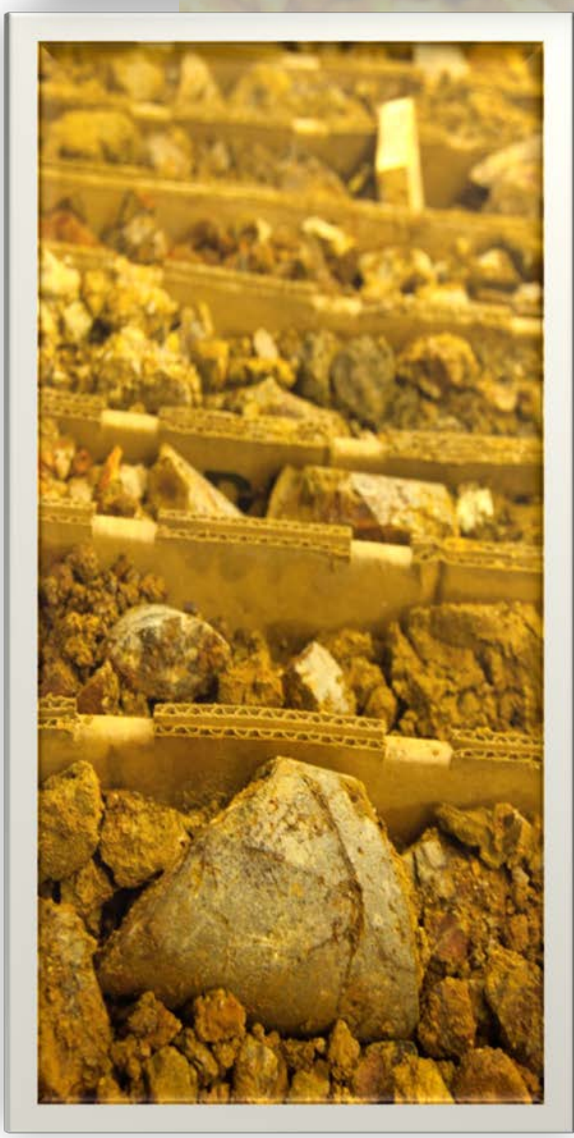
Rare Element Resources



Bear Lodge Project

Canadian NI 43-101

Pre-Feasibility Study Report

On the Reserves and Development of the Bull Hill Mine, Wyoming.

ROCHE Engineering

REPORT – OCTOBER 9th, 2014

RARE ELEMENT RESOURCES, Ltd

Bear Lodge Project
Canadian NI 43-101

Pre-Feasibility Study Report

Technical Report on the Mineral Reserves and Development of the Bull Hill Mine, Wyoming

Signed By Peter S. Dahlberg
General Manager, USA.
Roche Engineering, Inc.

October 9th, 2014 – Rev. 0

Roche Engineering, Inc.
9815 South Monroe, Suite 100
Sandy, Utah. 84070
USA

Phone: 801-871-2400
www.roche-engineering.com

PETER S. DAHLBERG, P.E.

Roche Engineering, Inc.

9815 Monroe Street, Suite 100, Sandy, Utah 84070, USA
Telephone: 801-871-2400
E-mail: pete.dahlberg@roche-engineering.com

CERTIFICATE OF QUALIFIED PERSON

I, Peter S. Dahlberg, P.E., do hereby certify that:

1. I am the Principal Engineer of:

   Roche Engineering, Inc.
   9815 Monroe Street
   Sandy, Utah, 84070, USA

2. I graduated from the Colorado School of Mines with a Bachelor of Science degree in Metallurgical Engineering in 1981.

3. I am a Registered Professional Engineer in the State of Utah (No. 319080-2202), a Registered Professional Engineer in the State of Colorado (No. 0035313), a Registered Professional Engineer in the state of Idaho (No. 11201), a Registered Professional Engineer in the state of Nevada (No. 016399), a Registered Professional Engineer in the state of Missouri (No. 022344), and a Registered Qualified Professional (QP) Member of the Society for Mining, Metallurgy and Exploration, Inc. (No. 01355QP) (all in good standing).

4. I have practiced my profession as a metallurgical engineer continuously for 33 years since my graduation from college. I have been involved in mineral processing operations in both management and engineering positions, and have extensive experience in process facility design and planning. I have conducted pre-feasibility and feasibility studies for numerous mining projects in North America, and Russia.

5. I have read the definition of "qualified person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.

6. I am responsible for the preparation of Items 1, 2, 3, 12, 13, 17, 18, 21, 22, 23, 24, 25, 26, and 27 of the technical report titled "Bear Lodge Project Canadian NI 43-101 Pre-Feasibility Study Report on the Reserves and Development of Bull Hill Mine, Wyoming", with an effective date of October 9, 2014, (the "Technical Report").

7. I have visited the Bear Lodge Project property on June 26, 2014, for a duration of one day. I inspected selected drill core to gain understanding of the geology, mineralization and rock strength characteristics; inspected the site layout to acquaint myself with proposed pit and support facility locations, road access and property boundaries; and visited the proposed hydrometallurgical plant site.

8. I have had no prior involvement with the property that is the subject of the Technical Report.

9. As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

10. I am independent of the issuer, Rare Element Resources Ltd., applying all of the tests in Section 1.5 of NI 43-101.

11. I have read NI 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form.

Dated the 9th day of October 2014.

Original signed and sealed by

Signed, Peter S. Dahlberg, P.E. 319080-2202

CONSENT OF QUALIFIED PERSON

British Columbia Securities Commission
Alberta Securities Commission
Saskatchewan Financial Services Commission
The Manitoba Securities Commission
Ontario Securities Commission
New Brunswick Securities Commission
Nova Scotia Securities Commission
Deputy Registrar, Securities Division, Prince Edward Island
Director of Securities, Department of Government Services and Lands,
  Newfoundland and Labrador
Registrar of Securities, Department of Justice, Yukon Territory
Securities Registries, Department of Justice, Northwest Territories
Government of Nunavut, Legal Registries Division
Toronto Stock Exchange

Dear Sirs and Mesdames:

Re: Technical Report titled "Bear Lodge Project Canadian NI 43-101 Pre-Feasibility Study Report on the Reserves and Development of the Bull Hill Mine, Wyoming" dated October 9, 2014.

I, Peter S. Dahlberg, P.E. consent to the public filing of the technical report titled "Bear Lodge Project Canadian NI 43-101 Pre-Feasibility Study Report on the Reserves and Development of the Bull Hill Mine, Wyoming" dated October 9, 2014, (the "**Technical Report**") by Rare Element Resources Ltd. ("**Rare Element**").

I also consent to any extracts from or a summary of the Technical Report in the press release titled "Rare Element Resources Announces 2014 Pre-Feasibility Study on the Bear Lodge Project; Operational and technical improvements support a long-life Project with after-tax Internal Rate of Return of 29% and a payback period of 2.9 years; Significant opportunities for further upside" dated August 26, 2014 (the "**Press Release**") of Rare Element.

I certify that I have read the Press Release filed by Rare Element and that it fairly and accurately represents the information in the Technical Report for which I am responsible.

Dated this 9th day of October, 2014.

Original signed and sealed by

Signed, Peter S. Dahlberg, P.E. 319080-2202

CERTIFICATE OF AUTHOR

Alan C Noble
Ore Reserves Engineering
12254 Applewood Knolls Drive
Lakewood, Colorado 80215

Telephone: 303 237 8271
Fax: 303 237 4533
Email: alan@ore-reserves.com

I, Alan C Noble, do hereby certify that:

I am a self-employed Mining Engineer for Ore Reserves Engineering, 12254 Applewood Knolls Drive, Lakewood, Colorado 80215 and carried out this assignment as author/reviewer.

1. This certificate applies to the Technical Report titled "**Bear Lodge Project Canadian NI 43-101 Technical Report on the Mineral Reserves and Development of the Bull Hill Mine**" (the "Technical Report"), dated October 9, 2014 for Rare Element Resources Inc.
2. I graduated from the Colorado School of Mines in Golden, Colorado with a Bachelor of Science Degree in Mineral Engineering in 1970.
3. I am a Registered Professional Engineer in the State of Colorado, USA, PE #26122. In addition, I am a Member of the Society for Mining, Metallurgy, and Exploration (SME).
4. I have practiced my profession as a mining engineer continuously since 1970, for a total of 44 years. During that time I worked on mineral resource estimates and mine planning for over 135 mineral deposits.
5. I have read the definition of "Qualified Person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education, registration as a professional engineer, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "Qualified Person" for the purposes of NI 43-101.
6. I am responsible for the preparation of Chapter 7, 8, 9, 10, & 14 of the Technical Report.
7. I have visited the Bear Lodge property several times, the most recently for two days starting August 11, 2014.
8. I have had prior involvement with the Bear Lodge property that is the subject of the Technical Report. The nature of my involvement included preparation of several previous Technical Reports and resources estimates.
9. I am independent of the issuer, Rare Element Resources Inc., applying all of the tests of Section 1.5 of NI 43-101.
10. I have read NI 43-101 and Form 43-101F1, and Chapters 7, 8, 9, 10, & 14 of the Technical Report have been prepared in compliance with the instrument and form.
11. At the effective date of the Technical Report, to the best of my information, knowledge and belief, Chapters 7, 8, 9, 10, & 14 of the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

I consent of the filing of the Technical Report with any Canadian stock exchange and consent other securities regulatory authority and any publication by them for regulatory purposes of the technical report.

Dated the 9th day of October 2014.

Digitally Signed and Sealed, Alan C. Noble, P.E. 26122

Alan C. Noble, P.E. 26122

CONSENT OF QUALIFIED PERSON

British Columbia Securities Commission
Alberta Securities Commission
Saskatchewan Financial Services Commission
The Manitoba Securities Commission
Ontario Securities Commission
New Brunswick Securities Commission
Nova Scotia Securities Commission
Deputy Registrar, Securities Division, Prince Edward Island
Director of Securities, Department of Government Services and Lands,
Newfoundland and Labrador
Registrar of Securities, Department of Justice, Yukon Territory
Securities Registries, Department of Justice, Northwest Territories
Government of Nunavut, Legal Registries Division
Toronto Stock Exchange

Dear Sirs and Mesdames:

Re: Technical Report titled "Bear Lodge Project Canadian NI 43-101 Pre-Feasibility Study Report on the Reserves and Development of the Bull Hill Mine, Wyoming" dated October 9, 2014.

I, Alan C. Noble, P.E. consent to the public filing of the technical report titled "Bear Lodge Project Canadian NI 43-101 Pre-Feasibility Study Report on the Reserves and Development of the Bull Hill Mine, Wyoming" dated October 9, 2014, (the "**Technical Report**") by Rare Element Resources Ltd. ("**Rare Element**").

I also consent to any extracts from or a summary of the Technical Report in the press release titled "Rare Element Resources Announces 2014 Pre-Feasibility Study on the Bear Lodge Project; Operational and technical improvements support a long-life Project with after-tax Internal Rate of Return of 29% and a payback period of 2.9 years; Significant opportunities for further upside" dated August 26, 2014 (the "**Press Release**") of Rare Element.

I certify that I have read the Press Release filed by Rare Element and that it fairly and accurately represents the information in the Technical Report for which I am responsible.

Dated the 9th day of October 2014.

Digitally Signed and Sealed, Alan C. Noble, P.E. 26122

Alan C. Noble, P.E. 26122

CERTIFICATE OF QUALIFIED PERSON

Jaye T Pickarts
Rare Element Resources, Inc.
225 Union Blvd. Suite 250
Lakewood, Colorado 80228

Telephone: 720 278 2460
Fax: 720 278 2490
Email: jpickarts@rareelementresources.com

I, Jaye T Pickarts, do hereby certify that:

I am the Chief Operating Officer for Rare Element Resources Inc., 225 Union Blvd., Suite 250 Lakewood, Colorado 80228

1. This certificate applies to the Technical Report titled "Rare Element Resources Inc., Bear Lodge Project, Canadian NI 43-101,Technical Report on the Mineral Reserves and Development of the Bull Hill Mine" (the "Technical Report"), dated October 9, 2014 for Rare Element Resources Inc.
2. I graduated from the Montana College of Mineral Science and Technology, Butte, Montana, with a Bachelor of Science Degree in Mineral Processing Engineering in 1982.
3. I am a Licensed Professional Engineer in the State of Colorado, USA, PE37268 and the State of Nevada, USA PE020893 and the State of Wyoming, USA PE13891. In addition, I am a Registered Member of the Society for Mining, Metallurgy, and Exploration (SME) No. 2543360 and a Qualified Person member of the Mining and Metallurgical Society of America (MMSA).
4. I have practiced my profession continuously since 1982, and have been involved in mineral processing and metallurgical engineering for a total of 32 years.
5. I have read the definition of "Qualified Person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education, registration as a professional engineer, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "Qualified Person" for the purposes of NI 43-101.
6. I am responsible for the preparation of Items 4 Property Description and Location; 5, Accessibility Climate Local Resources Infrastructure and Physiography; 6, History; 19, Market Studies and Contracts; and Item 20, Environmental Studies, Permitting and Social or Community Impact.
7. I have visited the property several times, the most recently on August 24, 2014 for a period of three days.
8. I have had prior involvement with the property that is the subject of the Technical Report. The nature of my involvement is the preparation of metallurgical test programs and environmental baseline studies prior to my engagement as the Chief Operating Officer for Rare Element Resources, during 2010 and part of 2011.
9. I am NOT independent of the issuer as described in Section 1.5 of NI 43-101.
10. I have read NI 43-101 and Form 43-101F1, and Items 4, 5, 6, 19, and 20 of the Technical Report have been prepared in compliance with the instrument and form.
11. As the effective date of the Technical Report, to the best of my information, knowledge and belief, Items 4, 5, 6, 19, and 20 of the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated the 9th day of October 2014.

Original signed and sealed by

Signed, Jaye T. Pickarts, P.E. 37268/020893/13891

CONSENT OF QUALIFIED PERSON

British Columbia Securities Commission
Alberta Securities Commission
Saskatchewan Financial Services Commission
The Manitoba Securities Commission
Ontario Securities Commission
New Brunswick Securities Commission
Nova Scotia Securities Commission
Deputy Registrar, Securities Division, Prince Edward Island
Director of Securities, Department of Government Services and Lands,
Newfoundland and Labrador
Registrar of Securities, Department of Justice, Yukon Territory
Securities Registries, Department of Justice, Northwest Territories
Government of Nunavut, Legal Registries Division
Toronto Stock Exchange

Dear Sirs and Mesdames:

Re: Technical Report titled "Bear Lodge Project Canadian NI 43-101 Pre-Feasibility Study Report on the Reserves and Development of the Bull Hill Mine, Wyoming" dated October 9, 2014.

I, Jaye Thomas Pickarts, P.E., consent to the public filing of the technical report titled "Bear Lodge Project Canadian NI 43-101 Pre-Feasibility Study Report on the Reserves and Development of the Bull Hill Mine, Wyoming" dated October 9, 2014, (the "**Technical Report**") by Rare Element Resources Ltd. ("**Rare Element**").

I also consent to any extracts from or a summary of the Technical Report in the press release titled "Rare Element Resources Announces 2014 Pre-Feasibility Study on the Bear Lodge Project; Operational and technical improvements support a long-life Project with after-tax Internal Rate of Return of 29% and a payback period of 2.9 years; Significant opportunities for further upside" dated August 26, 2014 (the "**Press Release**") of Rare Element.

I certify that I have read the Press Release filed by Rare Element and that it fairly and accurately represents the information in the Technical Report for which I am responsible.

Dated this 9th day of October, 2014.

Original signed and sealed by

Signed, Jaye T. Pickarts, P.E. 37268/020893/13891

WILLIAM L. ROSE, P.E.
WLR Consulting, Inc.
9386 West Iowa Avenue, Lakewood, Colorado 80232-6441, USA
Telephone: 303-980-8528
E-mail: wlrconsulting@comcast.net

CERTIFICATE OF QUALIFIED PERSON

I, William L. Rose, P.E., do hereby certify that:

1. I am the Principal Mining Engineer of:

   WLR Consulting, Inc.
   9386 West Iowa Avenue
   Lakewood, Colorado 80232-6441, USA

2. I graduated from the Colorado School of Mines with a Bachelor of Science degree in Mining Engineering in 1977.

3. I am a Registered Professional Engineer in the State of Colorado (No. 19296), a Registered Professional Engineer in the State of Arizona (No. 15055) and a Registered Member of the Society for Mining, Metallurgy and Exploration, Inc. (No. 2762350RM) (all in good standing).

4. I have practiced my profession as a mining engineer continuously for 37 years since my graduation from college. I have been involved in open pit mine operations in both management and engineering positions, and have extensive experience in mine design and planning. I have conducted estimations of mineral resources and reserves, mine production schedules, equipment and workforce requirements, and capital and operating costs for numerous projects in North, Central and South America, Europe, Africa and Asia.

5. I have read the definition of “qualified person” set out in National Instrument 43-101 (“NI 43-101”) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a “qualified person” for the purposes of NI 43-101.

6. I am responsible for the preparation of Item 15 and portions of Item 16 (subsections 16.1, 16.2, 16.3 and 16.4) of the technical report titled “Bear Lodge Project Canadian NI 43-101 Pre-Feasibility Study Report on the Reserves and Development of the Bull Hill Mine, Wyoming”, dated October 9, 2014 (the “Technical Report”).

7. I have visited the Bull Hill mine site near Sundance, Wyoming and the Upton, Wyoming plant site properties on June 26, 2014, for a combined duration of one day. I inspected selected drill core to gain understanding of the geology, mineralization and rock strength characteristics; inspected the mine site layout to acquaint myself with proposed pit and support facility locations, road access and property boundaries; and visited the proposed Hydromet plant and tailings storage site.

8. I have had no prior involvement with the property that is the subject of the Technical Report.

9. As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

10. I am independent of the issuer, Rare Element Resources Ltd., applying all of the tests in Section 1.5 of NI 43-101.

11. I have read NI 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form.

Dated this 9th day of October, 2014.

Original signed and sealed by

Signed, William L. Rose, P.E. 19296/15055

CONSENT OF QUALIFIED PERSON

British Columbia Securities Commission
Alberta Securities Commission
Saskatchewan Financial Services Commission
The Manitoba Securities Commission
Ontario Securities Commission
New Brunswick Securities Commission
Nova Scotia Securities Commission
Deputy Registrar, Securities Division, Prince Edward Island
Director of Securities, Department of Government Services and Lands,
Newfoundland and Labrador
Registrar of Securities, Department of Justice, Yukon Territory
Securities Registries, Department of Justice, Northwest Territories
Government of Nunavut, Legal Registries Division
Toronto Stock Exchange

Dear Sirs and Mesdames:

Re: Technical Report titled "Bear Lodge Project Canadian NI 43-101 Pre-Feasibility Study Report on the Reserves and Development of the Bull Hill Mine, Wyoming" dated October 9, 2014.

I, William L. Rose, P.E. consent to the public filing of the technical report titled "Bear Lodge Project Canadian NI 43-101 Pre-Feasibility Study Report on the Reserves and Development of the Bull Hill Mine, Wyoming" dated October 9, 2014, (the "**Technical Report**") by Rare Element Resources Ltd. ("**Rare Element**").

I also consent to any extracts from or a summary of the Technical Report in the press release titled "Rare Element Resources Announces 2014 Pre-Feasibility Study on the Bear Lodge Project; Operational and technical improvements support a long-life Project with after-tax Internal Rate of Return of 29% and a payback period of 2.9 years; Significant opportunities for further upside" dated August 26, 2014 (the "**Press Release**") of Rare Element.

I certify that I have read the Press Release filed by Rare Element and that it fairly and accurately represents the information in the Technical Report for which I am responsible.

Dated this 9th day of October, 2014.

Original signed and sealed by

Signed, William L. Rose, P.E. 19296/15055

CERTIFICATE OF AUTHOR

Jeffrey A Jaacks
Geochemical Applications International, Inc.
8493 East Foxhill Place, Centennial, CO 80112

Telephone: 303-713-1601
Email: jjaacks@comcast.net

I, Jeffrey A Jaacks, do hereby certify that:

I am a self-employed Geochemist/Geologist with Geochemical Applications International, Inc., 8493 East Foxhill Place, Centennial, Colorado, 80112 and carried out this assignment as author/reviewer.

1. This certificate applies to the Technical Report titled "Bear Lodge Project Canadian NI 43-101 Technical Report on the Mineral Reserves and Development of the Bull Hill Mine, Wyoming" with an effective date of October 9, 2014, (the "**Technical Report**") by Rare Element Resources Ltd. ("**Rare Element**").
2. I graduated from the University of San Diego, California with a Bachelor of Arts degree in Chemistry with a Specialization in Earth Sciences in 1979 and from the Colorado School of Mines in Golden, Colorado, with a Doctorate in Geochemistry in 1984.
3. I am a Certified Professional Geologist with the American Institute of Professional Geologists (CPG# 11249). In addition, I am a:
    a. Fellow and Past President in the Association of Applied Geochemists (AAG),
    b. Member of the American Institute of Professional Geologists (AIPG)
    c. Member of the Society of Economic Geologists (SEG).
4. I have practiced my profession as a Geochemist/Geologist continuously since 1980, for a total of 34 years. During that time I worked as:
    a. a geochemist/geologist for several major mining companies,
    b. as a Chief Geochemist for several of those companies,
    c. and for over 15 years as an independent consultant in the fields of exploration geochemistry and economic geology, including standards development and quality assurance and quality control programs for exploration and mining.
5. I have read the definition of "Qualified Person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "Qualified Person" for the purposes of NI 43-101.
6. I am responsible for the preparation of Chapter 11 of the Technical Report based upon information provided by Rare Element Resources and on discussions with Rare Element Resources representatives.
7. I have visited the property several times, the most recently on May 21-22, 2014.
8. I have had prior involvement with the property that is the subject of the Technical Report. The nature of my involvement included preparation of Quality Assurance program review Chapters for several previous Technical Reports, development of certified reference materials for the project, and establishing and reviewing of the Quality Assurance Programs from 2009 to the present.
9. I am independent of the issuer, Rare Element Resources Inc., applying all of the tests of Section 1.5 of NI 43-101.
10. I have read NI 43-101 and Form 43-101F1, and Chapter 11 of the Technical Report has been prepared in compliance with the instrument and form.
11. At the effective date of the Technical Report, to the best of my information, knowledge and belief, Chapter 11 of the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

I consent of the filing of the Technical Report with any Canadian stock exchange and consent other securities regulatory authority and any publication by them for regulatory purposes of the technical report.

Dated this 9th day of October 2014.

Original signed and sealed by

Dr. Jeffrey A. Jaacks, CPG. 11249

CONSENT OF QUALIFIED PERSON

British Columbia Securities Commission
Alberta Securities Commission
Saskatchewan Financial Services Commission
The Manitoba Securities Commission
Ontario Securities Commission
New Brunswick Securities Commission
Nova Scotia Securities Commission
Deputy Registrar, Securities Division, Prince Edward Island
Director of Securities, Department of Government Services and Lands,
Newfoundland and Labrador
Registrar of Securities, Department of Justice, Yukon Territory
Securities Registries, Department of Justice, Northwest Territories
Government of Nunavut, Legal Registries Division
Toronto Stock Exchange

Dear Sirs and Mesdames:

Re: Technical Report titled "Bear Lodge Project Canadian NI 43-101 Pre-Feasibility Study Report on the Reserves and Development of the Bull Hill Mine, Wyoming" dated October 9, 2014.

I, Jeffrey A. Jaacks, CPG consent to the public filing of the technical report titled "Bear Lodge Project Canadian NI 43-101 Pre-Feasibility Study Report on the Reserves and Development of the Bull Hill Mine, Wyoming" dated October 9, 2014, (the "**Technical Report**") by Rare Element Resources Ltd. ("**Rare Element**").

I also consent to any extracts from or a summary of the Technical Report in the press release titled "Rare Element Resources Announces 2014 Pre-Feasibility Study on the Bear Lodge Project; Operational and technical improvements support a long-life Project with after-tax Internal Rate of Return of 29% and a payback period of 2.9 years; Significant opportunities for further upside" dated August 26, 2014 (the "**Press Release**") of Rare Element.

I certify that I have read the Press Release filed by Rare Element and that it fairly and accurately represents the information in the Technical Report for which I am responsible.

Dated this 9th day of October, 2014.

Original signed and sealed by

Signed Dr. Jeffrey A. Jaacks, CPG 11249

Table of Contents

List of Tables

List of Figures

Abbreviations and Acronyms

ALS Laboratories .... ALS
Above Mean Sea Level .... amsl
Approximately .... appx
Average Selling Price .... asp
Bench Face Angles .... BFA
Bull Hill .... BH
Bureau of Land Management .... BLM
Canadian Institute of Mining, Metallurgy and Petroleum .... CIM
Code of Federal RegulationsCFR .... CFR
Controlled Source Audio-Magneto-Telluric .... CSMAT
Council of Environmental Quality .... CEQ
Discounted Cash Flow .... DCF
Definitive Feasibility Study .... DFS
Digital Elevation Model .... DEM
Distributed control system .... DCS
Environmental impact statement .... EIS
Fluid Cracking Catalysts .... FCC
Freight on Board .... FOB
FMC Corp .... FMC
(FE-Mn-REE) High Grade Ore .... FMR
Geographic information system .... GIS
General & administrative .... G&A
Global positioning system .... GPS
Geochemical Applications International Inc. .... GAII
Hydrochloric Acid .... HCl
Hydrometallurgical plant .... HYDROMET
High-grade .... HG
High density polyethylene .... HDPE
Heavy rare earth elements .... HREE
Inductively Coupled Plasma – used for elemental analysis .... ICP
Internal rate of return .... IRR
Inter-ramp angles .... IRA
Inverse-distance-power .... IDP

John T. Boyd Company.......... BOYD
Lynas Advanced Material Plant .... LAMP
Low grade .... LG
Leachate collection and recovery systems .... LCRS
Land Quality Division .... LQD
Light Rare Earth Elements.......... LREE
Minus .... -
Motor Control Center.......... MCC
Minerals Exploration Geochemistry.......... MEG
Mountain States R&D International .... MSRDI
Modified TREO.......... MTREO
Memorandum of understanding .... MOU
Mineralization.......... MNZN
National environmental policy act.......... NEPA
Net present value .... NPV
Net smelter returns .... NSR
Nearest neighbor .... NN
Nuclear Material Safety and Safeguards.......... NMSS
Nuclear Regulatory Commission.......... NRC
Nuclear Regulatory Guide.......... NUREG
Ore Reserves Engineering .... O.R.E.
Plus.......... +
Plus/minus .... +-
Pre-Feasibility Study .... PFS
Physical upgrading plant .... PUG
Pilot Plant Number.......... PP#
Pregnant leach solution.......... PLS
Refers to the size of a diamond core drill which extracts a core of 85mm.......... PQ
Quality assurance/quality control .... QA/QC
Qualified person.......... QP
Relative standard deviation.......... RSD
Right of first refusal .... ROFR

Record of decision	ROD
Rare Element Resource	RER
Rare earth	RE
Rare earth elements	REE
Rare earth magnesium pentaborate	CBT
Rare earth oxides	REO
Reverse Circulation Driling	RC
Societe Generale de Surveillance	SDS
Standard deviation	std dev
Standard penetration test	SPT
Total rare earth elements	TREE
Tailings storage facility	TSF
Total rare earth oxides	TREO
United Parcel Service	UPS
US Bureau of Mines	USBM
US Army Corps of Enginers	USACE
United States Forest Service	USFS
Waste Rock Facility	WRF
White Tail	WT
William Rose	WLRC
Work Breakdown Structure	WBS
Work in progress	WIP
Weighted average cost of capital	WACC
Wyoming Department of Environmental Quality	WDEQ
WLR Consulting Inc.	WLRC

Glossary

Ampere (amp)	A
Average percent total rare earth oxide	%TREO
Atmosphere	atm
Billion cubic feet	Bft^3
Chemical Process Simulation Software	ChemCAD
Centimeter	cm
Centimeter per second	cm/sec
Cubic yard	yd^3
Cubic foot	ft^3
Cubic feet per minute	cfm
Degrees	°
Degrees Fahrenheit	°F
Degrees Celsius	°C
Dollars per kilogram	$/kg
Dollars per year	$/y
Dollars per ton	$/t
Dry short tons per day	dstpd
Dry short tons of 2,000 pounds	ton
Ferro-manganese rare earth element	FMR
Feet (‘)	ft
Gallons per minute (US)	usgpm
Gram	g
Gravity (g-force)	g
Gram per cubic centimeter	g/cc
Gram per square meter	g/m^2
Hour	h
Horsepower	hp
Kilo (thousand)	K
Kilogram	kg
Kilometer	km
Kilowatt	kW
Kilowatt-hour	kWh

Kiloamp.. kA
Kilovolt.. kV
Mass Energy Balance Simulation Software ………………….………………… METSIM
Metric ton .... tonne
Metric ton per day .... mtpd
Metric ton per year .... mtpy
Miles per hour .... mph
Mega-annum (million years).. Ma
Million .... MM
Million tons .... MM tons
Microns .... µm
Millimeter .... mm
Milliliter.. mL
Megavolt-ampere .... MVA
Megawatt .... MW
Meter .... m
Ounce .... oz
Percent .... %
Parts per million .... ppm
Pounds per cubic foot .... lb/ft^3
Second .... sec
Square feet .... ft^2
Short tons .... st
Short ton unit .... STU
Short tons per day.. stpd
Short tons per year .... stpy
Square meter .... m^2
thousandth of an inch... mil
United States dollar.. USD
US dollars .... $
Volt V
Weight .... wt
Year .... y
Waste rock/ore... W/Ore

Weight basis .... w/w
US dollars/ore ton .... $/ore ton
Universal Transverse Mervator geographic coordinate system............................ UTM

Light Rare Earth Elements (LREE) include:

Element	Symbol REE	Molecular Wt	REO	Molecular Wt	Ratio REE/REO
Lanthanum	La	138.905	La_2O_3	325.8082	0.8527
Cerium	Ce	140.116	Ce_2O_3	328.2302	0.8538
Cerium	Ce	140.116	CeO_2	172.1148	0.8141
Praseodymium	Pr	140.908	Pr_2O_3	329.8142	0.8545
Neodymium	Nd	144.242	Nd_2O_3	336.4822	0.8574
Samarium	Sm	150.360	Sm_2O_3	348.7182	0.8624

Heavy Rare Earth Elements (HREE) include:

Element	Symbol REE	Molecular Wt	REO	Molecular Wt	Ratio REE/REO
Gadolinium	Gd	157.250	Gd_2O_3	362.4982	0.8676
Yttrium**	Y	88.906	Y_2O_3	225.8102	0.7874
Europium**	Eu	151.964	Eu_2O_3	351.9262	0.8636
Dysprosium**	Dy	162.500	Dy_2O_3	372.9982	0.8713
Terbium**	Tb	158.925	Tb_2O_3	365.8482	0.8688
Erbium	Er	167.259	Er_2O_3	382.5162	0.8745
Holmium	Ho	164.930	Ho_2O_3	377.8582	0.8730
Ytterbium	Yb	173.054	Yb_2O_3	394.1062	0.8782
Thulium	Tm	168.934	Tm_2O_3	385.8662	0.8756
Lutetium	Lu	174.967	Lu_2O_3	397.9322	0.8794

** Rare earths identified as "critical" by the US Department of Energy, Critical Materials Strategy Report (12/11) because of their importance to clean energy economies and associated supply risk. Praseodymium is added because of the use of didymium (Nd + Pr) as a major raw material for NdFeB permanent magnets.

1 Executive Summary

Rare Element Resources, Inc. ("Rare Element" or the "Company"), a wholly-owned subsidiary of Rare Element Resources Ltd., is progressing with technical work at its Bear Lodge rare earths property in Crook County, Wyoming. The purpose of this Preliminary Feasibility Study (PFS) is to provide the Company a preliminary plan for the development of a rare earth element (REE) mining operation at the Bull Hill Mine of the Bear Lodge Project, located in the Bear Lodge Mountains, Crook County, Wyoming, and the processing facility located near Upton, Weston County, Wyoming.

This Preliminary Feasibility Study (PFS) was commissioned to provide a technical report that contains: 1) the mineral reserve and resource model; 2) the technical activities of the rare earth exploration program; 3) establishment of a mineable reserve and an open pit mine plan; 4) a detailed description of mineral concentration and hydrometallurgical processing; and 5) an economic analysis of the rare earth project. These data are presented in this National Instrument 43-101 compliant report titled: "Technical Report on the Mineral Reserves & Development of the Bull Hill Mine". The results of the PFS show that the Bear Lodge Project is technologically feasible with favorable returns on invested capital. Key metrics of the updated PFS are summarized in Table 1.1.

Rare Element will be required to obtain permits to operate the Bull Hill Mine and the Hydromet plant and tailings storage facility from the United States Forest Service (USFS) and the Wyoming Department of Environmental Quality (WDEQ). In addition, a source materials possession license will be required from the United States Nuclear Regulatory Commission (NRC). In accordance with RER's Environmental, Health, and Safety Policy, Rare Element will comply with applicable federal and state environmental statutes, standards, regulations, and guidelines in the permitting of the Bull Hill Mine and Hydromet plant/tailings storage facility (TSF).

The issuance of a permit to mine on USFS land will be a major federal action that is triggered because of the proposed mine's effects on the quality of the human environment in the project area. The permitting process requires the preparation of an environmental impact statement (EIS) under the National Environmental Policy Act (NEPA), Council of Environmental Quality (CEQ) guidelines, and USFS NEPA procedures. The NRC will assess the environmental impacts of the Hydrometplant/TSF under their NEPA requirements.

Roche recommends that Rare Element proceed with a program to prepare a definitive feasibility study. This preparation should include additional investigations within the mine, the PUG and the Hydromet areas of the Bear Lodge Project. In addition, the company should continue to explore the development of individual element separation technology.

Table 1.1 - Bear Lodge Financial Summary and Operating Metrics (US$ Million)

PFS Key Metrics

Initial capital costs (M)	$290
Life-of-mine (LOM) capital costs (M)*	$453
Payback period	2.9 years
Pre-tax / After-tax IRR	32.7% / 28.6%
Pre-tax / After-tax NPV at 10% discount rate (M)	$426 / $330
Mine life / Project life	38 years / 45 years
Low-grade stockpile processing	Years 39-45
Assumed discounted basket price/kg	$24.60

Operating Metrics

	High Grade Processing Years 1 - 9	LOM Average**
Average annual mining rate (M tons/M tonnes)	3.72 / 3.37	3.72 / 3.38
Annual production TREO (tons/tonnes)	8,523 / 7,732	7,510 / 6,813
Mining average grade, % TREO	4.7%	2.8%
Strip ratio (waste to ore)	8.0:1	8.7:1
Physical Upgrade (PUG) Plant recovery rate	92.8%	87.9%
Hydrometallurgical recovery rate	88.3%	89.9%
Overall recovery rate	81.9%	79.0%
Operating cost per ton processed	$413.32	$296.93
Operating cost per kg TREO	$11.75	$15.05
Average annual operating cash flow (after-tax) (M)***	$84.5	$52.4

** Including expansion and sustaining capital*

*** LOM includes 7 years of low-grade stockpile processing*

**** During production years*

(Roche, 2014)

The Bear Lodge Project is located in northeast Wyoming, in a world-class mineralized district rich in the critical rare earths essential for electronics, high-strength permanent magnets, fiber optics, laser systems, and evolving green energy technologies. The Company controls 100% of the mining rights in the Project area.

The Bear Lodge Project consists of three principal components: 1) the small open-pit mine operation at the Bull Hill and Whitetail Ridge deposits and associated support facilities, located approximately 12 miles (19 kilometers) by road north of Sundance, Wyoming; 2) a physical upgrading (PUG) plant for mineral pre-concentration located adjacent to the mine; and 3) a hydrometallurgical (Hydromet) plant, located near Upton, Wyoming, for further concentration of the rare earth elements into a mixed TREO concentrate. The Upton site is approximately 40 miles (64 kilometers) south from the Bull Hill Mine site and is accessible by existing county and state roads. The site is also adjacent to an active transcontinental rail line, which will allow for easy delivery of processing equipment during construction and supplies during operations, as well as delivery of the final product to customers. The expected Project life is 45 years, using the current mineral reserves.

Mining at Bull Hill is planned as a small, conventional truck and shovel, open-pit operation that accesses near-surface mineralization. Mining will be selective to recover high-grade ores from the Bull Hill deposit first to maximize early cash flows and accelerate the payback of capital. Mining will align with the processing capacity, which is planned at an average rate of 220,000 tons (199,600 tonnes) per year in years 1 – 9, increasing to an average rate of 366,000 tons (332,000 tonnes) per year in years 10 – 38. The processing of ore from low-grade stockpiles is expected to continue in years 39 – 45. Waste rock will be stored at an adjacent waste rock facility, located on private land, and reclaimed and re-contoured concurrently with mine operations. The Inferred resource already delineated within the pit boundaries has the ability to improve economic returns.

In years 1 – 9, the PUG plant is scheduled to process high-grade ore, expected to average 4.7% TREO. In years 10 – 45, the mining rate will increase as the grade drops toward the expected LOM average of 2.8%. The increase in production rate is planned to coincide with the start of processing mid-grade and Whitetail Ridge ores. The PUG plant is designed to use a combination of crushing, screening, and gravity separation, depending on the ore type being treated, to reduce the physical mass of the ore by reducing gangue and concentrating the rare earth-bearing fines for shipment to the Hydromet plant. The Bull Hill deposit contains varying proportions of weathered high-grade oxide and oxide-carbonate ores, along with variable grades of stockwork mineralization adjacent to the higher-grade ores. Each of these ore types will have a different mass reduction and upgrade percentage in the PUG circuit. The mineral pre-concentrate produced at the PUG will be transported by covered truck to the Hydromet plant in Upton.

The Hydromet plant is designed to process the pre-concentrate through acid leaching followed by the Company's proprietary recovery technology. This process uses a chloride solution to extract the rare earth elements (REE) into a liquid, and then uses oxalate reagents to facilitate the selective precipitation of the REE. The benefits of this process are that it achieves a high-purity, nearly thorium-free, bulk TREO concentrate, and has the ability to regenerate and recycle a majority of the reagents used in the process, including acid and water.

In the PFS, the rare earth recovery rate is expected to be approximately 88.3% in the Hydromet process over the LOM. The average annual LOM nominal TREO production rate is anticipated to be approximately 7,510 tons (6,813 tonnes). The tailings produced from the processing will be neutralized, dewatered, and stored in an engineered, lined tailings storage facility (TSF) located on private land adjacent to the Hydromet plant.

The Project is sized to balance initial capital requirements and still be a meaningful supplier for current market demand, while minimizing the Project's environmental footprint. The plant is designed to have sufficient flexibility to produce higher tonnages of rare earth concentrates when market conditions warrant, with only minor modifications and optimization of operating parameters.

1.1 Mineral Reserves and Resources

The Company previously announced a Measured and Indicated (M&I) mineral resource of 17.3 million tons (15.7 million tonnes) averaging 3.11% TREO, and an Inferred resource of 29.3 million tons (26.6 million tonnes) averaging 2.58% TREO (see the Company's news release dated March 17, 2014). The additional work done to prepare the PFS resulted in an increase in the M&I resource tons by approximately 4% and a slight reduction of the average grade, from 3.11% to the current 3.05% (using a 1.5% cutoff grade). The current mineral resource is shown in Table 1.2:

Table 1.2 - Bear Lodge Project – Measured and Indicated Resource

Measured and Indicated Resource*

(using a 1.5% cutoff grade)

Deposit	**Tons (M)**	**Tonnes (M)**	**Grade TREO %**	**Contained TREO lbs (M)**	**Contained TREO Kg (M)**
Bull Hill					
Measured	3.0	2.7	3.77	226	102
Indicated	10.7	9.7	3.09	661	300
Total	13.7	12.4	3.24	887	402
Whitetail Ridge					
Measured	--	--	--	--	--
Indicated	4.3	3.9	2.47	212	96
Total	4.3	3.8	2.47	212	96
Project-wide M&I Resource	**18.0**	**16.3**	**3.05**	**1,099**	**498**

The mineral resource estimate is classified as M&I resources, as defined by Canadian Institute of Mining, Metallurgy and Petroleum ("CIM") Definition Standards on Mineral Resources and Mineral Reserves, as of June 30, 2014 using a basket price of $24.60 and is inclusive of proven and probable reserves. Mineral resources were estimated by Alan C. Noble, P.E. of Ore Reserves Engineering (O.R.E.), an independent Qualified Person as defined by NI 43-101. Readers are cautioned that mineral resources that are not mineral reserves do not have demonstrated economic viability. The terms "Measured and Indicated Mineral Resource" are terms recognized and required by Canadian regulations but not by the United States Security and Exchange Commission (SEC). U.S. investors are cautioned not to assume that any part or all of the mineral deposits in these categories will ever be converted into mineral reserves under SEC regulations.

The mine plan used in the PFS is expected to access areas of significantly higher grade within the M&I resource in years 1 – 9 of the Project's life. This reduces the environmental footprint of the Project and reduces the amount of stockpiling necessary, bringing cash flows forward and resulting in an attractive payback period of 2.9 years. A breakout of the high-grade resource is shown in Table 1.3:

Table 1.3 - High-Grade Material in Measured and Indicated Resource

Contained High-Grade in Measured and Indicated Resource*

(using a 3.0% cutoff grade)

	Tons (M)	Tonnes (M)	Grade TREO %	Contained TREO lbs (M)	Contained TREO Kg (M)
Contained High-Grade					
Measured	**1.7**	**1.5**	**4.92**	**167**	**76**
Indicated	**4.3**	**3.9**	**4.45**	**383**	**174**
Total	**6.0**	**5.4**	**4.51**	**550**	**250**

**The contained high-grade material is a subset of the M&I resource as of June 30, 2014 and identified above.*

1.1.1 Mineral Reserve

The mineral reserve is derived from and included as part of the M&I resource. Mineral reserves take into consideration mineability, selectivity, mining loss, and dilution, and identify that portion of the M&I resources economically recoverable under the current development scenario outlined in the PFS. The mineral reserve was calculated in a manner consistent with NI 43-101 standards and is summarized in Table 1.4.

Table 1.4 - Bear Lodge Project Mineral Reserve Estimate

Mineral Reserve Estimate*

(using a 1.5% cutoff grade)

	Grade % TREO	Tons (M)	Tonnes (M)	lbs (M)	Kg (M)
	Proven			**Contained TREO**	
High Grade	5.17	1.4	1.3	145	66
Mid Grade	2.36	1.2	1.1	57	26
Average / Total	**3.87**	**2.6**	**2.4**	**202**	**92**
	Probable				
High Grade	4.13	3.9	3.5	322	146
Mid Grade	1.89	9.1	8.3	343	156
Average / Total	**2.56**	**13.0**	**11.8**	**700**	**302**
	Total				
High Grade	4.41	5.3	4.8	467	212
Mid Grade	1.94	10.3	9.4	400	182
Average / Total	**2.78**	**15.6**	**14.2**	**867**	**394**

**Proven and Probable mineral reserve estimates were determined by Bill Rose, P.E. of WLR Consulting, an independent qualified person as defined by NI 43-101, as part of the Bull Hill Mine design and effective June 30, 2014. Reserves are for the ultimate pit, which includes both the Bull Hill and Whitetail Ridge resources. The mineral resources referenced above in Table 1.2 for the Bear Lodge Project were estimated by Alan C. Noble, P.E. of Ore Reserves Engineering (O.R.E.), an independent Qualified Person as defined by NI 43-101. The mineral resource estimate is the basis for the engineering studies that estimate reserves and is compliant with NI 43-101. SEC Industry Guide 7 does not address reporting of mineral resource estimates.*

Mineable reserves are calculated from an open-pit mine plan prepared by Bill Rose, P.E., WLR Consulting, an independent Qualified Person as defined by NI 43-101. Proven and probable mineral reserves are estimated in compliance with NI 43-101. The mineral reserves stated herein are calculated in accordance with the CIM Standards on Mineral Resources and Mineral Reserves as contemplated in NI 43-101, but are not recognized as reserves under SEC Industry Guide 7.

Since the Company reports mineral reserves to both NI 43-101 and SEC Industry Guide 7 standards, it is possible for the mineral reserve figures to vary between the two standards. Where such a variance occurs, it will arise from the different requirements for reporting mineral reserves. For example, NI 43-101 has a minimum requirement that mineral reserves be supported by a PFS, whereas the SEC Industry Guide 7 requires support from a feasibility study (FS) that demonstrates that reserves can be legally and economically extracted.

1.1.2 Inferred Mineral Resource

Both the Bull Hill and Whitetail Ridge deposits have a significant amount of drill-indicated Inferred resource. While this portion of the resource has greater uncertainty than the M&I resource and is assigned no economic value in the PFS, it represents significant upside opportunity for the project. About one-third of the Inferred Resource is contained within the designed pit and could be recovered during the mining operations currently contemplated in the PFS. The Inferred resource at the project is summarized in Table 1.5.

Table 1.5 - Inferred Mineral Resource within the Bear Lodge Project

Inferred Mineral Resource (using a 1.5% cutoff grade)*****

Deposit	Tons (M)	Tonnes (M)	Grade TREO %	Contained TREO lbs (M)	Contained TREO Kg (M)
Bull Hill	23.9	21.7	2.54	1,212	550
Whitetail Ridge	7.9	7.2	2.71	429	194
Inferred Resource	**31.8**	**28.9**	**2.58**	**1,641**	**744**

** Inferred resources were estimated by Alan C. Noble, P.E. of O.R.E, an independent Qualified Person as defined by NI 43-101. While the term "Inferred Mineral Resource" is recognized and required by NI 43-101, the SEC does not recognize it. Inferred mineral resources have considerable uncertainty as to their existence, and do not have demonstrated economic viability. It cannot be assumed that all or any portion will ever be upgraded into a higher category or recovered, and therefore, they are not included in the PFS evaluation.*

1.1.3 Total Rare Earth Oxide Distribution

The Bear Lodge Project is rich in "critical" rare earths, defined by the U.S. Department of Energy as those most essential to the "clean energy" economy and at the highest risk of supply disruption. These elements include neodymium, dysprosium, europium, terbium, and yttrium. The Company also believes that praseodymium is a critical REE because of its use in association with neodymium in high-intensity, permanent magnets. These elements are expected to experience higher demand growth, as green technologies advance in concert with increasing environmental standards worldwide. The distribution of REEs in the mineral reserve is outlined in Table 1.6 below:

Table 1.6 - REO Distribution in the Bear Lodge Proven and Probable Reserve

Composition of TREO in Proven & Probable Reserve*

	Relative Distribution	% REO in Proven & Probable Reserve
Neodymium (Nd)	17.88%	0.496%
Praseodymium Pr)	4.90%	0.136%
Europium (Eu)	0.68%	0.019%
Cerium (Ce)	43.02%	1.194%
Lanthanum (La)	26.83%	0.745%
Dysprosium (Dy)	0.45%	0.012%
Terbium (Tb)	0.14%	0.004%
Gadolinium (Gd)	1.64%	0.045%
Samarium (Sm)	2.99%	0.083%
Yttrium (Y)	1.30%	0.036%
Erbium (Er)	0.08%	0.002%
Other rare earths	0.09%	0.003%
TREO	**100.00%**	**2.775%**

* Report does not break out estimates for Holmium, Lutetium, Thulium and Ytterbium because they occur in negligible amounts. Values based on mineral reserves estimates listed above and a basket price of $24.60 as of June 30, 2014.

