

Three Kids Mine: History, Geology and Geotechnical Considerations for Site Restoration

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History: Open Pit Mine and Processing of Manganese Ore: 1917 Through 1961.

**Geology of Ore:
Pliocene
Hydrothermal
deposits emplaced as
part of Muddy Creek
Formation or
emplaced as part of
older volcanic rocks.**

**Geotechnical
Considerations:
Tailings ponds, waste
rock piles and three
large pits (up to 300'
deep) remain a safety
hazard.**

S. J. McCulloch

Three Kids Mine: History, Geology, and Geotechnical Considerations Introduction





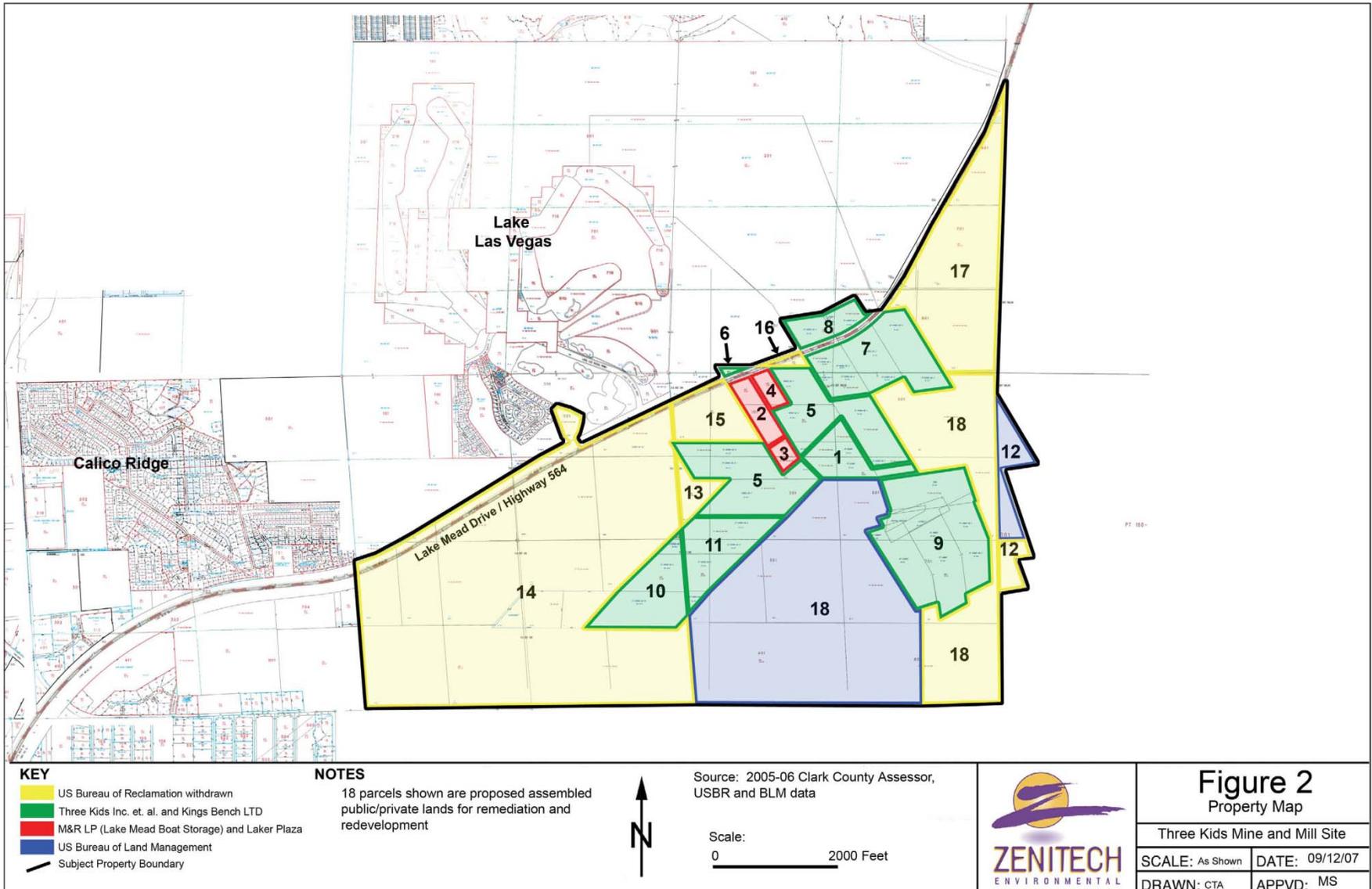
KEY  Subject Property Boundary	NOTES	Source: Quickbird / DigitalGlobe data Scale: 0 ————— 2000 Feet	 	Satellite Imagery Circa June, 2005	
				Three Kids Mine and Mill Site SCALE: As Shown DATE: 01/18/07 DRAWN: CTA APPVD: MS	

Mining B Pit 1952



Three Kids Mine Project Site Boundary

Current Property Ownership





Lake Las Vegas

Approx. location of original Three Kids Claim

Mill Site

Lake Mead Boat Storage

A & B Pits

Hydro Pit

Tailings Pond

Waste Rock

Tailings Pond

Waste Rock

Hulin Pit



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21/2011

36°04'38.37" N 114°54'55.04" W elev 1950 ft

History (Mine and Mill)

Manganese production of sufficient quality required a mill. The operational periods of the mills corresponded to periods of high demand in WWII and the Cold War Era.

