Canyon Fuel Company, LLC
A Subsidiary of Bowie Resource Holdings, LLC

C/007/0039
Received 5/26/16
Task ID #5192

Dugout Canyon Mine
P.O. Box 1029
Wellington, Utah 84542
(435) 637-6360
Fax (435) 636-2897

May 25, 2016

Mr. Daron Haddock
Division of Oil, Gas and Mining (DOGM)
P.O. Box 145801
Salt Lake City, Utah 84114

Dear Mr. Haddock:

As required by R645-301-880.300, I have enclosed a copy of the application for Phase III Bond Release on select Methane Degasification Sites at Dugout Canyon Mine, Carbon County, Utah, C/007/039.

- C1 and C2 Forms
- Revised Bond Calculations
- Public Notice Letter for Bond Release Application
- Copies of letters sent to adjoining property owners, local government bodies, planning agencies, sewage and water treatment authorities and water companies
- Notarized statement, stating that all applicable reclamation has been accomplished
- Updated M&RP Attachments

Public notice for Phase III Bond Release will be published in the Sun Advocate and appear in the paper on May 26th, June 2nd, June 9th and June 16th, 2016. After which the Affidavit of Publication will be submitted to the Division.

Please contact me at (435) 636-2872 should you have any questions or comments regarding the enclosed information.

Sincerely,

David G. Spillman

David G. Spillman, P.E.
Technical Services Manager

APPLICATION FOR COAL PERMIT PROCESSING

Permit Change ☒ New Permit ☐ Renewal ☐ Exploration ☐ Bond Release ☒ Transfer ☐

Permittee: Canyon Fuel Company, LLC
Mine: Dugout Canyon Mine **Permit Number:** C/007/039
Title: Methane Degasification Site Bond Release C/007/039
Description, Include reason for application and timing required to implement:
Application for Phase III Bond Release on Methane Degasification Sites G-3 and G-4.

Instructions: If you answer yes to any of the first eight (gray) questions, this application may require Public Notice publication.

☒ Yes ☐ No 1. Change in the size of the Permit Area? Acres: 1.82 Disturbed Area: 1.82 ☐ increase ☒ decrease.
☐ Yes ☒ No 2. Is the application submitted as a result of a Division Order? DO# _____
☐ Yes ☒ No 3. Does the application include operations outside a previously identified Cumulative Hydrologic Impact Area?
☐ Yes ☒ No 4. Does the application include operations in hydrologic basins other than as currently approved?
☐ Yes ☒ No 5. Does the application result from cancellation, reduction or increase of insurance or reclamation bond?
☒ Yes ☐ No 6. Does the application require or include public notice publication?
☐ Yes ☒ No 7. Does the application require or include ownership, control, right-of-entry, or compliance information?
☐ Yes ☒ No 8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?
☐ Yes ☒ No 9. Is the application submitted as a result of a Violation? NOV # _____
☐ Yes ☒ No 10. Is the application submitted as a result of other laws or regulations or policies?
Explain: _____
☐ Yes ☒ No 11. Does the application affect the surface landowner or change the post mining land use?
☐ Yes ☒ No 12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2)
☐ Yes ☒ No 13. Does the application require or include collection and reporting of any baseline information?
☐ Yes ☒ No 14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?
☐ Yes ☒ No 15. Does the application require or include soil removal, storage or placement?
☒ Yes ☐ No 16. Does the application require or include vegetation monitoring, removal or revegetation activities?
☐ Yes ☒ No 17. Does the application require or include construction, modification, or removal of surface facilities?
☐ Yes ☒ No 18. Does the application require or include water monitoring, sediment or drainage control measures?
☐ Yes ☒ No 19. Does the application require or include certified designs, maps or calculation?
☐ Yes ☒ No 20. Does the application require or include subsidence control or monitoring?
☒ Yes ☐ No 21. Have reclamation costs for bonding been provided?
☐ Yes ☒ No 22. Does the application involve a perennial stream, a stream buffer zone or discharges to a stream?
☐ Yes ☒ No 23. Does the application affect permits issued by other agencies or permits issued to other entities?

Please attach one (1) review copy 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.

David Spillman — Print Name
David Spillman, Engineering Manager 5/25/16 — Sign Name, Position, Date

Subscribed and sworn to before me this 25th day of May, 2016

Mona S. Clausing
Notary Public
My commission Expires: 11-7-19, 20___}
Attest: State of Utah } ss:
County of Carbon

NOTARY PUBLIC
MONA S. CLAUSING
Commission No. 686189
Commission Expires
NOVEMBER 07, 2019
STATE OF UTAH

For Office Use Only:	Assigned Tracking Number:	Received by Oil, Gas & Mining

Form DOGM- C1 (Revised 9/17/2013)

APPLICATION FOR COAL PERMIT PROCESSING
Detailed Schedule Of Changes to the Mining And Reclamation Plan

Permittee: Canyon Fuel Company, LLC
Mine: Dugout Canyon Mine **Permit Number:** C/007/039
Title: Application for Phase III Bond Release on Methane Degasification Sites G-3 and g-4.

Provide a detailed listing of all changes to the Mining and Reclamation Plan, which is required as a result of this proposed permit application. Individually list all maps and drawings that are added, replaced, or removed from the plan. Include changes to the table of contents, section of the plan, or other information as needed to specifically locate, identify and revise the existing Mining and Reclamation Plan. Include page, section and drawing number as part of the description.

			DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐ Add	☒ Replace	☐ Remove	Dugout M&RP, Methane Degasification Amendment, Chapter 2, Attachment 2-4
☐ Add	☒ Replace	☐ Remove	Dugout M&RP, Methane Degasification Amendment, Chapter 5, Attachment 5-2
☐ Add	☒ Replace	☐ Remove	Dugout M&RP, Chapter 5, Appendix 5-6, Bond Amount, Page A
☐ Add	☒ Replace	☐ Remove	Dugout M&RP, Chapter 5, Appendix 5-6, Demolition Costs, Page 1 of 68
☐ Add	☒ Replace	☐ Remove	Dugout M&RP, Chapter 5, Appendix 5-6, Vegetation Costs, Page 1 of 1
☐ Add	☐ Replace	☐ Remove	
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☐ Add	☐ Replace	☐ Remove	

Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.	**Received by Oil, Gas & Mining**
See cover letter for additional information.	

Dugout M&RP, Methane Degasification Amendment

Chapter 2, Attachment 2-4

Dugout Canyon Mine Permit Number C/007/039

Canyon Fuel Company

Redline Strikeout

Title page for reference only

Attachment 2-4

Well No.	Year Constructed		Year Plugged		Contemporaneous Reclamation		Final Reclamation		Bond Release Phases
	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual	Actual
G-2		2004		2009	2007			2009	Phase I & II
G-3		2004		2005		2005		2005	Phase I, II & III
G-4		2004		2005				2005	Phase I, II & III
G-5		2004		2009	2007			2009	Phase I & II
G-6		2004		2005				2007	Phase I & II
G-7		2005		2008/2009	2007			2009	Phase I & II
G-9		2005		2008	2008		2010	2012	Phase I
G-10		2006		2008	2007		2010	2010	Phase I & II
G-11		2006		2008	2008		2015		
G-12		2006		2009	2007		2010	2011	Phase I & II
G-13		2006		2008	2008			2009	Phase I & II
G-14		2006	2010 (B)	2009 (A)	2008		2010	2010	Phase I & II
G-15*	N/A				2008		2015	2015	
G-16		2008					2011	2013	Phase I & II
G-17*	N/A						2014	2014	
G-18		2007	2010	2008 (A)	2009		2010	2012	Phase I & II
G-19		2007		2008	2008		2010	2010	Phase I
G-22		2008					2011	2013	Phase I
G-25		2009					2013	2013	Phase I
G-26		2009					2013	2013	Phase I
G-30	2010							2013	Phase I
G-31		2007	2010	2008 (A)	2009		2011	2013	Phase I & II

Dates are approximate, all events are subject to availability of contractors, weather, mining needs, etc.

Although permitted, wells G-1, G-8 and G-29 were never drilled/constructed

*Sites were not drilled and received minor distrubance

Attachment 5-2 and
Attachment 2-4

Dugout M&RP, Methane Degasification Amendment

Chapter 5, Attachment 5-2

Dugout Canyon Mine Permit Number C/007/039

Canyon Fuel Company

Redline Strikeout

Title page for reference only

Attachment 5-2, Table 1

Well No.	Year Constructed		Year Plugged		Final Reclamation		Bond Release Phases
	Planned	Actual	Planned	Actual	Planned	Actual	Actual
G-2		2004		2009		2009	Phase I & II
G-3		2004		2005		2005	Phase I, II & III
G-4		2004		2005		2005	Phase I, II & III
G-5		2004		2009		2009	Phase I & II
G-6		2004		2005		2007	Phase I & II
G-7		2005		2008/2009		2009	Phase I & II
G-9		2005		2008	2010	2012	Phase I
G-10		2006		2008	2010	2010	Phase I & II
G-11		2006		2008	2015		
G-12		2006		2009	2010	2011	Phase I & II
G-13		2006		2008		2009	Phase I & II
G-14		2006	2010 (B)	2009 (A)	2010	2010	Phase I & II
G-15*	N/A				2015	2015	
G-16		2008			2011	2013	Phase I & II
G-17*	N/A				2014	2014	
G-18		2007	2010	2008 (A)	2010	2012	Phase I & II
G-19		2007		2008	2010	2010	Phase I
G-22		2008			2011	2013	Phase I
G-25		2009			2013	2013	Phase I
G-26		2009			2013	2013	Phase I
G-30	2010					2013	Phase I
G-31		2007	2010	2008 (A)	2011	2013	Phase I & II

Dates are approximate, all events are subject to availability of contractors, weather, mining needs, etc.

Although permitted, wells G-1, G-8 and G29 were never drilled/constructed

*Sites were not drilled and received minor distrubance

Dugout M&RP, Chapter 5, Appendix 5-6,

Bond Amount

Dugout Canyon Mine Permit Number C/007/039

Canyon Fuel Company

Redline Strikeout

Title page for reference only

Direct Costs				
Subtotal Demolition and Removal	~~$690,650~~		$728,253	
Subtotal Backfilling and Grading	~~$1,049,995~~		$1,049,995	
Subtotal Revegetation	~~$440,478~~		$435,566	
Direct Costs	~~$2,181,122~~		$2,213,814	
Indirect Costs				
Mob/Demob	~~$218,112~~	~~10.0%~~	$221,381	10.0%
Contingency	~~$109,056~~	~~5.0%~~	$110,691	5.0%
Engineering Redesign	~~$54,528~~	~~2.5%~~	$55,345	2.5%
Main Office Expense	~~$148,316~~	~~6.8%~~	$150,539	6.8%
Project Management Fee	~~$54,528~~	~~2.5%~~	$55,345	2.5%
Subtotal Indirect Costs	~~$584,541~~	~~26.8%~~	$593,301	26.8%
Total Reclamation Cost 2015 Dollars	~~$2,765,663~~		$2,807,115	
Escalation factor for 2015		~~0.012~~		0.012
Number of years to next review		~~5~~		5
Escalation	~~$169,970.00~~		$172,518.00	
Escalated Reclamation Cost to 2020	~~$2,935,633.15~~		$2,979,633.23	
Reclamation Cost (rounded to nearest $1,000)	~~$2,936,000.00~~		$2,980,000.00	
Bond Amount in 2009 Dollars	~~$3,550,000.00~~		$3,550,000.00	
Difference Between Cost Estimate and Bond	~~$614,000.00~~		$570,000.00	
Percent Difference	~~17.30%~~		16.06%	

$$Escalated\$ = \left(\$ \times \left[1 + Rate\right]^{Years}\right)$$

Demo Line Item Subtotals

Ref.	Description	Cost 2015 Dollars
1	Mine Belt BC-1 No 1	$ 11,120
2	Transfer Building No 2	$ 22,460
3	Feed Belt BC 2 No 3	$ 7,524
4	Stack Tubes 2 No4	$ 4,686
5	Head House 1 No 5	$ 4,098
6	Transfer Belt BC 2 No 6	$ 5,019
7	Head House 2 No 7	$ 1,376
8	Reclaim Tunnel No 8	$ 38,640
9	Reclaim Belt BC 4 No 9	$ 7,033
10	Escape Tunnel 60 inch No 10	$ 1,119
11	Crusher Building No 11	$ 18,507
12	Truck Loadout Belt BC 5 No 12	$ 6,306
13	Truck Loadout and Scale No 13	$ 16,232
14	Bathhouse No 14	$ 76,623
15	Substation No 15	$ 2,281
16	Power Lines and Poles No 16	$ 2,828
17	Retaining Wall No 17	$ 891
18	Gabion Wall No 18	$ 21,314
19	Pump House No 19	$ 3,474
20	Paved Road No 20	$ 150,348
21	Stream Culvert 72 inch No 21	$ 28,588
22	Water Tanks No 22	$ 2,466
23	Rock Dust Bin No 23	$ 1,396
24	Fuel Tank and Fuel Station No 24	$ 1,830
25	Holding Tank No 25	$ 3,198
26	Ventilation Fan No 26	$ 1,714
27	Magnet No 27	$ 3,953
28	Water System No 28	$ 27,407
29	Sewage System No 29	$ 9,185
30	Storage Containers Non30 (8)	$ 11,257
31	Gilson Well No 31	$ 2,901
32	Switch House No 32	$ 6,364
33	Portals No 33	$ 28,326
34	Storage & Bolts Bin No 34	$ 2,955
35	Storage Building No 35	$ 2,183
36	Sampling System No 36	$ 1,270
37	Stoker Storage Bin No 37	$ 1,039
38	Substation No 2 No 38	$ 2,524
39	Gabion Baskets No 39	$ 1,488
40	Pace Fan Culvert No 40	$ 1,691
41	Pace Fan & Generators No 41	$ 52,618
42	Pace Fan Portal No 42	$ 5,766
43	Refuse Pile No 43	$ 30,704
44	Refuse Site No 44	$ 14,463
45	Degas Well G2 No 45	$ 10,759
46	Degas Well G3 No 46	$ 5,588
47	Degas Well G4 No 47	$ 5,850
48	Degas Well G-5 No 48	$ 7,972
49	Degas Well G 6 No 49	$ 3,242
50	Degas Well G-7 No 50	$ 6,109
51	Degas Well G-9 No 51	$ 7,912
52	Degas Well G-10 No 52	$ 8,143
53	Degas Well G-11 No 53	$ 4,077
54	Degas Well G-12 No 54	$ 5,783
55	Degas Well G-13 No 55	$ 9,262
56	Degas Well G-14 No 56	$ 7,463
57	Degas Well G-15 No 57	$ 5,464
58	Degas Well G-16 No 58	$ 7,385
59	Degas Well G-17 No 59	$ 7,200
60	Degas Well G-18 No 60	$ 15,158
61	Degas Well G-19 No 61	$ 9,142
62	Degas Well G-22 & Access Road No 62	$ 15,993
63	Degas Well G-25 No 63	$ 9,067
64	Degas Well G-26 No 64	$ 8,441
66	Degas Well G-30 No 66	$ 8,917
67	Degas Well G-31 No 67	$ 18,881
68	AMV Road No 68	$ 47,689
	Total	~~$ 834,974~~
		$ 882,663

