

# Federal Agency Benefit Analysis of a Reclamation Monitoring Tool for Abandoned Mine Lands

Loren Barber Franklin, Reclamation Scientist  
Dennis Neuman, Principle Scientist  
Reclamation Research Group  
*A Division of*  
KC Harvey Environmental, LLC  
Bozeman, MT

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# Presentation Content

- Introduction to Abandoned Mine Lands Across the West
- Reclamation Monitoring and Maintenance
- What is the Reclamation Monitoring Handbook
- Completed Monitoring
- Handbook Benefit Analysis
- Analysis Results
- Updates to the Handbook



## Abandoned Mine Lands Post-Remediation Assessment Protocols and Handbook Version 5

Prepared for:  
Bureau of Land Management  
US Department of Interior  
Butte Field Office  
106 North Parkmont  
Butte, Montana 59701



Prepared by:  
Reclamation Research Unit  
Montana State University  
Bozeman, MT 59715



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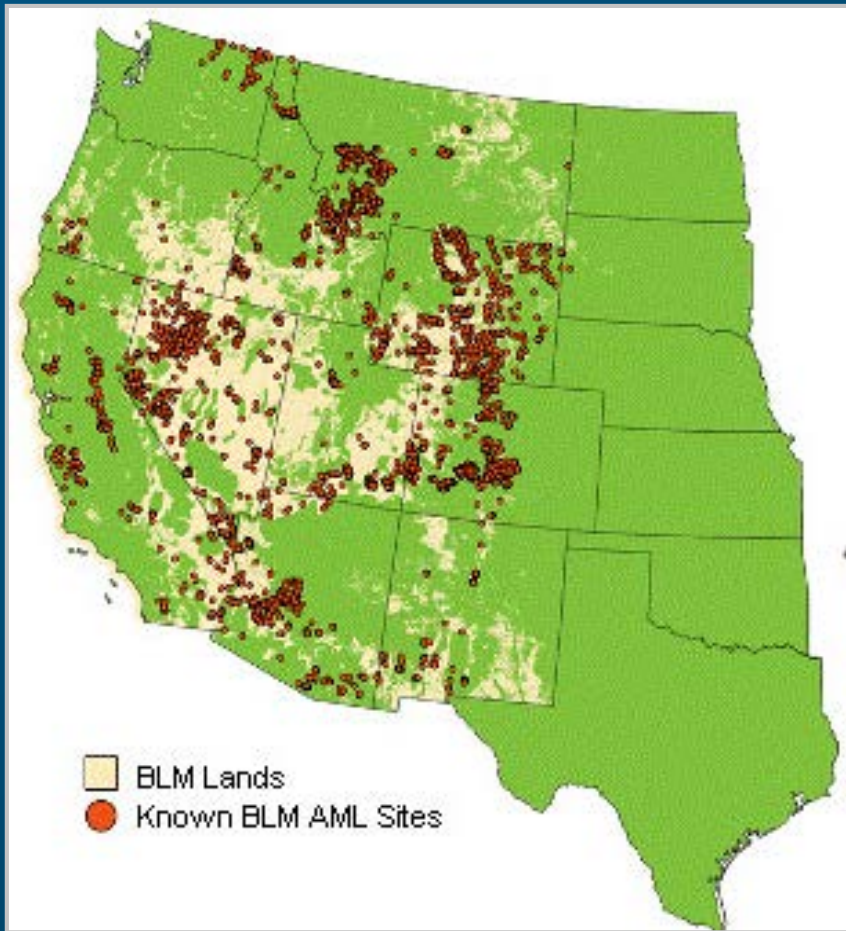
Revised by:  
Reclamation Research Group  
*A Division of*  
KC Harvey Environmental, LLC



December 2012

**KC HARVEY**  
ENVIRONMENTAL, LLC

# U.S. Bureau of Land Management (BLM) Abandoned Mine Lands (AML)



As of January 2013, BLM estimates:

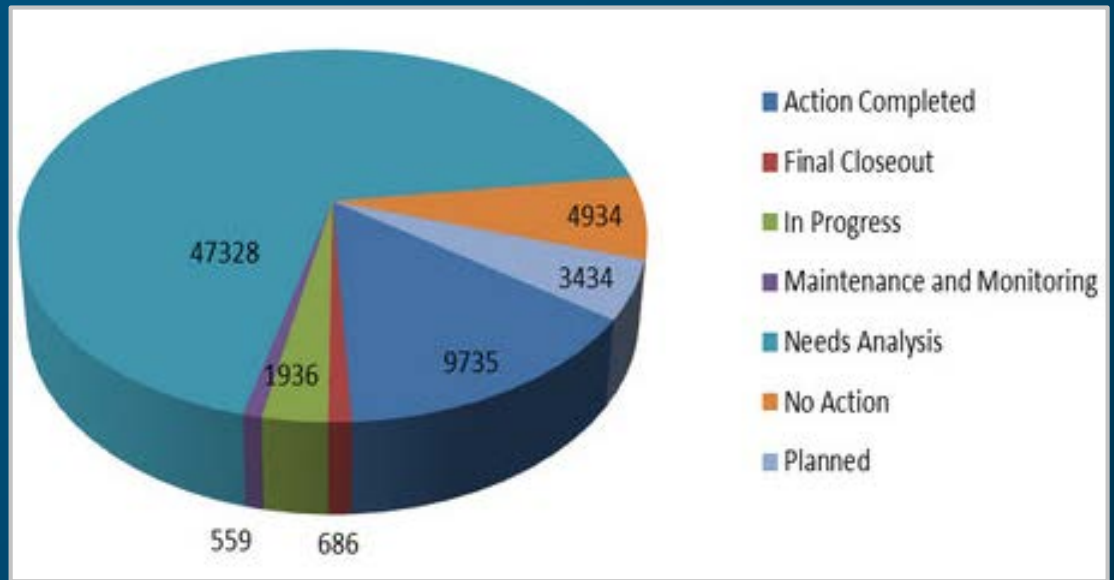
- 39,000 sites
- 76,600 features
  - Open adits and shafts
  - Waste dumps
  - Highwalls and pits
  - Tailings piles



