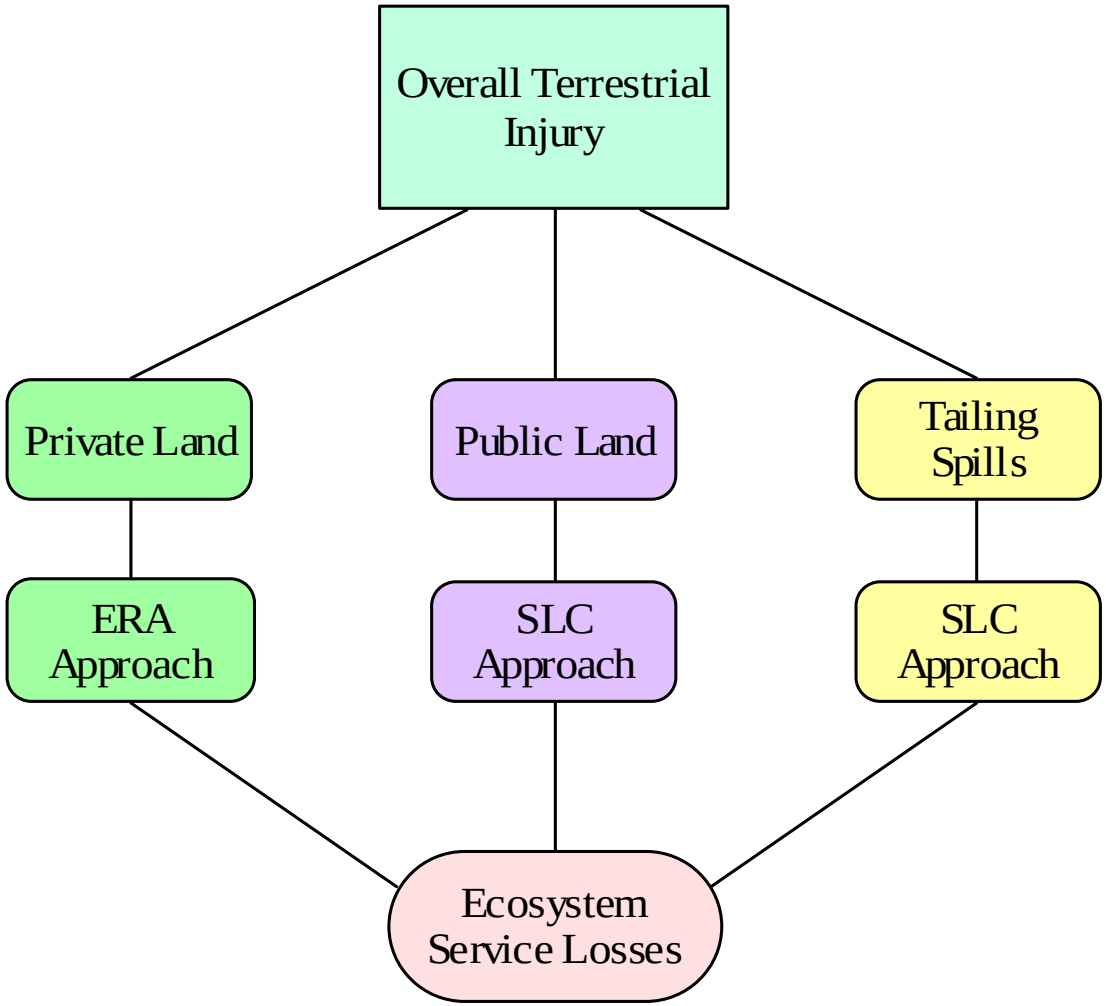
Evaluation of Terrestrial Injury at Questa Mine

March 2005

Overall Approach for Terrestrial Injury Assessment



Analytical Data Used

- Soil Data
  - Include various exposure areas; omit other exposure areas (SS1, SS2, SS7, SS8a-f) that have little or no habitat
  - Include only RI and WIS data; concerns about validation and reliability of historical data, so do not include though data not expected to be different
  - Consider soil exposure from 0-0.5 feet bgs for all receptors except the pocket gopher (0-2 feet bgs)

Data Used (Cont.)

