main Canyon Culvert Outlet Structure</i>	<i>16</i>
<i>3- Design of Sediment Control Structures:</i>	
<i>3.1 Design Specification for Expanded Sediment Pond</i>	<i>29</i>
<i>3.2 Sediment Yield</i>	<i>30</i>
<i>3.3 Sediment Pond Volume</i>	<i>32</i>
<i>3.4 Sediment Pond Summary</i>	<i>36</i>
<i>3.5 Alternate Sediment Control Area (ASCA's)</i>	<i>37</i>

Figures:

- Figure 1 Culvert Nomograph*
- Figure 2 Rip Rap Chart*
- Figure 3 Undisturbed and Disturbed Ditch Typical Section*
- Figure 4 Soil Erodibility Chart - Disturbed Areas*
- Figure 5 Soil Erodibility Chart - Undisturbed/Reclaimed Areas*
- Figure 6 Sediment Pond Stage-Volume Curve*
- Figure 7 Sediment Pond Stage-Discharge Curve*
- Figure 8 Reclamation Ditch RD-1 Typical Section*
- Figure 9 Runoff Curve Numbers for Forest Range*
- Figure 10 Main Canyon Culvert Inlet / Trash Barriers*
- Figure 11 Main Canyon Culvert Outlet*
- Figure 12 Typical Underdrain Construction*
- Figure 13A Installation of Re-Routed Culvert UD-3 (Front View)*
- Figure 13B Installation of Re-Routed Culvert UD-3 (Side View)*

CRANDALL CANYON MINE
SEDIMENTATION AND DRAINAGE CONTROL PLAN

hour precipitation event. All other undisturbed diversions, disturbed ditches and culverts are sized to safely convey runoff from a 10 year - 24 hour precipitation event. The sediment pond is sized to contain runoff from a 10 year - 24 hour precipitation event, as required.

- (d) The crescent-shaped area below the portals will be utilized as a water treatment facility for the mine water discharging from the mine and seeping from the slope below the portals. The plan is to divert all mine water into this area, where it will be treated with an aeration system and settling pond to reduce the iron content. Once treated, the mine water will flow into the main canyon culvert at the UPDES #002 discharge location. Calculations show a minimum 12" pipeline at a minimum grade of 3 % is more than adequate to carry the expected maximum discharge of 800 gpm or 1.78 cfs. A larger pipeline may be used. This system will be isolated from the rest of the minesite drainage by topography and jersey-barriers, and will no longer flow to the sediment pond. The location and drainage plans are shown on Plate 7-5. As a result of constructing this facility, the volume of runoff reporting to the sediment pond actually decreases by a small amount, estimated at about 0.05 ac/ft. However, since the facility may not be permanent and could be removed in the future, the runoff calculations for the affected ditches, culverts and sediment pond have not been changed to reflect any resulting decrease.*
- (e) When the Crandall Canyon Mine Portals were sealed as a result of the 2007 disaster, culvert system UD-3 which diverts undisturbed drainage area WSUD-3, was damaged beyond repair. Therefore it was decided to re-route UD-3 as shown on Figures 13A and 13B. Culvert UD-3 now reports to Disturbed Ditch DD-8, Culvert C-1, Disturbed Ditch DD-5, Culvert C-12 and ultimately into the Sediment Pond. Calculations show that all affected ditches, culverts and the Sediment Pond are adequately sized to handle the increased flow from WSUD-3 (See Tables 3, 5, 6, 7 and 11).*

CRANDALL CANYON MINE
 SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 1
 WATERSHED SUMMARY

<i>Watershed</i>	<i>Type</i>	<i>CN</i>	<i>Acres</i>	<i>Drains To</i>	<i>Final</i>
<i>Crandall</i>	<i>Undisturbed</i>	<i>69</i>	<i>3480.00</i>	<i>Main Culvert</i>	- <i>Crandall Creek</i>
<i>WSUD-1</i>	<i>Undisturbed</i>	<i>69</i>	<i>84.88</i>	<i>Culvert UD-1</i>	- <i>Crandall Creek</i>
<i>WSUD-2</i>	<i>Undisturbed</i>	<i>69</i>	<i>1.39</i>	<i>Ditch UD-2</i>	- <i>Culvert UD-1</i>
<i>WSUD-3</i>	<i>Undisturbed</i>	<i>69</i>	<i>8.66</i>	<i>Culvert UD-3</i>	- <i>Sediment Pond</i>
<i>WSDD-1</i>	<i>Undisturbed</i>	<i>69</i>	<i>0.14</i>	<i>Ditch DD-1</i>	- <i>Sediment Pond</i>
<i>WSDD-1</i>	<i>Reclaimed</i>	<i>75</i>	<i>0.08</i>	<i>Ditch DD-1</i>	- <i>Sediment Pond</i>
<i>WSDD-2</i>	<i>Reclaimed</i>	<i>75</i>	<i>0.15</i>	<i>Ditch DD-1</i>	- <i>Sediment Pond</i>
<i>WSDD-3</i>	<i>Undisturbed</i>	<i>69</i>	<i>0.13</i>	<i>Ditch DD-3</i>	- <i>Sediment Pond</i>
<i>WSDD-3</i>	<i>Reclaimed</i>	<i>75</i>	<i>0.15</i>	<i>Ditch DD-3</i>	- <i>Sediment Pond</i>
<i>WSDD-3</i>	<i>Disturbed</i>	<i>90</i>	<i>0.26</i>	<i>Ditch DD-3</i>	- <i>Sediment Pond</i>
<i>WSDD-3</i>	<i>Paved</i>	<i>95</i>	<i>0.33</i>	<i>Ditch DD-3</i>	- <i>Sediment Pond</i>
<i>WSDD-4</i>	<i>Paved Road</i>	<i>95</i>	<i>0.11</i>	<i>Ditch DD-4</i>	- <i>Sediment Pond</i>
<i>WSDD-4</i>	<i>Disturbed</i>	<i>90</i>	<i>0.08</i>	<i>Ditch DD-4</i>	- <i>Sediment Pond</i>
<i>WSDD-5</i>	<i>Undisturbed</i>	<i>69</i>	<i>0.12</i>	<i>Ditch DD-5</i>	- <i>Sediment Pond</i>
<i>WSDD-5</i>	<i>Reclaimed</i>	<i>75</i>	<i>0.33</i>	<i>Ditch DD-5</i>	- <i>Sediment Pond</i>
<i>WSDD-5</i>	<i>Paved Road</i>	<i>95</i>	<i>0.33</i>	<i>Ditch DD-5</i>	- <i>Sediment Pond</i>
<i>WSDD-7</i>	<i>Undisturbed</i>	<i>69</i>	<i>0.18</i>	<i>Ditch DD-7</i>	- <i>Sediment Pond</i>
<i>WSDD-7</i>	<i>Disturbed</i>	<i>90</i>	<i>0.17</i>	<i>Ditch DD-7</i>	- <i>Sediment Pond</i>
<i>WSDD-7</i>	<i>Paved Road</i>	<i>95</i>	<i>0.09</i>	<i>Ditch DD-7</i>	- <i>Sediment Pond</i>
<i>WSDD-8</i>	<i>Undisturbed</i>	<i>69</i>	<i>3.59</i>	<i>Ditch DD-8</i>	- <i>Sediment Pond</i>
<i>WSDD-8</i>	<i>Reclaimed</i>	<i>75</i>	<i>0.15</i>	<i>Ditch DD-8</i>	- <i>Sediment Pond</i>
<i>WSDD-8</i>	<i>Disturbed</i>	<i>90</i>	<i>0.37</i>	<i>Ditch DD-8</i>	- <i>Sediment Pond</i>
<i>WSDD-8</i>	<i>Paved Road</i>	<i>95</i>	<i>0.25</i>	<i>Ditch DD-8</i>	- <i>Sediment Pond</i>
<i>WSDD-10</i>	<i>Undisturbed</i>	<i>69</i>	<i>0.07</i>	<i>Ditch DD-10</i>	- <i>Sediment Pond</i>
<i>WSDD-10</i>	<i>Reclaimed</i>	<i>75</i>	<i>0.12</i>	<i>Ditch DD-10</i>	- <i>Sediment Pond</i>
<i>WSDD-10</i>	<i>Disturbed</i>	<i>90</i>	<i>0.61</i>	<i>Ditch DD-10</i>	- <i>Sediment Pond</i>
<i>WSDD-10</i>	<i>Paved Road</i>	<i>95</i>	<i>0.27</i>	<i>Ditch DD-10</i>	- <i>Sediment Pond</i>
<i>WSDD-11</i>	<i>Undisturbed</i>	<i>69</i>	<i>2.09</i>	<i>Ditch DD-11</i>	- <i>Sediment Pond</i>
<i>WSDD-11</i>	<i>Reclaimed</i>	<i>75</i>	<i>0.15</i>	<i>Ditch DD-11</i>	- <i>Sediment Pond</i>
<i>WSDD-11</i>	<i>Disturbed</i>	<i>90</i>	<i>0.04</i>	<i>Ditch DD-11</i>	- <i>Sediment Pond</i>
<i>WSDD-12</i>	<i>Undisturbed</i>	<i>60</i>	<i>8.82</i>	<i>Ditch DD-12</i>	- <i>Sediment Pond</i>
<i>WSDD-12</i>	<i>Disturbed</i>	<i>90</i>	<i>2.29</i>	<i>Ditch DD-12</i>	- <i>Sediment Pond</i>
<i>WSDD-13</i>	<i>Undisturbed</i>	<i>60</i>	<i>17.72</i>	<i>Ditch DD-13</i>	- <i>Sediment Pond</i>
<i>WSDD-13</i>	<i>Disturbed</i>	<i>90</i>	<i>3.70</i>	<i>Ditch DD-13</i>	- <i>Sediment Pond</i>
<i>WSDD-13</i>	<i>Paved</i>	<i>95</i>	<i>0.27</i>	<i>Ditch DD-13</i>	- <i>Sediment Pond</i>
<i>WSDD-14</i>	<i>Disturbed</i>	<i>90</i>	<i>0.89</i>	<i>Sediment Pond</i>	- <i>Sediment Pond</i>
<i>WSDD-14</i>	<i>Undisturbed</i>	<i>60</i>	<i>0.78</i>	<i>Sediment Pond</i>	- <i>Sediment Pond</i>
<i>WSDD-14</i>	<i>Paved</i>	<i>95</i>	<i>0.02</i>	<i>Sediment Pond</i>	- <i>Sediment Pond</i>
<i>WSDD-15</i>	<i>Paved</i>	<i>95</i>	<i>0.09</i>	<i>Ditch DD-7</i>	- <i>Sediment Pond</i>

CRANDALL CANYON MINE
 SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 4
 RUNOFF SUMMARY
 DRAINAGE TO SEDIMENT POND

<i>Watershed</i>	<i>Type</i>	<i>10 year/24 hour Volume-ac.ft.</i>	<i>10 year/24 hour Peak Flow-cfs</i>	<i>10 year/6 hour Peak Flow-cfs</i>	<i>25 year/6 hour Peak Flow-cfs</i>
WSDD-1	Undisturbed	0.02	0.10	0.04	0.06
WSDD-1	Reclaimed	0.01	0.04	0.01	0.01
WSDD-2	Reclaimed	0.01	0.06	0.01	0.03
WSDD-3	Undisturbed	0.00	0.03	0.00	0.01
WSDD-3	Reclaimed	0.01	0.05	0.01	0.02
WSDD-3	Disturbed	0.03	0.18	0.08	0.12
WSDD-3	Paved	0.05	0.32	0.17	0.22
WSDD-4	Paved	0.02	0.12	0.07	0.09
WSDD-4	Disturbed	0.01	0.08	0.04	0.05
WSDD-5	Undisturbed	0.00	0.03	0.00	0.01
WSDD-5	Reclaimed	0.02	0.10	0.02	0.04
WSDD-5	Paved	0.05	0.39	0.21	0.27
WSDD-7	Undisturbed	0.01	0.05	0.00	0.01
WSDD-7	Disturbed	0.02	0.12	0.05	0.07
WSUD-3	Undisturbed	0.30	1.40	0.23	0.43
WSDD-8	Undisturbed	0.13	0.75	0.10	0.20
WSDD-8	Reclaimed	0.01	0.05	0.01	0.02
WSDD-8	Disturbed	0.05	0.23	0.10	0.14
WSDD-8	Paved	0.04	0.37	0.20	0.26
WSDD-10	Undisturbed	0.00	0.03	0.00	0.01
WSDD-10	Reclaimed	0.01	0.03	0.01	0.01
WSDD-10	Disturbed	0.08	0.42	0.19	0.27
WSDD-10	Paved	0.04	0.35	0.19	0.24
WSDD-11	Undisturbed	0.07	0.47	0.06	0.12
WSDD-11	Reclaimed	0.01	0.04	0.01	0.02
WSDD-11	Disturbed	0.01	0.06	0.03	0.04
WSDD-12	Undisturbed	0.13	0.25	0.04	0.16
WSDD-12	Disturbed	0.29	3.33	1.51	2.10
WSDD-13	Undisturbed	0.26	0.49	0.07	0.30
WSDD-13	Disturbed	0.47	5.39	2.44	3.39
WSDD-13	Paved	0.04	0.20	0.11	0.14
WSDD-14	Disturbed	0.11	0.78	0.35	0.49
WSDD-14	Undisturbed	0.01	0.03	0.00	0.02
WSDD-14	Paved	0.02	0.07	0.04	0.05
WSDD-15	Paved	0.02	0.11	0.06	0.08
Totals		2.36	16.53	6.46	9.50

CRANDALL CANYON MINE
 SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 5
 RUNOFF CONTROL STRUCTURE
 WATERSHED SUMMARY