1936-1956: Mine and Mill Operations

- 1942: Water pipeline from Lake Mead to the new BMI complex also provided a supply of water for milling.
- First mill operated for only 11 months with a small town site built along present day Lake Las Vegas Parkway.
- Mining occurred in A & B Pits
- The mill produced only 14,000 tons of processed ore.

Construction of New Mill



History (Mine and Mill)

1951 to 1963: Mine and Mill Operations

- Manganese Inc. constructed and made improvements to the mill (changed process from a sulphur-dioxide leach to a floatation process).
- Mining in Pits A & B continued until the ore was exhausted by 1958.
- Production of the Hydro Pit began in 1958 and the Hulin Pit in 1959.
- The Army Defense Logistic Agency (DLA) began selling off manganese stockpiles in 1959.
- In 1961 government contracts were terminated and the mine and mill were closed.
- Lead reserves resulting from the kiln operation were shipped to Utah through 1963.
- Several manganese stockpiles remained on site in DLA inventory through 2003.

Blasting B Pit



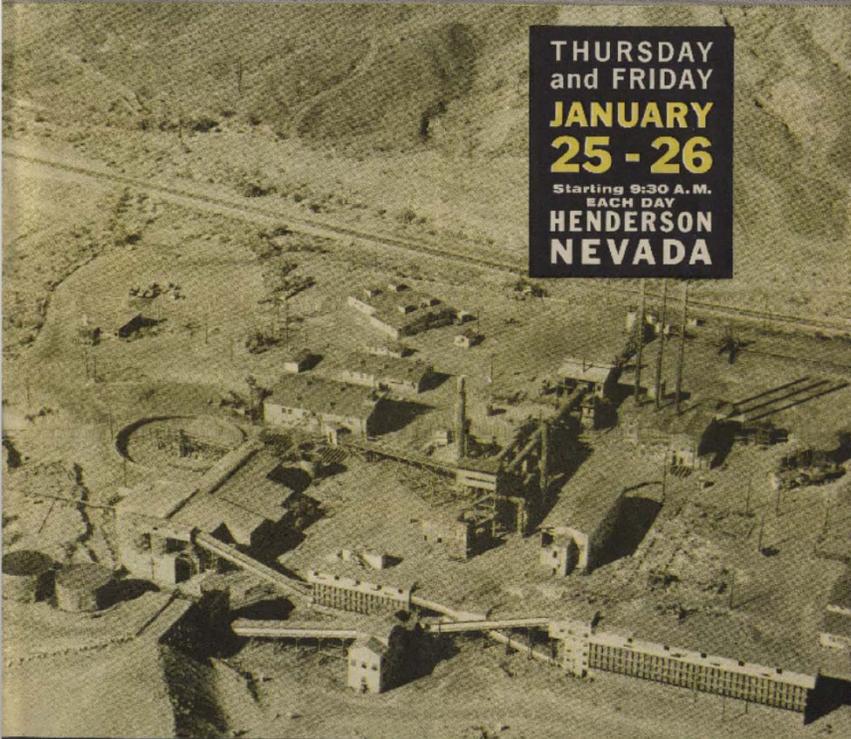
Stripping Hulin Pit



History (Post Mine and Mill)

1963 to Present:

- The site languished for many years following dismantling and auction of the mill.
- From 1979 to 1984, the Hulin Pit was operated as a solid waste landfill (ACBM).
- In the 1980's mine parcels were sold.
- The parcel containing the landfill was transferred to BLM in 1991.
- DLA continued to maintain manganese stockpiles through November 2003.
- In 2003 DLA, used the remaining stockpiles as a dust palliative on BOR property.
- From 1999 through present initial site assessments conducted by several different consultants for different entities.



\$5,854,386.34 INSTALLATION! Majority New Since 1955!
TREMENDOUS
2-DAY SALE
PIECE BY PIECE
TO HIGH BIDDERS

AUCTION

FORMER **MANGANESE, INC.** ORE MILLING and PROCESSING PLANT

THURSDAY
and FRIDAY
JANUARY
25 - 26
Starting 9:30 A.M.
EACH DAY
HENDERSON
NEVADA

Sale under supervision of
Milton J. WERSHOW Co. Leading Auctioneers
on the Pacific Coast