Exposure Areas to be Included in the ERA

Grouping	**Exposure Areas**
Mine Site	SS3 to SS6
Mine Site Reference	RSOIL and RCC
Red River Riparian	SS9
Red River Riparian Reference	RRRR and RUCCR
Campgrounds Mine Site	Camp-ERL and Camp-GTH
Campgrounds Reference	Camp-Junebug and Camp-UFL
Tailings	SS11 to SS14, WIS
Tailings Reference	RCR, RWIS
Windblown Tailings	SS-15 (0-2 inches)
Windblown Tailings Reference	SS-15 (2-6 inches)
Windblown Tailings Reference	RCR (0-2 inches)
South of Tailings Facility	SS17
Tailings Riparian	SS16
Tailings Riparian Reference	RLCCR

Injury Evaluation

Private Lands

Injury Evaluation on Private Lands

- Weight-of-Evidence Approach
  - Lines of Evidence
    - Wildlife Injury
      - SLC Screen
      - Bird and mammal ecological risk assessment
      - Reference comparison (“Referenced HQ”)
      - Mammal capture data
      - Literature reviews

Lines of Evidence

- SLC Screen
  - Screened EPCs (95 UCL of the mean or maximum) for all analytes against SLCs to derive HQs
  - Site-related HQs that exceed 1 and exceed reference HQs were then compared back to the reference HQs to derive a "Referenced HQ"
  - "Referenced HQ"
    - Reference HQ subtracted from site-related HQ to determine a "Referenced HQ"
    - $HQ_S - HQ_{ref}$ = "Referenced HQ"
    - Provided indication of potential risk relative to reference
  - Analytes with a "Referenced HQ" > 0 were further evaluated in the ecological risk assessment

New Screening Level Criteria

- SLC Screen
  - Beryllium, cadmium, cobalt, and lead were all found to have outdated EcoSSLs; more recent values from December 2003 were available and were used in the SLC screen; the following slide presents these values

New Screening Level Criteria

Updated SLC Values

Analyte	Current SLC (mg/kg)	Basis	Note	Updated SLC (mg/kg)	Basis	Comment
Beryllium	30	Mammalian EcoSSL	Old EcoSSL	36	New Mammalian EcoSSL	Replaced in SLC screen
Cadmium	0.4	Mammalian EcoSSL	Old EcoSSL	0.38	New Mammalian EcoSSL	Replaced in SLC screen
Cobalt	32	Plant EcoSSL	Old EcoSSL	13	New Plant EcoSSL	Replaced in SLC screen
Lead	15	Avian EcoSSL	Old EcoSSL	16	New Avian EcoSSL	Replaced in SLC screen

