

Mine Reclamation in the East Mancos River / Thunder Mine

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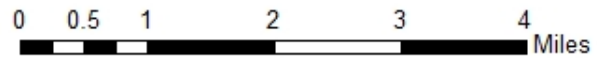
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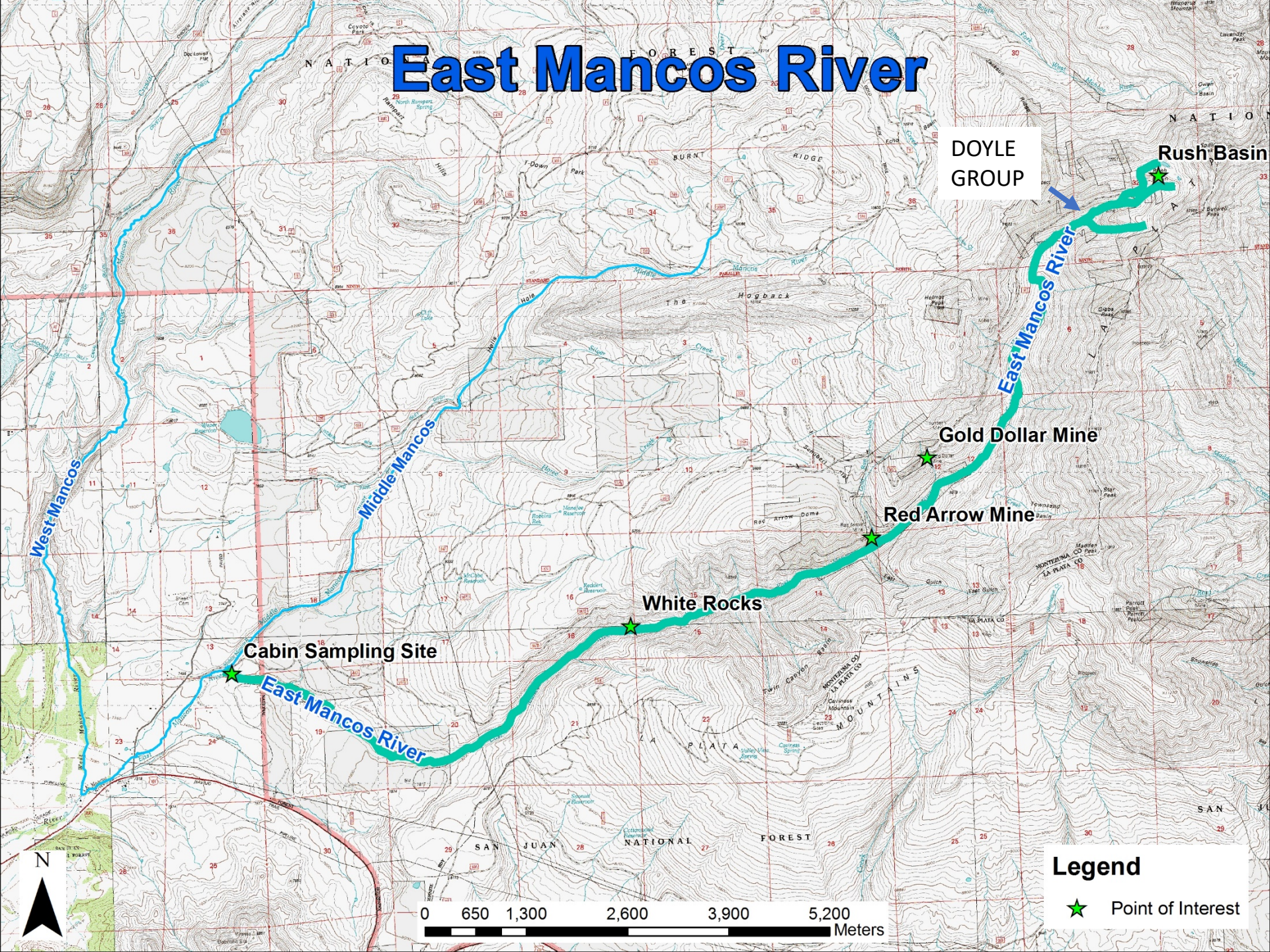
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East Manco River Location Map