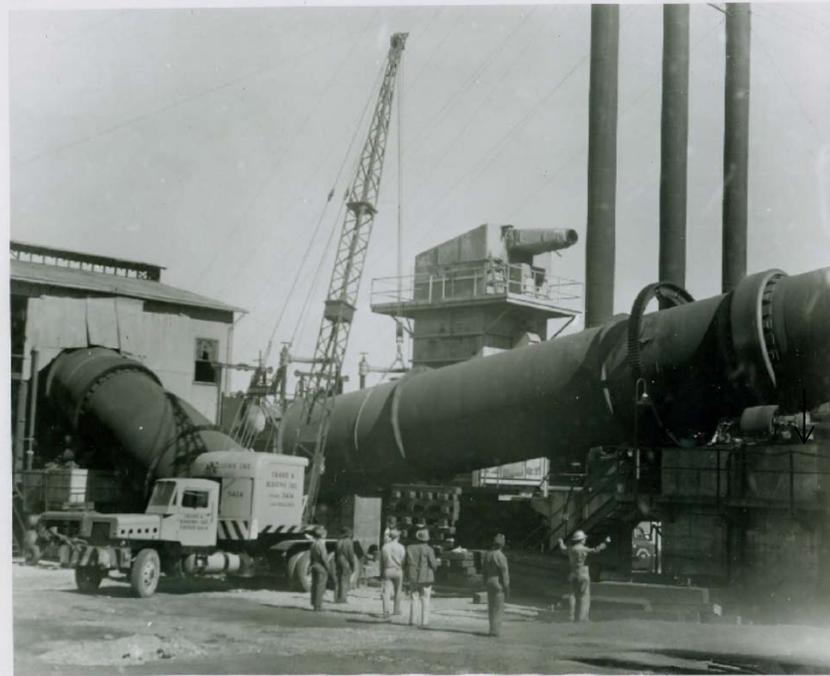
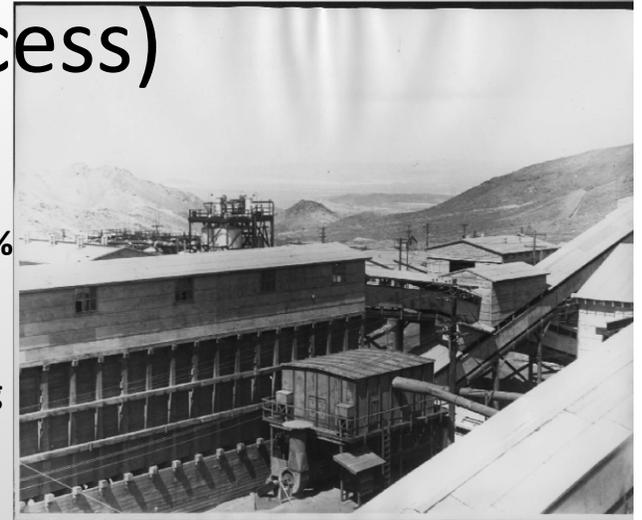
History (Milling Process)

1952 - 1961

Ore was segregated by grade, crushed and blended to average ~ 22.5% to 24% manganese, & beneficiated.

Beneficiation included mixing crushed particles with reagents and emulsifying the mixture of petroleum, plant-based oils, detergents and sulfuric acid.

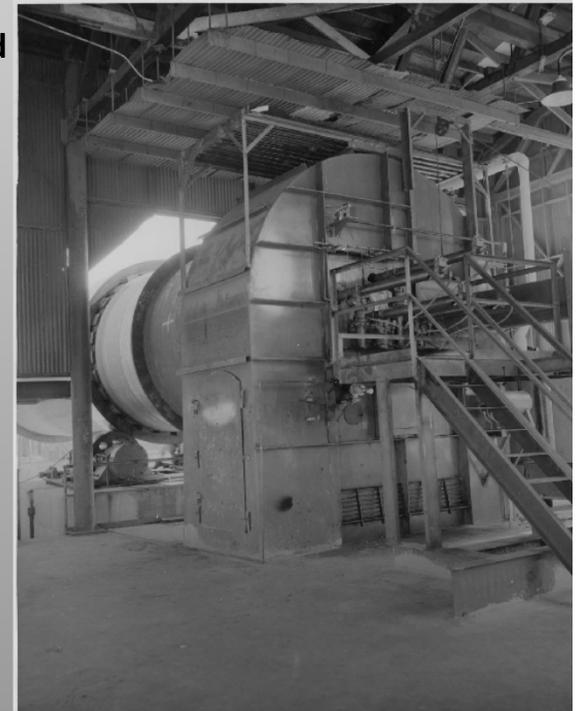
The emulsified mixture was sent to floatation cells. The manganese-rich concentrate was then sent to the mill for further processing and the gangue was pumped to tailing ponds.