**Chrystal Mine and Mill, Montana  
(AML and NPL Superfund Site)**

# BLM AML Inventory and Status

Estimates from January 2013



State	Action Completed	Final Closeout	In Progress	Maintenance and Monitoring	Needs Analysis	No Action	Planned	Total	Remaining Sites
Alaska	21	12	15	1	70	76	17	212	103
Arizona	118	175	30	100	2,675	623	276	3,997	3,081
California	133	1	47	10	1,223	114	314	1,842	1,594
Colorado	747	2	52	2	2,160	243	95	3,301	2,309
Idaho	246		40	152	240	292	163	1,133	595
Montana	381		118	1 (7)	442	224	40	1,206	601
Nevada	647	218	65		14,683	45	712	16,370	15,460
New Mexico	554		26		3,485	27	391	4,483	3,902
Oregon	33		8	48	640	31	8	768	704
Utah	2,426		620	4	188	1,278	12	4,528	824
Washington	13		16	0	63	2	8	102	87
Wyoming	58	30	3	18	859	40	32	1,040	912
<b>Total</b>	<b>5,377</b>	<b>438</b>	<b>1,040</b>	<b>336</b>	<b>26,728</b>	<b>2,995</b>	<b>2,068</b>	<b>38,982</b>	<b>30,172</b>

# Reclamation

Gregory Mine and Mill,  
Gregory Creek, Montana  
(BLM and MT DEQ AML)



Historic  
Mining



2012 Monitoring



*L. Franklin and M.  
Pokorny Images*

# Reclamation Monitoring and Maintenance

## Was reclamation successful?

- Removed contamination
- Reduced impacts to the environment
- Improved soil and water health
- Protects human and ecological health
- Revegetation success
- Reclamation goals achieved

## Products of reclamation monitoring and maintenance

- Maintenance needs
- Trend analysis of clean-up status
- Identify effective vs. non-effective reclamation methods
- Analysis of reclamation program to support further reclamation needs



Lower Indian Creek Repository and Reclaimed Creek, Montana 2012  
(BLM AML)

# Abandoned Mine Lands Post-Remediation Assessment Protocols and Handbook

Reclamation monitoring tool for AMLs  
Developed for BLM and USFS (2006)

Reclamation Research Unit, Montana State University- Bozeman



Electronic version and geodatabase: Mine  
Reclamation Evaluation Database (MRED)(2009)

Reclamation Research Group, LLC



Handbook Updates (2012)

KC Harvey Environmental, LLC



# The Handbook

- **Qualitative reclamation evaluation**
- **General summary questionnaire specific to overall reclamation progress and success**
- **Series of monitoring forms focusing on mine features**
- **Evaluation of risks to public safety and human health**
- **Recommendations for maintenance and further reclamation needs**



# Handbook Monitoring Forms

1. Public Safety and General Maintenance
2. Summary of Public Safety and General Maintenance
3. Evaluation of Waste Repository
4. Waste Rock Dump
5. Waste Removal Area
6. General Remediated Area
7. Wetland
8. Streams/ Riparian
9. Spring, Seep, or Pond
10. Adits and Shafts
11. Soil Borrow Area
12. Summary of Reclamation Evaluations
  - a. Revegetation Species
  - b. Native Species

Evaluation Area	Public Safety Concerns [Y/N]	Reclamation Concerns & Maintenance Suggestions		
		None [N]	Routine [N]	Critical [N]
A. Fences, gates, & signs				
B. Roads, culverts & bridges				
C. Erosion				
D. Geotechnical				
E. Adits & shafts				
F. Fire				
G. Waste repositories				
H. Monitoring wells				
I. Exposed waste materials				
J. Historic structures				
K. Surface waters				
L. Land uses issues				
M. Weeds				
N. Stormwater control				
O. Site boundaries				
P. Supplemental Information				

# Monitoring Questions

- **Vegetation cover**
- **Uniformity of vegetation cover**
- **Plant litter accumulation**
- **Plant litter/ soil contact**
- **Plant community dominated by**
  - Grasses
  - Forbs
  - Weeds
  - Trees & shrubs
- **Relative %**
  - Grasses
  - Forbs
  - Weeds
  - Trees & shrubs
- **Number of species with >1% cover**
- **New reproduction**
- **Noxious weeds**
- **Vegetation dieback or dead plants (soil pH)**



*P. Blicker Image*

Linton Mine and Mill Cramer Creek,  
Montana 2009  
(BLM AML)

### Form 5. Evaluation of Waste Removal Areas

Site Name: \_\_\_\_\_ Location within site: \_\_\_\_\_  
GPS coordinates (at center of area) of Removal Area Evaluated: \_\_\_\_\_

Date of Evaluation: \_\_\_\_\_  
Evaluator(s): \_\_\_\_\_

RM1. Are there area(s) of the site where wastes were removed?  Yes  No

RM2. Is there evidence that all the waste was not removed?  Yes  No

RM3. Were the removal areas covered with imported cover soil or fill materials?  Yes  No

RM4. Is the depth of cover soil or fill known?  Yes  No

RM5. Is excess settling of the cover soil evident?  Yes  No

RM6. Is the surface of the removal area vegetated?  Yes  No

Estimate the amount of vegetation cover:  
 80 - 100%       60 - 80%       40 - 60%  
 20 - 40%       0 - 20%

Estimate the uniformity of vegetation cover:  
 Very uniform       Cover varies, but no significant barren areas  
 Barren areas present  
 Small     Large     Infrequent     Frequent

Plant litter accumulation (% cover):  
 Heavy (>60%)     Moderate (20-60%)  
 Light (5-20%)     Negligible (<5%)