East Mancos River



DOYLE
GROUP

Rush Basin

Gold Dollar Mine

Red Arrow Mine

White Rocks

Cabin Sampling Site

East Mancos River

Middle Mancos

West Mancos

Legend

★ Point of Interest

0 650 1,300 2,600 3,900 5,200 Meters

East Mancos Timeline

- 1750 – Spanish Exploration, possibly small scale mining.
- 1888-1920 Doyle Group in Rush Basin is developed.
- 1933 – 1942 – Historic Red Arrow Mine Production
- 1950's – Possible re-mining of Doyle Group

East Mancos Timeline Continued

- August 20, 1969 – USFS finds 12” long trout in East Mancos, near the White Rocks. The population is small. USFS considers enhancing habitat to improve the fishery.
- 1975 – CDOW conducts fish surveys and finds that the entire East Mancos is “dead”.
- 1977 – CDOW conducts fish surveys and finds that the entire East Mancos is “dead”.

East Mancos Timeline Continued

- 1977 – Mining Laws enacted in the U.S.
- 1981 – Red Arrow Mining Permit is issued by CDRMS.
- 1986 – Gold Dollar mine pool is breached while trying to reopen the portal. Unknown amount of poor water quality rushes from the Gold Dollar Mine workings. Anecdotal reports of large scale fish kill.

East Mancos Timeline Continued

- 1988 - USFS conducts fish study in East Mancos. Finds the habitat near White Rocks is unsuitable for fish survival. Possibly due to turquoise colored silt suspended in the water?
- 1990 – CDOW conducts fish surveys and finds that the entire East Mancos is “dead”.

East Mancos Previous Studies and Timeline

- 1993 – Wendy Meyer Thesis Completed – Natural Geochemical Processes of Acid Rock Drainage
- 2000 – Colorado Geological Survey – Naturally Degraded Surface Waters Associated with Hydrothermally Altered Terrain in Colorado.
- 2000 – Colorado Division of Minerals and Geology Inspection Report – Gillis
- 2005 – Colorado Department of Public Health and Environment – Hazardous Materials Report

East Mancos Studies, Work, and Timeline

- 2009 – DRMS Watershed Study (Gold Dollar Area)
- 2012 – CDPHE East Mancos TMDL
- 2018/2019 – East Mancos River Watershed – Aqueous Metal Sources, Concentrations, Mass Loading and Aquatic Impacts (Including Mine Characterizations)