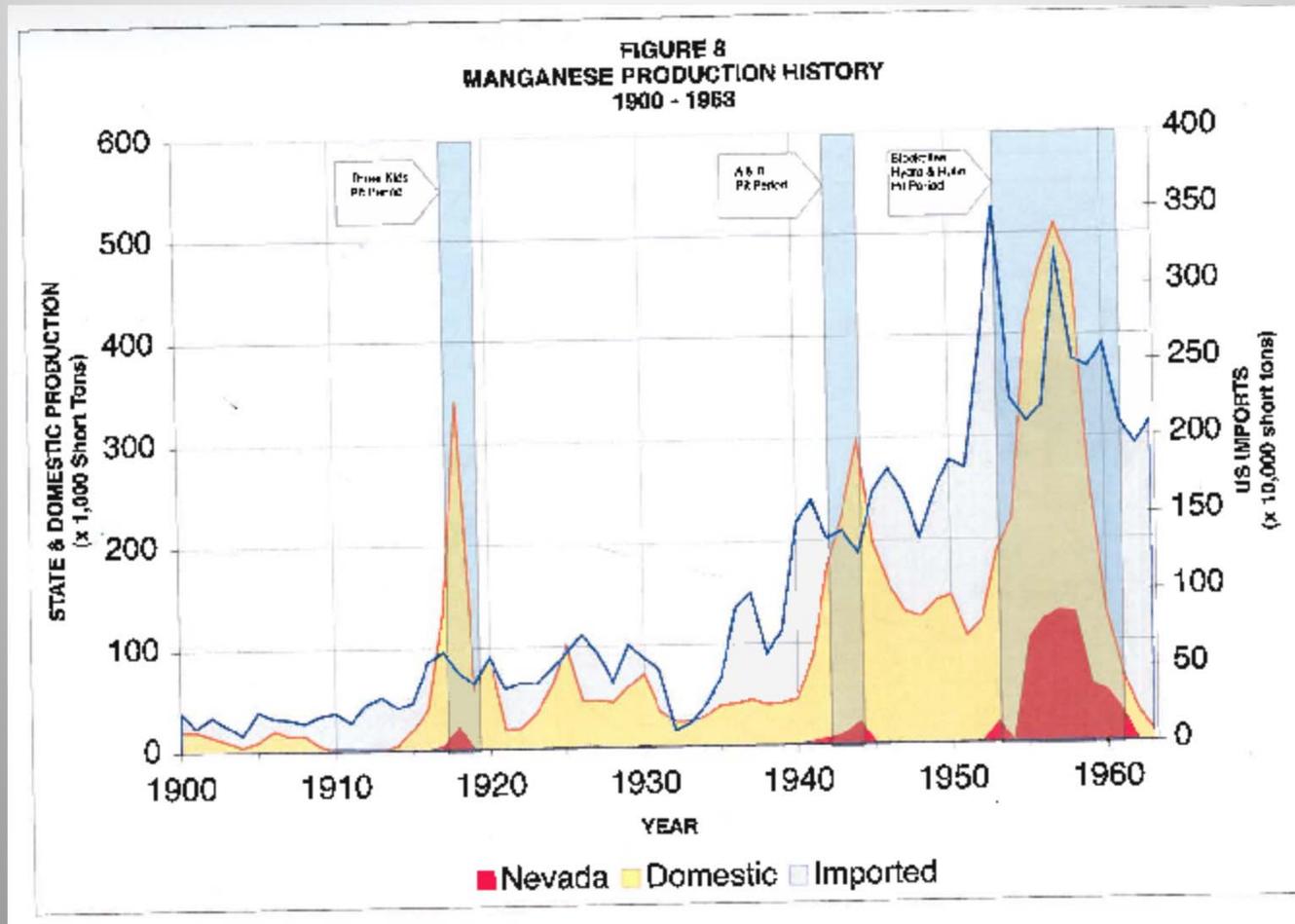
Dried concentrate was mixed with coke and sodium carbonate and heated in kilns set at 1800°F.

Desiccated manganese oxide concentrate was placed in nodulizing kiln and fired at 2400°F with Bunker C fuel oil.

Lead sulfite was volatilized in the process.



History (Production History)