1.2 Geology and Mineralization

The Bear Lodge Mountains of northeastern Wyoming are composed primarily of the upper levels of a mineralized Tertiary alkaline-igneous complex that is a component of the Black Hills Uplift of western South Dakota and northeastern Wyoming. Tertiary alkaline intrusive bodies in the northern Black Hills are located along a N70-80W trending belt that extends from Bear Butte in South Dakota, through the Bear Lodge Mountains, to Devil's Tower and Missouri Buttes in northeastern Wyoming. The Bear Lodge mining district is located in the Bear Lodge Mountains, near the western end of the northern Black Hills intrusive belt (Figure 7.1). The Bear Lodge Mountains expose and are underlain by multiple alkaline plugs, sills, and dikes intruded into Precambrian basement and Paleozoic and Mesozoic sedimentary rocks approximately 38 – 50 million years ago. Rare earth and gold mineralization are found in separate areas of the central crest and northern part of the Bear Lodge Mountains.

Rare earth element (REE) mineralization occurs in the north-central core of the Bear Lodge dome, which consists of multiple intrusions of phonolite, trachyte, and other alkaline igneous rocks, and a variety of associated breccias and diatremes. REE mineralization of the Bear Lodge district is hosted by carbonatite and carbonatite-related intrusive bodies that are similar to other REE-bearing carbonatites scattered around the world. The REE minerals within the mineralized bodies are dominantly REE fluorocarbonates, with subordinate, and generally minor, monazite and cerianite. Ancylite may be an important REE mineral component in the partially oxidized OxCa ore type. The Mountain Pass deposit in California is the largest REE-bearing carbonatite in North America, and it was one of the world's two principal sources of REE metals for many years.

1.3 Exploration

Rare Element's Bear Lodge Project REE exploration activities are focused on three carbonatite-related rare earth resource areas, the Bull Hill, Bull Hill NW, and Whitetail Ridge deposits, and two recently identified exploration target areas, Carbon and Taylor (Chapter 8.0). Several previous exploration target areas were incorporated into the Bull Hill deposit (previously referred to as Bull Hill SW), including Bull Hill West, Bull Hill Southwest Extension, and the Carbonatite Plug (or deep Bull Hill West). Geological characteristics of the REE deposits and new targets are reviewed in Chapter 8.0, and locations are provided in Figure 8.1. The Company's exploration activities at the Bear Lodge Project are summarized in Chapter 9. Currently, exploration activities in target areas peripheral to the Bull Hill-Whitetail pit are limited to surface exploration, including detailed geological mapping and geochemical/geophysical surveys to better define target concepts. An updated grade-thickness model by ORE incorporates drilling results for the Bear Lodge REE project through 2013.

1.4 Deposit Types

The Bull Hill deposit consists of an REE-mineralized carbonatite dike swarm and associated enveloping stockwork zones located within and along the western margin of the Bull Hill diatreme. Near-surface iron oxide-manganese oxide-rare earth (FMR) and oxide-carbonate (OxCa) dikes and veins are interpreted to be intensely (FMR) and moderately to weakly (OxCa) oxidized and leached equivalents of the carbonatite dikes at depth.

The Whitetail Ridge deposit is located approximately 1,500 feet (460 meters) northwest of the Bull Hill deposit and approximately 500 to 1000 feet (150 to 300 meters) west of the Bull Hill Northwest deposit.

The Whitetail Ridge deposit is characterized by about a 2.5X enrichment in overall HREE element grade relative to the Bull Hill resource, which adds potential economic upside to the Bear Lodge Project. The deposit remains open, and further drilling is expected to expand the resource and better define the extent of the REE mineralization.

1.5 Physical Upgrading Plant

The PUG plant is designed to use a combination of crushing, screening and gravity separation, depending on the ore type being treated, to reduce the physical mass of the ore by reducing gangue and concentrating the rare earth-bearing fines for shipment to the Hydromet plant. The Bull Hill deposit contains varying proportions of weathered high-grade oxide and oxide-carbonate ores. Each of these ore types will have a different mass reduction and upgrade percentage in the PUG circuit. On average, the PUG recovery is expected to be 92.8% in years 1-9 and 87.9% over the LOM. The mineral pre-concentrate produced at the PUG will be transported by covered truck to the Hydromet plant in Upton.

1.6 Hydrometallurgical Plant

The Hydromet plant is designed to process the pre-concentrate through acid leaching followed by the Company's proprietary recovery technology. This process uses a chloride solution to extract the rare earth elements (REE) into a liquid, and then uses oxalate reagents to facilitate the selective precipitation of the REE. The benefits of this process are that it achieves a high-purity, near thorium-free, bulk TREO concentrate and has the ability to regenerate and recycle a majority of the water and reagents used in the process.

The rare earth recovery rate in the Hydromet process in years 1 – 9 is expected to be 88.3 % and approximately 89.9% over the LOM. The average annual LOM nominal TREO production rate is anticipated to be approximately 7,510 tons (6,813 tonnes), with years 1 – 9 averaging 8,523 tons (7,732 tonnes). The tailings produced from the processing will be neutralized, dewatered and stored in an engineered, double-lined tailings storage facility located on private land adjacent to the Hydromet plant.

1.7 Capital Expenditures

In part because of the extensive existing infrastructure for transportation, energy, water and services initial start-up capital is estimated to be a relatively low $290 million. The life-of-mine capital cost for the Project, including sustaining capital, later phases of tailings construction, PUG and Hydromet expansion in Year 10 and closure costs, is estimated at $453 million. This includes start-up capital and a capital cost contingency that averages 18.8% on initial capital and 14.6% on sustaining capital. Initial expenditures of approximately $12 million are anticipated for infrastructure, including improving access roads, upgrading power and constructing the water supply facilities. Capital expenditures are summarized in Table 1.7 below.

Table 1.7- Capital Expenditures

(USD Millions)	Initial Capital	Sustaining Capital	LOM Capital
Mining	$57.9	$45.4	$103.4
PUG plant	8.0	36.8	44.8
Hydromet & tailings storage	126.2	20.9	147.0
Engineering and commissioning	30.1	12.2	42.3
Infrastructure	11.9	6.0	17.9
Owners costs & other	9.2	4.3	13.5
Closure costs	--	16.5	16.5
Total Direct and Indirect Costs	243.3	142.1	385.4
Contingency	47.1	20.8	67.9
Total	**$290.4**	**$162.9**	**$453.3**

1.8 Infrastructure

The project area is located 7 air miles or 12 road miles (11 or 19 kilometers) northwest of the town of Sundance, Wyoming, which is on US Interstate Highway 90, and 22 air miles (35 kilometers) west of the South Dakota state line.

The REO direct shipping ore or pre-concentrate will be shipped from the mine approximately 40 miles (64 kilometers) south along State Highway 116 to Upton, Wyoming. Tailings generated from beneficiation will be disposed in close proximity to the Hydromet plant.

All necessary infrastructure, such as housing, food, fuel, skilled labor, mining supplies, etc., would be available in the nearby towns, or further to the west in Gillette or to the southeast in Newcastle. Water rights at the mine site are available through permits issued by the Wyoming State Engineer's Office. The water supply at the hydrometallurgical plant is available from the City of Upton. At the mine site, a power line, which will be upgraded, runs to within a mile of the project area. Electrical power would be initially supplied by diesel generated power and eventually by the Powder River Energy Corporation (PreCorp) starting in year 10 of operation. Power costs are reported to be some of the lowest in the United States. Power for the hydrometallurgical site will be fed from a sub-station at a nearby industrial park.

Supplies can be trucked to the site 60 miles (100 kilometers) from Gillette, which is located on both US Interstate Highway 90 and rail lines. A Burlington Northern rail transport line is also located at Moorcroft, 34 miles (54 kilometers) west of Sundance, and at Upton, 40 miles (64 kilometers) south. The Powder River Basin is one of the world's major coal mining regions and it contains multiple large mines and two coal-fired power plants. Gillette, the largest city in the basin, would be a major logistics center for any development at the Bull Hill Mine. The current size of the total mine site property controlled by unpatented mining claims and one leased section is approximately 15 square miles (39 square kilometers) and is sufficiently large to support a mining operation, with no foreseeable obstacles regarding expansion. The hydrometallurgical site is located on approximately 400 acres (160 hectares) of private land west of the city of Upton adjacent to an existing industrial park.

1.9 Operating Costs

In years 1 – 9, the average total annual operating cost is estimated at $91 million, assuming a nominal processing rate of 220,000 tons (199,600 tonnes) per year of high-grade feed to the PUG plant, producing an average 8,523 tons (7,732 tonnes) per year of bulk TREO concentrate. In years 10 – 38, the average total annual operating cost is estimated at $111 million assuming a nominal production rate of 366,000 tons (332,000 tonnes) per year of feed to the PUG plant and production of 7,700 tons (6,985 tonnes) per year of bulk TREO concentrate per year. Previously stockpiled ores will be processed in years 39 – 45, with an average total annual operating cost estimated at $83 million, assuming an average feed rate of 423,000 tons (383,700 tonnes) and average production of 5,423 tons (4,920 tonnes) per year. While included in the economic evaluation, estimated applicable property and severance taxes are not included in the operating costs in Table 1.8

Table 1.8 - Operating Costs

	Years 1 - 9		LOM		
	Cost/Ton Ore Processed	Average Cost/Kg TREO	Cost/Ton Ore Processed	Average Cost/Kg TREO	LOM Total (M)
Mining	$69.83	$1.99	$42.98	$2.18	$668
PUG	20.39	0.58	21.56	1.09	335
Hydromet & tailings storage	292.03	8.30	212.68	10.78	3,306
G&A & road maintenance	31.08	0.88	19.71	1.00	306
Total	**$413.32**	**$11.75**	**$296.93**	**$15.05**	**$4,615**

1.10 Environmental and Permitting

The Company continues to support the United States Forest Service (USFS) efforts to prepare an Environmental Impact Statement (EIS) on the Project in accordance with the National Environmental Policy Act (NEPA) process. This process is key to securing the permits and approvals necessary to move into production. In early 2012, the Company submitted the Plan of Operations for the Project to the USFS, and it was accepted as complete in May 2013. Since then, the USFS has selected a Project Manager and prime contractor for preparation of the EIS, published notice in the Federal Register, and completed necessary scoping work. The USFS is currently working on the evaluation of the public comments, identification of alternatives, and preparation of the draft EIS. The US Army Corps of Engineers and the appropriate state and local government agencies are involved in the EIS process as cooperating agencies. The schedule, as distributed by the USFS in its scoping documents, calls for completion of the draft EIS in the first quarter of 2015 and the final EIS by mid-2015. The final Record of Decision (ROD) for the EIS, the decision document that establishes the acceptable operating conditions, is expected in the fourth quarter of 2015.

The Company will need to obtain a mining permit from the Wyoming Department of Environmental Quality – Land Quality Division. Additionally, the Company will need various permits or approvals from a number of other federal, state, and local agencies. The Company is pursuing those permits/approvals on a parallel path with the work currently being done on the EIS, where possible.

1.11 Production Timeline

The Company will incorporate the results of the PFS, as well as Project engineering, budgets, schedules, and other information into a Feasibility Study (FS), expected to begin, pending board approval, before the end of the year. Given the anticipated timing of the FS commencement, the Company could complete construction and begin commissioning the Project as early as late 2016, subject to permitting, financing, and other factors. The Company is reviewing all Project variables and expects to have updates to the anticipated schedule for the Bear Lodge Project in the fourth quarter of 2014.

1.12 Markets and Pricing

Because of their unique magnetic, catalytic and phosphorescent characteristics, rare earths are expected to continue to be essential elements in the next generation of a wide variety of technological advancements. Current projections from a variety of leading industry analysts call for an average of 7% to 8% per annum growth in demand from 2013 to 2020, with the fastest demand growth coming from magnet, metal alloy and catalyst uses of rare earths. The Company anticipates that this expected growth in demand, coupled with the factors listed below, will support a case for higher rare earth prices, both in the near- and long-term:

- Recent financial results from several of the six state-owned firms now consolidating the rare earth industry in China have been poor, suggesting there may be some pressure for these dominant producers to raise prices;

- Chinese production costs are escalating, particularly for labor, safety, and environmental protection, with some industry observers estimating that prices need to rise by 20% to offset environmental cost increases alone;
- The Chinese government has announced purchase prices for a domestic stockpiling program of certain rare earths that could reduce available supplies. The premiums to current market prices vary by element, but reports indicate that the Chinese government is expecting to pay an overall premium of approximately 10% above current prices;
- Demand growth projections by industry analysts indicate that China, which currently consumes approximately two-thirds of the global rare earths supply, may be a net importer of many rare earths by 2020;
- Geopolitical considerations, increasing environmental regulations, remote locations and high capital requirements for many potential new rare earth projects may serve to limit new supply. Research and development efforts for new uses of rare earths are expected to accelerate, driven in part by manufacturers having access to secure, non-Chinese rare earth sources, like the Bear Lodge Project.

To establish the assumed prices for the PFS, the Company used the trailing 12 months (TTM) Chinese export values for individual rare earth oxides, derived from the latest available customs statistics through June 2014, as reported by Metal-Pages, a UK-based firm that reports on metals trading across numerous sectors. Customs statistics report the value of goods exported based on actual market transactions and, as a result, provide empirical data on the underlying market prices. The assumed prices for gadolinium and samarium are based on published spot “FOB China” prices as reported by Metal-Pages, because no custom statistics are available. These spot prices are based on Metal-Pages’ survey of market participants and, according to some market sources, can differ significantly from realized prices, since most rare earths sales are done under private contracts.

For the PFS, the Company discounted certain of these individual rare earth oxide export values further (including cerium, europium and praseodymium) to account for current market conditions. Most significantly, the Company reduced the reported value for dysprosium by two-thirds to temper the impact of significant spikes in export values that occur in periods of high seasonal demand and that could be expected to diminish when alternative sources of dysprosium are developed.

The PFS prices then assume a 25% discount to the weighted average basket price of the Project's planned production to account for further costs to separate the high-quality, mixed TREO concentrate into individual rare earth oxides. Most of the transactions within the rare earth industry are done under private contract, and pricing information is of limited transparency, thus exact information on separation costs is unavailable. To arrive at the discount used in the PFS, the Company surveyed a number of market sources that suggested a discount of 20% to 30% was appropriate for the Company's 97+% pure TREO concentrate. As another reference point, the Company calculated a blended tolling charge, based on reported tolling charges in the rare earth market of $5.00/kg for light rare earth concentrate and $20 - $25/kg for heavy rare earth concentrates. Based on the Company's rare earth distribution, this blended charge is estimated at approximately $5.50 - $5.70/kg.

As a final data point, the Company investigated the historical monthly average pricing differential between rare earth concentrate and oxide, using the limited publicly available pricing data. Metal-Pages regularly quotes prices for only one rare earth concentrate, a 45% TREO cerium carbonate concentrate. The Company compared this with the 99% cerium oxide price using FOB China prices from the same source. Using the historical quoted prices for the two-year period ending June 2014, the average monthly price differential was 25.2%.

Given the opaque nature of much of the rare earths market and the limitations of the pricing methodologies noted above, Rare Element Resources took an empirical approach to the assumed rare earths pricing for this preliminary feasibility study. The prices of certain RE elements were revised downward significantly to take into account continuing weak RE market conditions.

Based on the evaluation methods identified above, the prices and rare earth distribution used in the PFS are outlined in Table 1.9.

Table 1.9 - TREO Product Pricing Used in PFS

Based on average LOM Project Output

Element	Recovered Distribution / Kg TREO (g/kg)*	Adjusted TTM Export Value / kg	Value / kg
Neodymium (Nd)	182	$71.26	12.97
Europium (Eu)**	7	$948.23	6.64
Praseodymium (Pr)**	50	$96.97	4.85
Dysprosium (Dy)**	4	$654.87	2.62
Lanthanum (La)	283	$6.77	1.91
Cerium (Ce)**	416	$4.54	1.89
Terbium (Tb)	1	$745.32	0.75
Gadolinium (Gd)	16	$46.50	0.74
Yttrium (Y)	10	$22.14	0.22
Samarium (Sm)	30	$5.50	0.17
Erbium (Er)	1	$50.36	0.05
	1,000 g	**Price / kilogram**	**$32.81**
After Discount 25%			**$24.60**

**Reflects concentrate grade, adjusted for anticipated recoveries and is based on a discounted basket price of $24.60/kg. Resources, reserves and economics were all calculated using a $24.60/kg basket price; however, elemental distribution and prices vary between resource models and the PFS economic model. Excludes ytterbium, holmium, thulium and lutetium that occur in negligible amounts and were not considered in the calculation of a basket price.*

***Adjusted downward to reflect current market conditions*

1.13 Sensitivity Analysis

The PFS includes a sensitivity analysis on the key factors of the Bear Lodge Project which are outlined in Table 1.10:

Table 1.10 – NPV Sensitivity Analysis (Based on pre-tax NPV)

(USD Millions)	Rare Earth Prices			Operating Costs			Capital Cost		
NPV	**-20%**	**Base**	**+20%**	**-20%**	**Base**	**+20%**	**-20%**	**Base**	**+20%**
@ 8% Discount	$176	$563	$949	$771	$563	$355	$624	$563	$502
@ 10% Discount	$117	$426	$735	$587	$426	$264	$483	$426	$368
@ 12% Discount	$73	$327	$581	$456	$327	$197	$381	$327	$272

There are numerous risks to the financial viability of the project, as discussed below. As such, sensitivity analysis is performed to assess the impacts on the financial results of the project, given variations in these risk factors.

1.14 Risks

The global market and price for rare earth minerals is not as large or well established as it is for commodity minerals. The rare earths industry is dominated by Chinese producers and consumers with virtually all sales and purchases of rare earths products based on contract prices negotiated privately by buyers and sellers. There are a few relatively well-known sources of published estimated prices that are based on surveys of market participants by the websites or organizations that publish them. These include metal-pages.com, asianmetal.com and "Industrial Minerals" magazine. However, prices for individual RE elements among these sources can differ markedly even in the same timeframe and, according to some market participants, prices for actual market transactions in rare earths sometimes differ significantly from the prices quoted by these sources.

There are some specialized consulting firms in rare earths or industrial minerals that perform market studies in the rare earths business and create rare earths price forecasts for clients based on the individual project's rare earths distribution and intended products. These organizations tend to use conventional mineral economics approaches to forecasting, based on historical experience in the rare earths markets and the limited information available. Such studies and forecasts are hindered by the lack of information in rare earths markets that lack the transparency that can be found in many other markets for the more common mineral commodities. The relatively recent start-up of newly created rare earths exchanges provides extremely limited data on exchange trades of certain physical RE metals, and there is no futures market or forward price curve for rare earths that could inform RE price forecasting.

Because of the comparatively narrow markets for REs, or REOs they cannot be considered commodities, and their markets may be subject to conditions and manipulations that would not be present in established commodity mineral markets.

Mineral markets are assumed to be volatile, thus currently unforeseen price level changes are possible and could have a significant impact on the financial results of the project.

The Company currently does not have off-take agreements for the sale of the REO concentrate. Several rare earth separation facilities have been identified as potential customers.

On January 21, 2014, the Company announced the filing of a utility patent for rare earth processing technology that produces thorium free, pure rare earth concentrate.

The process was developed and tested successfully in both bench and pilot scale programs within the last year. These test programs were conducted at the SGS Laboratories in Lakefield Ontario Canada.

Technology risks include the optimization of these technologies and their associated economics. Detailed engineering of several of the infrastructure and support facilities has not been completed. Remaining engineering tasks include the development of a raw water supply system and water rights at the mine site, establishment of access road easements along the county road, and the final power line routing to the mine site. These details will be finalized in the Feasibility Study.

One of the important project risks is with timely completion of the environmental and permitting process. The procedures for obtaining a mining permit from the Wyoming Department of Environmental Quality (WDEQ) are well established.

The Environmental Impact Statement (EIS) process is also well established in the National Environmental Policy Act (NEPA), which is the formal process to review the impact of proposed mining activities on federal public lands. A Plan of Operations was submitted to the United States Forest Service in 2012 and outlines the proposed disturbance and impacts associated with the project. This plan was accepted as complete in May 2013. While the Company is actively continuing to establish the environmental baseline conditions, there is a risk that the final Record of Decision (ROD) could be denied, contain conditions that would adversely affect the project economics, or be challenged. The Company is developing extensive impact studies and will establish the best available mitigation measures to meet or exceed regulatory agency requirements.

1.15 Further Project Opportunities

The Company has identified additional areas to optimize the Project to capture both technological and economic upside. The PFS identifies these, and the Company plans to incorporate them into the FS. Some of these opportunities include:

- *Enhanced Thorium Removal/Lower Costs from Proprietary Processing Technology* – Subsequent bench-scale testing has demonstrated the ability to eliminate detectable thorium within the final product by adjusting certain variables within the Company's proprietary process. The Company continues to evaluate this work and is looking at conducting larger-scale testing in the coming months. Additional opportunities to reduce costs include the adjustment of process variables and the investigation of selective removal of the lesser-valued rare earths early in the Hydromet process.
- *Rare Earth Separation as a Means to Participate More Fully in the Value Chain* – Initial studies indicate that the very high purity of the Company's concentrate should lend itself to lower cost separation by eliminating the need for the circuits required to remove impurities. The Company is investigating available alternatives to determine the costs/benefits of incorporating downstream separation into its business model.
- *Inferred Resource Within Pit Outline* – The 31.8 million tons (28.9 million tonnes) of Inferred mineral resource with an average grade of 2.58% TREO (using a 1.5% cutoff) was not considered in the economic evaluation in the PFS. Of this inferred resource, one-third, or approximately 11 million tons falls within the boundaries of the designed pit and could be recovered during mining. This material is currently defined as waste in the Project model. Recovery of any portion of this inferred mineral resource could reduce the stripping ratio; extend the high-grade mining period, and increase production, mine life, and revenues.
- *Additional Exploration Targets* – Geological, geochemical, and geophysical work, along with limited drilling, have identified a number of additional targets within the Project boundaries. Two of the most promising are the Taylor and Carbon areas, owing to their demonstrated enrichment in heavy rare earth elements (HREE; see Rare Element Technical Reports - Noble et al, 2013; Larochelle et al, 2012; and the Rare Element News release dated August 4, 2011). Higher HREE content can have a positive impact on revenues, because HREEs' generally command a higher price per kilogram. Further exploration on these targets is not currently planned until mining operations are established.
- *Capturing By-Product Mineral Value* - Mineralization at the Bear Lodge Project contains potentially valuable by-products, such as manganese, iron, magnesium, and

gold. If any of these can be economically recovered through the Hydromet plant, they could represent additional revenue for the Project.

- *Sale of Process By-products* – The current process will produce streams of ammonium nitrate, calcium chloride and thorium rich precipitate. If market studies indicate a market for these by-products, they could represent additional revenue for the project.

2 Introduction

2.1 Project Background

Rare Element is continuing with technical work directed toward development of its Bear Lodge Project in order to:

- Define and expand Measured and Indicated (M&I) near-surface oxidized high-grade rare earth element (REE) resources in the Bull Hill and Whitetail areas to provide the resource base for development of an open pit mining operation;
- Design a physical upgrading (PUG) process that provides adequate recovery and sufficiently high grades of REE mineral pre-concentrate for further processing in a hydrometallurgical plant;
- Refine and test on a larger pilot plant scale a proprietary hydrometallurgical process that economically recovers the REE minerals, dissolves the REEs, and precipitates a bulk mixed rare earth oxide (REO) concentrate for sale;
- Consider the capital and facilities required for possible future separation of REEs into individual REO for sale of value-added products;
- Establish the extent of REEs contained in lower-grade stockwork mineralization adjacent to high-grade dikes and their suitability to provide feed to the PUG plant;
- Expand and define resources enriched in HREES in the Bull Hill West, Taylor, and Carbon target areas.

In 2013, Rare Element further transitioned from exploration and evaluation to a development focus that emphasizes environmental studies, metallurgy, chemistry, and engineering. A proprietary processing technology was developed on a bench and pilot scale for mineralized material processing. A summary of this proprietary process was reported in a news release dated 4 March 2013, and a utility patent application was filed with the US Patent Office. Data from testing performed by SGS, Lakefield in 2013 and 2014 was used to estimate capital and operating costs. Various detailed engineering studies were accomplished to determine a mining method, and to identify and validate facility sites. A contractor will soon be selected to complete a Feasibility Study.

The Bear Lodge Project is held by Rare Element Resources, Inc. (formerly Paso Rico (USA), Inc.), a wholly owned subsidiary of Rare Element Resources Ltd. For purposes of this report, Rare Element, the Company, or RER refers to Rare Element Resources, Inc., a Wyoming U.S. company, which is the legal entity conducting business in the United States and also the employer of all US-based Company consultants, contractors, and employees.

2.2 Rare Earth Element Background Information

Rare earth elements are key components of green energy technologies and other high-technology applications. Some of the major applications include: hybrid automobiles, plug-in electric automobiles, advanced wind turbines, nickel-metal-hydride batteries, computer hard drives, magnetic refrigeration technologies, compact fluorescent light bulbs, metal alloys, additives in ceramics and glass, fluid and petroleum cracking catalysts, and a number of critical military uses. China currently produces approximately 86% of the 136,714 tons (124,000 tonnes) of rare earths consumed annually worldwide, and China has been reducing its exports of rare earths each year. The rare earths market is growing rapidly at 7 to 10 percent per year and is projected to accelerate further, if green technologies are implemented on a broad scale.

2.3 Purpose and Basis of Report

The purpose of this document is to provide a Pre-feasibility Study (PFS), and an updated mineral resources and reserve estimate for rare earth deposits in the Bull Hill area within the Bear Lodge Project, located in Crook County, Wyoming. The updated resource estimate is based on development and exploration drilling conducted by the Company at both the Bull Hill and the Whitetail Ridge deposit in 2013 and supersedes the resource estimate reported in an NI 43-101 compliant Technical Report issued in June 2013. This technical report includes summaries of the following:

- Characteristics of the geology, mineralogy, and ore controls of REE mineralization;
- Opportunities for expansion of M&I resources, and definition and discovery of additional HREE-enriched resources;
- Updated drilling data and estimate of resources through December 2013;
- Results of updated metallurgical testing and pilot plant results;
- An open pit mine plan and production schedule which further define minable reserves;
- A summary of environmental programs and applications employed to minimize the impact and provide the appropriate mitigation measures;
- Designs of processing facilities and infrastructure;
- Economic evaluation of mining and processing activities, including capital and operating costs and cash flow analysis; and

- A description of all other technical activities to date related to the development of the Bear Lodge Project.

The updated resource model has a defined study area on and around Bull Hill and Whitetail Ridge, where drilling data are included from the 2008 program through 2013. The REE deposits within the boundaries of the study area are the principal focus of this report, but the immediate surrounding area will be the focus of future exploration for REE mineralization by the Company.

This report was prepared using published information, unpublished Company reports, and data generated by the Company's employees, consultants, and contractors.

Prior NI 43-101 Technical Reports are entitled:

- "Technical Report on the Mineral Reserves and Resources and Development of the Bull Hill Mine", May 2, 2013 as amended on June 26, 2013, by Primary Author Alan C. Noble, P.E., Jaye T. Pickarts, P.E., and Richard K. Larsen, RMSME. (TR, June 2013).

- "Technical Report on the Mineral Reserves and Development of the Bull Hill Mine, a National Instrument 43-101 Report," by Primary Author Eric F. Larochelle, Eng., Alan C. Noble, P.E., Michael P. Richardson, P.E., Jaye T. Pickarts, P.E., Donald E. Ranta, Ph.D dated April 2012 and prepared by Roche Engineering Inc. (TR, April 2012).

- "Technical Report: Preliminary Economic Assessment (Scoping Study) of the Bear Lodge Rare-Earths Project—A National Instrument 43-101 Report, Crook County, Wyoming," by Michael P. Richardson, P.E., Alan C. Noble, P.E., Ron Roman, PhD, P.E., James G Clark, PhD, LGeo, dated November 2010 and prepared by John T. Boyd Company for Rare Element Resources Ltd.
- "Technical Report on the Bear Lodge Rare-Earths Property, Crook County, Wyoming – USA," by Alan C. Noble, P.E., James G. Clark, PhD, LGeo, and Donald E. Ranta, PhD, CPG, dated May 9, 2009 and prepared by Ore Reserves Engineering for Rare Element Resources Ltd.

- "Geological Exploration Report of the Bear Lodge Rare Earth Property, Crook County, Wyoming – USA," by Brian H. Meyer, P.Geol, dated September 30, 2002 and prepared by an independent geologist for Paso Rico Resources Ltd. (now known as Rare Element Holdings, Ltd.), which is a wholly owned subsidiary of Rare Element Resources Ltd.

Significant additions in all sections of this technical report contain previously unreported data.

As a part of the studies described in this technical report, work was performed on geologic evaluation, drilling and assaying, and resource estimation.

This technical report incorporates existing information from Rare Element files and considerable new drilling data from the 2013 drilling program that augments drilling data from the 2008 through 2012 exploration and drilling programs. The information is compiled in a digital drill hole database, complete with assays and geological information. In addition, the data includes thousands of pages of documents and other data gathered during nearly 40 years of exploration activities in the Bear Lodge district. Historic paper documents include supporting assay data for drill holes, surface geology, geochemistry, geophysical surveys, mineralogical and petrographic studies, geological interpretations, metallurgical testing, technical correspondence, and scientific publications. Much of the project information is in electronic format that allows for ease of use and analysis.

This technical report utilizes the results of current and recent exploration activities conducted by Rare Element, as well as the activities and results documented in previous reports compiled by geologists of mining companies formerly involved in the exploration of the property prior to the Company's involvement. These data include published institutional reports, such as the USGS and USBM investigative studies conducted over the same area of interest. The data referenced in this report are from the early 1970s through 2013. They are taken from reports prepared by Duval Corporation, Molycorp, FMC Corporation, Coca Mines Inc., Hecla, Newmont Exploration Limited, Phelps Dodge, Paso Rico (USA), and Rare Element. These data are included in the archival information provided by Rare Element. All related and pertinent referenced information are listed in Chapter 27 – References.

Peter Dahlberg P.E., General Manager, Roche Engineering is the primary author of this report and has reviewed and supervised the preparation of all sections of the report. Alan C. Noble, P.E. of Ore Reserves Engineering (O.R.E.) prepared the new resource model and William L. Rose, P.E. of WLR Consulting Inc., prepared the new mine plan and reserve estimate. Jaye T. Pickarts, P.E. Chief Operating Officer of

Rare Element, and Jeff Jaacks, Geochemical Applications International Inc., contributed to certain sections of this Technical Report on the Bear Lodge property. The drill hole database was verified independently by ORE, which frequently undertakes mineral property studies. ORE is familiar with the CIM mineral resource/reserve definitions and disclosure requirements of NI 43-101, to which the mineral resource and reserve classifications in this report conform.

Roche Engineering, O.R.E., Geochemical Applications International Inc, and WLR Consulting Inc. do not have any direct pecuniary or contingent interests of any kind in Rare Element or its mining properties. Roche and other consultants are to receive fees for their work based on time expended, expenses incurred, and their respective fee schedules.

2.4 Authors and Participants

This technical report was compiled and edited by Peter Dahlberg, P.E., General Manager of Roche Engineering, who is qualified as an Independent Qualified Person for the purpose of Canadian NI 43-101, Standards of Disclosure for Mineral Projects. All four of the authors - Noble, Rose, Jaacks, and Pickarts - observed the district geologic setting, the physical setting, and existing site conditions, and reviewed selected core sample intercepts of the REE mineralization. Peter Dahlberg is the primary author of this technical report and has reviewed and supervised the preparation of all sections of the report. Table 2.1 presents the authors of the report.

Table 2.1 - Qualified Persons for the Bear Lodge Project NI 43-101 Technical Report

Qualified Person	Company	Chapters	Has Visited the Property?
Peter Dahlberg	Roche Engineering	1,2,3,12,13,17,18,21,22,23,24,25,26,27	Yes
Alan C. Noble	Ore Reserves Engineering	7,8,9,10,14	Yes
William L. Rose	WLR Consulting Inc.	15,16	Yes
Jeffrey Jaacks PhD	Geochemical Applications International Inc.	11	Yes
Jaye T. Pickarts	Rare Element Resources	4,5,6,19,20	Yes

(Roche, 2014)

Mr. Dahlberg and Mr. Rose last visited the site in June 2014 and Mr. Noble last visited the Bear Lodge property in August 2014. Jeffrey Jaacks last visited the property in May 2014 and Jaye Pickarts visited the property numerous times beginning in 2010 and continuing into 2014, most recently in August 2014. During 2010 and continuing into 2013, Mr. Pickarts contributed in the preparation of metallurgical test programs and baseline environmental studies on the Bear Lodge Project. In 2011, he became the Company's Chief Operating Officer, and he thereafter managed and supervised all of the site engineering programs for the project.

Rare Element provided staff support and assistance by drafting certain figures incorporated in the report (as credited below each illustration) and aiding in the final assembly of the report. A number of figures drafted by ORE are also used in the report.

2.5 Terms of Reference

A portion of the overall REE resources are categorized as Measured and Indicated mineral resources. It is recognized that further infill drilling and testing are needed to place additional Inferred resources into higher reliability categories (i.e., Measured and Indicated resources) to extend mine life.

Where metric units are used, such is noted; and they are usually within parentheses. For the purpose of this report, the term "ppm" will refer to parts per million. See Glossary of Terms for other conversion factors.

Other abbreviations and terminology used in this report include those below and as set forth in the Glossary of Terms:

- IRR—The internal rate of return on an investment or project is the annualized effective compounded return rate or rate of return that makes the NPV of all cash flows from a particular investment equal to zero.
- NPV (Rate) —Net present value of a time series of cash flows both incoming and outgoing, is defined as the sum of the present values of the individual cash flows. The NPV of a sequence of cash flows takes as input the cash flows and a discount rate (Rate) and outputs a return of dollars above the discount rate.

- PUG—Physical Upgrade. Refers to the Physical Upgrade process or facility. The Physical Upgrade process uses mechanical equipment to upgrade the REE content of the ore, reducing the amount of gangue material in the pre-concentrate.
- RE—Rare-earth. See REE.
- REE—Rare-earth elements. Used particularly in reference to describing the 15 lanthanide elements (+ yttrium) as a group; also the total elemental content of rare-earth elements.
- REO—Rare-earth oxides or TREO - Total Rare-earth oxides. This common convention refers to the total rare-earth content (+ yttrium) generally from assay results, but quantities are expressed as the oxides of the REE (i.e., %REO).

3 Reliance on Other Experts

3.1 Introduction

The opinions expressed in this report are based on the available information and the interpretations, as supplied by Rare Element and third party sources, which were available at the time of this report. Peter Dahlberg P.E., General Manager, Roche Engineering is the primary author of this report and has reviewed and supervised the preparation of all sections of the report. Alan C. Noble, P.E. of Ore Reserves Engineering prepared the new resource model and William L. Rose, P.E. of WLR Consulting Inc., prepared the new mine plan and reserve estimate. Jeffrey Jaacks, PhD of Geochemical Applications International Inc. prepared the section on sample preparation, analysis and security. Jaye T. Pickarts, P.E. Chief Operating Officer of Rare Element, contributed to certain sections of this Technical Report on the Bear Lodge property. The report authors exercised all due care in reviewing the supplied information and believe that the basic assumptions are factual and correct, and that the interpretations are reasonable. Assumptions, conditions, and qualifications are as set forth in the body of this report.

This report was prepared using public and private documents, as well as data collected by various consultants on the Company's behalf. Reasonable care was taken in preparing this report; however, the authors cannot guarantee the accuracy or completeness of historic supporting documentation.

Estimates of mineral reserves and resource estimates require a high degree of assurance in the underlying data when the estimates are made. Unforeseen events and uncontrollable factors can have significant adverse or positive impacts on the estimates. Actual results may differ from estimates. The unforeseen events and uncontrollable factors include: geological uncertainties, including inherent sample variability, metal price fluctuations, variations in mining and processing parameters, adverse changes in environmental or mining laws and regulations and inflationary factors affecting cost estimates. The timing and effects of variances from estimated values cannot be accurately predicted. All associated economic projections are considered preliminary.

3.2 Exploration and Geology Data

Although ORE independently reviewed some of the drill hole and assay data, the accuracy of the results and conclusions from the review rely on the accuracy of the data as supplied by Rare Element. ORE relied on the supplied information and has no reason to believe that any material facts were withheld, or that a more detailed analysis may reveal additional material information. ORE did not undertake a program of independent sampling, drilling, or assaying.

The identification of mineralized subsurface rare earth intercepts is based on Rare Element's drilling from 2008 through 2013. The Company's drilling conducted from 2004 through 2007 was not used for any resource or reserve estimation, owing to its lack of precise collar and downhole survey data. In outlying parts of the district some historic drill hole data from Hecla and, to a lesser degree, from Duval Corporation and Molycorp, provide subsurface mineralization intercepts that are considered exploration targets for follow-up by the Company. The pre-2004 drilling was done prior to the inception of NI 43-101 standards and regulations. While the drill hole data were generated by experienced exploration companies that used contractors and laboratories recognized to have high standards at the time none of these data are used directly in the RER resource estimate. Where other supporting documentation was cited in this report, a reference for each source of information is found within Chapter 27 – References. The authors have borrowed freely from all sources cited, and specific citation is used only where necessary to emphasize a point.

With respect to the above-mentioned exploration reports, the authors cannot verify the professional qualifications of those involved in the preparation of such. However, the general thoroughness of each company's exploration program, and the relative consistency of comparative assay values from company report to company report, and including those from the USGS, indicate an apparent quality of work that is acceptable for the purpose of this report.

3.3 Land and Property Data

The land status information in Chapter 4 – Property Description and Location was provided by Rare Element. This information was reviewed by Jaye Pickarts, P.E. Chief Operating Officer, and Jerome Bensing, consulting landman, and appears to be reliable, based on the documents examined. In addition, the disclosure of information relating to land, legal, title, and related issues relies on the following documents:

- "Mineral Lease and Option for Deed and Assignment" agreement between Phelps Dodge Mining Company and Paso Rico (USA), Inc. dated March 30, 2000.
- Amended "Mineral Lease and Option for Deed and Assignment" agreement between Phelps Dodge Mining Company and Paso Rico (USA), Inc. dated August 9, 2001.
- "Notice of Termination of Mineral Lease and Option For Deed" agreement, "Lease Termination and Environmental Indemnity" agreement, and "Quitclaim Deed" and royalty assignment agreement all signed by Paso Rico, (USA), Inc. and Phelps Dodge Mining Company dated September 30, 2002.
- "Bear Lodge Venture Agreement" signed by Paso Rico (USA), Inc. and Newmont North American Exploration Limited dated June 1, 2006.
- "Royalty Purchase & Sale Agreement" signed by Freeport McMoRan Corporation (formerly Phelps Dodge Corporation) and Rare Element Resources Ltd. dated March 31, 2009.
- "Termination of Bear Lodge Venture and Right of First Refusal" agreement signed by Paso Rico (USA), Inc. and Newmont North American Exploration Limited dated May 14, 2010.
- "Exchange Agreement" between the Wyoming Board of Land Commissioners, through the Office of State Lands and Investments, and Rare Element Resources, Inc. dated November 13, 2012.

The primary author is not responsible for such information, which is found in Chapter 4 of this report, but has assumed it to be accurate for the purpose of this report.

3.4 Federal Tax Calculation

The calculation of federal income taxes was provided by Rare Element and the primary author is not responsible for this information. For the purposes of this report, federal income taxes are assumed to be accurate.

4 Property Description and Location

4.1 Bull Hill Project

The Bear Lodge Project consists of the Bull Hill mine site and is located in central Crook County, north-eastern Wyoming (see Figure 4.1), in the northwestern portion of the Black Hills uplift. The Upton Plant Site is located 40 miles (64.4 km) south of the Bull Hill Mine and approximately 2 miles (3.2 km) northwest of the town of Upton Wyoming in north-central Weston County.

Rare Element will be required to obtain permits to operate the Bull Hill Mine and the Hydromet plant and tailings storage facility from the United States Forest Service (USFS) and the Wyoming Department of Environmental Quality (WDEQ). In addition, a source materials possession license will be required from the United States Nuclear Regulatory Commission (NRC). In accordance with Rare Element's Environmental, Health, and Safety Policy, Rare Element will comply with applicable federal and state environmental statutes, standards, regulations, and guidelines in the permitting of the Bull Hill Mine and Hydromet plant/tailings storage facility (TSF).

There are no known environmental liabilities associated with either site. The Company began environmental baseline data collection in 2010 to characterize the conditions of each site. As of the date of this report, none of the permits have been obtained and work continues on the preparation of supporting data.

4.2 Bull Hill Mine and PUG Site Location

The mine property is situated in the central Bear Lodge Mountains, a relatively small northwesterly trending range. The project is flanked to the west by the Powder River Basin, famous for its extensive coal mining, and is bordered to the north and east by the Great Plains. The Bear Lodge Project lies about 7 air miles (11 kilometers) or 12 road miles (19 kilometers) northwest of the town of Sundance, Wyoming, approximately 22 air miles (35 kilometers) west of the South Dakota state line, 55 air miles (89 kilometers) east of Gillette, Wyoming, and 230 miles (370 kilometers) north of Cheyenne, the state capitol. Gillette is headquarters for the Wyoming coal mining industry and has many of the services required by the mining industry.

The Bear Lodge Project includes approximately 9,634 acres held by 499 unpatented lode mining claims and one section of fee land in the Bear Lodge Mining District of Crook County in the State of Wyoming, USA (Figure 1.2). Within the Project Area lies the Mine Area (approximately 1,700 acres) that includes the Mineable Pit, Waste Rock Facility, Physical Upgrade Plant (PUG), mine support facilities, and roads. The property is located within parts of Sections 5, 7, 8, 9, 10, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35 in Township 52 North and Range 63 West, Sixth Principal Meridian (Figure 4.1). The approximate center of the principal study area is at longitude 104 degrees 27 minutes West and latitude 44 degrees 30 minutes North (4,927,000N and 544,000E UTM coordinates). (Refer to Appendix A - Listing of the Claims).

4.3 Upton Hydromet Site Location

The Upton Hydromet project site is located in north-central Weston County, north-eastern Wyoming. The property is located 2 road miles (3.2 kilometers) northwest of the town of Upton, Wyoming and approximately 22 air miles (35 kilometers) or 40 road miles (64.4 kilometers) southwest of the town of Sundance, Wyoming. The approximate center of the Hydromet location is at longitude 104 degrees 39 minutes West and latitude 44 degrees 06 minutes North. When constructed, the Upton Hydromet plant will process mineral pre-concentrate from the Bull Hill PUG plant.

4.4 Bull Hill Mine and PUG Site Property Description and Ownership

Rare Element Resources, Inc. (formerly known as Paso Rico (USA), Inc.), holds a 100% interest in the 499 unpatented mineral claims that constitute the Bear Lodge Project area. The mineral estate is administered by the U.S. Department of the Interior, Bureau of Land Management ("BLM") and all mineral claims have been located in accordance with the U.S. mining laws, as amended, and have been properly filed with the BLM. The surface estate is land administered by the U.S. Forest Service. The holder or owner of a mineral claim has the right to develop the mineral resources underlying the mineral claim and use so much of the surface estate as may be required so long as they comply with surface use management regulations. There are currently no royalties payable to the U.S. government on minerals produced from federally owned lands.

These claims were, in part, acquired from Phelps Dodge Exploration Company (Phelps Dodge) by way of a "Mineral Lease and Option for Deed" in 2000. A portion of the claims and defined area of influence surrounding the claims were subject to a production royalty of 2% of Net Smelter Returns (NSR) payable to Phelps Dodge (now Freeport McMoRan Corporation). The production royalty was purchased subsequently by Rare Element Resources, Ltd. (parent of Rare Element Resources, Inc.) in March 2009. In July 2009, Rare Element Resources, Ltd assigned the Phelps

Dodge royalty to Rare Element Resources, Inc. and retained the production royalty only as it applies to the production of rare earth minerals.

