ANDALEX
RESOURCES, INC.

P.O. Box 910, East Carbon, Utah 84520
Telephone (435) 888-4000 Fax (435) 888-4002

Utah Division of Oil, Gas & Mining
Utah Coal Program
1594 West North Temple, Suite 1210
P.O. Box 145801
Salt Lake City, UT 84114-5801

March 16, 2018

Attn: Daron Haddock
Permit Supervisor

Re: Andalex Resources, Inc. C/007/019
T18-002 2017 Annual Report

Dear Mr. Haddock,

Attached you will find the completed 2017 Annual Report for the Tower Mine.

If you have any questions, please feel free to contact me directly at 435.888.4000

Sincerely,

Karin Madsen
Engineering Tech
UtahAmerican energy, Inc.

Gob Vent Hole

Status 2017

Annual Report

GVH #1

Drilled in 2005. Because GVH #1 was never included in the OSO agreement, and this hole was not considered necessary for future ventilation of the mine operation, it was plugged and the surface pad was reclaimed in 2009. The vegetation inventory was conducted and the GVH hole can now qualify for Phase II Bond Release. Report included.

GVH #2

Never drilled, not permitted, no disturbance, eliminated from consideration.

GVH #3

Drilled in 2005. Currently in production, or capable of production by OSO/Blue Tip/ Liberty Pioneer Energy. Hole has drill collar with valves, telemetry tower, three solar cells with controller box, telephone pole, vertical CMP drain and condenser-cooper structure. Site has been top-soiled, pocked, and seeded.

GVH #4

Drilled in 2005. Hole has drill collar with valves, telemetry tower, three solar cells with controller box. Telephone pole, some fencing structure, and condenser-cooler structure. Site has been top-soiled, pocked, and seeded.

GVH #5

Drilled in 2005. Because GVH #5 was never included in the OSO agreement, and this hole was not considered necessary for future ventilation of the mine operation, it was plugged and the surface pad was reclaimed in 2009. The vegetation inventory was conducted and the GVH hole can now qualify for Phase II Bond Release. Report included.

GVH #5A

Drilled in 2006. Has a drill collar with valve. Site has been top-soiled, pocked, and seeded. The vegetation inventory was conducted and the GVH hole can now qualify for Phase II Bond Release. Report included.

GVH #5B

Permitted but never drilled, no pad preparation. Eliminated from consideration. However was considered in the bonding.

GVH #6

Drilled in 2005. Hole has drill collar with valves, telemetry tower, three solar cells with controller box, telephone pole, vertical CPM drain, and condenser-cooler structure. Site has been top-soiled, pocked, and seeded. Site was sprayed for cheat grass in early 2014 and re-seeded.

GVH #7

Drilled in 2006. Currently in production or capable of production by OSO/Blue Tip/LPE. Hole has drill collar with valves, telemetry tower, three solar cells with controller box, vertical CMP drain, and condenser-cooler structures. Site has been top-soiled, pocked, and seeded.

GVH #7A

Drilled in 2006 from GVH pad #7. On same pad as 7. Has drill collar with valves, surrounded by cattle fencing. Site has been top-soiled, pocked, and seeded.

GVH #8

Drilled in 2006. Hole has drill collar with valves, telemetry tower, three solar cells with controller box and condenser-cooler structure. Site has been top-soiled, pocked, and seeded.

GVH #8A

Drilled in 2006. Currently in production or cabable of production by OSO/Blue Tip/LPE. Hole has drill collar with valves, telemetry tower, three solar cells with controller box and vertical CMP drain. Site has been top-soiled, pocked, and seeded.

GVH #9

Drilled in 2006. Currently in production or capable of production by OSO/Blue Tip/LPE. Hole has drill collar with valves, telemetry tower, three solar cells with controller box, vertical CMP drain, and condenser-cooler structures. Site has been top-soiled, pocked, and seeded.

GVH #10

Permitted but never drilled, no pad preparation. Eliminated from consideration, however was considered in the bonding.

GVH 10A

Permitted by never drilled, no pad preparation. Eliminated from consideration.

GVH #11

Drilled in 2008. Was considered in the bonding. Currently in production or capable of production by OSO/Blue Tip/LPE. Hole has drill collar with valves, telemetry tower, three solar cells with controller box, and vertical CMP drain. Site has been top-soiled, pocked, and seeded.

GVH #11A

Proposed, conditionally approved but never drilled. No bonding.

GVH #12

Drilled in 2008. This GVH is no longer needed for future ventilation and was never tied into the ventilation network, was plugged in July of 2014, as per the approved BLM plugging plan. The collar and all valves were removed and the pipe cut off at 18" below ground level. This GVH was fenced and re-seeded to augment existing vegetation in September of 2014. The vegetation inventory was conducted and the GVH hole can now qualify for Phase II Bond Release. Report included.

GVH #12A

Proposed, conditionally approved but never drilled. No bonding.

GVH #13

Drilled in 2008. This GVH is no longer needed for future ventilation and was never tied into the ventilation network, was plugged in July of 2014, as per the approved BLM plugging plan. The collar and all valves were removed and the pipe cut off at 18" below ground level. This GBH was fenced and re-seeded to augment existing vegetation in September of 2014. Before this site is eligible for Phase I Reclamation, the vertical culvert (water drain) needs to be removed. Once removed the 10 year reclamation clock can start. Was considered in bonding.

GVH #13A

Proposed, conditionally approved but never drilled. No bonding.

GVH #14

Drilled in 2008. This GVH is no longer needed for future ventilation and was never tied into the ventilation network, was plugged in July of 2014, as per the approved BLM plugging plan. The collar and all valves were removed and the pipe cut off at 18" below ground level. This GBH was fenced and re-seeded to augment existing vegetation in September of 2014. The vegetation inventory was conducted and the GVH hole can now qualify for Phase II Bond Release. Report included.

GVH #14A

Proposed, conditionally approved but never drilled. No bonding.

GVH #15

The drilling pad was prepared but the hole was never drilled. This GVH was fenced and re-seeded to augment existing vegetation in September of 2014. Before it is eligible for Phase I reclamation, the vertical culvert (water drain) needs to be removed. Once removed, the 10 year reclamation clock can start. Was considered in bonding.

GVH #15A

Proposed, conditionally approved but never drilled. No bonding.

GVH #16

The drilling pad was prepared but the hole was never drilled. This GVH was fenced and re-seeded to augment existing vegetation in September of 2014. Before it is eligible for Phase I reclamation, the vertical culvert (water drain) needs to be removed. Once removed, the 10 year reclamation clock can start. Was considered in bonding.

GVH #16A

Proposed, conditionally approved but never drilled. No bonding.

GVH #17

The drilling pad was prepared but the hole was never drilled. This GVH was fenced and re-seeded to augment existing vegetation in September of 2014. Before it is eligible for Phase I reclamation, the vertical culvert (water drain) needs to be removed. Once removed, the 10 year reclamation clock can start. Was considered in bonding.

IMPOUNDMENT INSPECTION AND CERTIFIED REPORT			Page 1 of
Permit Number	C/007/0019	Report Date	12-27-17
Mine Name	Tower Mine		
Company Name	UtahAmerican Energy, Inc.		
Impoundment Identification	Impoundment Name	B, C & E	
	Impoundment Number	None	
	UPDES Permit Number	UTG040029	
	MSHA ID Number	NA	

IMPOUNDMENT INSPECTION

Inspection Date	12-27-17
Inspected By	Karin Madsen
Reason for Inspection (Annual, Quarterly or Other Periodic Inspection, Critical Installation, or Completion of Construction)	4th Quarter/Annual

1. **Describe any appearance of any instability, structural weakness, or any other hazardous condition.**

Ponds B, C & E

No instability, structural weaknesses, or visible hazards were observed at time of inspection.

Required for an impoundment which functions as a SEDIMENTATION POND.

2. **Sediment storage capacity, including elevation of 60% and 100% sediment storage volumes, and, estimated average elevation of existing sediment.**

Sediment Elevations (Per Approved MRP):

Cell B1 (South Cell) Max Water Level 7077'	Cell B2 60% 7081'	Cell B3 Max Water and Sed. Level 7087'
Cell B4 (North Cell) Max Water and Sed Level 7091'	Pond C 60% 7046.9' 100% 7048.7'	Pond E 60% 6947.5' 100% 6949.3'

REGISTERED PROFESSIONAL ENGINEER 6449561 DAVID W. HIBBS 12/27/17 STATE OF UTAH

Cleaning of all B Cells must take place when sediment level reaches 7081' in Cell B2.

See section 5 for current sediment levels.

3. **Principle and emergency spillway elevations.**

Pond (B2 Cell 3)		Pond (C)		Pond (E)	
Principle	7081.0'	Principle	7053.1'	Principle	6957.6'
(Bottom of the culvert)		Emergency	7056.05'	Emergency	6958.6'

4. **Field Information.** Provide current water elevation, whether pond is discharging, type and number of samples taken, monitoring/instrumentation information, inlet/outlet conditions, or other related activities associated with the pond including but not limited to sediment cleanout, pond decanting, embankment erosion/repairs, monitoring information, vegetation on outslopes of embankments, etc.

Sediment markers visible in ponds B, E And C.

Pond E contains approximately 2 feet of water, and is freezing over. Pond C has no water accumulated.

B ponds were dry at time of inspection.
No discharge has occurred from the pond UPDES, therefore no samples were taken.
No observable problems exist at the inlets or outlets.
No observable conditions were apparent that could affect the stability or function of the structure.
Vegetation on out-slopes of pond embankments growing well.
Decant visible and operational-brush around decant valve was removed earlier this fall.

5. **Field Evaluation.** Describe any changes in the geometry of the impounding structure, average and maximum depths and elevations of impounded water, estimated sediment or slurry volume and remaining storage capacity, estimated volume of water impounded, and any other aspect of the impounding structure affecting its stability or function which has occurred during the reporting period.