<i>Structure</i>	<i>Type</i>	<i>Contributing Watersheds</i>
<i>Main Culvert</i>	<i>Culvert</i>	<i>Crandall Canyon Above Mine</i>
<i>UD-1</i>	<i>Culvert</i>	<i>WSUD-1</i>
<i>UD-2</i>	<i>Culvert</i>	<i>WSUD-2</i>
<i>UD-3</i>	<i>Culvert</i>	<i>WSUD-3</i>
<i>DD-1</i>	<i>Ditch</i>	<i>WSDD-1, WSDD-2</i>
<i>DD-3</i>	<i>Ditch</i>	<i>WSDD-1, WSDD-2, WSDD-3</i>
<i>DD-4</i>	<i>Ditch</i>	<i>WSDD-1, WSDD-2, WSDD-3, WSDD-4, WSDD-8, WSDD-12</i>
<i>DD-5</i>	<i>Ditch</i>	<i>WSDD-1, WSDD-2, WSDD-3, WSDD-4, WSDD-5, WSDD-8, WSDD-12</i>
<i>DD-7</i>	<i>Ditch</i>	<i>WSDD-7, WSDD-11</i>
<i>DD-8</i>	<i>Ditch</i>	<i>WSDD-8, WSUD-3</i>
<i>DD-10</i>	<i>Ditch</i>	<i>WSDD-10 + Mine Water</i>
<i>DD-11</i>	<i>Ditch</i>	<i>WSDD-11</i>
<i>DD-12</i>	<i>Ditch</i>	<i>WSDD-12</i>
<i>DD-13</i>	<i>Ditch</i>	<i>WSDD-13</i>
<i>DD-14</i>	<i>Sheet Flow</i>	<i>WSDD-14</i>
<i>C-1</i>	<i>Culvert</i>	<i>WSDD-1, WSDD-2, WSDD-3, WSDD-8</i>
<i>C-3</i>	<i>Culvert</i>	<i>WSDD-7, WSDD-11, WSDD-15</i>
<i>C-4</i>	<i>Culvert</i>	<i>WSDD-10 + Mine Water</i>
<i>C-5</i>	<i>Culvert</i>	<i>WSDD-11</i>
<i>C-6</i>	<i>Culvert</i>	<i>WSUD-2</i>
<i>C-7</i>	<i>Culvert</i>	<i>WSDD-1, WSDD-2, WSDD-3</i>
<i>C-9</i>	<i>Culvert</i>	<i>WSDD-4, WSDD-12</i>
<i>C-11</i>	<i>Culvert</i>	<i>WSDD-12</i>
<i>C-11A</i>	<i>Culvert</i>	<i>WSDD-12</i>
<i>C-12</i>	<i>Culvert</i>	<i>WSDD-1, 2, 3, 4, 5, 8, 12</i>
<i>C-13</i>	<i>Culvert</i>	<i>WSDD-13</i>
<i>C-14</i>	<i>Slot Culvert</i>	<i>WSDD-4</i>
<i>C-15</i>	<i>Slot Culvert</i>	<i>WSDD-15</i>
<i>C-16</i>	<i>Culvert</i>	<i>WSDD-13</i>
<i>C-17</i>	<i>Culvert</i>	<i>WSDD-13</i>
<i>Sediment Pond</i>	<i>Pond</i>	<i>WSDD-1, 2, 3, 4, 5, 7, 8, 10, 11, 12, 13, 14, WSUD-3</i>

CRANDALL CANYON MINE
 SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 6
 RUNOFF CONTROL STRUCTURE
 FLOW SUMMARY

Structure	Type	10 year/6 hour Peak Flow-cfs	10 year/24 hour Peak Flow-cfs	25 year/6 hour Peak Flow-cfs	100 year/6 hour Peak Flow-cfs
Main Culvert	Culvert	-	-	-	222.79
UD-1	Culvert	1.91	-	3.68	6.81
UD-2	Ditch	0.04	-	0.08	0.21
UD-3	Culvert	0.23	-	0.43	0.89
DD-1	Ditch	0.06	0.20	0.10	-
DD-3	Ditch	0.32	0.78	0.47	-
DD-4	Ditch	2.39	5.96	3.49	-
DD-5	Ditch	2.85	7.88	4.24	-
DD-7	Ditch	0.21	0.85	0.34	-
DD-8	Ditch	0.64	2.80	1.05	-
DD-10	Ditch	2.62	3.06	2.76	-
DD-11	Ditch	0.10	0.57	0.18	-
DD-12	Ditch	1.55	3.58	2.26	-
DD-13	Ditch	2.62	6.08	3.83	-
DD-14	Sht Flw	0.39	0.88	0.56	-
C-1	Culvert	0.96	3.58	1.52	-
C-3	Culvert	0.21	0.85	0.34	-
C-4	Culvert	2.62	3.06	2.76	-
C-5	Culvert	0.10	0.57	0.18	-
C-6	Culvert	0.04	-	0.08	-
C-7	Culvert	0.32	0.78	0.47	-
C-9	Culvert	0.11	0.20	0.14	-
C-11	Culvert	1.55	3.58	2.26	-
C-11A	Culvert	1.55	3.58	2.26	-
C-12	Culvert	2.85	7.36	3.92	-
C-13	Culvert	2.62	6.08	3.83	-
C-14	Slot Cul.	0.11	0.20	0.14	-
C-15	Slot Cul.	0.06	0.11	0.08	-
C-16	Culvert	2.62	6.08	3.83	-
C-17	Culvert	2.62	6.08	3.83	-
Sediment Pond	Pond	6.46	16.53	9.50	-

TABLE 7
 DISTURBED DITCH DESIGN SUMMARY

<i>Ditch</i>	<i>DD-1</i>	<i>DD-3</i>	<i>DD-4</i>	<i>DD-5</i>	<i>DD-7</i>	<i>DD-8</i>	<i>DD-10</i>
<i>Slope (%)</i>	30.77	3.00	11.91	4.50	3.33	3.59	3.33
<i>Length (ft.)</i>	130	75	168	628	142	557	70
<i>Manning's No.</i>	0.035	0.035	0.035	0.035	0.035	0.035	0.035
<i>Side Slope (H:V)</i>	1:1	1:1	1:1	1:1	1:1	1:1	1:1
<i>*Bottom Width (ft.)</i>	0	0	0	0	0	0	0
<i>Peak Flow 10/6 (cfs)</i>	0.06	0.32	2.39	2.85	0.21	0.64	2.62**
<i>Peak Flow 10/24 (cfs)</i>	0.20	0.78	5.96	7.88	0.85	2.80	3.06**
<i>Flow Depth (ft.) 10/6</i>	0.14	0.40	0.66	0.84	0.33	0.50	0.86
<i>Flow Depth (ft.) 10/24</i>	0.22	0.56	0.92	1.23	0.57	0.87	0.92
<i>Flow Area (ft²)10/6</i>	0.02	0.16	0.43	0.71	0.11	0.25	0.75
<i>Flow Area (ft²)10/24</i>	0.05	0.31	0.85	1.52	0.32	0.76	0.84
<i>Velocity (fps)10/6</i>	3.15	2.00	5.55	4.02	1.87	2.55	3.51
<i>Velocity (fps) 10/24</i>	4.26	2.50	6.97	5.19	2.66	3.68	3.65
<i>Rip-Rap Req'd (Y/N)</i>	N	N	Y	N	N	N	N
<i>Rip-Rap D₅₀</i>	-	-	6"	-	-	-	-

* All ditches are triangular.

** Flows include 1000 gpm (2.23 cfs) Mine Water Flow.

Note: Slope/Lengths from Plate 7-5.

CRANDALL CANYON MINE
SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 9
DISTURBED CULVERT DESIGN SUMMARY

Culvert	C-1	C-3	C-4	C-5	C-6	C-7	C-9	C-11	C-11A	C-12	C-13	C-14	C-15	C-16	C-17
Slope (%)	16.67	8.00	25.07	57.14	17.20	3.00	3.50	3.50	1.50	4.50	3.00	1.00	1.00	25.00	20.0
Length (ft.)	60	360	69	120	12	80	18	30	60	330	100	40	30	40	60
Manning's No.	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
Peak Flow 10/6 (cfs)	0.96	0.21	2.62*	0.10	0.04	0.32	0.11	1.55	1.55	2.85	2.62	0.11	0.06	2.62	2.62
Peak Flow 10/24 (cfs)	3.58	0.85	3.06*	0.57	N/A	0.78	0.20	3.58	3.58	7.36	6.08	0.20	0.11	6.08	6.08
Min. Diam. Req'd (ft.) 10/6	0.42	0.28	0.57	0.14	0.13	0.39	0.25	0.68	0.80	0.82	0.85	0.32	0.25	0.57	0.60
Min. Diam. Req'd (ft.) 10/24	0.69	0.46	0.61	0.28	N/A	0.54	0.32	0.93	1.09	1.16	1.17	0.40	0.32	0.79	0.82
Diam. Installed (ft.)	1.50	2.00	2.00	1.00	1.00	1.00	1.00	1.50	1.50	2.00	2.00	1.00	1.00	1.67	1.50
Velocity (fps) 10/6	6.80	3.53	10.18	6.13	3.11	2.71	2.20	4.27	3.10	5.46	4.59	1.38	1.18	10.17	9.35
Velocity (fps) 10/24	9.44	5.01	10.58	9.47	N/A	3.39	2.56	5.26	3.83	6.92	5.67	1.60	1.38	12.55	11.5
Rip-Rap D_{50}	12"	-	12"	6"	-	-	-	-	-	6"	-	-	-	12"	12"

* Includes 1000 gpm (2.23 cfs) Mine Water Flow.

Note: Slope/Lengths from Plate 7-5.

Source: (Haestad Methods, Flowmaster I, Version 3.42)

TABLE 10
 UNDISTURBED CULVERT DESIGN SUMMARY

<i>Culvert</i>	<i>*Main Canyon</i>	<i>UD-1</i>	<i>UD-3</i>
<i>Slope (%)</i>	8.00	23.33	30.00
<i>Length (ft.)</i>	1500	270	50'
<i>Manning's No.</i>	0.02	0.02	0.02
<i>Peak Flow 100/6 (cfs)</i>	222.79	-	-
<i>Peak Flow 10/6 (cfs)</i>	-	1.91	0.23
<i>Min. Diam. Req'd (ft.)</i>	3.75	0.52	0.22
<i>Diam. Installed (ft.)</i>	6.00	3.50	1.00
<i>Velocity (fps)</i>	20.14	9.16	5.93

* Culvert to be installed under expansion plan.
 All other undisturbed culverts are existing.

Note: Slope/Lengths from Plate 7-5.

Source: (Haestad Methods, Flowmaster I, Version 3.43)

Variable "CP" is the control practice factor, which can be divided into a cover and practice factor. Values were determined from Appendix 5A, Barfield, et.al., 1983.

Site	CP Factor
Disturbed Areas	1.20
Reclaimed Areas	0.100
Undisturbed Areas	0.003

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

SEDIMENT YIELD CALCULATIONS - USLE

Drainage	R	K	Acres	Slope Length Feet	%	LS	CP	A*	Yield**
Undisturbed	27.00	0.15	42.25	1700	53	79.60	0.003	00.967	0.019
Reclaimed	27.00	0.15	1.22	90	52	17.81	0.10	07.213	0.004
Disturbed	27.00	0.06	8.92	350	26	11.69	1.200	22.725	0.093

Total Sediment 1 year (ac.ft.) 0.116

Total Sediment 3 years (ac. ft.) 0.348

* A = tons/acre-year

** Yield = acre-ft/year

3.3 Sediment Pond Volume

The volumes shown in Table 11 are from the volumes calculated from the precipitation, runoff and sediment yield for a 10 year-24 hour precipitation event. The volumes were calculated based on the disturbed areas (and contributing undisturbed areas) runoff values, developed using the design parameters described in this section.

The sediment pond has been reconstructed, and the sediment pond volumes on Table 11, Table 12 and Figure 6 all represent the "As-Constructed" pond.

Mine Water

There may be times that the mine water oxidizer must be shut down for repair or cleaning, at which time the mine discharge water will need to bypass the treatment system. In such a case, the water will be directed to temporarily run down the road around the outside of the basin, and into the sediment pond through ditch DD-10 and existing culvert C-4 located below the treatment facility. Assuming the sediment level in the pond is below the approved clean-out level (7769'), and assuming the pond has been previously decanted under approved UPDES discharge criteria, the remaining capacity in the sediment pond is 3.22 ac. ft., as described in Table 12. The required freeboard for a 10 year -24 hour event is 2.452 ac. ft. (2.36 ac. ft. runoff + 0.092 ac. ft. direct precipitation) leaving a usable volume of 0.771 ac. ft. for the purpose of the above bypass. This equates to approximately 251,000 gallons. At an average flow rate of 500 gpm from the mine, the sediment pond could theoretically contain 8.37 hours worth of by-passed mine water in addition to the required 10 year - 24 hour storm event. The maximum amount of by-passed mine water storage would occur at a volume of 1.061 ac. ft. (0.290 acre-feet sediment level plus 0.771 acre-feet of mine water). As shown on Table 12, this volume would occur at elevation of 7773.2.

TABLE 11
SEDIMENT POND DESIGN

1. Use 2.50" for 10 year-24 hour event.	
2. Runoff Volume (from Table 4, 10 yr/24 hr) =	<u>2.360 ac. ft.</u>
3. Sediment Storage Volume	
USLE 0.116 ac.ft./yr. x 3 yrs. =	<u>0.348 ac. ft.</u>
4. Direct Precipitation into Pond	
0.441 acres x 2.50" / 12 in./ft. =	<u>0.092 ac. ft.</u>
5. Total Required Pond Volume	
2.360 + 0.348 + 0.092 =	<u>2.800 ac. ft.</u>
6.* Peak Flow (25 yr. - 6 hr. event) =	<u>9.500 cfs</u>
7. Pond Design Volume @ Principle Spillway = (See Table 12)	<u>3.513 ac. ft.</u>

* Peak Flow values from Table 4.