TOTAL with Phase I & II Bond Release Applied

Total with Phase I & II Bond Release	~~$ 690,650~~
	$ 728,253

Phase I & II Bond Release of Degas Wells Breakout

Description	Phase I Bond Release 60%	Phase II Bond Release 40%	Total
Degas Well G2 No 45	$ 6,455	$ 4,304	$ 10,759
Degas Well G3 No 46	$ 3,353	$ 2,235	$ 5,588
Degas Well G4 No 47	$ 3,510	$ 2,340	$ 5,850
Degas Well G-5 No 48	$ 4,783	$ 3,189	$ 7,972
Degas Well G 6 No 49	$ 1,945	$ 1,297	$ 3,242
Degas Well G-7 No 50	$ 3,665	$ 2,444	$ 6,109
Degas Well G-9 No 51	$ 4,747		$ 4,747
Degas Well G-10 No 52	$ 4,886	$ 3,257	$ 8,143
Degas Well G-11 No 53			
Degas Well G-12 No 54	$ 3,470	$ 2,313	$ 5,783
Degas Well G-13 No 55	$ 5,557	$ 3,705	$ 9,262
Degas Well G-14 No 56	$ 4,478	$ 2,985	$ 7,463
Degas Well G-15 No 57			
Degas Well G-16 No 58	$ 4,431		$ 4,431
Degas Well G-17 No 59			
Degas Well G-18 No 60	$ 9,095	$ 6,063	$ 15,158
Degas Well G-19 No 61	$ 5,485		$ 5,485
Degas Well G-22 & Access Road No 62	$ 9,596		$ 9,596
Degas Well G-25 No 63	$ 5,440		$ 5,440
Degas Well G-26 No 64	$ 5,065		$ 5,065
Degas Well G-30 No 66	$ 5,350		$ 5,350
Degas Well G-31 No 67	$ 11,329	$ 7,552	$ 18,881
AMV Road No 68	$ 10,086		$ 10,086
Total	~~$ 102,640~~	~~$ 41,684~~	~~$ 144,324~~
	$ 112,726	$ 41,684	$ 154,410

Bill King:
The totals were corrected as they were missing line item 68.

Vegetation Line Item Subtotals

Ref.	Description	Cost 2015 Dollars
V-1	Dugout Mine Vegetation	$ 169,874
V-2	Dugout Mine Refuse Pile	$ 115,534
V-3	Pace Canyon Fan Portal	$ 8,173
V-4	Degas Well G2	$ 2,478
V-5	Degas Well G3	$ 2,783
V-6	Degas Well G4	$ 2,128
V-7	Degas Well G5	$ 2,282
V-8	Degas Well G6	$ 3,233
V-9	Degas Well G7	$ 2,661
V-10	Degas Well G9	$ 1,711
V-11	Degas Well G10	$ 1,598
V-12	Degas Well G11	$ 1,731
V-13	Degas Well G12	$ 1,749
V-14	Degas Well G13	$ 2,395
V-15	Degas Well G14	$ 2,166
V-16	Degas Well G15	$ 4,230
V-17	Degas Well G16	$ 3,507
V-18	Degas Well G17	$ 2,738
V-19	Degas Well G-18	$ 3,801
V-20	Degas Well G-19	$ 2,850
V-21	Degas Well G-22 and Access Road	$ 9,769
V-22	Degas Well G-25	$ 5,949
V-23	Degas Well G-26	$ 3,270
V-24	Degas Well G-30	$ 5,095
V-25	Degas Well G-31	$ 3,886
V-26	AMV Road	$ 74,885
	Total	**$ 440,478**

Phase III Bond Release Breakout

Description	Phase III Bond Release 100%
Pace Canyon Fan Portal	$ -
Degas Well G2	$ -
Degas Well G3	$ 2,783
Degas Well G4	$ 2,128
Degas Well G5	$ -
Degas Well G6	$ -
Degas Well G7	$ -
Degas Well G9	$ -
Degas Well G10	$ -
Degas Well G11	$ -
Degas Well G12	$ -
Degas Well G13	$ -
Degas Well G14	$ -
Degas Well G15	$ -
Degas Well G16	$ -
Degas Well G17	$ -
Degas Well G-18	$ -
Degas Well G-19	$ -
Degas Well G-22 and Access Road	$ -
Degas Well G-25	$ -
Degas Well G-26	$ -
Degas Well G-30	$ -
Degas Well G-31	$ -
AMV Road	$ -
Total	**$ 4,911**

TOTAL Phase III Bond Release Applied

Total With Phase III Bond Release	**$ 435,566**

Copies of Letters to Adjoining Property Owners etc.

Dugout Canyon Mine Permit Number C/007/039

Canyon Fuel Company

Redline Strikeout

Title page for reference only

Canyon Fuel Company, LLC
A Subsidiary of Bowie Resource Holdings, LLC

C/007/0039
Received 5/26/16
Task ID #5192

Dugout Canyon Mine
P.O. Box 1029
Wellington, Utah 84542
(435) 637-6360
Fax (435) 636-2897

May 23, 2016

Wellington City Hall/Public Works
150 W Main
PO Box 559
Wellington, UT 84542
(435) 637-5213

Dear Wellington City:

Notice is hereby given that Canyon Fuel Company has filed an application with the Utah Department of Natural Resources, Division of Oil, Gas and Mining for Phase III Bond Release. The Phase III Bond Release will be for two Methane Degasification Well sites accounting for 1.82 acres at the Dugout Canyon Mine.

All areas for bond release have met the regulation of the R645 Utah Coal Rules in regards to the vegetation standards for Phase III Bond Release (refer to R645-301-880). The Methane Degasification Well sites G-3 and G-4 are proposed for release. The locations of the areas are as follows:

Methane Degasification Well sites, the permit area is located in Carbon County, Utah as follows:

G-3 Portion of N1/2SW1/4NW1/4 Section 19 Township 13 South, Range 13 East
G-4 Portion of N1/2NE1/4NW1/4 Section 24 Township 13 South, Range 12 East

Reclamation of the noted areas above were completed in 2005.

The Phase III bond release application is to release the remaining surety bond held for the Dugout Canyon Mine, Methane Degasification Well sites G-3 and G4 in the amount of $4,911. All areas within the Methane Degasification Well sites meet the requirements of the regulations for post mine land use of Wildlife Habitat, Recreational, Grazing and Vegetation establishment.

A copy of the Phase III bond release application may be examined at the office of Division of Oil, Gas and Mining, 1594 West North Temple, Suite 1210, Salt Lake City, Utah 84114-5801 and written comments, objections, or requests for an informal conference may be submitted to the Salt Lake City address. Said comments must be submitted thirty (30) days from the date of the last publication of this notice. This notice is being published to comply with the Surface Mining Control and Reclamation Act of 1977, and State and Federal regulations promulgated pursuant to said Act.

Published in the Sun Advocate of Carbon County Utah for four consecutive weeks beginning May 26, 2016.

Please contact me at (435) 636-2872 should you have any questions or comments regarding the enclosed information.

Sincerely,

David G. Spillman

David G. Spillman, P.E.
Technical Services Manager

Canyon Fuel Company, LLC
A Subsidiary of Bowie Resource Holdings, LLC

Dugout Canyon Mine
P.O. Box 1029
Wellington, Utah 84542
(435) 637-6360
Fax (435) 636-2897

May 23, 2016

Wellington Canal Company
1400 South 3250 East
Price, UT 84501
(435) 820-4590

Dear Wellington Canal Company:

Notice is hereby given that Canyon Fuel Company has filed an application with the Utah Department of Natural Resources, Division of Oil, Gas and Mining for Phase III Bond Release. The Phase III Bond Release will be for two Methane Degasification Well sites accounting for 1.82 acres at the Dugout Canyon Mine.

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Sincerely,

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David G. Spillman, P.E.
Technical Services Manager

Canyon Fuel Company, LLC
A Subsidiary of Bowie Resource Holdings, LLC

Dugout Canyon Mine
P.O. Box 1029
Wellington, Utah 84542
(435) 637-6360
Fax (435) 636-2897

May 23, 2016

Milton and Ardith Thayn Trust
7730 East Hwy 6
Price, UT 84501

Dear Mr. Thayn:

Notice is hereby given that Canyon Fuel Company has filed an application with the Utah Department of Natural Resources, Division of Oil, Gas and Mining for Phase III Bond Release. The Phase III Bond Release will be for two Methane Degasification Well sites accounting for 1.82 acres at the Dugout Canyon Mine.

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G-4 Portion of N1/2NE1/4NW1/4 Section 24 Township 13 South, Range 12 East

Reclamation of the noted areas above were completed in 2005.

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A copy of the Phase III bond release application may be examined at the office of Division of Oil, Gas and Mining, 1594 West North Temple, Suite 1210, Salt Lake City, Utah 84114-5801 and written comments, objections, or requests for an informal conference may be submitted to the Salt Lake City address. Said comments must be submitted thirty (30) days from the date of the last publication of this notice. This notice is being published to comply with the Surface Mining Control and Reclamation Act of 1977, and State and Federal regulations promulgated pursuant to said Act.

Published in the Sun Advocate of Carbon County Utah for four consecutive weeks beginning May 26, 2016.

Please contact me at (435) 636-2872 should you have any questions or comments regarding the enclosed information.

Sincerely,

David G. Spillman

David G. Spillman, P.E.
Technical Services Manager

Canyon Fuel Company, LLC
A Subsidiary of Bowie Resource Holdings, LLC

Dugout Canyon Mine
P.O. Box 1029
Wellington, Utah 84542
(435) 637-6360
Fax (435) 636-2897

May 23, 2016

Price River Water Improvement District
265 S Fairgrounds Rd
Price, UT 84501
(435) 637-6350

Dear Price River Water Improvement District:

Notice is hereby given that Canyon Fuel Company has filed an application with the Utah Department of Natural Resources, Division of Oil, Gas and Mining for Phase III Bond Release. The Phase III Bond Release will be for two Methane Degasification Well sites accounting for 1.82 acres at the Dugout Canyon Mine.

All areas for bond release have met the regulation of the R645 Utah Coal Rules in regards to the vegetation standards for Phase III Bond Release (refer to R645-301-880). The Methane Degasification Well sites G-3 and G-4 are proposed for release. The locations of the areas are as follows:

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A Subsidiary of Bowie Resource Holdings, LLC

Dugout Canyon Mine
P.O. Box 1029
Wellington, Utah 84542
(435) 637-6360
Fax (435) 636-2897

May 23, 2016

Price Public Works Complex
432 West 600 South
Price, UT 84501

Dear Price Public Works:

Notice is hereby given that Canyon Fuel Company has filed an application with the Utah Department of Natural Resources, Division of Oil, Gas and Mining for Phase III Bond Release. The Phase III Bond Release will be for two Methane Degasification Well sites accounting for 1.82 acres at the Dugout Canyon Mine.

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Dugout Canyon Mine
P.O. Box 1029
Wellington, Utah 84542
(435) 637-6360
Fax (435) 636-2897

May 23, 2016

Price City Administration
City Hall
185 East Main Street
Price, UT 84501

Dear Price City:

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A Subsidiary of Bowie Resource Holdings, LLC

Dugout Canyon Mine
P.O. Box 1029
Wellington, Utah 84542
(435) 637-6360
Fax (435) 636-2897

May 23, 2016

Bureau of Land Management
Price Field Office
125 South 600 West
Price, UT 84501
(435) 636-3600

Notice is hereby given that Canyon Fuel Company has filed an application with the Utah Department of Natural Resources, Division of Oil, Gas and Mining for Phase III Bond Release. The Phase III Bond Release will be for two Methane Degasification Well sites accounting for 1.82 acres at the Dugout Canyon Mine.

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Dugout Canyon Mine
P.O. Box 1029
Wellington, Utah 84542
(435) 637-6360
Fax (435) 636-2897

May 23, 2016

KFJ Ranch Partnership
Kerwin Jensen
Cleveland, UT 84518

Dear Mr. Jensen:

Notice is hereby given that Canyon Fuel Company has filed an application with the Utah Department of Natural Resources, Division of Oil, Gas and Mining for Phase III Bond Release. The Phase III Bond Release will be for two Methane Degasification Well sites accounting for 1.82 acres at the Dugout Canyon Mine.

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Technical Services Manager

Canyon Fuel Company, LLC
A Subsidiary of Bowie Resource Holdings, LLC

Dugout Canyon Mine
P.O. Box 1029
Wellington, Utah 84542
(435) 637-6360
Fax (435) 636-2897

May 23, 2016

Glen L Wells
350 N 700 W
Wellington, UT 84542
(435) 630-6368

Dear Mr. Wells:

Notice is hereby given that Canyon Fuel Company has filed an application with the Utah Department of Natural Resources, Division of Oil, Gas and Mining for Phase III Bond Release. The Phase III Bond Release will be for two Methane Degasification Well sites accounting for 1.82 acres at the Dugout Canyon Mine.

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A Subsidiary of Bowie Resource Holdings, LLC

Dugout Canyon Mine
P.O. Box 1029
Wellington, Utah 84542
(435) 637-6360
Fax (435) 636-2897

May 23, 2016

Gil H Conover
P.O. Box 83
Ferron, UT 84523

Dear Mr. Conover:

Notice is hereby given that Canyon Fuel Company has filed an application with the Utah Department of Natural Resources, Division of Oil, Gas and Mining for Phase III Bond Release. The Phase III Bond Release will be for two Methane Degasification Well sites accounting for 1.82 acres at the Dugout Canyon Mine.

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Technical Services Manager

Canyon Fuel Company, LLC
A Subsidiary of Bowie Resource Holdings, LLC

Dugout Canyon Mine
P.O. Box 1029
Wellington, Utah 84542
(435) 636-2872
Fax (435) 636-2897

May 23, 2016

Carbon County Planning/Zoning
65 South 100 East
Price, UT 84501
(435) 636-3260

Dear Carbon County Planning/Zoning:

Notice is hereby given that Canyon Fuel Company has filed an application with the Utah Department of Natural Resources, Division of Oil, Gas and Mining for Phase III Bond Release. The Phase III Bond Release will be for two Methane Degasification Well sites accounting for 1.82 acres at the Dugout Canyon Mine.