No changes in geometry have occurred. No change has occurred to the structure that would affect its stability or function.

There is no water within the ponds, except pond E which has little, therefore no discharging is anticipated within the near future.

Current Sediment Levels (approximate):
Sediment level was surveyed by Ware Surveying in November of 2017. Sediment levels at time of survey were:

Pond (B cell 2)	Pond (C)	Pond (E)
7075.2	7046.7'	6945.2

Qualification Statement

REGISTERED PROFESSIONAL ENGINEER 6449561 DAVID W. HIBBS 12/27/17 STATE OF UTAH

I hereby certify that; I am experienced in the construction of impoundments; I am qualified and authorized under the direction of a Registered Professional Engineer to inspect the condition and appearance of impoundments in accordance with the certified and approved designs for this structure; that the impoundment has been maintained in accordance with approved design and meet or exceed the minimum design requirements under all applicable federal, state and local regulations; and, that inspections and inspection reports are made by myself and include any appearances of instability, structural weakness or other hazardous conditions of the structure affecting stability.

Signature: _____ **Date:** 12.27.17

CERTIFIED REPORT

IMPOUNDMENT EVALUATION (If NO, explain under Comments)	YES	NO
1. Is impoundment designed and constructed in accordance with the approved plan?	XXXXX	
2. Is impoundment free of instability, structural weakness, or any other hazardous condition?	XXXXX	
3. Has the impoundment met all applicable performance standards and effluent limitations from the previous date of inspection?	XXXXX	

COMMENTS AND OTHER INFORMATION

Pond as built drawings were reviewed in 2/2014 to confirm clean-out elevations and spillway elevations by RJM

Certification Statement:

REGISTERED PROFESSIONAL ENGINEER 6449561 DAVID W. HIBBS 12/27/17 STATE OF UTAH

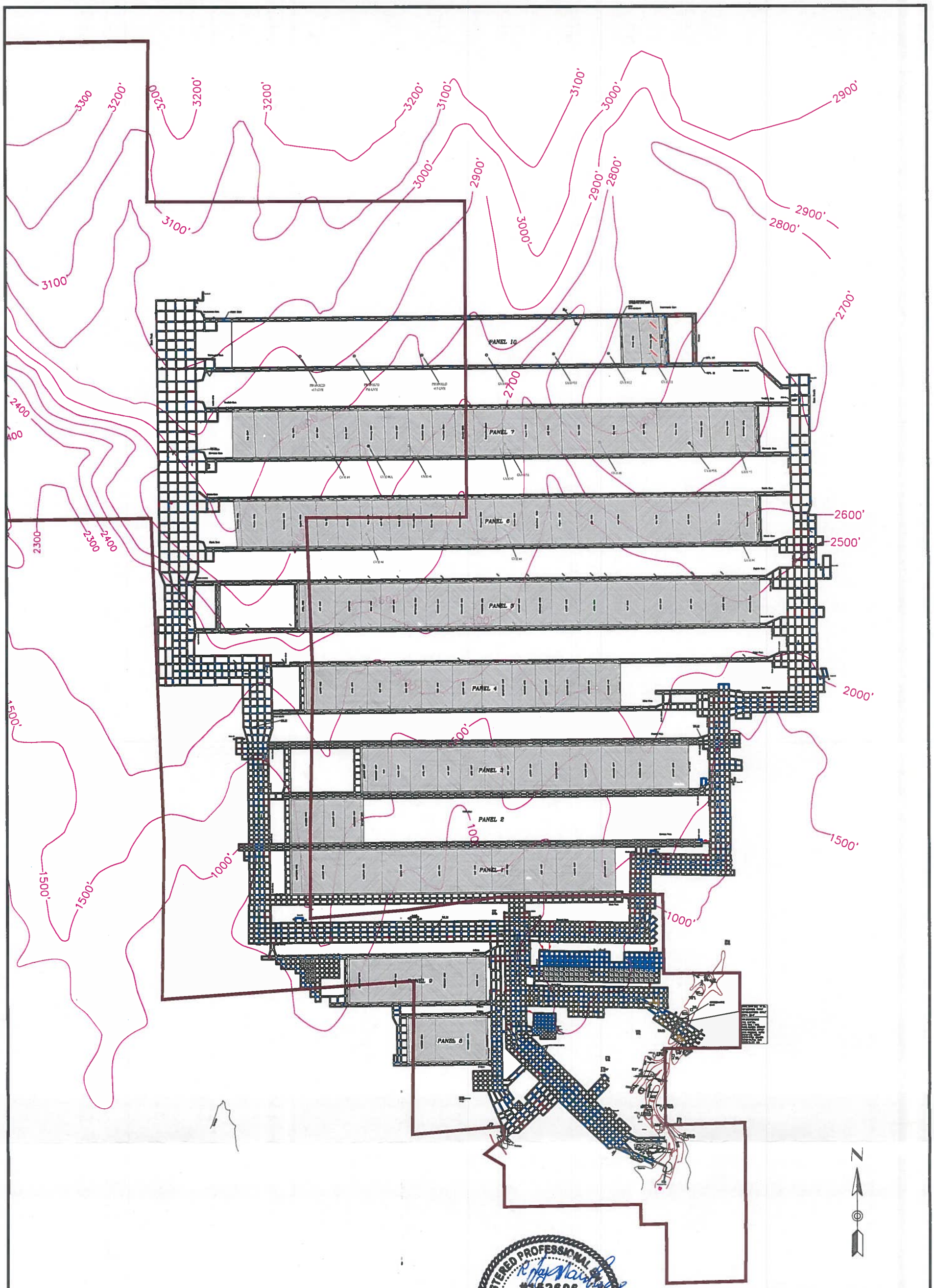
[PE Cert. Stamp]

I hereby certify that; I am experienced in the construction of impoundments; I am qualified and authorized in the State of Utah to inspect and certify the condition and appearance of impoundments in accordance with the certified and approved designs for this structure; that the impoundment has been maintained in accordance with approved design and meet or exceed the minimum design requirements under all applicable federal, state and local regulations; and, that inspections and inspection reports are made by myself or under my direction and include any appearances of instability, structural weakness or other hazardous conditions of the structure affecting stability in accordance with the Utah R645 Coal Mining Rules.

By: David Hibbs, President
(Full Name and Title)

Signature: [signature] Date: 12/27/17

P.E. Number & State: 6449561 Utah



REGISTERED PROFESSIONAL ENGINEER
#152606
R. JAY
MARSHALL
3/13/18
STATE OF UTAH

MINE DID NOT PRODUCE COAL IN 2017

750 0 1500 3000 FEET

MINE MAP

ABERDEEN MINE

TOWER DIVISION
6750 AIRPORT ROAD
PRICE, UTAH 84501

MSHA MINE ID #42-02028

DRAWN BY	PJ	SCALE	1" = 1500'
APPROVED BY	DH	DATE	1 MARCH 2016
SHEET			1 of 1

G:\Current Drawings\Mine Maps\Tower Mine\Aberdeen.dwg, 400 Scale, 3/1/2016 3:53:07 PM, 1:1

TOWER RESOURCES, INC.