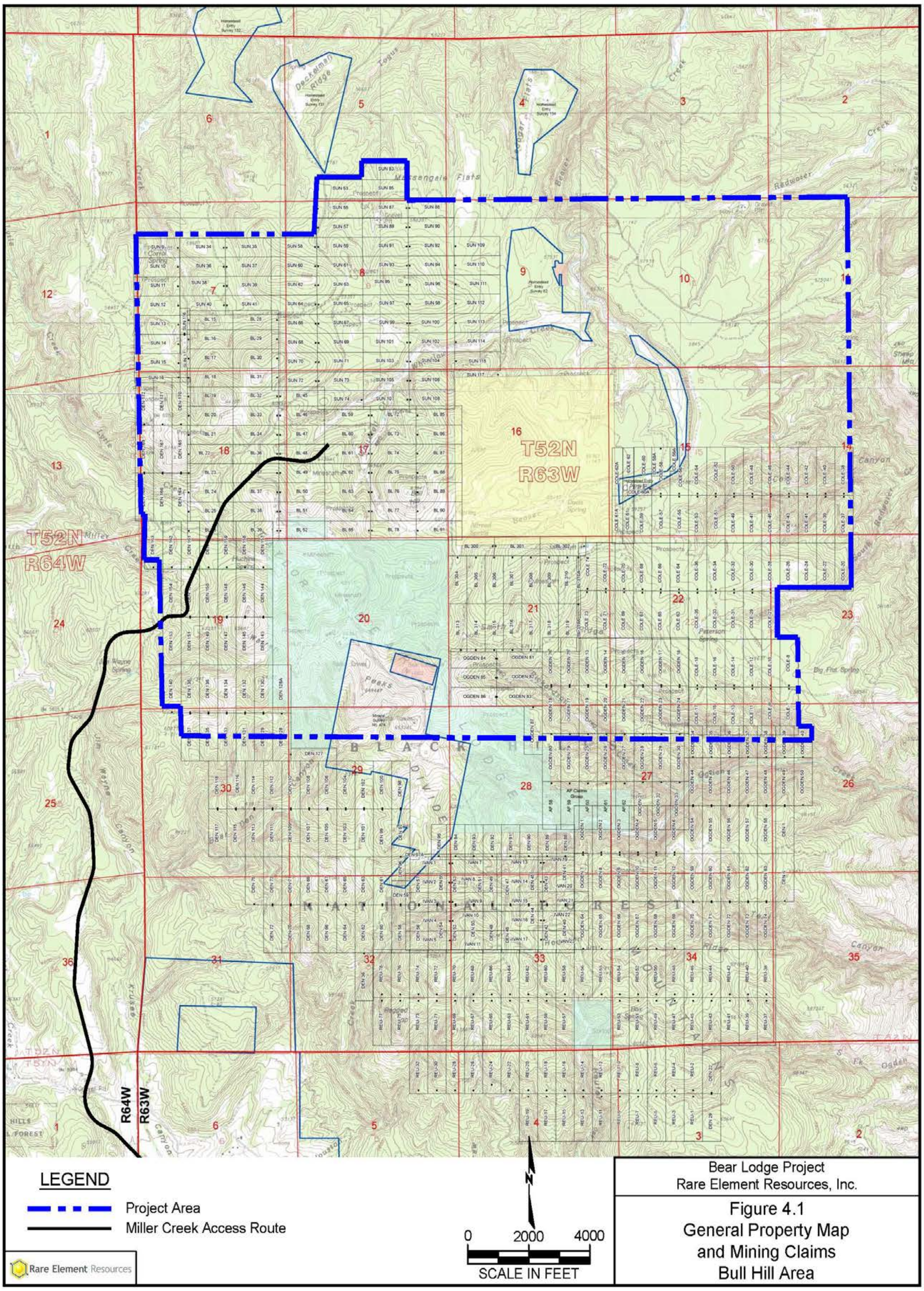
On June 1, 2006, Paso Rico (USA), Inc. and Newmont signed an agreement to establish the Sundance gold-exploration venture (Venture) on the Company's Bear Lodge property. Newmont spent approximately $2.85 million in exploration by May 2010 and chose to terminate the Venture agreement prior to earning any interest and returned the original claims to Paso Rico. In addition, Newmont transferred 327 unpatented mineral claims held outside the Venture to the Company. Newmont holds a 0.5% NSR royalty on the 327 claims it previously held independent of the Venture, and retains a right-of-first-refusal (ROFR) to the gold and other metals, but excluding rare earths, for both the royalty and the ROFR, on the property if Rare Element chooses to sell an interest or bring in a partner. The right of first refusal applies only to parties or partners for non-rare earth extraction and terminates on May 14, 2015. In addition and with respect to the Newmont joint venture termination, the Company assumed all obligations of Newmont in a Consulting Agreement with Bronco Creek Exploration and Mining, Inc. requiring the Company to pay as a finder's fee, 3% of exploration expenditures made during each quarter until a cap of $500,000 has been paid. The claims covered by the Consulting Agreement are outside of the rare earth deposit and are further subject to a 0.25% Net Smelter Returns Royalty with a cap of $3,000,000. As a result of the new agreement with Newmont, the Company retains a totally unencumbered rare earth project on 499 claims, and now has 100% interest in all gold and other minerals in the Bear Lodge district, subject to the above royalties on minerals other than rare earths. The core group of claims (original Venture area) is free of royalties other than the former Phelps Dodge royalty on rare earth production now payable to Rare Element's parent. Additional claims were added in 2011 and 2012.

The Company acquired 634 acres (263 hectares) in 2013 through a land exchange with the State of Wyoming, State Board of Land Commissioners within the project area and now own that land in fee. The Wyoming Patent to the land issued by the State Board of Land Commissioners provides for a production royalty to be determined for any mineral production from the land and further states that the mineral estate will revert to Wyoming State ownership at the conclusion of mining and termination of the Company's mining permit. The land was acquired for ancillary facilities in support of the actual mining operation on adjacent land. Rare Element's ownership of this land provides increased flexibility in the development of the planned waste rock storage facility adjacent to the open pit development.

All of the mining claims are unpatented, such that the paramount ownership and title of the land is held by the United States of America. Claim maintenance payments and related documents must be filed annually with the Wyoming State Office of the Bureau of Land Management (BLM) and recorded with the Crook County, Wyoming Clerk and Recorder in order to keep the claims from terminating by operation of law. The claims can be maintained in good standing so long as those requirements are met.

Surface usage and access to the claims are part of the rights held by the owners of mining claims.

Figure 4.1 Figure - General Property Map



(Rare Element, 2014)

In order to maintain all claims in good standing, Rare Element is responsible for payment of annual federal claim maintenance fees (currently $155/claim) and the recording of the annual claim maintenance and intent to hold notice with Crook County, Wyoming. All 499 unpatented claims included in the project are located on federal lands and are subject to annual maintenance fees payable to the United States Bureau of Land Management. Mineral rights on the mining claims and the 634 acre private parcel allow Rare Element mineral and surface rights to explore, develop, and mine the Bear Lodge property, subject to the prior procurement of required operating permits and approvals, and compliance with applicable federal, state, and local laws, regulations and ordinances. The Company believes that all of its mining claims are in good standing, and the authors of this report have no reason to believe otherwise and have accepted the land ownership and control to be as represented.

The author is not aware of the existence of any outstanding environmental liabilities, except for reclamation work associated with the Company's ongoing exploration and drilling activities. Permits required to carry out the exploration and evaluation program proposed in this report are included in Rare Element's Plan of Operations for the Exploration Environmental Assessment, which was transferred from Newmont. Permits for the Company's current operations were approved by both the U.S. Forest Service and the Wyoming Department of Environmental Quality. The Plan of Operation includes a reclamation plan and a posted reclamation bond of $430,000 to cover the reclamation cost of planned exploration work.

Additional permits and licenses are required for a mining and processing operation in order to proceed to mine development. These are discussed in more detail in Chapter 20.

4.5 Listing of Claims

Table 4.1 - Listing of Claims

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
Sun 9	581022		WMC-275672	7	52N	63W
				12	52N	63W
Sun 10	581023		WMC-275673	7	52N	63W
				12	52N	63W
Sun 11	581024		WMC-275674	7	52N	63W
				12	52N	63W
Sun 12	581025		WMC-275675	7	52N	63W
				12	52N	63W
Sun 13	581026		WMC-275676	7	52N	63W
				12	52N	63W
Sun 14	581027		WMC-275677	7	52N	63W
				12	52N	63W
Sun 15	581028		WMC-275678	7	52N	63W
				13	52N	63W
				12	52N	63W
Sun 16	581029		WMC-275679	7	52N	63W
				18	52N	63W
				13	52N	63W
Sun 17	581030		WMC-275680	7	52N	63W
				18	52N	63W
Sun 34	581047		WMC-275697	7	52N	63W
Sun 35	581048		WMC-275698	7	52N	63W
Sun 36	581049		WMC-275699	7	52N	63W
Sun 37	581050		WMC-275700	7	52N	63W
Sun 38	581051		WMC-275701	7	52N	63W
Sun 39	581052		WMC-275702	7	52N	63W
Sun 40	581053		WMC-275703	7	52N	63W
Sun 41	581054		WMC-275704	7	52N	63W
Sun 53	581066		WMC-275716	8	52N	63W
Sun 55	581068		WMC-275718	5	52N	63W
				8	52N	63W
Sun 57	581070		WMC-275720	8	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
Sun 58	581071		WMC-275721	8	52N	63W
				7	52N	63W
Sun 59	581072		WMC-275722	8	52N	63W
Sun 60	581073		WMC-275723	8	52N	63W
				7	52N	63W
Sun 61	581074		WMC-275724	8	52N	63W
Sun 62	581075		WMC-275725	8	52N	63W
				7	52N	63W
Sun 63	581076		WMC-275726	8	52N	63W
Sun 64	581077		WMC-275727	8	52N	63W
				7	52N	63W
Sun 65	581078		WMC-275728	8	52N	63W
Sun 66	581079		WMC-275729	8	52N	63W
				7	52N	63W
Sun 67	581080		WMC-275730	8	52N	63W
Sun 68	581081		WMC-275731	8	52N	63W
				7	52N	63W
Sun 69	581082		WMC-275732	8	52N	63W
Sun 70	581083		WMC-275733	8	52N	63W
				7	52N	63W
Sun 71	581084		WMC-275734	8	52N	63W
Sun 72	581085		WMC-275735	8	52N	63W
				17	52N	63W
				18	52N	63W
				7	52N	63W
Sun 73	581086		WMC-275736	8	52N	63W
				17	52N	63W
Sun 74	581087		WMC-275737	17	52N	63W
Sun 83	581096		WMC-275746	5	52N	63W
Sun 85	581098		WMC-275748	5	52N	63W
Sun 87	581100		WMC-275750	5	52N	63W
				8	52N	63W
Sun 88	581101		WMC-275751	4	52N	63W
				9	52N	63W
				8	52N	63W
				5	52N	63W
Sun 89	581102		WMC-275752	8	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
Sun 90	581103		WMC-275753	9	52N	63W
				8	52N	63W
Sun 91	581104		WMC-275754	8	52N	63W
Sun 92	581105		WMC-275755	9	52N	63W
				8	52N	63W
Sun 93	581106		WMC-275756	8	52N	63W
Sun 94	581107		WMC-275757	9	52N	63W
				8	52N	63W
Sun 95	581108		WMC-275758	8	52N	63W
Sun 96	581109		WMC-275759	9	52N	63W
				8	52N	63W
Sun 97	581110		WMC-275760	8	52N	63W
Sun 98	581111		WMC-275761	9	52N	63W
				8	52N	63W
Sun 99	581112		WMC-275762	8	52N	63W
Sun 100	581113		WMC-275763	9	52N	63W
				8	52N	63W
Sun 101	581114		WMC-275764	8	52N	63W
Sun 102	581115		WMC-275765	9	52N	63W
				8	52N	63W
Sun 103	581116		WMC-275766	8	52N	63W
Sun 104	581117		WMC-275767	9	52N	63W
				8	52N	63W
Sun 105	581118		WMC-275768	8	52N	63W
				17	52N	63W
Sun 106	581119		WMC-275769	9	52N	63W
				16	52N	63W
				17	52N	63W
				8	52N	63W
Sun 107	581120		WMC-275770	17	52N	63W
Sun 108	581121		WMC-275771	16	52N	63W
				17	52N	63W
Sun 109	581122		WMC-275772	9	52N	63W
Sun 110	581123		WMC-275773	9	52N	63W
Sun 111	581124		WMC-275774	9	52N	63W
Sun 112	581125		WMC-275775	9	52N	63W
Sun 113	581126		WMC-275776	9	52N	63W
Sun 114	581127		WMC-275777	9	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
Sun 115	581128		WMC-275778	9	52N	63W
Sun 116	581129		WMC-275779	7	52N	63W
Sun 117	617410		WMC-305384	16	52N	63W
				9	52N	63W
COLE 7	570451		WMC-260907	23	52N	63W
COLE 8	570452		WMC-260908	23	52N	63W
COLE 9	570453		WMC-260909	22	52N	63W
				23	52N	63W
				26	52N	63W
				27	52N	63W
COLE 10	570454		WMC-260910	22	52N	63W
				23	52N	63W
COLE 11	570455		WMC-260911	22	52N	63W
				27	52N	63W
COLE 12	570456		WMC-260912	22	52N	63W
COLE 13	570457		WMC-260913	22	52N	63W
				27	52N	63W
COLE 14	570458		WMC-260914	22	52N	63W
COLE 15	570459		WMC-260915	22	52N	63W
				27	52N	63W
COLE 16	570460		WMC-260916	22	52N	63W
COLE 17	570461		WMC-260917	22	52N	63W
				27	52N	63W
COLE 18	570462		WMC-260918	22	52N	63W
COLE 20	570464		WMC-260920	23	52N	63W
COLE 22	570466		WMC-260922	23	52N	63W
COLE 24	570468		WMC-260924	23	52N	63W
COLE 26	570470		WMC-260926	23	52N	63W
COLE 27	570471		WMC-260927	22	52N	63W
				23	52N	63W
COLE 28	570472		WMC-260928	22	52N	63W
				23	52N	63W
COLE 29	570473		WMC-260929	22	52N	63W
COLE 30	570474		WMC-260930	22	52N	63W
COLE 31	570475		WMC-260931	22	52N	63W
COLE 32	570476		WMC-260932	22	52N	63W
COLE 33	570477		WMC-260933	22	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
COLE 34	570478		WMC-260934	22	52N	63W
COLE 35	570479		WMC-260935	22	52N	63W
COLE 36	570480		WMC-260936	22	52N	63W
COLE 37	570481		WMC-260937	14	52N	63W
				23	52N	63W
COLE 38	570482		WMC-260938	14	52N	63W
COLE 39	570483		WMC-260939	14	52N	63W
				23	52N	63W
COLE 40	570484		WMC-260940	14	52N	63W
COLE 41	570485		WMC-260941	14	52N	63W
				23	52N	63W
COLE 42	570486		WMC-260942	14	52N	63W
COLE 43	570487		WMC-260943	14	52N	63W
				23	52N	63W
COLE 44	570488		WMC-260944	14	52N	63W
COLE 45	570489		WMC-260945	14	52N	63W
				15	52N	63W
				22	52N	63W
				23	52N	63W
COLE 46	570490		WMC-260946	14	52N	63W
				15	52N	63W
COLE 47	570491		WMC-260947	15	52N	63W
				22	52N	63W
COLE 48	570492		WMC-260948	15	52N	63W
COLE 49	570493		WMC-260949	15	52N	63W
				22	52N	63W
COLE 50	570494		WMC-260950	15	52N	63W
COLE 51	570495		WMC-260951	15	52N	63W
				22	52N	63W
COLE 52	570496		WMC-260952	15	52N	63W
COLE 53	570497		WMC-260953	15	52N	63W
				22	52N	63W
COLE 54	570498		WMC-260954	15	52N	63W
COLE 55	570499		WMC-260955	15	52N	63W
				22	52N	63W
COLE 56	570500		WMC-260956	15	52N	63W
COLE 56A	612965		WMC-303656	15	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
COLE 57	570501		WMC-260957	15	52N	63W
				22	52N	63W
COLE 58	570502		WMC-260958	15	52N	63W
COLE 58A	612966		WMC-303657	15	52N	63W
COLE 59	570503		WMC-260959	15	52N	63W
				22	52N	63W
COLE 60	570504		WMC-260960	15	52N	63W
COLE 60A	612967		WMC-303658	15	52N	63W
COLE 61	617406		WMC-305380	15	52N	63W
				22	52N	63W
COLE 61A	617407		WMC-305381	22	52N	63W
				15	52N	63W
COLE 62	617408		WMC-305382	15	52N	63W
COLE 62A	617409		WMC-305383	15	52N	63W
COLE 63	576950		WMC-268910	22	52N	63W
COLE 64	576951		WMC-268911	22	52N	63W
COLE 65	576952		WMC-268912	22	52N	63W
COLE 66	576953		WMC-268913	22	52N	63W
COLE 67	576954		WMC-268914	22	52N	63W
COLE 68	576955		WMC-268915	22	52N	63W
COLE 69	576956		WMC-268916	22	52N	63W
COLE 70	576957		WMC-268917	22	52N	63W
COLE 71	576958		WMC-268918	21	52N	63W
				22	52N	63W
COLE 72	576959		WMC-268919	21	52N	63W
				22	52N	63W
COLE 73	576960		WMC-268920	21	52N	63W
COLE 74	576961		WMC-268921	21	52N	63W
DEN 1	577594		WMC-270117	26	52N	63W
DEN 6	577599		WMC-270122	26	52N	63W
				35	52N	63W
DEN 22	577615		WMC-270138	3	51N	63W
DEN 29	577622		WMC-270145	3	51N	63W
DEN 36	577629		WMC-270152	32	52N	63W
DEN 40	577633		WMC-270156	33	52N	63W
DEN 41	577634		WMC-270157	28	52N	63W
				33	52N	63W
DEN 42	577635		WMC-270158	33	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
DEN 43	577636		WMC-270159	28	52N	63W
				33	52N	63W
DEN 44	577637		WMC-270160	33	52N	63W
DEN 45	577638		WMC-270161	28	52N	63W
				33	52N	63W
DEN 46	577639		WMC-270162	33	52N	63W
DEN 47	577640		WMC-270163	28	52N	63W
				33	52N	63W
DEN 48	577641		WMC-270164	33	52N	63W
DEN 49	577642		WMC-270165	28	52N	63W
				33	52N	63W
DEN 50	577643		WMC-270166	33	52N	63W
DEN 51	577644		WMC-270167	28	52N	63W
				33	52N	63W
DEN 52	577645		WMC-270168	32	52N	63W
				33	52N	63W
DEN 53	577646		WMC-270169	28	52N	63W
				29	52N	63W
				32	52N	63W
				33	52N	63W
DEN 54	577647		WMC-270170	32	52N	63W
DEN 55	577648		WMC-270171	29	52N	63W
				32	52N	63W
DEN 56	577649		WMC-270172	32	52N	63W
DEN 57	577650		WMC-270173	29	52N	63W
				32	52N	63W
DEN 58	577651		WMC-270174	32	52N	63W
DEN 59	577652		WMC-270175	32	52N	63W
DEN 60	57765		WMC-270176	32	52N	63W
DEN 61	577654		WMC-270177	29	52N	63W
				32	52N	63W
DEN 62	577655		WMC-270178	32	52N	63W
DEN 63	577656		WMC-270179	29	52N	63W
				32	52N	63W
DEN 64	577657		WMC-270180	32	52N	63W
DEN 65	577658		WMC-270181	29	52N	63W
				32	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
DEN 66	577659		WMC-270182	32	52N	63W
DEN 67	577660		WMC-270183	29	52N	63W
				32	52N	63W
DEN 68	577661		WMC-270184	32	52N	63W
DEN 69	577662		WMC-270185	29	52N	63W
				32	52N	63W
DEN 70	577663		WMC-270186	31	52N	63W
				32	52N	63W
DEN 71	577664		WMC-270187	29	52N	63W
				30	52N	63W
				31	52N	63W
				32	52N	63W
DEN 72	577665		WMC-270188	31	52N	63W
DEN 73	577666		WMC-270189	30	52N	63W
				31	52N	63W
DEN 75	577668		WMC-270191	30	52N	63W
				31	52N	63W
DEN 88	577681	612971	WMC-270204	28	52N	63W
DEN 89	577682	612972	WMC-270205	28	52N	63W
DEN 90	577683	612973	WMC-270206	28	52N	63W
DEN 91	577684	612974	WMC-270207	28	52N	63W
DEN 92	577685	612975	WMC-270208	28	52N	63W
DEN 93	577686	612976	WMC-270209	29	52N	63W
DEN 94	577687	612977	WMC-270210	28	52N	63W
				29	52N	63W
DEN 95	612953		WMC-303666	29	52N	63W
DEN 96	577689	612970	WMC-270212	29	52N	63W
DEN 97	577690		WMC-270213	29	52N	63W
DEN 97A	612969		WMC-303667	29	52N	63W
DEN 98	577691		WMC-270214	29	52N	63W
DEN 99	577692		WMC-270215	29	52N	63W
DEN 100	577693		WMC-270216	29	52N	63W
DEN 101	577694		WMC-270217	29	52N	63W
DEN 102	577695		WMC-270218	29	52N	63W
DEN 103	577696		WMC-270219	29	52N	63W
DEN 104	577697		WMC-270220	29	52N	63W
DEN 105	577698		WMC-270221	29	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
DEN 106	577699		WMC-270222	29	52N	63W
DEN 107	577700		WMC-270223	29	52N	63W
DEN 108	577701		WMC-270224	29	52N	63W
DEN 109	577702		WMC-270225	29	52N	63W
				30	52N	63W
DEN 110	577703		WMC-270226	29	52N	63W
				30	52N	63W
DEN 111	577704		WMC-270227	30	52N	63W
DEN 112	577705		WMC-270228	30	52N	63W
DEN 113	577706		WMC-270229	30	52N	63W
DEN 114	577707		WMC-270230	30	52N	63W
DEN 115	577708		WMC-270231	30	52N	63W
DEN 116	577709		WMC-270232	30	52N	63W
DEN 117	577710		WMC-270233	30	52N	63W
DEN 118	577711		WMC-270234	30	52N	63W
DEN 127	577720		WMC-270243	29	52N	63W
				30	52N	63W
DEN 128	577721		WMC-270244	30	52N	63W
DEN 128A	612968		WMC-303659	30	52N	63W
				19	52N	63W
				20	52N	63W
				29	52N	63W
DEN 129	577722		WMC-270245	30	52N	63W
DEN 130	577723		WMC-270246	19	52N	63W
				30	52N	63W
DEN 131	577724		WMC-270247	30	52N	63W
DEN 132	577725		WMC-270248	19	52N	63W
				30	52N	63W
DEN 133	577726		WMC-270249	30	52N	63W
DEN 134	577727		WMC-270250	19	52N	63W
				30	52N	63W
DEN 135	577728		WMC-270251	30	52N	63W
DEN 136	577729		WMC-270252	19	52N	63W
				30	52N	63W
DEN 137	577730		WMC-270253	30	52N	63W
DEN 138	577731		WMC-270254	19	52N	63W
				30	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
DEN 140	577733		WMC-270256	19	52N	63W
				20	52N	63W
DEN 143	577736		WMC-270259	19	52N	63W
DEN 144	577737		WMC-270260	19	52N	63W
DEN 145	577738		WMC-270261	19	52N	63W
DEN 146	577739		WMC-270262	19	52N	63W
DEN 147	577740		WMC-270263	19	52N	63W
DEN 148	577741		WMC-270264	19	52N	63W
DEN 149	577742		WMC-270265	19	52N	63W
DEN 150	577743		WMC-270266	19	52N	63W
DEN 151	577744		WMC-270267	19	52N	63W
DEN 152	577745		WMC-270268	19	52N	63W
DEN 153	577746		WMC-270269	19	52N	63W
DEN 154	577747		WMC-270270	19	52N	63W
DEN 157	577750		WMC-270273	18	52N	63W
				19	52N	63W
DEN 158	577751		WMC-270274	18	52N	63W
				19	52N	63W
DEN 159	577752		WMC-270275	18	52N	63W
				19	52N	63W
DEN 160	577753		WMC-270276	18	52N	63W
				19	52N	63W
DEN 161	577754		WMC-270277	18	52N	63W
				19	52N	63W
DEN 162	577755		WMC-270278	18	52N	63W
				19	52N	63W
DEN 163	577756		WMC-270279	18	52N	63W
				19	52N	63W
DEN 164	577757		WMC-270280	18	52N	63W
DEN 165	577758		WMC-270281	18	52N	63W
DEN 166	577759		WMC-270282	18	52N	63W
DEN 167	577760		WMC-270283	18	52N	63W
DEN 168	577761		WMC-270284	18	52N	63W
DEN 169	577762		WMC-270285	18	52N	63W
				13	52N	63W
DEN 170	577763		WMC-270286	18	52N	63W
DEN 171	577764		WMC-270287	18	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
DEN 172	577765		WMC-270288	18	52N	63W
				13	52N	64W
OGDEN 1	576938		WMC-268922	28	52N	63W
OGDEN 2	576939		WMC-268923	27	52N	63W
				28	52N	63W
OGDEN 3	576940		WMC-268924	27	52N	63W
OGDEN 4	576941		WMC-268925	27	52N	63W
OGDEN 5	576942		WMC-268926	27	52N	63W
OGDEN 6	576943		WMC-268927	27	52N	63W
OGDEN 7	576944		WMC-268928	28	52N	63W
				33	52N	63W
OGDEN 8	576945		WMC-268929	27	52N	63W
				28	52N	63W
				33	52N	63W
				34	52N	63W
OGDEN 9	576946		WMC-268930	27	52N	63W
				34	52N	63W
OGDEN 10	576947		WMC-268931	27	52N	63W
				34	52N	63W
OGDEN 11	576948		WMC-268932	27	52N	63W
				34	52N	63W
OGDEN 12	576949		WMC-268933	27	52N	63W
				34	52N	63W
OGDEN 13	577766		WMC-270289	21	52N	63W
OGDEN 14	577767		WMC-270290	21	52N	63W
				22	52N	63W
OGDEN 15	577768		WMC-270291	22	52N	63W
OGDEN 16	577769		WMC-270292	22	52N	63W
OGDEN 17	577770		WMC-270293	22	52N	63W
OGDEN 18	577771		WMC-270294	22	52N	63W
OGDEN 19	577772		WMC-270295	21	52N	63W
				28	52N	63W
OGDEN 20	577773		WMC-270296	21	52N	63W
				22	52N	63W
				27	52N	63W
				28	52N	63W
OGDEN 21	577774		WMC-270297	22	52N	63W
				27	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
OGDEN 22	577775		WMC-270298	22	52N	63W
				27	52N	63W
OGDEN 23	577776		WMC-270299	22	52N	63W
				27	52N	63W
OGDEN 24	577777		WMC-270300	22	52N	63W
				27	52N	63W
OGDEN 25	577778		WMC-270301	28	52N	63W
OGDEN 26	577779		WMC-270302	27	52N	63W
				28	52N	63W
OGDEN 27	577780		WMC-270303	27	52N	63W
OGDEN 28	577781		WMC-270304	27	52N	63W
OGDEN 29	577782		WMC-270305	27	52N	63W
OGDEN 30	577783		WMC-270306	27	52N	63W
OGDEN 31	577784		WMC-270307	27	52N	63W
OGDEN 32	577785		WMC-270308	27	52N	63W
OGDEN 33	577786		WMC-270309	27	52N	63W
OGDEN 34	577787		WMC-270310	27	52N	63W
OGDEN 35	577788		WMC-270311	27	52N	63W
OGDEN 36	577789		WMC-270312	27	52N	63W
OGDEN 37	577790		WMC-270313	27	52N	63W
OGDEN 38	577791		WMC-270314	26	52N	63W
				27	52N	63W
OGDEN 39	577792		WMC-270315	26	52N	63W
OGDEN 40	577793		WMC-270316	27	52N	63W
OGDEN 44	577797		WMC-270320	27	52N	63W
OGDEN 45	577798		WMC-270321	27	52N	63W
OGDEN 46	577799		WMC-270322	27	52N	63W
OGDEN 47	5777800		WMC-270323	27	52N	63W
OGDEN 48	5777801		WMC-270324	26	52N	63W
				27	52N	63W
OGDEN 49	5777802		WMC-270325	26	52N	63W
OGDEN 50	5777803		WMC-270326	26	52N	63W
OGDEN 54	5777807		WMC-270330	27	52N	63W
OGDEN 55	5777808		WMC-270331	27	52N	63W
OGDEN 56	5777809		WMC-270332	27	52N	63W
OGDEN 57	5777810		WMC-270333	27	52N	63W
OGDEN 58	5777811		WMC-270334	26	52N	63W
				27	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
OGDEN 59	5777812		WMC-270335	27	52N	63W
				34	52N	63W
OGDEN 60	5777813		WMC-270336	27	52N	63W
				34	52N	63W
OGDEN 61	5777814		WMC-270337	27	52N	63W
				34	52N	63W
OGDEN 62	5777815		WMC-270338	27	52N	63W
				34	52N	63W
OGDEN 63	5777816		WMC-270339	26	52N	63W
				27	52N	63W
				34	52N	63W
				35	52N	63W
OGDEN 64	5777817		WMC-270340	33	52N	63W
OGDEN 65	5777818		WMC-270341	33	52N	63W
OGDEN 66	5777819		WMC-270342	33	52N	63W
				34	52N	63W
OGDEN 67	5777820		WMC-270343	34	52N	63W
OGDEN 68	5777821		WMC-270344	34	52N	63W
OGDEN 69	5777822		WMC-270345	34	52N	63W
OGDEN 70	5777823		WMC-270346	34	52N	63W
OGDEN 71	5777824		WMC-270347	34	52N	63W
OGDEN 72	5777825		WMC-270348	34	52N	63W
OGDEN 73	5777826		WMC-270349	34	52N	63W
OGDEN 74	5777827		WMC-270350	34	52N	63W
				35	52N	63W
OGDEN 75	5777828		WMC-270351	21	52N	63W
OGDEN 76	5777829		WMC-270352	21	52N	63W
OGDEN 77	5777830		WMC-270353	21	52N	63W
				28	52N	63W
OGDEN 78	5777831		WMC-270354	21	52N	63W
				28	52N	63W
OGDEN 79	5777832		WMC-270355	28	52N	63W
OGDEN 80	5777833		WMC-270356	28	52N	63W
OGDEN 81	5777834		WMC-270357	21	52N	63W
OGDEN 82	5777835		WMC-270358	21	52N	63W
				22	52N	63W
OGDEN 83	5777836		WMC-270359	21	52N	63W
				28	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
OGDEN 84	5777837		WMC-270360	21	52N	63W
OGDEN 85	5777838		WMC-270361	21	52N	63W
OGDEN 86	5777839		WMC-270362	21	52N	63W
				28	52N	63W
OGDEN 87	5777840		WMC-270363	28	52N	63W
REU 1	570507		WMC-260963	3	51N	63W
REU 2	570508		WMC-260964	3	51N	63W
				34	52N	63W
REU 3	570509		WMC-260965	3	51N	63W
REU 4	570510		WMC-260966	3	51N	63W
				34	52N	63W
REU 5	570511		WMC-260967	3	51N	63W
REU 6	570512		WMC-260968	3	51N	63W
				34	52N	63W
REU 7	570513		WMC-260969	3	51N	63W
REU 8	570514		WMC-260970	3	51N	63W
				34	52N	63W
REU 9	570515		WMC-260971	3	51N	63W
				4	51N	63W
REU 10	570516		WMC-260972	3	51N	63W
				4	51N	63W
				33	52N	63W
				34	52N	63W
REU 11	570517		WMC-260973	4	51N	63W
REU 12	570518		WMC-260974	4	51N	63W
				33	52N	63W
REU 13	570519		WMC-260975	4	51N	63W
REU 14	570520		WMC-260976	4	51N	63W
				33	52N	63W
REU 15	570521		WMC-260977	4	51N	63W
REU 16	570522		WMC-260978	4	51N	63W
				33	52N	63W
REU 17	570523		WMC-260979	4	51N	63W
REU 18	570524		WMC-260980	4	51N	63W
				33	52N	63W
REU 19	570525		WMC-260981	4	51N	63W
REU 20	570526		WMC-260982	4	51N	63W
				33	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
REU 22	570528		WMC-260984	4	51N	63W
				33	52N	63W
REU 24	570530		WMC-260986	4	51N	63W
				33	52N	63W
REU 26	570532		WMC-260988	4	51N	63W
				33	52N	63W
REU 28	570534		WMC-260990	4	51N	63W
				5	51N	63W
				32	52N	63W
				33	52N	63W
REU 30	570536		WMC-260992	5	51N	63W
				32	52N	63W
REU 32	570538		WMC-260994	5	51N	63W
				32	52N	63W
REU 37	570543		WMC-260999	3	51N	63W
				34	52N	63W
				35	52N	63W
REU 38	570544		WMC-261000	34	52N	63W
				35	52N	63W
REU 39	570545		WMC-261001	3	51N	63W
				34	52N	63W
REU 40	570546		WMC-261002	34	52N	63W
REU 41	570547		WMC-261003	3	51N	63W
				34	52N	63W
RUE 42	570548		WMC-261004	34	52N	63W
REU 43	570549		WMC-261005	3	51N	63W
				34	52N	63W
REU 44	570550		WMC-261006	34	52N	63W
REU 45	570551		WMC-261007	34	52N	63W
REU 46	570552		WMC-261008	34	52N	63W
REU 47	570553		WMC-261009	34	52N	63W
REU 48	570554		WMC-261010	34	52N	63W
REU 49	570555		WMC-261011	34	52N	63W
REU 50	570556		WMC-261012	34	52N	63W
REU 51	570557		WMC-261013	34	52N	63W
REU 52	570558		WMC-261014	34	52N	63W
REU 53	570559		WMC-261015	33	52N	63W
				34	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
REU 54	570560		WMC-261016	33	52N	63W
				34	52N	63W
REU 55	570561		WMC-261017	33	52N	63W
REU 56	570562		WMC-261018	33	52N	63W
REU 57	570563		WMC-261019	33	52N	63W
REU 58	570564		WMC-261020	33	52N	63W
REU 59	570565		WMC-261021	33	52N	63W
REU 60	570566		WMC-261022	33	52N	63W
REU 61	570567		WMC-261023	33	52N	63W
REU 62	570568		WMC-261024	33	52N	63W
REU 63	570569		WMC-261025	33	52N	63W
REU 64	570570		WMC-261026	33	52N	63W
REU 65	570571		WMC-261027	33	52N	63W
REU 66	570572		WMC-261028	33	52N	63W
REU 67	570573		WMC-261029	33	52N	63W
REU 68	570574		WMC-261030	33	52N	63W
REU 69	570575		WMC-261031	32	52N	63W
				33	52N	63W
REU 70	570576		WMC-261032	32	52N	63W
				33	52N	63W
REU 71	570577		WMC-261033	32	52N	63W
REU 72	570578		WMC-261034	32	52N	63W
REU 73	570579		WMC-261035	32	52N	63W
REU 74	570580		WMC-261036	32	52N	63W
REU 75	570581		WMC-261037	32	52N	63W
REU 76	570582		WMC-261038	32	52N	63W
REU 77	570583		WMC-261039	32	52N	63W
REU 78	570584		WMC-261040	32	52N	63W
AF 58	612960		WMC-303651	28	52N	63W
AF 59	612961		WMC-303652	28	52N	63W
AF 60	612962		WMC-303653	28	52N	63W
AF 61	612963		WMC-303654	28	52N	63W
				27	52N	63W
AF 62	612964		WMC-303655	27	52N	63W
BL 15	571269		WMC-262061	7	52N	63W
BL 16	571270		WMC-262062	7	52N	63W
BL 17	571271		WMC-262063	7	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
BL 18	571272		WMC-262064	7	52N	63W
				18	52N	63W
BL 19	571273		WMC-262065	18	52N	63W
BL 20	571274		WMC-262066	18	52N	63W
BL 21	571275		WMC-262067	18	52N	63W
BL 22	571276		WMC-262068	18	52N	63W
BL 23	571315		WMC-262069	18	52N	63W
BL 24	571314		WMC-262070	18	52N	63W
BL 25	571313		WMC-262071	18	52N	63W
BL 26	571312		WMC-262072	18	52N	63W
BL 28	571311		WMC-262073	7	52N	63W
BL 29	571310		WMC-262074	7	52N	63W
BL 30	571309		WMC-262075	7	52N	63W
BL 31	571308		WMC-262076	18	52N	63W
				7	52N	63W
BL 32	571307		WMC-262077	18	52N	63W
BL 33	571306		WMC-262078	18	52N	63W
BL 34	571305		WMC-303660	18	52N	63W
BL 35	571304		WMC-303661	18	52N	63W
BL 36	571303		WMC-303662	18	52N	63W
BL 37	571302		WMC-262082	18	52N	63W
BL 38	571301		WMC-262083	18	52N	63W
BL 39	571300		WMC-262084	18	52N	63W
BL 45	571299		WMC-262085	18	52N	63W
				18	52N	63W
BL 46	571298		WMC-262086	17	52N	63W
				18	52N	63W
BL 47	571297	624471	WMC-303663	17	52N	63W
				18	52N	63W
BL 48	571296		WMC-303664	17	52N	63W
				18	52N	63W
BL 49	571295		WMC-303665	17	52N	63W
				18	52N	63W
BL 50	571294		WMC-262090	17	52N	63W
				18	52N	63W
BL 51	571293		WMC-262091	17	52N	63W
				18	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
BL 52	571292		WMC-262092	17	52N	63W
				18	52N	63W
BL 59	510598	612978	WMC-247983	17	52N	63W
BL 60	510599	612979	WMC-247984	17	52N	63W
BL 61	510600	612980	WMC-247985	17	52N	63W
BL 62	510601	612981	WMC-247986	17	52N	63W
BL 63	510602	612982	WMC-247987	17	52N	63W
BL 64	510603	612983	WMC-247988	17	52N	63W
BL 65	510604	612984	WMC-247989	17	52N	63W
BL 72	510611	612985	WMC-247996	17	52N	63W
BL 73	510612	612986	WMC-247997	17	52N	63W
BL 74	510613	612987	WMC-247998	17	52N	63W
BL 75	510614	612988	WMC-247999	17	52N	63W
BL 76	510615	612989	WMC-248000	17	52N	63W
BL 77	510616	612990	WMC-248001	17	52N	63W
BL 78	510617	612991	WMC-248002	17	52N	63W
BL 85	571291		WMC-262093	16	52N	63W
				17	52N	63W
BL 86	571290		WMC-262094	16	52N	63W
				17	52N	63W
BL 87	571289		WMC-262095	16	52N	63W
				17	52N	63W
BL 88	571288		WMC-262096	16	52N	63W
				17	52N	63W
BL 89	571287		WMC-262097	16	52N	63W
				17	52N	63W
BL 90	571286		WMC-262098	16	52N	63W
				17	52N	63W
BL 91	571285		WMC-262099	16	52N	63W
				17	52N	63W
BL 300	571284		WMC-262100	21	52N	63W
BL 301	571283		WMC-262101	21	52N	63W
BL 302	571282		WMC-262102	21	52N	63W
BL 304	571281		WMC-262103	21	52N	63W
BL 305	519137	612992	WMC-249541	21	52N	63W
BL 306	519138	612993	WMC-249542	21	52N	63W
BL 307	519139	612994	WMC-249543	21	52N	63W
BL 308	519140	612995	WMC-249544	21	52N	63W

Claim Name	Recording Reception No.	AMENDED RECORDATION RECEPTION NO.	BLM Serial No.	Section	Township	Range
BL 309	519141	612996	WMC-249545	21	52N	63W
BL 310	571280		WMC-262104	21	52N	63W
BL 310A	624291		WMC-308967	21	52N	63W
BL 313	571279		WMC-262105	21	52N	63W
BL 314	571278		WMC-262106	21	52N	63W
BL 315	519147	612997	WMC-249551	21	52N	63W
BL 316	519148	612998	WMC-249552	21	52N	63W
BL 317	519149	612999	WMC-249553	21	52N	63W
BL 318	519150	613000	WMC-249554	21	52N	63W
BL 319	571277		WMC-262107	21	52N	63W
BL 319A	627298		WMC-309537	21	52N	63W
IVAN 1	577054		WMC-270381	29	52N	63W
IVAN 2	577055		WMC-270382	32	52N	63W
IVAN 3	577046		WMC-270383	32	52N	63W
IVAN 4	577047		WMC-270384	32	52N	63W
IVAN 5	577048		WMC-270385	32	52N	63W
IVAN 7	577049		WMC-270386	28	52N	63W
IVAN 8	577050		WMC-270387	33	52N	63W
IVAN 9	577051		WMC-270388	33	52N	63W
IVAN 10	577052		WMC-270389	33	52N	63W
IVAN 11	577053		WMC-270390	33	52N	63W
IVAN 13	577045		WMC-270391	28	52N	63W
IVAN 14	577044		WMC-270392	33	52N	63W
IVAN 15	577043		WMC-270393	33	52N	63W
IVAN 16	577042		WMC-270394	33	52N	63W
IVAN 17	577041		WMC-270395	33	52N	63W
IVAN 19	577040		WMC-270396	28	52N	63W
IVAN 20	577039		WMC-270397	33	52N	63W
IVAN 21	577038		WMC-270398	33	52N	63W
IVAN 22	577037		WMC-270399	33	52N	63W
IVAN 23	577036		WMC-270400	33	52N	63W

(Rare Element, 2014)

4.6 Upton Hydromet Site Property Description and Ownership

Rare Element currently holds an option to purchase all land within the Upton Hydromet site as part of the project. The land within the Upton Hydromet site is private, and the purchase option is valid until 2014 and can be extended upon mutual agreement with the land owner. Access to the Upton site is by way of a County Road. The land purchase is conditional upon the completion of due diligence.

5 Accessibility, Climate, Local Resources, Infrastructure and Physiography

5.1 Accessibility

Access to the Bear Lodge Project is good except for the winter months, when snow storms can make travel difficult. The project area is located 7 air miles (11 kilometers) or 12 road miles (19 kilometers) northwest of the town of Sundance, Wyoming, which is on US Interstate Highway 90, and 22 air miles (35 kilometers) west of the South Dakota state line. Primary access to the property is from the town of Sundance, although good, well maintained gravel roads provide access from the west, north, and east. The project site is reached by traveling west from Sundance about one mile along I-90, then 1.5 miles (2.4 kilometers) west on US Highway 14, then north on the paved Sundance-Warren Peaks Road (USFS road #838 and County Road 100) for approximately 9 miles to the project area and proposed Physical Upgrade (PUG) Plant site. Once mine operations begin, year-round road access to the mine site will be maintained via the Sundance Miller Creek Road. Road access within the property is relatively extensive via a number of good quality dirt logging roads and four-wheel-drive trails that were constructed originally during logging or exploration activities, and subsequently rehabilitated. Figure 5.1 displays the access routes to the Bear Lodge Project.

Mineralized material from the mine will be beneficiated to create an REE mineral pre-concentrate for shipment from the mine approximately 40 miles (64.4 kilometers) south to Upton, Weston County, Wyoming (Township 48 North, Range 65 West) via Wyoming highway #116. Mineral concentrate from the PUG plant will first be trucked 8 miles down the Sundance-Miller Creek road, which joins the Warren Peak road one mile from the junction with Highway 14. The mineral concentrate will then be hauled along Highway 116 to Upton, where the trucks will turn right on US Highway 16 for 2 miles (3.2 kilometers) then exit to the left on the Buffalo Creek road. The Hydromet plant will be located less than a mile south of the exit from US Highway 16. At the Upton site, the pre-concentrate will be processed through leaching, neutralization, and precipitation to produce the final REE product. Tailings generated from beneficiation will be dewatered, neutralized and disposed of in close proximity to the plant. Figure 5.2 shows the Upton Hydromet project permit area, which encompasses approximately 850 acres (344 hectares).

5.2 Climate and Physiography

The Bear Lodge Mountains have a warm and relatively dry climate during summer, followed by cold winters with variable amounts of snow. Optimal field conditions extend from June through October.

The property lies within the Black Hills National Forest and covers the crest of the Bear Lodge Mountains, a narrow northwest-trending range situated in northeastern Wyoming. Physiographically, the mountains are a northwesterly extension of the Black Hills uplift of western South Dakota. The range is characterized by rounded grass and pine-covered mountains that reach an elevation of 6,400 feet (1,951 meters) within the property.

The mountains have moderate slopes covered by western yellow (ponderosa) pine and aspen forest interspersed with dense thickets of brush. Narrow, grassy meadows cover the upper reaches of seasonal drainages. The lowest point within the project area is about 5,800 feet (1,768 meters) elevation.

The climate of Crook County varies with topography. There are two major areas: the Bear Lodge Mountains and the lower-lying foothills and plains area. Climatic data from the radar station referenced in the Final Preliminary Assessment/Site Inspection Report, Former PM-1 Reactor (US Air Force Air Combat Command, December 2006) are used for the Bear Lodge Mountains and are considered the most representative for the study area. The following summarizes data from the radar station:

- Average annual air temperature is 43.6°F (6.4 °C).
- Lowest recorded temperature is -42°F (-41°C).
- Highest recorded temperature is 105°F (40.5°C).
- Average annual precipitation is 17.41 inches (44.2 centimeters).
- Lowest annual precipitation was 11.58 inches (29.4 centimeters) in 1954.
- Highest annual precipitation was 25.38 inches (64.5 centimeters) in 1964.
- Average seasonal snowfall recorded for Sundance is 64 inches (162.5 centimeters).

The average total precipitation in Sundance is 18.14 inches (46.1 centimeters) and the average total snowfall is 74.6 inches (189.4 centimeters). Most of the precipitation occurs as thunderstorms during April through July. Winds are generally from the west or northwest. The climate at Upton is more moderate, and there is a weather station within the city limits. The following data summarize the Upton weather:

- Average annual air temperature is 43.6°F (6.4 °C).
- Lowest recorded temperature (January) is 6°F (-14.4°C).
- Highest recorded temperature (July/August) is 89°F (31.7°).
- Average annual precipitation is 14.9 inches (37.8 centimeters).
- Highest average seasonal snowfall is 9.2 inches (23.4 centimeters) in March.

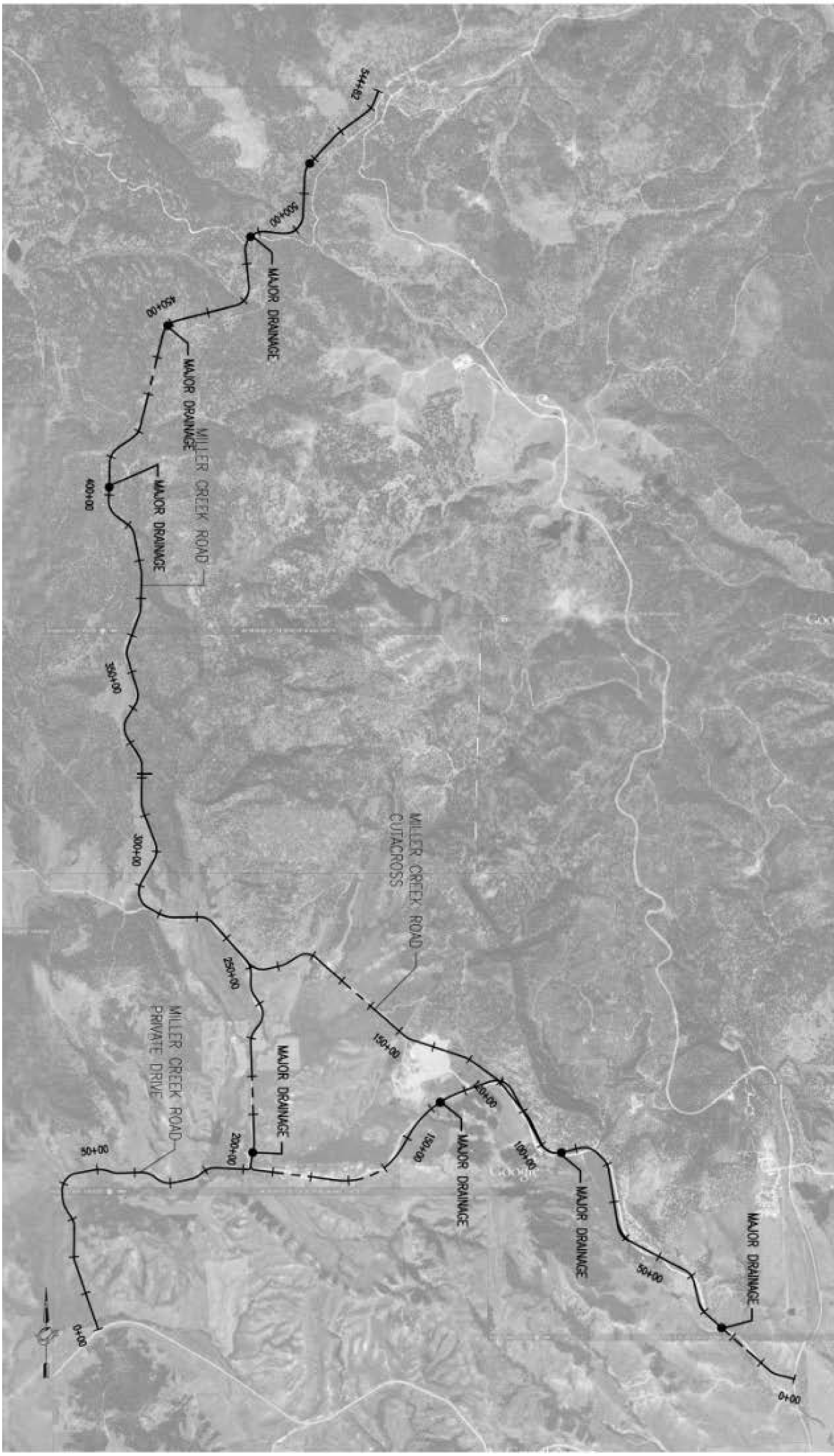
5.3 Infrastructure and Local Resources

Motels, restaurants, gas stations, and other services are available at Sundance, Upton, and other nearby towns, and a greater variety of accommodations are available to the east in Spearfish, South Dakota. All necessary infrastructure, such as housing, food, fuel, etc., would be available in these towns, or further to the west in Gillette and southeast in Newcastle. Water rights at the mine site are available through permitting by the Wyoming State Engineer's Office. The water supply at the Hydromet Plant is available from the City of Upton. Near the mine site, a power line, which requires upgrading, runs to within a mile of the project area. Economical electrical power would be supplied by the Powder River Energy Corporation. Power for the Hydromet site will be fed from a sub-station at a nearby industrial park, supplied by Powder River Energy Corporation.