CRANDALL CANYON MINE
 SEDIMENTATION AND DRAINAGE CONTROL PLAN

TABLE 12
 SEDIMENT POND
 STAGE / VOLUME DATA

<i>Elev.</i>	<i>Area</i>	<i>Volume</i>	<i>Acc. Volume</i> <i>(ac.ft.)</i>	<i>Remarks</i>
7766	1756.67	.0000	.0000	<i>Bottom of Pond</i>
7767	3706.92	2731.80	0.063	
7768	5119.14	4413.03	0.164	
7769	5857.00	5488.07	0.290	<i>Sediment Cleanout Level</i>
7770	6949.54	6403.32	0.437	<i>Maximum Sediment Level</i>
7771	7806.54	7378.14	0.606	
7772	8894.51	8350.53	0.798	
7773	9905.02	9399.77	1.014	
7773.2	-	-	1.061	<i>Max. Elev. of Mine Water</i>
7774	11055.91	10480.47	1.254	
7775	12153.06	11604.49	1.520	
7776	13120.22	12636.64	1.810	
7777	14084.05	13602.14	2.123	
7778	15043.33	14563.69	2.457	
7779	15984.66	15514.00	2.813	
7780	16934.94	16459.15	3.191	
7780.81	17669.26	14014.70	3.513	<i>Principal Spillway</i>
7781	17868.13	3376.05	3.591	
7781.81	18661.53	15028.20	3.936	<i>Emergency Spillway</i>
7782	18848.42	3430.08	4.012	
7783	19886.14	19367.28	4.457	
7784	21113.55	20499.85	4.927	
7785	22110.39	21611.97	5.423	<i>Top of Embankment</i>

TABLE 13
 SEDIMENT POND
 STAGE / DISCHARGE DATA

Head (ft.)	Q (cfs) Weir Controlled	Q (cfs) Orifice Controlled	Q (cfs) Pipe Flow Controlled
0.0	-	-	-
0.2	1.69	6.77	17.14
0.4	4.77	9.57	17.32
0.6	8.76	11.72	17.50
0.8	13.49	13.53	17.68
1.0	18.85	15.13	17.86

- Note: 1- 25 year-6 hour flow = 9.500 cfs.
 2- Flow will be weir controlled at a head of 0.64' over riser inlet.

Weir Controlled

$Q = CLH^{1.5}$; where : $C = 3.0$, $L = \text{Circumference of Riser} = 6.2832'$

Orifice Controlled

$Q = C'a (2gH)^{0.5}$; where : $C = 0.6$, $a = \text{Area of Riser} = 3.1416 \text{ ft}^2$, $g = 32.2 \text{ ft/sec}^2$

Pipe Flow Controlled

$Q = \frac{a (2gH')^{0.5}}{(1+K_e+K_b+K_cL)^{0.5}}$; where

- $a = \text{Area of Pipe} = 1.77 \text{ ft}^2$
- $H' = \text{Head} = H + 9.1 \text{ (At outlet of Riser)}$
- $K_e = 1.0$
- $K_b = 0.5$
- $K_c = 0.043$
- $L = 90'$

3.4 Sediment Pond Summary

- a) *The sedimentation pond has been designed to contain the disturbed area (and contributing undisturbed area) runoff from a 10 year-24 hour precipitation event, along with 3 years of sediment storage capacity. Runoff to the pond will be directed by various ditches and culverts as described in the plan.*
- b) *The required volume for the sediment pond is calculated at 2,800 acre feet, including 3 years of sediment storage. The existing sediment pond size is 3,513 acre feet (at the principle spillway), which is more than adequate.*
- c) *The pond will meet a theoretical detention time of 24 hours. It is equipped with a decant, a culvert principle spillway and an open-channel emergency spillway. Any discharge from the pond will be in accordance with the approved UPDES Permit.*
- d) *The pond inlets will be protected from erosion, and the spillway will discharge into the main Crandall Canyon drainage.*
- e) *The pond is temporary, and will be removed upon final reclamation of the property.*
- f) *The pond expansion will be constructed according to the regulations and under supervision of a Registered, Professional Engineer.*

- g) *The pond volume has been increased at the request of the Forest Service to provide a greater level of protection for forest resources located down stream from the minesite. The enlarged pond capacity (3.513 acre ft.) is over-designed by nearly 25% to contain the 10 year-24 hour design event.*

<i>Storm Event</i>	<i>Pond Volume Required</i>	<i>Pond Capacity Provided</i>
<i>10 yr./24 hr.</i>	<i>2.800 acre ft.</i>	<i>125%</i>

3.5 Alternate Sediment Control Areas (ASCA's)

ASCA-2 (consisting of 0.34 acre) exists at the northwest corner of the site. This area was initially constructed as a substation pad but was never utilized as such. A 12-inch CMP culvert was installed to act as a discharge into UD-1. A silt fence and strawbale dike have been placed to trap the sediment and prevent erosion. (Refer to Plates 7-5)

ASCA-5, ASCA-6, ASCA-7 and ASCA-11 consist of the topsoil stockpiles #1, #2, #3, and #4 respectfully. These stockpiles are located on the north and south side of the access road as shown on Plate 2-3. Disturbed areas associated with the topsoil stockpiles are 0.20 acres, 0.22 acres, 0.62 acres and 0.65 acres for ASCA-5, ASCA-6, ASCA-7, and ASCA-11, respectively. All topsoil stockpiles have been protected from erosion by a combination of dikes, silt-fencing, berms, and a vegetative cover. (Refer to Plate 2-3)

ASCA-9 (0.15 acres) is the outslope of the sediment pond; ASCA-10 (0.02 acres) is the headwall of the inlet of the main by-pass culvert. The drainage from these areas can not be directed to the sediment pond and are too close to the creek to construct separate sediment ponds. Therefore GENWAL has used alternate sediment control methods such as silt fences, straw bale dikes and vegetation. (Refer to Plate 7-5)

Note: ASCA's 1, 3, 4 and 8 have been eliminated through previous permitting actions.

A 0.30 acre water treatment facility is located within WSDD-10. This facility contains a settling basin for treating mine discharge water. The treated water is then piped directly to a UPDES outfall into Crandall Creek. Therefore, surface runoff from this facility does not report to the sediment pond.

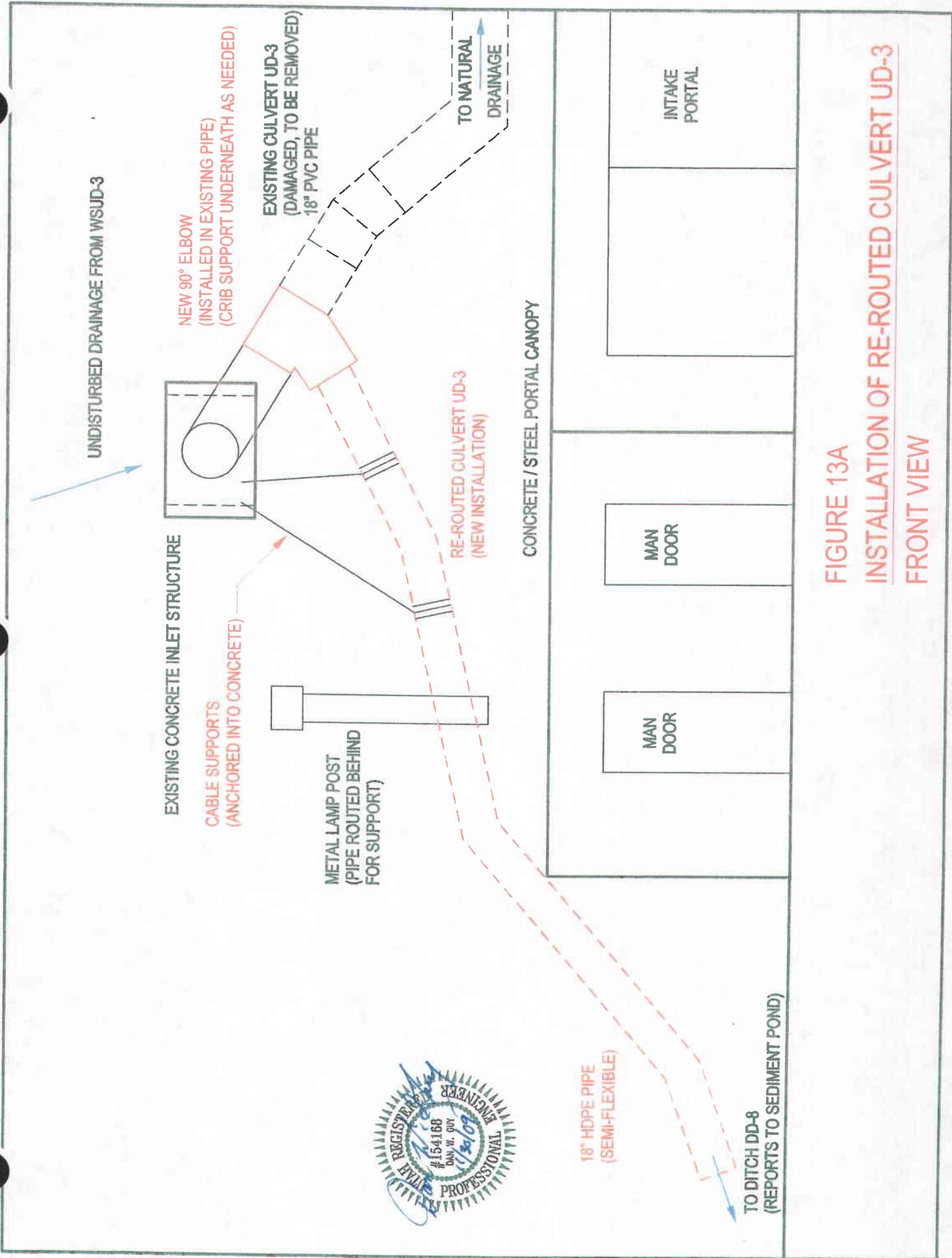
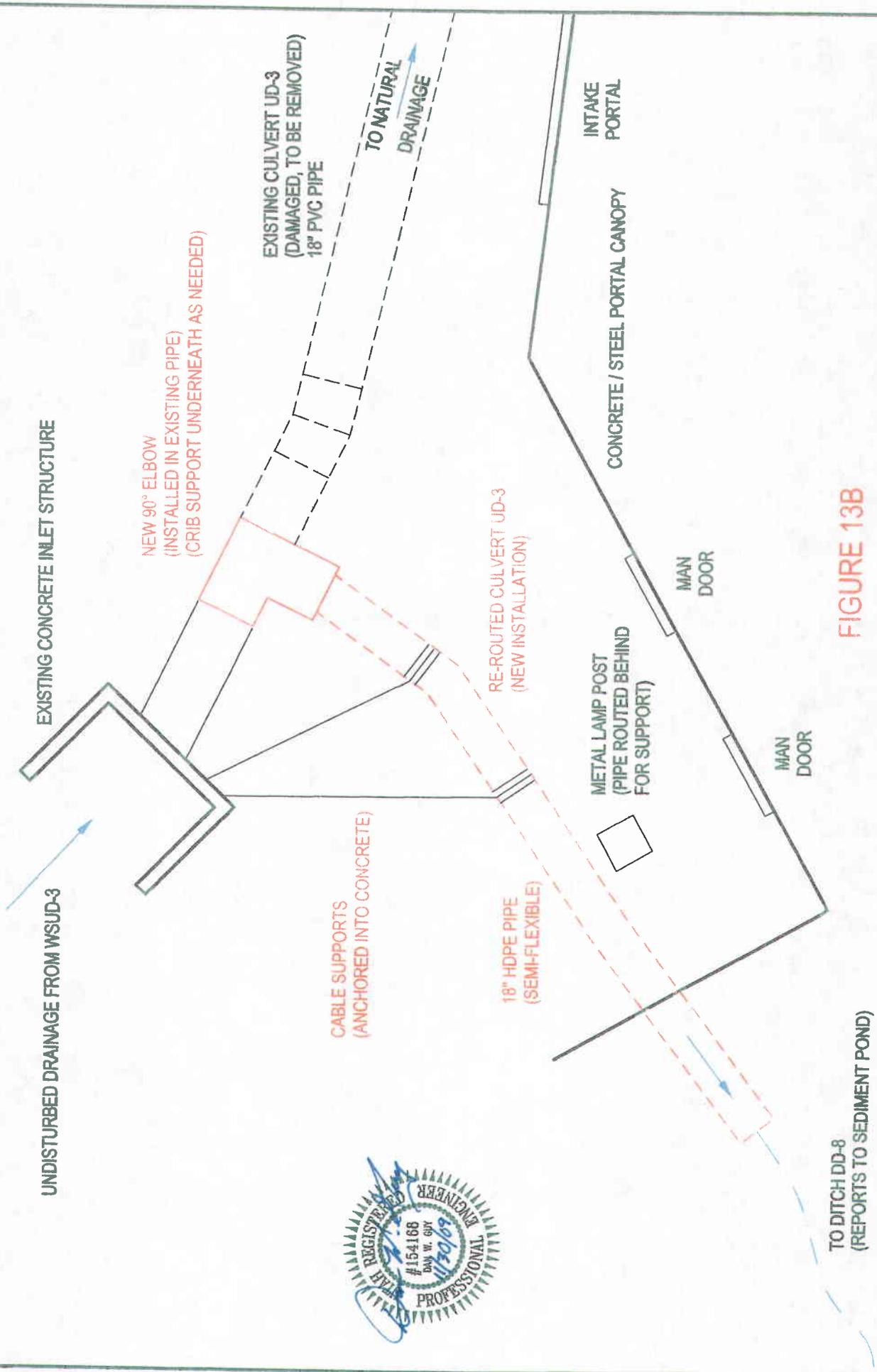


FIGURE 13A
 INSTALLATION OF RE-ROUTED CULVERT UD-3
 FRONT VIEW



**FIGURE 13B
 INSTALLATION OF RE-ROUTED CULVERT UD-3
 SIDE VIEW**





To: Dave Shaver
From: Dan Guy
Subject: Mine Water Treatment Outlet Structures
Date: October 14, 2009

Per your request, I have evaluated the adequacy of the proposed mine water treatment area spillway and discharge pipe. The following parameters were used for the calculations:

1. Flow - 2.65 cfs or 1189 gpm;
 - a. Flow is based on a maximum expected mine water discharge of 1000 gpm (2.23 cfs) plus the calculated 10 year-24 hour precipitation runoff from the disturbed area of WSDD-10 (0.42 cfs) or 189 gpm as shown on Table 4 of Appendix 7-4.
2. Spillway sizing is a concrete trapezoid with a 3'4" bottom and 1:1 side slopes with a depth of 16", at a slope of 3%;
3. The culvert is a 12" diameter poly pipe at a measured slope of 4.27%.
4. Calculations were performed with the Flowmaster I, Version 3.43 computer program.