2017 RTK GPS SUBSIDENCE SURVEY

9/22/2017

STATION	NORTHING (FEET)	EASTING (FEET)	2003 ELEVATION	2007 ELEVATION	2008 ELEVATION	2009 ELEVATION	2010 ELEVATION	2011 ELEVATION	2012 ELEVATION	2013 ELEVATION	2014 ELEVATION	2015 ELEVATION	2016 ELEVATION	2017 ELEVATION	2016-2017	NOTES
Rebar on ridge	505,141.92	2,217,261.07	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	0.00	CONTROL
Yellow Rebar	507,073.59	2,223,128.18	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	0.00	CONTROL
S-10	507,824.28	2,217,196.61	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	0.00	CONTROL
S16	508,650.48	2,210,725.70	8,809.53	8,809.64	8,809.75	8,809.71	8,809.72	8,809.70	8,809.68	8,809.69	8,809.68	8,809.70	8,809.73	8,809.75	-0.02	---
S17	508,190.63	2,213,802.51	8,624.48	8,624.43	8,624.43	8,624.44	8,624.43	8,624.45	8,624.46	8,624.44	8,624.46	8,624.48	8,624.45	8,624.46	-0.01	---
99-1	508,942.12	2,215,063.90	8,572.35	8,572.13	8,572.14	8,572.12	8,572.14	8,572.13	8,572.13	8,572.12	8,572.13	8,572.14	8,572.13	8,572.13	0.00	---
99-2	509,023.29	2,218,624.20	8,551.12	8,551.01	8,550.98	8,550.96	8,551.00	8,550.98	8,550.97	8,550.99	8,550.97	8,550.97	8,550.99	8,550.97	0.02	---
S20	510,331.29	2,217,642.56	8,574.26	8,573.87	8,573.78	8,573.77	8,573.78	8,573.82	8,573.79	8,573.80	8,573.79	8,573.81	8,573.81	8,573.78	0.03	---
S21	510,581.75	2,214,956.87	8,489.90	8,489.22	8,489.35	8,489.39	8,489.48	8,489.45	8,489.41	8,489.42	8,489.41	8,489.44	8,489.40	8,489.42	-0.02	---
S32	509,739.02	2,218,933.12	8,548.93	8,548.80	8,548.81	8,548.79	8,548.77	8,548.80	8,548.81	8,548.80	8,548.81	8,548.82	8,548.83	8,548.80	0.03	---
G-17	513,692.46	2,210,938.01	---	8,488.24	8,488.23	8,488.22	8,488.24	8,488.25	8,488.23	8,488.23	8,488.23	8,488.26	8,488.24	8,488.26	-0.02	---
G-12	513,184.13	2,216,526.83	---	8,311.00	8,311.02	8,311.00	8,311.01	8,311.02	8,311.03	8,311.01	8,311.03	8,311.03	8,311.01	8,311.01	0.00	---
E1/4 36	513,118.57	2,214,340.00	---	8,280.66	8,280.65	8,280.61	8,280.61	8,280.64	8,280.60	8,280.62	8,280.60	8,280.59	8,280.60	8,280.62	-0.02	Section cor.
S1/4 36	510,454.70	2,211,696.79	---	8,606.46	8,606.43	8,606.44	8,606.43	8,606.43	8,606.43	8,606.44	8,606.43	8,606.40	8,606.38	8,606.41	-0.03	Section cor.
West Side Subsidence Line, Set in 2007																
1	509,702.03	2,211,401.87	---	8,702.64	8,702.59	8,702.60	8,702.61	8,702.62	8,702.63	8,702.61	8,702.63	8,702.64	8,702.60	8,702.62	-0.02	W. side line
2	509,802.00	2,211,401.17	---	8,693.70	8,693.69	8,693.69	8,693.69	8,693.67	8,693.68	8,693.70	8,693.68	8,693.68	8,693.66	8,693.71	-0.05	W. side line
3	509,905.87	2,211,391.89	---	8,684.35	8,684.35	8,684.36	8,684.34	8,684.35	8,684.37	8,684.37	8,684.37	8,684.35	8,684.36	8,684.35	0.01	W. side line
4	510,003.89	2,211,387.55	---	8,673.73	8,673.77	8,673.77	8,673.75	8,673.75	8,673.78	8,673.75	8,673.78	8,673.77	8,673.74	8,673.74	0.00	W. side line
5	510,100.53	2,211,381.55	---	8,663.92	8,663.94	8,663.94	8,663.92	8,663.94	8,663.92	8,663.91	8,663.92	8,663.90	8,663.93	8,663.90	0.03	W. side line
6	510,205.72	2,211,424.42	---	8,646.43	8,646.50	8,646.49	8,646.51	8,646.53	8,646.54	8,646.52	8,646.54	8,646.56	8,646.55	8,646.59	-0.04	W. side line
7	510,305.04	2,211,417.01	---	8,635.74	8,635.70	8,635.68	8,635.70	8,635.69	8,635.70	8,635.72	8,635.70	8,635.73	8,635.71	8,635.68	0.03	W. side line
8	510,401.40	2,211,415.19	---	8,625.82	8,625.81	8,625.80	8,625.81	8,625.80	8,625.83	8,625.81	8,625.83	8,625.77	8,625.79	8,625.78	0.01	W. side line
9	510,505.66	2,211,402.20	---	8,614.38	8,614.39	8,614.39	8,614.38	8,614.38	8,614.39	8,614.37	8,614.39	8,614.39	8,614.40	8,614.37	0.03	W. side line
10	510,608.91	2,211,401.63	---	8,603.45	8,603.45	8,603.46	8,603.45	8,603.47	8,603.46	8,603.47	8,603.46	8,603.48	8,603.51	8,603.50	0.01	W. side line
11	510,709.16	2,211,393.00	---	8,596.31	8,596.29	8,596.29	8,596.30	8,596.28	8,596.30	8,596.30	8,596.30	8,596.31	8,596.26	8,596.32	-0.06	W. side line
12	510,798.94	2,211,380.99	---	8,588.76	8,588.74	8,588.72	8,588.72	8,588.75	8,588.73	8,588.74	8,588.73	8,588.75	8,588.72	8,588.74	-0.02	W. side line
13	510,898.92	2,211,375.38	---	8,576.09	8,576.10	8,576.09	8,576.09	8,576.11	8,576.09	8,576.12	8,576.09	8,576.07	8,576.07	8,576.07	0.00	W. side line
14	511,010.59	2,211,370.03	---	8,561.49	8,561.50	8,561.47	8,561.49	8,561.47	8,561.48	8,561.50	8,561.48	8,561.50	8,561.47	8,561.51	-0.04	W. side line
15	511,112.19	2,211,366.93	---	8,548.90	8,548.83	8,548.81	8,548.81	8,548.82	8,548.80	8,548.83	8,548.80	8,548.80	8,548.81	8,548.82	-0.01	W. side line
16	511,228.34	2,211,359.45	---	8,543.69	8,543.65	8,543.61	8,543.63	8,543.63	8,543.63	8,543.62	8,543.63	8,543.66	8,543.62	8,543.65	-0.03	W. side line
17	511,338.04	2,211,366.01	---	8,542.64	8,542.59	8,542.57	8,542.60	8,542.59	8,542.58	8,542.57	8,542.58	8,542.59	8,542.57	8,542.56	0.01	W. side line
18	511,437.15	2,211,398.56	---	8,535.12	8,535.08	8,535.06	8,535.10	8,535.08	8,535.09	8,535.07	8,535.09	8,535.08	8,535.05	8,535.04	0.01	W. side line
19	511,553.98	2,211,419.93	---	8,526.12	8,526.05	8,526.02	8,526.04	8,526.05	8,526.03	8,526.06	8,526.03	8,526.06	8,526.07	8,526.04	0.03	W. side line
20	511,693.22	2,211,455.79	---	8,517.15	8,517.08	8,517.07	8,517.06	8,517.11	8,517.12	8,517.10	8,517.12	8,517.07	8,517.09	8,517.13	-0.04	W. side line
21	511,807.12	2,211,469.85	---	8,512.56	8,512.50	8,512.49	8,512.47	8,512.52	8,512.50	8,512.50	8,512.50	8,512.53	8,512.52	8,512.54	-0.02	W. side line
22	511,915.39	2,211,476.19	---	8,510.95	8,510.89	8,510.90	8,510.87	8,510.90	8,510.91	8,510.89	8,510.91	8,510.94	8,510.88	8,510.86	0.02	W. side line
23	512,092.42	2,211,408.58	---	8,505.00	8,504.98	8,504.98	8,504.93	8,504.95	8,504.98	8,504.95	8,504.98	8,504.96	8,504.99	8,504.97	0.02	W. side line
24	512,192.21	2,211,384.74	---	8,495.80	8,495.72	8,495.71	8,495.71	8,495.73	8,495.71	8,495.72	8,495.71	8,495.73	8,495.66	8,495.69	-0.03	W. side line
25	512,292.93	2,211,375.13	---	8,483.93	8,483.94	8,483.94	8,483.94	8,483.92	8,483.92	8,483.95	8,483.92	8,483.92	8,483.96	8,483.92	0.04	W. side line
26	512,408.97	2,211,358.60	---	8,471.08	8,471.04	8,471.05	8,471.04	8,471.06	8,471.07	8,471.05	8,471.07	8,471.07	8,471.06	8,471.05	0.01	W. side line
27	512,515.37	2,211,308.35	---	8,462.95	8,462.90	8,462.89	8,462.91	8,462.92	8,462.90	8,462.91	8,462.90	8,462.93	8,462.88	8,462.90	-0.02	W. side line
28	512,650.10	2,211,333.27	---	8,449.75	8,449.72	8,449.72	8,449.73	8,449.73	8,449.74	8,449.72	8,449.74	8,449.71	8,449.77	8,449.76	0.01	W. side line
29	512,873.07	2,211,295.54	---	8,430.09	8,430.05	8,430.03	8,430.06	8,430.04	8,430.04	8,430.06	8,430.04	8,430.05	8,430.07	8,430.07	0.00	W. side line
30	512,993.25	2,211,287.69	---	8,428.71	8,428.68	8,428.69	8,428.74	8,428.76	8,428.75	8,428.71	8,428.75	8,428.74	8,428.73	8,428.76	-0.03	W. side line
31	513,091.16	2,211,285.96	---	8,427.18	8,427.16	8,427.15	8,427.18	8,427.20	8,427.20	8,427.19	8,427.20	8,427.21	8,427.20	8,427.18	0.02	W. side line
32	513,217.13	2,211,297.36	---	8,423.25	8,423.21	8,423.20	8,423.24	8,423.23	8,423.21	8,423.22	8,423.21	8,423.22	8,423.24	8,423.21	0.03	W. side line
33	513,353.03	2,211,313.87	---	8,425.43	8,425.38	8,425.38	8,425.40	8,425.39	8,425.40	8,425.41	8,425.40	8,425.40	8,425.38	8,425.37	0.01	W. side line
34	513,491.93	2,211,317.92	---	8,407.84	8,407.78	8,407.79	8,407.80	8,407.79	8,407.79	8,407.78	8,407.79	8,407.81	8,407.81	8,407.77	0.04	W. side line
35	513,607.49	2,211,335.06	---	8,406.22	8,406.17	8,406.17	8,406.18	8,406.18	8,406.16	8,406.16	8,406.16	8,406.22	8,406.17	8,406.19	-0.02	W. side line
36	513,719.38	2,211,366.06	---	8,403.71	8,403.68	8,403.66	8,403.69	8,403.66	8,403.68	8,403.69	8,403.68	8,403.69	8,403.70	8,403.69	0.01	W. side line
37	513,810.83	2,211,402.93	---	8,400.29	8,400.24	8,400.26	8,400.26	8,400.25	8,400.27	8,400.30	8,400.27	8,400.28	8,400.30	8,400.28	0.02	W. side line
38	513,932.97	2,211,450.36	---	8,396.17	8,396.14	8,396.14	8,396.15	8,396.13	8,396.15	8,396.14	8,396.15	8,396.13	8,396.11	8,396.12	-0.01	W. side line
39	514,038.94	2,211,462.97	---	8,394.29	8,394.25	8,394.24	8,394.26	8,394.25	8,394.25	8,394.26	8,394.25	8,394.24	8,394.20	8,394.22	-0.02	W. side line

TOWER RESOURCES, INC.