Litter /soil contact (% litter in contact with soil):  
 None     Infrequent (< 5%)  
 Frequent (5-50%)     Majority (> 50%)

Plant community is dominated by:  
 Grasses     Forbs     Weeds     Trees & shrubs

Estimate Relative Proportion (%) of each item:  
Grasses \_\_\_\_; Forbs \_\_\_\_; Weeds \_\_\_\_; Trees & shrubs \_\_\_\_

Estimated number of species having > 1% cover: \_\_\_\_\_  
Species identified: \_\_\_\_\_

Evidence of reproduction (new plants or stems):  
 None     Not Common     Some Occurring     Common

Noxious weed species present (% cover):  
 None     Infrequent (< 5%)  
 Frequent (5-25%)     Dominant (> 25%)  
Species identified: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

# Monitoring Questions



Belle Eldridge Mine and Mill Spruce Gulch,  
South Dakota 2009  
(BLM AML)

- Water diversion features
- Seeps
- Acid drainage
- Exposed waste
- Upward movement of acid and/or contaminants
- Slope instability or subsidence
- Erosion
- Erosion potential
- Metal salts
- Adverse impacts on adjacent lands

Is there evidence of vegetation dieback  
or dead plants?  Yes  No

Soil pH 1: \_\_\_\_\_

Soil pH 2: \_\_\_\_\_

Soil pH 3: \_\_\_\_\_

RM7. Does the removal area have water diversion features?  Yes  No

Are the diversions operating properly?  Yes  No

RM8. Are seeps present in the removal area?  Yes  No

pH point 1: pH: \_\_\_\_\_ SC: \_\_\_\_\_

pH point 2: pH: \_\_\_\_\_ SC: \_\_\_\_\_

pH point 3: pH: \_\_\_\_\_ SC: \_\_\_\_\_

RM9. Is acidic drainage present in the removal area?  Yes  No

RM10. Is there evidence of exposed waste within the  
removal area?  Yes  No

Soil pH 1: \_\_\_\_\_

Soil pH 2: \_\_\_\_\_

Soil pH 3: \_\_\_\_\_

RM11. Is there evidence of upward movement of acid  
and/or contaminants from the underlying materials?  Yes  No

RM14. Is there evidence of instability (slope failure,  
or subsidence) within the removal area?  Yes  No

RM15. Is there evidence of erosion in the removal area?  Yes  No

Evidence of soil movement

Presence of rills  Presence of gullies

Erosion potential:  Stable  Moderate  Severe

RM16. Are metal salts visible on the surface of the  
removal area?  Yes  No

RM17. Is there evidence of adverse impact on adjacent land  
from the removal area?  Yes  No

Comments and additional remarks:

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Attach digital photo(s) and record GPS coordinates of areas within the removal sites that  
may require maintenance (collect maintenance points with the MRED).

Collect pH points if necessary.

# Mine Reclamation Evaluation Database (MRED)

Adit\_Shaft

Page 1 Page 2 P

Mine_ID	<input type="text"/>
Site_Name	<input type="text"/>
Location	<input type="text"/>
Date_	<input type="text" value="1/25/2011"/>
Evaluator	<input type="text"/>
Water_Disch	<Null>
Disch_Flow	<Null>
Disch_Chan	<Null>

ok X

Adit\_Shaft

Page 1 Page 2 Page 3 Page 4 Attributes

Condition	good, some iron s
Terminates	creek
AMD	No
Abv_pH	0
Abv_SC	0
Abv_DO	0
At_pH	7
At_SC	0

View from GPS screen

# Types of AMLs Monitored and Environmental Issues

- **Abandoned mines: gold, silver, copper, lead, zinc, uranium, placer**
- **Contaminants/ remnants from mining left in place**
- **Disturbed environments:**
  - Erosion
  - Lack of vegetation
  - Weeds
  - Physical and chemical hazards
  - Soil and water impaired health
- **Ecological Hazards**
- **Human Health Recreational Hazards**

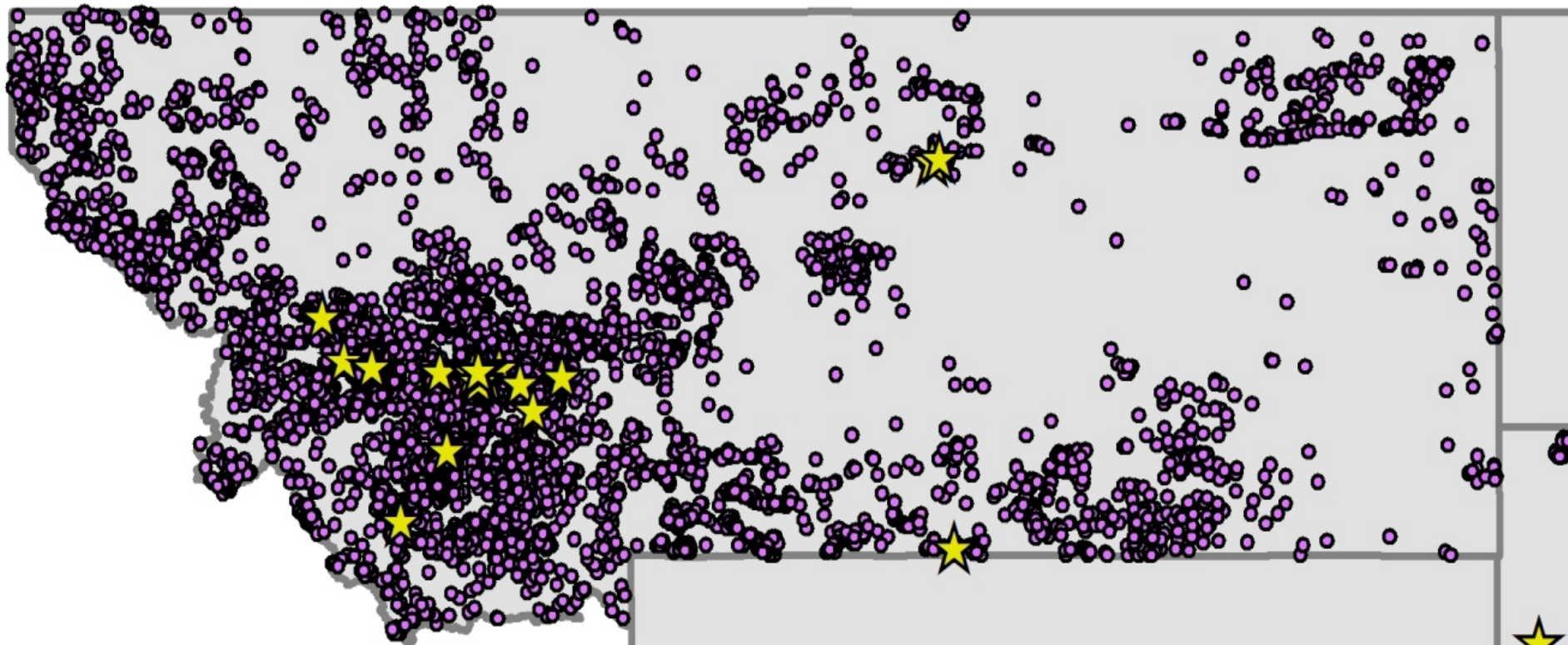
# Monitored BLM and USFS Reclaimed Abandoned Mine Lands