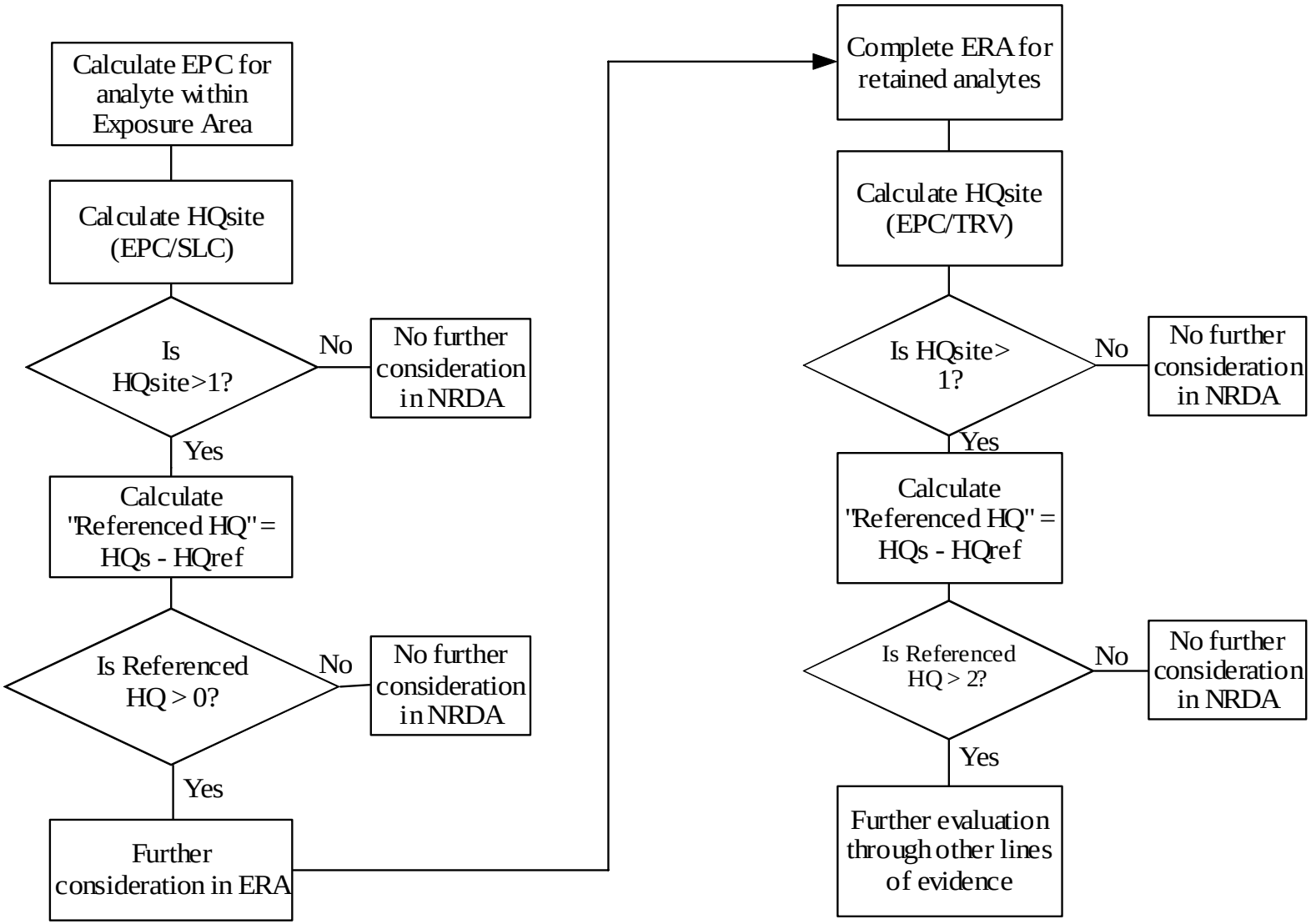
Lines of Evidence (cont.)

- Bird and mammal ERA
  - Important receptors (from BERA)
    - Red-tailed hawk, American robin, Canada goose
    - Elk, shrew, deer mouse, pocket gopher, red fox
  - Assumed 100% area use factor for all receptors
  - Evaluated LOAEL-based HQs in order to protect populations (no resident special-status species)
  - Used site-specific biota concentrations when available; used BAFs when no site-specific data is available
  - Based on 95 UCL of the mean (more conservative than the mean)

Lines of Evidence (cont.)

- Reference Comparison (“Referenced HQ”)
  - Site-related HQs that exceed 1 are compared to Reference HQs to derive “Referenced HQ”
  - Analytes that have a “Referenced HQ” greater than 2 may have potential to cause risk and are further evaluated using other lines of evidence

Conceptual Flow Chart for SLC/ERA Screen



Lines of Evidence (cont.)

- Mammal Capture Data
  - Assessed results of mammal trapping in 2002 and 2003
  - Evaluated differences in tissue concentration between mine-related sites and associated reference sites

Lines of Evidence (cont.)

- Literature Review
  - Performed literature review to further evaluate potential toxicity of various analytes that were identified as possibly causing risk based on the ERA

Results for Private Lands

ERA Screening Results

Referenced HQs for Analytes with LOAEL-based HQs Greater than two in the ERA for Private Lands

Area	Receptor	Analyte	LOAEL-based HQs		"Referenced HQ"
			Site	*Reference*	
Mine Site	Shrew	Molybdenum	3.52	0.38	**3.14**
Tailings Facilities	Pocket Gopher	Molybdenum	8.94	0.144	**8.80**
	Deer mouse	Molybdenum	43.7	0.902	**42.8**
South of Tailings	Shrew	Molybdenum	**2.95**	0.234	**2.08**
	Deer mouse	Molybdenum	**4.19**	0.902	**3.29**

Reference Comparison Results (cont.)