2017 DIFFERENTIAL LEVEL SUBSIDENCE SURVEY

9/22/2017

STATION	NORTHING (FEET)	EASTING (FEET)	8/22/2005 ELEVATION	10/28/2006 ELEVATION	10/10/2007 ELEVATION	10/30/2008 ELEVATION	10/26/2009 ELEVATION	10/21/2010 ELEVATION	10/15/2011 ELEVATION	11/4/2012 ELEVATION	10/8/2013 ELEVATION	10/24/2014 ELEVATION	10/14/2015 ELEVATION	11/9/2016 ELEVATION	9/3/2017 ELEVATION	2016-2017	NOTES
Rebar on ridge	505,141.92	2,217,261.07	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	8,241.62	0.00	CONTROL
Yellow Rebar	507,073.59	2,223,128.18	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	8,534.90	0.00	CONTROL
S-10	507,824.28	2,217,196.61	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	8,594.59	0.00	CONTROL
1	511,963.35	2,216,981.20	8,509.59	8,509.63	8,509.51	8,509.33	8,509.30	8,509.29	8,509.30	8,509.31	8,509.30	8,509.30	8,509.30	8,509.31	8,509.30	0.01	1/2" rebar w/cap
2	512,062.12	2,216,965.01	8,503.78	8,503.80	8,503.70	8,503.54	8,503.49	8,503.47	8,503.45	8,503.45	8,503.45	8,503.46	8,503.46	8,503.46	8,503.45	0.01	1/2" rebar w/cap
3	512,165.33	2,216,978.66	8,496.82	8,496.84	8,496.74	8,496.58	8,496.57	8,496.55	8,496.52	8,496.53	8,496.53	8,496.52	8,496.53	8,496.52	8,496.52	0.00	1/2" rebar w/cap
4	512,263.52	2,217,010.76	8,486.13	8,486.14	8,486.04	8,485.87	8,485.90	8,485.89	8,485.87	8,485.87	8,485.88	8,485.88	8,485.89	8,485.89	8,485.89	0.00	1/2" rebar w/cap
5	512,367.50	2,217,038.78	8,473.91	8,473.89	8,473.81	8,473.67	8,473.69	8,473.67	8,473.66	8,473.67	8,473.68	8,473.67	8,473.67	8,473.66	8,473.65	0.01	1/2" rebar w/cap
6	512,490.58	2,217,143.42	8,461.52	8,461.51	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	1/2" rebar w/cap
7	512,589.90	2,217,213.86	8,453.25	8,453.25	8,453.19	8,453.09	8,453.12	8,453.11	8,453.11	8,453.12	8,453.11	8,453.10	8,453.11	8,453.09	8,453.09	0.00	1/2" rebar w/cap
8	512,692.18	2,217,262.33	8,445.26	8,445.25	8,445.23	8,445.16	8,445.17	8,445.17	8,445.16	8,445.16	8,445.17	8,445.16	8,445.17	8,445.16	8,445.16	0.00	1/2" rebar w/cap
9	512,800.40	2,217,300.21	8,436.64	8,436.66	8,436.64	8,436.67	8,436.66	8,436.65	8,436.66	8,436.67	8,436.65	8,436.64	8,436.65	8,436.64	8,436.63	0.01	1/2" rebar w/cap
10	512,891.71	2,217,336.16	8,430.74	8,430.79	8,430.77	8,430.77	8,430.76	8,430.77	8,430.77	8,430.77	8,430.76	8,430.76	8,430.76	8,430.76	8,430.76	0.00	1/2" rebar w/cap
11	513,000.47	2,217,368.65	8,424.38	8,424.43	8,424.41	8,424.40	8,424.40	8,424.41	8,424.40	8,424.41	8,424.42	8,424.41	8,424.41	8,424.40	8,424.40	0.00	1/2" rebar w/cap
12	513,103.93	2,217,402.82	8,416.62	8,416.64	8,416.67	8,416.69	8,416.68	8,416.67	8,416.67	8,416.68	8,416.67	8,416.67	8,416.68	8,416.67	8,416.67	0.00	1/2" rebar w/cap
13	513,196.61	2,217,451.14	8,408.31	8,408.36	8,408.37	8,408.36	8,408.36	8,408.37	8,408.38	8,408.38	8,408.36	8,408.37	8,408.37	8,408.35	8,408.35	0.00	1/2" rebar w/cap
14	513,295.64	2,217,494.35	8,393.48	8,393.50	8,393.50	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	1/2" rebar w/cap
15	513,371.68	2,217,541.37	8,380.48	8,380.51	8,380.50	8,380.51	8,380.53	8,380.52	8,380.53	8,380.52	8,380.50	8,380.51	8,380.51	8,380.50	8,380.50	0.00	1/2" rebar w/cap
16	513,462.85	2,217,588.68	8,368.30	8,368.34	8,368.36	8,368.35	8,368.35	8,368.34	8,368.34	8,368.34	8,368.35	8,368.36	8,368.35	8,368.35	8,368.34	0.01	1/2" rebar w/cap
17	513,556.68	2,217,641.91	8,360.76	8,360.76	8,360.77	8,360.75	8,360.74	8,360.74	8,360.73	8,360.74	8,360.73	8,360.74	8,360.73	8,360.73	8,360.72	0.01	1/2" rebar w/cap
18	513,635.51	2,217,689.80	8,360.47	8,360.47	8,360.47	8,360.46	8,360.44	8,360.46	8,360.46	8,360.47	8,360.47	8,360.47	8,360.47	8,360.46	8,360.45	0.01	1/2" rebar w/cap
19	513,711.41	2,217,742.70	8,356.49	8,356.52	8,356.51	8,356.51	8,356.49	8,356.51	8,356.52	8,356.52	8,356.51	8,356.51	8,356.50	8,356.51	8,356.50	0.01	1/2" rebar w/cap
20	513,820.43	2,217,768.54	8,346.15	8,346.17	8,346.16	8,346.17	8,346.15	8,346.14	8,346.14	8,346.14	8,346.15	8,346.14	8,346.15	8,346.14	8,346.13	0.01	1/2" rebar w/cap
21	513,912.62	2,217,806.85	8,331.93	8,331.92	8,331.92	8,331.93	8,331.90	8,331.92	8,331.91	8,331.91	8,331.90	8,331.89	8,331.90	8,331.88	8,331.88	0.00	1/2" rebar w/cap
22	513,997.37	2,217,848.12	8,315.25	8,315.22	8,315.23	8,315.22	8,315.20	8,315.21	8,315.20	8,315.19	8,315.19	8,315.19	8,315.19	8,315.17	8,315.17	0.00	1/2" rebar w/cap
23	514,100	2,217,900	8,298.55	8,298.52	8,298.53	8,298.52	8,298.49	8,298.49	8,298.48	8,298.48	8,298.50	8,298.50	8,298.51	8,298.50	8,298.50	0.00	1/2" rebar w/cap
24	514,250	2,218,000	8,286.01	8,285.97	8,285.97	8,285.98	8,285.95	8,285.97	8,285.96	8,285.95	8,285.96	8,285.95	8,285.97	8,285.96	8,285.95	0.01	1/2" rebar w/cap
25	514,400	2,218,150	8,273.43	8,273.39	8,273.40	8,273.40	8,273.37	8,273.38	8,273.36	8,273.36	8,273.38	8,273.37	8,273.38	8,273.36	8,273.35	0.01	1/2" rebar w/cap
26	514,500	2,218,200	8,256.00	8,255.95	8,255.96	8,255.97	8,255.95	8,255.95	8,255.94	8,255.94	8,255.95	8,255.95	8,255.96	8,255.95	8,255.94	0.01	1/2" rebar w/cap

WARE SURVEYING & ENGINEERING

G.P.S. & CONVENTIONAL SURVEYING - AUTOCAD MAPPING - CIVIL ENGINEERING

TOWER RESOURCES, INC.

2017 STATIC GPS SUBSIDENCE SURVEY

9/22/2017

STATION	NORTHING (FEET)	EASTING (FEET)	2005 ELEV. (FEET)	2006 ELEV. (FEET)	2007 ELEV. (FEET)	2008 ELEV. (FEET)	2009 ELEV. (FEET)	2010 ELEV. (FEET)	2011 ELEV. (FEET)	2012 ELEV. (FEET)	2013 ELEV. (FEET)	2014 ELEV. (FEET)	2015 ELEV. (FEET)	2016 ELEV. (FEET)	2017 ELEV. (FEET)	2016-2017 (FEET)	NOTES
S10	507,824.28	2,217,196.61	8,594.72	8,594.75	8,594.75	8,594.74	8,594.75	8,594.75	8,594.74	8,594.74	8,594.76	8,594.75	8,594.76	8,594.76	8,594.75	0.01	1/2" alum. Cap
S20	510,331.38	2,217,642.84	8,573.89	8,573.72	8,573.70	8,573.71	8,573.71	8,573.70	8,573.72	8,573.70	8,573.71	8,573.72	8,573.71	8,573.70	8,573.72	-0.02	5/8" rebar w/cap
SEC 36-31	513,118.67	2,214,339.99	8,280.12	8,280.01	8,279.91	8,279.92	8,279.91	8,279.92	8,279.93	8,279.91	8,279.93	8,279.91	8,279.91	8,279.92	8,279.92	0.00	1923 brass cap
SEC 36-1-31	510,465.01	2,214,345.45	8,459.10	8,458.70	8,458.52	8,458.50	8,458.51	8,458.52	8,458.52	8,458.51	8,458.49	8,458.52	8,458.53	8,458.51	8,458.53	-0.02	1923 brass cap
SEC 36-1	510,454.53	2,211,696.78	8,606.30	8,606.12	8,605.98	8,605.97	8,605.97	8,605.96	8,605.98	8,605.98	8,605.97	8,605.97	8,605.95	8,605.96	8,605.95	0.01	1923 brass cap