Site Name	Date Evaluated	Agency	Evaluation Contractor
Vindicator Mine	2008	USFS	Pioneer Technical Services
Lower Hector Mine	2008	USFS	Pioneer Technical Services
Daily West Mine	2008	USFS	Pioneer Technical Services
Hector Mine	2008	USFS	Pioneer Technical Services
Morning Mine	2008	USFS	Pioneer Technical Services
Bullion Mine	2008	USFS	Pioneer Technical Services
Jack Creek Tailings	2008	USFS	Pioneer Technical Services
Nonpareil Mill Site	2008	USFS	Pioneer Technical Services
Buckeye Mine	2008	USFS	Pioneer Technical Services
Elkhorn Mine	2008	USFS	Pioneer Technical Services
Highland Mill	2008	USFS	Pioneer Technical Services
North Ida Mine	2008	USFS	Pioneer Technical Services
Brooklyn Mine	2008	USFS	Pioneer Technical Services
Lady Leith Mine	2008	USFS	Pioneer Technical Services
Spring Creek Tailings	2008	USFS	Pioneer Technical Services
Black Pine Mine	2008	USFS	Pioneer Technical Services
Indian Creek	2012	BLM	KC Harvey Environmental
Gregory Mine/Mill	2012	BLM	KC Harvey Environmental
Belle Eldridge Mine*	2009	BLM	Reclamation Research Group
Ermont Mine	2009	BLM	Reclamation Research Group
High Ore Creek	2009	BLM	Reclamation Research Group
Linton Mine/Mill	2009	BLM	Reclamation Research Group
Pryor Mtns. U Mine	2009	BLM	Reclamation Research Group
Redwing/ Waldy Mine	2009	BLM	Reclamation Research Group

\*Belle Eldridge Mine is located in South Dakota. All other mines are located in Montana.



# Mines Monitored using the Monitoring Handbook



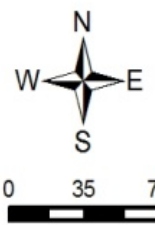
## AML Hardrock Mine or Mine and Mill Sites Monitored:

2012 (KCH/RRG) – (2 BLM)

2009 (RRG) – (6 BLM)

2006 (Pioneer) – (16 USFS)

-  Monitored Mine Sites
-  Abandoned Mine Lands
-  State Boundaries



Montana Bureau of Mines and Geology (MBMG) Abandoned and Inactive Mines Database, 2005. Includes USFS and BLM Mine Inventory.

# Types of Reclamation Observed at Monitored AMLs

## Most prominent:

- Waste removal and consolidation
- Repository(s):
  - Lined and unlined
  - On-site and off-site
- Capped waste rock piles
- Waste removal from streams
- Revegetation- seed application

## Rare to none:

- Revegetation- transplants or plantings
- *In situ* treatment of contaminated soils