Three Kids
Period

A & B Pit
Period

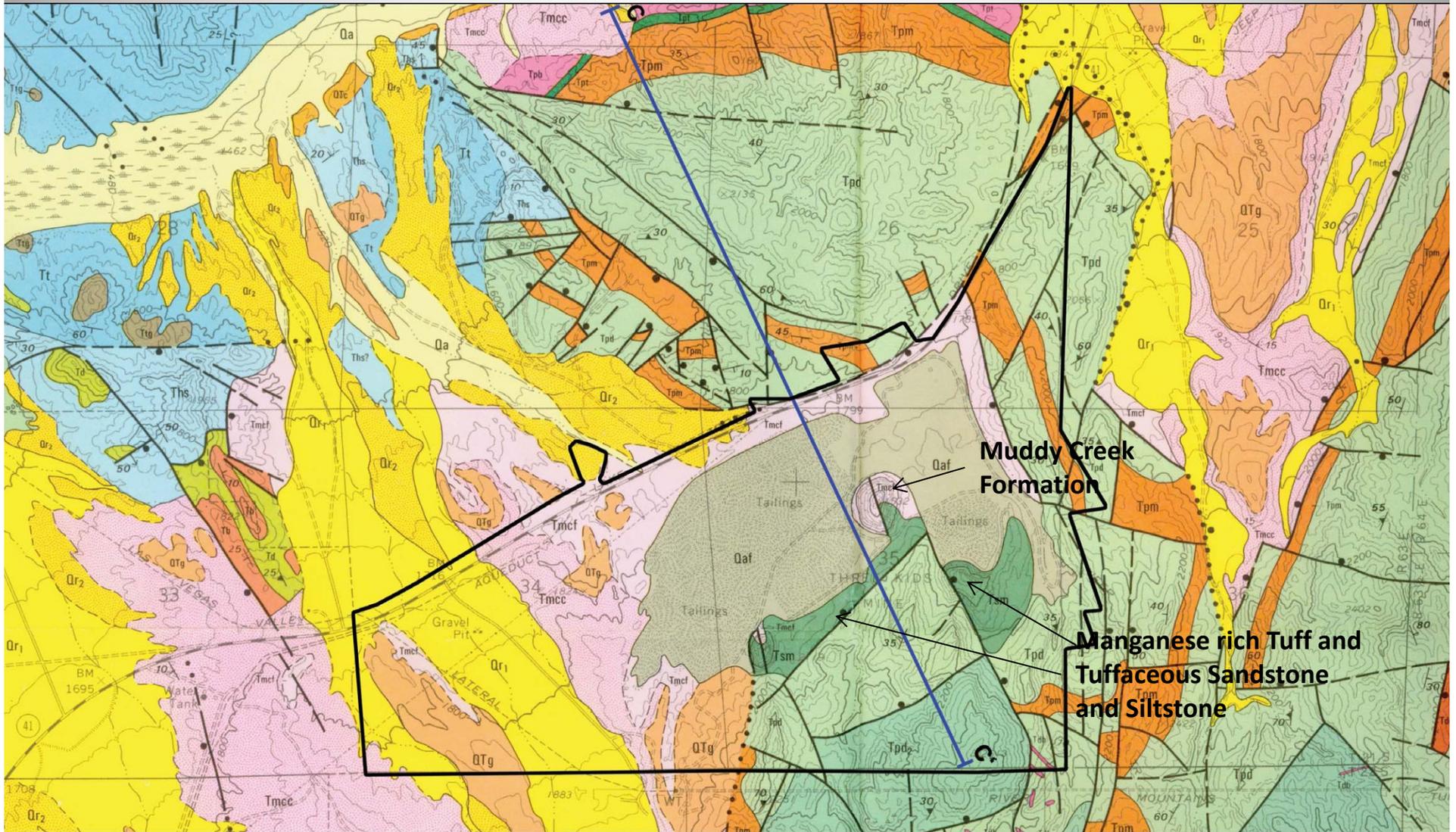
Stockpiles, Hydro &
Hulin Pit Period

Geology: Introduction

General Geology of the Three Kids Mine Project Site area:

- Tertiary Volcanic Rocks of Powerline Road (Tpd, Tpd₂, Tpm, & Tsm):
 - Mid-tertiary = Miocene
 - River Mountains primarily comprised of dacite flows with interbedded sandstones, conglomerates, and breccias
 - Basalt and andesite flows (~11.8 my old) and dikes are also present
- Tertiary Manganiferous Sedimentary Rocks of the Three Kids Mine (Tsm):
 - Manganese-rich tuff, tuffaceous sandstone, and tuffaceous siltstone
 - Dominantly of pyroclastic origin; variably reworked by water
 - Deposits underlie Tmcf
- Tertiary Muddy Creek Formation (Tmcf & Tmcc):
 - Late Miocene to Early Pliocene and unconformably overlies volcanic rocks
 - Comprised of sedimentary rocks (gypsiferous siltstone and claystone & conglomerates)
 - Fine-grained facies overlain by a basalt at Fortification Hill which is dated at ~ 5.88 my old
- Quaternary-Tertiary Older Alluvial Fan Deposits (QTg):
 - Fan surfaces are well dissected and characteristically form rounded linear ridges
 - Deposits typically unconformably overlie Tmcf
- Quaternary Pediment and Fan Deposits of the River Mountains (Qr₁):
 - Anastomosing network of undifferentiated Holocene alluvium occurring in low wash terraces

Geology: Ore Body Mapped as Manganese Rich Tuffaceous Sandstone and Siltstone by Bell & Smith, 1980