- The food ingestion rate (FIR) for the deer mouse (0.45 kg/kg/d) was based on lactating female mice; the FIR of non-breeding mice ranges from 0.18 to 0.22 kg/kg/d (USEPA 1993)
- Breeding season near Questa is estimated to last 6.8 months (based on regression equation in USEPA 1993)
- The use of the non-breeding FIR results in HQs that are half those of the breeding FIR-based HQs.

Mammal Capture Data Results

- Indicates that mammals are still living at the site and any estimated injury is certainly not catastrophic
- Same or more numbers of deer mice captured at Mine Site than at the Mine Site Reference
- Greater abundance of species at Tailings relative to Cater Ranch
- No statistically significant differences in Mine Site whole body concentrations compared to Mine Site Reference
- Lead, manganese, and molybdenum were statistically higher in Tailings body burdens versus Cater Ranch
- Taken together, these results suggest at best, minimal injury to small mammals focused only at Tailings site

Trapping Effort and Capture Rates for Areas at Questa Mine

Area	Snap Trap Nights	Sherman Trap Nights	Gopher Traps Nights	Total Trap Nights	# Captured		Number of Species	Animals Per Trap Night
					Deer Mouse	Total		
Rock Piles at Mine Site	0	160	0	160	5	11	4	0.07
Mine Site	254	94	0	348	26	49	5	0.14
Mine Site Reference	150	109	0	259	26	44	7	0.17
Tailings	340	0	30	370	30	45	8	0.12
Tailings Reference	209	88	112	409	38	48	3	0.12
Tailings Riparian	241	59	0	300	29	41	5	0.14
Tailings Riparian Reference	160	160	0	320	6	7	2	0.02
Red River Riparian	211	46	0	320	32	41	7	0.13
Red River Riparian Reference	138	140	0	278	32	43	8	0.15

Notes

Ten animals at the Tailings were noted as pregnant, lactating, or breeding versus only three at Tailings Reference

Literature Review Results

- Eisler 2000
  - Horses, pigs, rodents, and ruminant and nonruminant wildlife are comparatively tolerant of high dietary intakes of molybdenum as compared to cattle and sheep
  - No adverse effects noted in deer at dietary levels of 1000 mg/kg molybdenum after 8 days and only slight effects at 2,500 mg/kg after 25 days
  - In rodents, molybdenum is neither teratogenic nor embryocidal to golden hamsters at doses up to 100 mg/kg BW, and has no measurable effect on fertility or gestation in female rats given similar doses
- These toxicity studies suggest that it is unlikely that, at current concentrations, molybdenum is causing injury to small mammals at any of the mine-related sites

Wildlife Injury Assessment Results (cont.)

Summary and Conclusions for Molybdenum on Mine Site and Tailings

Area	Receptor	Conclusion
Mine Site	Masked Shrew	Magnitude of exceedance was low and the mammal capture data did not suggest that mammals were being impacted at the population level; captured mammals appeared healthy with glossy coats.
Tailings	Pocket Gopher	Magnitude of exceedance was low and the mammal capture data did not suggest that mammals were being impacted at the population level; all captured mammals appeared healthy and 4 gophers were captured at the Tailings while 3 were captured at Tailings Reference (though trapping effort at the reference site was almost four times that at the Tailings Facility).
	Masked Shrew	Magnitude of exceedance was low and the mammal capture data did not suggest that mammals were being impacted at the population level; all captured mammals appeared healthy with glossy coats.
	Deer Mouse	Magnitude of exceedance was elevated but the mammal capture data did not suggest that mammals were being impacted at the population level; all captured mammals appeared healthy with glossy coats and greater species diversity was noted at the Tailings area. In addition, a greater proportion of adult females at the Tailings Facility were pregnant or lactating than at the Tailings Reference area.
	Elk	Magnitude of exceedance was very low and elk have a large home range so they would not likely be exposed consistently to the Tailings forage. Additionally, deer mice are likely more sensitive than elk, and capture data for deer mice indicated that this sensitive species was not being impacted at the population level.