LOCAL COORDINATE SYSTEM

WARE SURVEYING & ENGINEERING

G.P.S. & CONVENTIONAL SURVEYING - AUTOCAD MAPPING - CIVIL ENGINEERING

VEGETATION MONITORING
FOR
PHASE II BOND RELEASE

2017

AT THE
CENTENNIAL MINE
CARBON COUNTY, UTAH

Prepared by

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

by

Patrick Collins, Ph.D.

for

UTAH AMERICAN ENERGY, INC.
Centennial Mine
Tower Division
Post Office Box 902
Price, Utah 84501

January 2018

TABLE OF CONTENTS

INTRODUCTION 1

METHODS 3

Transect and Quadrat Placement 3
Cover, Frequency and Composition 3
Sample Size & Adequacy 3
Photographs 4

RESULTS 4

Reclaimed GVH-01 4
Reclaimed GVH-05 4
Reclaimed GVH-5A 5
Reclaimed GVH-12 5
Reclaimed GVH-12 Access Road 5
Reclaimed GVH-13 6
Reclaimed GVH-14 6
Reclaimed GVH-15 6
Reclaimed GVH-16 6
Reclaimed GVH17- 7
Sagebrush/Grass Reference Area 7
Aspen/Snowberry/Grass (seral) Reference Area 7
Reclaimed Sites vs. Reference Areas 8

DISCUSSION 10

SUMMARY TABLES 11

COLOR PHOTOGRAPHS 23

SAMPLE LOCATION MAP 27

INTRODUCTION

The Centennial Mine is located within the Book Cliffs Plateau, about 10 miles northeast of the town of Price, Utah. The coal mine went into 'temporary cessation' in 2008. Because it is a very deep mine, a number of boreholes, called gob gas holes (GVHs), were drilled and placed in strategic locations to discharge excess gas as a safety precaution during mining operations. Since that time, several of the borehole drill sites have been reclaimed and reseeded with the final seed mixtures. State rules require reclaimed sites be allowed enough time for acceptable plant establishment before applications can be made for bond releases. One such time-frame, called the *Responsibility Period*, prescribes at least 10 years before the mine operator can submit a request for *Final* or *Phase III Bond Release* through the State of Utah, Division of Oil, Gas & Mining (DOGM). It has been estimated that this period of time is long enough to determine whether or not adequate re-establishment of a given reclaimed plant community has occurred.

Prior to the end of the Responsibility Period required for Final Bond Release, a portion of the bond can be recovered through the **Phase II Bond Release** process. State Code regulation R646-301–880.321 states that at the completion of Phase II, *after revegetation has been established on the regraded mined lands in accordance with the approved reclamation plan, a portion of bond may be released*. Phase II Bond Release success standards are primarily based on establishing enough vegetation to meet runoff control requirements as stated in the regulations that "*no part of the bond or deposit will be released under this paragraph so long as the lands to which the release would be applicable are contributing suspended solids to streamflow or runoff outside the permit area in excess of the requirements set by UCA 40-10-17(2)(j) of the Act and by R645-301-751*".

One method to address the requirements for Phase II Release and to show the limits for the contribution of excess *suspended solids to streamflow or runoff outside the permit area,* is to employ erosion control and soil loss measurements. Another way to meet these requirements involve vegetation monitoring studies on the reclaimed lands. The purpose of this report is to address the latter – to conduct a study and record quantitative data to ascertain whether or not the revegetated areas have enough vegetation cover to

adequately control erosion and soil loss. The reclaimed areas have been compared to the background conditions, or nearby native plant communities that have not been disturbed by mine-related operations. Consequently, the total living cover of the vegetation in the reclaimed areas have been quantitatively sampled along with those areas chosen for final revegetation success standards, or *reference areas*. Reference areas are often native, undisturbed plant communities chosen to document the land condition before disturbance is made by the mine-related activities. Using this approach, data are recorded in the reference areas and compared with the reclaimed areas for bond release applications.

The following is a list of the reclaimed GVH sites, the dates they were seeded and applicable reference areas.

SAMPLE SITE	**YEAR SEEDED**	**GPS NAME**	**COORDINATES (UTM; NAD 27)**	**REFERENCE AREA COMPARISON**
GVH-01	2009	ANGVH1	523627 4397698	Sagebrush/Grass
GVH-05	2009	ANGVH5	523623 4398178	Sagebrush/Grass
GVH-05A	2009			Sagebrush/Grass
GVH-12	2014	AGVH12	523011 4398654	Aspen/Snowberry/Grass (seral)
GVH-12 (Access Road)	2014			Sagebrush/Grass
GVH-13	2014	AGVH13	522686 4398654	Aspen/Snowberry/Grass (seral)
GVH-14	2014	AGVH14	522362 4398653	Sagebrush/Grass
GVH-15	2012	AGVH15	522038 4398652	Sagebrush/Grass
GVH-16	2012	AGVH16	521713 4398651	Aspen/Snowberry/Grass (seral)
GVH-17	2012	AGVH17	521389 4398650	Sagebrush/Grass
Sagebrush/Grass Reference Area	N/A	AGVHSR	522309 4398459	
Aspen/Snowberry/Grass (seral) Reference Area	N/A	AGVH9R	522002 4398050	

METHODS

Quantitative and qualitative data were taken of the vegetation at the reclaimed GVH sites and reference areas for the Centennial Mine in the first week of September 2017. Methodologies used for sampling were performed in accordance with the guidelines provided by DOGM.

Transect and Quadrat Placement

Random/regular placement of sample quadrats were designed as an attempt to provide unbiased accuracy of the data compiled. This was accomplished by establishing long transect lines along the entire lengths of the reclaimed and reference areas. At regular intervals along the transect lines, random numbers were generated and used to measure distances at right angles to determine sample locations. Whether these random numbers were odd or even determined which side of the transect line a given quadrat was placed. The number of transect lines and random numbers selected were of ample size to insure that the sample locations reached the entire lengths and widths of each study area. This insured that the sample quadrats were placed randomly over the entire study area in an attempt to adequately represent the site as a whole.

Cover, Frequency and Composition

Cover estimates were made using ocular methods with meter square quadrats. Species composition and relative frequencies were also assessed from the quadrats. Additional information recorded on the raw data sheets were: slope, exposure, problem areas, grazing use, animal disturbance and other appropriate notes. Plant nomenclature followed "*A Utah Flora*" (Welsh et al. 2008).

Sample Size & Adequacy

Sampling adequacy was calculated using the formula given below.

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

where,

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

The values used for "t" and "d" insured that sample adequacy was met with 80% confidence within a 10% deviation from the true mean.

Photographs

Color photographs of each sample area were taken at the time of sampling and submitted with this report.

RESULTS

Reclaimed GVH-01

The reclaimed GVH-01 site was dominated by two grass species, western wheatgrass (*Elymus smithii*) and mountain brome (*Elymus carinatus*). Two shrubs were also important with respect to cover and frequency at this site – big sagebrush (*Artemisia tridentata*) and rubber rabbitbrush (*Chrysothamnus nauseosus*). Five forbs were also present in the sample quadrats, but had much less cover and frequency values. For a list of all plant species present in the samples refer to Table 1.

Total living cover for GVH-01 was estimated at 68.00% (Table 2-A). The relative lifeform composition was dominated by grasses at 76.05%, followed by shrubs at 21.31%, then forbs at only 2.64% (Table 2-B)

Reclaimed GVH-05

GVH-05 was dominated by three plant species (Table 3) which consisted of one shrub, big sagebrush, and two grasses, mountain brome and Gt. Basin wildrye (*Elymus cinereus*).

Like the above site, the total living cover here was estimated at 68.00% (Table 4-A) and was comprised mostly of grasses at 64.76% followed by shrubs at 32.57% and forbs at 2.67% (Table 4-B).

Reclaimed GVH-05A

GVH-05A was dominated by Kentucky bluegrass (*Poa pratensis*) and a "weedy" plant called knotweed (*Polygonum aviculare*). Another grass species, mountain brome, was also relatively important at this site with respect to cover and frequency (Table 5).

Total living cover for GVH-05A was estimated at 60.25% (Table 6-A). Lifeform composition was dominated by grasses at 64.36% and forbs at 35.64% (Table 6-B). No shrubs were present in the sample quadrats.

Reclaimed GVH-12

Similar to other reclaimed sites in this study, GVH-12 was dominated by Gt. Basin wildrye and mountain brome, however, unlike the previous sites, Lewis flax (*Linum lewisii*) was a common forb species here (Table 7).

The total living cover for this site was estimated at 68.25% (Table 8-A). The composition of this cover was comprised of 76.91% grasses, 20.87% forbs and 2.22% shrubs (Table 8-B).

Reclaimed GVH-12 (Access Road)

Because there was some surface disturbance created for access to GVH-12 drill site, and because the plant community prior disturbance to make the access road was not the same as the drill pad and therefore has different revegetation success standards, the reclaimed road was sampled separately. The Reclaimed GVH-12 Access Road was dominated by two shrubs – big sagebrush and low rabbitbrush (*Chrysothamnus viscidiflorus*), but western wheatgrass was also a common species here (Table 9).

Total living cover of the reclaimed access road was 73.75% (Table 10-A) and was comprised of

60.17% shrubs, 35.60% grasses and 4.23% forbs (Table 10-B).

Reclaimed GVH-13

The most common plant at GVH-13 was mountain brome grass by quite a wide margin, but Gt. Basin wildrye, rubber rabbitbrush, big sagebrush, Kentucky bluegrass and western wheatgrass were also important species (Table 11).

The total living cover for the site was 58.50% (Table 12-A). The composition of the living cover consisted of 67.28% grasses, 26.23% shrubs and 6.49% forbs (Table 12-B).

Reclaimed GVH-14

The reclaimed GVH-14 site was dominated by grasses including mountain brome, Kentucky bluegrass and western wheatgrass (Table 13).

Total living cover for GVH-14 was estimated at 61.75% (Table 14-A). Lifeform composition was dominated by grasses at 82.38%, forbs at 15.34%, followed by shrubs at 2.27% (Table 14-B).