- Geologic Cross Section
- Subject Property

NOTES
See Figure 6 for Geologic key and Cross Section



Source: Bell and Smith, 1980, Nevada Bureau of Mines and Geology

Scale:
0 2000 Feet



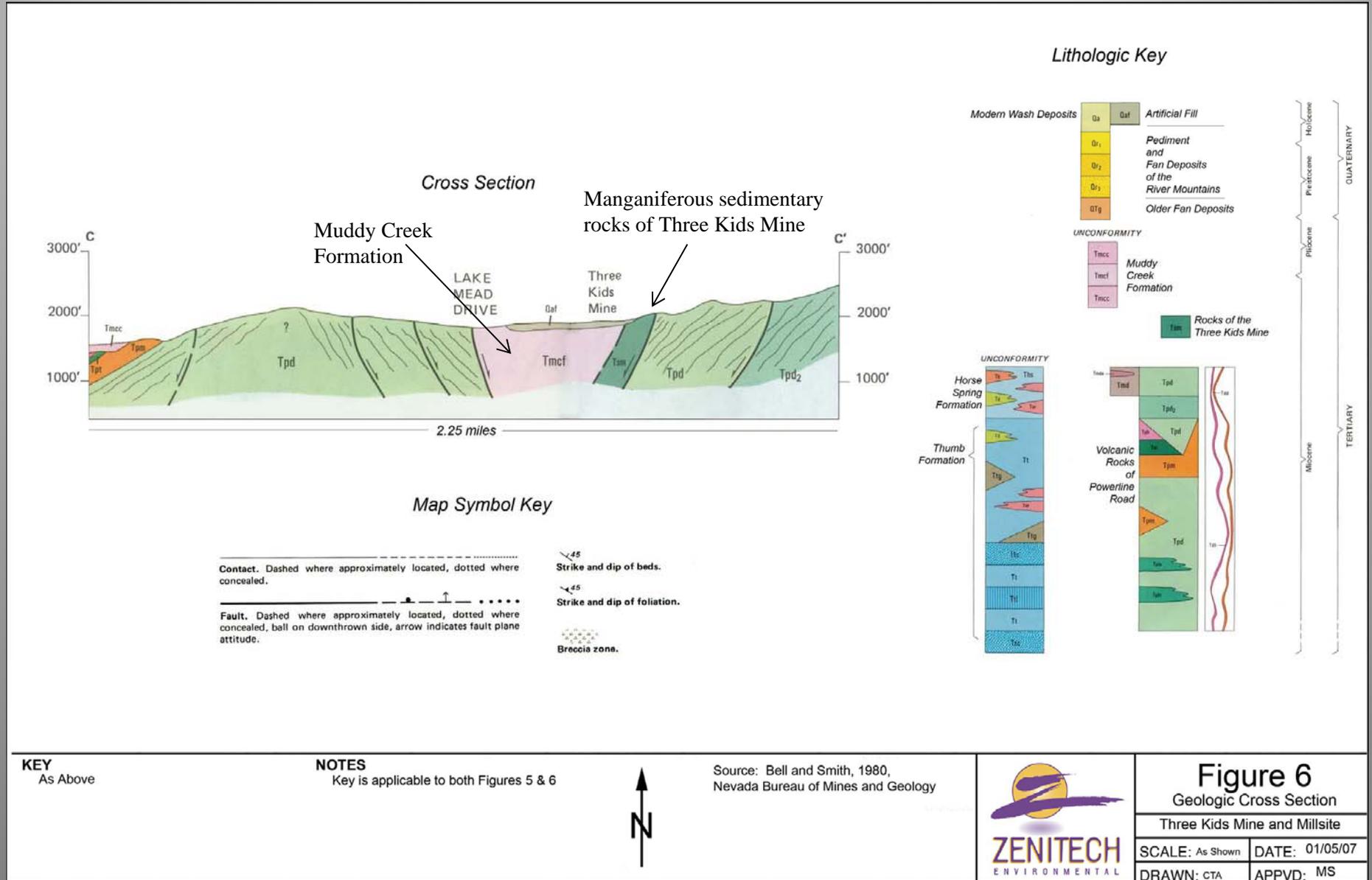
Figure 5
Geologic Map

Three Kids Mine and Millsite

SCALE: As Shown DATE: 01/05/0

DRAWN BY: MS

Geology: Cross Section from Bell & Smith, 1980



Hydrogeology

Test well was installed in the northeast corner of Three Kids Mine property in 1991:

- Total depth was 1100 feet bgs
- Majority of the Test well is un-cased (only top several feet has surface casing)
- Drillers report described hard, well-consolidated layers. {Materials encountered are likely siltstone and claystone of the Muddy Creek Formation}
- Groundwater was initially reported at 720 ft bgs
- During groundwater sampling several years later, the DTW was gauged at 560 ft bgs
- An estimated unsaturated zone of approximately 200 to 400 feet exists between the bottom of the deepest pit and groundwater
- Groundwater flow likely occurs as fracture flow
- More work would need to be done on-site to better understand local hydrogeology

Geotechnical Considerations During Site Restoration



- Tailings material
- Waste Rock
- Open pits
- Steep shear cliffs
- Faults
- fractures