Wildlife Injury Assessment Results (cont.)

Summary and Conclusions for
Molybdenum on South of Tailings

Area	Receptor	Conclusion
South of Tailings	Red Fox	Magnitude of exceedance was low. Mammal capture data were not available for this area but mammals are likely in similar or better condition as those captured at the Tailings. Additionally, the ERA was performed using the maximum soil to mammal BAF found for the Tailings which results in conservative risk estimates.
	Pocket Gopher	Magnitude of exceedance was low. Mammal capture data was not available for this area but mammals are likely in similar or better condition as those captured at the Tailings.
	Masked Shrew	Magnitude of exceedance was low. Mammal capture data was not available for this area but mammals are likely in similar or better condition as those captured at the Tailings. Additionally, the ERA was performed using the maximum BAF found for the Tailings soil tested for earthworms which results in conservative risk estimates.
	Deer Mouse	Magnitude of exceedance was low. Mammal capture data was not available for this area but mammals are likely in similar or better condition as those captured at the Tailings. Additionally, the ERA was performed using the maximum BAF found for the Tailings soil tested for earthworms which results in conservative risk estimates.

Notes
BAF = bioaccumulation factor

Potential Terrestrial Injury

Private Lands

Scaling Private Lands Injury

- Group Grope

Injury Evaluation

Public Lands

Injury Evaluation on Public Lands

- Weight-of-Evidence Approach
  - Lines of Evidence
    - Habitat Assessment
      - SLC review
      - SLC screen
      - SLC secondary screen review
      - Plant and earthworm bioassays
      - Vegetation/soil fauna surveys