Supplies can be trucked to the site 60 miles (100 kilometers) from Gillette, which is located on both US Interstate Highway 90 and rail lines. A Burlington Northern rail transport line is also located at Moorcroft, 34 miles (54 kilometers) west of Sundance, and at Upton, 40 miles (64 kilometers) south. The Powder River Basin contains multiple coal-fired power plants, and Gillette, the largest city in the basin, would be a major logistics center for any development at the Bull Hill Mine. The current size of the mine property, at approximately 15 square miles (39 square kilometers), is sufficiently large to support a mining operation, with no foreseeable obstacles to expansion. The Hydromet site is located on approximately 840 acres (340 hectares) of private land, west of the city of Upton.

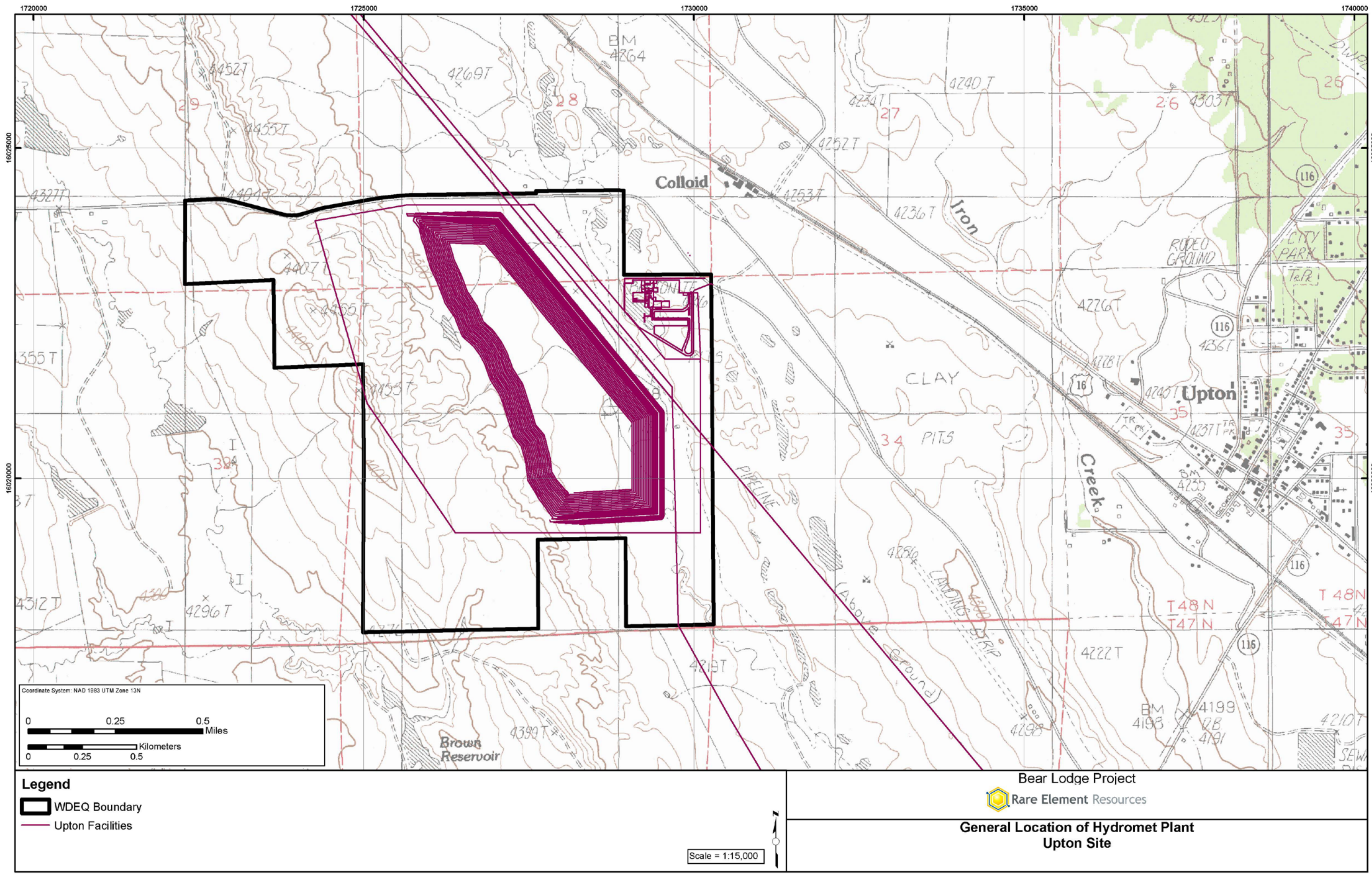
A description of the Waste Rock Facility can be found in Section 16.5 along with figures that illustrate the growth of the facility over time. A description of the Talings Storage Facility (TSF) can be found in Section 18.2.7 along with figures tha illustrate the growth of the facility over time.

Figure 5.1 - Access Map Showing the Bear Lodge Project



(Oakley, 2012)

Figure 5.2 - Access Aerial (Upton Hydromet Site Plan General Arrangement)



6 History

6.1 History of the Rare Earth District

The Bear Lodge Mountains were initially prospected for gold during the late nineteenth and early twentieth century, with a reportedly short-lived mine and mill in operation (the Bock Mine). Thorium and rare earth mineralization in the Bear Lodge Mountains were first discovered in 1949 as a result of uranium exploration activity by prospectors, and the mineralization, along with some carbonatite occurrences, were documented by the U.S. Bureau of Mines in 1951. The USBM completed a limited radiometric survey and a ten-hole drilling program in the area of the rare earth mineralization in 1950-1951. The exploration activity for uranium during the late 1940s and early 1950s included the excavation of hundreds of bulldozer trenches. The exploration effort was short-lived, because the uranium grades are very low, and there were no readily available markets for thorium or rare earths at that time.

In 1972, Duval Corporation acquired the exploration rights to the area by claim staking, based on the results of a stream sediment geochemical survey. They initiated an exploration program based on a Climax exploration model for disseminated “porphyry-type” molybdenum-copper (Mo-Cu) mineralization. This program continued until the end of the 1977 field season. Duval identified locally high-grade occurrences of copper and rare earth metals, and low-grade gold mineralization within an altered syenite-carbonatite alkaline intrusive complex. They completed 13 diamond drill holes (WBD-1 to 13) for a total of 20,363 feet (6,207 meters), 5 rotary drill holes (WBR-1 to 5) for 765 feet (233 meters), and approximately 42 claim-validation rotary drill holes (DUVR-1 to 42) for 2,105 feet (642 meters). Duval reported an intercept of 40 feet (12.2 meters) averaging 3.5% copper and 4.7 ounces of silver/ton in hole WBD-5, and many drill holes encountered significant intercepts with total rare earth abundances that range from 1% to 15% in association with carbonatite and carbonatite-related intrusive bodies.

Duval recognized that the Bear Lodge property had potential to host an economically significant rare earth element (REE) deposit, and they brought Molycorp into the project as an operating joint venture partner in 1978. Molycorp owned and operated the Mountain Pass rare earth mine in California. From 1978 to 1980, Molycorp completed 12 diamond drill holes (BL-1 to 12) for a total of 13,618 feet (4,151 meters), 165 claim-validation holes (MOL-1 to 165) for 8,250 feet (2,515 meters), and soil geochemical, ground magnetic, IP/resistivity, and radiometric surveys.

The Company also completed a TEM geophysical survey and had all pre-existing core analyzed for REE content. Molycorp withdrew from the joint venture in 1980. Duval continued with a diminished level of exploration activity until September 1984. With the divestiture of Duval and spin-off of Battle Mountain Gold Company, the property was abandoned after management rejected a recommended rare earth metallurgical feasibility study.

The USGS conducted field and laboratory studies on the property between 1975 and 1979, including geological mapping, rock geochemistry, petrographic studies, and radiometric surveys covering a large area that encompasses the current Bear Lodge Project area. M.H. Staatz of the USGS documented results of the work in Professional Paper 1049D, entitled "Geology and Description of Thorium and Rare Earth Deposits in the Southern Bear Lodge Mountains, Northeastern Wyoming" in 1983. The report concludes that "the Bear Lodge disseminated deposits have one of the largest resources of both total rare earths and thorium in the United States".

Hecla acquired a land position in the district in 1986 and added to it in 1988 by optioning additional claims. Hecla discovered high-grade REE mineralization and concentrated on rare earth exploration until the end of the 1990 field season, at which time rare earth prices were falling. Hecla then acquired Coca Mines, which controlled an adjacent property that hosted a small gold discovery. Following the Coca acquisition in 1991, Hecla focused on the low-grade gold potential of the merged property position. Hecla completed 12 diamond drill holes for 13,756 feet (4,194 meters) during its REE exploration phase and defined rare earth mineralization in several carbonatite dike sets along the southwestern flank of Bull Hill. The dike sets are part of the current Bull Hill REE deposit.

The USBM conducted work in the Bear Lodge Mountains to evaluate the REE mineralization in the early 1950s, and again in 1990. In 1950, the USBM conducted sampling that identified an REE-anomalous area defined by total REE abundances greater than (>) 2000 ppm and drilled the anomalous area (mostly Whitetail Ridge) with 10 shallow core holes that ranged in depth from 23.5 to 220.1 feet (7.2 to 67.1 meters). The work was reviewed in 1990 and resulted in an estimate of potential REE resources in the general Bull Hill area.

Newmont Exploration Limited acquired a small land package in the district and carried out limited gold exploration activities from 1986 until 1988. The company drilled 10 reverse circulation holes totaling 3,115 feet (949 m).

Phelps Dodge acquired a large part of the area in 1994 and focused their efforts on gold exploration over the next three years. It appears that Phelps Dodge ceased exploration due more to the downturn in gold prices, rather than to lowered expectations for the property.

Paso Rico (USA), Inc. began looking at the Bear Lodge property in 1998-99, staked some claims, and negotiated a lease and option agreement on adjacent claims held by Phelps Dodge Corporation in March 2000. The lease was terminated and replaced by a 2% NSR royalty in September 2002. The 2% royalty was purchased from Freeport McMoRan Corporation by Rare Element in March 2009 and Phelps Dodge/Freeport has no further interests in the property. Rare Element Resources Ltd. was incorporated in the province of British Columbia on June 3, 1999 and acquired Paso Rico Resources Ltd. (Paso Rico) in 2003, as a wholly owned subsidiary, in order to explore and develop primarily the rare earth mineralization, but also the gold mineralization. Rare Element owns the Bear Lodge property claims in Wyoming. On June 1, 2006, Rare Element, through its subsidiary, Paso Rico, and Newmont North American Exploration signed an agreement to establish a gold exploration venture on the joint Newmont-Rare Element claim block. This agreement was terminated in May 2010, with Rare Element becoming the sole participant in the combined gold-REE project.

6.2 Historical Resource Estimates

This section discusses a number of historical resource estimates for rare earth elements as well as gold that are included as part of the historical record for the project. As to the rare earth historical resources, no qualified person did sufficient work on these estimates to classify them as current resources, and the reliability of the estimates is unknown. Further, Rare Element did not conduct work to verify historical rare earth resources, but rather used current drilling and geological data developed by the company between 2004 and 2013 for purposes of its resource estimation. The gold historical resource is not progressing under Rare Element's current development plant. Rare Element does not consider the historical estimates as current resources, and the historical estimates should not be relied upon.

6.2.1 Rare Earth Resources

Molycorp first reported resource estimates for rare earth metals on the Bear Lodge property in 1980. The company stated that it had partially drilled two "shallow blanket-type stockwork bodies which total 9.1 million short tons (8.26 million tonnes) of potential resources, with an estimated grade of 1.71% REO", and a third deep tabular body which "has been estimated to contain 6.8 million short tons (6.2 million tonnes) of potential resources at a grade of 1.25% REO" (Lujan 1980). Molycorp's methodology and key assumptions for its resource estimation were not described.

In 1991, Hecla reported "total geological reserves for the three main dikes at 4.3 million short tons (3.9 million tonnes) at an average grade of 3.8% total REO" in the first estimate of the Bull Hill deposit, and "roughly 8.5 million short tons (7.7 million tonnes) at an average grade of 3.0% total REO" for the three dike swarms (Wineteer, 1991). The historical resource estimate of 4.3 million short tons (3.9 million tonnes) at 3.8% REO is based on about ten holes drilled in or near the resource area, and it would likely be classified as an inferred mineral resource according to Section 1.2 of National Instrument 43-101. The Hecla resource estimate was based on drill hole assay intercepts and geological interpretations of continuity in the main mineralized dikes along a strike length of about 1000 feet (328 meters). The other historical resource estimates have drill hole spacing's too broad to establish mineralization continuity and insufficient mineralized intercepts to constitute anything other than exploration targets.

Most of the historical drill core was discarded over the years, and only minor skeleton core samples are still available. Historical assays cannot be confirmed, and many original assay certificates from Duval and Molycorp are lost. However, the quality of work performed by Duval, Molycorp, and Hecla is likely to be at or above the standards of the industry, and their exploration and drilling results clearly indicate the high potential for the property to host economically significant REE mineralization.

The USBM conducted exploration work in the Bear Lodge Mountains for REE in 1950-51 and re-evaluated that work in 1990 (Gersic *et al.*, 1990). In 1950, the USBM conducted sampling that identified an REE-anomalous area defined by total REE abundances >2000 ppm. Subsequently, it drilled 9 of 10 shallow core holes, which ranged in depth from 23.5 to 220.1 feet (7.2 to 67 meters), into one of the anomalous areas—now termed the Whitetail Ridge resource area. The mineralized portions of the holes are reported to have many small mineralized veins and veinlets in a "stockwork" deposit, and the average grade was 1.5% REE for nearly all of the holes. In 1990, the USBM re-evaluated the earlier work and drilling results. The USBM probably had access to considerably more exploration data from the area, possibly including the Duval and Molycorp drill data, old and new surface trench sampling data, and the USGS surface sampling assay results. The USBM reported for the area drilled that "A general estimate of the REE resource possible in the stockwork deposit in the Bear Lodge area was calculated to be approximately 84 million short tons (76.2 million tonnes) containing 1.5% REO within 200 feet (61 meters) of the surface. The estimate was made by assuming a 0.6 square mile (1.6 square kilometers) area, a 100 feet (30.5 meter) average depth of stockwork REO mineralization, an average grade of 1.5%, and a tonnage factor of 1 short ton/12 cubic feet (1 tonne / 0.34 cubic meter) of rock in place." This historical estimate should only be used as an indication of exploration potential.

6.2.2 Gold Resources

Rare Element, through its predecessor entity, Paso Rico (USA), and Newmont North American Exploration signed an agreement to establish the Sundance gold exploration venture on June 1, 2006. This agreement was terminated in May 2010, with Rare Element becoming the sole participant in the gold exploration project. Rare Element continued exploration of gold on the property in 2010 following the termination of the Rare Element/Newmont joint venture. The gold target areas were a result of the collaborative exploration efforts by Newmont and Rare Element under the prior joint venture. Those joint efforts were based upon information in a historical database containing results from earlier exploration activities.

Zones of anomalous gold mineralization in rock chip and soil samples are widespread in the Bear Lodge intrusive complex and superjacent sedimentary rocks. The mineralization occurs in a variety of environments that include intrusive and hydrothermal breccias, fracture-fault zones, Paleozoic clastic and carbonate sedimentary rocks, fenitized Precambrian granite, and carbonatite. The near-surface zones of gold mineralization are generally low-grade and disseminated. Several of these zones were partially delineated by previous operators and further expanded with more recent drilling by Newmont and Rare Element, leading to delineation of an NI 43-101 compliant inferred gold resource prepared by O.R.E. for Rare Element in April 2011 and which was included in a previous technical report, dated April 2012 and titled, “Technical Report on the Mineral Reserves and Development of the Bull Hill Mine”, filed with the Canadian securities regulators on SEDAR.

The inferred gold resource as of April 2012 includes 947,000 ounces of gold (26,847 kilograms) contained in 76.4 million short tons (69.3 million tonnes) averaging 0.42 grams per tonne gold, using a gold price of $1,200 per ounce and a 0.15 grams per tonne cutoff grade in three deposits on the property: those being Smith, Taylor, and Carbon. This inferred gold resource does not include the results from the Company’s 2011 gold drilling program.

Based on current economic conditions for gold, and Rare Element’s focus on the development of the rare earth resource, the previously stated gold resource is no longer expected to be economic and is not reported in this technical report. The Company suspended gold exploration on the property at the end of 2011 and does not plan any additional development activities.

7 Geological Setting and Mineralization

7.1 Introduction

This section discusses the geology and mineralization of the Bear Lodge property based on the most recent geological and mineralogical data derived from work conducted on the property through 2013.

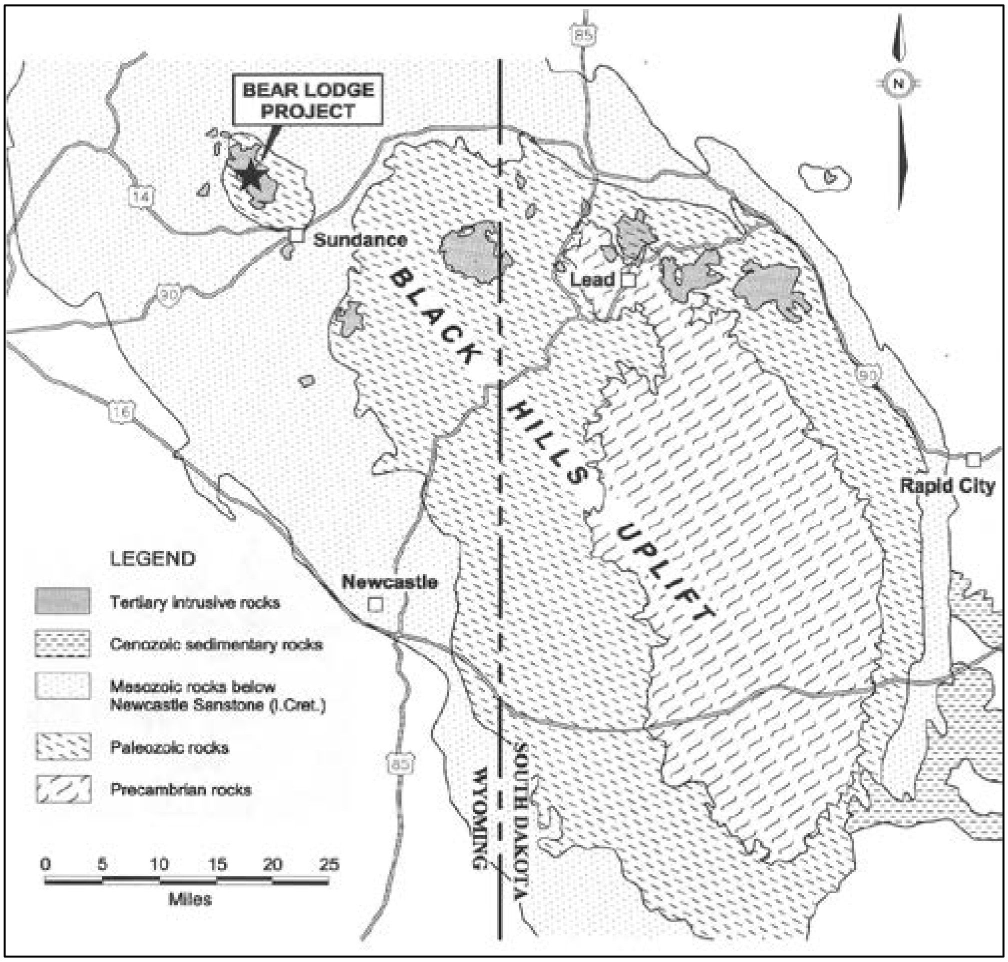
7.2 Regional Geology

The Bear Lodge Mountains of northeastern Wyoming are part of the Black Hills Uplift, formed during the Late Cretaceous-Tertiary Laramide Orogeny. The uplift has a northwesterly orientation and extends from the western South Dakota – Nebraska border through northeastern Wyoming into southeastern Montana. The exposed basement consists of Precambrian schist, gneiss, and granite overlain by Paleozoic and Mesozoic clastic and carbonate sedimentary rocks that were subsequently eroded from higher elevations. The Paleozoic and Mesozoic rocks were subjected to large-scale monoclinal folding that encircles the Black Hills Uplift. Younger Oligocene, Miocene, and Pliocene sediments disconformably overlie the older sedimentary and igneous rocks at lower elevations of the uplift (Figure 7.1).

Tertiary alkaline intrusive bodies in the northern Black Hills are located along a N70-80W trending belt that extends from Bear Butte in South Dakota, through the Bear Lodge Mountains, to Devil's Tower and Missouri Buttes in northeastern Wyoming (Figure 7.1). The alkaline igneous rocks generally transition in composition from silica-saturated to silica-undersaturated from southeast to northwest. Potassium-argon age dates of the Tertiary intrusive rocks range from 38 to 60.5 Ma (Lisenbee 1985), with younger intrusions more common toward the northwestern end of the belt (Figure 7.1). Isolated anticlinal domes are dispersed throughout the region and are probably cored by alkaline igneous plugs of Tertiary age. On a broader scale, the Bear Lodge intrusive complex and other Black Hills alkaline igneous bodies are part of a northerly trending belt of scattered alkaline-igneous systems that occur from Mexico to Canada, several of which are associated with significant gold deposits (e.g., Cripple Creek in Colorado, the Zortman-Landusky complex in Montana, and the Carache Canyon breccia pipe in New Mexico).

Aside from the Bear Lodge intrusive complex, only the Gallinas Mountains complex in New Mexico is known to host carbonatite associated with significant rare earth occurrences along this belt.

Figure 7.1 - Geologic Setting and General Geology of Bear Lodge Mountains



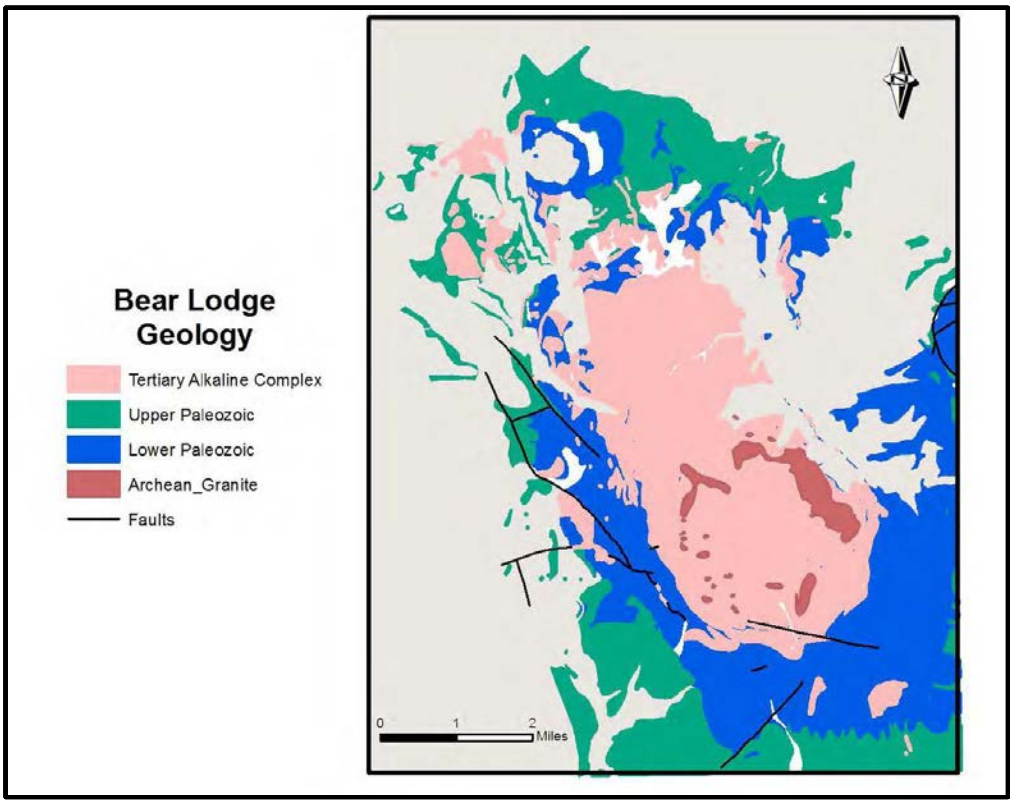
(Modified from Karner, 1981)

7.3 District Geology

Surface rock exposures are limited, so considerable information was gleaned from float samples and trenches. Bedrock outcrop exposure is less than 5%, and extensive soil cover obscures details of the underlying rocks, structures, and alteration patterns.

The Bear Lodge mining district is located in the Bear Lodge Mountains, near the western end of the northern Black Hills intrusive belt (Figure 7.1). The Tertiary alkaline intrusive belt consists of a series of intrusive centers that trends about N75°W and extends from Bear Butte in South Dakota, through the Bear Lodge Mountains, to Devil's Tower and the Missouri Buttes in northeastern Wyoming. There is a tendency for the alkaline igneous rocks to be silica-saturated in the eastern part of the belt and silica-undersaturated in the western part of the belt. The Bear Lodge alkaline-igneous complex consists of a central elongated core overlain by older Paleozoic and Mesozoic sediments in the southern half of the range, and by post- intrusion Tertiary sediments in the northern half (Figure 7.2 and Table 7.1). The core consists of the upper levels of a mineralized Tertiary alkaline-igneous complex that intruded and domed the surrounding Paleozoic and Mesozoic sedimentary rocks in the early Tertiary (approximately 38-50 million years ago). The alkaline-igneous complex has surface dimensions of approximately 2.8 by 6 miles (4.5 by 10 km), elongate in a northwesterly orientation, and with a number of small intrusive outliers cutting sedimentary rocks outside the complex. The Bear Lodge complex consists of multiple intrusions of phonolite, trachyte, and other alkaline igneous rocks, and a variety of associated breccias and diatremes. REE mineralization occurs in the north-central core, and anomalous gold mineralization is widespread.

Figure 7.2 - Geology of the Bear Lodge District



(Modified from Staatz, 1983)

Several large Precambrian granitic bodies occur within the southern portion of the complex. The Precambrian units may be roof pendants or, alternatively, may be anchored in the basement. Large isolated blocks of Precambrian granite are found in sections 20 and 21 within the intrusive complex. Screens of quartzite, conglomerate, and minor shaly limestone from the Deadwood Formation sediments occur along the periphery of the complex and can also host gold mineralization.

The Paleozoic sedimentary rocks consist mainly of limestone and quartzite, with minor sandstone, shale, and siltstone. Mesozoic rocks include siltstone and shale, with minor sandstone. Tertiary sediments unconformably overlie all older rocks and consist of loosely consolidated siltstone, sandstone, and conglomerate of local derivation. Quaternary deposits include alluvium, soil cover, and colluvial deposits (Table 7.1). Table 7.1 summarizes the formations and rock units in and around the Bear Lodge Project area.

Table 7.1 - Summary of Bear Lodge Project Formations and Lithologies

Geol. Time	Formation	Thickness (Feet)	Thickness (Meters)	Lithology
Quaternary				alluvium, land-slide debris
Pliocene / Miocene	Ogallala	0-56	0-17	unconsolidated gravels, trachyte-phonolite pebble-boulder conglomerate
Oligocene	White River	0-138	0-42	poorly bedded, friable, tan siltstone
Unconformity				
Eocene / Paleocene	Alkali intrusives			trachyte, phonolite, heterolithic diatreme breccia, latite, syenite, lamprophyre, pseudoleucite porphyry, carbonatite, silicocarbonatite
Cretaceous	Lakota	10-13	3-4	light grey to white medium grained sandstone
Jurassic	Morrison	< 20	< 6	greenish-grey claystone
Jurassic	Sundance	~374	~114	sandstone & shale members
Triassic / Permian	Spearfish	509-896	155-273	reddish brown, friable shale, siltstone &fine grained sandstone, white gypsum
Permian	Minnekahta	43-59	13-18	thin grey limestone marker
Permian	Opeche	66-85	20-26	Fine grained reddish brown siltstone & Shale
Permian / Pennsylvania	Minnelusa	574-650	175-198	tan-light brown friable calcareous sandstone
Mississippian	Pahasapa	509-574	155-175	grey, massive fine grained limestone
Ordovician	Whitewood	~148	~45	light grey fine grained limestone
Ordovician / Cambrian	Deadwood	> 886	> 270	hard white, red quartzite, thin bedded shaly limestone commonly inflated or replaced by Tertiary intrusive bodies
Precambrian				Granitic basement and/or roof pendants

(Modified after Meyer, 2002)

The Bear Lodge complex consists predominantly of silica-undersaturated alkaline-igneous intrusive rocks, and it is the only intrusive series in the alkaline belt where associated carbonatitic intrusions are found. The high-level nature of the Bear Lodge complex is confirmed by the presence of sparsely scattered outcrops of vesicular lavas and coeval pyroclastic deposits in the northern Bear Lodge Mountains.

Recognizable hydrothermal alteration includes pervasive fenitization (alkali-ferric iron metasomatism), K-feldspar-pyrite alteration, minor silicification, and localized argillic alteration, along with superimposed surface weathering and oxidation. Structural mapping and interpretation are hindered by thick soil cover and lack of outcrop. However, geophysical surveys (magnetics, radiometrics, and IP/resistivity) confirm the limited field data that indicate a predominance of both northwesterly and east-northeasterly structural trends.

7.3.1 Tertiary Igneous Intrusions

The Bear Lodge alkaline intrusive complex contains multiple intrusions as plugs, sills, and dikes of trachyte and phonolite porphyry, with lesser amounts of syenite, latite, nepheline syenite, pseudoleucite porphyry, malignite, pyroxenite, lamprophyre, and late-stage carbonatite and silicocarbonatite, and the complex is penetrated by a variety of intrusive and diatremic breccia bodies. The core of the complex consists primarily of subvolcanic phonolite and trachyte porphyry, with subordinate syenite, nepheline syenite, and pseudoleucite phonolite porphyry. Carbonatite exposures occur only on the upper southeastern flank of Carbon Hill. The alkalic rocks penetrated Precambrian granite and gneiss, and were intruded as plugs, dikes, and sills into the superjacent Paleozoic sedimentary rocks. The Bear Lodge complex may have been laccolithic in form but after deep erosion, only vestiges of sedimentary-hosted intrusive sills remain in the periphery of the dome and the core is all intrusive rock. Numerous intrusion and intrusive breccias occur within the complex, and four diatremes are identified. The intrusion breccia bodies consist of a phonolitic to trachytic igneous matrix carrying varying proportions of cognate clasts, as well as local minor syenite and/or lamprophyre clasts. In contrast to the intrusion breccias, the heterolithic intrusive breccias contain abundant clasts of phonolite-trachyte, with subordinate syenite, and lamprophyre in a fine-grained carbonate-K feldspar-biotite-sulfide matrix. The sulfides are oxidized in surface exposures, and the carbonate is dissolved and replaced by silica and iron oxides. The Bull Hill and Carbon Hill diatremic breccias are the most prominent examples of the heterolithic intrusive breccias. Carbonatite and silicocarbonatite dikes intrude the heterolithic breccias and are late in the igneous sequence. Lamprophyre, pseudoleucite phonolite porphyry, and latite dikes are also late in the intrusive sequence. Most of the rock units are affected by widespread potassic alteration and have a thick near-surface oxidized/weathered zone.

Geological events that can be interpreted in the core of the complex include multiple intrusions of dominantly porphyritic phonolite and trachyte, multiple brecciation events, carbonatite magmatism, alkali-ferric iron metasomatism (fenitization), hydrothermal alteration, and supergene oxidation. Pre- intrusion, syn-intrusion, and post-intrusion faulting and deformation disrupt the geology, although displacements appear to be relatively small. Soil and alluvial cover is extensive. Surface rock exposure in the complex is probably on the order of five percent or less, which further complicates interpretation of the geologic and hydrothermal history. Major structural trends are oriented west-northwesterly, northwesterly (parallel to the elongation of the complex), and northeast or east-northeasterly. The complex plays host to a variety of mineralization types, including gold (Au), lanthanides (rare earth elements), base metals (copper/Cu, lead/Pb, zinc/Zn, and molybdenum/Mo), and thorium (Th). Intrusive rock types, mineralization, and alteration patterns share many features with the Cripple Creek complex in Colorado.

Major intrusive rock units listed in approximate order from youngest to oldest units include the following:

Carbonatite: Carbonatite intrusions range from microveinlets up to dikes approaching 80 feet (24.4 m) in width. They are encountered primarily in drill core, except for the outcrop on Carbon Hill, and represent one of the latest igneous intrusive events in the district. Drilling data indicate that the dikes most commonly strike northwesterly and dip steeply to the southwest or northeast. The carbonatitic rocks can be classified as either sovite (calcitic carbonatite) or silicocarbonatite.

Sovite: Sovite consists of fine to coarsely crystalline calcite, with a range of essential to accessory minerals that may include biotite, K-feldspar, apatite, clinopyroxene, strontianite, dolomite, barite, celestite, sulfides, Fe-Ti oxides, and REE and thorium minerals. Sulfide and oxide minerals may include pyrite, pyrrhotite, chalcopyrite, specularite, galena, sphalerite, rutile, ilmenite, and molybdenite, and total sulfide abundances (mostly pyrite and pyrrhotite) range from trace amounts to 30 percent. Fluorite is very rare in carbonatites.

Silicocarbonatite: Silicocarbonatite is carbonatite with 30-50% silicate minerals. In the Bear Lodge district silicocarbonatite contains calcite with significant biotite or phlogopite and K-feldspar ± accessory aegirine, apatite, strontianite, barite, celestite, sulfides, Fe-Ti oxides, and REE and thorium minerals. Sulfide and oxide minerals include pyrite, pyrrhotite, chalcopyrite, specularite, galena, sphalerite, and rutile. Silicocarbonatite occurs often as contact zones enveloping a sovitic carbonatite core.

Rare-earth mineral abundances in carbonatite range from trace amounts to more than 20%, while REE minerals tend to be significantly less abundant in silicocarbonatite.

Intrusive breccia: Intrusive breccia has a rock flour matrix enveloping abundant clasts of trachyte and phonolite ± minor pseudoleucite, lamprophyre, and syenite porphyry clasts. The unit can be either matrix or clast supported. Heterolithic intrusive breccias occur as diatremes, and as small dike-like bodies. Carbon Hill and Bull Hill are the two most important examples of large diatremic breccia bodies. (Note: A diatreme is defined as a breccia-filled volcanic pipe that was formed by one or more gaseous explosions.

Intrusion breccia: The intrusion breccias are composed of trachytic or phonolitic clasts dispersed in an igneous matrix of the same composition. Intrusion breccias are often contact breccias along the margins of intrusive bodies.

Pseudoleucite porphyry: Pseudoleucite porphyry occurs as small dikes that post-date trachyte/phonolite, and as rare clasts within parts of some heterolithic breccias. The porphyry is characterized by pseudoleucite and sanidine phenocrysts set in a dark brown to greenish grey, fine grained groundmass of devitrified glass, nepheline, K feldspar, biotite, sodic pyroxene, and sulfides. Andradite garnet can occur rarely as both phenocrysts and groundmass. Pseudoleucite porphyry and heterolithic intrusive breccia host low-grade gold mineralization in the East and West Breccia deposits in Section 21.

Trachyte-phonolite porphyries: Trachyte-phonolite porphyries form stocks and sills in the core of the intrusive complex and are the most abundant lithology type. Trachyte and phonolite are associated with syenite in parts of the complex, and they can be found as extrusive flows locally along the outer margin. Trachyte and phonolite are often difficult to distinguish in the field, owing to fine grains size and/or hydrothermal alteration.

Unoxidized trachyte and phonolite are light to dark grey or greenish grey in color. They contain sparse to abundant sanidine phenocrysts ± subordinate phenocrysts of clinopyroxene, biotite, and/or feldspathoids dispersed in a fine-grained, aphanitic groundmass of alkali feldspar ± devitrified glass, nepheline and/or sodalite, biotite, augite, alkali amphibole, and/or sulfide. Both trachyte and phonolite may exhibit trachytic texture. Disseminated pyrite is common. Phonolite is distinguished in the field by the presence of feldspathoid phenocrysts. Some of the trachyte is carbonate-flooded at the surface and at depth.

Syenite: Syenite is interpreted to be the coarse-grained equivalent of the trachyte/phonolite porphyry unit, and some variations are gradational with it. The unit includes syenite, nepheline syenite, and microsyenite lithologies and their porphyritic equivalents. Syenitic rocks are light to medium grey and range from fine grained (microsyenite) to medium or coarse grained. They are composed of alkali feldspar ± subordinate nepheline, biotite, clinopyroxene, alkali amphibole, hornblende, sphene, olivine, magnetite and pyrite. Allanite, apatite, pyrrhotite, and ilmenite may be present rarely as accessory phases. Syenitic rocks are often carbonate-flooded with calcite microveinlets and patchy calcite replacement of phenocrysts and groundmass below the zone of oxidation.

Lamprophyre: Lamprophyric rocks can occur both early and late in the intrusive sequence. They are dark grey to black and fine grained. They contain a variable assemblage that may include biotite, pyroxene, alkali feldspar, nepheline, and/or sulfides, and mafic mineral abundances may exceed 50 percent. Sulfide mineralogy is principally pyrite, and magnetite is a common accessory. Carbonate can occur in ocellar patches in association with apatite. The lamprophyres occur in dikes and in local intimate association with syenite. Lamprophyre dikes intrude the Bull Hill diatreme.

7.3.2 Alteration

Hydrothermal alteration identified in the Bear Lodge alkaline-igneous complex is dominated by K- feldspar-pyrite alteration and/or fenitization (alkali-ferric iron metasomatism). Carbonate alteration is common, but not as widespread as the potassic alteration. Carbonate is leached from many surface exposures during supergene oxidation of pyrite. Minor amounts of argillization, sericitization, and silicification are noted locally.

The greatest concentration of REE-mineralized carbonatite dikes and veins occurs in the vicinity of the Bull Hill diatreme. Beneath the oxidation zone, the heterolithic intrusive breccias of the Bull Hill diatreme are characterized by a variety of alkaline igneous clasts in a matrix of K feldspar, biotite, carbonate, and pyrite. Carbonate is largely absent within the zone of supergene oxidation, apparently replaced by silica and limonitic FeOx. Sulfides are strongly oxidized to limonite ± hematite, and biotite/phlogopite exhibits variable moderate to strong oxidation, as well. It is difficult to discriminate alteration related to the intrusion of the carbonatitic bodies, although stockworks of hairline calcite veinlets and patchy replacement of K feldspar and biotite may be related to the carbonatite intrusions. Many of the clasts are carbonate-flooded and some exhibit pyritic reaction rims. Fenitization (alkali-ferric iron metasomatism), an alteration type often associated with carbonatites, is spotty in the Bull Hill area, based on petrographic examination of drill core and K abundance measurements made at the surface with a gamma ray spectrometer. Pyrite is essentially the only sulfide phase in the breccia matrix and clasts, although a variety of sulfide phases occurs in the carbonatite.

FeOx-MnOx-REE (FMR) dikes and veins are interpreted to represent primary carbonatite that was subjected to heavy supergene oxidation and weathering. They consist primarily of iron and manganese oxides and amorphous silica, along with variable abundances of silicate and accessory minerals. Silicate and accessory minerals include biotite, quartz, chalcedony, K feldspar, apatite, barite, and celestite. The FMR veins and dikes can also host significant supergene REE minerals, generally of the bastnasite group. The FMR material occurs as stockwork veinlets, veins and dikes throughout the oxidation zone. Toward the bottom of the oxidation zone, the FMR veins become transitional to carbonatite and carry residual carbonate and sulfide, along with mixed primary and supergene REE mineralogy. In some of the drill holes, friable FMR and transitional carbonatite dike material were washed away during the drilling process, and a negative sampling bias is likely in the zones of more friable FMR.

Fenitization, or alkali-ferric iron metasomatism, is widespread across the Bear Lodge property and may be genetically related to carbonatite intrusion. Fenitized rocks are often difficult to recognize in the field or in drill core, except in the case of altered Precambrian granitic rocks, where the dissolution of quartz strongly suggests interaction with alkali-ferric iron-rich fluids. The effect of fenitization in the Bear Lodge alkaline igneous rocks is the destruction of primary magnetite, the replacement of primary plagioclase by K feldspar, and the substitution of Fe3+ for Al3+ in the lattice structures of the feldspars. Fenitization was identified across the Bear Lodge property in a series of studies that utilized the cathodoluminescence petrographic method. The fenite alteration may be accompanied by the precipitation of LREE-enriched apatite or the LREE enrichment of primary apatite, and by sulfide deposition. This alteration, its distribution, and paragenesis were described in a Newmont-sponsored M.S. thesis at the University of Idaho (J. Felsman, 2009). Duval drill hole WBD-12, collared south of Carbon Hill, intersected high-grade copper-silver mineralization in a massive fenite halo on a carbonatite dike.

7.3.3 Mineralization

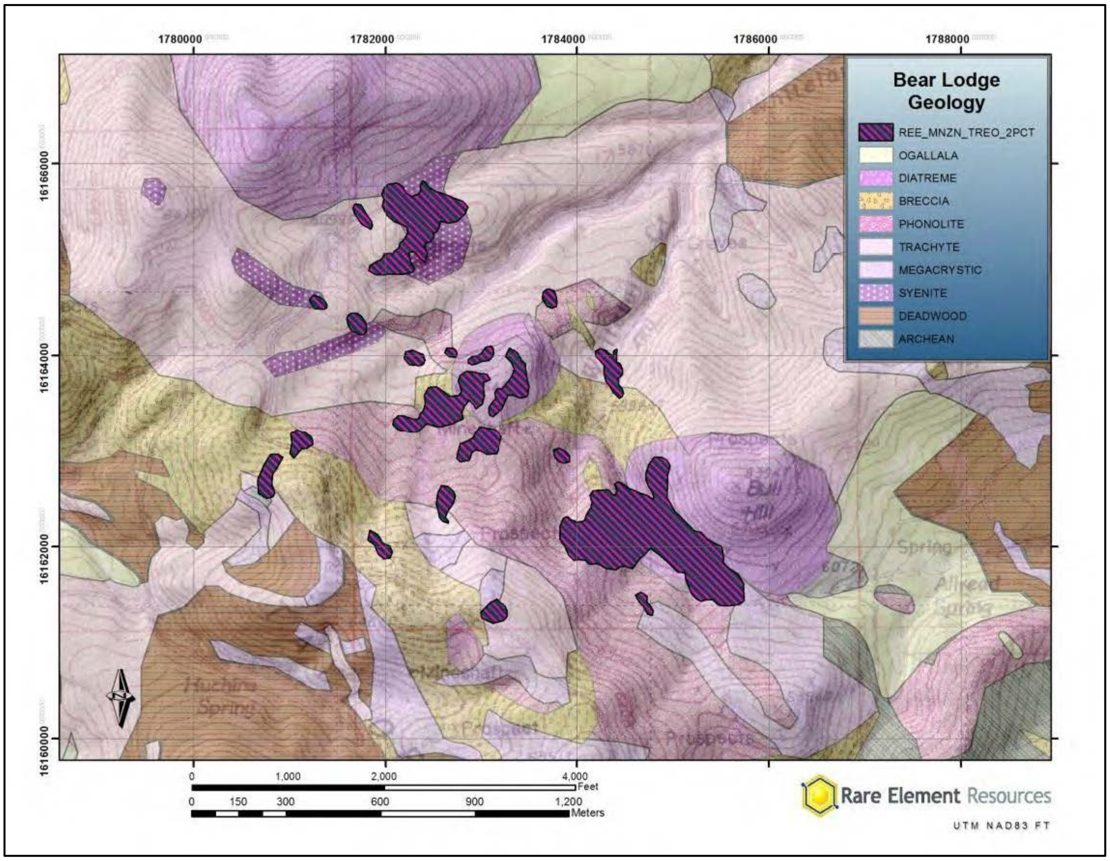
The Bear Lodge intrusive complex hosts a variety of mineralization types, including gold, lanthanides (rare earth elements), base metals (Cu, Pb, Zn, and Mo), thorium (Th), and uranium (U). The Bear Lodge REE deposits are contained within carbonatite and carbonatite-related dikes, veins, and stockwork. Gold is generally associated with potassic alteration that may overlap or halo strong REE mineralization. Gold may be both structurally controlled and disseminated.