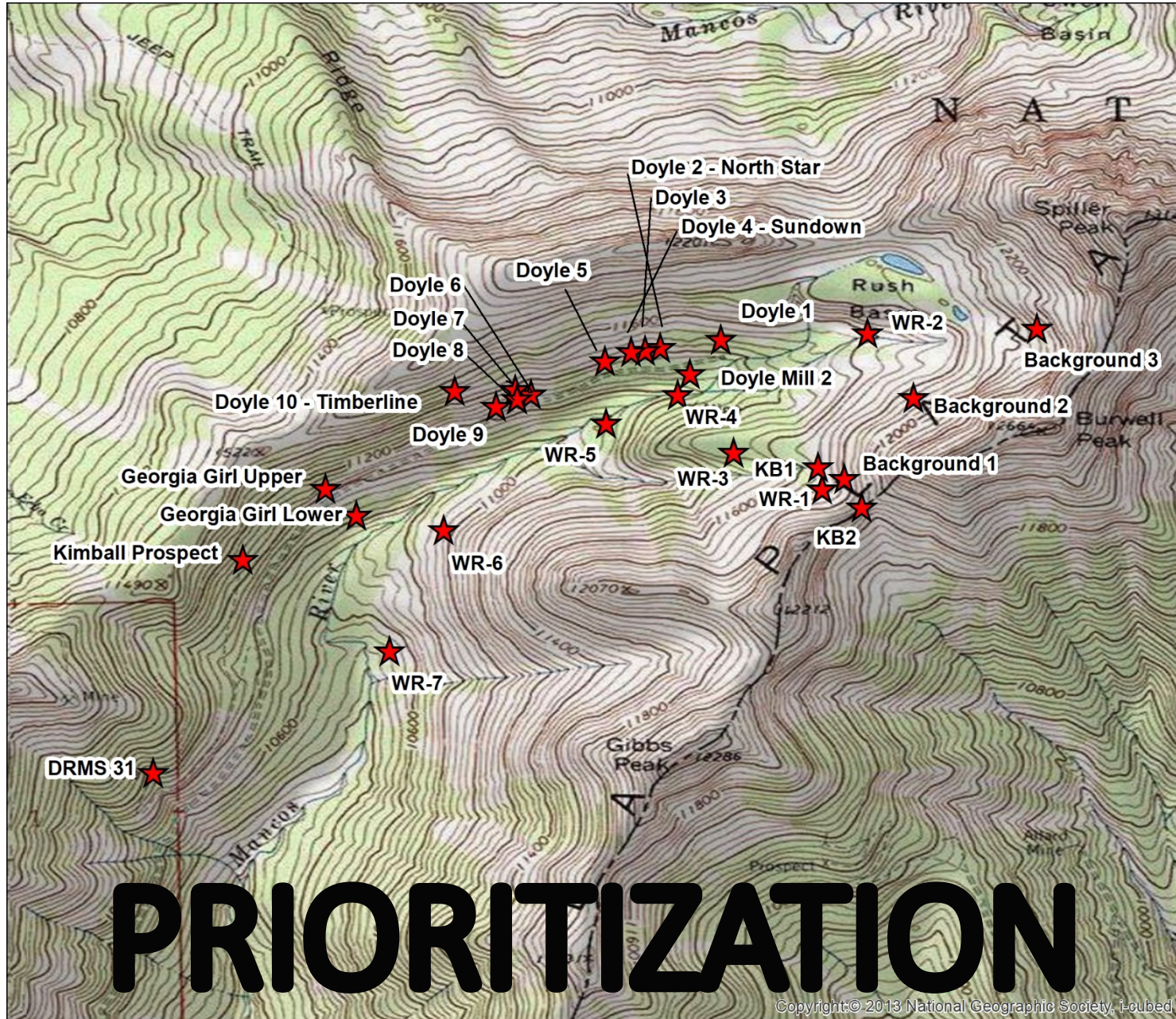










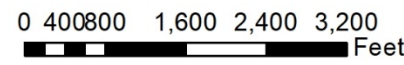


PRIORITIZATION

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Map Created 7/1/2020

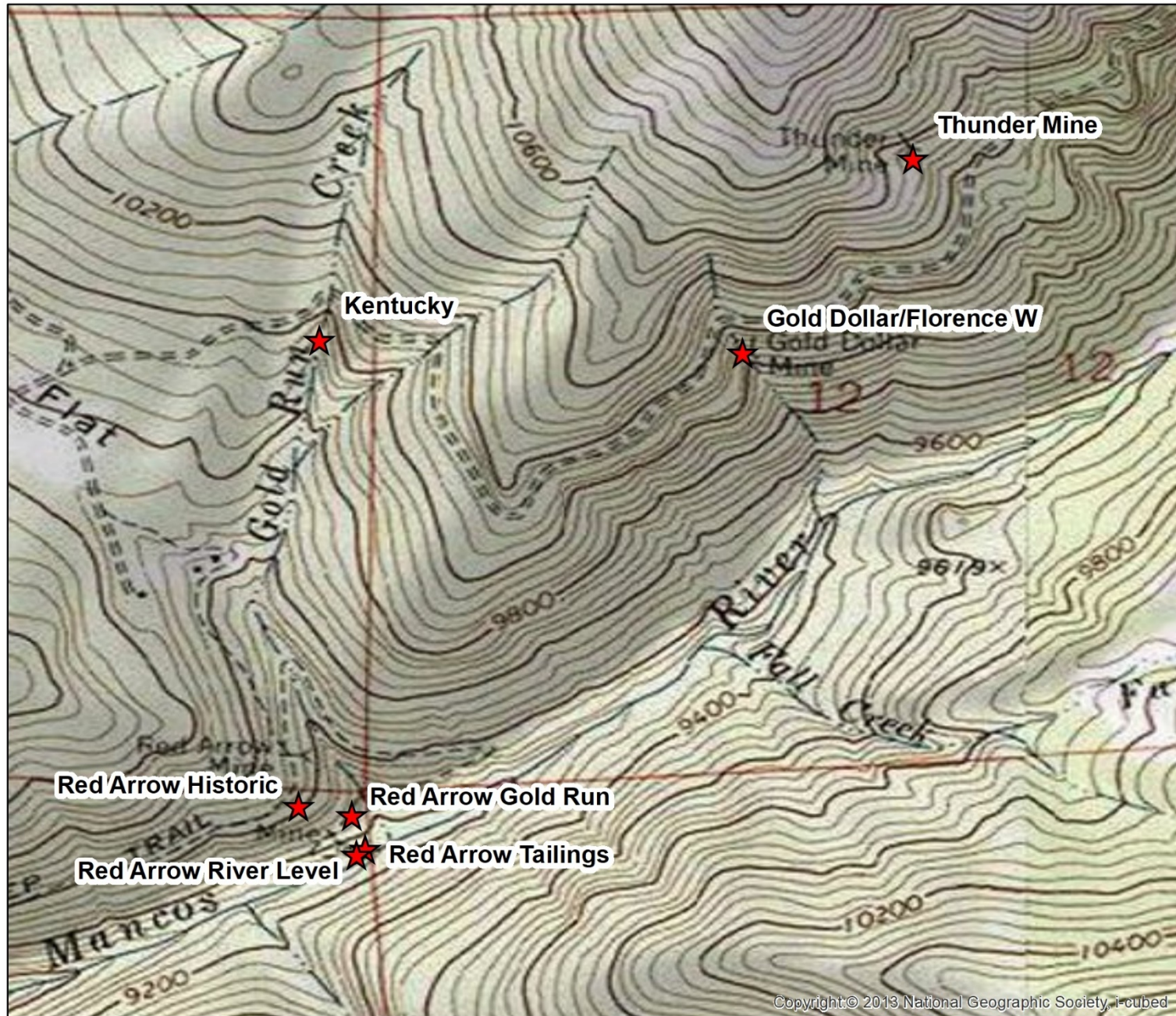


Legend

★ Waste Rock Sample Sites



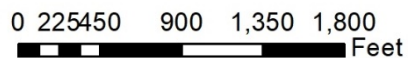
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Legend

★ Waste Rock Sample Sites



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Site	Copper, dissolved, lb/d	Copper Load Rank
Thunder Mine	0.10536	1
Doyle 2 (North Star Mine)	0.06133	2
WR-1 (Morning Star Claim Mine)	0.04196	3
Doyle 10 (Timberline Mine)	0.02084	4
Doyle 8 Repeat (Pike Lode Claim Mine Repeat)	0.01397	5
Doyle 3 (North Star and Sundown Tunnel Shared Portal)	0.01243	6
Doyle 8 (Pike Lode Claim Mine)	0.00969	7
WR-4	0.00604	8
Doyle 6 (Out of Sight Lode Mine)	0.00509	9
KB2 (Great Divide Claim Mine)	0.00425	10
WR-6	0.00260	11
Red Arrow Tailings	0.00189	12
Doyle 9 (Linnie B Lode Mine)	0.00181	13
Red Arrow Gold Run	0.00173	14
Doyle 5 (Tenderfoot Claim Mine)*	0.00113	15