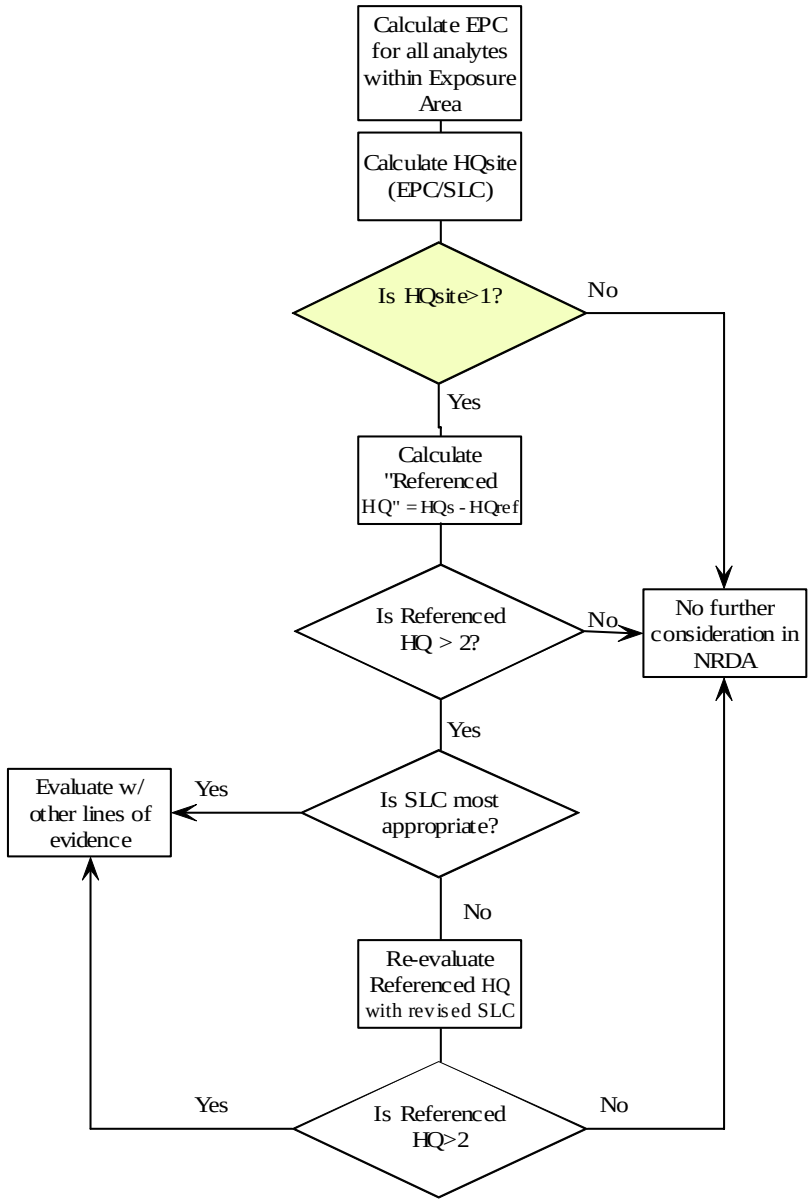
Lines of Evidence

- Habitat Level
  - SLC screening
    - Compared 95 UCL EPC-based analyte concentration to the associated SLC to determine the HQ
    - Retained analytes where EPC-based HQs > 1
    - Retained analytes where HQsite > HQref
    - Derived “Referenced HQ” factor as the difference between HQsite and HQreference (“Ref-HQ” = HQs-HQref)
    - Retained analyte where “Ref-HQ” > 2

Lines of Evidence (cont.)

- SLC Review
  - Confidence in some of the SLCs is low; therefore, TRVs with higher confidence are recommended and used to perform a secondary screen
  - Some SLCs may not be appropriate based on background concentrations for the region
  - Secondary screen process follows the SLC screen steps previously discussed

- Conceptual Flow Chart for Public Lands SLC Screen



Lines of Evidence (cont.)

- Plant and Earthworm Bioassays
  - Results of the site-specific bioassays were evaluated to determine if impacts can be seen in laboratory toxicity tests using soils from the sites

Lines of Evidence (cont.)

- Vegetation/Soil Fauna Surveys
  - Vegetation transects were surveyed at various sites; results were reviewed to determine if significant habitat differences exist between mine-related sites and associated reference sites
  - Soil fauna surveys were also performed at various sites and reviewed

Results for Public Lands

Habitat Assessment Results – SLC Screen

Exposure Area	Soil Depth	Analyte	EPC HQ-Site	EPC HQ-Ref	"Ref-HQs" > 2
Red River Riparian	All Depths	Manganese	7.37	2.89	4.47
		Molybdenum	19.2	3.48	15.7
Campgrounds	0-0.5 feet bgs	Boron	8.20	2.50	5.70
		Cadmium	2.51	0.15	2.36
		Manganese	7.30	3.35	3.95
		Molybdenum	60.5	14.8	45.7
Tailings Riparian	All Depths	Boron	19.16	7.24	11.9
		Manganese	5.12	2.85	2.27
		Molybdenum	23.7	2.58	21.1
		Vanadium	15.3	10.4	4.90
Windblown Tailings	0-2 inches	Molybdenum	3.65	0.15	3.50
		Vanadium	17.55	15.10	2.45

Note: Campground driven primarily by Goat Hill data. Because this Campground resides on a large debris fan, the relationship between mining related impacts and those due to the debris fan are unclear.

Habitat Assessment Results – SLC Review

- Boron
  - SLC for boron (0.5 mg/kg) was based on plants (Efroymson et al. 1997a) but confidence in the benchmark was low; additionally, in the same study 10 mg/kg in soil had no effect on growth and less than a 20% reduction on growth in two different soil types.
  - Kabata-Pendias and Pendias (1991) note that several studies indicate that certain plants can tolerate from 348 to 4800 mg/kg in tissues depending on species.
  - The lowest tissue concentration that caused toxicity was 80 ppm for barley seedlings though most plants did not demonstrate toxicity until higher tissue concentrations were reached (283-333 mg/kg for alfalfa and cotton).
  - The highest boron concentration found in plant tissue on public lands was in above-ground grass at Tailings Riparian (114 mg/kg); Tailings Riparian Reference also had a concentration of 104 mg/kg in above-ground grass.