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A Subsidiary of Bowie Resource Holdings, LLC

Dugout Canyon Mine
P.O. Box 1029
Wellington, Utah 84542
(435) 637-6360
Fax (435) 636-2897

May 23, 2016

Bowie Resources Partners
Ryan Wilson
225 North 5th Street Suite 900
Grand Junction, CO 81501
(970) 263-5130

Dear Mr. Wilson:

Notice is hereby given that Canyon Fuel Company has filed an application with the Utah Department of Natural Resources, Division of Oil, Gas and Mining for Phase III Bond Release. The Phase III Bond Release will be for two Methane Degasification Well sites accounting for 1.82 acres at the Dugout Canyon Mine.

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David G. Spillman

David G. Spillman, P.E.
Technical Services Manager

Notarized Statement of Completion

Dugout Canyon Mine Permit Number C/007/039

Canyon Fuel Company

Redline Strikeout

Title page for reference only

Canyon Fuel Company, LLC
A Subsidiary of Bowie Resource Holdings, LLC

Dugout Canyon Mine
P.O. Box 1029
Wellington, Utah 84542
(435) 637-6360
Fax (435) 636-2897

May 25, 2016

Mr. Daron Haddock
Division of Oil, Gas and Mining (DOGM)
P.O. Box 145801
Salt Lake City, Utah 84114

Dear Mr. Haddock:

Notice is hereby given to the Utah Department of Natural Resources, Division of Oil, Gas and Mining that Canyon Fuel Company, P.O. Box 1029, Wellington, Utah 84542, has completed the reclamation work for Phase III Bond Release on select Methane Degasification Sites of the Dugout Canyon Mine Permit C/007/039. The Phase III bond release applies to 1.82 acres used for Methane Degasification Well Sites where reclamation was completed in 2005. Canyon Fuel Company has completed Phase III of the approved reclamation plan and all areas have met the regulation of the R645 Utah Coal Rules.

The location of the areas are as follows:

G-3 Portion of N1/2SW1/4NW1/4 Section 19 Township 13 South, Range 13 East
G-4 Portion of N1/2NE1/4NW1/4 Section 24 Township 13 South, Range 12 East

The Phase III bond release application is for a surety bond reduction of $4,911 on the current bond for Dugout Canyon Mine. All areas within the Methane Degasification Well sites meet the requirements of the regulations for post mine land use of Wildlife Habitat, Recreational, Grazing and Vegetation establishment.

Please contact me at (435) 636-2872 should you have any questions or comments regarding the enclosed information.

Sincerely,

David G. Spillman, P.E.
Technical Services Manager

STATE OF UTAH
COUNTY OF: Carbon
ON THE 25th DAY OF May 2016
PERSONALLY APPEARED BEFORE ME
Mon S. Claus SIGNER(S) OF THE ABOVE
INSTRUMENT, WHO DULY ACKNOWLEDGED TO ME THAT
HE/SHE/THEY EXECUTED THE SAME

Mon S. Claus
NOTARY PUBLIC

NOTARY PUBLIC
MONICA S. CLAUSING
Commission No. 686189
Commission Expires
NOVEMBER 07, 2019
STATE OF UTAH

Public Notice Letter for Bond Release Application

Dugout Canyon Mine Permit Number C/007/039

Canyon Fuel Company

Redline Strikeout

Title page for reference only

Public Notice Phase III Bond Release Application Dugout Canyon Mine, Canyon Fuel Company LLC.

Public Notice
Phase III Bond Release Application
Dugout Canyon Mine
Canyon Fuel Company
P.O. Box 1029
Wellington, UT 84542
MSHA # 42-01890
Permit # C/007/039
Permit Renewed 3/16/2013

Notice is hereby given that Canyon Fuel Company has filed an application with the Utah Department of Natural Resources, Division of Oil, Gas and Mining for Phase III Bond Release. The Phase III Bond Release will be for two Methane Degasification Well sites accounting for 1.82 acres at the Dugout Canyon Mine.

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Revegetation Monitoring Sites: G-2, G-3, G-4, G-5, G-6 & Reference Areas

2014

Dugout Canyon Mine
Carbon County, Utah

Prepared by

MT. NEBO SCIENTIFIC, INC.
330 East 400 South, Suite 6
P.O. Box 337
Springville, Utah 84663
(801) 489-6937

Patrick D. Collins, Ph.D.

for

CANYON FUEL COMPANY, LLC
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

March 2015

TABLE OF CONTENTS

INTRODUCTION 1

METHODS 1
- Transect Placement 1
- Cover, Frequency & Composition 1
- Density 2
- Annual Biomass Production 2
- Sample Adequacy 2
- Diversity 3
- Photographs, Sample Location Map & Site Coordinates 3

RESULTS 4
- Site G-2 4
- Site G-3 5
- Site G-4 6
- Site G-5 7
- Site G-6 8
- Reference Area: Sagebrush/Snowberry/Grass 8
- Reference Area: Aspen/Maple/Douglas Fir 10
- Data Summary Tables 11
- Statistical Comparisons 25
  - Total Living Cover 25
  - Woody Species Density 26
  - Annual Biomass Production 27
  - Total Diversity 28

DISCUSSION 29
- Vegetation Establishment 29
- Final Bond Release Considerations 26

SUMMARY & CONCLUSIONS 31

SAMPLE LOCATION MAP . . . . . Attachment

INTRODUCTION

The Dugout Canyon Mine in Carbon County, Utah has developed sites on the land surface to drill boreholes for de-gasification measures to augment their underground coal mining operations. In doing so, relatively small pads were constructed to drill the de-gas boreholes. Although they were somewhat variable in size, each pad was approximately 200 ft x 300 ft. Prior to land disturbance caused for drill pad construction, the existing vegetation was quantitatively measured along with "reference areas" that were left undisturbed to be used for final revegetation success standards following reclamation of the sites.

In the growing season of 2014, several reclaimed sites studied to assess the current condition of the revegetated pads. When assessing the condition of the vegetation on the reclaimed sites, it can be determined whether or not they are approaching their revegetation success standard and if bond release could soon be a viable option for some of the sites.

The sites sampled in 2014 were G-2, G-3, G-4, G-5 and G-6 along with the associated reference areas. Prior to pad construction, these de-gas drill sites and their reference areas were first sampled in 2003. Sites G-3 and G-4 were reclaimed in 2005, G-6 was reclaimed in 2007, G-2 and G-5 were reclaimed in 2009.

METHODS

Transect Placement

Transect lines for quantitative sampling were randomly placed throughout the reclaimed and reference areas. From these transect lines, sample locations were chosen using random numbers on both sides and at right angles to them.

Cover, Frequency & Composition

Cover estimates were made using ocular methods with meter square quadrats. Species composition and relative frequencies were also assessed from the quadrats. Plant nomenclature follows "*A Utah Flora*" (Welsh et al. 2008).

Density

Density estimates for the woody plant species on the reclaimed and reference areas were made using a distance method called the point-quarter technique. In this method, random points were placed on the sample sites and divided into four quarters. The distances to the nearest woody plant species were then recorded in each quarter. The average point-to-individual distance was equal to the square root of the mean area per individual. Final calculations resulted in the number of individual woody plants per acre.

Annual Biomass Production

Total annual biomass productivity was estimated by clipping, drying and weighing current annual growth in sample quadrats. "Double sampling" methods were employed by placing four additional quadrats around the clipped quadrat, then estimating the production of them relative to the clipped plot. Herbaceous and woody species production were clipped, weighed and reported separately.

Sample Adequacy

Sample adequacy for cover, density and production was attempted with the goal that 90% of the samples were within 10% of the true mean for the plant communities in the area. The following formula was used:

$$nMIN = \frac{t^2 s^2}{(dx)^2}$$

where,

nMIN	= minimum adequate sample
t	= appropriate confidence t-value
s	= standard deviation
x	= sample mean
d	= desired change from mean

Diversity

One diversity index was employed to some of the reclaimed datasets for comparisons with the reference areas – *MacArthur's Diversity Index*. This index is an effective diversity measurement and is computed using the equation $1/\sum pi^2$ (MacArthur and Wilson 1976, The Theory of Island Biogeography, Princeton: Princeton University Press). In this equation *pi* is the proportion of sum frequency contributed by the *i*th species in the sample area of concern. The proportional contribution of each species is then squared and the values for all species in the sample areas are summed. This index integrates the number of species and the degree to which frequency of occurrence was equitably distributed among those species. In other words, this index provides greater weight to those species that are present more often (with greater frequency) than those that are merely "present" in one or two quadrats.

Photographs, Sample Location Map & Site Coordinates

Color photographs were taken of the sample areas and have been included in this report. An aerial image map showing the sample sites has also been included. Coordinates of the monitoring sites are shown below.

Revegetation Monitoring Sites (2014)

SITE NAME	GPS NAME	COORDINATES (meters; NAD 27)
Reclaimed Site: G-2	DUGG-2	12 S 541234 4392461
Reclaimed Site: G-3	DUGG-3	12 S 541759 4392466
Reclaimed Site: G-4	DUGG-4	12 S 540755 4392949
Reclaimed Site: G-5	DUGG-5	12 S 541253 4392875
Reclaimed Site: G-6	DUGG-6	12 S 541857 4392930
Reference Area: Sagebrush/Snowberry/Grass	DUGRSG	12 S 541789 4392550
Reference Area: Aspen/Maple/Douglas Fir	DUGRAF	12 S 541840 4392837

RESULTS

Site: G-2

A sagebrush/snowberry/grass plant community at this drill site was reclaimed 2009. Vegetation sampling in 2014 showed that, like its native condition, it is again dominated by sagebrush (*Artemisia tridentata*). Other important species included Kentucky bluegrass (*Poa pratensis*), Western wheatgrass (*Elymus smithii*), mountain brome (*Bromus carinatus*), snowberry (*Symphoricarpos oreophilus*) and thickspike wheatgrass (*Elymus lanceolatus*). For a list of all species encountered in the sample quadrats, refer to Table 1.

Site: G-2

The total living cover in 2014 was estimated at 58.75% (Table 2-A), of which was nearly equally represented with grasses (47.46%) and shrubs (46.98%), much fewer forbs (5.56%). The understory composition is shown on Table 2-B.

With all the young plants and more mature plants becoming established, woody species density was quite high with a total of 11,969 individuals per acre. The woody plants in the samples consisted of only sagebrush and snowberry, with the former being the dominant (Table 3).

Site: G-3

Another sagebrush/snowberry/grass community when it was in its native state, this site was reclaimed earlier, or in 2005. In 2014, this site was dominated by grass species, namely Western wheatgrass, thickspike wheatgrass, crested wheatgrass (*Agropyron cristatum*) and bluebunch wheatgrass (*Elymus spicatus*). Sagebrush was the only shrub present in the samples and had a relatively low cover value (Table 4).

The total living cover for this site was estimated at 61.13% (Table 5-A) and was comprised of 94.02% grasses, 4.10% shrubs and 1.88% forbs (Table 5-B).

As one might expect from the cover data, woody species density was low at only 112 individuals per acre with sagebrush and snowberry being the only shrubs encountered in the samples (Table 6).

Because the site has been reclaimed long enough to be a candidate for Phase III Bond Release, the annual biomass productivity was also measured in 2014. It was estimated at 463.48 pounds per acre (Table 7).

Site: G-3

Site: G-4

Like site G-3, G-4 was reclaimed in 2005. In its native condition it was once an aspen/Douglas fir community, but it was disturbed even before the drill pad was constructed by road building and early logging activities. Following re-seeding, this site is currently dominated by bluebunch wheatgrass, sagebrush, Sandberg's bluegrass (Poa secunda) and Kentucky bluegrass (Table 8).

Site: G-4

The total living cover was estimated at 77.00% (Table 9-A), mostly coming from understory (75.75%), with overstory as a minor component (1.25%). The understory composition was comprised of 77.25% grasses, 15.95% woody plants and 6.81% forbs (Table 9-B).

The total woody density at the site was calculated at 2,191 plants per acre and was dominated by sagebrush and snowberry (Table 10).

Annual biomass was also sampled at this site with a total of 1,471.91 pounds per acre (Table 11).

Site: G-5

Like sites G-2 and G-3 described above, G-5 was a sagebrush/snowberry/grass community before the drill pad was constructed. The drill pad here was reclaimed in 2009. In 2014, the site was dominated by sagebrush, Sandberg's bluegrass, smooth brome, Western wheatgrass and bluebunch wheatgrass (Table 12).

Site: G-5

The total living cover at this site was 63.00% of which consisted of 60.50% understory cover and 2.50% overstory (Table 13-A). The composition of the understory cover was comprised of 54.88% grasses, 39.69% shrubs and 5.43% forbs (Table 13-B).

The woody species density totaled 4,749 plants per acre (Table 14) and included sagebrush, snowberry and white fir (*Abies concolor*).

Site: G-6

The last reclaimed drill site sampled in 2014 was G-6. Prior to the disturbance to the native vegetation it was an aspen/maple/Douglas fir community. This area was reclaimed and re-seeded in 2007. By 2014, it was dominated by Kentucky bluegrass, smooth brome, Western wheatgrass, sagebrush, bluestem wheatgrass and Sanderg's bluegrass (Table 15).

The total living cover in 2014 was estimated at 58.75% (Table 16-A). The composition of the cover was 79.30% grasses, 11.08% trees/shrubs and 9.62% forbs (Table 16-B).

Site: G-6

Site G-6 had a total density of 1,447 individuals per acre and dominated by a wide margin by sagebrush (Table 17).

Reference Area: Sagebrush/Snowberry/Grass

A reference area was chosen and sampled in 2003 to represent future revegetation success standards for the sagebrush/snowberry/grass communities that were disturbed by construction of the de-gas drill sites or G-2, G-3 and G-5.

Also sampled in 2014, the Sagebrush/Snowberry/ Grass Reference Area was dominated by Vasey big sagebrush (*Artemisia tridentata* var. *vaseyana*), snowberry, Sandberg's bluegrass, bluebunch wheatgrass and Watson penstemon (*Penstemon watsonii*). For a list of all species sampled in the quadrats, refer to Table 18.

Sagebrush/Snowberry/Grass Reference Area

In 2014, the total living cover of the Sagebrush/Snowberry/Grass Reference Area was 56.25% (Table 19-A), of which the understory composition was comprised of 65.47% woody plants, 19.47% grasses, and 15.05% forbs (Table 19-B).

Woody species density was estimated at 5,892 plants per acre, most of which were Vasey sagebrush and snowberry (Table 20).

Annual biomass production was also sampled in 2014, with an estimated total of 855.65 pounds per acre (Table 21).

Reference Area: Aspen/Maple/Douglas Fir

In 2003, another reference area was chosen to represent future revegetation success standards for sites proposed for disturbance a that time, or G-4 and G-6. This reference area was within an aspen/maple/douglas fir community.

Sampled again in 2014, plants present in the overstory quadrats were aspen (*Populus tremuloides*), big-toothed maple (*Acer grandidentatum*) , Douglas fir (*Pseudotsuga menziesii*) and white fir. Dominant understory species were big-toothed maple, snowberry, aspen, Douglas fir and muttongrass (*Poa fendleriana*). For a list of all species present in the sample quadrats, refer to Table 22.