Based on the calculations, the expected maximum flow of 2.65 cfs (1189 gpm) will pass through the spillway structure at a depth of 0.26 ft, which is less than 20% of the 16" total depth of the spillway. The culvert will also carry the flow at a full flow diameter of 0.80 ft, which is approximately 55% of the full flow capacity of 4.79 cfs or 2150 gpm.

The proposed outlet structures are therefore considered adequate for the maximum expected flows from this area.



Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: MINE WATER TREATMENT AREA SPILLWAY

Solve For Depth

Given Input Data:

Bottom Width.....	3.33 ft
Left Side Slope..	1.00:1 (H:V)
Right Side Slope.	1.00:1 (H:V)
Manning's n.....	0.035
Channel Slope....	0.0300 ft/ft
Discharge.....	2.65 cfs

Computed Results:

Depth.....	0.26 ft
Velocity.....	2.79 fps
Flow Area.....	0.95 sf
Flow Top Width...	3.86 ft
Wetted Perimeter.	4.08 ft
Critical Depth...	0.26 ft
Critical Slope...	0.0307 ft/ft
Froude Number....	0.99 (flow is Subcritical)

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: MINE WATER TREATMENT DISCHARGE PIPE

Solve For Full Flow Diameter

Given Input Data:

Slope.....	0.0427 ft/ft
Manning's n.....	0.020
Discharge.....	2.65 cfs

Computed Results:

Full Flow Diameter.....	0.80 ft
Full Flow Depth.....	0.80 ft
Velocity.....	5.26 fps
Flow Area.....	0.50 sf
Critical Depth....	0.72 ft
Critical Slope....	0.0378 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	2.65 cfs
QMAX @.94D.....	2.85 cfs
Froude Number.....	FULL

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: GENWAL MINE

Comment: MINE WATER TREATMENT DISCHARGE PIPE

Solve For Full Flow Capacity

Given Input Data:

Diameter.....	1.00 ft
Slope.....	0.0427 ft/ft
Manning's n.....	0.020
Discharge.....	4.79 cfs

Computed Results:

Full Flow Capacity.....	4.79 cfs
Full Flow Depth.....	1.00 ft
Velocity.....	6.09 fps
Flow Area.....	0.79 sf
Critical Depth....	0.90 ft
Critical Slope....	0.0374 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	4.79 cfs
QMAX @.94D.....	5.15 cfs
Froude Number.....	FULL

ATTACHMENT 7

SAFETY FACTOR DETERMINATION

STABILITY ANALYSIS
FOR
MINE WATER TREATMENT FACILITY EMBANKMENT

GENWAL MINE

PREPARED BY: DAN W. GUY, P.E.
BLACKHAWK ENGINEERING, INC.
NOVEMBER 2009



Introduction:

This report is an evaluation of the expected factors of safety of the proposed embankment for the Mine Water Treatment Facility.

Procedure:

Soil characteristics for the proposed embankment material have been tested by RB&G Engineering, Inc., to determine density, cohesion and internal friction angles. These parameters were then used in the safety factor calculations along with the maximum slope height and slope angles for the structure.

Calculations:

Stability calculations were performed using the Hock Method from Rock Slope Engineering. Under this method, stability projections can be made using soil characteristics such as density, cohesion, internal friction angle and proposed slope height. This information can then be plotted on the provided circular failure charts to determine factors of safety for both Dry and Saturated Conditions. The shear strength available to resist failure and the shear stress present along the possible failure surface are included in the analysis of the factor the safety. The shear strength is characterized by the cohesion and the friction angle. Failure would be assumed to occur on a circular failure slope, which is based on the angle of internal friction. These analyses have been addressed and verified using the Hoek Method (Hoek, Evert, And J.W. Bray, "Rock Slope Engineering" Spon Press, 270 Madison Ave. New York, NY, 1974)."

Slope heights and angles were estimated from the General Plan for the Iron Treatment Facility for the Crandall Canyon Mines. Since this is a proposed facility calculations were run on 2 slope height and angle scenarios:

- (1) The actual proposed height of 7' with an angle of 2.5H:1V. This will allow for slight changes that may occur during construction.
- (2) A maximum height of 10' with an angle of 2H:1V. This will allow for slight changes that may occur during construction.

Results:

Based on the proposed soil characteristics and slope heights and angles, a factor of safety of 10.53 for dry conditions and 7.66 for saturated conditions can be achieved for the proposed slope of 2.5h:1V (21.80°) at a height of 7'. A factor of safety of 7.66 for dry conditions and 6.02 for saturated conditions can be achieved for the steeper slope angle of 2H:1V (26.57°) and a greater height of 10'.

Summary:

Based on the parameters used in this report, expected factors of safety for the proposed embankment run from 7.66 to 10.53 for dry conditions and 6.02 to 7.66 for saturated conditions. Both sets of parameters show the expected factor of safety to be will in excess of the required 1.30.

TABLE 1
CALCULATION SUMMARY

Maximum Slope Height (H)	7'	10'
Slope Angle	2.5H:1V (21.80°)	2H:1V (26.57°)
Safety Factor (Dry)	10.53	7.66
Safety Factor (Saturated)	7.66	6.02

*Density (γ) = 118.1 pcf

*Cohesion (c) = 908 psf

*Internal Friction Angle (ϕ) = 40.1°

Note:

Based on most conservative results of laboratory tests.

C =Cohesion-psf
 γ =Density-pcf
 H =Slope Height-ft.
 ϕ =Internal Friction Angle

(DRY CONDITIONS)

CIRCULAR FAILURE CHART NUMBER 1

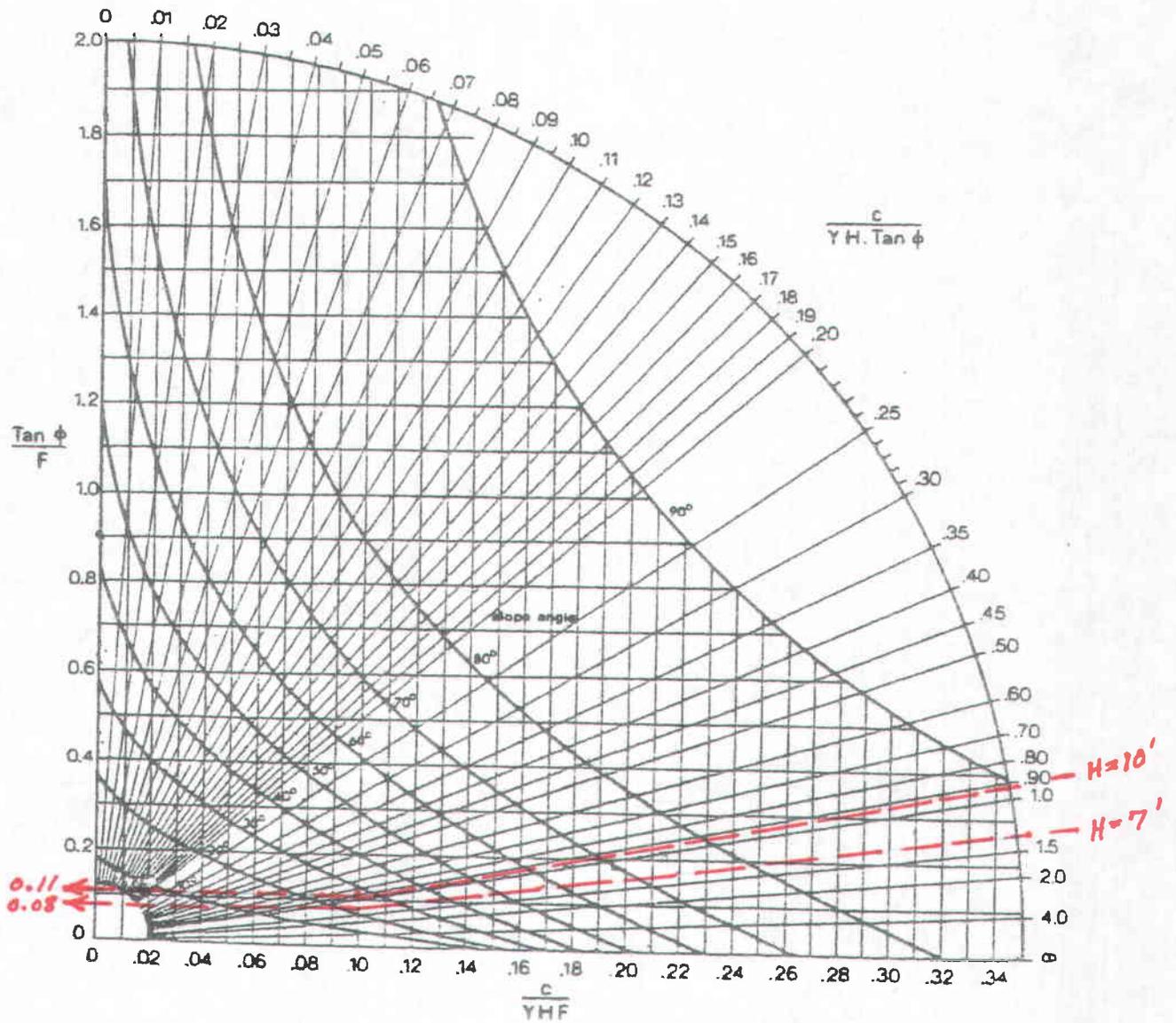


Figure 1

C=Cohesion-psf
 Y=Density-pcf
 H=Slope Height-ft.
 ϕ =Internal Friction Angle

(SATURATED CONDITIONS)

CIRCULAR FAILURE CHART NUMBER 5

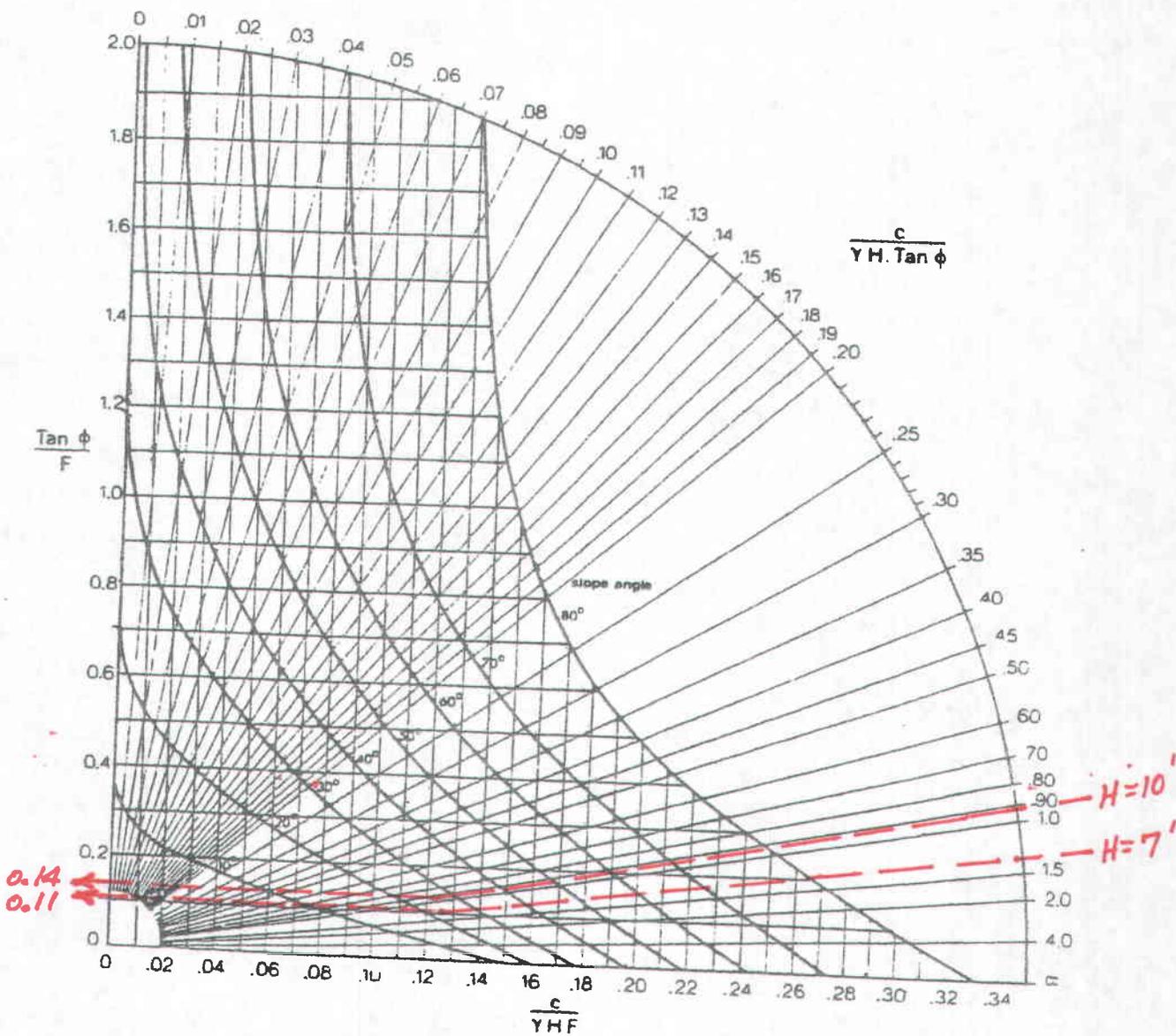


Figure 2

APPENDIX 1
SOIL ANALYSES

Project *Crandall Cyn*
Westridge Mine

Project No. 0 Boring No. 0

Location 0 Depth / Elev. (ft)