Reclaimed GVH-15

Reclaimed GVH-15 site was dominated by grass species, primarily western wheatgrass (Table 15). Other common grass species present were mountain brome, Kentucky bluegrass and crested wheatgrass (*Agropyron cristatum*).

Total living cover for GVH-15 was estimated at 59.25% (Table 16-A). The relative lifeform composition was dominated by grasses at 89.48%, followed distantly by forbs at 7.11%, then shrubs at only 3.40% (Table 16-B).

Reclaimed GVH-16

GVH-16 was dominated by western wheatgrass. Other common species at the site were low rabbitbrush, big sagebrush, crested wheatgrass and mountain brome grass (Table 17).

Total living cover here was also estimated at 65.75% (Table 18-A) and was comprised most of grasses at 82.70% followed by shrubs at 16.47% and forbs at only 0.83% (Table 18-B).

Reclaimed GVH-17

The most common plant at GVH-17 was western wheatgrass by a wide margin. The only other species present here were Kentucky bluegrass, mountain bromegrass and knotweed (Table 19).

The total living cover for the site was 61.75% (Table 20-A). The composition of the living cover was mostly grasses at 95.27%. Forbs made up the remaining portion of the cover at only 4.73% (Table 20-B).

Sagebrush/Grass Reference Area

The reference area chosen to represent revegetation success standards for several of the reclaimed sites was a Sagebrush/Grass plant community. This community was sampled during the same time period as the reclaimed GVH sites. The dominant two plants here were big sagebrush and Kentucky bluegrass (Table 21). Other species common in this community were low rabbitbrush, silvery lupine (*Lupinus argenteus*) and snowberry (*Symphoricarpos oreophilus*).

The total living cover of the Sagebrush/Grass Reference Area was 57.75% (Table 22-A). The composition of this area was comprised of 59.56% shrubs, 29.41% grasses and 11.03% forbs (Table 22-B).

Aspen/Snowberry/Grass (seral) Reference Area

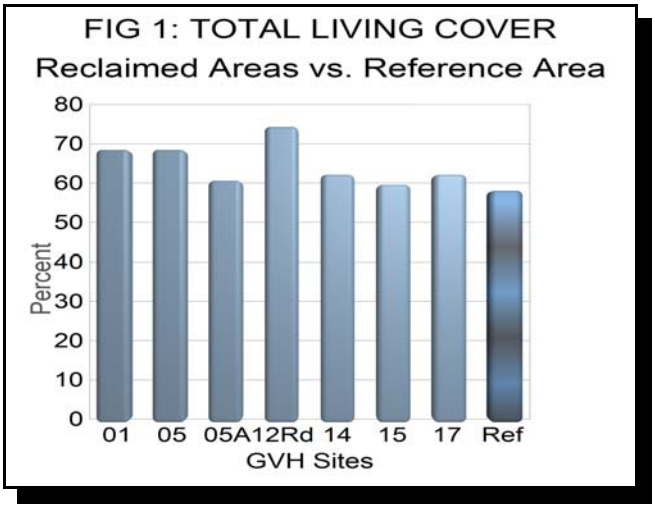
The remaining reclaimed GVH sites in this study had a different reference area chosen to represent final revegetation success standards. Because this community had many young aspen trees present we called this community "seral". The most common plants for this community were low rabbitbrush, Kentucky bluegrass and quaking aspen (*Populus tremuloides*) trees (Table 23).

This community had a total living cover of 65.75%, with 2.75% coming from overstory and the remaining 63.00% from understory cover (Table 24-A). The composition of the understory

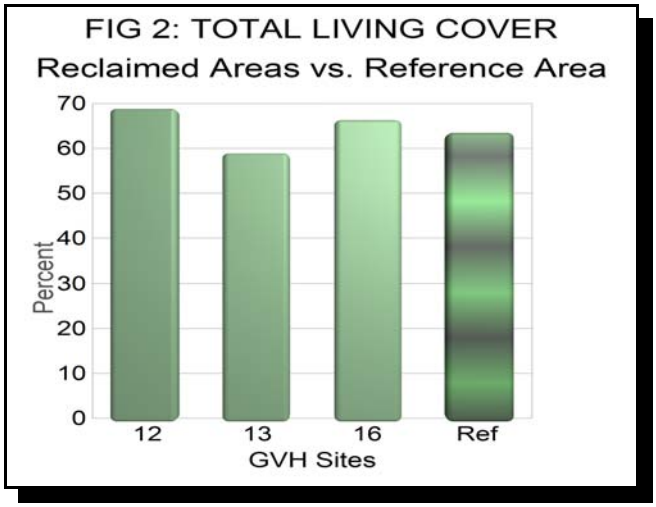
cover consisted of 48.94% woody plants, 38.07% grasses and 12.99% forbs (Table 24-B).

Reclaimed Sites vs. Reference Areas

A graphical comparison of the total living cover of the applicable reclaimed GVH sites and the **Sagebrush/Grass Reference Area** is shown in Figure 1.



Next, a comparison of the total living cover of the remaining reclaimed GVH sites and the **Aspen/Snowberry/Grass (seral) Reference Area** in Figure 2.



Student's t-tests were employed to compare the **total living cover** of each reclaimed site with the appropriate reference area (Figures 3 & 4). A summary of the findings follows:

- GVH-01 cover is significantly greater statistically compared to the reference area.

- GVH-05 cover is significantly greater than the reference area.

- GVH-05A cover is higher but not significant statistically when compared to its reference area.

- GVH-12 cover is significantly greater than the reference area.

- GVH-12 (Access Road) cover is also significantly greater than the reference area.

- GVH-13 cover is less but not statistically different than the reference area.

- GVH-14 cover is more but not significantly greater reference area.

FIG. 3. Statistical Analyses - Student's t-tests comparing total living cover of the reclaimed GVH Sites with the **Sagebrush/Grass Reference Area** (2017).

Reclaimed GVH-01: $\bar{x}$=68.00; s=6.40; n=20
Reference Area: $\bar{x}$=57.75; s=12.40; n=20
t =3.285; df =38; SL=p<0.005

Reclaimed GVH-05: $\bar{x}$=68.00; s=10.17; n=20
Reference Area: $\bar{x}$=57.75; s=12.40; n=20
t =2.858; df =38; SL=p<0.010

Reclaimed GVH-5A: $\bar{x}$=60.25; s=11.01; n=20
Reference Area: $\bar{x}$=57.75; s=12.40; n=20
t =0.674; df =38; SL=NS

Reclaimed GVH-12 Access Rd: $\bar{x}$=73.75; s=8.20; n=20
Reference Area: $\bar{x}$=57.75; s=12.40; n=20
t =4.813; df =38; SL=p<0.005

Reclaimed GVH-14: $\bar{x}$=61.75; s=10.16; n=20
Reference Area: $\bar{x}$=57.75; s=12.40; n=20
t =1.116; df =38; SL=NS

Reclaimed GVH-15: $\bar{x}$=59.25; s=10.64; n=20
Reference Area: $\bar{x}$=57.75; s=12.40; n=20
t =0.411; df =38; SL=NS

Reclaimed GVH-17: $\bar{x}$=61.75; s=9.91; n=20
Reference Area: $\bar{x}$=57.75; s=12.40; n=20
t =1.127; df =38; 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

- GVH-15 cover is more but not significantly greater than the reference area.

- GVH-16 cover is more but not significant statistically when compared to the reference area.

- GVH-17 cover is more but not significantly greater than its reference area.

DISCUSSION

The State of Utah, Division of Oil, Gas & Mining encourages the collection of quantitative data to monitor and show vegetation establishment on reclaimed sites. Approval by DOGM for Phase II Bond Release is dependent on several factors. One of the most important factors may be whether or not the reclaimed site is controlling erosional sediments as outlined in the INTRODUCTION of this report. Comparing "background" conditions (or in this case the approved reference areas) to the GVH sites, it has been shown that the total living cover values, so important for erosion control, of the reclaimed areas were either greater by statistically significant margins, or only slightly different with no statistically significance.

FIG. 4. Statistical Analyses - Student's t-tests comparing total living cover of the reclaimed GVH Sites with the **Aspen/Snowberry/Grass Reference Area** (2017).

Reclaimed GVH-12: $\bar{x}$=68.25; s=7.46; n=20
Reference Area: $\bar{x}$=63.00; s=5.10; n=20
t =2.598; df =38; SL=p<0.025

Reclaimed GVH-13: $\bar{x}$=58.50; s=9.63; n=20
Reference Area: $\bar{x}$=63.00; s=5.10; n=20
t =1.847; df =38; SL=NS

Reclaimed GVH-16: $\bar{x}$=65.75; s=7.96; n=20
Reference Area: $\bar{x}$=63.00; s=5.10; n=20
t =1.301; df =38; 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

In conclusion, the data and analyses presented in this report suggest that the seeding for revegetation at the Centennial Mine is becoming established and Phase II bond release through DOGM may be warranted.

Table 1: Centennial Mine. Total cover, standard deviation and frequency by species (2017).

GVH-01 n=20

	Mean Percent	Standard Deviation	Percent Frequency
TREES & SHRUBS			
Amelanchier utahensis	0.25	1.09	5.00
Artemisia tridentata	6.50	11.08	35.00
Chrysothamnus nauseosus	4.50	11.17	15.00
Chrysothamnus viscidiflorus	1.00	4.36	5.00
Populus tremuloides	1.25	3.83	10.00
Purshia tridentata	0.75	1.79	15.00
Symphoricarpos oreophilus	0.75	2.38	10.00
FORBS			
Hedysarum boreale	0.50	1.50	10.00
Linum lewisii	0.25	1.09	5.00
Lupinus argenteus	0.50	1.50	10.00
Taraxacum officinalis	0.25	1.09	5.00
Tragopogon dubius	0.25	1.09	5.00
GRASSES			
Bromus carinatus	10.00	11.73	60.00
Elymus smithii	25.50	23.55	65.00
Elymus spicatus	3.50	10.62	10.00
Elymus trachycaulus	2.75	11.99	5.00
Poa pratensis	9.50	15.32	30.00

Table 2: Centennial Mine. Total Cover and composition (2017).