The Bear Lodge intrusive rock types, and patterns of alteration and mineralization, share many features with the Cripple Creek alkaline igneous complex in Colorado. In both districts, REEs and Au are spatially related, but the highest concentrations of REEs and Au are not necessarily coincident. The Bear Lodge REE deposits exhibit a pronounced zonation between LREE- and HREE-enrichment. The Bull Hill deposit is enriched in light rare earth elements (LREE), while peripheral deposits at Whitetail Ridge, Carbon, and Taylor are characterized by relative enrichment in heavy rare earth elements and yttrium (HREE's and Y), as well as gold. In the Cripple Creek deposit, the REE minerals, bastnasite and monazite, are common in gold telluride veins, while apatite with LREE-enriched rims is common in wall rocks adjacent to the Au-bearing veins. The Bear Lodge property hosts a significant REE deposit central to several small peripheral gold mineralized materials, in contrast with Cripple Creek, which hosts a significant gold deposit and associated minor REE-enrichment. More detailed descriptions of the geology, alteration, and mineralization associated with the Bear Lodge REE and gold mineralized material deposits and significant mineralized zones are provided below.

7.4 Bear Lodge REE Project Geology

The Bear Lodge REE deposits are located in the northern lobe, and near the axis of, the northwest-trending elongate dome forming the Bear Lodge Mountains. They are associated with carbonatite and silicocarbonatite dikes, veins, and stockwork that intrude the Bull Hill and Whitetail diatreme bodies and their host trachyte and phonolite intrusions. The northwest alignment of diatreme pipes extends from Bull Hill through Whitetail Ridge, to Carbon Hill, and coincides with numerous north- to northwest-striking alkaline igneous dikes and mineralized zones (Figure 7.3). Carbonatite and silicocarbonatite dikes intrude diatremes, heterolithic breccias, and surrounding trachyte, phonolite, and igneous intrusion breccia. They commonly strike northwesterly to northerly. Within the Bear Lodge REE deposit, the main carbonatite and silicocarbonatite dikes are generally concentrated within the margins of the diatreme, with smaller dikes and veinlets extending outward into the adjacent wall rocks along a northwest-trending corridor that extends from the south and west flanks of Bull Hill, through the Whitetail diatreme, towards the Carbon Hill diatreme.

Figure 7.3 - Geology of the Bear Lodge Project area



(John Ray, Rare Element, 2013)

Major structural trends are oriented west-northwest, northwest (parallel to the axis of the dome), north, and northeast or east-northeast. Widespread thin soil cover and lack of outcrop hinder structural mapping and interpretation. Surface rock exposure in the complex is probably on the order of 5% or less. Data obtained between 2011 and 2013 from surface mapping of drill pads, roads, and trenches, along with borehole televiewer data and detailed geological cross sections support earlier district-wide observations that indicate a predominant orthogonal set of northwest and northeast structures, as well as subordinate north-northwest, east-northeast, and northerly trending structures. Geophysical surveys (magnetics, radiometrics, and IP/resistivity) are in accord with the field data. Emplacement of REE mineralized carbonatite and carbonatite-related dikes, veins, and stockwork is controlled primarily along the northwesterly structures, with subordinate controls along northerly and east-northeasterly structures. Carbonatite-related REE mineralization extends along the northwesterly trending zone for more than 1800 meters (Figure 7.3)

Most of the rock units within the project area are affected by widespread potassic alteration and have a thick near-surface oxidized zone. Recognizable hydrothermal alteration includes pervasive fenitization (alkali-ferric iron metasomatism), K-feldspar-pyrite alteration, minor silicification, and localized argillic alteration, along with superimposed oxidation and surface weathering.

Geological events that are interpreted in the core of the complex include multiple intrusions of dominantly porphyritic phonolite and trachyte, multiple brecciation events, a primary diatreme event that hosts carbonatite magmatism, alkali-ferric iron metasomatism (fenitization), hydrothermal alteration, REE and gold mineralization, and supergene oxidation. Pre-intrusion, syn-intrusion, and post-intrusion faulting and deformation disrupt the geology, although displacements appear to be relatively small.

7.5 Bear Lodge Deposit Alteration and REE Mineralization

REE mineralization in the Bear Lodge deposit is contained primarily within dikes, veins, and stockwork of carbonatite, variably oxidized and leached carbonatite (transitional and oxide-carbonate), and FMR. The latter two types of mineralization represent progressive degrees of hydrothermal and supergene alteration of the carbonatite that generally decrease with increasing depth. The FMR dikes and veins are typically black to rusty brown in color. Many are friable, and drill recoveries are often poor. However, some of the FMR bodies were subject to late silicification and may be highly competent. REE grades tend to be higher in the FMR bodies than in the corresponding carbonatite and can reach more than 20% TREO. The FMR bodies and mineralization style tend to persist to depths of 500 feet (152 m) or more beneath the surface.

Within the overall deposit, REE mineralization is concentrated in three main resource areas, described in the next section (Chapter 8.0). These include: Bull Hill (formerly known as Bull Hill Southwest, and including Bull Hill West), Bull Hill Northwest, and the Whitetail Ridge resource areas. The greatest concentration of REE-mineralized bodies occurs in NW-trending dike swarms and stockworks in the Bull Hill resource area. Overall, the REE mineralization extends for more than 1800 meters along the northwesterly trend (Figure 7.3). Individual dikes can reach 80 feet in width (24.4m). The REE mineralization is open at depth, based on existing drilling, but the REE mineralization types are zoned with depth. The generalized vertical distribution of REE mineralization types in the Bull Hill and Whitetail resource area is shown schematically in Table 7.2, with descriptions following.

Table 7.2 - Zonal REE Mineralogy in the Bull Hill and Whitetail Carbonatite and Derivative Dikes and Veins from the Surface to Depth

Zone	Mineralized Body	REE Mineralogy
Oxide	FMR dikes and veins; oxidized and leached carbonatite (surface to appx. 5,600 feet/ 1,707 meters) elevation ±300-500 feet (91-152 meters) thickness) FeOx-MnOx-REE ± Ksp, ap, Q, bi	Bastnasite group minerals (bastnasite-dominant), monazite, ± variable, but generally subordinate cerianite
Oxide-Carbonate	Variably oxidized and partially leached carbonatite (variable thickness, surface to appx. 5,600 feet/1,707 meters elevation) FeOx-MnOx-REE-calc ± Ksp, ap, Q, bi	Bastnasite group minerals (bastnasite-dominant), ancylite, monazite, ± variable, but generally subordinate cerianite
Transitional	Partly oxidized carbonatite (appx. 5,600 feet/1,707 meters elevation): about 20 feet/6.1 m thick Calc-REE-sulf-FeOx-REE ± Ksp, ap, aeg, bi	Predominantly ancylite; minor to significant bastnasite group minerals, ± monazite
Sulfide	Unoxidized carbonatite and silicocarbonatite (< 5,600 feet/1,707 meters elevation) Calc-REE-sulf (py-po±cp,sl,gn,mb)-bi ± Ksp, ap, aeg	Predominantly ancylite; minor to significant bastnasite group minerals; ± minor monazite, carbocernaite, burbankite

(Noble et al, 2013)

7.5.1 Unoxidized Zone

The upper contact of the unoxidized, or sulfide-bearing, zone is generally relatively flat-lying, and extends from depth upward to within approximately 600 feet (183 meters) of the surface, locally deeper along structural zones. The bottom of this zone has not been reached by drilling. The unoxidized zone is characterized by rare earth mineralization accompanied by sulfides, but with no oxidation or apparent leaching of carbonate minerals. REE mineralization in the carbonatite consists primarily of ancylite (Sr (La, Ce) $(CO_3)_2OH•H_2O$) and subordinate bastnasite group minerals (REE fluorocarbonates that include bastnasite, parisite, and synchysite) ± minor monazite (Table 7.2). The presence of carbocernaite [(Ca,Na)(Sr,Ce,Ba)(CO3)2] and/or burbankite [$(Na,Ca)3(Sr,Ba,Ce)3(CO3)5$] is noted rarely in some dikes. Ancylite forms stubby, prismatic crystals that are intimately intergrown with strontianite and minor barite ± minor bastnasite group REE minerals in hexagonal pseudomorphs after an earlier REE phase (possibly burbankite).

Ancylite and the bastnasite group REE minerals may occur also as discrete phases intergranular to the gangue minerals. The gangue mineralogy in the carbonatite is dominated by calcite, with subordinate amounts of sulfide minerals ± biotite, apatite, sanidine, barite, and strontianite.

The sulfide minerals are present in amounts from less than 5% (locally less than 1%) to more than 20% and include pyrrhotite and pyrite ± minor amounts of chalcopyrite, galena, sphalerite, and/or molybdenite. Pyrite is commonly the most abundant sulfide phase, although it is not uncommon for pyrrhotite to be the most abundant sulfide. Sulfides are always unoxidized in this zone. Rare earth grades in the carbonatite can reach in excess of 10% TREO, although average grades of the dikes are less than 3% TREO.

There are no mining activities planned for the unoxidized mineralization in the near future, since a mineable reserve estimate and a viable metallurgical process have not been developed. Current mining plans will leave a buffer of oxidized mineralization over the unoxidized minerals to prevent oxidation.

7.5.2 Transitional Zone

Directly overlying the unoxidized zone is a narrow, conformable, flat-lying zone, generally less than 20 feet (6 m) thick, and characterized by carbonatite-style mineralization with variable sulfides and variable indications of gangue mineral leaching. Between 10% and 90% of the sulfides are oxidized to limonite. The transitional zone grades rapidly upward into the oxide-carbonate zone. It occurs at depths of 500 to 600 feet (152-183m) beneath the surface.

7.5.3 Oxide-Carbonate Zone

The oxide-carbonate (OxCa) zone generally occurs at the base of the oxidized zone, but may reach the surface in places. It extends to nearly 500 feet (152m) in depth. The OxCa zone overlies the transitional zone and extends lateral to, or beneath, the oxidized zone. It is characterized by moderately to strongly oxidized carbonatite, with less than 10% residual sulfides.

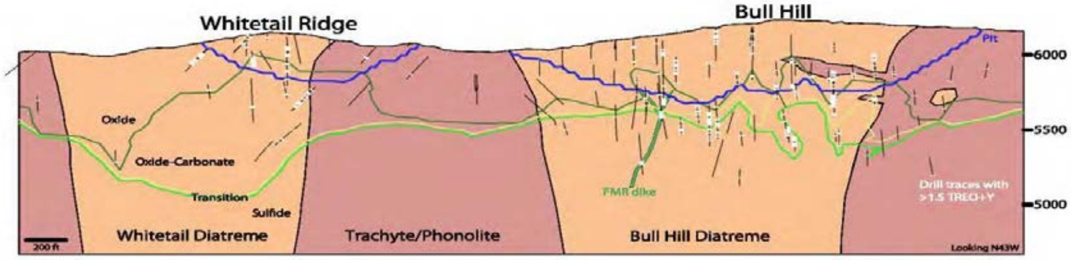
The oxide-carbonate zone (OxCa) is visually similar to oxidized mineralization in the overlying oxide/FMR zone, with all or nearly all of the sulfide minerals oxidized and residual matrix carbonate greater than 1.5 percent. The rare earth mineral assemblage consists of variable proportions of fibrous bastnasite group minerals, stubby ancylite, and generally subordinate monazite and cerianite. Hexagonal pseudomorphs occur also in this zone and contain bastnasite group minerals and/or ancylite accompanied by strontianite and barite. Bastnasite appears to form largely from the partial to nearly complete replacement of ancylite. The upper boundary of this zone is irregular, and locally shallows above some of the more robust dike zones.

7.5.4 Oxide Zone

The oxide zone extends from the surface to depths of up to 600 feet (183m). FMR dikes and veins within the oxide zone represent primary carbonatite that was subjected to intense oxidation and complete to nearly complete leaching of gangue carbonates. FMR consists primarily of iron and manganese oxides and amorphous silica, along with variable abundances of silicate and accessory minerals that may include biotite, quartz, chalcedony, K feldspar, apatite, barite, and celestite. The FMR veins and dikes host significant hydrothermal or supergene REE minerals, dominantly bastnasite group minerals, with subordinate monazite and cerianite. The FMR material occurs as stockwork veinlets, veins, and dikes throughout the oxidized zone.

A schematic cross section of the Bull Hill dike and vein swarm is shown in Figure 7.4. Selected significant drill intercepts, alteration zones, and mineralization types are summarized in the figure.

Figure 7.4 - Schematic Cross-Section of the Bull Hill Dike and Vein Swarm(Looking N45W)



(Black Scale Bar = 200 ft.)

(Rare Element, 2013)

7.5.5 Stockwork Mineralization

The stockwork mineralization consists of zones of intersecting veins and veinlets that tend to occur as envelopes along and between larger FMR/carbonatite veins and dikes. Stockwork-type mineralization is common in all of the REE mineralization types summarized in Table 7.2. Individual veinlets can range from sub-millimeter to meter widths and exhibit either random orientation or orientation sub-parallel to the major dikes and veins. REO grades in the stockwork mineralization tend to be lower than in the dikes and larger veins, with a range between approximately 0.5% and 3% TREO. Vein densities vary widely, with higher vein densities and abundance of contained vein material generally corresponding to higher REO grades within a given stockwork zone. The stockwork style of mineralization contributes significantly to the contained REO resource in the Bull Hill, Bull Hill NW, and Whitetail Ridge resource areas, and in the Carbon and East Taylor target areas. Recognition and quantification of this category of mineralization will be an important component in the mine grade control plan.

7.6 Bear Lodge District REE Zonation

The Bear Lodge REE deposits (oxidized and OxCa) in the Bull Hill area are generally LREE-enriched, with the bulk of the REE's contained in bastnasite group minerals and variable, but subordinate, monazite and cerianite. Exploration drilling of the Whitetail resource area and the Carbon and East Taylor target areas in 2010 through 2013 led to the recognition of an apparent district zonation of LREE- and HREE-enrichment, in which the western and northern areas are enriched in HREE. Preliminary mineralogical studies and assay data suggest that the HREE may be hosted in HREE-enriched bastnasite group minerals at Whitetail Ridge and Carbon, and in HREE-enriched bastnasite group minerals, along with xenotime/rhabdophane and yttrium-vanadium phosphate at East Taylor. Monazite at Whitetail Ridge, Carbon, and East Taylor appears to be enriched in Nd, but not generally in HREE. Table 7.3 summarizes the REE mineralogy in the Oxide and OxCa zones at the Bull Hill and Whitetail Ridge resource areas and the Carbon and Taylor target areas.

Table 7.3 - Oxide Zone REE Mineralogy Distribution of the Bear Lodge REE District

Area	REE Mineralogy
Bull Hill Resource Area	bastnasite group minerals; monazite; cerianite; REE-MnOx
Whitetail Ridge Resource Area)	bastnasite group minerals (Y, Th); cerianite; monazite (Nd, Sr, Th); REE-MnOx
Carbon REE	bastnasite group minerals (Y, Th); apatite
East Taylor)	bastnasite group minerals (Y, Th); monazite (Nd, Sr, Th); cerianite; REE-MnOx; xenotime/rhabdophane; Y-V phosphate

(Modified from Noble et al, 2013)

8 Deposit Types

8.1 Introduction

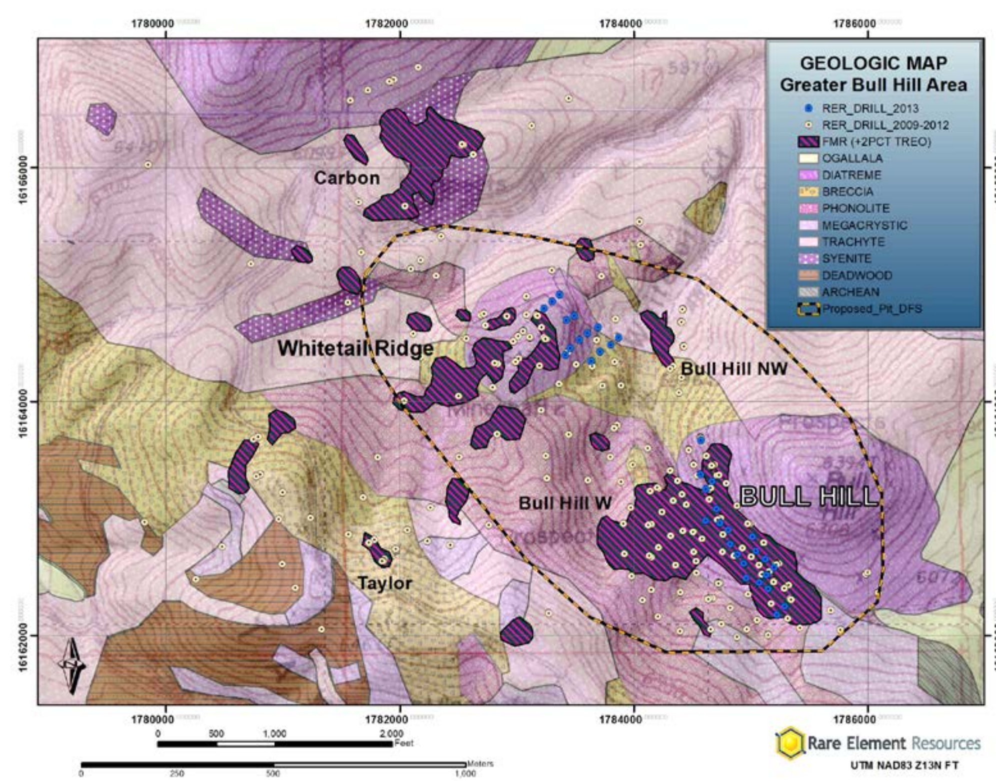
This section discusses the characterization of the rare earth deposit types within the Bear Lodge REE district, based on the most current geological and mineralogical data accumulated through 2013.

8.2 Carbonatite-Hosted Rare Earths

The USGS stated that the Bear Lodge Mountains contain one of the largest deposits of disseminated rare earth elements (REE) in North America (Staatz, 1983). REE-mineralized carbonatites were discovered and defined during exploration of the Bear Lodge Project area over the past forty years. The carbonatites occur within an alkaline intrusive complex and share similarities with the Mountain Pass (California) carbonatite-hosted rare earth deposit and with the Mount Weld Carbonatite-hosted REE deposit in Western Australia. The geological and mineralogical characteristics of these two REE deposits can serve as exploration models for the current project. Based on knowledge of carbonatite-hosted REE deposits, including the two aforementioned, Rare Element Resources conducted detailed exploration of the Bear Lodge property between 2004 and 2013, using a variety of geological, geochemical, and geophysical methods, as well as historic exploration data from other companies that had worked previously on the property, to identify a series of exploration targets. Exploration methods included detailed geological mapping, structural studies, soil and rock chip geochemical surveys, and airborne and ground geophysical surveys. The latter included magnetics, radiometrics, gravity, and CSAMT. The database developed from this work was utilized to develop sophisticated targeting methods. Drilling based on this work defined the Bull Hill and Whitetail deposits under current development, and confirmed the potential of adjacent target areas at Bull Hill Northwest, Carbon, and Taylor.

The Bear Lodge REE deposit comprises three main resource areas: Bull Hill (includes Bull Hill West); Bull Hill Northwest, and Whitetail Ridge, plus several exploration targets that may contain resources but need further work (Figure 8.1). These three deposits contain carbonatite-related dikes and veins that range in size from hairline fracture veinlets to dikes that may exceed 80 feet (24.4m) in width. The higher-grade REE-bearing dikes and veins are commonly surrounded by lower-grade stockworks of veinlets. Oxidized mineralization (FMR and OxCa) extends to depths of 500 to 600 feet (152 to 183 meters) beneath the surface and contains the mineral resource described in this report (contained within the oxide and OxCa alteration zones described in Chapter 7.0). Oxide zone REE mineralization is dominated by rare earth minerals of the bastnasite group, with variable, and typically subordinate, quantities of monazite and cerianite. Oxide-carbonate mineralization contains a variable mix of bastnasite group minerals and ancylite, with varied and subordinate quantities of monazite and cerianite.

Figure 8.1 - Locations of REE Resource Areas, Bear Lodge Deposits and REE Target Areas



(Rare Element, 2013)

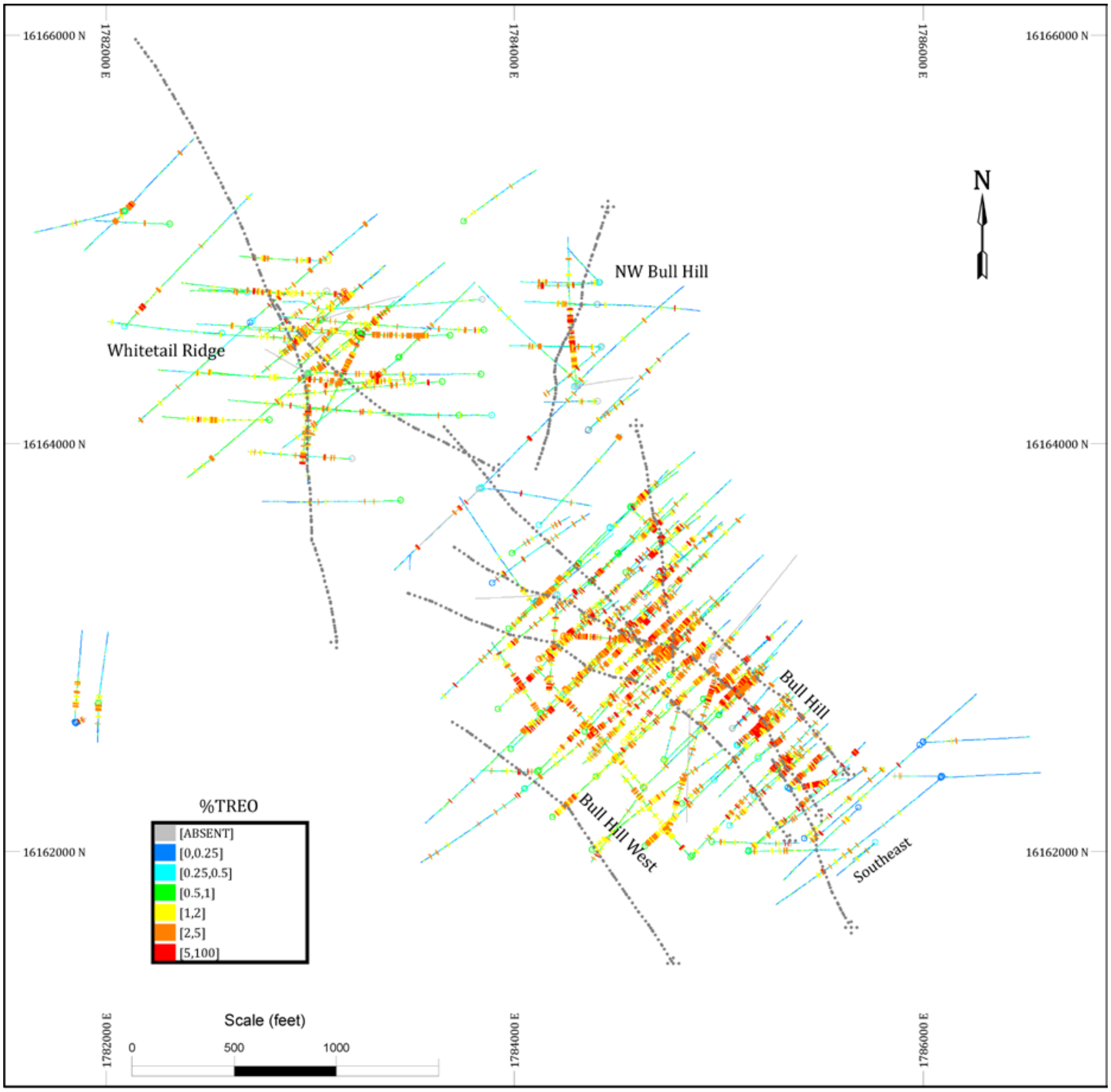
The highest concentration of REE-mineralized bodies occurs in a series of steeply dipping, northwest and lesser north-trending dike swarms and stockworks along the western contact zone between the Bull Hill diatreme and enveloping trachytic and phonolitic intrusive rocks. The Bull Hill deposit area forms the bulk of the Bear Lodge REE deposit and generally exhibits light REE-enrichment (LREE); defined as cerium (Ce), lanthanum (La), neodymium (Nd), praseodymium (Pr), and samarium (Sm). The Bull Hill mineralized zone extends approximately 1,700 feet (518 meters) in a north-westerly direction, by 300 feet (91 meters) to more than 700 feet (213 meters) in a north-easterly direction, reflecting the overall orientation of a relatively persistent swarm of steeply dipping, northwest-striking dikes and veins of FMR and carbonatite (Figure 8.2). Individual dikes display traceable strike lengths of 300 to 800 feet (91 to 244 meters), down dip extensions of 300 feet (91 meters) to more than 800 feet (91 meters), and thicknesses of less than 10 feet (3 meters) to more than 80 feet (24.4m). Individual dikes can pinch, swell, and bifurcate along strike and down dip. These generally follow the interdigitating contact between the Bull Hill diatreme and adjacent trachyte and phonolite.

Drilling shows that the southern two thirds of the dike swarm east of the Whitetail Creek drainage include a persistent northwest-striking zone of dikes, veins, and stockwork. Within this zone is a relatively continuous dike, locally more than 80 feet (24.4m) thick and steeply dipping to vertical, and multiple subparallel dikes and stockwork zones. In general, the main dike zone appears to follow the interfingering contact between diatreme breccia and the host trachyte-phonolite unit in the southern portion of the Bull Hill deposit. Increased density of drilling through 2013, as well as limited surface mapping and trenching, define a more complex distribution of mineralization in the northern third of the deposit. The NW-trending zone described above contains northerly-striking splays at either end. At the northern end of the NW-trending zone, the main dike splits at an inflection point into a horsetail that consists of a more WNW-trending set of dikes and stockwork, and another set of smaller NNW-trending dikes and stockwork zones (Figure 8.2). Zones of moderate to strong stockwork are observed between the dike splays.

Drilling through 2013 indicates that FMR and carbonatite dikes, veins, and stockwork extend west of the drainage that borders the west flank of Bull Hill and are variably hosted by diatreme, trachyte, and phonolite (Bull Hill West). To the south of Bull Hill, mineralization may be offset along an easterly-trending fault, or feather out close to the boundary with Section 20, which is withdrawn currently from mineral entry and drilling. Structural orientation, the diatreme contact, and host rock lithology exhibit a complex interplay of controls on the localization of mineralization in the Bull Hill resource area.

REE mineralization in the Bull Hill Northwest resource area is contained within dikes, veins, and minor stockwork of FMR and carbonatite/silicocarbonatite that intrude trachyte and phonolite. Less well-understood, owing to decreased drilling densities compared with the Bull Hill resource area, the dikes, veins, and stockwork zones are northerly trending, steeply dipping to vertical, and relatively narrow and broadly spaced. Individual dikes appear to have strike lengths of less than 100 feet (30 meters), down dip extensions to more than 200 feet (60 meters), and thicknesses to 10 feet (3 meters). The oxide zone extends downward to a relatively flat-lying contact with a narrow oxide-carbonate zone that is conformable with a narrow transition zone (unlike the irregular oxide/oxide-carbonate upper contact at Bull Hill that extends locally to the surface).

Figure 8.2 - Plan View of Drill Hole Traces and Mineralized Intercepts Projected to the Surface



Coordinates are UTM Zone 13, NAD 83, US Survey Feet

(A. Noble, 2013)

Pre-existing fractures in more competent host rock in this area may have influenced the northerly orientations and size of the dikes and veins. The size and spacing of veins, elevated original sulfide content, and faults or structural zones may have enhanced leaching of gangue carbonate during oxidation, leaving little to no oxide-carbonate zone. In the Bull Hill Northwest resource area, structure appears to be the dominant control on the localization of mineralization, and there may be additional mineralized zones to the north.

REE mineralization in the Whitetail Ridge resource area is contained within discontinuous dikes, veins, and stockwork FMR, and carbonatite/silicocarbonatite hosted primarily by heterolithic breccia of the Whitetail diatreme. Higher-grade mineralized zones typically contain narrow, steeply dipping dikes and veins up to 10 feet (3 meters) in thickness. The dikes appear to be emplaced along WNW and NNW to N-S structures that run through the Whitetail diatreme. Based on the resource in Chapter 14, this area exhibits an overall HREE enrichment of about 1.89 times that of the Bull Hill resource area, with variable, and subordinate, quantities of monazite and cerianite accompanying the bastnasite group minerals. In addition, the bastnasite group minerals exhibit variable Ce depletion and common enrichment in Nd, Y, and Th. Monazite shows significant Nd and Th enrichment (relative to Bull Hill), as well. The oxide to oxide-carbonate boundaries are variable in the area, more similar to zones observed at the Bull Hill resource area.

Lithology and structure appear to exert significant control on the localization of mineralization in the Whitetail Ridge resource area. The diatreme appears to have been relatively permeable and less brittle than host rocks in the other resource areas. Mineralization is dominantly hosted within discontinuous stockwork veinlets and hairline fractures (referred to as disseminated deposits by Staatz, 1983).

HREE-enriched FMR veins and stockwork zones were drilled between 2010 and 2012 in two additional target areas – Carbon and East Taylor (Figure 8.1 RER Technical Reports dated April 13, 2012 and June 26, 2013). They are particularly enriched in europium, terbium, dysprosium, gadolinium, and yttrium (Eu, Tb, Dy, Gd, and Y, respectively). Carbon is located approximately 800 feet (244 meters) northwest of the Whitetail Ridge resource area (Figure 8.1, e.g., drill hole SUN-079). FMR veins and stockwork at Carbon are locally silicified and hosted by phonolite, trachyte, and syenite. The East Taylor target is located approximately 2,500 feet (760 meters) west of the main Bull Hill resource area, and 2,500 feet (760 meters) southwest of the Whitetail Ridge resource area (Figure 8.1). Steeply dipping FMR veins and stockwork are hosted by trachyte and minor Deadwood Formation sediments, and define a zone that may extend more than 700 feet (213 meters) east-west by 250 feet (76 meters) north-south. No resource estimates have yet been conducted for the Carbon and East Taylor target areas, but more drilling is planned in the future to further delineate the extent, orientation, and degree of HREE enrichment of mineralization in these areas.

8.3 Pre-Assessment of the Distribution of Thorium & Uranium at the Bull Hill REE Deposit

Thorium and uranium abundances in Measured and Indicated resources at the Bull Hill and Whitetail Ridge REE deposits are listed in Table 8.1, and thorium and uranium residence in mineral phases is summarized in Table 8.2. There is a wide range of thorium and uranium abundances in the mineralized bodies that probably reflects variations in the proportions of thorium and uranium-bearing mineral phases. Average thorium and uranium abundances are given below and expressed as abundance in ppm per one percent of REO abundance.

Table 8.1 - Thorium and Uranium Abundance

Element	Range (ppm/1% REO)	Average (ppm/1% REO)
Thorium	37-429	134.7
Uranium	3-120	31.2
Thorium + Uranium	40-441	165.9

(A. Noble 2014)

Table 8.2 - Thorium & Uranium-Bearing Mineral Phases Associated with the Bear Lodge REE Deposit

Mineral Phase	Formula	Occurrence	Importance
Monazite	$(Ce,La,Nd,Th)PO_4$ (May contain multiple percent Th and minor U)	Variable distribution in REE-mineralized dikes and veins. May constitute up to 1/3 of REE minerals locally, but generally minor abundance.	High
Thorianite and Thorite	ThO_2 and ThSiO4 (Primary Th minerals)	Variable distribution in REE-mineralized dikes and veins.	Low to Moderate
Pyrochlore (betafite)	$(Ca, U)_2(Ti, Nb, Ta)_{2O6}(OH)$	Identified tentatively as trace accessory in oxidized REE mineralized dikes and veins.	Low
Uranpyrochlore	$(U,Ca,Ce)_2(Nb,Ta)_2O_6(OH,F)$	Trace accessory in host rocks.	Low
Britholite	$(Ce,Ca,Th,La,Nd)_5(SiO_4,PO_4)_3(OH,F)$	Trace accessory noted in some gold-bearing veins outside zone of REE mineralization.	Low

(A. Noble, 2014)

Minor amounts of thorium and uranium may also be present in the primary REE minerals, the REE fluocarbonates (bastnasite, parisite, and synchysite) and ancylite (hydrous Sr-REE carbonate), but thorium and uranium do not appear in the literature as essential components of these phases. Thorium abundances appear to be higher in bastnasite group minerals and monazite from the Whitetail Ridge resource area and from the Taylor and Carbon exploration target areas. Average thorium and uranium abundances of the bastnasite group minerals and ancylite from the Bull Hill deposit, based on electron microprobe analyses conducted by the Company in 2006, are presented in Table 8.3.

Table 8.3 - Average Thorium and Uranium Abundances of the Bastnasite Group Minerals & Ancylite

Mineral Phase	Formula	Average Th (%)	Average U (%)
Bastnasite	$REE(CO_3)F$	0.2	0
Parisite	$Ca(Ce,La)_2(CO_3)_3F_2$	0.3	0
Synchysite	$CaREE(CO_3)_2F$	0.29	0.04
Ancylite	$SrREE(CO_3)_2(OH)\bullet(H_2O)$	0.27	0.06

(Clark, 2006)

9 Exploration

9.1 Introduction

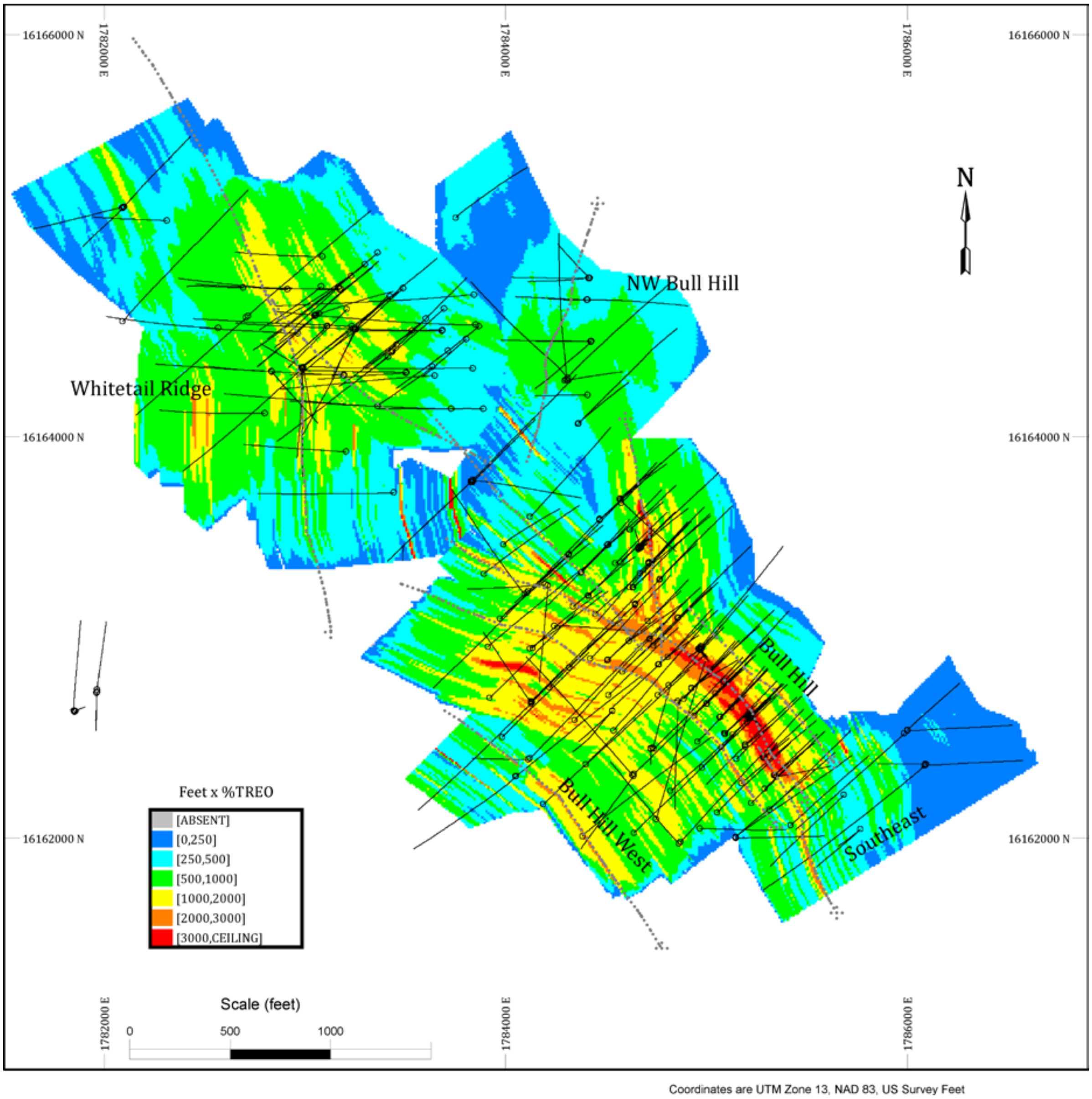
This section discusses the results of exploration for rare earth elements (REE) conducted on the Bear Lodge property through 2013.

The Bear Lodge mining district has been explored for rare earths, precious metals, and base metals by a number of major mining companies over the past 40 years. These various exploration campaigns identified a number of rare earth occurrences that the Company believes warrant further exploration and evaluation. Initial exploration for copper has not progressed past early tests by Duval, but their activities led serendipitously to further exploration for gold and rare earths, both of which have the potential to become substantial resources. Historical exploration activities are largely documented in Chapter 6.0 – History. The Bear Lodge Project comprises RER exploration activities targeting REE. Past exploration activity for gold by Newmont and Rare Element was conducted under the auspices of the Sundance Gold project.

9.2 Bear Lodge Project Exploration Target Areas

Rare Element's Bear Lodge Project REE exploration activities are focused on three carbonatite-related rare earth resource areas, the Bull Hill, Bull Hill NW, and Whitetail Ridge deposits, and two recently identified exploration target areas, Carbon and Taylor (Chapter 8.0). Several previous exploration target areas were incorporated into the Bull Hill deposit (previously referred to as Bull Hill SW), including Bull Hill West, Bull Hill Southwest Extension, and the Carbonatite Plug (or deep Bull Hill West). Geological characteristics of the REE deposits and new targets are reviewed in Chapter 8.0, and locations are provided in Figure 8.1. The exploration areas are described briefly below and summarized in Table 9.1, The Company's exploration activities at the Bear Lodge Project are summarized in Table 9.2. An updated grade-thickness model by ORE that incorporates drilling results for the Bear Lodge REE project through 2013 is shown in Figure 9.1.

Figure 9.1 - Grade-Thickness Block Model



(A. Noble, 2014)

9.2.1 Bull Hill

The Bull Hill deposit consists of an REE-mineralized carbonatite dike swarm and associated enveloping stockwork zones located within and along the western margin of the Bull Hill diatreme. Near-surface iron oxide-manganese oxide-rare earth (FMR) and oxide-carbonate (OxCa) dikes and veins are interpreted to be intensely (FMR) and moderately to weakly (OxCa) oxidized and leached equivalents of the carbonatite dikes at depth. The dike swarm was discovered by Hecla Mining Company and described in an unpublished Hecla report (Wineteer, 1991). Rare Element conducted additional drilling from 2004-2013, in order to confirm the continuity and grade of the mineralized bodies at Bull Hill. As described in Chapter 8.0, increased drilling density shows that the southern two thirds of the dike swarm east of the drainage include a persistent northwest-striking zone of dikes, veins, and stockwork that envelops a relatively continuous, steeply dipping to vertical main dike that locally reaches 80 feet (24 meters) in width, and multiple sub-parallel dikes. At the northern end of the NW-trending zone, the main dike splits into a horsetail of smaller N, WNW- and NNW-trending dikes and stockwork zones (Figures 8.2 and 9.1).

Drilling from 2010 through 2013 indicates that the zone of REE-mineralized dikes, veins, and stockwork persists well to the west of the main Bull Hill dikes. The area west of the drainage comprises significant additional REE resources that are included in the current resource estimate (see Figure 9.1). Drilling conducted during 2011 - 2013 indicates that the southeastern end of the dike swarm feathers out, terminates, and/or is offset along an easterly trending fault that is approximately coincident with the northern boundary of Section 20 (currently withdrawn from mineral entry). The Bull Hill deposit remains open to the west, northwest, and north.

The presence of a deep carbonatite plug located beneath the Bull Hill West area (now part of the Bull Hill resource area) had been inferred from drilling and geophysical surveys that include airborne magnetics, ground IP/resistivity, and reprocessed NURE geophysical data. Molycorp drill holes BL-1, BL-8, BL-9, and BL-12, Hecla drill holes WP-7 and WP-8, and several Rare Element drill holes intersect significant intercepts of weakly mineralized (1-3% total REO) FMR stockwork, sulfide-bearing carbonatite, and silicocarbonatite stockworks and breccias in this area. In this model the stockwork zones are interpreted to represent the brecciated carapace over a buried carbonatite plug. During the 2010 drilling season, RES10-57 targeted the inferred carbonatite plug. It intersected extensive deep carbonatite dikes and brecciation with grades up to 3.8% TREO, consistent with an interpretation as the apical carapace of a large buried carbonatite body. The deep carbonatite plug target has since been abandoned, because mining of the sulfide zone is not currently in the development plans. The overlying area was extensively drilled to target the shallower oxide and oxide-carbonate zones in 2011 and 2012, with further discovery of FMR and Ox-Ca dikes, veins, and stockwork.

9.2.2 Bull Hill Northwest

The Bull Hill Northwest deposit is located approximately 1,000 feet (300 meters) north of the Bull Hill deposit (Figures 8.1 and 9.1). Hecla discovered strongly-mineralized

FMR and carbonatite dike bodies in this area in drill hole WP-2. Drilling in 2010 provided evidence for a system of narrow, steeply dipping, northerly trending FMR, OxCa, and carbonatite dikes hosted predominantly by trachyte and phonolite. The Rare Element drilling suggests that Hecla's drill hole WP-2 may have penetrated down-dip along a northerly-striking dike, which resulted in a long intercept of high-grade mineralization. Additional controls on mineralization in the Bull Hill NW area include widespread NE to ENE fractures and joints, and these structures may have played a role in focusing the mineralization. Several near-surface NNE trending hematitic fracture zones (possible faults) traverse this target area and may further complicate interpretation of dike orientation and distribution. Soil geochemical and radiometric anomalies within approximately 500 feet (150 meters) NNE of this area, and the current distribution of significant drill intercepts, indicate that the deposit remains open to the north and provides an attractive exploration target area. Further drilling is needed to better define mineralization in this area.

9.2.3 Whitetail Ridge

The Whitetail Ridge deposit is located approximately 1,500 feet (460 meters) northwest of the Bull Hill deposit and approximately 500 to 1000 feet (150 to 300 meters) west of the Bull Hill Northwest deposit. The USBM explored a disseminated stockwork REE deposit in the Whitetail Ridge area in the early 1950's. In 1950, the USBM conducted sampling that identified an REE-anomalous area defined by total REE abundances greater than 2000 ppm. The sampling program was followed in 1951 by a limited drill program that tested the anomalous area with 10 shallow core holes that ranged in depth from 23.5 to 220.1 feet (7 to 67 meters). The drilling identified FMR stockwork veinlets that consist of REE minerals in a matrix of iron and manganese oxides. A re-evaluation of the data by the USBM in 1990 estimated that the area contains about 76.2 million standard tons of material containing 1.5% REO (Gersic et al., 1990). The USBM estimate is considered unreliable and suitable only as an indication of exploration potential.

Evaluation of the historic USBM data, along with results of detailed geological mapping and sampling, a positive ground radiometric anomaly, and REE mineralization in nearby drill holes, confirmed this area as a prospective target. Historic drill hole WP-1, drilled within the Whitetail Ridge target area by Hecla in 1987, intersected 430 feet (131 meters) that averages 2.44% TREO in a near-surface intercept from 0 to 430 feet (131 meters). Several 10-foot (3-meter) intercepts with grades ranging from 5.5 to 13.7% TREO are contained within the larger intercept. Rare Element conducted additional detailed geological mapping and rock chip sampling in 2010, and drilled two core holes to follow up the anomaly at WP-1 (RES10-20 and RES10-21). Encouraging aspects of the drill holes include intercepts of more than 70 feet (21 meters) at 4.1% TREO (approximate true thickness of 36 feet or 11 meters), and the presence of several steeply dipping, higher-grade zones surrounded by lower grade stockwork. The 2011 and 2012 drill programs at Whitetail Ridge identified and updated a Whitetail Ridge resource to the Indicated category (2.25 million tons at a grade of 2.61 % TREO). Additional drilling in 2013 resulted in an expansion of the Indicated resource to 4.26 million tons (3.86 million tonnes) at 2.49% TREO; see chapter 14 of this report). Significantly, the Whitetail Ridge deposit is characterized by about a 2.5X enrichment in overall HREE element grade relative to the Bull Hill resource, which adds potential economic upside to the Bear Lodge Project. The deposit remains open, and further drilling is expected to expand the resource and better define the extent of the REE mineralization.

9.2.4 Carbon and Taylor

Two reverse circulation drill holes (SUN-076 and SUN-079) completed during the 2010 Sundance gold exploration program were collared south of the Carbon diatreme and approximately 800 feet (250 meters) northwest of the Whitetail Ridge deposit. Significant moderate enrichment of HREE in FMR vein material hosted by trachytic and syenitic intrusive rocks was identified and suggests a new REE exploration target area that may be an extension of the Whitetail Ridge REE resource area. The Carbon target was tested by three core holes in 2011, and by six reverse circulation (RC) and 2 core holes in 2012. Drilling results warrant further exploration drilling on the Carbon target.

The Taylor target is located approximately 2,500 feet (700 meters) west of Bull Hill. A reverse circulation drill hole (SUN-090), collared at Taylor and completed during the 2010 Sundance gold exploration program, yielded significant HREE-enriched REE mineralization in FMR dikes, veins, and stockwork in trachyte and the Deadwood Formation. In 2011, the RC hole was twinned and offset with a total of 7 core holes, confirming the presence and nature of mineralization drilled by SUN-090. The mineralized zone has an apparent East-West trend and remains open both to the east and west. These results along, with the significant HREE-enrichment elevate the target to a high priority.

HREE-enrichment at the Carbon and Taylor targets, and district wide zonation of LREE and HREE are discussed in two Rare Element Technical Reports (Noble et al, 2013, and Larochelle et al, 2012), and in an Rare Element news release dated August 4, 2011.