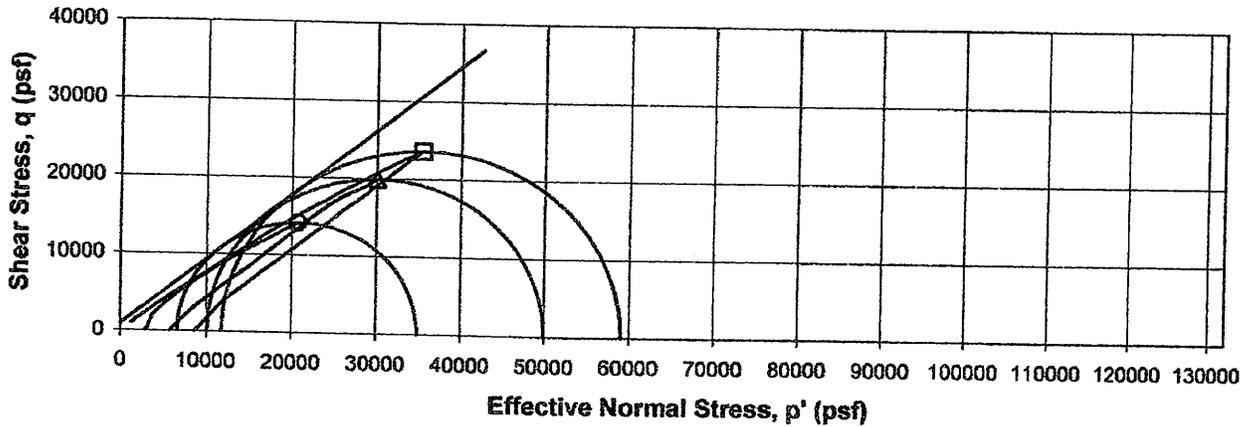
Date 11/5/09 Sample Type Remolded

Tested By J Boone Failure Criteria Max deviator stress

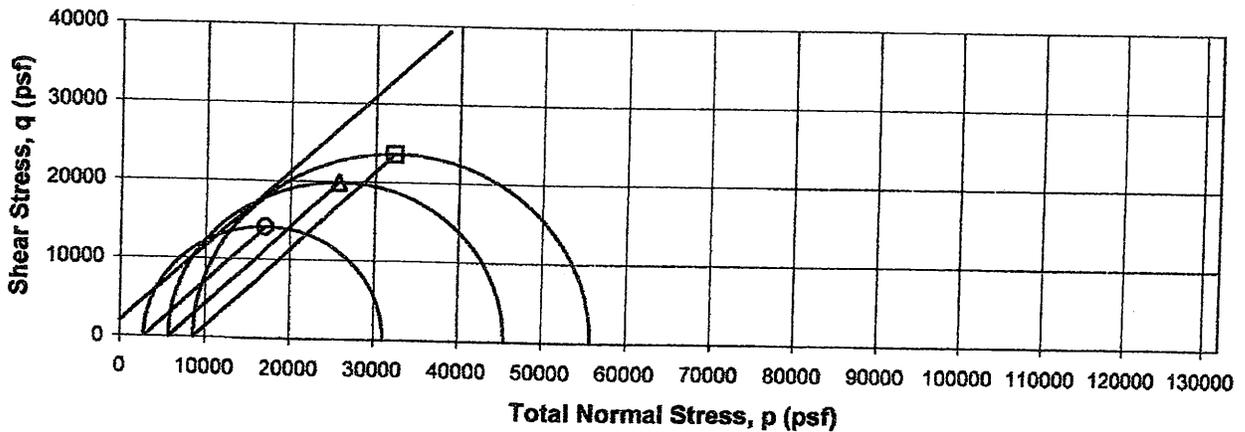
Sample Description Lt Brown Silty Gravel w/ Sand GM: Non Plastic

Summary of Results	σ'_{consol} psf	$\sigma_{d,f}^*$ psf	ϵ_f	$\sigma'_{1,f}^*$ psf	$\sigma'_{3,f}^*$ psf
Stage 1 ○	2880	28253	6.2%	34920	6667
Stage 2 △	5758	39866	12.0%	49987	10121
Stage 3 □	8639	47239	12.8%	59108	11869

Effective stress failure envelope $c' = 908$ psf $\phi' = 40.1^\circ$



Total stress failure envelope $c = 2000$ psf $\phi = 44^\circ$



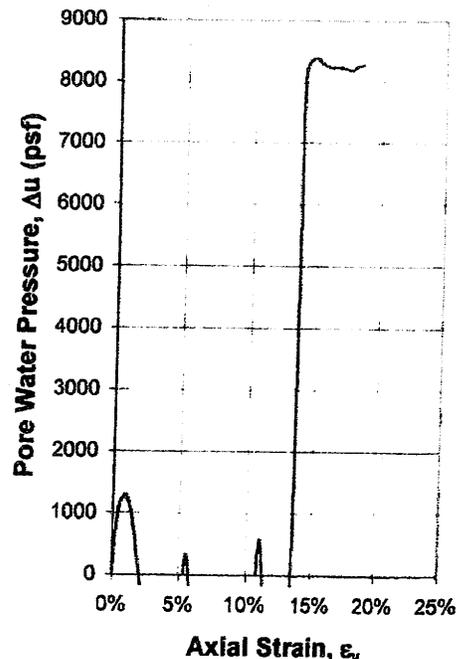
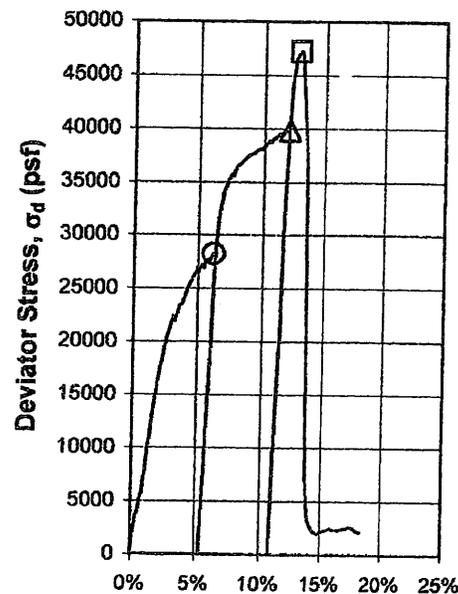
See page two for plots of deviator stress and pore water pressure versus strain.

*Values corrected for membrane effects

** A_c calculated according to ASTM D 4767 10.3.2.1 Method A

Crandall Cys
Project ~~Westridge Mine~~
Project No. 0 Boring No. 0
Location 0 Depth / Elev. (ft)
Date 11/5/09 Sample Type Remolded
Tested By J Boone Failure Criteria Max deviator stress
Sample Description Lt Brown Silty Gravel w/ Sand GM: Non Plastic

Symbol		○	△	□		
Stage		1	2	3		
Initial	Vertical effective consolidation stress σ'_c	2880	5758	8639	(psf)	
	Height L_o	6.3	5.90	5.56	(in)	
	Diameter D_o	2.8	2.95	3.02	(in)	
	Moisture w_o	6.9%	15.5%	15.0%		
	Dry unit weight γ_{do}	122.5	118.1	119.2	(pcf)	
	Est. specific gravity G_s	2.68	2.68	2.68		
	Void ratio e_o	0.36	0.42	0.40		
	Saturation S_o	51%	100%	100%		
	After consolidation	Moisture w	15.5%	15.0%	14.6%	
		Dry unit weight γ_d	118.1	119.2	120.3	(pcf)
Void ratio e		0.416	0.403	0.390		
Saturation S		100%	100%	100%		
Area A_c		6.40	6.70	7.04	(in ²)	
Time to 50% consolidation t_{50}		0.23	2.23	262.16	(min)	
B-value B		0.95	-	-		
Results at Failure	Total back pressure	14400	10914	12507	(psf)	
	Deviator stress $\sigma_{d,f}$	28253	39866	47239	(psf)	
	Major principal effective stress σ'_1	34920	49987	59108	(psf)	
	Minor principal effective stress σ'_3	6667	10121	11869	(psf)	
	Strain ϵ_f	6.2%	12.0%	12.8%		
	Strain rate, /min	0.04%	0.04%	0.04%		
Sketch at Failure						



Remarks **Draft**

*Values corrected for membrane effects

** A_c calculated according to ASTM D 4767 10.3.2.1 Method A

MULTI-STAGE CONSOLIDATED-UNDRAINED
TRIAxIAL COMPRESSION TEST

Crandall Co
~~Westridge~~ Mine

Project	0	Boring No	0
Project No.	0	Depth / Elev. (ft)	
Location	11/5/09	Sample Type	Remolded
Date	J Boone	Failure Criteria	Max deviator stress
Tested By	Lt Brown Silty Gravel w/ Sand GM: Non Plastic		
Sample Description			

*Values corrected for membrane effects

**A_c calculated according to ASTM D 4767 10.3.2.1 Method A

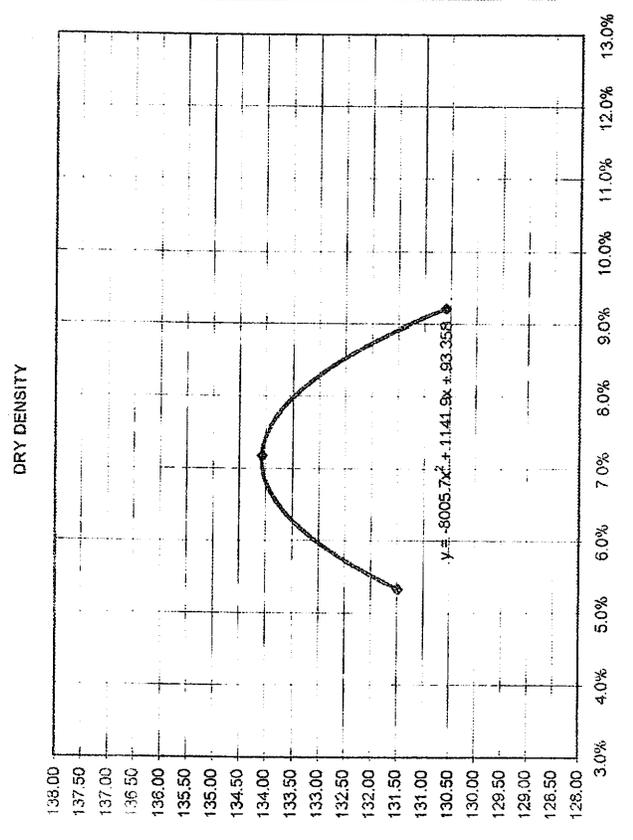
JOHANSEN & TUTTLE ENG. INC.

MOISTURE / DENSITY RELATIONSHIPS

CLIENT	SCAMP CONST.	TEST #	1	MAX DRY DENSITY	134.1
PROJECT	GENWALL MINE	DATE SAMPLE	10/15/2009	BY	SCAMP
METHOD	AASHTO T-180	DATE TESTED	10/19/2009	BY	LWT
				OPTIMUM MOISTURE	7.1%

TEST	1	2	3
WATER ADDED	2%	2%	2%
CYL. & SOIL WT.	24.89	25.28	25.20
CYL. WT.	14.5	14.5	14.5
WET SOIL WT.	10.39	10.78	10.70
WET DENSITY	138.50	143.70	142.63
CONTAINER #	1	2	3
CONT. & WET SOIL	526.8	550.2	542.3
CONT. & DRY SOIL	502.8	516.9	501
WATER WT.	24	33.3	41.3
CONT. & DRY SOIL	502.8	516.9	501
CONT. WT.	52.8	53	52.9
DRY SOIL WT.	450	463.9	448.1
MOISTURE	5.3%	7.2%	9.2%
DRY DENSITY	131.49	134.07	130.59

ROAD BASE



X2= -8005.7
X= 1141.9
C= 93.356

JOHANSEN & TUTTLE ENGINEERING



NUCLEAR RELATIVE COMPACTION
TEST DATA

PROJECT: Genwall - Grandal Canyon

DATE: 10-29-70

LOCATION: Grandal Canyon Mine

TESTED BY: RLG

DENSITY/MOISTURE STANDARDS: 2316 1 641

TEST NUMBER	1	2	3	4	5	6				
STATION										
OFFSET										
ELEVATION										
DEPTH	8"	-	-	-	-	-				
WET DENSITY	133.0	130.3	130.1	126.3	123.1	125.1				
DRY DENSITY	128.6	125.5	124.4	121.8	118.2	122.8				
MAX. DRY DENSITY	134.1	-	-	-	-	-				
OPTIMUM MOISTURE	7.1	-	-	-	-	-				
% MOISTURE	5.1	4.2	4.0	4.0	4.7	5.0				
% COMPACTION	95.9	93.6	92.8	90.4	94.4	94.2				

REMARKS: ~~Wet~~ wet & compact North corner

JOHANSEN & TUTTLE ENGINEERING



NUCLEAR RELATIVE COMPACTION
TEST DATA

PROJECT: Greenville-Crandal Canyon

DATE: 11-4-04

LOCATION: Crandal Canyon Mine

TESTED BY: ZF

DENSITY/MOISTURE STANDARDS: 2316 1 691

TEST NUMBER	1	2	3	4	5					
STATION										
OFFSET										
ELEVATION										
DEPTH										
WET DENSITY	127.5	128.9	130.1	131.2	130.3					
DRY DENSITY	123.8	124.2	125.4	127.0	125.5					
MAX. DRY DENSITY	134.1	-	-	-	-					
OPTIMUM MOISTURE	7.1	-	-	-	-					
% MOISTURE	4.2	4.5	4.7	4.6	4.8					
% COMPACTION	92.3	92.6	93.8	94.7	93.6					

REMARKS North corner better

ATTACHMENT 8
CONSTRUCTION SPECIFICATIONS
AND DRAWINGS

Crandall Canyon Mine Mine Water Treatment Facility



Preliminary

- 1) Grade and pour a concrete trough behind the retaining wall (between wall and rock ledge) to catch and divert seepage water from the ledge. Concrete to be about 6" thick, and sloped to a common point where it will discharge from a pipe to the outside of the wall. Grade as necessary to get proper slope and elevation for the trough.
- 2) Install a French drain in the low lying area on top of the bedrock, and continue the drain in a ditch within and across the existing fill area. Underdrain will consist of a rigid perforated 4" pipe surrounded by pea gravel. From the seepage collection area the drain pipe (solid) will be laid to the existing 12" discharge line and will connect by dropping into the top. Contractor to supply drain pipe, fittings and pea gravel.
- 3) After the underdrain system is in place, smooth out the pond bottom area suitable for placement of the pit liner.