GVH-01 n=20

	Mean Percent	Standard Deviation
A. TOTAL COVER		
Understory	68.00	6.40
Litter	11.75	4.26
Bareground	11.75	6.76
Rock	8.50	3.57
B. COMPOSITION		
Shrubs	21.31	19.84
Forbs	2.64	4.34
Grasses	76.05	19.53

Table 3: Centennial Mine. Total cover, standard deviation and frequency by species (2017).

GVH-05 n=20

	Mean Percent	Standard Deviation	Percent Frequency
TREES & SHRUBS			
Artemisia tridentata	23.00	17.85	75.00
FORBS			
Artemisia dracunculus	0.25	1.09	5.00
Carduus nutans	0.25	1.09	5.00
Cynoglossum officinalis	0.50	2.18	5.00
Hedysarum boreale	0.50	1.50	10.00
Linum lewisii	0.25	1.09	5.00
GRASSES			
Bromus carinatus	21.25	17.95	75.00
Elymus cinereus	11.00	15.30	50.00
Elymus smithii	4.75	10.06	20.00
Elymus spicatus	1.75	7.63	5.00
Elymus trachycaulus	0.75	3.27	5.00
Poa pratensis	3.75	7.56	25.00

Table 4: Centennial Mine. Total Cover and composition (2017).

GVH-05 n=20

	Mean Percent	Standard Deviation
A. TOTAL COVER		
Understory	68.00	10.17
Litter	10.70	2.97
Bareground	14.25	8.41
Rock	7.05	3.58
B. COMPOSITION		
Shrubs	32.57	24.42
Forbs	2.67	5.19
Grasses	64.76	23.30

Table 5: Centennial Mine. Total cover, standard deviation and frequency by species (2017).

GVH-5A n=20

	Mean Percent	Standard Deviation	Percent Frequency
TREES & SHRUBS			
FORBS			
Achillea millefolium	2.50	6.22	15.00
Carduus nutans	3.00	7.31	20.00
Polygonum aviculare	15.75	17.41	55.00
GRASSES			
Bromus carinatus	6.50	7.60	50.00
Elymus smithii	1.00	3.00	10.00
Elymus trachycaulus	0.50	2.18	5.00
Poa pratensis	31.00	18.48	90.00

Table 6: Centennial Mine. Total Cover and composition (2017).

GVH-5A n=20

	Mean Percent	Standard Deviation
A. TOTAL COVER		
Understory	60.25	11.01
Litter	8.75	3.49
Bareground	21.00	13.00
Rock	10.00	4.18
B. COMPOSITION		
Shrubs	0.00	0.00
Forbs	35.64	28.38
Grasses	64.36	28.38

Table 7: Centennial Mine. Total cover, standard deviation and frequency by species (2017).

GVH-12			n=20
	Mean Percent	**Standard Deviation**	**Percent Frequency**
TREES & SHRUBS			
Chrysothamnus nauseosus	1.75	5.31	10.00
FORBS			
Artemisia dracunculus	0.50	1.50	10.00
Convolvulus arvensis	1.00	4.36	5.00
Cynoglossum officinalis	0.50	2.18	5.00
Linum lewisii	4.00	4.64	45.00
GRASSES			
Agropyron cristatum	3.25	9.78	10.00
Bromus carinatus	14.50	14.22	65.00
Elymus cinereus	28.00	26.76	60.00
Elymus smithii	7.00	11.00	40.00
Elymus spicatus	3.75	11.92	10.00
Hordeum jubatum	1.00	4.36	5.00
Poa pratensis	3.00	9.54	10.00

Table 8: Centennial Mine. Total Cover and composition (2017).

GVH-12		n=20
	Mean Percent	**Standard Deviation**
A. TOTAL COVER		
Understory	68.25	7.46
Litter	11.20	3.52
Bareground	13.50	5.72
Rock	7.05	2.80
B. COMPOSITION		
Shrubs	2.22	6.80
Forbs	20.87	26.28
Grasses	76.91	25.39

Table 9: Centennial Mine. Total cover, standard deviation and frequency by species (2017).

GVH-12 Access Road n=20

	Mean Percent	Standard Deviation	Percent Frequency
TREES & SHRUBS			
Artemisia tridentata	31.75	16.98	90.00
Chrysothamnus viscidiflorus	12.75	11.88	65.00
Symphoricarpos oreophilus	0.75	3.27	5.00
FORBS			
Hedysarum boreale	0.50	2.18	5.00
Lupinus argenteus	2.75	5.80	20.00
GRASSES			
Agropyron cristatum	2.00	4.85	15.00
Elymus smithii	17.50	21.53	65.00
Elymus spicatus	1.25	5.45	5.00
Elymus trachycaulus	0.75	3.27	5.00
Poa pratensis	3.75	10.11	20.00

Table 10: Centennial Mine. Total Cover and composition (2017).

GVH-12 Access Road n=20

	Mean Percent	Standard Deviation
A. TOTAL COVER		
Understory	73.75	8.20
Litter	9.45	1.99
Bareground	11.85	6.43
Rock	4.95	4.01
B. COMPOSITION		
Shrubs	60.17	26.56
Forbs	4.23	8.04
Grasses	35.60	28.67

Table 11: Centennial Mine. Total cover, standard deviation and frequency by species (2017).

GVH-13 n=20

	Mean Percent	Standard Deviation	Percent Frequency
TREES & SHRUBS			
Artemisia tridentata	6.25	15.40	15.00
Chrysothamnus nauseosus	8.00	14.09	30.00
Chrysothamnus viscidiflorus	0.50	2.18	5.00
Symphoricarpos oreophilus	0.25	1.09	
FORBS			
Artemisia dracunculus	2.50	8.87	10.00
Carduus nutans	1.00	4.36	5.00
GRASSES			
Agropyron cristatum	0.75	3.27	5.00
Bromus carinatus	22.75	24.11	65.00
Elymus cinereus	8.75	15.72	30.00
Elymus smithii	3.00	5.57	25.00
Linum lewisii	0.75	2.38	10.00
Poa pratensis	4.00	10.79	15.00

Table 12: Centennial Mine. Total Cover and composition (2017)

GVH-13 n=20

	Mean Percent	Standard Deviation
A. TOTAL COVER		
Understory	58.50	9.63
Litter	14.00	7.00
Bareground	15.00	9.08
Rock	12.50	6.02
B. COMPOSITION		
Shrubs	26.23	32.80
Forbs	6.49	16.99
Grasses	67.28	32.01

Table 13: Centennial Mine. Total cover, standard deviation and frequency by species (2017).

GVH-14			n=20
	Mean Percent	**Standard Deviation**	**Percent Frequency**
TREES & SHRUBS			
Chrysothamnus nauseosus	1.25	5.45	5.00
FORBS			
Achillea millefolium	3.75	6.87	30.00
Artemisia dracunculus	1.50	3.57	15.00
Carduus nutans	1.25	5.45	5.00
Cynoglossum officinalis	2.25	6.02	15.00
Linum lewisii	1.25	2.68	20.00
GRASSES			
Bromus carinatus	22.25	16.99	80.00
Elymus smithii	11.75	18.46	45.00
Poa pratensis	16.50	13.52	75.00

Table 14: Centennial Mine. Total Cover and composition (2017).

GVH-14		n=20
	Mean Percent	**Standard Deviation**
A. TOTAL COVER		
Understory	61.75	10.16
Litter	18.20	6.75
Bareground	12.95	5.70
Rock	7.10	3.49
B. COMPOSITION		
Shrubs	2.27	9.91
Forbs	15.34	19.10
Grasses	82.38	22.74

Table 15: Centennial Mine. Total cover, standard deviation and frequency by species (2017).

GVH-15 n=20

	Mean Percent	Standard Deviation	Percent Frequency
TREES & SHRUBS			
Artemisia nova	0.75	3.27	5.00
Rosa woodsii	0.50	2.18	5.00
Symphoricarpos oreophilus	0.75	3.27	5.00
FORBS			
Carduus nutans	0.50	2.18	5.00
Cynoglossum officinalis	1.25	2.68	20.00
Linum lewisii	1.75	3.96	20.00
GRASSES			
Agropyron cristatum	6.25	15.72	15.00
Bromus carinatus	7.75	13.92	30.00
Elymus cinereus	2.75	9.93	10.00
Elymus smithii	30.25	29.64	55.00
Poa pratensis	6.75	16.38	15.00

Table 16: Centennial Mine. Total Cover and composition (2017).

GVH-15 n=20

	Mean Percent	Standard Deviation
A. TOTAL COVER		
Understory	59.25	10.64
Litter	14.75	5.80
Bareground	16.25	9.20
Rock	9.75	4.32
B. COMPOSITION		
Shrubs	3.40	8.38
Forbs	7.11	11.03
Grasses	89.48	13.61

Table 17: Centennial Mine. Total cover, standard deviation and frequency by species (2017).

GVH-16 n=20

	Mean Percent	Standard Deviation	Percent Frequency
TREES & SHRUBS			
Artemisia tridentata	4.00	8.60	20.00
Chrysothamnus nauseosus	0.50	2.18	5.00
Chrysothamnus viscidiflorus	5.00	10.37	20.00
Symphoricarpos oreophilus	0.25	1.09	5.00
FORBS			
Artemisia dracunculus	0.50	2.18	5.00
GRASSES			
Agropyron cristatum	3.25	14.17	5.00
Bromus carinatus	2.25	6.02	15.00
Elymus smithii	48.00	23.95	95.00
Poa pratensis	2.00	6.00	10.00

Table 18: Centennial Mine. Total Cover and composition (2017).