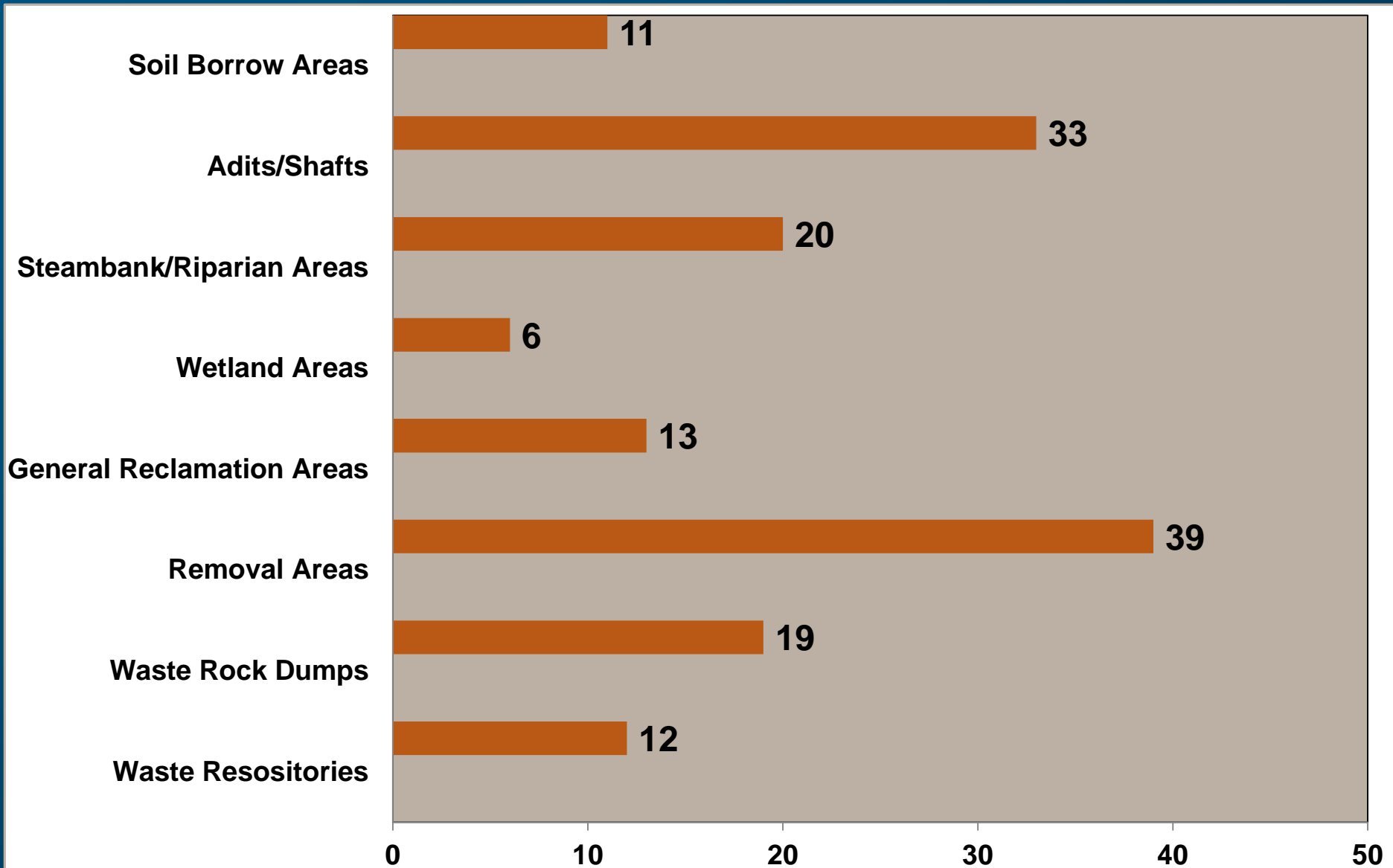
Ermont Mine and Mill  
Repository, Montana 2009  
(BLM AML)

# Mine Reclamation Evaluation Database

## Public Safety and General Maintenance Data in MRED

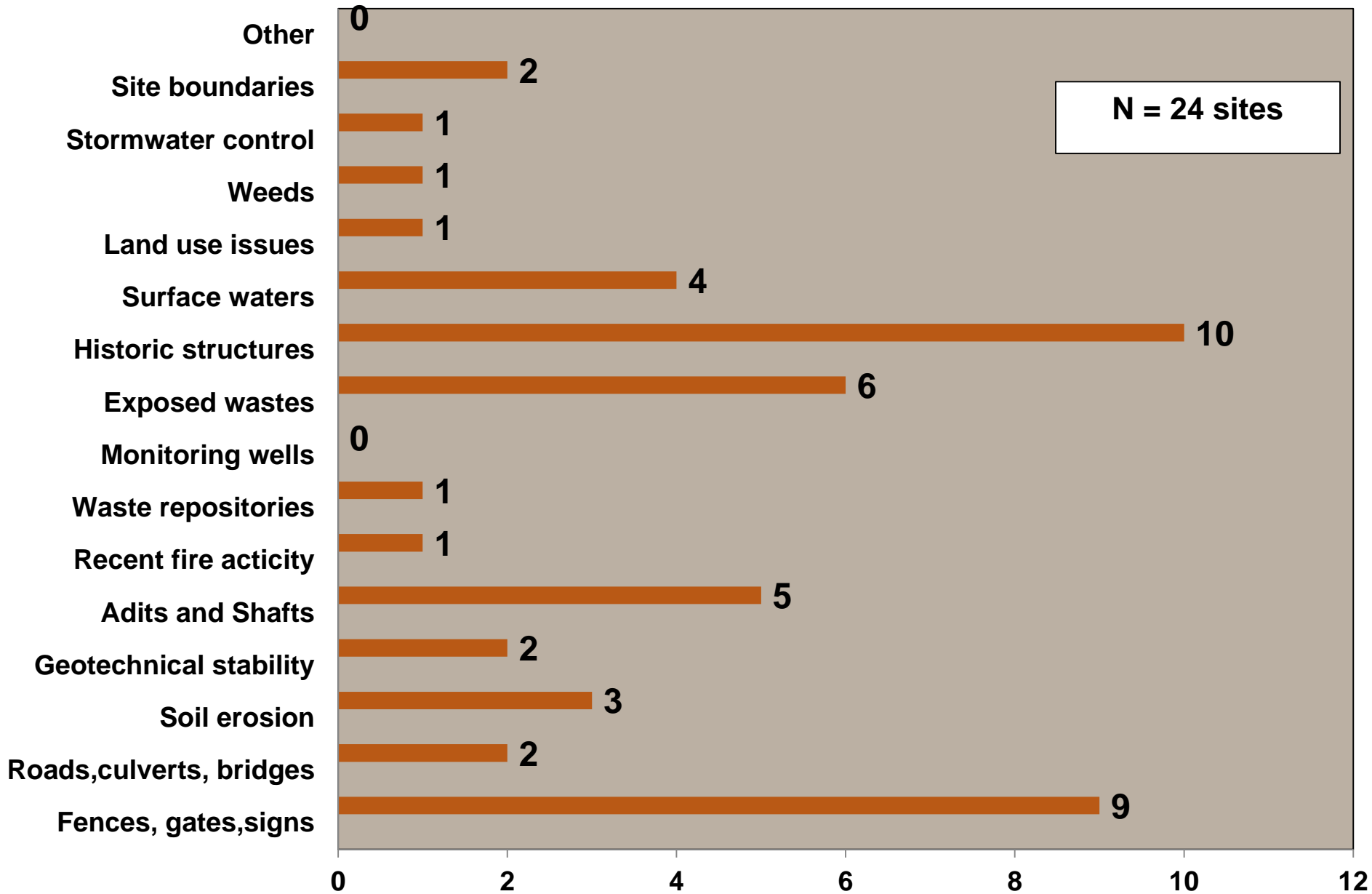
Mine ID	Site Name	Public Safety Type	Intact	Risks	Adverse Impacts	Related to Reclamation	Description	Location
erm072309	Ermont	Stability	NA	No	No	No	subsidence area with fences intact	Open Pit Vertical Shaft Subsidence Area
erm072309	Ermont	Other	NA	Yes	No	No	trash dump with glass and rusted wire	Trash Dump 1
erm072309	Ermont	Fence	No	No	No	No	gate is open and lying on the ground	Open Gate to Repository
erm072309	Ermont	Other	NA	Unk	No	No	2 trash dumps with rusty cans and glass	Trash Dump 2
erm072309	Ermont	Historic	NA	Yes	No	No	historic materials in rubble, could be public safety issue	Structure Rubble
lin080509	Linton	Roads	Yes	No	Yes	No	plugged culvert; weeds	Plugged Culvert
01pr081009	Marie	Erosion	NA	No	Yes	Yes	deep gully on decommissioned road	
07pr081009	DWU	Stormwater	No	No	Yes	Unk	drainage ditch blown out; gully	
04pr081109	CMM pit	Stormwater	Yes	No	No	Yes	stormwater retention area; poor veg except for willows at bottom	