Aspen/Maple/Douglas Fir Reference Area

Total living cover in this reference area was 78.38%, 44.75% of which was understory cover and 33.63% from overstory (Table 23-A). The understory cover composition included 88.71% woody plants, 9.07% grasses and only 1.73% forbs (Table 23-B).

Total woody species density was estimated at 5,871 individuals per acre, and was dominated by snowberry, big-toothed maple, aspen and Douglas Fir (Table 24).

Annual biomass production was also sampled in 2014, with an estimated total of 769.49 pounds per acre (Table 25).

Data Summary Tables

Table 1: Dugout Canyon Mine. Living Cover and Frequency by Plant Species (2014).

Reclaimed Site: G-2			n=20
Sagebrush/Snowberry/Grass			
	Mean Percent	**Standard Deviation**	**Percent Frequency**
SHRUBS			
Artemisia tridentata	24.00	16.02	90.00
Symphoricarpos oreophilus	4.75	9.55	20.00
FORBS			
Cynoglossum officinale	1.25	3.49	15.00
Erigeron sp.	1.75	5.76	10.00
GRASSES			
Bromus carinatus	5.75	12.28	20.00
Bromus tectorum	0.50	1.50	10.00
Elymus lanceolatus	4.00	7.52	25.00
Elymus smithii	6.25	9.47	35.00
Elymus spicatus	2.00	6.78	10.00
Poa pratensis	8.50	12.56	35.00

Table 2: Dugout Canyon Mine. Total Cover and Composition (2014).

Reclaimed Site: G-2		n=20
Sagebrush/Snowberry/Grass		
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Understory	58.75	9.73
Litter	11.10	3.60
Bareground	24.25	11.54
Rock	5.90	2.10
B. % COMPOSITION		
Shrubs	46.98	22.47
Forbs	5.56	11.97
Grasses	47.46	24.48

Table 3: Dugout Canyon Mine. Woody Species Density (2014).

Reclaimed Site: G-2	n=20
Sagebrush/Snowberry/Grass	
SPECIES	**Individuals/Acre**
Artemisia tridentata	11370.39
Symphoricarpos oreophilus	598.44
TOTAL	**11968.83**

Table 4: Dugout Canyon Mine. Living Cover and Frequency by Plant Species (2014).

Reclaimed Site: G-3			n=40
Sagebrush/Snowberry/Grass			
	Mean Percent	**Standard Deviation**	**Percent Frequency**
SHRUBS			
Artemisia tridentata	2.63	7.66	17.50
FORBS			
Lupinus argenteus	0.88	2.93	10.00
Penstemon watsonii	0.25	1.56	2.50
GRASSES			
Agropyron cristatum	11.38	22.50	25.00
Bromus inermis	2.63	9.15	10.00
Elymus lanceolatus	11.63	14.93	50.00
Elymus smithii	22.50	21.07	65.00
Elymus spicatus	7.50	15.29	32.50
Poa secunda	1.75	5.07	12.50

Table 5: Dugout Canyon Mine. Total Cover and Composition (2014).

Reclaimed Site: G-3		n=40
Sagebrush/Snowberry/Grass		
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Understory	61.13	7.87
Litter	12.63	4.74
Bareground	18.13	8.12
Rock	8.13	2.67
B. % COMPOSITION		
Shrubs	4.10	12.20
Forbs	1.88	5.50
Grasses	94.02	14.81

Table 6: Dugout Canyon Mine. Woody Species Density (2014).

Reclaimed Site: G-3	n=40
Sagebrush/Snowberry/Grass	
SPECIES	**Individuals/Acre**
Artemisia tridentata	110.69
Symphoricarpos oreophilus	1.40
TOTAL	**112.10**

Table 7: Dugout Canyon Mine. Annual Biomass Production (2014).

Reclaimed Site: G-3 n=40 (DS n=160)

Sagebrush/Snowberry/Grass

	Pounds/Acre	
LIFEFORM	**MEAN**	**STD. DEV.**
Herbaceous	404.98	171.68
Woody	58.50	161.52
TOTAL	**463.48**	**90.43**

Table 8: Dugout Canyon Mine. Living Cover and Frequency by Plant Species (2014).

Reclaimed Site: G-4			n=20
Aspen/Douglas Fir (Previously Disturbed)			
	Mean Percent	**Standard Deviation**	**Percent Frequency**
OVERSTORY			
Pseudotsuga menziesii	1.25	5.45	5.00
UNDERSTORY			
TREES & SHRUBS			
Artemisia tridentata	10.50	15.16	35.00
Mahonia repens	0.25	1.09	5.00
Populus tremuloides	1.00	4.36	5.00
Symphoricarpos oreophilus	0.75	3.27	5.00
FORBS			
Cynoglossum officinale	0.75	1.79	15.00
Medicago sativa	0.50	2.18	5.00
Penstemon sp.	3.00	5.79	25.00
Tragopogon dubius	1.00	3.00	10.00
GRASSES			
Elymus cinereus	1.75	7.63	5.00
Elymus spicatus	28.25	15.99	90.00
Poa pratensis	10.25	11.34	55.00
Poa secunda	17.75	14.36	80.00

Table 9: Dugout Canyon Mine. Total Cover and Composition (2014).

Reclaimed Site: G-4		n=20
Aspen/Douglas Fir (Previously Disturbed)		
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Overstory (O)	1.25	5.45
Understory (U)	75.75	10.64
Litter	6.70	3.10
Bareground	11.80	8.90
Rock	5.75	3.16
O + U	77.00	8.86
B. % COMPOSITION		
Trees/Shrubs	15.95	17.98
Forbs	6.81	8.86
Grasses	77.25	20.66

Table 10: Dugout Canyon Mine. Woody Species Density (2014).

Reclaimed Site: G-4	n=20
Aspen/Douglas Fir (Previously Disturbed)	
SPECIES	**Individuals/Acre**
Artemisia tridentata	1588.55
Chrysothamnus nauseosus	27.39
Lonicera involucrata	27.39
Populus tremuloides	109.56
Pseudotsuga menziesii	54.78
Symphoricarpos oreophilus	383.44
TOTAL	**2191.11**

Table 11: Dugout Canyon Mine. Annual Biomass Production (2014).

n=20 (DS n=80)

Reclaimed Site: G-4
Aspen/Douglas Fir (Previously Disturbed)

	Pounds/Acre	
LIFEFORM	**MEAN**	**STD. DEV.**
Herbaceous	853.26	783.87
Woody	618.65	996.18
TOTAL	**1471.91**	**742.35**

Table 12: Dugout Canyon Mine. Living Cover and Frequency by Plant Species (2014).

Reclaimed Site: G-5			n=20
Sagebrush/Snowberry/Grass			
	Mean Percent	**Standard Deviation**	**Percent Frequency**
OVERSTORY			
Abies concolor	2.50	10.90	5.00
UNDERSTORY			
SHRUBS			
Artemisia tridentata	24.75	19.40	90.00
Symphoricarpos oreophilus	0.50	2.18	5.00
FORBS			
Achillea millefolium	1.50	3.91	15.00
Cynoglossum officinale	1.00	2.00	20.00
Penstemon sp.	0.25	1.09	5.00
Taraxacum officinale	0.50	2.18	5.00
GRASSES			
Bromus carinatus	8.25	14.17	30.00
Elymus lanceolatus	2.00	4.00	20.00
Elymus smithii	8.00	15.92	30.00
Elymus spicatus	4.00	7.52	25.00
Poa secunda	9.75	16.08	45.00

Table 13: Dugout Canyon Mine. Total Cover and Composition (2014).		
Reclaimed Site: G-5		n=20
Sagebrush/Snowberry/Grass		
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Overstory (O)	2.50	10.90
Understory (U)	60.50	12.64
Litter	7.90	3.13
Bareground	24.00	14.37
Rock	7.60	3.15
O + U	63.00	11.22
B. % COMPOSITION		
Shrubs	39.69	26.81
Forbs	5.43	6.69
Grasses	54.88	26.36

Table 14: Dugout Canyon Mine. Woody Species Density (2014).	
Reclaimed Site: G-5	n=20
Sagebrush/Snowberry/Grass	
SPECIES	**Individuals/Acre**
Abies concolor	59.36
Artemisia tridentata	4511.17
Symphoricarpos oreophilus	178.07
TOTAL	**4748.60**

Table 15: Dugout Canyon Mine. Living Cover and Frequency by Plant Species (2014).

Reclaimed Site: G-6			n=20
Aspen/Maple/Douglas Fir			
	Mean Percent	**Standard Deviation**	**Percent Frequency**
TREES & SHRUBS			
Agropyron cristatum	0.25	1.09	5.00
Artemisia tridentata	5.00	8.51	35.00
Populus tremuloides	0.25	1.09	5.00
Taraxacum officinale	0.75	2.38	10.00
FORBS			
Achillea millefolium	2.25	6.61	20.00
Cynoglossum officinale	2.25	4.87	25.00
Polygonum aviculare	0.50	1.50	10.00
GRASSES			
Bromus carinatus	8.50	13.70	35.00
Bromus tectorum	0.50	2.18	5.00
Elymus lanceolatus	3.00	4.30	35.00
Elymus smithii	7.50	10.06	50.00
Elymus spicatus	4.50	7.89	30.00
Poa pratensis	19.25	19.06	60.00
Poa secunda	4.25	11.54	20.00

Table 16: Dugout Canyon Mine. Total Cover and Composition (2014).

Reclaimed Site: G-6		n=20
Aspen/Maple/Douglas Fir		
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Understory	58.75	13.59
Litter	11.65	6.38
Bareground	20.75	11.76
Rock	8.85	3.26
B. % COMPOSITION		
Trees/Shrubs	11.08	16.51
Forbs	9.62	14.59
Grasses	79.30	21.46

Table 17: Dugout Canyon Mine. Woody Species Density (2014).

Reclaimed Site: G-6	n=20
Aspen/Maple/Douglas Fir	
SPECIES	**Individuals/Acre**
Acer grandidentatum	18.09
Artemisia tridentata	1248.39
Chrysothamnus nauseosus	18.09
Populus tremuloides	54.28
Pseudotsuga menziesii	72.37
Rosa woodsii	18.09
Symphoricarpos oreophilus	18.09
TOTAL	**1447.41**

Table 18: Dugout Canyon Mine. Living Cover and Frequency by Plant Species (2014).

Reference Area			
Sagebrush/Snowberry/Grass			n=40
	Mean Percent	**Standard Deviation**	**Percent Frequency**
OVERSTORY			
Pseudotsuga menziesii	1.75	10.93	2.50
UNDERSTORY			
TREES & SHRUBS			
Amelanchier utahensis	2.88	9.87	10.00
Artemisia tridentata var. vaseyana	22.75	13.32	97.50
Juniperus scopulorum	0.50	3.12	2.50
Pseudotsuga menziesii	1.13	4.94	10.00
Symphoricarpos oreophilus	9.50	13.03	45.00
FORBS			
Achillea millefolium	0.25	1.56	2.50
Cynoglossum officinale			
Erigeron engelmannii	0.38	1.73	5.00
Erigeron engelmannii	2.50	4.87	27.50
Eriogonum sp.	0.13	0.78	2.50
Erysimum asperum	0.13	0.78	2.50
Lupinus argenteus	0.50	1.50	10.00
Penstemon watsonii	3.38	5.74	30.00
GRASSES			
Elymus spicatus	4.75	4.74	60.00
Poa secunda	5.50	6.10	60.00

Table 19: Dugout Canyon Mine. Total Cover and Composition (2014).

Reference Area		n=40
Sagebrush/Snowberry/Grass		
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Overstory (O)	1.75	10.93
Understory (U)	54.50	10.59
Litter	18.38	10.53
Bareground	18.28	12.16
Rock	8.85	10.34
O + U	56.25	16.91
B. % COMPOSITION		
Trees/Shrubs	65.47	20.00
Forbs	15.05	17.92
Grasses	19.47	12.87

Table 20: Dugout Canyon Mine. Woody Species Density (2014).

Reference Area	n=40
Sagebrush/Snowberry/Grass	
SPECIES	**Individuals/Acre**
Amelanchier utahensis	257.76
Artemisia tridentata var. vaseyana	4124.18
Juniperus scopulorum	110.47
Pseudotsuga menziesii	73.65
Symphoricarpos oreophilus	1325.63
TOTAL	**5891.69**

Table 21: Dugout Canyon Mine. Annual Biomass Production (2014).

Reference Area n=40 (DS n=160)

Sagebrush/Snowberry/Grass

	Pounds/Acre	
LIFEFORM	**MEAN**	**STD. DEV.**
Herbaceous	169.04	299.91
Woody	686.61	470.86
TOTAL	**855.65**	**282.08**

Table 22: Dugout Canyon Mine. Living Cover and Frequency by Plant Species (2014).

Reference Area			n=40
Aspen/Maple/ Douglas Fir			
	Mean Percent	**Standard Deviation**	**Percent Frequency**
OVERSTORY			
Abies concolor	5.75	16.45	12.50
Acer grandidentatum	9.00	15.50	25.00
Populus tremuloides	11.00	17.72	30.00
Pseudotsuga menziesii	7.88	16.20	22.50
UNDERSTORY			
TREES & SHRUBS			
Abies concolor	2.75	6.70	17.50
Acer grandidentatum	13.13	12.98	67.50
Artemisia tridentata	0.13	0.78	2.50
Juniperus communis	2.13	7.82	7.50
Mahonia repens	3.63	7.66	25.00
Populus tremuloides	4.13	9.08	22.50
Pseudotsuga menziesii	4.13	9.48	22.50
Rosa woodsii	1.25	3.49	12.50
Symphoricarpos oreophilus	8.25	10.10	57.50
FORBS			
Achillea millefolium	0.13	0.78	2.50
Aquilegia caerulea	0.00	0.00	2.50
Cynoglossum officinale	0.13	0.78	2.50
Smilacina stellata	0.13	0.78	2.50
Taraxacum officinale	0.13	0.78	2.50
Thalictrum fendleri	0.25	1.09	5.00
Viola adunca	0.13	0.78	2.50
GRASSES			
Poa fendleriana	4.13	4.73	57.50

Table 23: Dugout Canyon Mine. Total Cover and Composition (2014).

Reference Area		n=40
Aspen/Maple/ Douglas Fir		
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Overstory (O)	33.63	15.93
Understory (U)	44.75	13.37
Litter	41.73	19.17
Bareground	12.10	13.71
Rock	1.43	1.07
O + U	78.38	12.52
B. % COMPOSITION		
Trees/Shrubs	88.71	12.46
Forbs	1.73	3.88
Grasses	9.07	9.84

Table 24: Dugout Canyon Mine. Woody Species Density (2014).