KB1 (Morning Star Claim Mine)	0.00085	16
WR-3	0.00083	17
WR-5 (Tenderfoot No. 2 Mill Tailings)	0.00053	18
Outwest Historic (Red Arrow Historic)	0.00041	19
Red Arrow River Level	0.00040	20
Doyle 1 (Daylight Claim Mine)	0.00039	21
Doyle 4 (Sundown Tunnel)	0.00038	22
Kentucky Lower	0.00036	23
Georgia Girl Lower	0.00031	24
Georgia Girl Upper	0.00027	25
Doyle Mill 2	0.00027	26
Gold Dollar/Florence W	0.00022	27
WR-2 (Narrow Gauge Claim Mine)	0.00021	28
Kimball Prospect	0.00019	29

Waste Rock Pile Copper Loading Ranked

1. Thunder
2. North Star Mine
3. Morning Star Claim Mine
4. Timberline Mine
5. Pike Lode Claim Mine
6. North Star and Sundown Shared Portal Mine Waste
7. WR-4 Unknown Mine
8. Out of Sight Lode Mine
9. Great Divide Claim Mine
10. WR-6 Unknown Mine

Reclamation

- Waste rock reclamation is more feasible.
- Majority of the known mining concerns in the East Mancos River basin are waste rock related, but there are a few draining mines.
- Route Acid Mine Drainage off of waste rock piles.
- Active water treatment is not currently viable – liability and cost concerns.