04pr081109	CMM	Erosion	No	No	Yes	Yes	severely eroded toe of re-grading and revegetation area	
09pr081109	Dandy Central	Stability	No	Yes	No	Yes	deep hole in excavated area, approximately 1 x 1 ft	
bel081209	Belle Eldridge Repository	Fence	No	No	No	No	fence down by stormwater runoff ditch	Fence
bel081209	Belle Eldridge	Fence	No	No	No	No	fence down	Fence
bel081209	Belle Eldridge	Historic	No	Yes	No	No	old mill moderate safety hazard; signage recommended	Historic Mill
bel081209	Belle Eldridge	Waste	NA	Unk	Yes	No	area near adit where waste was not completely removed; slopes into discharge channel	Exposed Waste
bel081209	Belle Eldridge	Waste	NA	Unk	Yes	No	waste left in this area; no vegetation; near discharge channel	Exposed Waste
bel081209	Belle Eldridge	Waste	NA	Unk	Yes	No	waste pile adjacent to old mill; abuts discharge channel	Exposed Waste
hoc081909	HOC Repository	Fence	No	No	No	No	fencing wire partially down- needs tightening	
hoc081909	HOC Repository	Erosion	No	No	Yes	No	erosion netting not intact; cows inside enclosure; erosive soil on slope; sparse vegetation	