Reference Area	n=40
Aspen/Maple/ Douglas Fir	
SPECIES	**Individuals/Acre**
Abies concolor	403.66
Acer grandidentatum	1651.35
Artemisia tridentata	73.39
Juniperus communis	146.79
Populus tremuloides	807.32
Pseudotsuga menziesii	623.84
Rosa woodsii	183.48
Symphoricarpos oreophilus	1981.62
TOTAL	**5871.45**

Table 25: Dugout Canyon Mine. Annual Biomass Production (2014).

Reference Area n=40 (DS n=160)

Aspen/Maple/ Douglas Fir

	Pounds/Acre	
LIFEFORM	**MEAN**	**STD. DEV.**
Herbaceous	66.07	178.02
Woody	703.43	341.98
TOTAL	**769.49**	**236.11**

Statistical Comparisons

To monitor the current condition of the vegetation, specific parameters of the reclaimed de-gas drill sites were compared with their respective reference areas. Those sites that were sagebrush/snowberry/grass communities prior to disturbance were compared with Sagebrush/Snowberry/Grass Reference Area, an area nearby that was left undisturbed to be used for final revegetation success standards. Likewise, those disturbed communities that were aspen/maple/Douglas fir communities before they were disturbed were compared to a reference area with the same name.

Although establishing the condition of the vegetation at the reclaimed sites was an important objective of the field study, two of the sites have been reclaimed long enough to meet the *10-year "responsibility period"* and *Phase III* or *final bond release* may soon be possible through the State of Utah, Division of Oil, Gas & Mining (DOGM). The two sites that have been reclaimed long enough for bond release considerations are **G-03** and **G-04**. Consequently, additional parameters were sampled for these two sites and compared with their reference areas. Restored vegetation at mine sites should be sampled for two consecutive years at the end of the responsibility period to be considered for Phase III bond release. Although the remaining sites (**G-2**, **G-5** and **G-6**) have not met this time period, they were also compared with their respective reference areas to determine if vegetation establishment may be approaching final bond release. Following is a summary of the sample results for each parameter of the reclaimed areas when compared to the reference areas.

Total Living Cover

When the total living cover values of **G-02**, **G-03** and **G-05** were compared to the **Sagebrush/Snowberry/Grass Reference Area**, the differences were not statistically significant (Fig. 1- A, 1-B, 1-D) .

When sites **G-04** and **G-06** were compared to the **Aspen/Maple Douglas Fir Reference Area**, the former was not significant statistically (Fig. 1-C), whereas in the latter the difference was significant (Fig. 1-E).

Woody Species Density

When total woody species densities of **G-02**, **G-03** and **G-05** were compared, **G-2** had a significantly greater number of woody plants than its reference area (Fig. 2-A), **G-3** had much less (Fig. 2-B) and there was not a significant difference in **G-05** (Fig. 2-D).

When the density values of **G-04** and **G-06** were compared to their reference area, both reclaimed areas had significantly less individuals per acre (Fig. 2-C and 2-E).

Fig. 1. STUDENT'S T-TEST - Dugout Canyon Mine. **Total living cover** comparisons between the reclaimed sites and reference areas (2014).

A. Reclaimed Area G-2: $\bar{x}$=58.75; s=7.73; n=20
Reference Area S/S/G: $\bar{x}$=56.25; s=16.91; n=40
t = 0.6272; df = 58; SL= NS

B. Reclaimed Area G-3: $\bar{x}$=61.13; s=7.87; n=40
Reference Area S/S/G: $\bar{x}$=56.25; s=16.91; n=40
t = 1.6547; df = 78; SL= NS

C. Reclaimed Area G-4: $\bar{x}$=77.00; s=8.86; n=20
Reference Area A/M/D: $\bar{x}$=78.38; s=12.52; n=40
t = 0.4401; df = 58; SL= NS

D. Reclaimed Area G-5: $\bar{x}$=63.00 s=11.22; n=20
Reference Area S/S/G: $\bar{x}$=56.25; s=16.91; n=40
t = 1.6129; df = 58; SL= NS

E. Reclaimed Area G-6: $\bar{x}$=58.75$^{(U)}$; s=13.59; n=20
Reference Area A/M/D: $\bar{x}$=78.38$^{(O+U)}$; s=12.52; n=40
t = 5.5650; df=58; SL= p<0.01

Reclaimed Area G-6: $\bar{x}$=58.75$^{(U)}$; s=13.59; n=20
Reference Area A/M/D: $\bar{x}$=44.75$^{(U)}$; s=13.37; n=40
t = 3.8029; df = 58; SL= p<0.01

$\bar{x}$= sample mean
s = sample standard deviation
n = sample size
NS = non-significant
t = Student's t-value
df = degrees of freedom
SL = significance level
p = probability level
S/S/G = Sagebrush/Snowberry/Grass
A/M/D = Aspen/Maple/Douglas Fir
$^{(U)}$Understory total living cover
$^{(O+U)}$Overstory plus understory total living

Annual Biomass Production

Total annual biomass production is an additional parameter that is compared to revegetation standards when Phase III bond release is an option. Because sites **G-3** and **G-4** were the only two sites that are approaching the end of their responsibility period, production was measured in 2014 at these sites as well as their reference areas. For both sites the differences when compared to the reference areas were statistically significant; site **G-3** had *less* production (Fig. 3-A) and **G-4** had *more* (Fig. 3-B).

Fig. 2. STUDENT'S T-TEST - Dugout Canyon Mine. **Woody species density** comparisons between the reclaimed sites and reference areas (2014).

A. Reclaimed Area G-2: $\bar{x}$=11968.83; s=6515.93; n=20
Reference Area S/S/G: $\bar{x}$=5891.69; s=2216.50; n=40
t = 5.3488; df = 58; SL= p<0.01

B. Reclaimed Area G-3: $\bar{x}$=112.10; s=76.21; n=40
Reference Area S/S/G: $\bar{x}$=5891.69; s=2216.50; n=40
t = 16.4817; df = 78; SL= p<0.001

C. Reclaimed Area G-4: $\bar{x}$=2191.11; s=799.29; n=20
Reference Area A/M/D: $\bar{x}$=5871.45; s=2198.80; n=40
t = 7.2245; df = 58; SL= p<0.01

D. Reclaimed Area G-5: $\bar{x}$=4748.60; s=2387.50; n=20
Reference Area S/S/G: $\bar{x}$=5891.69; s=2216.50; n=40
t = 1.6750; df = 58; SL= NS

E. Reclaimed Area G-6: $\bar{x}$=1447.41; s=1401.55; n=20
Reference Area - A/M/D: $\bar{x}$=5871.45; s=2198.80; n=40
t = 8.1859; df = 58; SL= p<0.01

$\bar{x}$= sample mean
s = sample standard deviation
n = sample size
NS = non-significant
t = Student's t-value
df = degrees of freedom
SL = significance level
p = probability level
S/S/G = Sagebrush/Snowberry/Grass
A/M/D = Aspen/Maple/Douglas Fir

Total Diversity

Another parameter often measured to meet final revegetation requirements for Phase III bond release is diversity. When the diversity of **G-3** was compare to the **Sagebrush/ Snowberry Reference Area,** the reclaimed site was slightly *more* diverse (Fig. 4-A).

Fig. 3. STUDENT'S T-TEST - Dugout Canyon Mine. **Annual biomass production** comparisons between the reclaimed sites and reference areas (2014).

A. Reclaimed Area G-3: $\bar{x}$=463.48; s=90.43; n=40
Reference Area S/S/G: $\bar{x}$=855.65; s=282.08; n=40
t =8.3732 ; df=78; SL=P<0.01

B. Reclaimed Area G-4: $\bar{x}$=1471.91; s=742.35; n=20
Reference Area A/M/D: $\bar{x}$=769.49; s=236.11; n=40
t =5.4932 ; df =58; SL=P<0.01

$\bar{x}$= sample mean
s = sample standard deviation
n = sample size
NS = non-significant
t = Student's t-value
df = degrees of freedom
SL = significance level
p = probability level
S/S/G = Sagebrush/Snowberry/Grass
A/M/D = Aspen/Maple/Douglas Fir

When the diversity value site **G-4** was compared to that of the **Aspen/Maple/Douglas Fir Reference Area,** the reclaimed site was somewhat *less* (Fig. 4-B).

Fig. 4. MacARTHUR'S INDEX - Dugout Canyon Mine. **Diversity** comparisons between the reclaimed sites and reference areas (2014).

A. Reclaimed Area G-3: $1/\sum pi^2 = 6.563$
Reference Area S/S/G: $1/\sum pi^2 = 6.257$

B. Reclaimed Area G-4: $1/\sum pi^2 = 5.689$
Reference Area A/M/D: $1/\sum pi^2 = 7.291$

S/S/G = Sagebrush/Snowberry/Grass
A/M/D = Aspen/Maple/Douglas Fir

DISCUSSION

Vegetation Establishment

When one considers the vegetation establishment of all reclaimed sites sampled in 2014 for the Dugout Canyon Mine, they are progressing relatively well. The total living cover values are all approaching, or are greater than, their respective reference areas.

The woody species density results are varied, but most of the reclaimed areas had fewer plants per acre when compared to their reference areas (the exception was G-2). Regarding the woody species densities, it has been suggested at other reclaimed sites that perhaps high density values in some of the native plant communities (e.g. reference areas) have been the result of domestic livestock and wildlife grazing pressure because those animals sometimes select the herbaceous species over the woody plants, especially in the summer months. Consequently, after past consultations with Utah Division's of Wildlife Resources (DWR) and Oil, Gas & Mining (DOGM) biologists, sometimes less woody species density values provides more opportunity for increased forb and grass species establishment that can provide greater species diversity in the summer range for the resident wildlife species as well as domestic livestock. Consequently, a pre-set woody species density values of 2,000 - 2,500 plants per acre for reclaimed areas have sometimes been recommended. On other sites, the landowners have preferred fewer shrubs for their property to be consistent with their postmining land use plans.

Final Bond Release Considerations

Besides assessing the current condition of the vegetation, monitoring provided information as to whether or not the reclaimed sites are approaching the revegetation success standards to enable final or Phase III bond releases. Generally speaking, state and federal regulations require the reestablished vegetation to be: a) diverse, effective, and permanent, b) the plant species be compatible with the approved postmining land use, c) will have the same seasonal characteristics of growth as the original vegetation, d) are capable of self-regeneration and plant succession and e) be compatible with the plant and animal

species of the area. To meet these requirements, specific parameters of the reclaimed areas are often compared with a reference area, or a native plant community with characteristics similar to those communities before they are disturbed by mining-related activities. In other words, the reference areas are often used to drive or set the revegetation success standards for the sites when they are reclaimed.

As mentioned previously, the only 2 sites that have been reclaimed long enough to begin considerations for final bond release are sites G-3 and G-4. In theory, the 2014 results could be considered the first of the two consecutive sample years necessary for bond release. G-3 met the revegetation success standard for total living cover and diversity, but fell short for woody species density and annual biomass production. Also mentioned above, perhaps fewer woody species may not be a negative factor, especially in relatively small isolated areas like the drill sites. The low annual production recorded should not cause too much concern at G-3. It appeared that the gate of this fenced area must have been left open for a time period, or judging from all the cattle sign (droppings) and the amount of consumed vegetation observed (cut back by animals), perhaps the reclaimed site may have even been used as an *enclosure* rather than an *exclosure* for livestock. When the field study was conducted, it was estimated by the investigators that 85% of the vegetation had been eaten by animals, most likely cattle. This, of course, resulted in very low production measurements since the vegetation was clipped in the field and weighed in the lab to provide the annual biomass productivity results. Site G-4 met the standard for total living cover and production, but did not meet that woody species density standard of its reference area.

SUMMARY & CONCLUSIONS

Several reclaimed de-gasification drill sites were sampled in the growing season of 2014 to monitor establishment of the vegetation. In summary, all the reclaimed sites are progressing relatively well with respect to plant establishment. Almost all the plants becoming established are desirable, native and non-weedy species. The total living cover values at all sites are approaching or are greater than their respective reference areas. The reclaimed sites were quite diverse as shown by diversity indices. The lower woody species densities on the sites, when compared to reference areas, should be addressed by the permittee, regulatory agencies and landowners. What are the desired postmining land uses and what are expectations of the landowners? This should drive the revegetation success standards and ultimately be used for final bond release considerations. Because all these de-gas sites are relatively small, it may be desirable to have fewer woody plants in some areas to provide a more diverse habitat for wildlife and domestic livestock. Annual biomass production should not be an issue for final bond release if the reclaimed sites exclude livestock grazing until the plant communities are established.

It would be timely and prudent to address the final revegetation success standards because there are several of these small, reclaimed drill sites in the area and the *responsibility period* prior for final bond release will soon be approaching.

G-4
G-5
G-6
A/M/D Ref
S/S/G Ref
G-2
G-3
1283 ft
Revegetation Monitoring
Study Areas
2014
Dugout Canyon Mine
Carbon County, Utah
MT. NEBO SCIENTIFIC, INC
Springville, Utah
March 2015
Google earth

Revegetation Monitoring Sites: G-3, G-4 & Reference Areas

2015

Dugout Canyon Mine
Carbon County, Utah

Prepared by

MT. NEBO SCIENTIFIC, INC.
330 East 400 South, Suite 6
P.O. Box 337
Springville, Utah 84663
(801) 489-6937

Patrick D. Collins, Ph.D.

for

CANYON FUEL COMPANY, LLC
Dugout Canyon Mine
P.O. Box 1029
Wellington, UT 84542

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TABLE OF CONTENTS

INTRODUCTION 1

METHODS 1

Transect Placement 1
Cover, Frequency & Composition 1
Density 2
Annual Biomass Production 2
Sample Adequacy 2
Diversity 4
Photographs, Sample Location Map & Site Coordinates 5

RESULTS 6

Site G-3 6
Site G-4 7
Reference Area: Sagebrush/Snowberry/Grass 8
Reference Area: Aspen/Maple/Douglas Fir 10
Data Summary Tables 12
Statistical Comparisons 20
Total Living Cover 20
Woody Species Density 21
Annual Production 22
Total Diversity 23
Comparisons Between Years 24

DISCUSSION 28

SUMMARY & CONCLUSIONS 30

SAMPLE LOCATION MAP . . . . . Attachment

INTRODUCTION

Relatively small pads were constructed for the Dugout Canyon Mine to drill boreholes for de-gasification as a means to increase safety of their underground coal mining operations. Although they were somewhat variable in size, each pad was approximately 200 ft x 300 ft. Prior to land disturbance caused for drill pad construction, the existing vegetation was quantitatively sampled along with "reference areas" that were left undisturbed so they could be used for final revegetation success standards following reclamation of the sites.

Sites G-3 and G-4 were reclaimed in 2005. In 2014 and 2015, several reclaimed sites were studied to assess the current condition of the revegetated pads. The sites sampled in 2014 were G-2, G-3, G-4, G-5 and G-6 along with the associated reference areas. In 2015, G-3, G-4 and their reference areas were sampled again.