Table 9.1 - Bear Lodge Project Exploration Target Areas, 2004 through 2012

Target Area	Location	Comment
Bull Hill (includes Bull Hill West and Bull Hill SE extension	West flank of Bull Hill	NW to N trending dike swarm, drilled previously by three Hecla holes. 144 new core holes (2004 – 2013) delineate system of dikes, veins, stockwork; additional radiometric and soil surveys, trenches, and surface samples indicate mineralization.
Carbonatite Plug (Deep Bull Hill West)	Southwest of Bull Hill, west of drainage (previous inferred West Bull Hill Fault")	Postulated REE-mineralized carbonatite plug beneath stockwork carbonatite carapace, IP anomaly at depth; multiple Rare Element, Hecla, and Molycorp drill holes intersect FMR/CBT stockwork and veins at shallow to moderate depths. Two deep holes (2010) intersect dense CBT/SBT dikes, breccia, and stockwork at depth; possible down dip projection of dikes at SW Bull Hill, and/or plug carapace.
Bull Hill Northwest	Approximately 1,000 feet (300 meters) north of Bull Hill deposit	High-grade REE-mineralized dike or dikes first intersected by Hecla drill hole WP-2. Approximately 18 core holes (2007-2011) indicate presence of northerly trending, steeply-dipping narrow dikes, hosted primarily by trachyte-and phonolite.
Whitetail Ridge	Approximately 500-1,000 feet (150-300 meters) west of Bull Hill NW deposit and 1500 feet (460 meters) NW of Bull Hill deposit	Strong REE mineralization in FMR and Ox-Ca dikes, veins, and stockwork, with a coincident radiometric anomaly. Tested by Hecla drill hole WP-1, and USBM shallow holes. Approximately 62 core holes (2010-2013) indicate N to WNW trending, steeply dipping narrow veins, and widespread disseminated stockwork zones, hosted primarily by diatreme; moderate HREE enrichment.
Carbon	Approximately 800 feet (250 meters) northwest of Whitetail Ridge deposit	Area coincident with previous Au target areas; selected intervals from 2 RC holes (2010) contain strong REE mineralization within FMR veins and stockwork and localized silicification; hosted in syenite breccias and phonolite; 5 core and 6 RC holes (2011-2012) confirm strong REE mineralization and indicate HREE enrichment.
Taylor	Approximately 2,500 feet (700 meters) west of Bull Hill deposit	Area coincident with previous Au target areas: selected intervals from 1 RC hole (2010) contain strong REE mineralization within FMR dikes, veins, and stockwork hosted in trachyte-phonolite; 7 core holes (2011) confirm strong REE mineralization and indicate HREE enrichment.

(John Ray et al, 2014)

9.3 Rare Element's REE Exploration Activities

Rare Element began exploration of the Bear Lodge Project properties for REE in late 2004. Paso Rico (USA), the predecessor entity to Rare Element, had conducted limited geological and geophysical work. Exploration was focused initially in the southwest Bull Hill area that was identified and explored by Hecla Mining Company (Hecla) from 1987 through 1991. Most of the core drill holes targeted strike and dip extensions of the carbonatite dike swarm at the Bull Hill SW target. The Company conducted limited drilling programs in 2004, 2005, 2007, and 2008. From 2009 through 2013, Rare Element conducted aggressive core drilling campaigns in order to expand and upgrade the deposit at Bull Hill, as well as to test additional target areas, including Bull Hill NW, Whitetail Ridge, Bull Hill West, Carbon, and Taylor (Figures 8.1 and 9.1). In addition, geophysical surveys and geological mapping and sampling were carried out in order to identify additional targets and improve geological understanding of controls on mineralization. From 2010 through 2012, the Company also drilled 92 large-diameter (PQ) core holes totaling 15,717 feet (4,792 m) that provided bulk sample material for metallurgical testing. Rare Element's exploration history from 2004 to 2013 is summarized in Table 9.2.

In 2008 and early 2009, the Company engaged ORE, Datamine North America, and GIS Technologies to advance its project development activities. A drill-hole database was assembled with the assistance of Datamine, and GIS Technologies organized much of the Bear Lodge data into a Geographic Information System format. ORE has continued consultation on exploration and development drilling through the 2013 drill campaigns and has modeled updates of the resource and reserve estimates of the deposit. In order to address data security and growth issues, as well as merge Rare Element and Newmont district-wide databases, the Company's and Newmont's data were migrated into a unified database developed and maintained by EDM Solutions since 2011. The system is web-based with links to modeling programs that include Studio and Leapfrog. GIS spatial data is generated directly from the database with automated updates.

The 2009 exploration program marked the beginning of a dramatic increase in the total drilling compared to prior years (15,388 feet/4690m in 20 core holes), as well as additional geological mapping and geophysical surveys in the Bull Hill and Whitetail Ridge areas. The aggressive 2010 through 2013 exploration and drilling programs were designed to continue expansion and upgrade of existing resources, as well as to identify and explore new targets. Geological mapping and geophysical surveys were directed towards improving the understanding of the surface structural signatures and controls on mineralization within the deposits and project area. The Company conducted ground radiometric and soil surveys in 2009 and 2010, and controlled source audio-magneto-telluric (CSMAT) surveys over both rare earth and surrounding precious metal target areas in 2010 and 2011. Geological mapping, rock chip sampling, and radiometric surveys were carried out in areas with newly created exposures of subcrop and outcrop, including drill roads and drill pads. Trenches excavated during the 2011 field season exposed subcrop and outcrop in the Bull Hill resource area. The trenches were a focus of detailed mapping, sampling, and radiometric surveys. Borehole televiewer surveys were conducted on selected drill holes during the 2011 through 2013 drill seasons and provided additional detailed geological and structural information.

In 2012, 7 core holes totalling 4,550 feet (1387 m) were drilled to provide geotechnical information for slope stability consultant Sierra Geotechnical LLC. Core from these holes remains unsplit and has been sub-sampled for geotechnical laboratory testing. These drill holes were surveyed by televiewer to provide additional structural information to Sierra Geotechnical.

In 2013 fourteen HQ core holes were drilled at the Whitetail Ridge resource area, for a total of 11,697.5 feet. The objective of the program was to upgrade the size and resource category of the Whitetail Ridge oxide resources, and to further delineate the HREE (Eu, Tb, Dy, and Y) enrichment in the deposit. Following the Whitetail Ridge development drilling 21 PQ core holes and 6 reverse circulation (RC) drill holes were drilled along the high-grade dike zone at Bull Hill in order to gain a better understanding of the grade distribution in the zone, and to provide additional material for ongoing pilot plant testing. The RC drill holes twinned selected PQ drill holes, with the objective of developing reliable methodology that would give comparable results to the PQ core drilling and thus enable the use of less expensive RC methodology to replace core drilling for resource estimation purposes.

Table 9.2 - Rare Element's Bear Lodge Project Exploration, 2004 through 2012

Year	Drilling	Other	Area	Results
2004-2008	12 core holes 13,317 feet (4059m)		Bull Hill	Confirm dike continuity, grade from historic drilling. No drilling in 2006.
2009	20 core holes 15,388 feet (4690m)		Bull Hill, Bull Hill NW	Continued infill, step-off drilling, 200 feet (60 meters) centers, Bull Hill dike swarm; confirm Bull Hill NW
		Ground radiometric survey	Bull Hill, Bull Hill NW &W, Whitetail Ridge, Carbon	Radiometric anomalies coincident with REE's and structures
		Mapping & rock chip sampling	Bull Hill drill roads	High REE associated with Fe-Mn Ox surface veins, stockwork
2010	65 core holes 42,409 feet (12,926m)		Bull Hill, Bull Hill NW, Whitetail Ridge, Bull Hill W	Continued infill, step-off drilling, 100 to 200 feet (30 to 60 meters) centers, Bull Hill deposit; increased reserve and resource
	3 SUN RC		Carbon, Taylor	Selected intervals w/FMR and significant REO
		Ground radiometric survey	Infill, expand prior Bull Hill to Carbon survey; Cole claims	NE broad anomalies cut by narrower NW zones; NS zone over Bull Hill (dike?)
		Soil survey	Infill Newmont survey, Bull Hill	NITON results comparable to lab; strong anomalies at Bull Hill, Bull Hill W
		CSAMT survey	Bull Hill and Au target areas (Carbon, Taylor)	Definition of Au and possible REE structures, dikes, and diatreme
		Mapping & rock chip sampling	Whitetail Ridge; drill roads, drill pads	High REE associated with Fe-Mn Ox surface veins, stockwork; exposed E-NE veins, Bull Hill
2011	63 core holes 48,474 feet (14,775m)		Bull Hill, Bull Hill W, Whitetail Ridge, Carbon, Taylor, Bull Hill NW	Continued infill, step-off drilling100 to 200 feet (30 to 60 meters) centers, Bull Hill deposit and target areas; increase reserve and resource
		Borehole televiewer surveys	Bull Hill, Bull Hill W, Whitetail Ridge, Taylor	5 drill holes surveyed; lithologic, mineralization, and structural data; confirm NW and NE fabric
		CSAMT survey	Expansion of 2010 survey, esp. Bull Hill	Definition of structures, contacts, possible identification of diatreme and dikes
		Trenches; mapping, radiometric surveys, channel sampling	Bull Hill, Bull Hill W	Strong NE jointing fabric; also cross-cutting NW dikes, veins; exposed dikes Bull Hill W
		Mapping and rock chip sampling	Drill roads, drill pads	High REE associated with Fe-Mn Ox surface veins, stockwork; exposed E-NE, N veins, Bull Hill W, Taylor

2012	82 core holes 57,419.5 feet (14,719.4m)		Bull Hill, Bull Hill W, Whitetail Ridge	Definition and infill of Bull Hill, expansion of Bull Hill W, definition of Whitetail Ridge, PQ bulk sample core for met tests
		Geotechnical core holes	Bull Hill, Bull Hill W, Whitetail Ridge	Recommended drilling for slope stability studies
	42 SUN RC holes 24,805 feet (7,563m)		Pug site, Section 16, Whitetail Ridge, Taylor, Carbon	Core twin study and expansion at Whitetail Ridge, Section 16 condemnation, PUG site condemnation, exploration at Taylor and Carbon.
2013	14 core holes 11,698 feet (3566.5m)		Whitetail Ridge	Upgrade significant part of resource to Indicated category
	21 core holes 10,651 feet (3,247m)		Bull Hill	Infill drilling for better definition of high-grade dike zone
	6 RC holes 2,730 feet (832.1m)		Bull Hill	Twin select PQ core holes to determine reliability of RC methodology in FMR ore zones

(John Ray et al, 2014)

10 Drilling

10.1 Introduction

This section discusses drilling conducted on the Bear Lodge property through October 2013.

10.2 Historical Base Metal and REE Drilling

Rare earth element (REE) exploration drilling on the Bear Lodge property prior to its acquisition by Rare Element was conducted by Molycorp and Hecla (see Chapter 6.0). Duval assayed for select REEs once carbonatite core intercepts were recognized, but their primary exploration objective was base metals. Drill holes, footages, and assay intervals from historical base metal and REE exploration drilling are summarized in Table 10.1 below. Note that Duval also completed 42 rotary claim discovery holes totalling 2,105 feet (641.6 m) and 5 RC drill holes totalling 765 feet (233.2 m) for claim assessment from 1972 through 1984. Claim assessment was maintained by Molycorp during their joint venture with Duval from 1978 through 1980.

Table 10.1 - Historical Core Drilling for base Metals and REE

Company	Dates	Number of Drill Holes	Total Footage	Number of Assay Intervals
Duval Corporation	1972 - 1977	13	20,363.00	914
Molycorp, Inc.	1978 - 1980	12	13,618.00	Indeterminate
Hecla Mining	1987 - 1990	12	13,765.50	612

(metric units not reported)

(A.Noble et al June 2013)

Exploration drill holes by Molycorp, Duval, and some by Hecla, were widely spaced across the property. A portion of Hecla's drilling was focused on southwest Bull Hill, where three holes were drilled from two sites into the current Bull Hill resource area at varying inclination and azimuth, owing to space and permitting restrictions.

10.3 Rare Element's Bear Lodge Project REE Drilling

Rare Element began exploration drilling at the Bear Lodge property in August 2004. The Company carried out seasonal drill campaigns every year from 2004 through 2008, except for 2006, with two to four drill holes per year.

The programs were expanded substantially from 2009 through 2013, following release of the first resource estimate in April 2009 (Noble et al, 2009). The drill programs were designed to expand and upgrade the REE resource, to test targets outside of the Bull Hill SW resource area, and provide material for metallurgical testing. Between 2004 and the end of October 2013, a total of 199,357.5 feet (60,780 m) was completed in 261 core holes that range in depth from 88 to 1,886 feet (27 to 575 m) in the exploration and development drilling programs. These holes include 21 PQ-diameter drill holes completed between August and October 2013 in order to upgrade the resource category of a high-grade portion of the Bull Hill deposit and provide more detailed data on grade distribution. During the 2010 through 2012 drilling seasons, an additional 16,545 feet (5,044m) were drilled in 92 large diameter core holes (PQ- and HQ-size) for the bulk sample program (Table 10.2). Dr. James Clark, Rare Element's Vice President of Exploration, supervised the drilling on site during 2004, 2005, 2007, and part of 2008. Two geologists experienced in industry-standard drilling practices supervised drilling during the remainder of 2008 and 2009, under the direction of Dr. Clark. Dr. Ellen Leavitt, CPG, consulting geologist, supervised the drilling on site in 2010 and 2011, and John Ray, Rare Element's Chief Geologist supervised the 2012 and 2013 drilling programs.

Table 10.2 - Rare Element REE Drilling

Rare Element Resources	Dates	Number of Drill Holes	Total Footage	Number of Assay Intervals
Exploration	2004	3	3,248 (990m)	36
	2005	2	2,174 (663m)	11
	2007	3	3,057 (932m)	58
	2008	4	4,840 (1,476m)	77
	2009	20	15,388 (4,691m)	1,635
	2010	63	42,409 (12,930m)	4,361
	2011	63	48,474 (14,779m)	3,024*
	2012*** (Core)	68	57,419.5 (17,506m)	5,700
	2012 **** (RC)	42	24,805 (7,562.5m)	2,481
Exploration Drilling Total	2013 (core)	35	22,348	3,004
	2013 (RC)	6	2,730	442
		309	226,892.5 (69,174.5m)	20,829
Bulk Sample/Metallurgy**	2010	40	3,870 (1,180m)	
	2011	38	5,821.5 (1,775m)	
	2012	14	6,853.5 (2,089m)	
Bulk Sample Drilling Total		92	16,545.5 (5,044m)	

(John Ray, Rare Element, 2013)

*assays completed for less than half of 2011 drill core, at time of January 04, 2012 resource update.

** Drill core utilized for metallurgical testing. See Chapter 13.

***2012 Includes 7 unsplit core holes for geotechnical study

****2012 RC drill holes not included in resource calculations

Rare Element's initial drill programs focused on the Bull Hill resource. A number of angle holes were drilled in a variety of generally north-easterly orientations from two sites in order to confirm the dike swarm on the southwest flank of Bull Hill. Permitting restrictions through 2009 limited access to roads and sites along the drainage areas.

Beginning in 2009, drilling at Bull Hill was focused on a grid with 100- to 200-foot spacing. Drill holes were oriented at 045º azimuth and inclined to the northeast, along 045º fences or sections of holes in order to delineate the north-westerly, generally vertical to southwest-dipping dike swarm. Other orientations drilled in 2009 included a northerly-directed hole (RES09-08) and a westerly-oriented hole (RES09-11).

In 2010 increased access to previously restricted areas was allowed with specified operating and reclamation requirements. The improved access led to more closely spaced infill drilling in the Bull Hill resource area. The Bull Hill NW target area was identified in 2010 and nine holes, mostly at an east-west orientation, were drilled to test the developing model of northerly trending dikes in that area. Orientations of drill holes in the Whitetail Ridge resource area were largely at a 045º azimuth. However, the dominant orientation of the mineralized bodies was still incompletely understood. Modeling suggested a north-south orientation for the southwestern quadrant of Whitetail, with a northwesterly trend for the remainder of the stockwork mineralization. In addition, several un-surveyed historic drill sites were reoccupied and drilled.

In 2011 continued drilling in the Bull Hill resource area focused on step-out holes to the south and west of the main dike swarm, some of which also provided infill intercepts of deeper parts of the dike swarm. Emphasis was also placed on testing possible extension of mineralization across the valley, southwest of Bull Hill. The majority of drill holes were aligned along the 045º/225º grid. Several holes were drilled perpendicular to the 045º sections to test for east to north-easterly structures and veins. A fence of drill holes directed to the northwest (315º azimuth) was completed in the Bull Hill West target area, west of the Bull Hill drainage. One hole was drilled to the southeast (135º azimuth) in the northern third of the resource, east of the drainage.

Core drilling in 2012 was focused on the Bull Hill, Bull Hill West, and Whitetail Ridge areas. The 2012 Bull Hill/Bull Hill West program had multiple purposes involving further infill drilling to upgrade the Bull Hill measured and indicated resource, as well as to test the lower grade vein and stockwork mineralization at Bull Hill West. This was accomplished by locating sites at Bull Hill West, further to the west than in previous drilling, while staying on the 045º fences and drilling shallow angles to the northeast in order to test and expand the main Bull Hill dike swarm. A total of 31 core holes totalling 28,211 feet (8,598.7 m) out of the total 2012 program were completed in this development phase of drilling. Whitetail Ridge drilling was directed toward further delineation and expansion of strong REE mineralization identified in previous drilling in this area. Drilling was initially undertaken on 090º fences, based on apparent N-S horsetailing of mineralization north of Bull Hill. In mid-program, the preferred drill orientation was changed back to 045º based on analysis of results. Thirty drill holes totalling 24,658.5 feet (7,518m) were completed during this phase of the program. Seven core holes totalling 4,550 feet (1,387m) out of the total 2012 program were drilled at Whitetail Ridge and Bull Hill for geotechnical study. These holes were not split and assayed, but were selectively sampled for testing at a geotechnical laboratory.

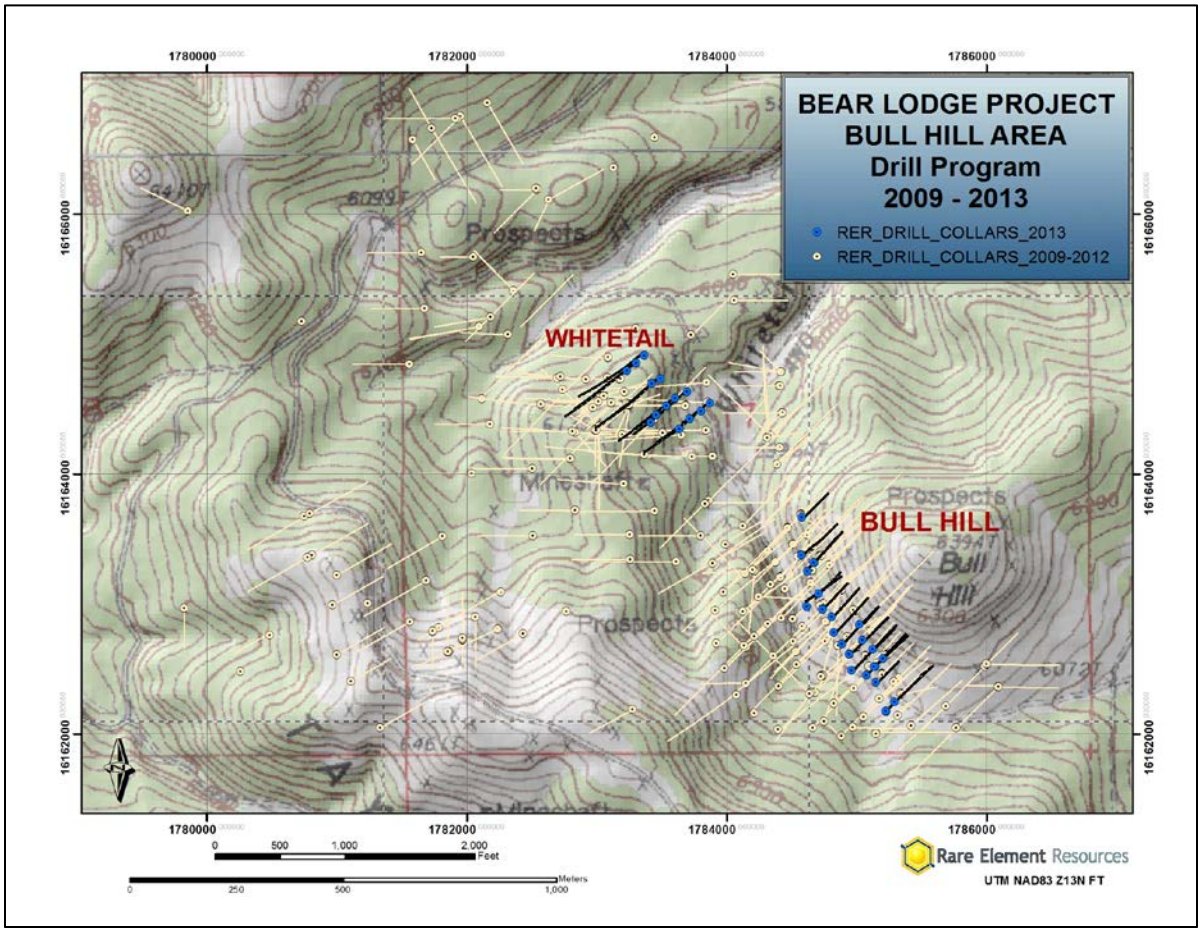
Fourteen PQ drill holes totalling 6,853.5 feet (2,089m) were also completed during 2012 in the Whitetail Ridge and Bull Hill West areas to complement the PQ core previously drilled at Bull Hill and held in storage. This material comprises more than 20 tons and was collected for purposes of metallurgical testing, including the 2013 pilot plant testing.

The 2013 drilling program was conducted in two phases. The first phase took place in June and July and involved infill drilling at the Whitetail Ridge deposit in order to upgrade a significant portion of the resource from the Inferred to Indicated category. During this phase, 14 HQ core holes were drilled for a total of 11,697.5 feet (3,556.3 m). The holes were drilled on a grid at an azimuth of 230°. All but one of the holes was drilled at an inclination of -60°, with the remaining hole drilled at an inclination of -45°.

The second phase was designed to upgrade part of the high-grade resource at the Bull Hill deposit to the Measured category and develop a more detailed model of the REE grade distribution in that part of the deposit. It consisted of 21 PQ diameter core holes totalling 10,650.5 ft. (3,247.1 m) and 6 reverse circulation (RC) twin holes totalling 2,730 ft. (832.3 m). The RC twin holes were drilled using a center return hammer with the objective of minimizing hole erosion and obtaining assay data directly correlative to that from the adjacent core holes. The RC twin holes were part of a program to determine the viability of replacing core with less costly RC drilling in future drill programs, and the RC data were not used in the resource estimate database.

The current spacing between fences of drill holes within the main Bear Lodge Project area ranges from approximately 100 to 800 feet (30 to 250 m), with fences 100 feet (30 m) and 200 feet (60 m) apart in the three main resource areas. Drill hole spacing along the fences ranges from 100 to 200 feet (30 to 60 m) (Figure 10.1).

Figure 10.1 - Rare Element 2009 - 2013 REE Drill Holes



(John Ray, Rare Element, 2013)

10.3.1 Drilling Logistics and Methods

Core drilling operations during 2004 (August to December) were performed by AK Drilling of Butte, Montana, utilizing a truck-mounted Longyear 44 core drilling rig. Drilling operations in 2005 (October), 2007 (May, June, and October), 2008 (August and September), 2009 (August to December), 2010 (May to November), 2011 (June to November), and 2012 (June to December) were conducted by Godbe Drilling LLC of Montrose, Colorado, and Layne Christensen Company (2009) of Chandler, Arizona. The 2005 and 2008 drilling programs were conducted with a skid-mounted Longyear LF-70 core drill, while both truck-mounted Longyear 44 and skid-mounted Longyear LF-70 drill rigs were used for the 2007 drilling program. Two LF-70 drills were utilized by Godbe Drilling for the 2009 drill program, while Layne Christensen utilized a CS1500 truck-mounted core drill. Two LF-70 drills and a CS-1000 were utilized by Godbe Drilling for the 2010 (June to December) and 2011 (June to

November) drill programs. A Maxidrill 10-C was brought in as a fourth drill during the second half of the 2011 drill program. The 2012 program employed two skid-mounted LF-70 drills, the track-mounted Maxidrill 10-C, and a skid-mounted CS-1000 rig. The 2013 drilling program was conducted by Major Drilling of Salt Lake City, Utah and utilized a track-mounted Longyear LF-70 and a track-mounted Longyear LF-90 core drilling rigs, and a track-mounted Schramm T-450GT RC drill rig.

In general the holes were drilled with HQ-sized core (77.8 mm inside diameter). During the 2004 through 2008 drill programs (12 holes total), HQ core was drilled through the oxidation zone (to approximate depths of 300 to 500 feet/90 to 150 m), after which core size was generally reduced to NQ (60.3 mm inside diameter). In 2007, two drill holes (RES07-1 and RES07-2) were drilled deeper with HQ core before reducing to NQ in order to secure a larger sample for metallurgical testing. In 2008, one hole (RES08-4) was reduced from HQ to NQ at about 300 feet (90 m), and then from NQ to BQ (46.1 mm diameter) at about 1,400 feet (425 m) depth. BQ core was drilled to the end of the hole (1,886 feet/575 m). From 2009 through 2012 most holes were drilled with HQ-sized core, with the exception of 15 holes that were reduced to NQ prior to the end of the hole. One hole (RES10-57) was drilled with PQ-sized core (85 mm diameter) through the top several hundred feet to address anticipated recovery problems associated with broken ground. Initial use of the larger diameter PQ core provided additional opportunities to reduce in the event of adverse down-hole drilling conditions. The core was reduced to HQ-sized core, and then to NQ-sized core several hundred feet from the end of the hole (1,675 feet; 510 m).

In 2013 HQ-sized core was used for the Whitetail Ridge infill drilling and PQ-sized core for the Bull Hill high-grade infill drilling.

10.3.2 Recovery and Rock Quality

The un-oxidized carbonatite dikes, along with FMR and OxCa veins and dikes, the near-surface oxidized equivalents of the carbonatite dikes, were the target of most drilling completed in the Bull Hill area through 2008. From 2004 through 2008, core recovery in the friable, leached, and weathered FMR zones was generally much lower than in the more competent OxCa and sulfide-bearing carbonatite rocks, with a range from 0 to 100% and an average recovery of slightly better than 70 percent. The low recoveries are due primarily to the presence of the variably leached and fractured FMR dikes, veins, and stockwork, which tend to fracture and disaggregate easily during the drilling process. The zones may also contain void space that also reduces recoveries. The void space results from dissolution of matrix carbonate in the original host. Average core recovery in the oxidized zone was improved significantly during the 2009 drilling program to better than 80%, owing to consultation with Clint Johnson of Western Mud Services, the Godbe Drilling mud engineer, and a consequent change in the mud formula for drilling in the oxidized zone. Through 2009 core recovery in the transitional and un-oxidized carbonatite zones was generally ≥ 90% to 100%. In 2010, 2011, and 2012 Godbe Drilling continued to focus on improving recoveries in the oxide zone. During these drilling campaigns, recoveries of FMR dikes and veins averaged 80% in the oxide zone and 88% in the oxide-carbonate zone. Recoveries of carbonatite/silicocarbonatite dikes and veins (transitional and sulfide zones) averaged 94%. In 2011, when a higher proportion of stockwork was drilled, particularly in the area of Bull Hill West, recoveries of stockwork FMR in the oxide and oxide-carbonate zones averaged 83%. Recoveries in 2012 were variable, but similar to those achieved previously. Average 2012 drill hole recoveries for the stockwork-dominated zone west of Bull Hill ranged between 69% and 93% per hole, and averaged 81% for the area, while Whitetail Ridge recoveries ranged between 77% and 94% per hole and averaged 86% for the area. Analysis of relative recoveries in the different resource areas and oxidation zones is ongoing. Recoveries using HQ diameter core for the 2013 drilling at Whitetail Ridge ranged from 79 – 92% and averaged 87.1 percent.

The recovery issues with FMR in HQ core suggested the use of PQ core for bulk sampling of FMR and oxide-carbonate material for metallurgical testing. Friable FMR zones generally maintain integrity much better in PQ than in HQ core, owing to the larger diameter of the PQ core. The higher volume of material contained in PQ-size core appears to better absorb the torque of bit rotation, with consequently less material lost to “plucking” of FMR veins and stockwork on the core surface. While this was the case for PQ core drilling conducted through 2012, recoveries were somewhat poorer and exhibited more variation in the 2013 Bull Hill high-grade infill program. Core recoveries in this program averaged 86.8% and ranged between 77 and 92 percent.

Minimal material was returned to the surface in a small subset of intervals from all drill holes in the FMR material, owing to extreme friability and loss of material in voids, possibly related to zones of structural disruption, fracturing related to stockwork mineralization, or voids related to dissolution of matrix carbonate. Local analytical bias resulting from poor recoveries in the FMR zones is likely and is under investigation. A case can be made for under-representation of grade in areas with poor recoveries, as well-mineralized but poorly consolidated material might be washed away during the drilling process. ORE suggests that this might be the most probable case. There may also be void zones that lack mineralized material. Beginning in 2012, definitive void areas were not included in assay intervals, and are tabulated as voids.

10.3.3 Collar Surveys

Rare Element contracted the drill hole collar surveys for all 2008 through 2013 core holes to Bear lodge Ltd., professional engineers and land surveyors based in Sundance, Wyoming. Collars were marked and surveyed after completion of each hole. During the survey, the WGS84 geographic coordinates are measured and corrected on-the-fly while in the field. Geographic coordinate corrections are based on a correction factor transmitted from an accurately located base station set up by Bear lodge Ltd. in the vicinity of the area being surveyed. At the end of each day the measurements are uploaded to a computer and processed by "TG Office" to produce a set of projected coordinate values. Coordinates are provided in numerous geographic projection systems, with the original data obtained in WGS84. Through 2011, Rare Element requested UTM Zone 13 (m) projected coordinate values based on the NAD27 geographic datum. Bear Lodge Ltd. has also routinely provided the data in additional coordinate systems, including NAD83 and the Wyoming State Plane System. Bear Lodge Project data utilized for development activities and resource estimates is currently reported in NAD83 US survey feet coordinates.

10.3.4 Down-Hole Surveys

Down-hole surveys were conducted on all core holes drilled by Rare Element from the 2008 through 2013 drill programs. Survey point intervals were approximately every 100 feet (30.5 m). The surveys demonstrate deviation of the drill stem from a straight-line projection of the surface bearing and inclination. Measurements were carried out by the drillers utilizing an electronic single shot instrument (Reflex EZ-SHOT). The instrument provides seven parameters in a single shot, including: azimuth, dip, roll angle relative gravity, roll angle relative magnetic north, temperature, magnetic field strength, and magnetic dip angle. The instrument is sensitive to magnetic interference. Measurements are read and recorded from a digital display on the instrument at the collar after retrieval. Subsequently, all data are entered into the database.

Azimuth measurements are corrected to true north using appropriate magnetic declination for the period of drilling, as determined by the NOAA declination calculator. In general, very minor dip deflections were recorded in the 2010, 2011, and 2012 drill holes. Deflections were generally no more than several degrees upward or downward, but ranged up to 10 degrees in 2009 over 1000 feet (300 m). Lateral deflection was typically less than 5 degrees, but ranged up to 10 degrees over 1000 feet (300 m) in 2009.

In the 2013 drilling, azimuth deviation was generally 5 degrees or less for 11 of 14 HQ drill holes at Whitetail Ridge, based on the first survey at a depth of 100 feet. However, three of the HQ holes showed azimuth deviation of 6 – 10 degrees. Azimuth deviation in the PQ holes at Bull Hill was generally less than 2 degrees and never more than 3 degrees, based on the results from the first survey at a depth of 100 feet. Inclination deviations ranged from less than 3 degrees to a maximum of 6 degrees.

10.3.5 Summary of Drilling Results

The evaluation of the drill data is ongoing. All core holes drilled and assayed between 2009 and 2013 were evaluated and included by ORE in the current resource estimate update. True thicknesses of the drill intercepts are estimated from cross sections and 3D modeling of the mineralized zones. The 261 core holes completed by Rare Element (not including bulk sample drill holes) confirm and expand the extent of the known rare earth mineralization (Figure 8.2). This drilling expands and better defines the historic resource originally identified by Hecla (Wineteer, 1991), as well as the resource estimates completed for the Company by O.R.E. and reported in a series of news releases from 2009 to 2013. To date, the drilling allows for delineation of Measured, Indicated, and Inferred resources in the Bull Hill deposit, additional Indicated and Inferred resources in the Whitetail Ridge deposit, and Inferred resources in the Bull Hill NW deposit.

11 Sample Preparation, Analyses and Security

11.1 Introduction

This section discusses sample preparation, analyses, and security at the Bear Lodge Project through 2013. Data from the 2013 Bear Lodge Project drilling used in the preparation of the figures and tables in this section are taken from Jaacks, 2014 (QAQC Results for the 2013 Bear Lodge Drilling Program). Data from the earlier 2009 – 2012 drilling programs used in the preparation of this section are taken from previous Rare Element Technical Reports dated May 2, 2013 (as amended on June 26, 2013), April 13, 2012, and November 2010. Dr. Jeffrey Jaacks is an independent consultant engaged by Rare Element Resources to guide the analytical program and conduct QAQC evaluations of resultant assay data. The primary author of this technical report has never had any relationship to Dr. Jeffrey Jaacks, or to the issuer of the laboratories that analyzed or tested any of the samples. In addition, the laboratories that analyzed and tested the samples are independent of Rare Element Resources, Inc.

11.2 Historic Sample Preparation and Analyses

Molycorp, Inc. and Hecla are reported to have used industry standard practices for sample collection, sample preparation, and analytical techniques in their exploration and evaluation efforts, but detailed descriptions of those procedures have not been found. Duval core was logged at a facility in Hulett, Wyoming, and alternate 10-foot runs were split with one half bagged for assay and the other half retained. The intervening, 10-foot core runs were also split and assayed in especially interesting mineralized zones. Skeleton core boxes were prepared once holes were completed and core was stored in a large metal shed in Hulett. Duval JV partner Molycorp closely followed the Duval logging and sampling protocols during their drilling project.

When Duval located the DUV 1 through 42 claims in 1972, discovery work consisted of drilling a 50-foot rotary hole along the center line of the claims. These conventional rotary holes were poorly sampled using catch pans and shovel piles. As well, deeper rotary holes drilled by Duval as scout holes for follow-up core holes were also poorly sampled, with significant wall rock contamination as the holes got deeper. Two Duval rotary holes completed in 1983 for assessment were sited off the Warren Peak road north of the Four Corners intersection, and this drilling employed reverse circulation dual wall pipe, resulting in more representative samples taken on 10 foot intervals.

All three of those companies were or are viable companies that discovered and developed multiple mineral deposits, and their techniques of sampling, sample preparation, analysis, and security produced results that are representative, reliable, and reflect industry standard results for the time.

11.2.1 Historic Analytical Methods

Most of the drill hole assaying was accomplished by major laboratories that were in existence at the time the exploration activities were conducted. Once the Duval split core for assay was bagged, it was sent weekly to the Rapid City, SD airport where it was air freighted to Chemical and Mineralogical Services (CMS), South Salt Lake, Utah for analysis for Au, Ag, Cu, Mo, Pb and Zn. CMS was the standard laboratory used by the Salt Lake Office of Duval Exploration and employed industry standard analytical techniques for the time. After rare earth-mineralized carbonatite was recognized, pulps were sent to Merlin Salmon, FluoXspec, Denver, CO for x-ray fluorescence analysis for rare earth elements. Molycorp arranged for their own analytical procedures during their JV with Duval. Only portions of the Duval and Molycorp, Inc. assays are currently available, and none are currently being used for resource estimation.

The historic drill hole data were replaced with more reliable information from the 2009 through 2013 drill programs carried out by Rare Element. Because of the limited amount of information available from the Molycorp, Inc. and Duval data, those drilling data are used only to assist in geological interpretation and to guide exploration. They were not used for resource estimation purposes. Hecla drill hole data were used for their initial in-house resource estimates, but were replaced with data from more recent Company drill holes for the Rare Element resource estimates

11.3 Rare Element's Sample Preparation and Analyses

11.3.1 2004-2005 Sample Preparation

Drill core samples from Rare Element's 2004 and 2005 drilling programs were shipped to the ALS Chemex facility for sample preparation and analysis. The samples were crushed in the laboratory to 70% passing -10 mesh (-2 millimeters), and a 250 gram split of the sample was pulverized into a pulp of 85% passing -200 mesh (-75 microns), which was used for the analysis.

11.3.2 2007-2008 Sample Preparation

Drill core samples from Rare Element's 2007 and 2008 drilling programs were shipped to Activation Laboratories (Actlabs) in Ancaster, Ontario, Canada for sample preparation and analysis. The samples were crushed in the laboratory to 70% -10 mesh (-2 millimeters). A 250 gram split of the sample was pulverized into a pulp of 85% -200 mesh (-75 microns), and the pulp was analyzed.

11.3.3 2009-2013 Sample Preparation

Drill core samples from all holes from Rare Element's 2009 through 2013 drilling programs were shipped by truck to Minerals Exploration & Environmental Geochemistry (MEG) in Reno, Nevada for sample preparation. The samples were crushed in the laboratory using a roll crusher followed by jaw crushing to 85% -10 mesh (-2 millimeters), and a 250-gram split of the sample was pulverized into a pulp of 85% -200 mesh (-75 microns). Standards, blanks, and crush duplicates were inserted by MEG into the sample stream, numbered in sequence, and blinded to the analytical laboratory. Starting in 2010, analytical duplicates were also inserted into the sample stream to monitor analytical reproducibility as well as preparation reproducibility. Additional pulverized splits were archived by MEG against the chance that a pulp sample might be lost during shipment to the assay lab. Quality control samples were included with the sample stream at a rate of 10%. The 2009, 2012 and 2013 drill sample assay pulps, standards, duplicates and blanks were sent to Activation Laboratories in Ancaster, Ontario, Canada for quantitative assay. The 2010-2011 drill sample assay pulps, standards, blanks and duplicates were sent to ALS in Vancouver, British Columbia, Canada for quantitative assay.

11.3.4 2004-2005 Assaying

Drill core samples from Rare Element's 2004 and 2005 drilling programs were analyzed for REE, Au, Fe, Mn, U, Th, and Y. None of these assays are currently being used for resource estimation. The 2004 and 2005 drill hole data were replaced with more reliable information from the 2009 through 2013 drill programs.

11.3.5 2007-2008 Assaying

Drill core samples from Rare Element's 2007 and 2008 drilling programs were analyzed for REE, Au, V, Cr, Co, Ni, Cu, Zn, Ga, Ge, As, Rb, Sr, Zr, Nb, Mo, Ag, In, Sn, Sb, Cs, Ba, Hf, Ta, W, Tl, Pb, Bi, Th, and U. The REE include La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, and Y. The REE and multi-element geochemical package were analyzed using lithium metaborate fusion with an ICP/MS finish (ActLabs code 4B2-STD), and Au was analyzed by 30-gram fire assay with a neutron activation finish (ActLabs code 1A1). Quality control for the ActLabs assay data were monitored with blanks and standards provided by the analytical laboratory. None of these assays are currently being used for resource estimation. The 2007 and 2008 drill hole data were replaced with more reliable information from the 2009 through 2013 drill programs.

11.3.6 2009 Assaying

Pulps were prepared by Minerals Exploration Geochemistry of Reno, Nevada from the 2009 drill core samples and sent to Activation Laboratories of Ancaster, Ontario, Canada for assay. Sets of standards, blanks, and duplicates were inserted to monitor analytical quality. The samples were analyzed for REE, Au, V, Cr, Co, Ni, Cu, Zn, Ga, Ge, As, Rb, Sr, Zr, Nb, Mo, Ag, In, Sn, Sb, Cs, Ba, Hf, Ta, W, Tl, Pb, Bi, Th, and U. The REE include La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, and Y. The REE and multi-element geochemical package were analyzed using lithium metaborate fusion with an ICP/MS finish (ActLabs code 4B2-QUANT). Gold was analyzed using a 30-gram fire assay with atomic absorption finish (ActLabs code 1A2). Over limit REE assays were completed as part of the 4B2-STD-QUANT analytical package.

11.3.7 2010-2011 Assaying

The 2010 and 2011 drill samples were prepared by Minerals Exploration Geochemistry of Reno, Nevada and sent to ALS in Vancouver, Canada for assay. Sets of standards, blanks, and duplicates were inserted at regular intervals to monitor analytical quality. The samples were analyzed for REE, Sn, Ta, Tb, Th, U, W, Zr, and Au. The REE include La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, and Y. The REE and multi-element geochemical package were analyzed using lithium metaborate fusion with an ICP/MS finish (ALS code ME-MS81h). Gold was analyzed by 30-gram fire assay with an ICP/AES finish (ALS code Au-ICP21). Over limit REE assays were analyzed using a lithium metaborate fusion followed by ICP/AES finish (ALS Code ME-OGREE). Quality control for the ALS assay data was monitored using blanks and internal standards provided by Rare Element through MEG, and by selected duplicate analyses. Preparation of the Bear Lodge Project internal standards is discussed in Section 11.4.

11.3.8 2012-2013 Assaying

Pulps were prepared by Minerals Exploration Geochemistry of Reno, Nevada from the 2012-2013 drill core samples and sent to Activation Laboratories of Ancaster, Ontario, Canada for assay, with sets of standards, blanks, and duplicates were inserted to monitor analytical quality. The samples were analyzed for REE, Au, Ag, As, Ba, Be, Bi, Co, Cr, Cs, Cu, Ga, Ge, Hf, In, Mo, Nb, Ni, Pb, Rb, Sb, Sc, Sn, Sr, Ta, Th, Tl, U, V, W, Zn, Zr and major oxides. The REE include La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, and Y. The major oxides include SiO2, Al2O3, Fe2O3(T), MnO, MgO, CaO, Na2O, K2O, TiO2, P2O5, and LOI. The REE and multi-element geochemical package were analyzed using lithium metaborate fusion with an ICP/MS finish (ActLabs code 8-REE). Gold was analyzed using a 30-gram fire assay with atomic absorption finish (ActLabs code 1A2). Over limit REE assays were completed as part of the 8-REE analytical package.

11.3.9 Laboratory Certifications

ALS and Activation Laboratories are both ISO 9001 accredited and operate to standards consistent with ISO 17025 methods. Sample preparation laboratories do not require certification; however, Rare Element conducts quality checks on the preparation laboratory through the submittal of preparation duplicates to the analytical laboratories and evaluation of the resultant data.

11.4 Rare Element’s Standards

Rare Element’s standards program was initiated in 2009 at the recommendation and under the direction of Dr. Jeffrey Jaacks of Geochemical Applications International Inc. Six standards were originally developed from drill rejects stored at Mountain States Research and Development in Tucson, AZ (Standard series RE09001X through RE09006X). Materials from oxide, transitional, and sulfide mineralization types were prepared from drill intervals of like matrix material and grade. Additional oxide reference materials were collected in the fall of 2010, and five additional standards (Standard series RE09007X, RE10001X through RE10004X) were prepared for a total of 11 REE standards for use in the drilling programs. The RE09007X and RE10001X – RE10004X series standards were collected as bulk samples from mineralized outcrop exposed by roads being developed for new drill sites on the property. These materials were sent to MEG for preparation. All reference materials were collected from REE mineralization on the Bear Lodge property in Wyoming.

11.4.1 Method of Preparation

The standard materials were dried, crushed, pulverized, and then passed through a 150-mesh screen. The +150 material was discarded. The -150 material was mixed for 3 to 5 days in a ball mill with a 100 kilogram capacity. The material was rotary split and packaged in 50-gram samples placed into Kraft bags.

11.4.2 Laboratories for Certification

The original standard samples were sent to the following laboratories for certification analyses:

- ALS Chemex, Vancouver, Canada
- Activation Laboratories, Mississauga, Ontario
- Mountain States R&D International, Vail, Arizona
- Memorial University of Newfoundland

The second series of standards underwent additional round robin certification analyses at:

- SGS, Toronto
- ACME Labs, Vancouver
- Hazen Labs, Golden, Colorado
- Genanalysis, Perth
- UltraTrace, Perth
- Inspectorate, Vancouver

ALS Chemex, Activation Laboratories, SGS, ACME Labs, Genanalysis, UltraTrace and Inspectorate laboratories are all certified to ISO 9003 Standards. Mountain States, Memorial University, and Hazen Labs are not certified to ISO 9003 Standards.

Ten replicate pulp samples were submitted to each laboratory for each standard. The samples were randomized to blind the replicates to the analytical laboratory. Blanks were also included with each standard set.

11.4.3 Analytical Methods for Certification

The original standard samples were analyzed using a 4-acid digestion or a lithium metaborate fusion on 0.1 to 0.2 gram samples followed by ICP finish for Y, Ce, La, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu.

Fusion digestions show improved accuracy and precision for REE analyses over analytical methods using 4 acids. Fusion digestions are “total” digestions that are more destructive to the sample matrix than variants of 4-acid digestions. Four-acid digestions are also considered by the industry to be “total” digestions. However, this is not necessarily so, as some resistate mineral phases which contain REE are not truly digested in their entirety. Fusions are far better at destroying these resistate mineral matrices and releasing REE contained therein. The analyses from the 4-acid digestions display poorer accuracy and precision as a result of the less effective digestion and incomplete digestion of the resistate phases, thus the 4-acid data were not used for certification of the standards.

Standards RE09007X and RE01001X-RE1004X were certified using lithium metaborate fusions with ICP-OES finish.

11.4.4 Determination of Certified Values

The means and standard deviations were calculated for all of the analytical data for each standard material.

11.5 2007-2008 Assay Quality Control

Rare Element enacted a quality control program in 2007 concurrently with the change of analytical laboratories from ALS Chemex to Activation Laboratories. The program included the assay of blank samples to monitor possible contamination, assays of internal standards provided by Actlabs, and assay of analytical duplicate samples. The quality control program was expanded in the 2008 drilling sample assays to include more blank and duplicate samples.

11.6 2009-2013 Assay Quality Control

At the request of Rare Element, Dr. Jeffrey Jaacks of Geochemical Applications International Inc. (GAII) conducted a review of the results for the quality assurance and quality control (QA/QC) program used in rare earth element assaying for the Bear Lodge exploration drill programs conducted during 2009 and 2012-2013 at Activation Laboratories and drill programs conducted during 2010-2011 at ALS Laboratories. Quality control data reviewed herein include standards, blanks, preparation (crush), and analytical (pulp) duplicate results, as well as the 2010-2013 check analysis program results.