# Summary of Mine Features Evaluated at all AMLs Monitored with the Handbook



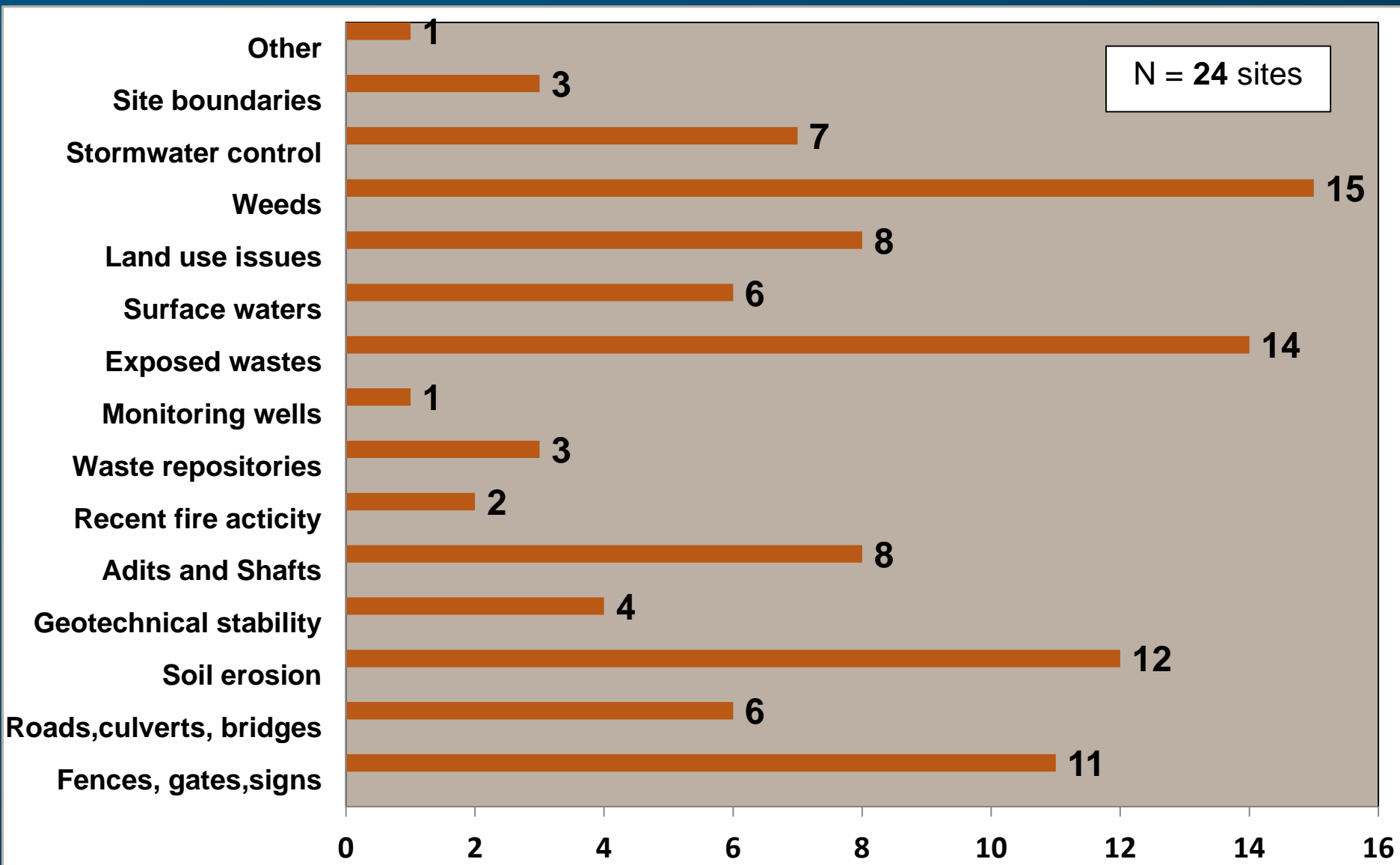


# Summary of Public Safety Concerns





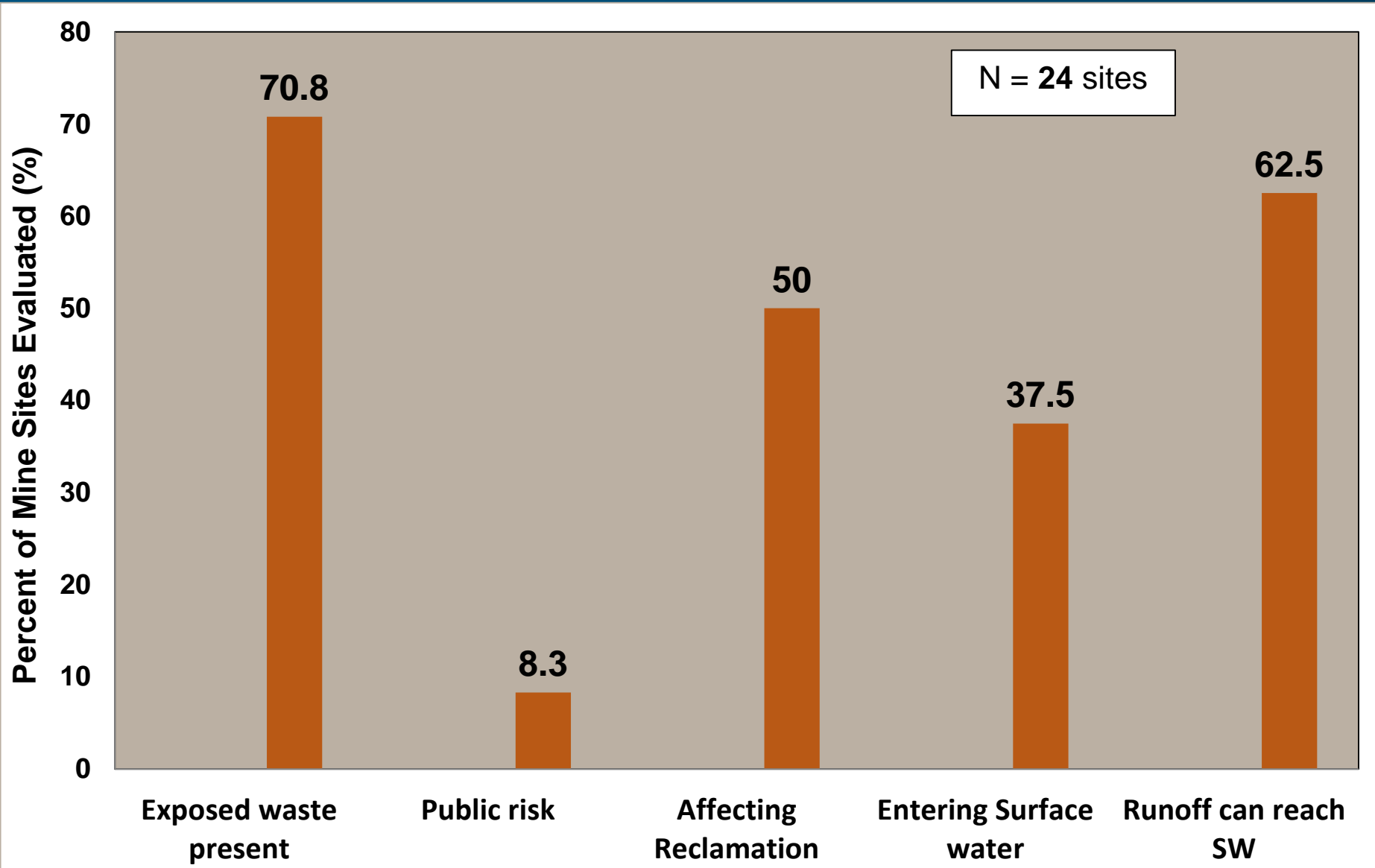
# Summary of Reclamation and Maintenance Concerns