When assessing the condition of the vegetation on the reclaimed sites, it can often be determined whether or not they are approaching revegetation success standards and if bond release applications could be sought.

METHODS

Transect Placement

Transect lines for quantitative sampling were randomly placed throughout the reclaimed pads and reference areas. From these transect lines, sample locations were chosen using random numbers on both sides of the lines and at right angles to them.

Cover, Frequency & Composition

Cover estimates were made using ocular methods with meter square quadrats. Species composition and relative frequencies were also assessed from the quadrats. Plant nomenclature follows Welsh et al. (2008)[1] .

[1] Welsh, S.L., N.D. Atwood, S. Goodrich and L.C. Higgins. 2008. A Utah flora. Print Services, Brigham Young University, Provo, UT. 1019 pp.

Density

Density estimates for the woody plant species on the reclaimed pads and reference areas were made using a distance method called the point-quarter technique. In this method, random points were placed on the sample sites and divided into four quarters. The distances to the nearest woody plant species were then recorded in each quarter. The average point-to-individual distance was equal to the square root of the mean area per individual. Final calculations resulted in the number of individual woody plants per acre.

Annual Production

Total annual production was estimated by clipping, drying and weighing current annual growth in sample quadrats. "Double sampling" methods were employed by placing four additional quadrats around the clipped quadrat, then estimating the production of them relative to the clipped plot. Herbaceous and woody species production were clipped, weighed and reported separately.

Sample Adequacy

Sample adequacy for cover, density and production was attempted with the goal that 90% of the samples were within 10% of the true mean for the plant communities in the area. The

following formula was used:

$$nMIN = \frac{t^2 s^2}{(dx)^2}$$

where,

nMIN	= minimum adequate sample
t	= appropriate confidence t-value
s	= standard deviation
x	= sample mean
d	= desired change from mean

Diversity

One diversity index was employed to some of the reclaimed datasets for comparisons with the reference areas – *MacArthur's Diversity Index* (MacArthur and Wilson 1967)[2]. This index is an effective diversity measurement and is computed using the equation $1/\sum pi^2$. In this equation *pi* is the proportion of sum frequency contributed by the *i*th species in the sample area of concern. The proportional contribution of each species is then squared and the values for all species in the sample areas are summed. This index integrates the number of species and the degree to which frequency of occurrence was equitably distributed among those species. In other words, this index provides greater weight to those species that are present more often (with greater frequency) than those that are merely "present" in one or two quadrats.

[2] MacArthur, R.H. and E.O Wilson. 1967. The Theory of Island Biogeography. Princeton University Press, Princeton, N.J., 1967. 215 pp.

Photographs, Sample Location Map & Site Coordinates

Color photographs were taken of the sample areas and have been included in this report. An aerial image map showing the sample sites has also been included. Coordinates of the monitoring sites are shown below.

Revegetation Monitoring Sites (2015)		
SITE NAME	**GPS NAME**	**COORDINATES** (meters; NAD 27)
Reclaimed Site: G-3	DUGG-3	12 S 541759 4392466
Reclaimed Site: G-4	DUGG-4	12 S 540755 4392949
Reference Area: Sagebrush/Snowberry/Grass	DUGRSG	12 S 541789 4392550
Reference Area: Aspen/Maple/Douglas Fir	DUGRAF	12 S 541840 4392837

RESULTS

Site: G-3

Site G-3 was a sagebrush/snowberry/grass community when it was in its native state. Following disturbance, this site was reclaimed in 2005. In 2015, the reclaimed site was dominated by grass species, namely Western wheatgrass (*Elymus smithii*) and thickspike wheatgrass (*E. lanceolatus*). Big sagebrush (*Artemisia tridentata*) was the only shrub present in the samples and had a fair cover value in 2015 (Table 1).

Photo 1, Site: G-3

The total living cover for this site was estimated at 62.88% (Table 2-A) and was comprised of 78.83% grasses, 14.24% shrubs and 6.93% forbs (Table 2-B).

As one might expect from the cover data, woody species density was low at only 128 individuals per acre with sagebrush as the dominant plant species (Table 3).

Because the site has been reclaimed long enough to be a candidate for Phase III Bond Release, annual production was also measured in 2015. It was estimated at 1,388.79 pounds per acre (Table 4).

Photo 2, Site: G-3

Site: G-4

Site G-4 was also reclaimed in 2005. In its native condition it was once an aspen/Douglas fir community, but it was disturbed even before the drill pad was constructed by road building and early logging activities. This site is currently dominated by bluebunch wheatgrass (*Elymus spicatus*), Sandberg's bluegrass (*Poa secunda*) and Kentucky bluegrass (*Poa pratensis*). Sagebrush was also an important species at this site (Table 5).

Photo 3, Site: G-4

The total living cover was estimated at 76.75% (Table 6-A). The understory composition was

Photo 4, Site: G-4

comprised of 77.60% grasses, 15.46% woody plants and 6.95% forbs (Table 6-B).

As shown on Table 7, the total woody density at the site was calculated at 1,499 plants per acre and was dominated by sagebrush, aspen (*Populus tremuloides*) and snowberry (*Symphoricarpos oreophilus*).

Annual production was also sampled at this site with a total of 1,903.89 pounds per acre (Table 8).

Reference Area: Sagebrush/Snowberry/Grass

A reference area was chosen and first sampled in 2003 to represent future revegetation success standards for the sagebrush/snowberry/grass communities that would be

Photo 5, Sagebrush/Snowberry/Grass Reference Area

disturbed by construction of the de-gas drill site G-3.

Also sampled in 2015, the Sagebrush/Snowberry/Grass Reference Area was dominated by Vasey big sagebrush (*Artemisia tridentata* var. *vaseyana*), snowberry, Sandberg's bluegrass, bluebunch wheatgrass and Watson penstemon (*Penstemon watsonii*). For a list of all species sampled in the quadrats, refer to Table 9.

The total living cover of the Sagebrush/Snowberry/Grass Reference Area in 2015 was 58.25% (Table 10-A), of which the understory composition was comprised of 57.08% woody plants, 22.63% forbs and 20.29% grasses (Table 10-B).

Photo 6, Sagebrush/Snowberry/Grass Reference Area

Woody species density was estimated at 6,223 plants per acre, most of which were Vasey sagebrush and snowberry (Table 11).

Annual production was also sampled in 2015, with an estimated total of 1495.96 pounds per acre (Table 12).

Reference Area: Aspen/Maple/Douglas Fir

Another reference area was chosen in 2003 to represent future revegetation success standards for drill site G-4. This reference area was within an aspen/maple/Douglas fir community.

Photo 7, Aspen/Maple/Douglas Fir Reference Area

Sampled again in 2015, plants present in the overstory quadrats were big-toothed maple (*Acer grandidentatum*), aspen, Douglas fir (*Pseudotsuga menziesii*) and white fir (*Abies concolor*). Dominant understory species were big-toothed maple, snowberry and Douglas fir (Table 13).

Total living cover in this reference area was 72.38%, 42.75% of which was understory cover and 29.63% from overstory (Table 14-A). The understory cover composition included 74.79% woody plants, 12.52% grasses and 12.69% forbs (Table 14-B).

Total woody species density was estimated at 5,186 individuals per acre, and was dominated by snowberry, big-toothed maple, aspen, Douglas fir and white fir (Table 15).

Annual production was sampled in 2015, with an estimated total of 1,120.59 pounds per acre (Table 16).

Photo 8, Aspen/Maple/Douglas Fir Reference Area

Data Summary Tables

Table 1: Dugout Canyon Mine. Living Cover and Frequency by Plant Species (2015).

Reclaimed Site: G-3			n=40
Sagebrush/Snowberry/Grass			
	Mean Percent	**Standard Deviation**	**Percent Frequency**
TREES & SHRUBS			
Artemisia tridentata	9.00	14.06	37.50
FORBS			
Lupinus argenteus	4.00	7.43	25.00
Tragopogon dubius	0.25	1.56	2.50
GRASSES			
Agropyron cristatum	3.63	7.58	20.00
Bromus carinatus	0.25	1.56	2.50
Bromus tectorum	1.88	6.68	7.50
Elymus hispidus	3.25	5.97	25.00
Elymus lanceolatus	12.50	19.36	35.00
Elymus smithii	18.63	18.27	60.00
Elymus spicatus	0.88	5.46	2.50
Poa pratensis	8.63	13.69	32.50

Table 2: Dugout Canyon Mine. Total Cover and Composition (2015).

Reclaimed Site: G-3		n=40
Sagebrush/Snowberry/Grass		
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Understory	62.88	7.90
Litter	13.48	5.47
Bareground	14.25	7.46
Rock	9.40	5.68
B. % COMPOSITION		
Trees/Shrubs	14.24	21.40
Forbs	6.93	11.96
Grasses	78.83	23.02

Table 3: Dugout Canyon Mine. Woody Species Density (2015)

Reclaimed Site: G-3	n=40
Sagebrush/Snowberry/Grass	
SPECIES	**Individuals/Acre**
Amelanchier utahensis	0.80
Artemisia tridentata	124.28
Juniperus osteosperma	0.80
Symphoricarpos oreophilus	2.41
TOTAL	**128.29**

Table 4: Dugout Canyon Mine. Annual Biomass Production (2015).

Reclaimed Site: G-3 n=40 (DS n=160)

Sagebrush/Snowberry/Grass

	Pounds/Acre	
LIFEFORM	**MEAN**	**STD. DEV.**
Herbaceous	938.23	621.57
Woody	450.56	747.22
TOTAL	**1388.79**	**315.14**

Table 5: Dugout Canyon Mine. Living Cover and Frequency by Plant Species (2015).

Reclaimed Site: G-4			n=20
Aspen/Douglas Fir (Previously Disturbed)			
	Mean Percent	**Standard Deviation**	**Percent Frequency**
UNDERSTORY			
TREES & SHRUBS			
Artemisia tridentata	9.00	11.58	40.00
Populus tremuloides	1.00	4.36	5.00
Symphoricarpos oreophilus	2.00	5.79	15.00
FORBS			
Cynoglossum officinale	2.50	4.33	30.00
Lupinus argenteus	0.75	3.27	5.00
Medicago sativa	0.75	3.27	5.00
Penstemon sp.	0.75	2.38	10.00
Tragopogon dubius	0.50	1.50	10.00
GRASSES			
Elymus spicatus	24.00	18.75	75.00
Poa pratensis	16.25	14.48	70.00
Poa secunda	19.25	17.56	70.00

Table 6: Dugout Canyon Mine. Total Cover and Composition (2015)

Reclaimed Site: G-4		n=20
Aspen/Douglas Fir (Previously Disturbed)		
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Understory	76.75	7.12
Litter	8.80	4.34
Bareground	7.90	4.38
Rock	6.55	3.11
B. % COMPOSITION		
Trees/Shrubs	15.46	15.71
Forbs	6.95	8.53
Grasses	77.60	17.16

Table 7: Dugout Canyon Mine. Woody Species Density (2015).	
Reclaimed Site: G-4	n=20
Aspen/Douglas Fir (Previously Disturbed)	
SPECIES	**Individuals/Acre**
Artemisia tridentata	1161.34
Populus tremuloides	131.12
Pseudotsuga menziesii	56.19
Rosa woodsii	18.73
Symphoricarpos oreophilus	131.12
TOTAL	**1498.51**

Table 8: Dugout Canyon Mine. Annual Biomass Production (2015).

Reclaimed Site: G-4 n=20 (DS n=80)

Aspen/Douglas Fir (Previously Disturbed)

	Pounds/Acre	
LIFEFORM	**MEAN**	**STD. DEV.**
Herbaceous	1452.37	894.17
Woody	451.52	771.86
TOTAL	**1903.89**	**383.33**

Table 9: Dugout Canyon Mine. Living Cover and Frequency by Plant Species (2015).

Reference Area			
Sagebrush/Snowberry/Grass			n=40
	Mean Percent	**Standard Deviation**	**Percent Frequency**
OVERSTORY			
Pseudotsuga menziesii	0.63	3.90	2.50
UNDERSTORY			
TREES & SHRUBS			
Amelanchier utahensis	0.88	5.46	2.50
Artemisia tridentata var. vaseyana	21.88	11.49	90.00
Pseudotsuga menziesii	0.63	3.90	2.50
Symphoricarpos oreophilus	10.50	12.54	57.50
FORBS			
Antennaria microphylla	0.88	3.14	7.50
Artemisia ludoviciana	1.13	3.95	7.50
Cynoglossum officinale	0.13	0.78	2.5
Erigeron engelmannii	0.13	0.78	2.50
Eriogonum sp.	0.38	1.73	5.00
Hymenoxys acaulis	1.13	2.85	17.50
Lupinus argenteus	2.75	5.70	27.50
Penstemon watsonii	6.00	5.27	67.50
GRASSES			
Bromus carinatus	0.75	2.86	7.50
Bromus tectorum	0.50	3.12	2.50
Elymus spicatus	1.88	4.43	17.50
Elymus trachycaulus	0.50	1.87	7.50
Poa secunda	7.38	7.83	60.00
Stipa columbiana	0.25	1.56	2.50

Table 10: Dugout Canyon Mine. Total Cover and Composition (2015)

Reference Area		n=40
Sagebrush/Snowberry/Grass		
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Overstory (O)	0.63	3.90
Understory (U)	57.63	10.00
Litter	15.70	8.72
Bareground	14.60	9.27
Rock	12.08	9.76
O + U	58.25	9.32
B. % COMPOSITION		
Trees/Shrubs	57.08	19.19
Forbs	22.63	14.20
Grasses	20.29	14.99

Table 11: Dugout Canyon Mine. Woody Species Density (2015)

Reference Area	n=40
Sagebrush/Snowberry/Grass	
SPECIES	**Individuals/Acre**
Amelanchier utahensis	194.46
Artemisia tridentata var. vaseyana	4200.32
Juniperus scopulorum	38.89
Pseudotsuga menziesii	38.89
Symphoricarpos oreophilus	1750.13
TOTAL	**6222.69**

Table 12: Dugout Canyon Mine. Annual Biomass Production (2015).

Reference Area n=40 (DS n=160)

Sagebrush/Snowberry/Grass

	Pounds/Acre	
LIFEFORM	**MEAN**	**STD. DEV.**
Herbaceous	350.36	660.87
Woody	1145.60	664.82
TOTAL	**1495.96**	**297.41**

Table 13: Dugout Canyon Mine. Living Cover and Frequency by Plant Species (2015).