Habitat Assessment Results – SLC Review

- Cadmium
  - Eco-SSL is lower than mean reported background concentrations for soils in the western United States
    - Cadmium Eco-SSL = 0.38 mg/kg
    - 50th percentile of reported soil background concentrations = 0.40 mg/kg (Eco-SSL report)
    - 75th percentile of reported soil background concentrations ~ 0.7 mg/kg (Eco-SSL report)

Habitat Assessment Results – SLC Review

- Lead
  - Eco-SSL is lower than mean reported background concentrations for soils in the western United States
    - Lead Eco-SSL = 16 mg/kg
    - 50th percentile of reported background concentrations = 19 mg/kg
    - Mean reported soil lead background concentration for New Mexico = 18 mg/kg (Table 2.3 of Eco-SSL Guidance)
  - Eco-SSL for birds is based on the woodcock but other bird species are much less sensitive with Eco-SSLs of 33 mg/kg for the dove and 100 mg/kg for the hawk; woodcock is not a potential receptor at Questa Mine
  - The next-most conservative Eco-SSL for lead (59 mg/kg) is based on the shrew

Habitat Assessment Results – SLC Review

- Manganese
  - SLC based on Plant Eco-SSL (152 mg/kg)
  - Mean reported soil manganese background concentration in New Mexico is 367 mg/kg (Table 2.3 of Eco-SSL Guidance)
  - Plant screening level from Efroymson et al 1997a is 500 mg/kg, with low confidence in this value

Habitat Assessment Results – SLC Review

- Molybdenum
  - Molybdenum had an SLC based on plants of 2 mg/kg (Efroymson et al. 1997a) but confidence in the benchmark was low.
  - Singh and Mourya (1983) found that 1-3 mg/kg increased growth and yield at all levels.
  - Kabata-Pendias and Pendias (1991) note that some native plants, particularly leguminous species, have been known to accumulate as much as 350 mg/kg in tissues without showing toxicity symptoms.
  - Soil microbes TRV is 200 mg/kg based on Efroymson et al. 1997b; confidence in this benchmark is moderate
  - Soil microbes support plant function.

Habitat Assessment Results – SLC Review

- Zinc
  - SLC based on plant Eco-SSL (130 mg/kg)
  - Details regarding this Eco-SSL were not available

Habitat Assessment Results – Secondary Screen

- Molybdenum had an SLC based on plants (Efroymson et al. 1997) but confidence in the benchmark was low; a more appropriate TRV with higher confidence is available
- Confidence in the boron SLC was also low but other TRVs had similarly low confidence

Habitat Assessment Results - Secondary Screen (cont.)

Review of SLC Values

Analyte	Current SLC (mg/kg)	Basis	Note	Other TRV (mg/kg)	Basis	Comment
Molybdenum	2	Plant[a]	Low Confidence	200	Soil Microbes[b]	Moderate Confidence; reevaluate in secondary screen

Notes

[a] Efroymson et al. 1997a

[b] Efroymson et al. 1997b

Habitat Assessment Results - Secondary Screen (cont.)

- Based on the reevaluation for molybdenum, “Referenced HQs” at all public locations were less than one
- Molybdenum was considered to pose negligible risk to habitat

Habitat Assessment Results – Analytes Retained after Secondary Screen

Exposure Area	Soil Depth	Analyte	"Referenced HQs" Greater than 2
Red River Riparian	All Depths	Manganese	4.47
Campgrounds	0-0.5 feet bgs	Boron	5.70
		Cadmium	2.36
		Manganese	3.95
Tailings Riparian	All Depths	Boron	11.9
		Manganese	2.27
		Vanadium	4.90
Windblown Tailings	0-2 inches	Vanadium	2.45

Note: Campground driven primarily by Goat Hill data. Because this Campground resides on a large debris fan, the relationship between mining related impacts and those due to the debris fan are unclear.