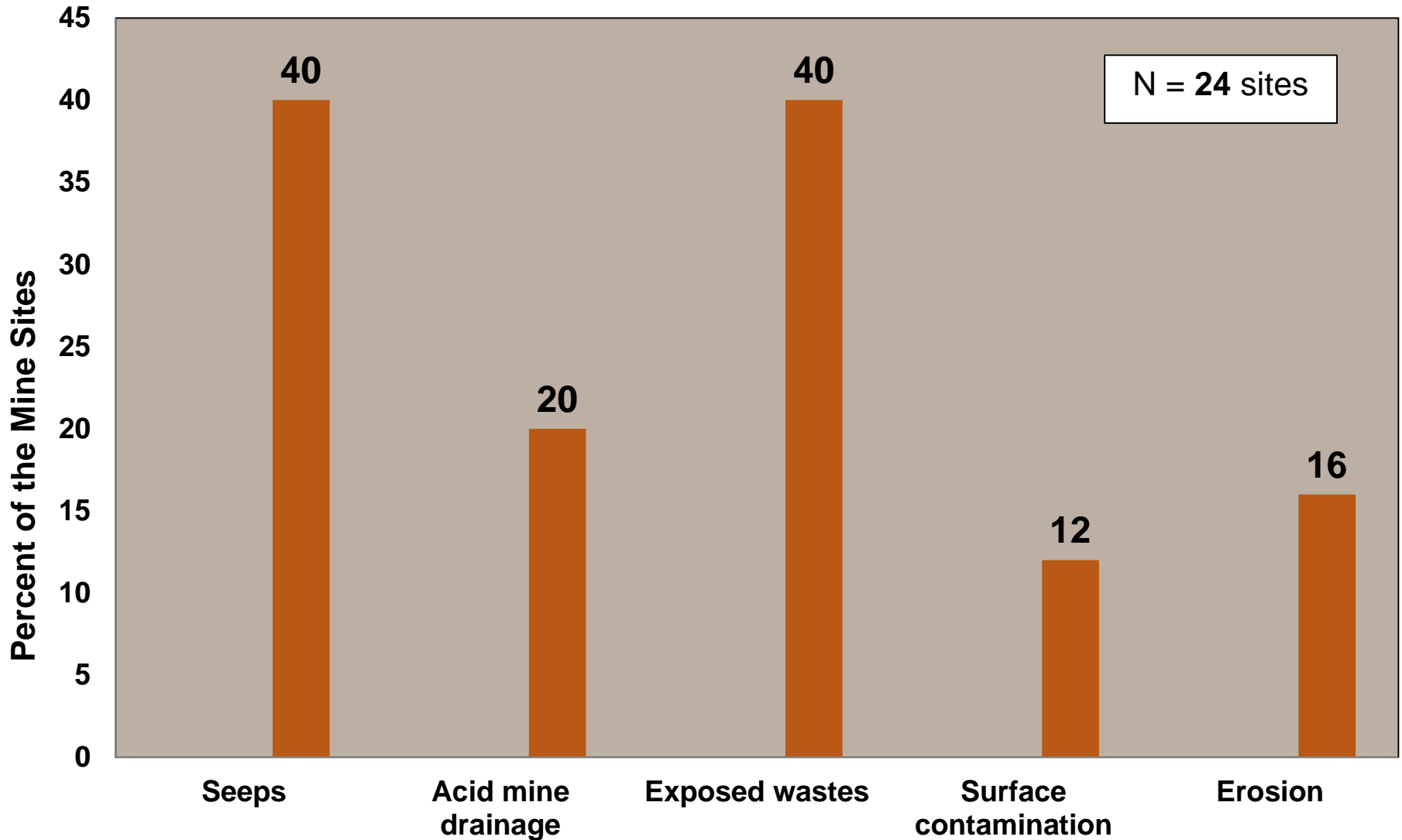




# Percent of Mine Sites Evaluated with Exposed Waste



# Monitoring Results for Waste Removal Areas





## Gregory Mine and Mill (9 of 17)

# Monitoring Results for Revegetation Success

## Linton Mine (5 of 16)

Seeded Species Common Name	Species identified with >1% cover	Notes
Annual Ryegrass		
Regreen		
Slender Wheatgrass	Wheatgrass spp	No species identified
Tufted hairgrass		
Bluejoint reedgrass		
Tall fescue	Fescue spp	No species identified
Hard fescue		
Rocky Mountain Iris		
Blue flax	X	
Rocky Mountain penstemon		
Rough fescue		
Western wheatgrass		
Sheep fescue		
Pubescent wheatgrass		
Yarrow	X	
Silky lupine		

Seeded Species Common Name	Species identified with >1% cover	Notes
Nebraska sedge	Carex spp	No species identified
Fowl mannagrass		
Tufted hairgrass		
Basin wildrye	X	
Speckled alder		Planted
willow	X	Planted
Bluebunch wheatgrass	X	
Rough fescue		
Thickspike wheatgrass		
Green needlegrass	X	
Idaho fescue	X	
Sandberg bluegrass		
Silvery lupine		
Blue flax	X	
Yarrow	X	
Annual ryegrass		
Alfalfa	X	

## Red Wing Waldy Mine (6 of 13)

Seeded Species Common Name	Species identified with >1% cover	Notes
Bluebunch wheatgrass	Wheatgrass spp	No species identified
Idaho fescue	Fescue spp	No species identified
Prairie Junegrass		
Columbia needlegrass		
Rough fescue		
Sandberg bluegrass	Poa spp	No species identified
White yarrow	X	
Silky lupine		
Sulfur flower		
Regreen		
Tufted hairgrass		
Bluejoint reedgrass	X	
Slender wheatgrass		

# Lessons Learned- Reclamation Evaluations

- Updates necessary to help with evaluation methodology and data analysis
- Training needed to complete evaluations
- Ecological function not addressed
- Seeps, wetlands, ponds and other water features not evaluated efficiently
- Updates to the MRED
- Acidity/ pH not utilized in the evaluation

# Handbook Updates

- 1. Addition of a Form 9: Evaluation of a Spring, Seep, or Pond**
- 2. Addition to Form 12: Summary of Reclamation Evaluations**
  - Vegetation species observed
  - Revegetation seed mix
  - Prevalence of reclamation species and native species
- 3. Addition to Form 7: Evaluation of Wetland Areas**
  - Wetland function and water quality
- 4. All Forms**
  - Ecological function
  - Soil/ seep (water pH)

# **In Conclusion....General Recommendations for Enhancing Reclamation**

- **Implement confirmation sampling**
- **Final construction completion reports with reclamation details, including seed mixes**
- **In-situ treatments for residual acidity and contamination**
- **Organic soil amendment application**
- **Pre-reclamation vegetation assessment for native species in reference area**
- **Time matters**



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**Northern Region**