Aspen/Maple/ Doug Fir			
Reference Area			n=40
Aspen/Maple/ Douglas Fir			
	Mean Percent	**Standard Deviation**	**Percent Frequency**
OVERSTORY			
Abies concolor	4.75	10.49	17.50
Acer grandidentatum	11.25	18.83	30.00
Populus tremuloides	8.38	16.97	25.00
Pseudotsuga menziesii	5.25	13.65	15.00
UNDERSTORY			
TREES & SHRUBS			
Abies concolor	1.13	4.81	10.00
Acer grandidentatum	12.80	15.10	70.00
Artemisia tridentata	0.38	1.73	5.00
Mahonia repens	1.25	4.58	7.50
Populus tremuloides	1.75	4.55	15.00
Pseudotsuga menziesii	3.50	8.75	17.50
Rosa woodsii	1.25	7.05	5.00
Symphoricarpos oreophilus	10.63	8.60	77.50
FORBS			
Achillea millefolium	1.00	3.20	10.00
Cynoglossum officinale	0.88	2.20	15.00
Osmorhiza depauperata	1.75	4.41	17.50
Penstemon sp.	0.38	1.32	7.50
Thalictrum fendleri	0.83	2.01	15.00
Viola adunca	0.13	0.78	2.50
GRASSES			
Elymus trachycaulus	0.25	1.56	2.50
Poa fendleriana	2.88	4.31	35.00
Poa secunda	2.00	6.30	12.50

Table 14: Dugout Canyon Mine. Total Cover and Composition (2015)

Reference Area		n=40
Aspen/Maple/ Douglas Fir		
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Overstory (O)	29.63	17.55
Understory (U)	42.75	15.81
Litter	41.58	19.16
Bareground	13.10	13.56
Rock	2.58	1.91
O + U	72.38	8.66
B. % COMPOSITION		
Trees/Shrubs	74.79	22.77
Forbs	12.69	16.90
Grasses	12.52	19.04

Table 15: Dugout Canyon Mine. Woody Species Density (2015)

Reference Area	n=40
Aspen/Maple/ Douglas Fir	
SPECIES	**Individuals/Acre**
Abies concolor	356.57
Acer grandidentatum	1134.53
Amelanchier utahensis	64.83
Artemisia tridentata	162.08
Juniperus osteosperma	64.83
Populus tremuloides	713.14
Prunus virginiana	64.83
Pseudotsuga menziesii	551.06
Rosa woodsii	194.49
Symphoricarpos oreophilus	1880.08
TOTAL	**5186.44**

Table 16: Dugout Canyon Mine. Annual Biomass Production (2015).

Reference Area n=40 (DS n=160)

Aspen/Maple/ Douglas Fir

	Pounds/Acre	
LIFEFORM	**MEAN**	**STD. DEV.**
Herbaceous	262.17	458.24
Woody	858.42	463.80
TOTAL	**1120.59**	**287.49**

Statistical Comparisons

Although monitoring the progress of the vegetation at the reclaimed sites was an important objective for the field studies, two of the sites have been reclaimed long enough to meet the *10-year "responsibility period"* and, if revegetation success standards are met, may therefore be candidates for *Phase III* or *final bond release* through the State of Utah, Division of Oil, Gas & Mining (DOGM). Restored vegetation at mine sites need to be sampled for two consecutive years at the end of the responsibility period to be considered for bond release. Two sites, G-03 and G-04, were studied in 2014 and 2015. Consequently, appropriate parameters were analyzed for these two sites to be compared with their reference areas. Following is a statistical comparison of the sample results for each parameter of the reclaimed areas when compared to the reference areas.

Total Living Cover

When the total living cover of **Site G-3** was compared statistically to the cover of the Sagebrush/Snowberry/Grass Reference Area, the difference was highly significant (Fig. 1-A), or G-3 had significantly more total living cover.

Next, when the total living cover of **Site G-4** was compared to its reference area, the Aspen/Maple/Douglas Fir Reference Area, the difference was not statistically significant (Fig. 1-B).

Fig. 1. STUDENT'S T-TEST - Dugout Canyon Mine. **Total living cover** comparisons between the reclaimed sites and reference areas (2015).

A. Reclaimed Area G-3: $\bar{x}$=62.88; s=7.90; n=40
Reference Area S/S/G (O+U): $\bar{x}$=58.25; s=9.32; n=40
t=2.3967 ; df=78 ; SL=p<0.05

B. Reclaimed Area G-4: $\bar{x}$=76.75; s=7.12; n=20
Reference Area A/M/D (O+U): $\bar{x}$=72.38; s=8.66; n=40
t=1.9489; df=58 ; SL=NS

$\bar{x}$= sample mean
s = sample standard deviation
n = sample size
NS = non-significant
t = Student's t-value
df = degrees of freedom
SL = significance level
p = probability level
S/S/G = Sagebrush/Snowberry/Grass
A/M/D = Aspen/Maple/Douglas Fir
(U) Understory total living cover
(O+U) Overstory plus understory total living cover

Woody Species Density

Woody species densities of the reclaimed drill pads were then compared to the reference areas. The total density of woody plants in the reference area was significantly greater than the reclaimed **Site G-3** (Fig. 2-A).

Similarly, when the total woody species density of **Site G-4** was compared to the Aspen/Maple/ Douglas Fir Reference Area, the difference was also significant (Fig. 2-B).

Fig. 2. STUDENT'S T-TEST - Dugout Canyon Mine. **Woody species density** comparisons between the reclaimed sites and reference areas (2015).

A. Reclaimed Area G-3: $\bar{x}$=128.29; s=196.23; n=40
Reference Area S/S/G: $\bar{x}$=6222.69; s=2222.87; n=40
t=17.2727; df=78 ; SL=p<0.01

B. Reclaimed Area G-4: $\bar{x}$=1498.51; s=808.31; n=20
Reference Area A/M/D: $\bar{x}$=5186.44; s=1876.97; n=40
t=8.3790; df=58; SL=p<0.01

$\bar{x}$= sample mean
s = sample standard deviation
n = sample size
NS = non-significant
t = Student's t-value
df = degrees of freedom
SL = significance level
p = probability level
S/S/G = Sagebrush/Snowberry/Grass
A/M/D = Aspen/Maple/Douglas Fir

Annual Production

Total annual production was the next parameter to be compared statistically to the corresponding reference areas. Reclaimed **Site G-3** and the Sagebrush/Snowberry/Grass Reference Area had a difference that was not statistically significant in 2015 (Fig. 3-A). However, when the annual production of **Site G-4** was compared to the Aspen/Maple/ Douglas Fir Reference Area, the difference was statistically significant – the reclaimed site had greater production (Fig. 3-B).

Fig. 3. STUDENT'S T-TEST - Dugout Canyon Mine. **Annual production** comparisons between the reclaimed sites and reference areas (2015).

A. Reclaimed Area G-3: $\bar{x}$=1388.79; s=315.14; n=40
Reference Area S/S/G: $\bar{x}$=1495.96; s=297.41; n=40
t=1.5642; df=78; SL=NS

B. Reclaimed Area G-4: $\bar{x}$=1903.89; s=383.33; n=20
Reference Area A/M/D: $\bar{x}$=1120.59; s=287.49; n=40
t=8.8815; df=58; SL=p<0.01

$\bar{x}$= sample mean
s = sample standard deviation
n = sample size
NS = non-significant
t = Student's t-value
df = degrees of freedom
SL = significance level
p = probability level
S/S/G = Sagebrush/Snowberry/Grass
A/M/D = Aspen/Maple/Douglas Fir

Total Diversity

Another parameter often measured to meet final revegetation requirements for Phase III bond release is diversity. When the diversity of **Site G-3** and **Site G-4** were compared to their respective reference areas, the reference area were more diverse, but only by very narrow margins (Fig. 4).

Fig. 4. MacARTHUR'S INDEX - Dugout Canyon Mine. **Diversity** comparisons between the reclaimed sites and reference areas (2015).

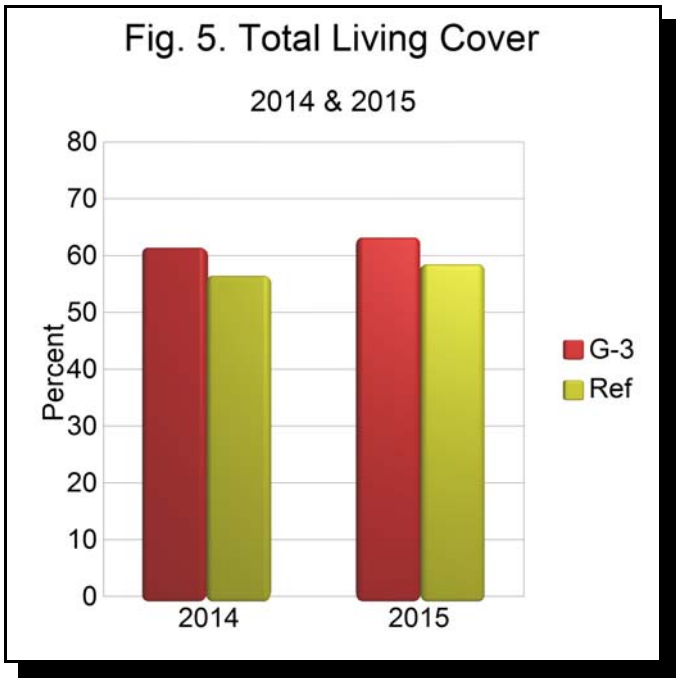
A. Reclaimed Area G-3: $1/\sum pi^2 = 6.935$
Reference Area S/S/G: $1/\sum pi^2 = 7.077$

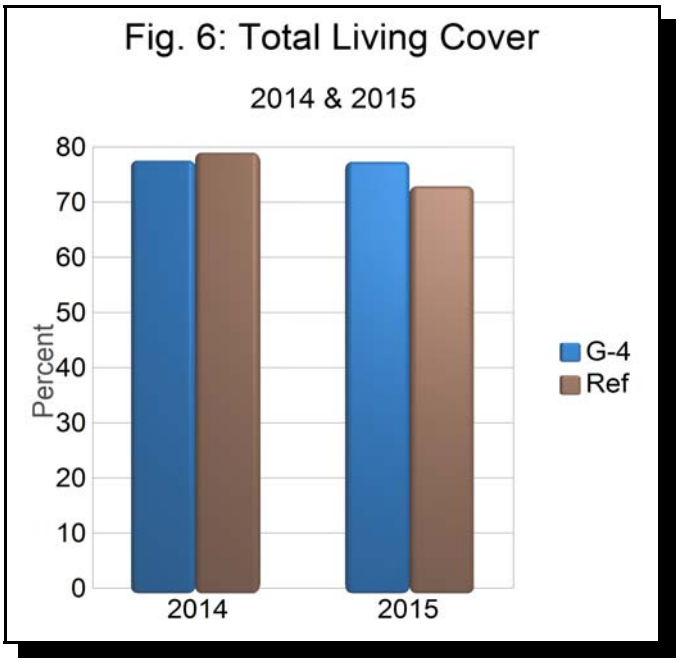
B. Reclaimed Area G-4: $1/\sum pi^2 = 7.199$
Reference Area A/M/D: $1/\sum pi^2 = 8.301$

S/S/G = Sagebrush/Snowberry/Grass
A/M/D = Aspen/Maple/Douglas Fir

Comparisons Between Years

This report provides the results from quantitative sampling the vegetation at two de-gas drill sites in 2015. A previous report was submitted that provides the results for 2014. However, to show an immediate overview comparison between these two years without referring to the 2014 report, summary graphs have been provided below.





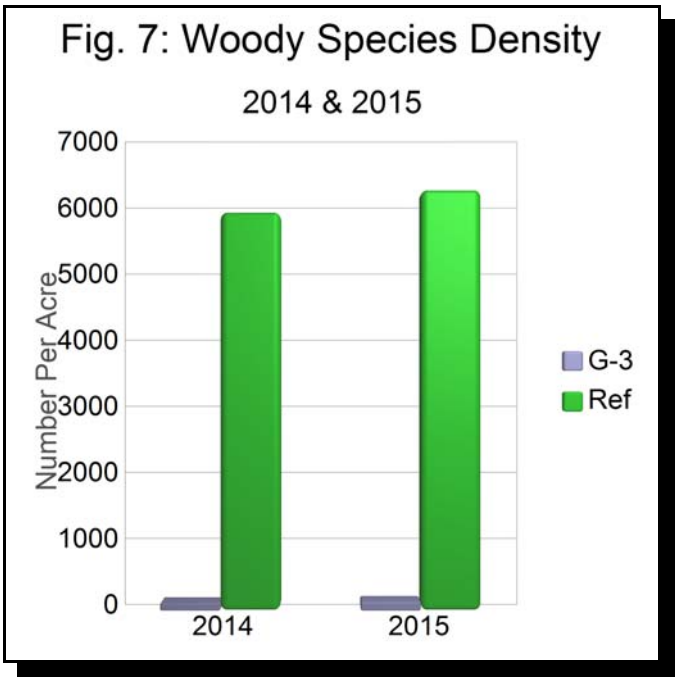


Fig. 7: Woody Species Density
2014 & 2015
Number Per Acre
7000
6000
5000
4000
3000
2000
1000
0
2014
2015
G-3
Ref

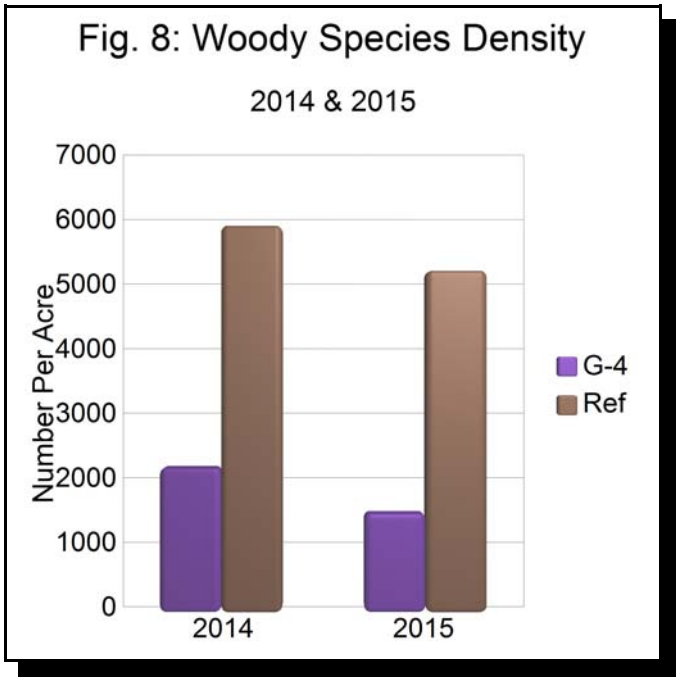


Fig. 8: Woody Species Density
2014 & 2015
Number Per Acre
7000
6000
5000
4000
3000
2000
1000
0
2014
2015
G-4
Ref