Habitat Assessment Results – Plant Bioassays

- No statistically significant difference between Red River Riparian and associated reference areas based on plant bioassays
- No statistically significant differences in survival, height, shoot biomass, or total biomass between Tailings Riparian and reference; however, root biomass was significantly lower at Tailings Riparian

Habitat Assessment Results – Earthworm Bioassays

- No statistically significant differences in growth and survival were found between Red River Riparian and Tailings Riparian and associated references

Habitat Assessment Results - Vegetation Community Surveys

- Number of species and cover are similar at Red River Riparian and Tailings Riparian and associated reference
- Shrub cover at Tailings Riparian is higher than the associated reference site though tree cover and number of tree species is higher at the reference site

Habitat Assessment Results - Soil Fauna Surveys

- Soil fauna community structure showed limited variation between Red River Riparian and Tailings Riparian and associated reference sites

Habitat Assessment Results (cont.)

Summary and Conclusions for Molybdenum on Public Lands

Area	Summary	Conclusion
Red River Riparian	6 of 7 LOE indicate no impact, 1 of 7 LOE indicate potential impact or risk	No impact
Campgrounds	1 of 2 LOE indicate no impact or risk, 1 of 2 indicate potential risk	It is likely that the ecological conditions at the campgrounds are similar to those at the Red River Riparian; as a result this suggests that impact is unlikely.
Tailings Riparian	4 of 7 LOE indicate no impact or risk, 2 of 7 are uncertain, and 1 of 7 indicate potential risk	No impact
Windblown Tailings	1 of 2 LOE indicate no impact or risk, 1 of 2 indicate potential risk	It is likely that the ecological conditions at the Windblown Tailings area are similar to those at the Tailings area; as a result this suggests that impact is unlikely.

Notes
LOE = Lines of evidence

Scaling Public Land Injury

- Group Grope

Tailings Pipeline Releases

Tailings Pipeline Releases

- Based on May 2002 Tailings Report 267 of 343 (78%) documented releases of tailings material from pipeline occurred prior to Dec. 1980
- A major reason for this reduction in releases was due to replacement of the existing pipeline with rubber-lined steel pipes between the mill and just below the Ranger Station between 1980 and 1982.
- The remaining section of pipeline between the Ranger Station and the Tailings Facility was replaced with rubber-lined steel pipes in 1991.

Pipeline-associated tailings exposures

- URS/EPA studies identified a total of 3.8 acres of tailings material
- Most of this acreage (>70%) is associated with 4 locations; all of which are on Molycorp property.
- Approx. 1 acre of tailings has been covered and about ½ of this acreage was removed in 2002/3.
- This leaves about 2.8 acres of tailings material potentially exposed

Pipeline associated tailings exposures

- Area 8 (40% or 1.5 acres)
  - Believed to be several spills
  - Dates unknown
  - Not covered
- Area 24 (14% or 0.52 acres)
  - Not a spill – clean-out material from lower dump sump/emergency dump sump for line pressure release
  - ca 1970s
  - Covered with soil prior to 1979
- Area 41 and 42 (12% or 0.46 acres)
  - Not spills – resulted from upper dump sump clean out – piled per agreement with NMED
  - Late 1980s-early 1990s
  - Not covered – but vegetated by 1996
- Area 1 (6% or 0.22 acres)
  - Pipeline spill
  - Prior when line moved from this location – 1979
  - Not covered

Pipeline-associated tailings exposures

- The remaining 57 locations account for 1 acre of exposed tailings material; most of which are isolated areas.
  - 2 (~3%) locations have an area of >0.1 to 0.2 acres
  - 3 (~5%) locations have an area >0.05 to 0.1 acres
  - 52 (~84%) locations have an area $\leq$0.05 acres

Historic and Ongoing Exposure

- Environmental impacts associated with pipeline releases are unknown. However, any acute impacts would have likely been limited in both time and space.
- As noted before, almost 80% of the documented pipeline releases, and presumably the short-term acute effects associated with them, occurred prior to Dec. 1980.
- Because of the small extent and isolated nature of most documented exposures, longer-term impacts due to continued exposure are likely associated only with the larger releases.
- Considering home-range distances, its likely that only the Area 8 release (1.5 acre extent) has resulted in any long term environmental impact to wildlife.

Site 8

Site 8: Bare tailings deposit in a large catchment area in the Columbine Park area.

Site 42

Site 42. Large tailings pile near the Upper Dump Sump.

Scaling Pipeline Tailings Release Injury

- Group Grope

Total Potential Terrestrial Injury