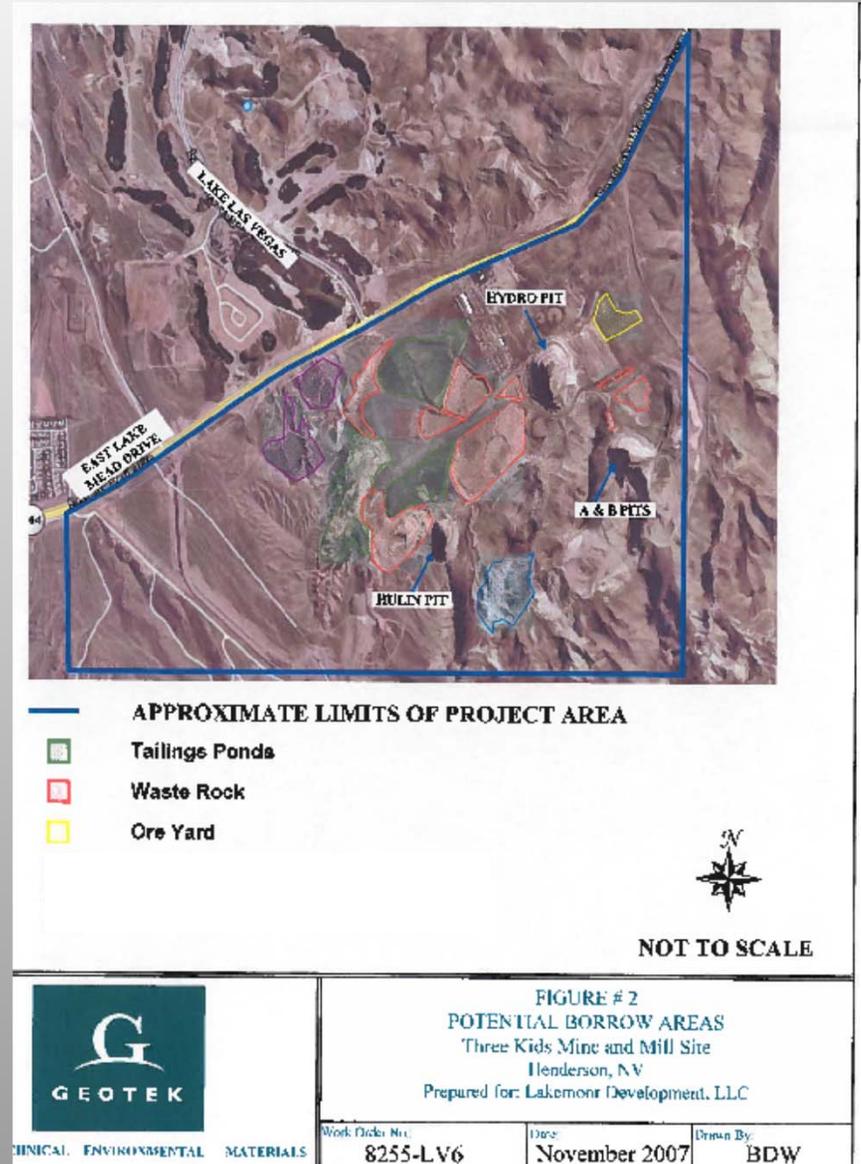
Geotechnical Considerations During Site Restoration

Three Tailings Ponds:

- Approximately 2-3 mcy of tailings material.
- Depth to native material beneath tailings ponds typically range from 9.0 feet to >40.0 feet bgs.
- Gangue from milling process placed hydraulically in the ponds.
- Tailings ponds not engineered.
- Total concentrations of some chemicals of potential concern range as high as:
 - TPH = 6,900 mg/kg
 - Arsenic = 2,300 mg/kg
 - Lead = 21,000 mg/kg
 - Manganese = 160,000 mg/kg
- The upper 4 to 5 feet are dry and underlying material has high water content and minimal shear strength.

Materials Handling Considerations:

- Difficult to excavate with a scraper.
- Dust control will be necessary for dry material. The tailings material is fine grained and may become airborne during removal.
- Underlying high water content tailings present removal and transportation difficulties unless dewatered (~40 – 85% moisture content).
- TPH, VOCs, & Metals content needs to be considered.