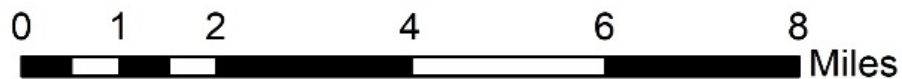
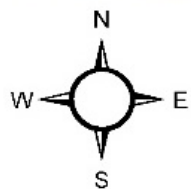
East Mancos Mine Reclamation Summary

Site	Reclamation Recommended	Waste Rock Copper Load Rank	
Thunder Mine	YES	1	Consolidation and capping of waste rock and route mine drainage
Doyle 2 (North Star Mine)	YES	2	Consolidation and capping of waste rock
WR-1 (Morning Star Claim Mine)	Potentially	3	Potential capping of waste rock by hand labor
Doyle 10 (Timberline Mine)	NO	4	Access too difficult
Doyle 8 Repeat (Pike Lode Claim Mine Repeat)	---	5	---
Doyle 3 (North Star and Sundown Tunnel Shared Portal)	YES	6	Consolidation and capping of waste rock
Doyle 8 (Pike Lode Claim Mine)	Potentially	7	Capping of waste rock
WR-4	Potentially	8	Revegetation
Doyle 6 (Out of Sight Lode Mine)	YES	9	Capping of waste rock
KB2 (Great Divide Claim Mine)	Potentially	10	
WR-6	NO	11	
Red Arrow Tailings	YES	12	Amend and revegetate
Doyle 9 (Linnie B Lode Mine)	YES	13	Route mine drainage
Red Arrow Gold Run	YES	14	Revegetation and remove building and trash
Doyle 5 (Tenderfoot Claim Mine)	Potentially	15	Route mine drainage
KB1 (Morning Star Claim Mine)	NO	16	
WR-3	NO (except for closure of adit)	17	
WR-5 (Tenderfoot No. 2 Mill Tailings)	Potentially	18	Revegetation
Outwest Historic (Red Arrow Historic)	NO	19	
Red Arrow River Level	YES	20	Revegetation, clean up trash and oil, and maintain sediment pond
Doyle 1 (Daylight Claim Mine)	NO	21	
Doyle 4 (Sundown Tunnel)	NO	22	
Kentucky Lower	NO	23	
Georgia Girl Lower	NO	24	
Georgia Girl Upper	NO	25	
Doyle Mill 2	NO	26	
Gold Dollar/Florence W	YES	27	Close road to the site
WR-2 (Narrow Gauge Claim Mine)	NO	28	
Kimball Prospect	NO	29	
DRMS 31	NO	30	
WR-7	NO	31	
Doyle 7 (Pike Lode Claim Mine)	NO	32	

Thunder Mine – Top Priority

- Highest Copper, Arsenic, and Lead load calculated for the entire basin from waste rock pile only. 2nd highest load for Zinc.
- The waste rock sits in an ephemeral drainage swale
- The mine drainage flows over and seeps into the waste rock pile
- Longest kill zone 2,000 feet long
- The waste rock contains arsenopyrite, and fine-grained galena.
 - Arsenic
 - Lead















Thunder Reclamation Options

- Route mine drainage off of the waste rock
- Consolidate the waste rock on site, out of the drainage swale and cap.

**Consolidation
Area**

**Thunder Waste
Rock Pile**

Kill Zone



Future Work

- Investigate a handful of additional mines and add to the report for the East Mancos.
- Investigate the South Fork of the West Mancos River (Owen Basin), including mine sites.
- Collect data and report out on the East and South Fork of the West Mancos mine sites for unplanned release characteristics.