GVH-16 n=20

	Mean Percent	Standard Deviation
A. TOTAL COVER		
Understory	65.75	7.95
Litter	8.75	3.49
Bareground	15.75	8.10
Rock	9.75	3.70
B. COMPOSITION		
Shrubs	16.47	23.29
Forbs	0.83	3.63
Grasses	82.70	23.28

Table 19: Centennial Mine. Total cover, standard deviation and frequency by species (2017).

GVH-17 n=20

	Mean Percent	Standard Deviation	Percent Frequency
TREES & SHRUBS			
FORBS			
Polygonum aviculare	2.75	5.58	20.00
GRASSES			
Bromus carinatus	3.25	5.31	30.00
Elymus smithii	51.75	16.90	100.00
Poa pratensis	4.00	8.46	20.00

Table 20: Centennial Mine. Total Cover and composition (2017).

GVH-17 n=20

	Mean Percent	Standard Deviation
A. TOTAL COVER		
Understory	61.75	9.91
Litter	6.70	2.33
Bareground	23.75	8.79
Rock	7.80	4.52
B. COMPOSITION		
Shrubs	0.00	0.00
Forbs	4.73	9.47
Grasses	95.27	9.47

Table 21: Centennial Mine. Total cover, standard deviation and frequency by species (2017).

Sagebrush/Grass Reference Area n=20

	Mean Percent	Standard Deviation	Percent Frequency
TREES & SHRUBS			
Artemisia tridentata	21.75	14.86	90.00
Chrysothamnus viscidiflorus	9.00	12.71	45.00
Symphoricarpos oreophilus	4.50	5.68	45.00
FORBS			
Astragalus sp.	1.25	3.11	15.00
Lupinus argenteus	4.75	7.15	30.00
Penstemon watsonii	0.50	2.18	5.00
GRASSES			
Festuca thurberi	2.50	5.12	20.00
Poa pratensis	13.50	7.60	85.00

Table 22: Centennial Mine. Total Cover and composition (2017).

Sagebrush/Grass Reference Area n=20

	Mean Percent	Standard Deviation
A. TOTAL COVER		
Understory	57.75	12.40
Litter	14.25	5.97
Bareground	15.00	11.40
Rock	13.00	8.57
B. COMPOSITION		
Shrubs	59.56	17.54
Forbs	11.03	11.31
Grasses	29.41	13.46

Table 23: Centennial Mine. Total cover, standard deviation and frequency by species (2017).

Aspen/Snowberry/Grass Reference Area (seral) n=20

	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
Populus tremuloides	2.75	5.36	25.00
UNDERSTORY			
SHRUBS			
Artemisia tridentata	2.75	7.66	15.00
Chrysothamnus viscidiflorus	16.75	13.90	75.00
Populus tremuloides	6.75	11.54	35.00
Symphoricarpos oreophilus	5.00	8.94	25.00
FORBS			
Achillea millefolium	1.25	3.11	15.00
Carduus nutans	0.25	1.09	5.00
Lupinus argenteus	6.50	11.19	35.00
GRASSES			
Elymus spicatus	2.00	5.10	15.00
Elymus trachycaulus	2.75	6.98	15.00
Poa pratensis	19.00	11.47	85.00

Table 24: Centennial Mine. Total Cover and composition (2017).

Aspen/Snowberry/Grass Reference Area (seral) n=20

	Mean Percent	Standard Deviation
A. TOTAL COVER		
Overstory (O)	2.75	5.36
Understory (U)	63.00	5.10
Litter	27.75	6.02
Bareground	7.65	3.77
Rock	1.60	1.20
O + U	65.75	5.97
B. COMPOSITION		
Trees & Shrubs	48.94	22.31
Forbs	12.99	17.93
Grasses	38.07	16.57

Reclaimed GVH-01

Reclaimed GVH-05

Reclaimed GVH-05A

Reclaimed GVH-12

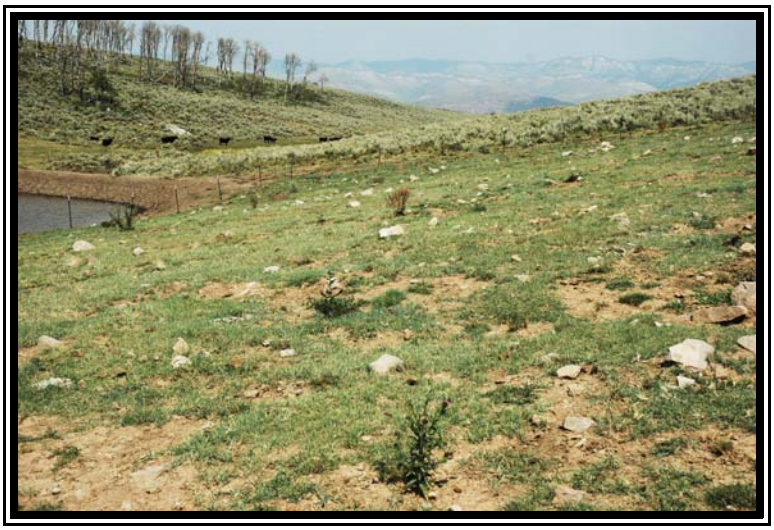
Reclaimed GVH-12 Access Road

Reclaimed GVH-13

Reclaimed GVH-14

Reclaimed GVH-15

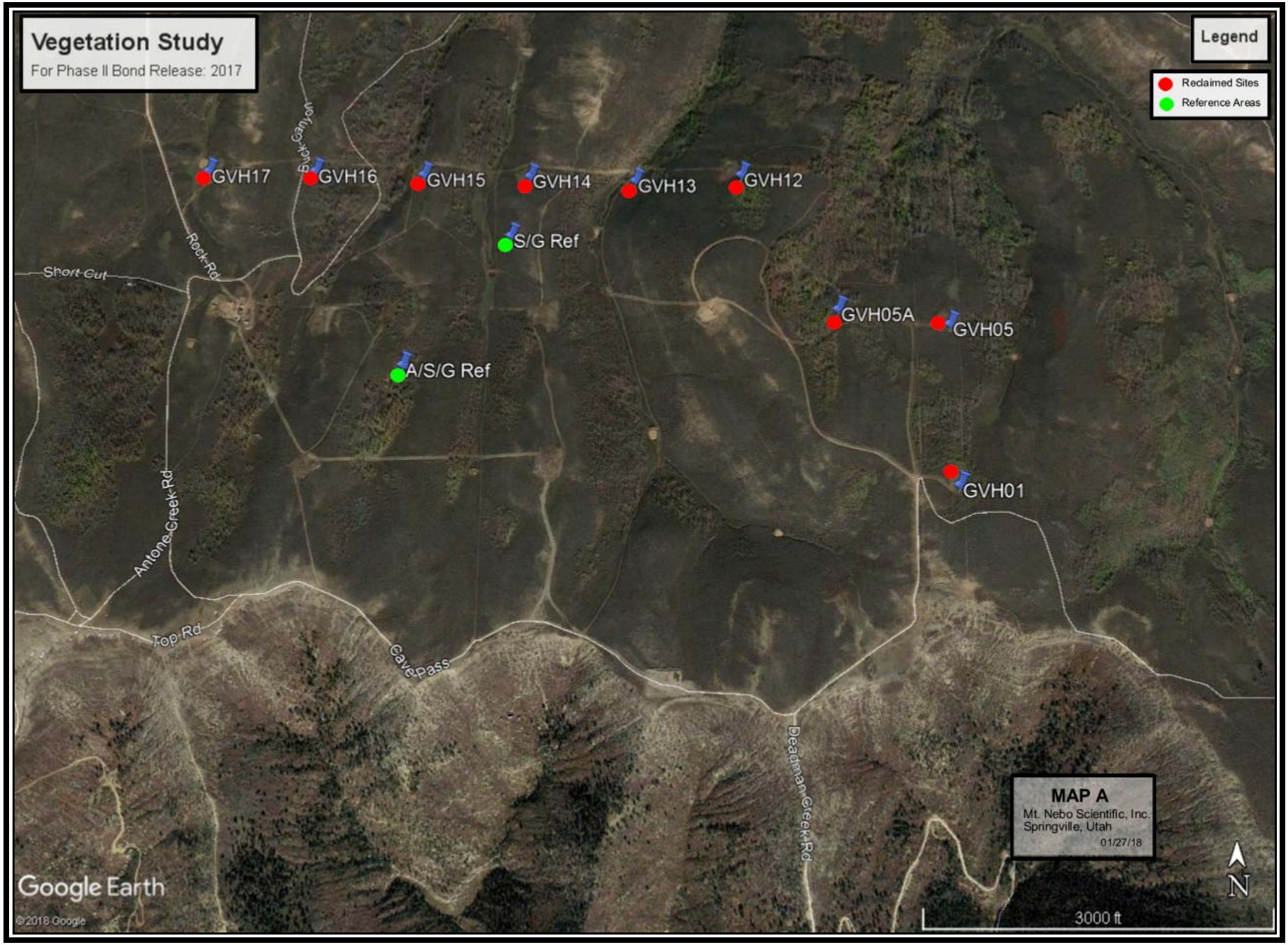
Reclaimed GVH-16



Reclaimed GVH-17

Sagebrush/Grass Reference Area

Aspen/Snowberry/Grass Reference Area


Vegetation Study
For Phase II Bond Release: 2017
Legend
Reclaimed Sites
Reference Areas
GVH17
GVH16
GVH15
GVH14
GVH13
GVH12
S/G Ref
GVH05A
GVH05
A/S/G Ref
GVH01
Buck Canyon
Rock Rd
Short Cut
Antone Creek Rd
Top Rd
Cave Pass
Deadman Creek Rd
MAP A
Mt. Nebo Scientific, Inc.
Springville, Utah
01/27/18
N
3000 ft
Google Earth
©2018 Google