Construct settling basin

- 4) Using a structural granular borrow material, construct a berm around the perimeter of the pond area. The material must be placed in 8" lifts and compacted to 90% density using vibratory sheepsfoot compactors. The top of the berm should be a minimum of 8' wide with 2.5/1 sideslopes. Berm to be level on top, with an elevation of 7815'. Berm must be compacted as it is constructed. Water is available locally if needed.
- 5) Unload jersey barriers from supplier and store in convenient location upon arrival. Genwal will provide the Jersey barriers.
- 6) Construct a double wall of barriers atop the berm. Approximately 51 jersey barriers will be needed according to the plan. The barriers are 10' long each. Stagger the joints as much as possible. Extend the barriers beyond the end of the existing retaining wall on the east end, and abut the barriers to the wall on the west end.
- 7) Cut a spillway notch in the barrier wall at the lower end of the pond.
- 8) Install the pit liner (and felt underlayment) in the basin area. Anchor the material to the barrier wall by extending it over the inner barrier and draping it into the space between the barriers. Trim the excess material as needed. Then backfill the space between the barriers. Genwal will supply the pit liner and felt material.
- 9) Along the inside of the retaining wall, affix the pit liner material to a wooden board secured

securely to the concrete wall.

10) After the spillway/discharge system is completed, the area below the basin should be graded and a ditch constructed along the edge of the road to the existing culvert inlet to handle surface runoff.

Construct the spillway/discharge system

11) At the toe of the berm outslope at the discharge end of the pond, next to the ledgerock, install a 2'x2'x2' precast concrete inlet box. The box must have a grate over the inlet. Contractor to supply the inlet box.

12) Extend the 12" poly pipe from the existing pipe up to the concrete inlet box.

13) Construct a 2' high earthen berm around the inlet box and extend this berm on either side back up to the top of the spillway barriers, thereby creating a spillway channel (2' deep) leading from the barrier spillway down to the inlet box.

14) Extend a second layer of pit liner material from the barrier spillway halfway down the spillway channel.

15) Riprap the inner surface of the spillway channel from the barrier spillway to and around the inlet box (bottom and sides) with 8" minimum rock.

16) Grout the riprap with concrete

Install the oxidizer

17) Using suitable earthen material, backfill and compact the upper end of the site where the oxidizer unit goes. When finished, the area should be backfilled to near the top of the upper barrier wall. The area should be sloped slightly to drain to the east end, where a ditch constructed along the barrier wall will drain out to the road.

18) Construct and install a chain-link fence guard around the gravity take-up area between the bent columns.

19) Gravel the access area around the Oxidizer location with a 4" layer of drain-rock gravel. Contractor to supply the drain rock.

20) Disconnect the existing poly pipe manifold at the flange joint

21) Install the Oxidizer. It must be level. The unit weighs about 2000 pounds. Genwal will do the shop modifications to the unit so that it will have 12" flange connections pre-installed at the inlet and outlet ends

22) Plumb up the 12" inlet pipe from the existing line to the oxidizer. This line must be adequately supported from underneath. It should be equipped with a Tee and a 2" drain valve extending from the end of the connection Tee. Contractor will provide all plumbing pipe, fittings and fixtures.

23) Plumb up the 12" outlet pipes (2 each) from the Oxidizer to the pond. These pipes should be sloped for positive drainage and adequately supported from underneath.

Additional construction

24) Install a 6' high chain-link fence around the outer perimeter of the basin. Affix the fence pole to the top of the inner Jersey barriers. Provide one personnel gate at the upper end of the basin, and one at the lower end near the spillway.

25) Extend additional Jersey barriers along the edge of the road from the pond barriers up to the coexisting concrete platform. Leave a gap between one set of barriers to allow personnel access to the Oxidizer.

26) Plumb up a pipe gooseneck at the existing relief port. This should be plumbed to allow relief water to spill into the pond rather than behind the retaining wall.

27) Place 8" rock (rip-rap) at toe of berm along Forest Service road suitable to prevent erosion from runoff from road.

28) Roughen and re-seed the outslopes of the berm (Genwal to provide seed)

NOTES:

- a) Location of barriers is approximate and can vary to accommodate final configuration of berm.
- b) Berm corner can be rounded off to facilitate construction if needed.
- c) Genwal will provide electrical hookup of Oxidizer and area lighting.
- d) Genwal will provide datum elevation benchmark. Contractor to carry all elevations forward.
- e) All work must be done in compliance with MSHA laws and regulations
- g) Bids must be submitted by Wednesday, September 23. Work must commence as soon thereafter once the Purchase Order is issued, and all Genwal supplied materials ready for delivery on site.

LEGEND

EXISTING 1' CONTOUR LINES

EXISTING DRAIN PIPE TO REMAIN

EXISTING CONCRETE WALL
TOP OF WALL
ELEV = 7820.3

EXISTING CONCRETE WALL
TOP OF WALL
ELEV = 7819.8

EXISTING
CONCRETE WALL
TOP OF WALL
ELEV = 7820.3

NEW POURED CONCRETE
SEEP COLLECTOR - SEE
DETAIL THIS SHEET

EXISTING RETAINING WALL
TO REMAIN

EXISTING CONCRETE WALL
TOP OF WALL
ELEV = 7819.0

SEE SEEP COLLECTOR
SECTION THIS SHEET

SEEP AREA

SEEP AREA DRAINAGE DIRECTLY TO BASIN OUTFLOW

EXISTING CONCRETE WALL
TOP OF WALL
ELEV = 7818.5

EXISTING CONCRETE WALL
TOP OF WALL
ELEV = 7818.0

4" PERFORATED DRAIN PIPE
WRAPPED WITH LANDSCAPE
FABRIC IN BED OF PEA
GRAVEL

UNDERDRAIN SYSTEM

EXISTING EDGE OF BEDROCK

4" PERFORATED DRAIN PIPE
WRAPPED WITH LANDSCAPE
FABRIC IN TRENCH FILLED
WITH PEA GRAVEL BEYOND
BEDROCK AREA

NOTE:
GRADE BEDROCK AREA AS
REQUIRED TO ACCOMMODATE
POND LINER - FIELD VERIFY
CONDITIONS

BELT STRUCTURE
TO REMAIN

PROVIDE 8.0'x10.0'
GUARD BETWEEN CONCRETE
FOUNDATION PILLARS
PER SPECIFICATIONS

EXISTING
CONCRETE
PAD

EXISTING FOREST SERVICE ROAD

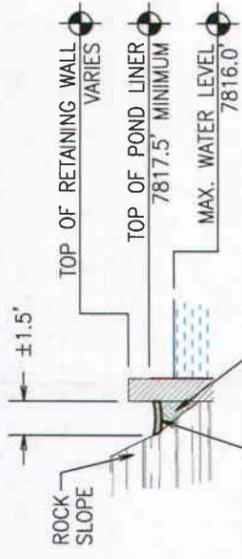
4" DRAIN PIPE
CONNECT TO TOP
OF EXISTING DRAIN
PIPE

EXISTING DISCHARGE PIPE

TYPICAL EDGE OF
STONE OUTCROP

EXISTING DRAIN PIPE

INLET BOX



NEW 6" POURED TROUGHED
CONCRETE GUTTER -
1/4-12 SLOPE MIN. -
TYPICAL

NOTE: APPROXIMATELY
(2) CUBIC YARDS OF
CONCRETE WILL BE REQUIRED
FOR THE GUTTER SEEP
COLLECTOR.

SEEP COLLECTOR SECTION

NO SCALE

I CERTIFY THIS MAP TO BE TRUE AND CORRECT
TO THE BEST OF MY KNOWLEDGE.



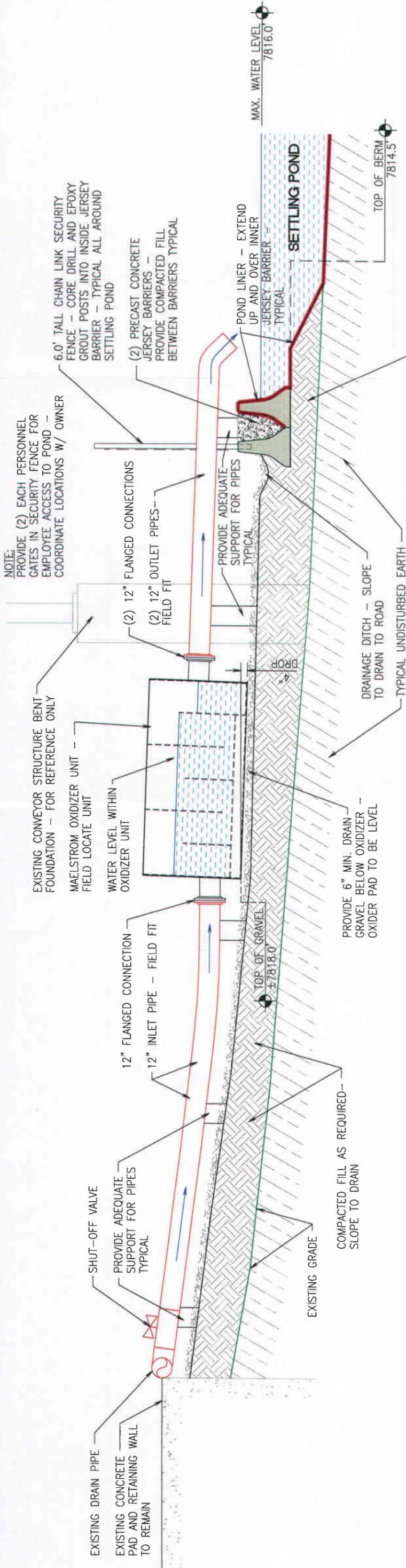
UNDERDRAIN SYSTEM

IRON TREATMENT FACILITY

Crandall Canyon Mines
Crandall Canyon
P.O. BOX 910
EAST CARBON, UTAH 84520

DRAWN BY	PJ	SCALE	1" = 20'
APPROVED BY	DS	DATE	23 NOV. 2009
REVISION	4	SHEET	2 of 5





SECTION A-A'
GENERALIZED OXIDIZER UNIT PAD

NOTE: PROVIDE (2) EACH PERSONNEL GATES IN SECURITY FENCE FOR EMPLOYEE ACCESS TO POND - COORDINATE LOCATIONS W/ OWNER

6.0' TALL CHAIN LINK SECURITY FENCE - CORE DRILL AND EPOXY GROUT POSTS INTO INSIDE JERSEY BARRIER - TYPICAL ALL AROUND SETTLING POND