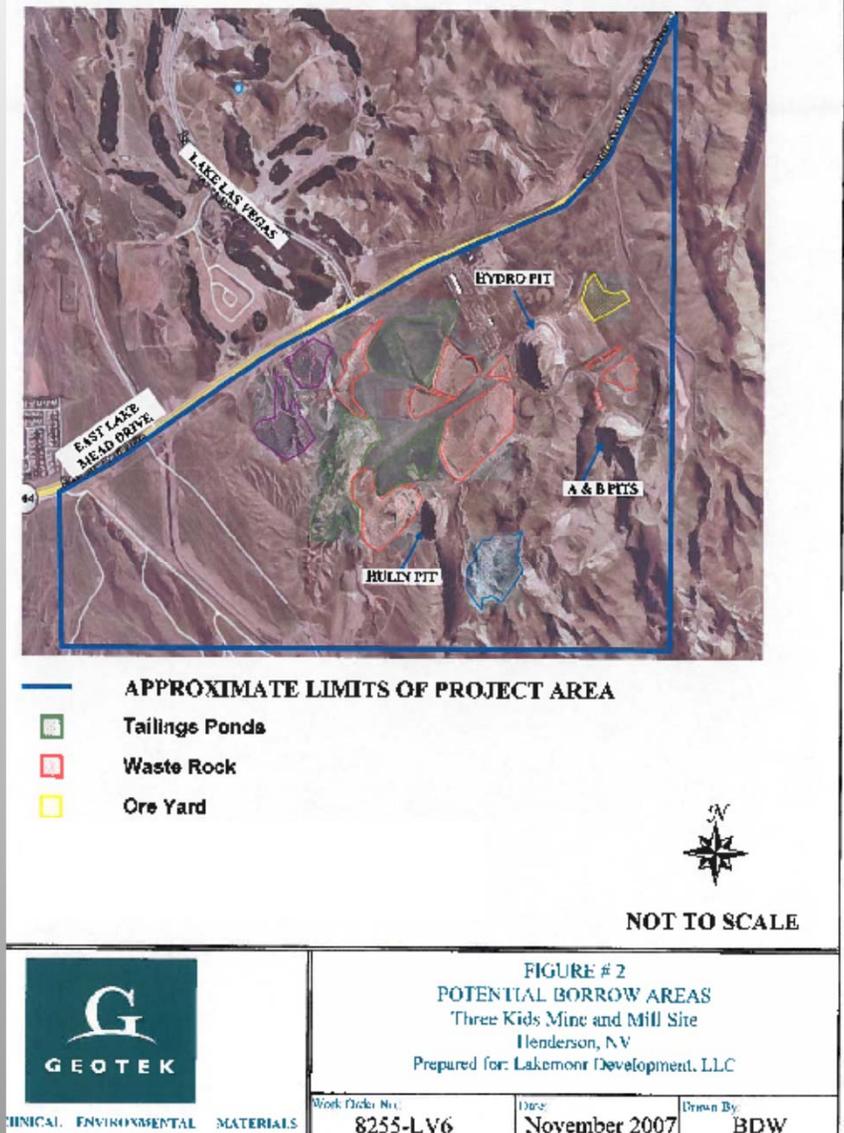
Geotechnical Considerations During Site Restoration

Waste Rock:

- Nine areas of waste rock.
- Primarily comprised of Muddy Creek material: gypsiferous sandstone.
- Depth to native ranges from 30.0 feet to 80.0 feet.
- Surficial layer of loose silty sand with gravel, cobbles and gypsum.
- Some large (oversized) boulders present.

Materials Handling Considerations:

- Likely can be excavated with conventional equipment.
- Gypsum content needs to be considered.



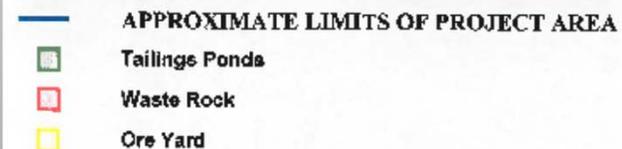
Geotechnical Considerations During Site Restoration

Ore Yard

- The majority of the ore yard is considered to be low-grade ore.
- Contains sandstone and volcanic tuff with manganese substitution.
- Grain size is silt, sand, gravel and cobbles.

Material Handling Considerations:

- Likely can be excavated with conventional equipment such as a scraper, or bulldozer.
- Gypsum content needs to be considered.
- Metals content needs to be considered.



NOT TO SCALE



TECHNICAL ENVIRONMENTAL MATERIALS

FIGURE # 2
POTENTIAL BORROW AREAS
Three Kids Mine and Mill Site
Henderson, NV
Prepared for: Lakemont Development, LLC

Work Order No. 8255-LV6

Date: November 2007

Drawn By: BDW

Recognized Hazards



Next Steps

- H.R. 2512 and S.1492
 - Three Kids Mine Remediation and Reclamation Act
 - Provides for Conveyance & Clean-up
 - Provides for a Permanent Protective Remedy
 - Supported by BLM & NDEP
- Site Characterization & Remedy Determination
- Agreements and Assurances
- Remedy Implementation & Monitoring
- Property Re-use

Three Kids Mine

Questions?



References:

Bell, John W. and Smith, Eugene I., 1980, Geologic Map of the Henderson Quadrangle. NV Bureau of Mines and Geology, Map No. 67.

Geoteck, December 28, 2007: Preliminary Geotechnical Engineering Study for Remediation of the Former Three Kids Mine and Mill Site, Henderson, NV.

Jbr Environmental Consultants, Inc. November 1, 2000: Site Investigation Report, Three Kids Mine Property, Clark County, NV.

Jbr Environmental Consultants, Inc., January 22, 2001: Site Investigation Report, Supplement, Three Kids Mine Property, Clark County NV.

Longwell, C.R. and Others, 1965, Geology and Mineral Deposits of Clark County, NV. NV Bureau of Mines and Geology, Bulletin 62

Ninyo & Moore, April 25, 1999: Preliminary Soil Assessment Report, Three Kids Mine, Clark County, NV

Ninyo & Moore, July 15, 1999: Supplemental Preliminary Soil Assessment and Waste Characterization Report, Three Kids Mine, Clark County, NV.

Zenitech Environmental Services, December 28, 2007: Phase I Environmental Site Assessment, Three Kids Mine and Mill Site, Clark County NV

Zenitech Environmental Services, November 4, 2008: Sampling and Analysis Plan In Support of Site Characterization.