11.6.1 2009-2013 Quality Assurance Protocol

Individual drill holes in the 2009-2013 drill programs were submitted as separate jobs. A minimum of 2 sets of duplicates, 2 lower grade standards, 2 higher-grade standards, and 2 blanks were included with each drill hole submitted for analysis. Sample numbers were used rather than drill hole number and footage to identify each sample. MEG prepared the core samples and inserted the quality control samples into the sample stream, which were then blinded to the analytical laboratories. MEG also prepared crush (preparation) and pulp (analytical) duplicates from the materials submitted for preparation. Rare Element quality assurance program on average contained 1 duplicate, 1 high-grade standard, 1 low-grade standard, and 1 blank for 40 samples for a total of 8 QAQC samples in an analytical batch size of 80 samples, or 10% quality control samples.

11.6.2 2009-2013 Blanks

The blanks were prepared by MEG from the same volcanic matrix material in a series of batches that were used during the 2009-2011 drill programs. In 2012 and 2013, RER included a quartz sand sample blank with samples being submitted for preparation. Both blank matrixes actually contained very low concentrations of the light rare earth elements. However, these light rare earth element concentrations exceeded the background analytical threshold of 15 times the detection limit. Heavier REE analyses (Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu) indicated detectable concentrations of these elements, but all less than 15 times the lower detection limits. This would suggest that there was no carry-over contamination for the light rare earth elements, but that the concentrations of light rare earth elements were due to natural background rather than contamination in the blanks. Analytical reproducibility of the light rare earth elements in these materials indicates that the blanks are actually excellent low-grade standards for the light rare earth elements.

11.6.3 2009-2013 Standards

The RE09003X and RE09006X standards were used for the 2009 analytical program at Actlabs. The RE09001X, RE09003X, RE09004X, RE09006X, RE09007X, and RE10003X standards were used for the 2010-2011 analytical program at ALS and the 2012 analytical program at Actlabs. The RE09003X, RE09007X, RE10001X, and RE10003X standards were used for the 2013 analytical program at Actlabs. These standards were prepared from Bull Hill REE-mineralized materials by MEG in Reno, Nevada using the protocol discussed in Section 11.5.

11.6.4 Historical Standard Values

The standards were originally certified for Y, La, Ce, Pr, Nd, and Sm analyses. In a project of this magnitude, where the number of quality control analyses for the laboratory of choice far exceeds the original number of analyses in the certificate, it is acceptable practice to use statistics for the standards which are calculated based upon the current analytical method at the laboratory(ies) used in the drill program to evaluate QA/QC results. These statistics (the "historical mean and standard deviation") were used in evaluation of the standards results of this study and are within 2-5% of the original values established by the qualifying round robin studies. Table 11.1 shows a list of the historical statistics derived from analyses for the combined 2009-2013 drill programs, along with the number of analyses used to generate these statistics. The "%TREO" is the average percent total rare earth oxide content for each standard.

Table 11.1 - Standard Statistics Generated from 2009-2013 Drill Standard Analyses

Standard	RE09001X	RE09003X	RE09004X	RE09006X	RE09007X	RE10001X	RE10003X
Count	141	258	77	64	120	11	339
TREO (%)	1.65 ± 0.13	1.69 ± 0.15	4.18 ± 0.24	4.11 ± 0.30	1.80 ± 0.08	0.88 ± 0.05	3.35 ± 0.54
TREO RSD	3.8	4.5	2.9	3.6	2.2	2.7	3.6
Element (ppm)	Mean ± 2SD	Mean ± 2SD	Mean ± 2SD	Mean ± 2SD	Mean ± 2SD	Mean ± 2SD	Mean ± 2SD
Y	154 ± 17	104 ± 12	160 ± 21	117 ± 13	234 ± 13	110 ± 9	447 ± 41
La	3505 ± 346	3854 ± 399	10672 ± 765	10643 ± 740	4208 ± 206	1851 ± 86	8552 ± 728
Ce	5997 ± 532	6444 ± 677	16008 ± 1070	16211 ± 1601	6319 ± 354	3132 ± 208	12934 ± 1063
Pr	711 ± 70	720 ± 73	1631 ± 125	1672 ± 136	694 ± 38	349 ± 17	1349 ± 119
Nd	2705 ± 242	2581 ± 253	5706 ± 380	5328 ± 405	2581 ± 121	1385 ± 84	4893 ± 413
Sm	526 ± 51	416 ± 43	837 ± 60	629 ± 42	576 ± 31	327 ± 23	1066 ± 100
Eu	123 ± 13	86 ± 8	163 ± 11	114 ± 8	154 ± 8	80 ± 6	292 ± 22
Gd	292 ± 64	195 ± 57	373 ± 69	299 ± 213	401 ± 41	183 ± 8	768 ± 126
Tb	22.1 ± 4.2	13.7 ± 3.8	22.1 ± 3	17.8 ± 13.7	37.4 ± 4.2	15.8 ± 1.3	73.9 ± 9.5
Dy	62.3 ± 9.1	38.6 ± 6.5	59.6 ± 10	40.2 ± 6.9	105 ± 9.3	43.2 ± 3.6	216.8 ± 26.8
Ho	6.5 ± 1.7	4.1 ± 1.3	5.8 ± 2.5	4.1 ± 1.7	9.7 ± 0.9	4.2 ± 0.6	20.5 ± 3.9
Er	11.7 ± 6.5	8 ± 5.3	10.1 ± 4.1	12.5 ± 19	14.3 ± 3.1	7 ± 1.5	29.5 ± 10.4
Tm	1.2 ± 0.3	0.9 ± 0.2	1.2 ± 0.4	0.9 ± 0.2	1.4 ± 0.3	0.8 ± 0.1	2.6 ± 0.5
Yb	7.7 ± 2	6 ± 1.3	8.1 ± 1.3	6.5 ± 2.1	7.8 ± 1.5	4.7 ± 0.6	14.8 ± 5.1
Lu	1 ± 0.2	0.8 ± 0.1	1.2 ± 0.1	0.9 ± 0.2	1 ± 0.2	0.6 ± 0.1	1.9 ± 0.6

(Jaacks, 2014)

11.6.5 Relative Standard Deviation

The percent RSD (Relative Standard Deviation = Standard Deviation divided by the mean) values are displayed in Table 11.2. RSD is a measure of a standard's performance. One normally expects a well-behaved standard to have an RSD value of less than 5%. Provisional standard RSD values range from 5-15%. Materials with RSDs of less than 15% are acceptable for use as certified reference materials. Materials with RSD's of greater than 15% (highlighted by the red font in Table 11.2) are not normally used or certified as reference materials.

In the original round robin studies the standards were certified for Y, La, Ce, Pr, Nd, and Sm analyses. RSD values in Table 11.2 show that the standard history analyses have acceptable accuracy and precision for analyses of Y, La, Ce, Pr, Nd, Sm, Eu and Gd. The analytical history indicates that the standards are not as effective for the heavier rare earth elements (Tb, Dy, Ho, Er, Tm, Yb, and Lu), because of the difficulty that both Actlabs and ALS have in producing consistently reliable analyses for samples with low concentrations of heavy rare earth element from year to year as the instrumental calibrations change. This should not have a significant impact upon resource calculations, as the total heavy rare earth element oxide percentage of the combined heavy (Gd through Lu) oxides amounts to less than 1-2% of the total rare earth oxide content of the samples. One can see this in Table 11.2, where the RSD values for the %TREO are all acceptable with values of less than 4.5.

The RSDs for %TREO for each individual laboratory are elevated by the year-to-year calibration changes, which have an impact on the analytical results, but should have no significant impact on resource calculations owing to the low concentrations of these elements.

Table 11.2 - Standard RSD's Generated from 2009-2013 Drill Standard Analyses

Standard	RE09001X	RE09003X	RE09004X	RE09006X	RE09007X	RE10001X	RE10003X
Count	141	258	77	64	120	11	339
TREO (%)	1.65 ± 0.13	1.69 ± 0.15	4.18 ± 0.24	4.11 ± 0.30	1.80 ± 0.08	0.88 ± 0.05	3.35 ± 0.54
TREO RSD	3.8	4.5	2.9	3.6	2.2	2.7	3.6
Element (ppm)	% RSD	% RSD	% RSD	% RSD	% RSD	% RSD	% RSD
Y	4.5	4.9	3.3	3.8	2.8	4.0	4.5
La	4.9	5.2	3.6	3.5	2.4	2.3	4.3
Ce	5.3	4.7	3.5	3.7	2.8	3.3	4.1
Pr	4.9	5.1	3.6	3.4	2.7	2.4	4.4
Nd	4.9	5.0	3.8	4.1	2.3	3.0	4.2
Sm	5.7	5.9	6.5	5.6	2.7	3.5	4.7
Eu	4.4	5.3	3.3	4.9	2.5	3.7	3.8
Gd	7.3	8.4	8.3	8.6	5.1	2.3	8.2
Tb	13.5	15.9	21.4	20.2	5.6	4.1	6.4
Dy	10.9	14.7	9.3	35.6	4.4	4.1	6.2
Ho	9.6	14.1	6.7	38.4	4.9	7.2	9.4
Er	13.4	10.9	7.8	15.7	10.8	10.4	17.7
Tm	27.9	33.2	20.4	76.0	11.2	7.6	9.6
Yb	9.7	8.1	5.7	8.2	9.9	6.1	17.2
Lu	10.9	10.8	14.8	12.9	11.1	9.6	16.6

(Jaacks, 2014)

11.6.6 Standards Results

The quality control results for the standards are given in Table 11.3. As mentioned previously, the historical statistics compare favourably with the original round robin statistics generated for the RER standards. The bias between the two sets of means is within 8.5 percent with one exception. Analyses of the RE10001X standard are biased 27.7 percent higher than the original round robin analyses. This reflects the change in protocol in that lab since the original round robin certification, which will be discussed below. The RSD's are all less than 5 when including analyses at both ALS and Actlabs. There are less than 17 samples for any given standard, which exceed the warning control limit of the mean ± 2 standard deviations (or well below the 5% failure limit). A very limited number of samples (less than 1%) exceed the mean ± 3 standard deviations. Standards analyses show acceptable accuracy for resource estimation.

Table 11.3 - 2009-2013 Drill Standard Analyses Results

TREO (%)	Certificate Mean	Historical Mean ± 2SD	Count	% Bias	% RSD	#>10%	# >2SD	# >3SD
RE09001X	1.49	1.65 ± 0.13	141	10.7	3.8	2	6	1
RE09003X	1.69	1.69 ± 0.15	258	0.0	4.5	6	3	2
RE09004X	4.00	4.18 ± 0.24	77	4.5	2.9	1	4	1
RE09006X	4.20	4.11 ± 0.30	64	-2.1	3.6	1	2	0
RE09007X	1.41	1.80 ± 0.08	120	27.7	2.2	0	6	0
RE10001X	0.88	0.88 ± 0.05	11	0.0	2.7	0	0	0
RE10003X	3.24	3.35 ± 0.54	339	3.4	3.6	6	17	5

(Jaacks, 2014)

11.6.7 Standards Quality Control Graphs

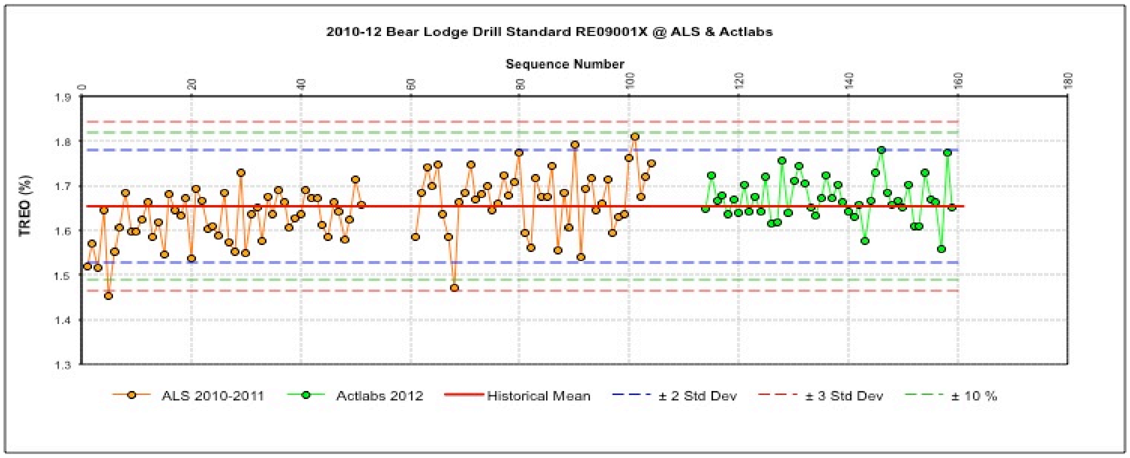
An example of the results of the standard analyses is displayed in Figure 11.1 for %TREO, which is representative of the entire series of rare earth element results. Sequence numbers are presented on the x-axis and concentration on the y-axis. The historical mean is indicated by the solid red line, and the ± 2 standard deviation control limits are depicted by the dashed blue lines, located above and below the red historical mean line. The ± 3 standard deviation control limits are depicted by the dashed red lines and the ± 10% (of the mean) control limits are depicted by the dashed green lines.

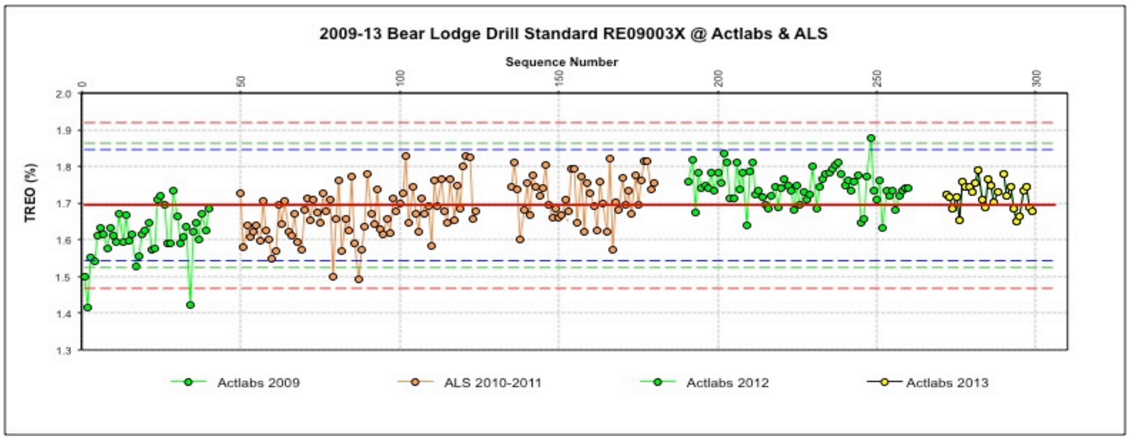
Visual examination of the quality control plots for %TREO reveals that the standard analyses exceeding ± 2 standard deviations just exceed these control limits, but very rarely exceed ± 3 standard deviations. None of the failures cluster, and the failures do not occur systematically within any given analytical certificate for the rare earth elements.

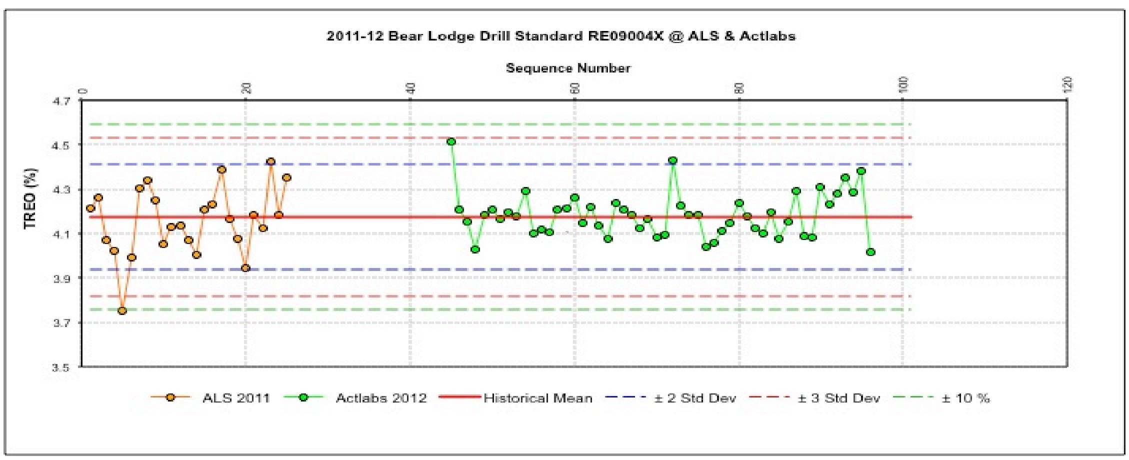
The 2009 and 2012-2013 Actlabs and 2010-2011 ALS analyses are within 2 percent of one another for the 2009-2013 time period. One can see in Figure 11.1 for Standards RE09003X and RE09006X that the Actlabs analyses display a better precision than the ALS analyses but the analyses from both labs show comparable accuracy. There is less than a 2 percent bias in comparable analyses between the two laboratories.

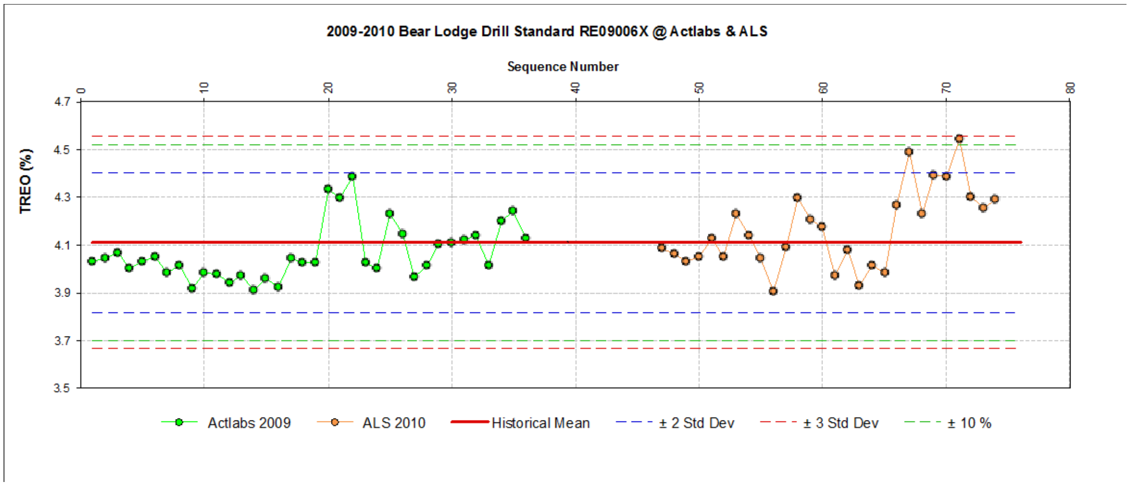
The standards indicate that light rare earth element analyses from Actlabs and ALS for the 2009-2013 drill programs are of acceptable accuracy for resource analyses.

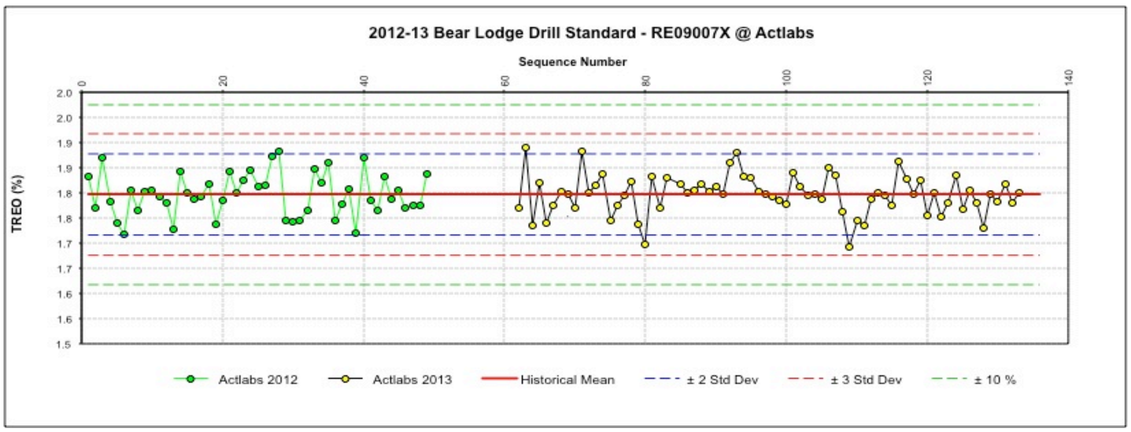
Figure 11.1 - Standard Analyses for % TREO

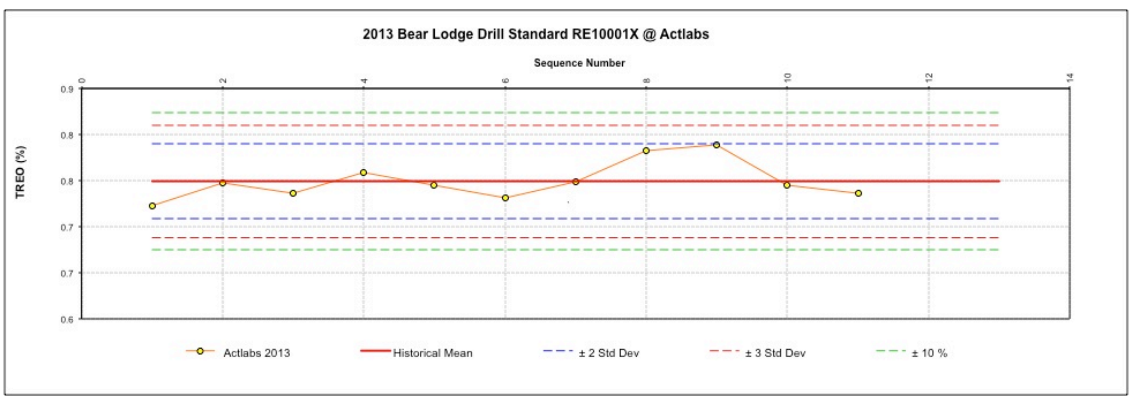


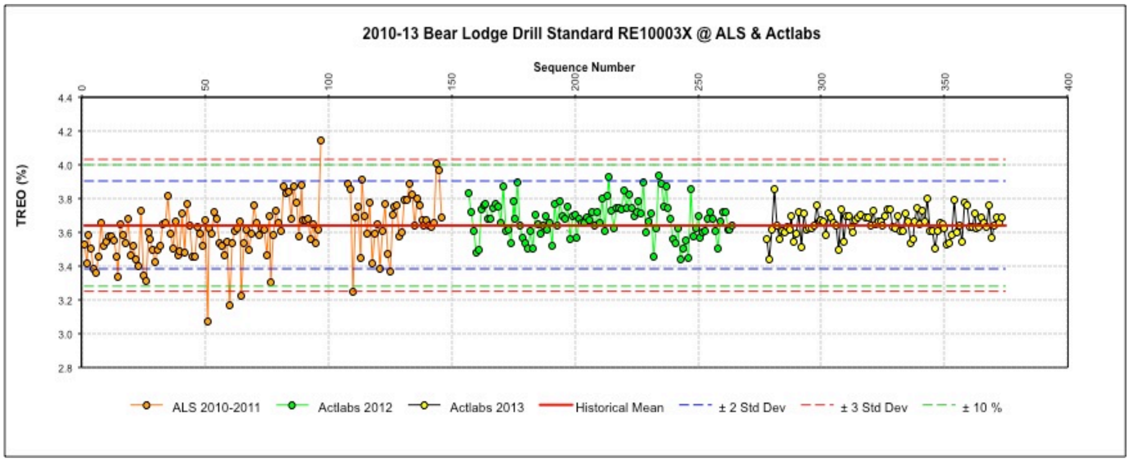





2009-2010 Bear Lodge Drill Standard RE09006X @ Actlabs & ALS
Sequence Number
TREO (%)
Actlabs 2009
ALS 2010
Historical Mean
± 2 Std Dev
± 3 Std Dev
± 10 %


2012-13 Bear Lodge Drill Standard - RE09007X @ Actlabs
Sequence Number
TREO (%)
Actlabs 2012
Actlabs 2013
Historical Mean
± 2 Std Dev
± 3 Std Dev
± 10 %


2013 Bear Lodge Drill Standard RE10001X @ Actlabs
Sequence Number
TREO (%)
Actlabs 2013
Historical Mean
± 2 Std Dev
± 3 Std Dev
± 10 %



(Jaacks, 2014)

11.6.8 2009-2013 Crush (Preparation) Duplicates

Five hundred and five sets of crush duplicates were prepared from selected drill intervals to evaluate preparation reproducibility at Minerals Exploration Geochemistry Laboratory. The results are displayed in Figure 11.2 and tabulated in Table 11.4 for the TREO. The duplicates show acceptable preparation precision for TREO. Correlation between the analytical duplicates is high. Bias is low, and more than 95% of the crush duplicate analyses are within ± 20% of the original analyses. The crush duplicates display acceptable preparation precision for resource estimation.

11.6.9 2009-2013 Pulp (Analytical) Duplicates

Four hundred and seventy-six sets of pulp duplicates were prepared from selected drill intervals to evaluate analytical reproducibility at Actlabs and ALS. The duplicates show acceptable analytical precision for TREO. Correlation between the analytical duplicates is high. More than 97% of the pulp duplicate analyses are within ± 10% of the original analyses. The pulp duplicates display acceptable analytical precision for resource estimation.

Table 11.4 - 2009-2013 Drill Duplicates Results

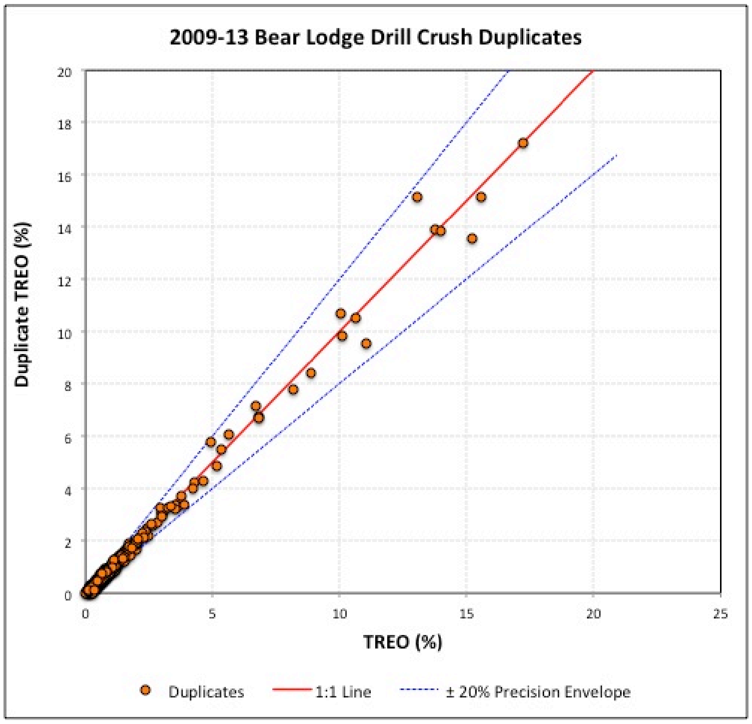
Statistics	Original Crush TREO %	Duplicate Cush TREO %	Original Pulp TREO %	Duplicate Pulp TREO %
Count =	505	505	476	476
Min =	0.013	0.009	0.012	0.012
Max =	22.830	24.486	22.813	24.063
Mean =	1.246	1.234	1.320	1.320
Std Dev =	2.113	2.168	2.228	2.261
Precision =	9.3		6.5	
% Bias =	1.0		0.0	
Correlation =	1.00		1.00	
% of samples within 10% of one another =	79		97	
% of samples within 20% of within 20% of one another =	95		99	

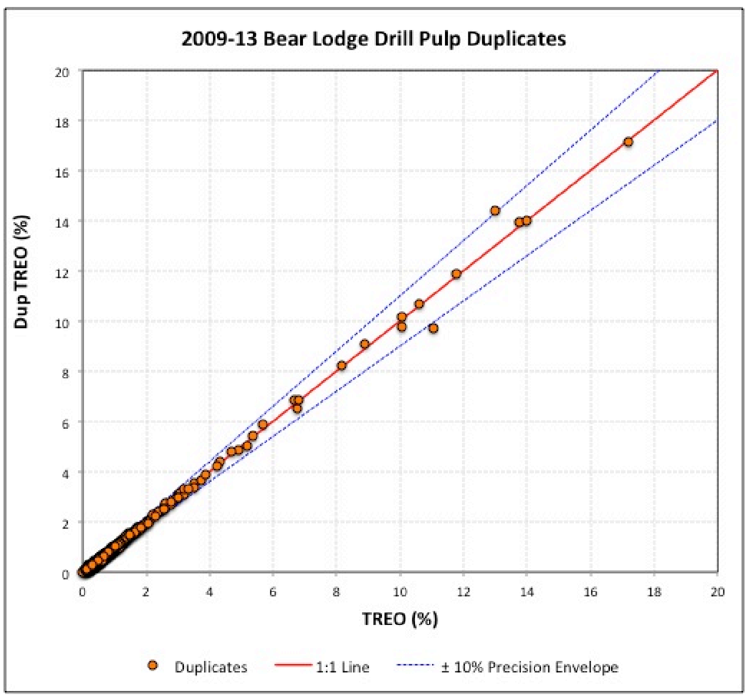
(Jaacks, 2014)

11.6.10 Duplicates Quality Control Graphs

Figure 11.2 shows the quality control plots for the crush (preparation) and pulp (analytical) duplicates for TREO. A precision envelope of ± 20% is shown in blue dashed lines centered about the solid red 1:1 line (indicating 100 % correlation) for the crush duplicates. A precision envelope of ± 10% is shown in the analytical duplicates. Ninety-five percent of the crush duplicate analyses are within ± 20 percent of one another for the TREO analyses. Ninety-seven percent of the pulp duplicate analyses are within ± 10 percent of one another for the TREO analyses.

Figure 11.2 - Crush and Pulp Duplicate Analyses for % TREO





(Jaacks, 2014)

11.6.11 2010-2013 Check Analysis Programs

Four check analysis programs were conducted utilizing samples from the annual drill programs. The check samples were randomly selected from the population of samples with TREO grades exceeding 1.0% for each year. The 2010 and 2011 sets of check samples were sent to Actlabs for analysis. The 2012 and 2013 check analysis samples were sent to ALS for analysis, as both labs use a comparable analytical method to analyze for the REE elements. Standards, blanks, and pulp duplicates were included to monitor analytical accuracy and precision. These quality control samples indicated acceptable accuracy and precision within each check program. The results for the check analysis programs are presented in Table 11.5 and Figure 11.3.

Five hundred and eighteen check samples were analyzed from 2010 to 2013 at ActLabs and ALS. All check analyses show strong correlation and acceptable precision for TREO. Precision varied from 5.2 to 11.8%. The bias between laboratories varies from -0.5% in 2013 to 9.0% in 2010. However, the overall bias averages around 2.6% between the two laboratories, which is within acceptable limits. For 2010 to 2013 inclusive, more than 89% of check analyses are within ± 10% of the original analyses (the N<10% column), and more than 96% of the check analyses are within ± 20% (the N<20% column) of one another.

Table 11.5 - 2010-2013 Check Analysis Results

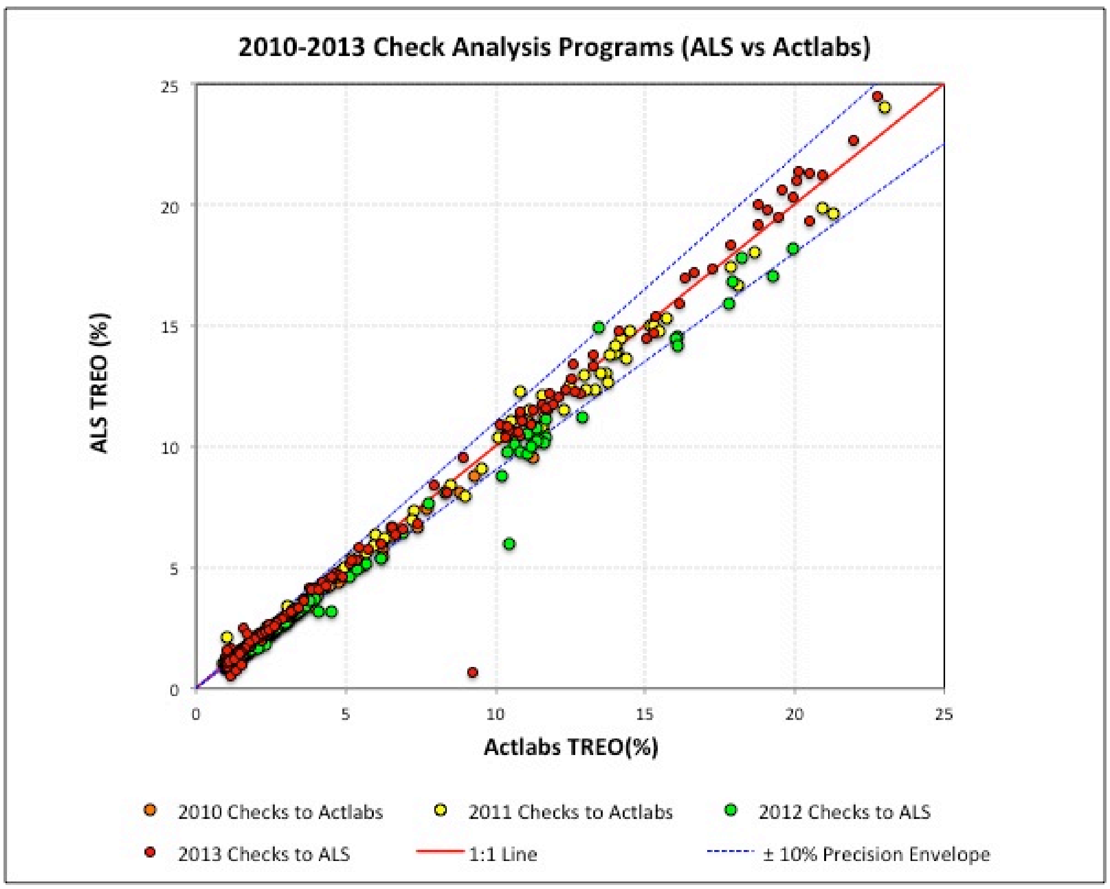
1° Lab	Check Lab	Year	N =	Min TREO %	Max TREO %	Actlabs Bias (%)	Precision (%)	N < 10% (%)	**N< 20% (%)**
ALS	Actlabs	2010	75	0.99	11.3	5.8	7.6	92	97
ALS	Actlabs	2011	163	0.93	24	1.6	5.2	96	99
Actlabs	ALS	2012	114	0.91	5.08	9	11.8	72	96
Actlabs	ALS	2013	166	0.99	24.22	-0.5	8.8	92	94
	2010-2013		518	0.91	24.2	2.6	8.7	89	96

(Jaacks, 2014)

11.6.12 Check Analysis Program Quality Control Graph

Figure 11.3 shows the quality control plot for the combined 2010-2013 check analysis programs for TREO. A precision envelope of ± 10% is shown in blue dashed lines centered about the solid red 1:1 line for the check analyses. 2010 check analyses are shown with orange dots, 2011 check analyses are shown with yellow dots, 2012 check analyses are shown with the green dots, and 2013 check analyses are shown with the red dots. Correlation within any given year is excellent. One may observe that the 2010 and 2012 groupings are more biased (closer to the 10% control limit) than the 2011 or 2013 check analyses, which lie closer to the 1:1 red line.

Figure 11.3 - 2010-2013 Check Analysis for % TREO



(Jaacks, 2014)

11.6.13 2009-2013 QA/QC Conclusions

- The blanks used in the 2009-2013 drill programs contained low concentrations of the light rare earth elements. Another blank should be used for drill programs.
- The quality control standards display acceptable accuracy for TREO and the light rare earth elements (Y, La, Ce, Pr, Nd, Sm, Eu) analyses of 2009-13 drill samples. The TREO results show that less than 3% of the standards analyses exceed the mean ± 2 standard deviation control limits, and less than 0.1% of the standard analyses exceed the mean ± 3 standard deviation failure limits.
- Crush duplicates indicate acceptable precision or reproducibility for sample preparation at Minerals Exploration Geochemistry. Ninety-five percent of the crush duplicate analyses are within ± 20% of the original analyses. The crush duplicates display acceptable preparation precision for resource estimation.
- Pulp duplicates indicate acceptable precision or reproducibility for analyses at ALS and Actlabs. Ninety-seven percent of the pulp duplicate analyses are within ± 10% of the original analyses. The pulp duplicates display acceptable analytical precision for resource estimation.
- The 2010-2013 check analyses programs validate earlier analyses by the primary laboratory. Precision and bias are within acceptable limits. More than 89% of check analyses are within ± 10% of the original analyses.
- The analytical accuracy of the analyses for the heavier rare earth elements (Tb, Ho, Er, Tm, Yb, and Lu) is more variable because of the difficulty that the laboratories have in producing consistently reliable analyses for samples with low concentrations of heavy rare earth elements. Year to year changes in instrumental calibrations affect the accuracy of these analyses. However, this should not have a significant impact upon resource calculations, as the total heavy rare earth element oxide percentage of the combined heavy (Tb through Lu) oxides amounts to less than 1% of the total rare earth oxide content of the samples.
- Actlabs and ALS use similar digestion methods and analytical finishes to analyze for rare earth elements. Data from the round robins and the historical quality control data indicate that the analyses from both of these laboratories have acceptable accuracy and precision, and are directly comparable (within 2.6% of one another) for the rare earth elements.
- The 2009-2013 drill program analyses are of acceptable quality for resource modeling.

11.7 2009-2013 Security

Sample security was supervised by Dr. James Clark, consultant to Rare Element during the 2004, 2005, and 2007 Rare Element drilling programs, by senior geologists reporting to Dr. Clark during the 2008 and 2009 programs, by Dr. Ellen Leavitt, CPG, consulting geologist, during the 2010 and 2011 drilling programs, and by John Ray, Chief Geologist, during the 2012 and 2013 drill programs. All drill core was transported from the project site to a locked and secure storage facility each evening (either the Vista West storage and sample preparation facility, near Sundance, or one of two storage and sample preparation facilities on East Cleveland Street in Sundance. No core was left unsupervised on site. The core was logged at the storage facilities, and successive intervals were split for analysis at these locations. Split core samples from each drill hole were shrink-wrapped and/or placed in rice bags on wooden pallets, and then shipped by truck using NPT Transport and UPS to MEG. The shipper was responsible for delivery to MEG, and Rare Element's personnel monitored the progress of the shipment via tracking number. The shipping paperwork and sample guides were sent to Shea Clark Smith of MEG, who also monitored the progress of the shipments from the core facilities to MEG, and subsequently to the analytical laboratories. MEG was responsible for shipment and tracking from the sample preparation facility to the laboratory. In 2009, Rare Element leased the core facility in Vista West and transferred all of its 2004 – 2008 cores to this facility from storage units at Energy Electric in Sundance.

In 2010, Rare Element acquired a secure storage warehouse at 2111 East Cleveland Street in Sundance and moved drill core, as well as splitting and logging operations to that location. In April 2012, the Company began leasing the old Energy Electric office and warehouse building at 2409 East Cleveland Avenue in Sundance, WY. They moved most of the drill core, plus the splitting and logging operations, to that facility and conducted core storage, splitting, and logging operations there from 2012 to the present.

In the authors' collective opinion, the quality of sample preparation and analytical procedures, as well as sample security measures, are all of excellent quality and state of the industry.

12 Data Verification

12.1 Introduction

This section discusses verification of the Bear Lodge Project database accumulated through 2013.

12.2 General

Rare Element obtained the geological, exploration, and drilling data package from Phelps Dodge and Newmont, covering most of the work done on the property by a variety of companies and claim owners through 1996. The exploration reports by Duval, Molycorp, FMC, Hecla, and others, referenced in this and earlier technical reports, exhibit relative consistency of reported rare earth values contained in carbonatites and FMR-type veins. The authors assume that the data and assay values are representative of the geology and mineralization in the REE-mineralized carbonatite system. However, many of these drill holes have been replaced with holes that were surveyed and assayed using up to date methods. Owing to the limited amount of information available from the Duval, Molycorp, and Hecla programs, those data were used only to assist in geological interpretation and to guide exploration. Those data were not used for resource estimation.

Newmont organized nearly all of the historical exploration data into an electronic database compatible with a GIS format and provided a copy to Rare Element in 2006. Rare Element then added all of the REE assay results from drilling done by the Company between 2004 and 2009 and created a drill hole database consisting of 356 drill holes and 18,067 lines of assay data. Rare Element geologists and contractors verified these data using available original geologic logs and assay certificates for each of the 356 historic drill holes and 18,067 lines of assay information. These data were compared to corresponding intervals in the digital database to verify information included in the database. Based on operating results and historical descriptions, there is strong evidence that the sampling, sample preparation, assaying, and security of samples were conducted in accordance with industry acceptable practices for the time period in which the samples were collected and processed. However, these historical data are not used in any current estimates of resources.

Re-analysis of the historic drill core, donated to the South Dakota School of Mines, was not possible, as the remaining material was systematically culled over the years by the School of Mines in order to facilitate storage. Only randomly-skeletonized core from the Duval, Molycorp, and Hecla holes is available (held by Rare Element in Sundance, WY).

Original collar location and down-hole survey data are available for only a few of the historical drill holes. However, these drill hole collar locations were re-surveyed using a hand-held GPS, and collar elevations were obtained by registering the drill holes on the USGS digital elevation model (DEM) for the appropriate quadrangle maps. Drill data prior to 2008 were not used for the updated resource estimates because the azimuths and inclinations are considered insufficiently accurate for use in detailed resource estimates. Collar coordinates for the 2008 through 2013 drill holes used in the current resource estimate were surveyed by Rare Element. All of the drill hole collars were originally in the database in UTM coordinates based on NAD27, but these have been converted to coordinates based on the NAD83 datum. All collar survey reporting is now entered in NAD 83 Zone 13N format in units of U.S. Feet.

Rare Element conducted its own REE drilling programs throughout the joint venture with Newmont from 2006 until the spring of 2010. The Company maintained a separate database of REE drilling results during this period. The Company's focus on exploration for REEs continued, while gold was the focus of Newmont's exploration efforts. Separation of the two exploration drilling programs for REEs and gold, and their respective drilling data, continued through the 2009 drill season. Rare Element assumed control of the gold exploration program and management of the gold drill database in the spring of 2010, with the termination of Newmont's interest in the property in May 2010. Beginning with the 2012 drilling program, the entire exploration and development focus turned to REE, and the Sundance gold exploration effort was concluded.

From 2008 through 2010, the Company compiled analytical data in Excel, Access, and Datamine for use in GIS and 3D mapping software. A much more aggressive REE exploration drill program was carried out during the 2010 drill season, and a need was recognized for a unified, secure database. Following assessment of several web-based databases during the fall of 2010 and winter of 2011, EDM Solutions was selected to implement the drill data management system. The current drill database is built on an MS SQL SERVER platform and hosted on a secure "Cloud" server with restricted access. Security and backup features are built into the system and are considered industry standard. Support and maintenance are provided by EDM Solutions of Reno, Nevada.

Dr. Jeffrey Jaacks of Geochemical Applications International Inc. (GAII) conducted a review of the results for the quality assurance and quality control (QA/QC) program used in rare earth element assaying for the Bear Lodge exploration drill programs.

REE assays for the 2009, 2012, and 2013 programs were conducted by Activation Laboratories of Ancaster, Ontario, and assays for the 2010 and 2011 drill programs were done by ALS Laboratories (see Chapter 11.0 – Sample Preparation, Analyses and Security). Both laboratories are independent of Rare Element Resources. These data display acceptable accuracy and precision for resource estimation. The quality control data are included in the updated resource estimate completed by ORE for this updated pre-feasibility report.

On-site Company geologists and ORE personnel have conducted extensive reviews and verified data from Rare Element's 2009 – 2013 drilling programs, which are used in the current resource estimate. Ongoing assessment of data in 2013 was carried out by O.R.E., with compilation in Excel and Datamine as before, and with links to the current database.

Dr. James Clark, former Vice President of Exploration and a co-author of one of the earlier technical reports, supervised work conducted by Hecla and Rare Element, and attests to the verification of the data. Dr. Ellen Leavitt, a Qualified Person for purposes of NI 43-101, supervised the on-site work on REE exploration from early 2010 through 2011, and she has attested to the verification of those data. Richard Larsen and John Ray, both Qualified Persons for purposes of NI 43-101, managed aspects of the 2012 and 2013 exploration and development drilling programs.

The author attests to the quality and accuracy of the data for purposes of this report.

The primary author has contacted the author of the metallurgical testwork upon which the process modeling and financial modeling is based to verify that the results obtained are those published by SGS Lakefield. In addition, a Roche Engineering employee has been present to observe and personally verify a significant portion of the test work that is the basis of this report.

13 Mineral Processing and Metallurgical Testing

13.1 Historical Test-work

Metallurgical test work was conducted by four laboratories on various components of the project in order to provide the necessary design criteria for this pre-feasibility study. The initial bench scale testwork was conducted by Mountain States R&D International (MSRDI). Subsequently, a pilot scale test program conducted and completed in early 2012 by Hazen Research Laboratories. A parallel series of tests to verify the Hazen process work was conducted by Nagrom of Perth, Australia.

The test work mentioned above tested the use of conventional technology and formed the basis for the NI 43-101 compliant PFS report: Roche Engineering Inc., "Rare Element Resources Inc., Bear Lodge Project, Canadian NI 43-101", April 13, 2012. The results of this early testing are not relevant to the current processing methods.

13.2 Rare-Earth Metallurgical Testing

SGS Minerals Services has conducted the most recent bench-scale and pilot-scale testing programs for the PUG plant and the most recent bench-scale and pilot plant testing programs for the Hydromet plant.

This progression in testing is viewed as an important series of steps in determining the amenability to extraction of rare earths from the Bear Lodge ore. Samples were collected from a combination of PQ and HQ core holes and bulk sampling as described in Chapter 11. The tested samples were representative of typical Bull Hill oxide and oxide carbonatite mineralization, which represent the majority of the resource. Whitetail ore was also included in the test program which had not been previously tested. Partially oxidized and stockwork mineralization were not tested in this program since this material will not be part of the proposed mining plan. Variability testing was completed to evaluate how ore types in all areas of the pit respond to screening, gravity separation and magnetic separation. It was found that in order to optimize recoveries from all ore types, three different physical upgrade flowsheets would be required.

Ultimately, it has been found that the most recent test work by SGS Lakefield, which uses crushing and screening in combination with various configurations of gravity and magnetic separation, (depending on ore type) provides the optimum grade and recovery of pre-concentrate to the hydromet plant. Further, the precipitation of PLS using oxalic acid, in combination with numerous other process improvements, produces a higher grade product with much improved economics compared to the 2012 PFS.