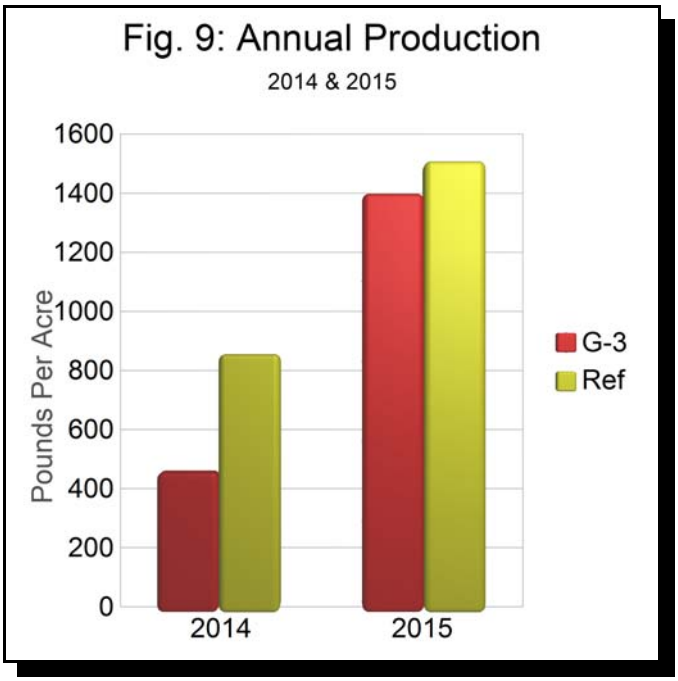


Fig. 9: Annual Production
2014 & 2015
Pounds Per Acre
1600
1400
1200
1000
800
600
400
200
0
2014
2015
G-3
Ref

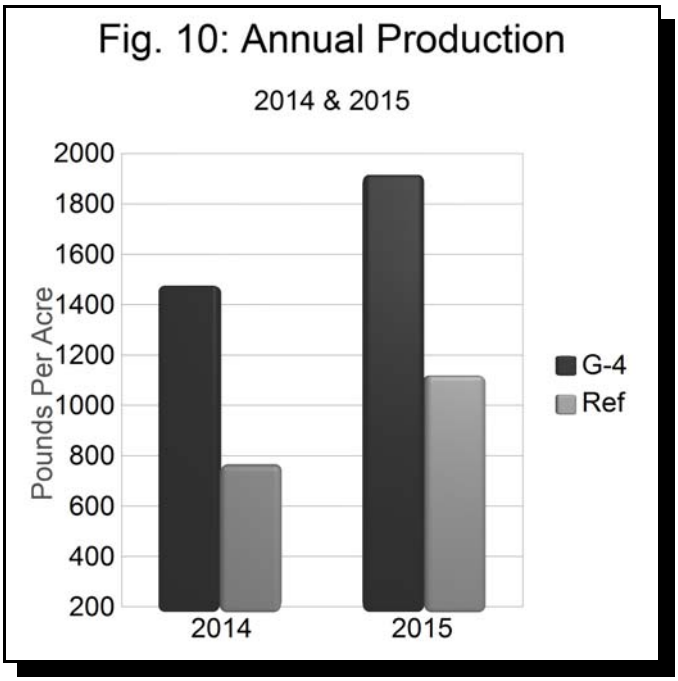


Fig. 10: Annual Production
2014 & 2015
Pounds Per Acre
2000
1800
1600
1400
1200
1000
800
600
400
200
2014
2015
G-4
Ref

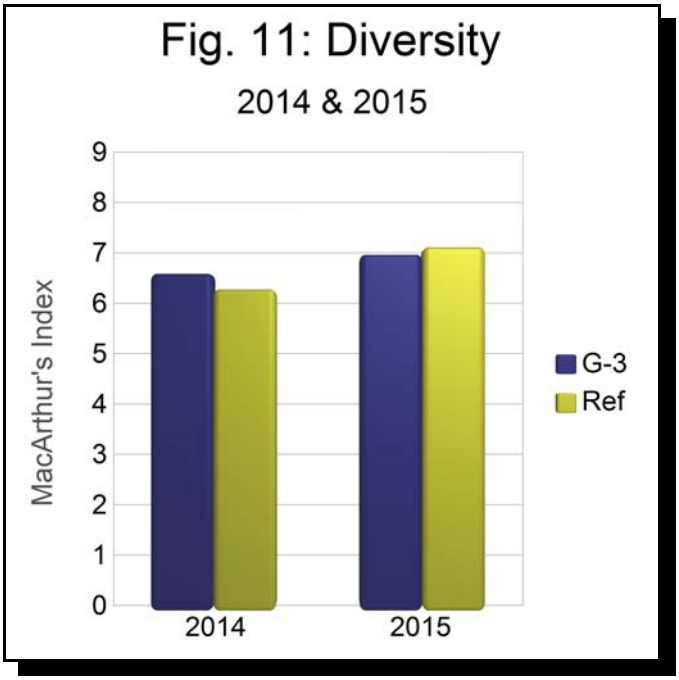


Fig. 11: Diversity
2014 & 2015
MacArthur's Index
9
8
7
6
5
4
3
2
1
0
2014
2015
G-3
Ref

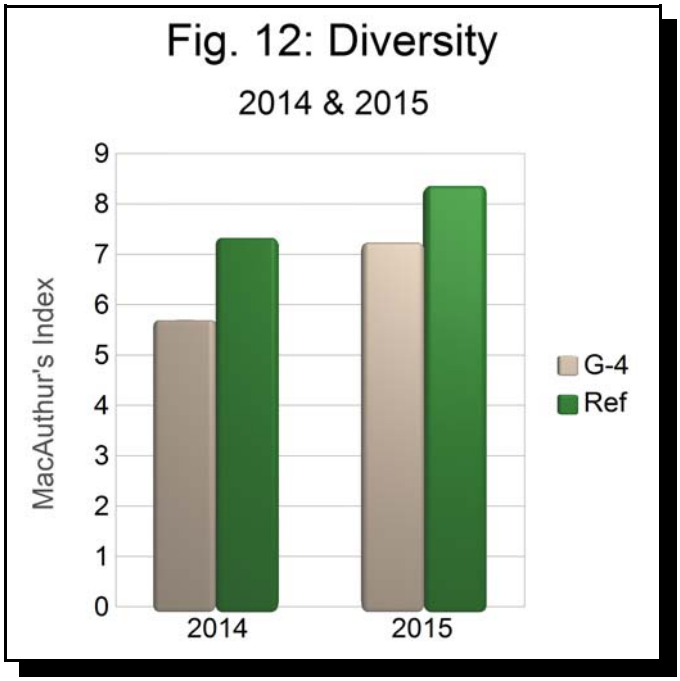


Fig. 12: Diversity
2014 & 2015
MacAuthur's Index
9
8
7
6
5
4
3
2
1
0
2014
2015
G-4
Ref

DISCUSSION

Besides assessing the current condition of the vegetation, monitoring provides information as to whether or not the reclaimed sites are approaching the revegetation success standards that could enable final or Phase III bond releases. Generally speaking, state and federal regulations require the reestablished vegetation to be: a) diverse, effective, and permanent, b) plant species be compatible with the approved postmining land uses, c) will have the same seasonal characteristics of growth as the original vegetation, d) are capable of self-regeneration and plant succession and e) be compatible with the plant and animal species of the area. To meet these requirements, specific parameters of the reclaimed areas are often compared with a reference area, or a native plant community with characteristics similar to those communities before they were disturbed by mining-related activities. In other words, the reference areas are often used to drive or set the revegetation success standards for the sites after they are reclaimed.

As mentioned previously, the 2 sites that have been reclaimed long enough to begin considerations for final bond release are Sites G-3 and G-4. The 2014 and 2015 sample results could be considered the final *two consecutive sample* years necessary for a bond release application.

In 2014, G-3 met the revegetation success standards for total living cover and diversity, but fell short for woody species density and annual production. As postulated in the 2014

report, the low annual production recorded should not have caused too much concern at this site; it appeared that the gate of this fenced area must have been left open for a time period judging from the amount the cattle sign (droppings) and the amount of consumed vegetation observed (cut back by animals). In other words, it seemed that the reclaimed site may have been used at times as an *enclosure* rather than an *exclosure* for livestock. This, of course, would have resulted in very low production measurements because only the remaining vegetation was clipped in the field and weighed in the lab to provide the annual productivity results. This theory was tested in 2015 by making sure the fence around the reclaimed pad excluded cattle. Sample results demonstrated a remarkable increase in annual production (Fig. 9), and when compared to the reference area, the difference was non-significant statistically (Fig. 3). Therefore in 2015, G-03 met cover, production and diversity requirements, but the woody species density was again much lower than the reference area.

Site G-4 met the revegetation standards for total living cover and production in 2014 and 2015, but the woody species density values for both of those years were appreciably less of its reference area. Diversity was less in 2014, but much closer to that of the reference area in 2015. (**NOTE:** A reminder that this site was disturbed *before* construction of the drill pad by logging and road building activities should also be considered).

Regarding the woody species densities, it has been suggested at other reclaimed sites that

perhaps the high density values in some of the native plant communities (e.g. reference areas) have been the result of domestic livestock and wildlife grazing pressure because those animals sometimes select the herbaceous species over the woody plants, especially in the summer months. Consequently, after past consultations with Utah Divisions of Wildlife Resources (DWR) and Oil, Gas & Mining (DOGM) biologists, sometimes less woody species density values provides more opportunity for increased forb and grass species establishment that can provide greater species diversity in the summer range for the resident wildlife species as well as domestic livestock. Consequently, pre-set (and fewer) woody species density values for reclaimed areas have sometimes been recommended. On other reclaimed sites, landowners have preferred less shrubs for their property to be more consistent with their postmining land use plans.

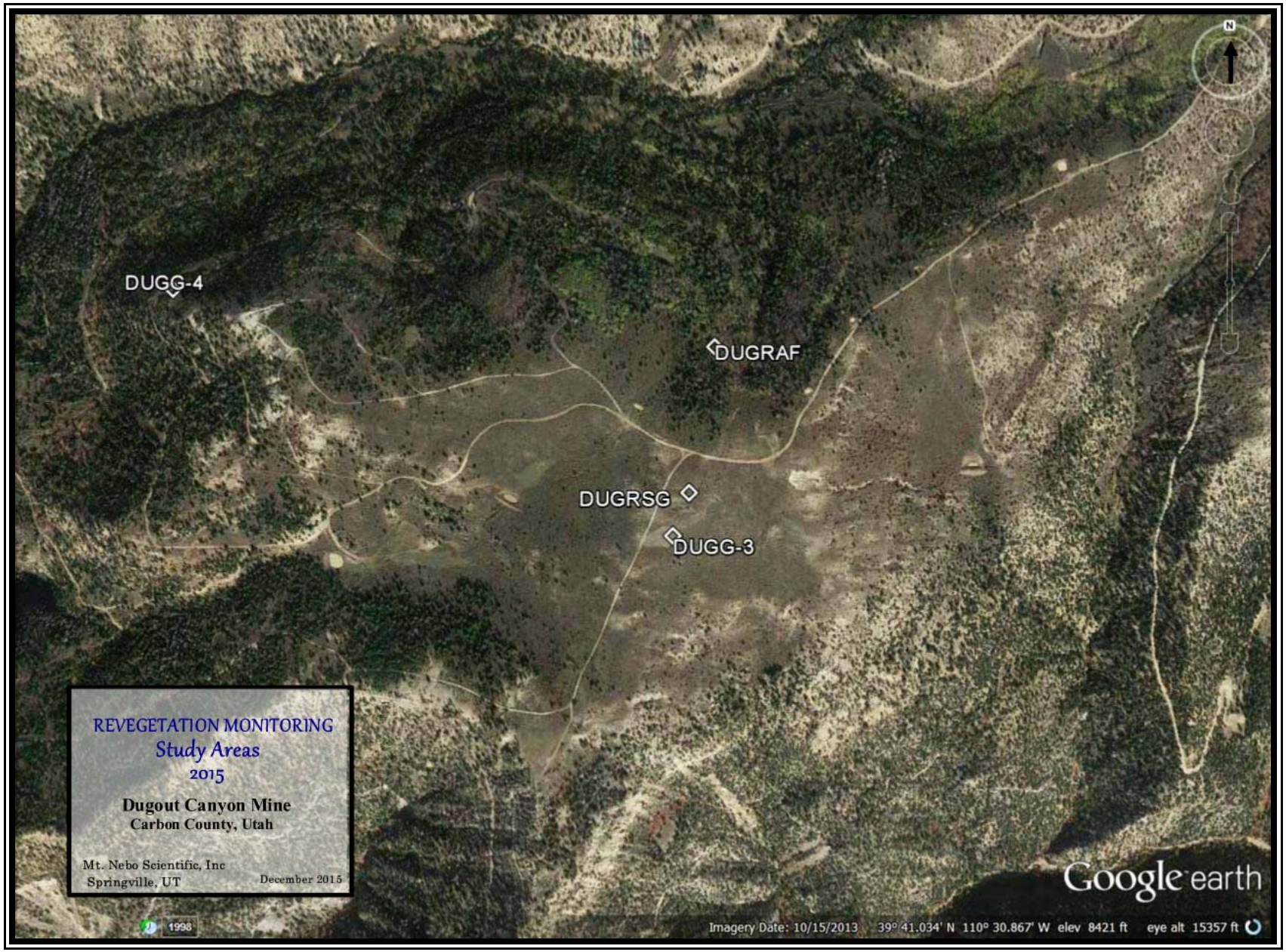
SUMMARY & CONCLUSIONS

To monitor establishment of the restored vegetation, two reclaimed de-gasification drill sites were sampled in the growing seasons of 2014 and 2015. The reclaimed sites have progressed quite well with respect to plant establishment. Almost all the plants becoming established were desirable, native and non-weedy species. The **total living cover** values at the reclaimed sites were nearly equal or greater than their respective reference areas. The reclaimed sites were also quite diverse as shown by **diversity indices**. The revegetation

standards were met for **annual production** on the sites when access to them by cattle was restricted.

The lower **woody species densities** on the sites, when compared to reference areas, should be addressed by the permittee, regulatory agencies and landowners. The desired postmining land uses of the landowners should be confirmed. This should drive the revegetation success standards and ultimately be used for final bond release considerations. Because all the de-gas sites are relatively small, it may be a non-issue to have fewer woody plants in some areas. Furthermore, it could provide a more diverse habitat for wildlife and domestic livestock.

It may be timely and prudent to address the final revegetation success standards of all the de-gas sites because there are several of these small, reclaimed drill pads in the area and the *responsibility period* prior for final bond release will soon be approaching. Whether or not G-3 and G-4 are worthy for final bond release could dependant on results of discussions by the mine operator, landowners and biologists from the State of Utah, Division of Oil, Gas & Mining.


DUGG-4
DUGRAF
DUGRSG
DUGG-3
REVEGETATION MONITORING
Study Areas
2015
Dugout Canyon Mine
Carbon County, Utah
Mt. Nebo Scientific, Inc
Springville, UT
December 2015
Google earth
Imagery Date: 10/15/2013 39° 41.034' N 110° 30.867' W elev 8421 ft eye alt 15357 ft