(2) PRECAST CONCRETE JERSEY BARRIERS - PROVIDE COMPACTED FILL BETWEEN BARRIERS TYPICAL

POND LINER - EXTEND UP AND OVER INNER JERSEY BARRIER - TYPICAL

SETTLING POND

TOP OF BERM 7814.5

MAX. WATER LEVEL 7816.0

EXISTING CONVEYOR STRUCTURE BENT FOUNDATION - FOR REFERENCE ONLY

MAELSTROM OXIDIZER UNIT - FIELD LOCATE UNIT

WATER LEVEL WITHIN OXIDIZER UNIT

(2) 12" FLANGED CONNECTIONS

(2) 12" OUTLET PIPES - FIELD FIT

PROVIDE ADEQUATE SUPPORT FOR PIPES TYPICAL

DRAINAGE DITCH - SLOPE TO DRAIN TO ROAD

TYPICAL UNDISTURBED EARTH

PROVIDE 6" MIN. DRAIN GRAVEL BELOW OXIDIZER OXIDER PAD TO BE LEVEL

COMPACTED FILL AS REQUIRED - SLOPE TO DRAIN

EXISTING GRADE

SHUT-OFF VALVE

PROVIDE ADEQUATE SUPPORT FOR PIPES TYPICAL

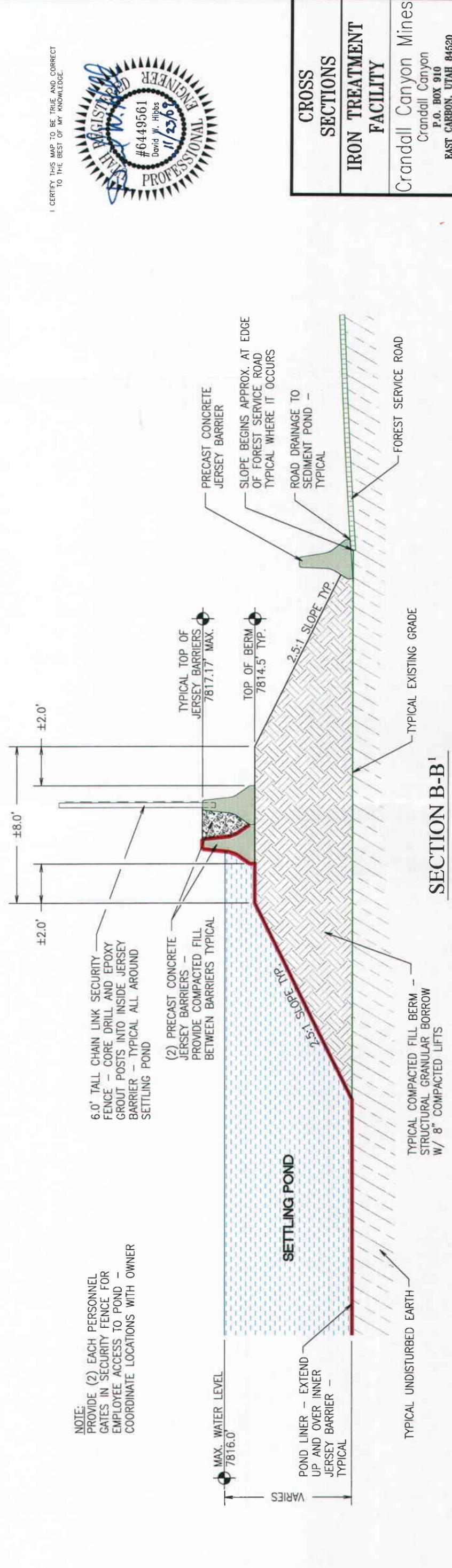
12" INLET PIPE - FIELD FIT

12" FLANGED CONNECTION - FIELD FIT

TOP OF GRAVEL ±7818.0

EXISTING CONCRETE PAD AND RETAINING WALL TO REMAIN

EXISTING DRAIN PIPE



SECTION B-B'
TYPICAL GENERALIZED BERM SECTION

NOTE: PROVIDE (2) EACH PERSONNEL GATES IN SECURITY FENCE FOR EMPLOYEE ACCESS TO POND - COORDINATE LOCATIONS WITH OWNER

6.0' TALL CHAIN LINK SECURITY FENCE - CORE DRILL AND EPOXY GROUT POSTS INTO INSIDE JERSEY BARRIER - TYPICAL ALL AROUND SETTLING POND

(2) PRECAST CONCRETE JERSEY BARRIERS - PROVIDE COMPACTED FILL BETWEEN BARRIERS TYPICAL

SETTLING POND

TOP OF BERM 7814.5 TYP.

TYPICAL TOP OF JERSEY BARRIERS 7817.17' MAX.

2.5:1 SLOPE TYP.

2.5:1 SLOPE TYP.

ROAD DRAINAGE TO SEDIMENT POND - TYPICAL

SLOPE BEGINS APPROX. AT EDGE OF FOREST SERVICE ROAD TYPICAL WHERE IT OCCURS

PRECAST CONCRETE JERSEY BARRIER

TYPICAL UNDISTURBED EARTH

FOREST SERVICE ROAD

TYPICAL COMPACTED FILL BERM - STRUCTURAL GRANULAR BORROW W/ 8" COMPACTED LIFTS

EXISTING GRADE

POND LINER - EXTEND UP AND OVER INNER JERSEY BARRIER - TYPICAL

VARIES

MAX. WATER LEVEL 7816.0

NOTE: PROVIDE (2) EACH PERSONNEL GATES IN SECURITY FENCE FOR EMPLOYEE ACCESS TO POND - COORDINATE LOCATIONS W/ OWNER

I CERTIFY THIS MAP TO BE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE.



CROSS SECTIONS	
IRON TREATMENT FACILITY	
Crandall Canyon Mines	
Crandall Canyon	
P.O. BOX 910	
EAST CARBON, UTAH 84620	
DRAWN BY	PJ
SCALE	1" = 20'
APPROVED BY	DS
DATE	23 NOV. 2009
REVISION	5
SHEET 3 of 5	

NOTE:
 PROVIDE (2) EACH PERSONNEL
 GATES IN SECURITY FENCE FOR
 EMPLOYEE ACCESS TO POND -
 COORDINATE LOCATIONS WITH OWNER

(2) PRECAST CONCRETE
 JERSEY BARRIERS -
 SAWCUT AND REMOVE AN
 OPENING IN BOTH BARRIERS
 TO CREATE SPILLWAY -
 SEE DETAIL THIS SHEET

6.0' TALL CHAIN LINK SECURITY
 FENCE - CORE DRILL AND EPOXY
 GROUT POSTS INTO INSIDE JERSEY
 BARRIER - TYPICAL ALL AROUND
 SETTLING POND

JERSEY BARRIERS BEYOND

TYPICAL COMPACTED FILL
 BETWEEN JERSEY BARRIERS

MAX. TOP OF WATER/
 SPILLWAY ELEVATION
 7816.0'

4" CONCRETE SURFACE
 ALL AROUND CULVERT
 INLET TYPICAL

SETTLING POND

±2.0'

±7.0' MAX.

±8.5' MAX. DEPTH

2.5:1 SLOPE TR.

POND LINER - EXTEND
 THROUGH SPILLWAY BEYOND
 OUTSIDE JERSEY BARRIER

TYPICAL COMPACTED FILL BERM
 STRUCTURAL GRANULAR BORROW
 W/ 8" COMPACTED LIFTS

TYPICAL EXISTING GRADE EARTH

TYPICAL COMPACTED FILL

18" CULVERT WITH
 ±18" MIN. COVER

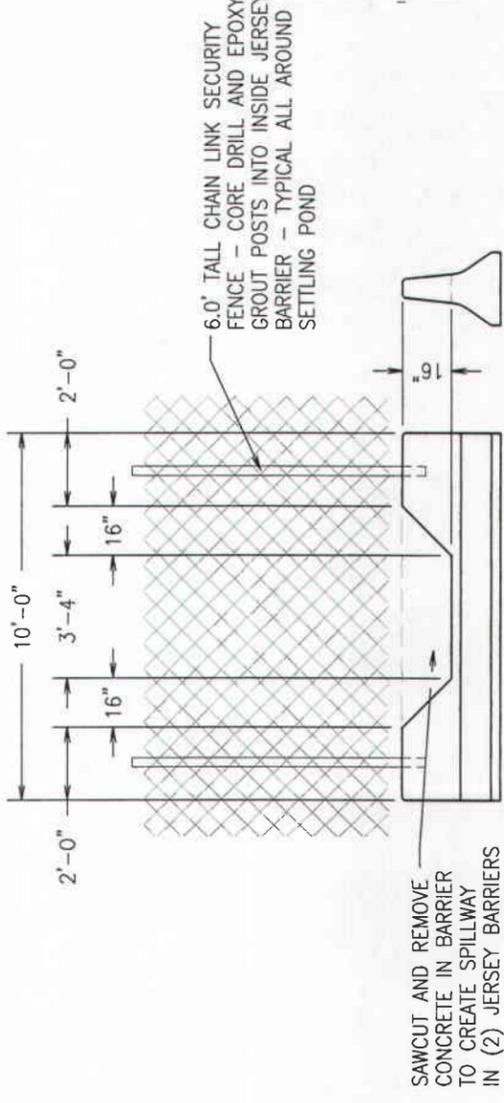
±17.4% AVERAGE SLOPE

2" DIA VENT PIPE
 2.0'x2.0'x2.0' PRECAST
 CONCRETE JUNCTION BOX
 STRUCTURE

12" DISCHARGE PIPE FROM
 JUNCTION BOX STRUCTURE

TOP OF
 PIPE
 7805.5'

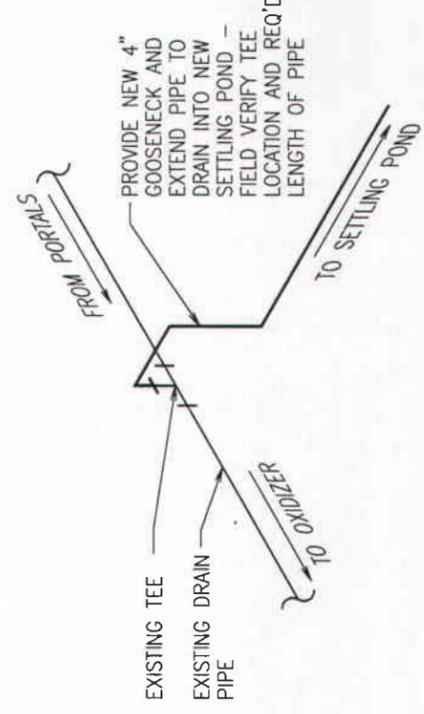
**SECTION C-C'
 SPILLWAY SECTION**



I CERTIFY THIS MAP TO BE TRUE AND CORRECT
 TO THE BEST OF MY KNOWLEDGE.



CONSTRUCTION DETAILS	
IRON TREATMENT FACILITY	
Crandall Canyon Mines Crandall Canyon P.O. BOX 910 EAST CARBON, UTAH 84520	
DRAWN BY PJ	SCALE 1" = 20'
APPROVED BY DS	DATE 23 NOV. 2009
REVISION 4	SHEET 4 of 5



OVERFLOW TEE SCHEMATIC

NO SCALE

JERSEY BARRIER DETAIL AT SPILLWAY

NOTES:

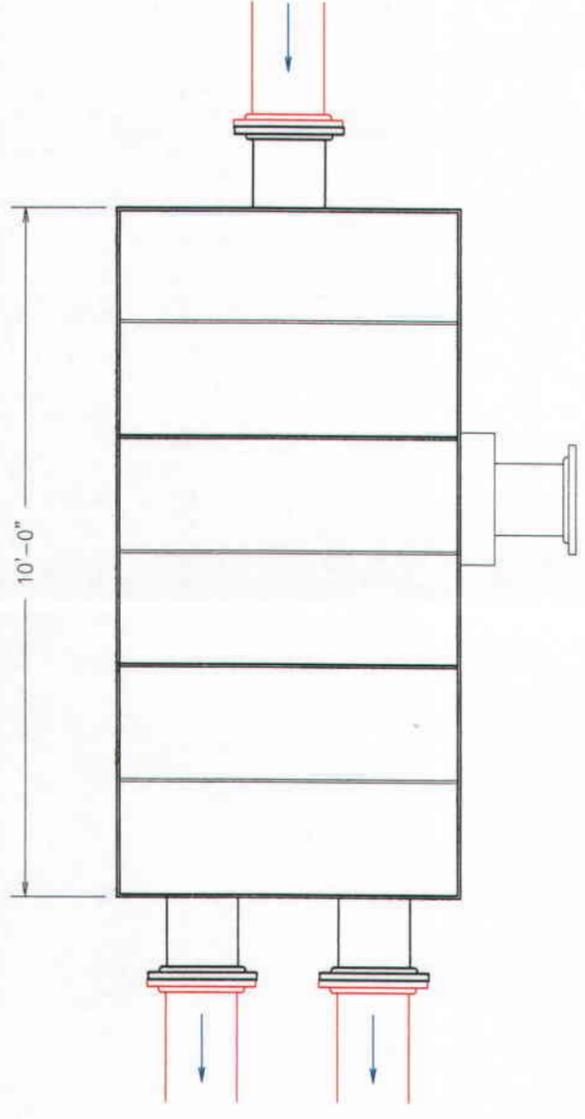
ITEMS DENOTED WITH BLACK LINES ARE RELATED TO THE MAELSTROM OXIDIZER UNIT.

ITEMS DENOTED WITH RED LINES ARE RELATED TO ITEMS THAT ARE TO BE FABRICATED.

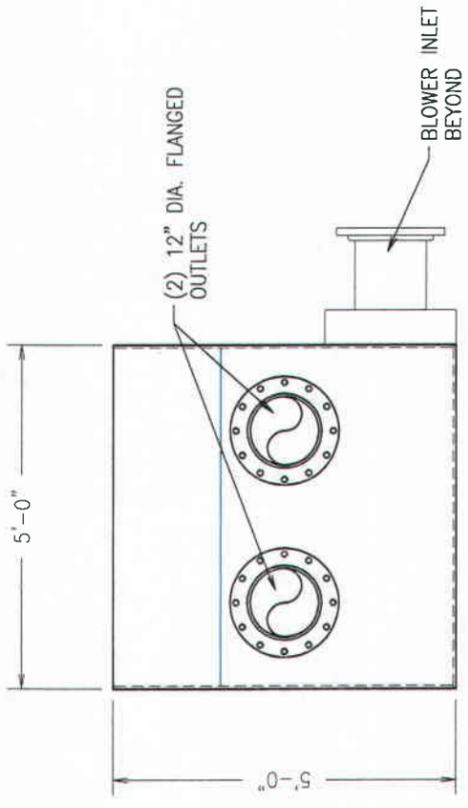
ALL JOINTS THAT CAN REASONABLY BE WELDED IN THE SHOP SHALL BE DONE SO.

ALL WELDED JOINTS SHALL BE WATER TIGHT AND GROUND SMOOTH WHENEVER POSSIBLE.

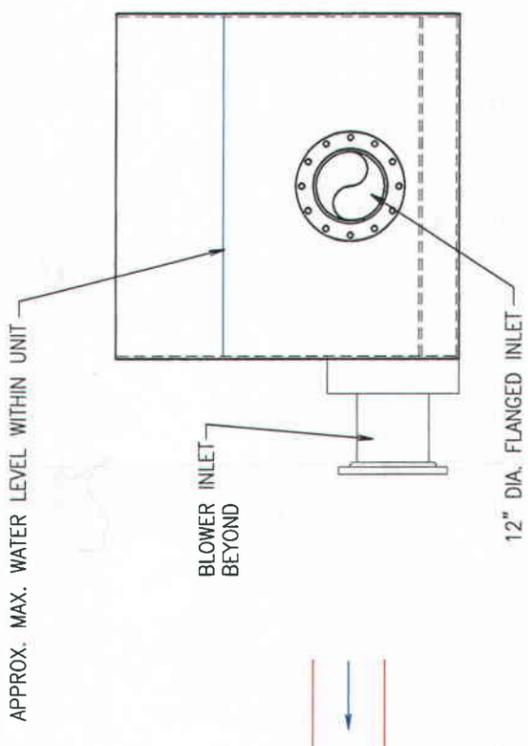
OXIDIZER UNIT MANUFACTURED BY:
ENVIRONMENTAL SOLUTIONS, LLC
314 POLO CLUB DRIVE
MOON TOWNSHIP, PENNSYLVANIA 15108
PHONE: (412) 262-2606 OR (412) 716-7600



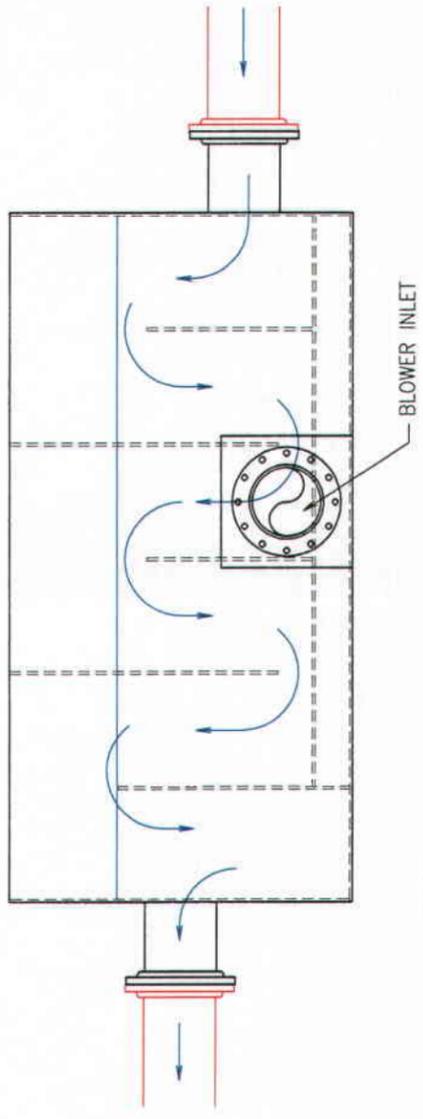
TOP VIEW



OUTLET END



INLET END



LEFT SIDE VIEW

NOTE:
RIGHT SIDE SIMILAR.

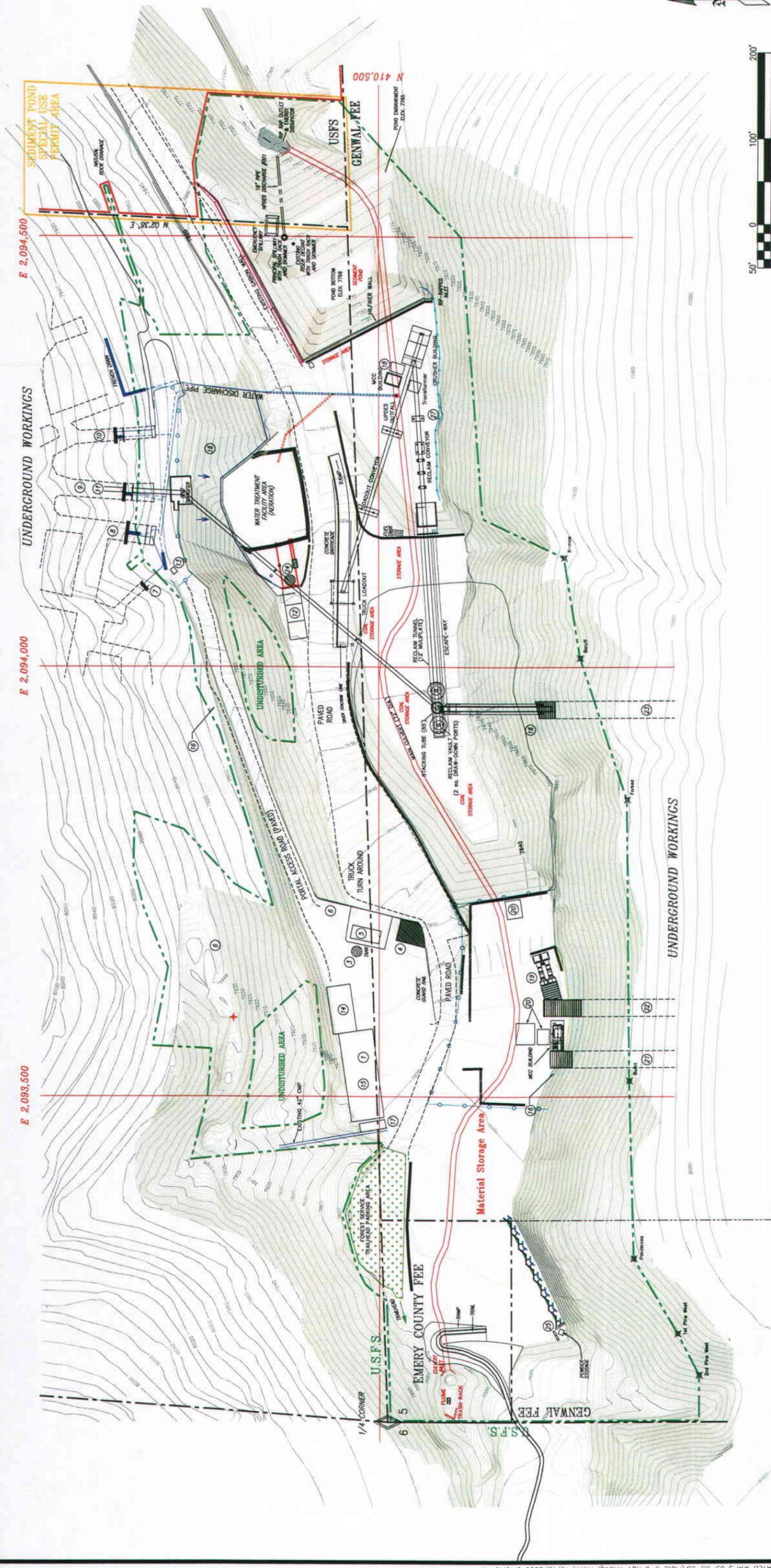
I CERTIFY THIS MAP TO BE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE.



OXIDIZER UNIT	
IRON TREATMENT FACILITY	
Crandall Canyon Mines Crandall Canyon P.O. BOX 910 EAST CARBON, UTAH 84520	
DRAWN BY: PJ	SCALE: 1" = 20'
APPROVED BY: DS	DATE: 12 OCT. 2009
REVISION: 2	SHEET: 5 of 5

PLATE 5-3

SURFACE FACILITIES



RECEIVED
DEC 09 2009
DIV. OF OIL, GAS & MINING

- LEGEND:**
- SEDIMENT POND (SPECIAL USE PERMIT AREA)
 - EXTENT OF DISTURBANCE
 - 10' CONTOUR
 - JERSEY BARRIERS
 - RE-ESTABLISHED USFS ROAD (DOUBLE-LANE)
 - SAFETY BARRIERS
 - FENCING

- FACILITY LEGEND:**
1. Shop
 2. Ventilation Fan
 3. Rocklust Silo
 4. Concrete Dumpster Pad
 5. Power Center
 6. Power Pole
 7. Offices & Bathhouse (u/grd)
 8. Intake Portal
 9. Belt Portal
 10. Fan Portal
 11. Mine Belt
 12. Oil Storage
 13. Visual Disconnect
 14. New Warehouse and Office Building
 15. 4500 Gallon Cullinary Water Tank
 16. Shotcrete
 17. Parts Shed
 18. Portable Shed
 19. Ventilation Fan
 20. Material Storage Sheds
 21. Intake Portal
 22. Return Portal
 23. Belt Portal
 24. Mag Tank
 25. Powder Storage
 26. Cap Storage
 27. Concrete Ditch



GENWAL™
 RESOURCES, INC.
 P.O. Box 1077, 794 North "C" Canyon Rd, Price Utah
 Telephone: (435) 888-4000

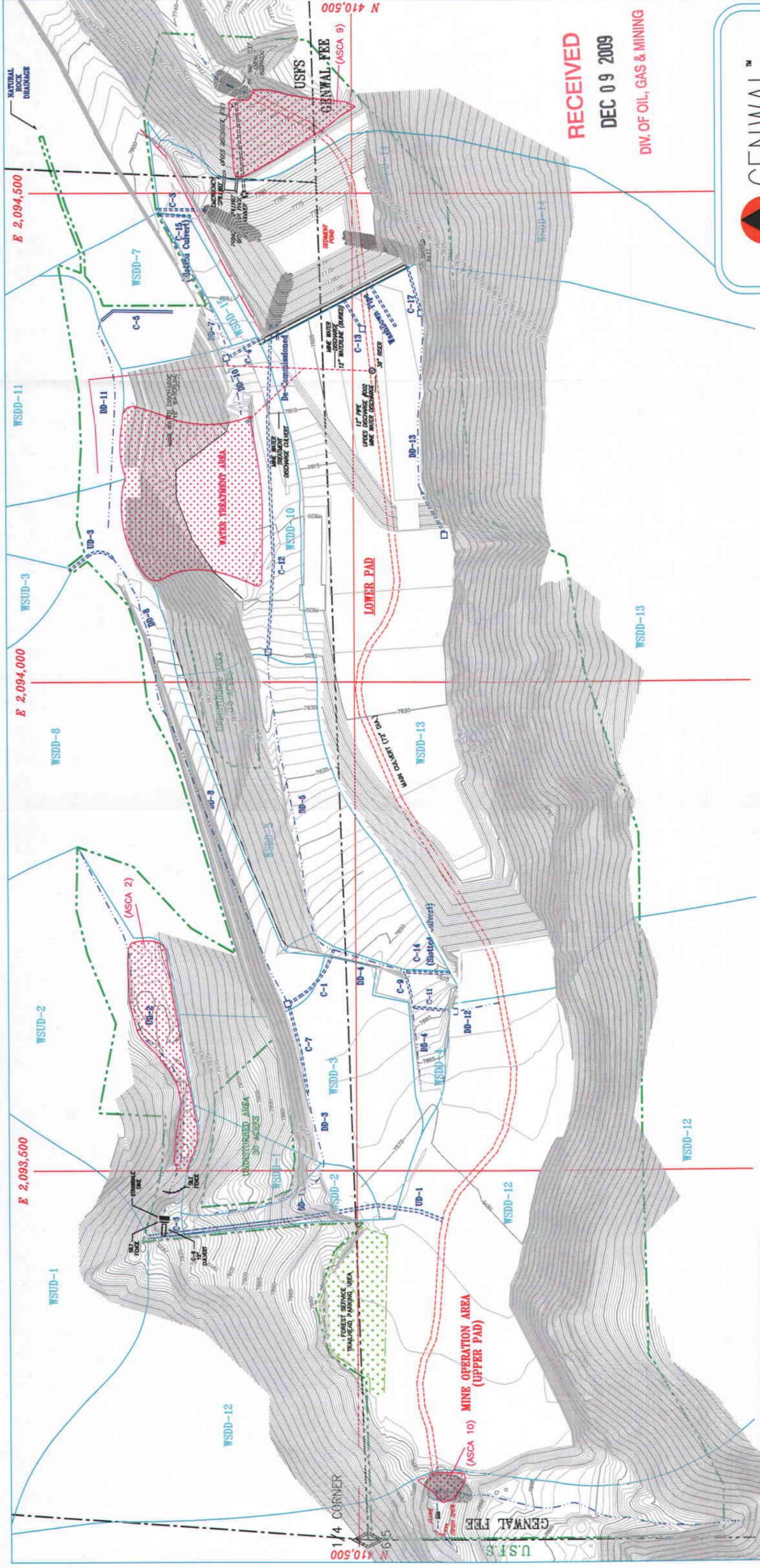
CRANDALL CANYON MINE
SURFACE FACILITIES

REV: 17	ACAD: 5-3
DATE: 10-12-09	BY: PJW
SCALE: AS SHOWN	PLATE #: 5-3



PLATE 7-5

DRAINAGE MAP



LEGEND:

	POTENTIAL EXTENT OF DISTURBANCE
	10' CONTOUR
	JERSEY BARRIERS
	WATERSHED BOUNDARY
	UNDISTURBED/DISTURBED WATERSHED
	DIVERSION DITCH
	CULVERT (Solid-Above Grd/Dashed-Buried)
	6' DIAMETER CULVERT
	ASCA AREA



CONTOUR INTERVAL = 10'



GENWAL™
RESOURCES, INC.
 P.O. Box 1077, 794 North "C" Canyon Rd, Price Utah
 Telephone: (435) 888-4000

CRANDALL CANYON MINE
DRAINAGE MAP

REV: 15	ACAD: 7-5
DATE: DEC. 2009	BY: PLJ
SCALE: 1" = 100'	PLATE #: 7-5

RECEIVED
DEC 09 2009
 DIV. OF OIL, GAS & MINING

E 2,093,500 E 2,094,000 E 2,094,500

N 410,500 N 410,500