13.3 Summary of Process Design Criteria

13.3.1 Process Description

The flow sheet that was used in this PFS evaluation is described stage-wise as follows:

13.3.2 Crushing and Screening

In years 1-9 of mine life, mined ore will be crushed and screened for direct processing at Upton without application of gravity and magnetic separators (PUG Plant). The ore will be stage-crushed and screened at a cut-off size of 3 inches. Approximately 20% of mined feed ore will be stockpiled as low-grade coarse material (+ 3 inch) while the undersize (- 3 inch) fraction will be transported to the leach plant at Upton.

A set of cone and roll crushers will be installed at Upton to reduce the ore from minus 3 inch to 100% passing - 48 mesh mineral pre-concentrate.

On the basis of crusher work index (kW-hr/ mt), Phillips Enterprises determined the crusher power requirements for Whitetail ore. This ore was classified as soft, CWI = 6.0 kWh/mt or 5.4 kWh/st) and abrasive AI = 0.237g). For Bull Hill composite ore, the crusher work indices was determined by Hazen Research as 10.98 -13.11 kWh/mt.

13.3.3 PUG Plant

In years 10-45, the crushing plant will be modified by adding beneficiation units to upgrade the ore by gravity and magnetic separation. Mine production will be ramped up to process mid-grade ore at a feed rate of 1346 tpd in order to off-set the decrease in REO grade and high gangue content of the ore.

Bull Hill ores (mid- and low grade oxides and carbonatite) plus White Tail ores responded well to pilot-scale gravity and magnetic separation techniques. The mass pull was equivalent to 40-77% of feed mass.

13.3.4 Acid Digestion, Rare Earths and Base Metal Separation

The PUG process produces a mineral concentrate rich in rare earth (RE) minerals. Subsequently, at the hydromet plant the mineral concentrates are leached in hot chloride solution to extract rare earths, thorium, uranium and significant amounts of base metals.

The rare earth (RE) metals plus thorium are selectively precipitated from the pregnant leach solution (PLS) using oxalic acid while all the base metals, including uranium, remain in the barren PLS. Rare earth oxalate precipitates are dried and roasted to produce a +97% pure mixed REO powder.

Bulk REO powder or RE carbonate solids are dissolved in nitric acid to generate a bulk RE nitrate solution containing thorium that serves as feed to the thorium extraction plant. A double hydroxylation process is applied to extract thorium selectively from RE nitrates. The thorium hydroxide residue is contained and transported to a third-party disposal facility while the pure RE nitrate solution is subjected to a final precipitation process to produce RE hydroxide solids. The RE hydroxide cake is dried and calcined at moderate temperature to produce a marketable +97% mixed REO powder.

13.3.5 Acid and Water Recovery

The barren PLS is a source of significant amounts of reagents (free hydrochloric and oxalic acid) , water and base metals. Therefore, a distillation process is applied to recover water and hydrochloric acid at atmospheric pressure. Energy costs associated with boiling water are mitigated by a cheaper energy source (natural gas) and a heat recovery system that is coupled to the distillation column. Residual solution from the column is pumped through a chiller to crystallize and recover unreacted oxalic acid.

13.3.6 Neutralization and Base Metal Recovery

The metal-rich liquor from the distillation column is neutralized with limerock and small amounts of quicklime to produce a mixed base metal hydroxide cake. This cake is then mixed with the leach residue, dewatered and transported to the double lined tailing storage facility.

The filtrate is passed through a chiller to crystallize calcium as $CaCl_2$ crystals with smaller amounts of NaCl crystals. The final filtrate, with few metal ions, is recycled to the distillation column for water recovery. The metallurgical plant is designed to run without effluent discharge to the environment.

13.4 Overall Rare Earth Recovery Used in Economic Evaluation

In this PFS, overall rare earth recovery was calculated by combining individual recoveries from the PUG and Hydromet plants.

13.4.1 Screening and PUG Recovery

In years 1-9, the recovery of rare earth oxides (REOs) to the mineral pre-concentrate is based on ore passing the 3 inch cut-off size and the rejection of coarse material that is below economic grade. However, in subsequent years 10-45, recovery includes screening and PUG plant efficiencies as shown in the Table 13.1 below.

Table 13.1 - REO Recoveries at PUG Plant in Years 1-9 and Years 10-45

REO RECOVERY BY SCREENING ONLY : YEARS 1-9

Minerals	Screening		PUG		Overall	
Ore Type	%REO Rec	% Mass Pull	%REO Rec	% Mass Pull	%Rec	%Mass Pull
BH HG Ox	92	80	100	100	92	80
BH HG OxCa	99	94.5	100	100	99	94.5

REO RECOVERY BY SCREENING + PUG: YEARS 10 - 45

Minerals	Screening		PUG		Overall	
Ore Type	%REO Rec	% Mass Pull	%REO Rec	% Mass Pull	%Rec	%Mass Pull
BH MG Ox	95	80	91	77	88	55
BH MG OxCa	100	100	91	77	91	77
BH LG Ox	94	80	91	77	86	56
BH LG OxCa	100	100	91	77	91	77
WT	92	71	86	55.5	80	40

(SGS Lakefield, 2014)

13.4.2 Hydrometallurgical Recovery

The composite pre-concentrates from the PUG Plant will be acid leached to produce a rare earth rich solution from which a +97%REE oxalate precipitate will be produced. Hydrometallurgical recovery is a product of leach and oxalate precipitation efficiencies with an additional 1%-2% loss in Thorium.

In this PFS, the mineral concentrates to Hydromet plant were composited by head grade. The composite ores represent the mineral resources to be mined in specific phases of the project life. All the composited ores were processed at the Pilot Plant to derive the leach and precipitation efficiencies that characterizes the ore.

Composites D represents the Bull Hill oxide and carbonatite ores to be processed at the start of mine life. Other composites represent mixed ores to be mined later as shown in Table 13.2 below. The development of these composites is explained in section 13.6.5.1.

Table 13.2 - Representative Mine Life Composites

YEAR PERIOD					
Years 1-6	**Year 7-14**	**Year 15-19**	**Year 23-26**	**Year 20-22**	**Year 27-45**
Comp D	Comp C	Comp B	Comp B	Comp E	Comp E

(Rare Element, 2014)

The head grade of the composites is shown in Table 13.3. The leach extraction and precipitation efficiency for each composite is shown in Table 13.4.

Table 13.3 - Head Grade of Composites

Composite Ore	Headgrade											
	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	MgO %	CaO %	Na_2O %	K_2O %	MnO %	La g/t	Ce g/t	Pr g/t	Nd g/t
Comp D	22.8	6.69	18.0	1.01	8.76	0.36	4.92	7.94	22,344	33,474	3,359	12,937
Comp C	32.3	9.73	13.6	1.44	9.21	0.31	7.50	4.44	12,247	19,836	2,084	7,833
Comp B	40.3	12.4	12.9	1.12	5.11	0.27	9.72	3.03	7,072	11,618	1,196	4,155
Comp E	45.4	14.2	13.0	1.15	0.93	0.30	11.1	3.21	5395.0	9,597	1,167	4,156

Composite Ore	Headgrade														
	Sm g/t	Eu g/t	Gd g/t	Tb g/t	Dy g/t	Ho g/t	Er g/t	Tm g/t	Yb g/t	Lu g/t	Y g/t	Sc g/t	U g/t	Th g/t	TREO g/t
Comp D	1,791	405	923	74	229	26.0	45.1	4.7	25.9	4.9	668	<25	164	1,056	8.94
Comp C	1,039	229	499	40	130	15.5	27.7	2.9	16.2	3.0	395	<25	109	538	5.20
Comp B	670	149	351	27	82	8.8	14.7	1.4	8.2	1.7	220	<25	71	391	2.99
Comp E	537	115	278	20	55	6.0	10.2	1.1	5.8	1.1	140	< 25	79	239	2.52

(SGS Lakefield, 2014)

Table 13.4 - REE Extraction at Leach and Precipitation Plants

% REE LEACHED					% REE PRECIPITATED	% HYDROMET RECOVERY				
(-)	B	C	E	D		(-)	B	C	E	D
La	97	88	95	89	98	La	95.1	86.2	93.1	87.2
Ce	85	86	83	87	100	Ce	85.0	86.0	83.0	87.0
Pr	97	87	95	89	100	Pr	97.0	87.0	95.0	89.0
Nd	96	87	95	89	100	Nd	96.0	87.0	95.0	89.0
Sm	95	87	94	88	100	Sm	95.0	87.0	94.0	88.0
Gd	93	87	94	87	100	Gd	93.0	87.0	94.0	87.0
Tb	93	86	91	85	100	Tb	93.0	86.0	91.0	85.0
Dy	89	84	89	82	100	Dy	89.0	84.0	89.0	82.0
Ho	87	82	87	80	99	Ho	86.1	81.2	86.1	79.2
Er	84	79	83	77	99	Er	83.2	78.2	82.2	76.2
Eu	88	88	94	88	100	Eu	88.0	88.0	94.0	88.0
Tm	83	78	78	75	93	Tm	77.2	72.5	72.5	69.8
Yb	79	75	75	74	99	Yb	78.2	74.3	74.3	73.3
Y	86	81	83	78	100	Y	86.0	81.0	83.0	78.0
Lu	72	70	66	70	93	Lu	67.0	65.1	61.4	65.1
Sc	11	11	7	15	92	Sc	10.1	10.1	6.4	13.8
Th	82	55	73	55	100	Th	82.0	55.0	73.0	55.0
U	67	60	67	61	0	U	0.0	0.0	0.0	0.0

(SGS Lakefield, 2014)

13.4.3 Waste Streams

In this PFS, the solid waste is comprised of the following:

- Screen coarse rejects
- PUG rejects
- Neutralized leach residue
- Neutralized mixed base metal hydroxides
- Calcium chloride solids
- Thorium-rich precipitate

The average annual production for each waste stream is presented in the Table 13.5 below:

Table 13.5 - Average Annual Production of Waste Streams

Years 1 to 9	Short tons per year
Years 1 to 9 Average Total Screening Coarse Reject	41,109
Years 1 to 9 Average Total PUG Reject	0
Years 1 to 9 Average Neutralized Leach Residue	137,692
Years 1 to 9 Average Neutralized Mixed Base Metal Hydroxides	41,031
Years 1 to 9 Average Calcium Chloride Solids	114,789
Years 1 to 9 Average Thorium-Rich Precipitate	136
Years 10+	
Years 10+ Average Total Screening Coarse Reject	70,441
Years 10+ Average Total PUG Reject	79,178
Years 10+ Average Neutralized Leach Residue	155,610
Years 10+ Average Neutralized Mixed Base Metal Hydroxides	44,887
Years 10+ Average Calcium Chloride Solids	159,595
Years 10+ Average Thorium-Rich Precipitate	192

(Roche, 2014)

13.5 Mineral Processing – Batch Tests

13.5.1 Variability Tests

Granulometry and screen tests were performed on ore from Bull Hill and Whitetail deposits to assess the benefits of upgrading the ore by simple screening. BH oxide (Ox) ores are more amenable to upgrade by screening than oxide-carbonatite (OxCa) ores from the same deposit. Neither the BH Ox nor BH OxCa respond well to magnetic separation, but they do respond to gravity separation.

Whitetail ore responds well to beneficiation techniques where gravity and magnetic separators are applied in stages on the coarse ore. 3 inch drill core samples were obtained from BH and WT deposites. Figure 13.1 and 13.2 are maps indicating multiple sites (central and outlaying zones) where drill core samples were taken in

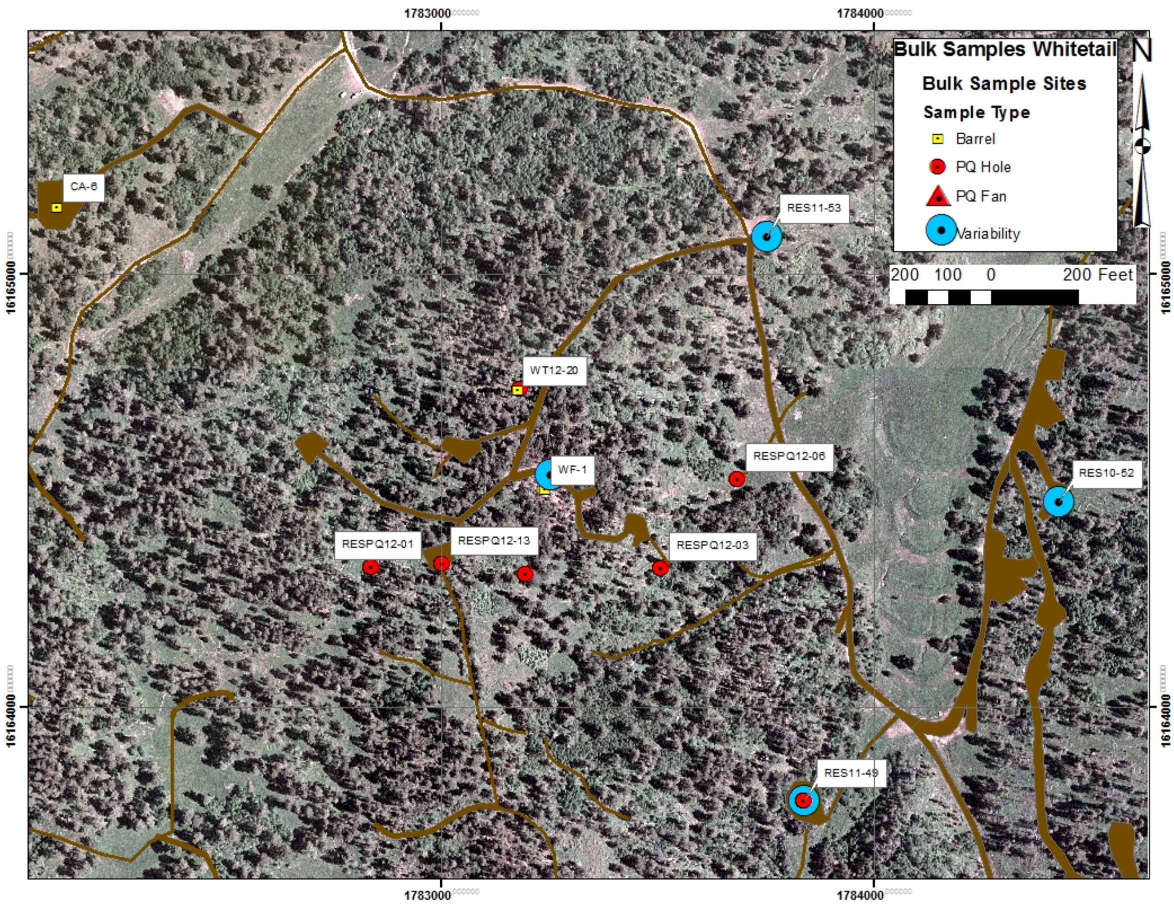
2010 (RES 10) and 2012 (RES 12) for the Whitetail and Bull Hill areas, respectively. Table 13.6 tabulates the sample weights along with the sample IDs.

Table 13.6 - Ore Sample Identification Table

Sample Id	Weight, kg	Drum ID
RES 10-21	13.84	Drum 1 12-3689
RES 10-21	13.64	Drum 1 12-3689
SUB-TOTAL	***27.48***	
RES 10-52	6.46	Drum 3 12-3691
RES 10-52	15.74	Drum 3 12-3691
SUB-TOTAL	***22.2***	
RES 11-21	11.97	Drum 3 12-3691
SUB-TOTAL	***11.97***	
RES 11-35	9.3	Drum 1 12-3689
RES 11-35	12.28	Drum 1 12-3689
RES 11-35	11.84	Drum 5 12-3693
RES 11-35	9.14	Drum 2 12-3690
SUB-TOTAL	***42.56***	
RES 11-42	4.46	Drum 1 12-3689
RES 11-42	12.6	Drum 4 12 3693
SUB-TOTAL	***17.06***	
RES 11-44	13.74	Drum 2 12-3690
RES 11-44	16.26	Drum 5 12-3693
RES 11-44	9.98	Drum 6 12-3694
SUB-TOTAL	***39.98***	
RES 11-49	5.7	Drum 2 12-3690
RES 11-49	9.9	Drum 6 12-3694
SUB-TOTAL	***15.6***	
RES 11-52	15.64	Drum 5 12-3693
SUB-TOTAL	***15.64***	
RES 11-53	12.18	Drum 4 12-36393
SUB-TOTAL	***12.18***	
RES PQ 11-03	13.4	Drum 3 12-3691
RES PQ 11-03	11.18	Drum 5 12-3693
RES PQ 11-03	11.72	Drum 6 12-3694
SUB-TOTAL	***36.3***	
RES PQ 11-07	11.94	Drum 3 12-3691
RES PQ 11-07	12.76	Drum 4 12-3693
RES PQ 11-07	12.28	Drum 6 12-3694
SUB-TOTAL	***36.98***	

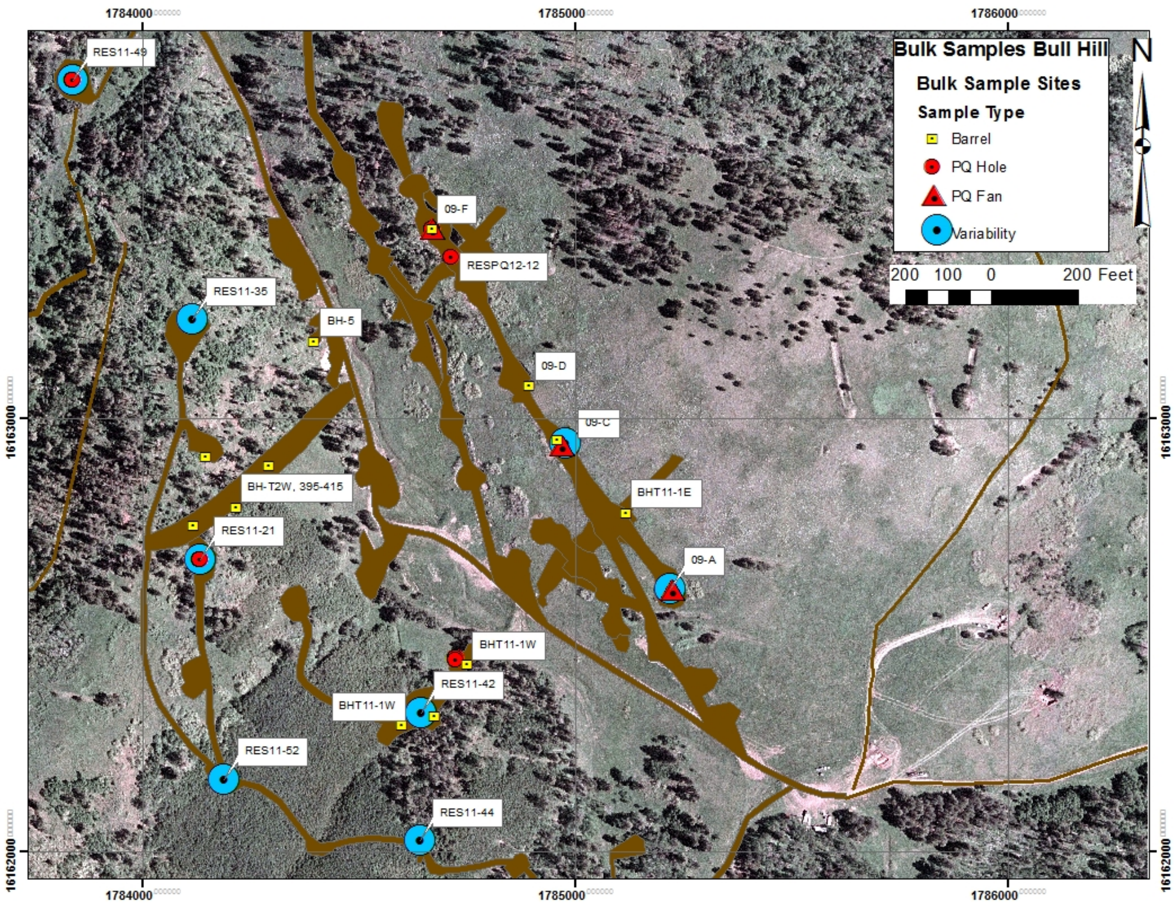
(Rare Element, 2011-2013)

Figure 13.1 - Sample Locations for Whitetail



(Rare Element, 2012)

Figure 13.2 - Sample Locations for Bull Hill

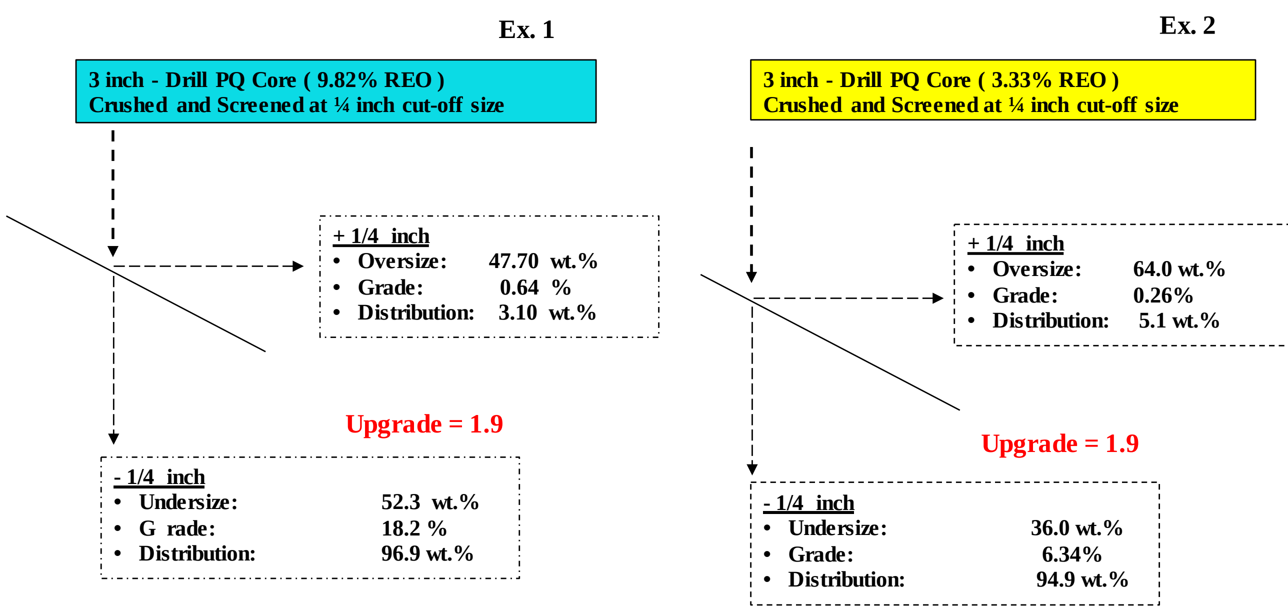


(Rare Element, 2012)

Bull Hill Ore: Variability Screen Tests

Crushed ore (+¼ inch) was subjected to screening to assess recovery of REOs to minus ¼ inch fraction. Figure 13.3 illustrates the behavior of crushed core samples from the central zones of the BH deposits located near rare earth dikes. Rare earth minerals (9.84%TREO and 3.33%TREO) were upgraded by a factor of 1.9. The mass pull to minus ¼ inch was 52.3% and 36% with recoveries 96.9% and 94.9%, respectively.

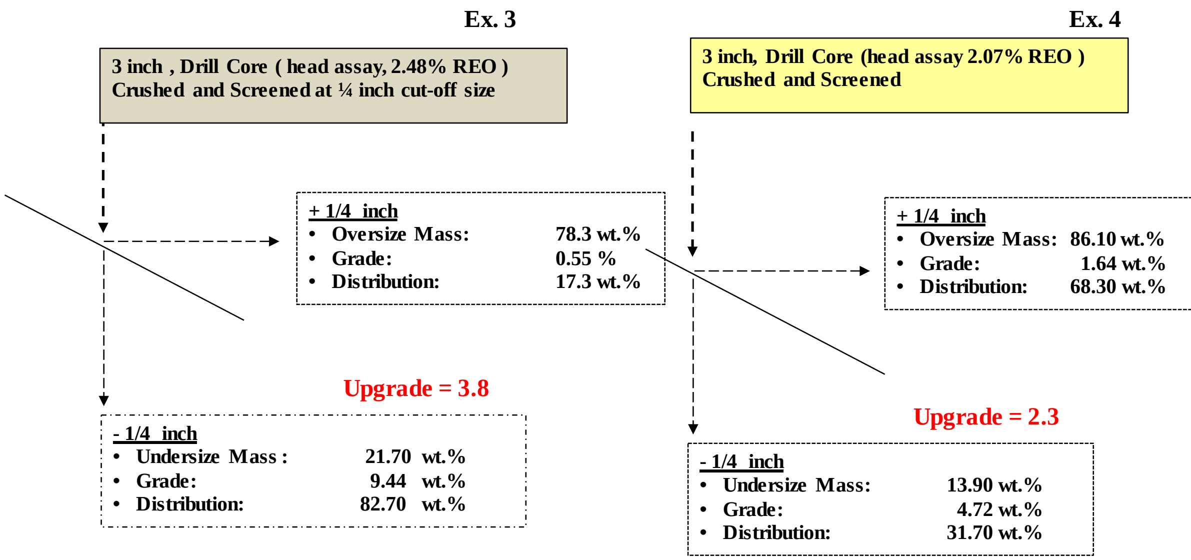
Figure 13.3 - Separation of REOs by Screening at ¼" Bull Hill High Grade



(Rare Element, 2014)

Low-grade ores from BH deposits were processed as illustrated in Figure 13.4. Rare earth minerals (2.48% TREO and 2.07% TREO) were upgraded by a factor of 3.81 and 2.3, respectively. The mass pull to minus ¼ inch was 21.7% and 13.9% with recoveries 82.7% and 31.7%, respectively. Upgrade factors are sufficiently high but recoveries were on the low side and hence the need to improve recovery by introducing gravity and magnetic separators. In general, drill core samples from outlying zones of the deposit did not upgrade well after screening. However, all samples leach well in chloride media.

Figure 13.4 - Separation of REOs by Screening at ¼" Bull Hill Low Grade



(Rare Element, 2014)

Table 13.7 tabulates the cumulative percent REO in size fractions less than one quarter inch for three different samples: RES 11-19, RES 11-52 and RES 11-43.

Table 13.7 - Cumulative Percent REO Contained Below Size Fraction, Bull Hill

Test No.	Cumulative Products	Mass %	Ce203 %	La203 %	Nd203 %	Pr203 %	Sm203 %	Y203 %	REO %
RES11-49	+1/4"	64.0	3.2	3.3	4.7	10.1	21.4	11.7	5.1
	-1/4"	36.0	95.8	96.7	95.3	89.9	78.6	88.3	94.9
	-48 mesh	24.5	85.4	86.7	85.8	81.4	71	76.0	84.5
	-100 mesh	22.9	80.0	81.6	81.3	77.1	67.3	71.4	79.6
	-200 mesh	20.4	69.5	70.7	70.7	66.9	58.5	62.1	69.1
	-325 mesh	18.9	63.3	63.6	63.8	60.3	52.9	55.8	62.6
	-500 mesh	17.7	58.5	58.1	58.5	55.1	48.4	50.8	57.5
	HEAD (Calc.)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
RES11-52	+1/4"	22.7	29.3	29.9	29.2	30.5	25.9	28.6	29.4
	-1/4"	77.3	70.7	70.1	70.8	59.5	74.1	71.4	70.5
	-48 mesh	55.5	45.3	49.4	50.5	49.8	58.0	43.7	48.4
	-100 mesh	51.0	41.3	44.9	46.1	45.3	53.3	41.4	43.7
	-200 mesh	44.7	34.2	38.2	39.3	38.4	45.2	33.4	36.7
	-325 mesh	39.6	29.2	33.3	34.2	33.3	39.3	28.2	31.7
	-500 mesh	32.1	23.8	27.7	28.2	27.0	30.6	24.4	26.0
	HEAD (Calc.)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
RES11-53	+1/4"	87.4	71.2	70.5	74.6	67.1	82.2	81.6	72.2
	-1/4"	12.5	28.8	29.5	25.4	32.9	17.8	18.4	27.8
	-48 mesh	4.7	24.9	24.6	20.5	28.0	10.5	14.9	23.8
	-100 mesh	4.1	24.1	23.7	19.7	27.1	9.8	14.0	22.4
	-200 mesh	3.2	22.0	21.0	17.5	23.9	8.7	12.5	20.2
	-325 mesh	2.6	19.6	18.2	15.2	20.7	7.6	10.7	17.7
	-500 mesh	2.0	17.0	15.0	12.6	17.4	6.4	9.0	15.0
	HEAD (Calc.)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Drill core samples RES 11-49 show that 84.5% of REO will report to 24.5% of mass in -48 mesh fraction. But these results were not duplicated for RES 11-52 and RES 11-53. There are many reasons for that, however, process-wise the deposit requires other simple techniques to upgrade rare earths.

(SGS Lakefield, 2012)

For Whitetail, REOs are upgraded to the fines but exhibited poor recovery. Most of the mass and REOs remain in the coarse fractions (+ ¼ inch) as shown in the Table 13.8.

Table 13.8 - Cumulative Percent REO Contained Below Size Fraction, Whitetail

VARIABILITY SAMPLE: RES 10-21
(Whitetail deposit)

Grades%									
Test No.	**Cumulative Products**	**Mass %**	**Ce203**	**La203**	**Nd203**	**Pr203**	**Sm203**	**Y203**	**REO**
RES 10-21	+1/4"	88.1	0.73	0.49	0.27	0.08	0.05	0.02	1.84
	-1/4"	13.9	2.18	1.45	0.71	0.22	0.10	0.07	4.72
	-48 mesh	**6.0**	**4.31**	**2.84**	**1.35**	**0.43**	**0.15**	**0.12**	**9.20**
	-100 mesh	5.1	4.79	3.12	1.49	0.47	0.17	0.12	10.2
	-200 mesh	4.1	5.31	3.33	1.59	0.51	0.19	0.13	11.0
	-325 mesh	3.5	5.62	3.40	1.63	0.52	0.19	0.13	11.5
	-500 mesh	2.7	6.10	3.48	1.68	0.54	0.20	0.14	12.1
	HEAD (Calc.)	100.0	0.93	0.62	0.33	0.10	0.06	0.03	2.07

%Distribution									
Test No.	**Cumulative Products**	**Ce203**	**La203**	**Nd203**	**Pr203**	**Sm203**	**Y203**	**REO**	**UF**
RES 10-21	+1/4"	87.6	67.6	70.0	88.6	78.0	88.8	88%	0.08
	-1/4"	32.4	32.4	30.0	31.4	22	31.2	31.7	2.3
	-48 mesh	**27.9**	**27.6**	**24.7**	**26.6**	**15.5**	**23.3**	**26.8**	**4.4**
	-100 mesh	26.4	25.8	23.1	24.9	14.7	21.2	25.2	4.9
	-200 mesh	23.2	21.9	19.7	21.2	12.8	17.7	21.8	5.3
	-325 mesh	20.9	19.0	17.2	18.5	11.1	15.5	19.3	5.6
	-500 mesh	17.8	15.3	13.9	15.1	9.1	12.7	16.0	5.9
	HEAD (Calc.)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	

(SGS Lakefield, 2012)

13.5.2 Magnetic Tests

Whitetail solids (-0.5+0.18mm) responded well to magnetic separation and the data are shown in Table 13.9. About 4.1% of total REO+Y_2O_3 plus 62.2% of total silicates reported to the non-magnetic mass fraction 30.5 wt.%., This implies that 95.9% of REO+Y_2O_3 was recovered to the magnetic fraction (69.5 wt.%) mass. Non-magnetics are a sterile mass of Aluminum clays that are rejected. Magnetic separation was applied to enhance gangue rejection and improve REO recovery.

Table 13.9 - Cumulative Percent REO Contained Below Size Fraction, Whitetail

Distibution of REO+Y to Magnetic & Non-Magnetic Fractions (optimized feed size: -0.5 + 0.18mm)

WF Comp -2.0+1.0mm Magnetic Characterisation									
PRODUCT	YIELD	Au		Si02		Fe203		TREO+Y203	
	%	ppb	dist.	%	dist.	%	dist.	%	dist.
6000 GAUSS MAGNETICS	5.30%	155	100.00%	6.90%	1.12%	57.61	10.48%	3.61	5.89%
9000 GAUSS MAGNETICS	38.32%	IS	IS	8.29%	9.74%	52.53	69.11%	5.09	59.88%
NON-MAGNETICS	56.39%	IS	IS	51.54%	89.13%	10.54	20.40%	1.97	94.12%
Calculated Head	100.00%	8	100.00%	32.61%	100.00%	29.12%	100.00%	3.25	100.00%

WF Comp -0.5+0.18mm Magnetic Characterisation									
PRODUCT	YIELD	Au		Si02		Fe203		TREO+Y203	
	%	ppb	dist.	%	dist.	%	dist.	%	dist.
3000 GAUSS MAGNETICS	2.15%	IS	IS	7.63	0.58%	63.74	4.18%	15	15
6000 GAUSS MAGNETICS	44.54%	198	74.30%	8.56	13.57%	56.33	76.36%	4.55	45.48%
9000 GAUSS MAGNETICS	16.18%	IS	IS	22.95	13.23%	28.44	14.01%	12.15	44.07%
12000 GAUSS MAGNETICS	6.61%	IS	IS	44.37	10.44%	13.33	2.68%	4.29	6.35%
NON-MAGNETICS	30.51%	100	25.70%	57.24	62.18%	2.99	2.78%	0.60	4.10%
Calculated Head	100.00%	100	100.00%	28.09	100.00%	32.86	100.00%	4.46	100.00%

WF Comp -0.09+0.45mm Magnetic Characterisation									
PRODUCT	YIELD	Au		Si02		Fe203		TREO+Y203	
	%	ppb	dist.	%	dist.	%	dist.	%	dist.
3000 GAUSS MAGNETICS	1.08%	IS	IS	9.12	0.38%	61.81	1.93%	4.10	0.79%
6000 GAUSS MAGNETICS	20.26%	IS	IS	9.12	7.07%	61.81	36.28%	4.10	14.79%
9000 GAUSS MAGNETICS	27.59%	279	40.32%	12.46	13.16%	49.30	39.41%	8.19	40.25%
12000 GAUSS MAGNETICS	12.72%	IS	IS	16.07	7.82%	39.97	14.73%	11.47	25.96%
NON-MAGNETICS	38.36%	297	59.68%	48.76	71.58%	5.88	7.65%	2.67	18.22%
Calculated Head	100.00%	191	100.00%	26.13	100.00%	34.51	100.00%	5.62	100.00%

(Nagrom, Australia, 2013)

13.5.3 Gravity Tests

Whitetail samples responded to gravity separation and these data are illustrated in Table 13.10.

Table 13.10 - Gravity Separation Testing, Whitetail

Whitetail Deposit (Wifley Table Batch Results)									
WF Comp -1+0.425MM Wet Table -20+32 mesh									
PRODUCT	YIELD	Au		Si02		Fe203		TREO+Y203	
WET TABLE	%	ppb	dist.	%	dist.	%	dist.	%	dist.
SUPERCONCENTRATE	1.45%	740	3.00%	8.68	0.33%	31.47	1.99%	7.82	4.54%
CONCENTRATE	11.79%	979	32.26%	18.63	5.68%	33.37	17.12%	5.57	26.29%
MIDDLINGS	73.94%	290	59.91%	40.65	77.66%	22.49	72.31%	2.16	63.85%
TAILINGS	12.81%	135	4.83%	49.36	16.34%	15.42	8.59%	1.04	5.31%
Calculated Head	**100.00%**	**358**	**100.00%**	**38.71**	**100.00%**	**23**	**100.00%**	**2.5**	**100.00%**

Superconcentrate + Concentrate = Mass pull (13.25 wt.%)
Recovery of TREO+Y203 to total concentrate = 30.84%
Concentrate grade = 5.81%
Head grade = 2.50%
Upgrade factor = 2.33

(SGS Lakefield, 2013)

13.6 Mineral Processing – Pilot Tests

13.6.1 Pilot PUG Composites

Eight (8) drill core samples were shipped to SGS-Lakefield for pilot testing and then combined into four composites of which three (Comp 1A, Comp 2 and Comp 4) were from the Bull Hill deposit and one (Comp 3) was from the Whitetail deposit. The purpose of the preliminary pilot tests of July 2013 was to confirm the beneficiation flowsheet (Bull Hill oxides, Bull Hill OxCa and WT Ox/OxCa). After a thorough study of solids behavior under gravity and magnetic forces, PUG flowsheets for BH and WT deposits were designed. Subsequently, the flowsheets were applied to ores that represent the mineral resource according to the mine development plan.

These samples were prepared and composited per RER instructions. These data are illustrated in Table 13.11.

Table 13.11 - Composite Summary

Sample ID	Ore Type	Type	Proportion (%)					
			BHHG	BH Mid/HG	Whitetail	Comp 1A	Comp 2	Comp 3
Sample A	BHHGOx	Drill Core	28.6	20.7		13.3		
		Bulk	18.4	13.4		43.3		
Sample B	WTHGOx	Drill Core			6.1			11.7
		Bulk			13.4			
Sample C	BHMGOx	Drill Core		6.3		36.7		
		Bulk		1.9		6.7		
Sample D	WTMGOx	Drill Core			52.1			51.7
Sample E	BHHGOxCa	Drill Core	42.4	30.8			50	
		Bulk	10.6	7.7				
Sample F	WTHGOxCa	Drill Core			2.1			3.3
Sample G	BHMGOxCa	Drill Core		19.2			50	
Sample H	WTMGOxCa	Drill Core			26.3			33.3
Total			100.0	100.0	100.0	100.0	100.0	100.0

(SGS Lakefield, 2014)

A tabulation of the TREO analysis of each Composite is presented in Table 13.12 below:

Table 13.12 - TREO Analysis of PUG Pilot Composites

Composites:

Composite 1A:	BH HG Ox + BH MG Ox	(6.76 %TREO)
Composite 2:	BH HG OxCa + BH MG OxCa	(5.58 %TREO)
Composite 3:	WT HG OxCa /Ox + WT MG OxCa/Ox	(3.17%TREO)
Composite 4:	BH Superhigh Grade Ox	(16.40%TREO)

(SGS Lakefield, 2013)

The minus 3” material was used in the test program, with the coarse material treated as reject. Similarly, pieces of competent core material were rejected from the received drill core prior to testing. This was based on the understanding that the competent, hard, coarse material contained only low levels of rare earth oxides (REO), and would be rejected. Assays of the coarse rejects (+6” and -6/+3”) confirmed levels of REO significantly lower than in the corresponding fine (-3") fractions. The data showing the upgrade that is attributed to screening is illustrated in Table 13.1.

13.6.2 Pilot PUG Test on COMP 1A

The pilot flowsheet for Composite 1A (BH oxide ore) required screening and gravity separation. This flowsheet is illustrated in figure 13.5. High losses of REOs to gravity tailings are mitigated by magnetic /gravity scavengers that are coupled to the tail end of the flowsheets. For Comp 1A, the flowsheet comprises of primary screens, a primary rougher gravity separator and a suitable primary magnetic scavenger. In addition, the circuit also included secondary screens, a secondary rougher gravity separator, and a secondary magnetic separator.

Table 13.13 presents the recovery data for each of the streams in the flowsheet. For Comp 1 A, total REO recovery to combined concentrates was 94.8% to 80.5% of total feed mass.

For Bull Hill high grade oxide ore, the mass pull was found to be too high to achieve an acceptable upgrade factor. In the PFS, BH high-grade oxide ore is screened at a 3-inch size in years 1-9 and the minus 3 inch material is processed without gravity or magnetic separators. In subsequent years, low-grade BH oxide ore will be subjected to this flowsheet after screening at three inches.

Table 13.13 - Comp 1A : PUG Concentrates and Tailings

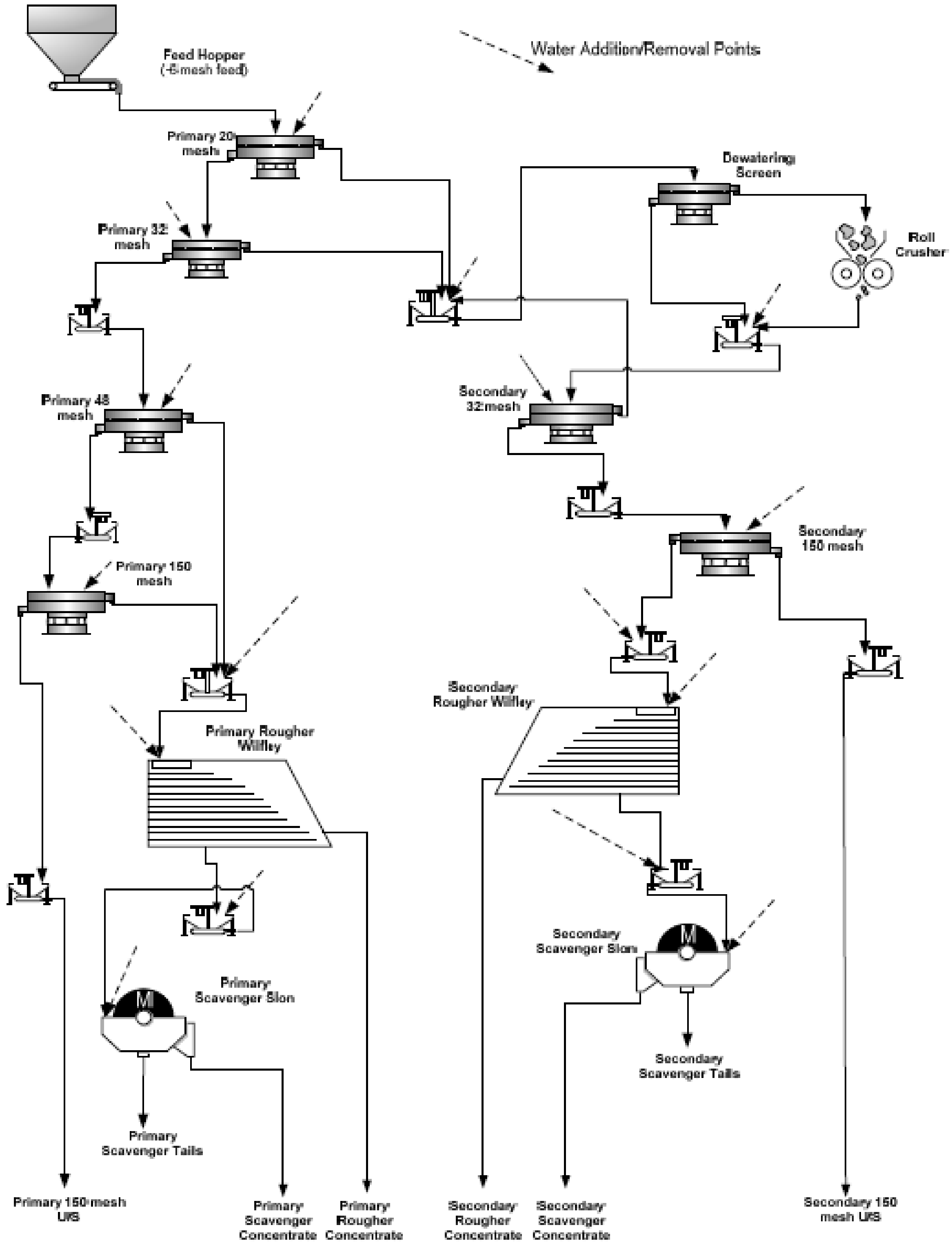
Streams	Wt.	K_{80}	Reconciled Grade, % or g/t							Reconciled Distribution %						
	(%)	(μm)	SiO_2	Al_2O_3	Fe_2O_3	TREO[1]	CREO[2]	U	Th	SiO_2	Al_2O_3	Fe_2O_3	TREO[1]	CREO[2]	U	Th
PP Feed	100.0	1,762	40.3	11.9	13.5	7.22	1.60	105	1,416	100	100	100	100	100	100	100
150 mesh U/S	28.1	-	30.8	10.0	14.3	13.9	3.08	159	2,615	21.4	23.6	29.8	54.1	54.1	42.7	51.8
Secondary 150 mesh U/S	29.1	62	41.8	12.2	14.1	5.57	1.25	101	1,219	30.2	29.9	30.5	22.5	22.7	28.1	25.1
Primary Ro Conc	4.3	219	26.6	7.67	21.9	10.5	2.26	142	1,848	2.8	2.7	6.9	6.2	6.0	5.8	5.6
Primary Scav Conc	3.5	222	38.4	11.1	14.3	9.33	2.14	122	1,429	3.3	3.3	3.7	4.5	4.7	4.1	3.5
Secondary Ro Conc	5.7	303	28.3	7.83	27.9	3.98	0.77	91	763	4.0	3.8	11.9	3.2	2.8	5.0	3.1
Secondary Scav Conc	9.8	347	41.6	11.4	18.4	3.24	0.70	72	629	10.1	9.4	13.3	4.4	4.2	6.7	4.3
Final PUG Conc	**80.5**	-	**36.0**	**10.8**	**16.1**	**8.51**	**1.88**	**120**	**1,644**	**72.0**	**72.7**	**96.1**	**94.8**	**94.5**	**92.3**	**93.4**
Primary Scav Tails	4.5	249	52.1	15.3	4.14	5.09	1.23	103	1,468	5.8	5.7	1.4	3.1	3.4	4.4	4.6
Secondary Scav Tails	15.1	392	59.5	17.1	2.27	0.96	0.22	23	182	22.3	21.6	2.5	2.0	2.1	3.3	1.9

[1] TREO represents total rare earth oxides and includes Y_2O_3

[2] CREO represents the following rare earth oxides, as specified by RER: Pr_2O_3, Nd_2O_3, Dy_2O_3, Tb_2O_3, Eu_2O_3 and Y_2O_3

(SGS Lakefield, 2013)

Figure 13.5 - Comp 1A Flowsheet



(SGS Lakefield, 2014)

13.6.3 Pilot PUG Test on COMP 2

The flowsheet for Comp 2 is a mirror image of Comp 1A except for different scavenger units. This flowsheet is illustrated in Figure 13.6. In this flowsheet, a suitable secondary gravity separator that is coupled to the primary gravity separator will serve as a scavenger.

Table 13.14 presents the recovery data for each of the streams in the flowsheet. For Comp 2, total REO recovery was 87.2 % to 74.3 % of total feed mass. However, if the primary gravity tails are recovered as part of the concentrate, overall recovery is increased to 94.2% to 81.9% of total mass. For Comp 1, Bull Hill high-grade OxCa ore, the mass pull was found to be too high to achieve an acceptable upgrade factor. In the PFS, BH high-grade OxCa ore is screened at 3-inch cut-off size in years 1-9 and the minus 3-inch material is processed without gravity or magnetic separators. In subsequent years, low-grade BH oxide ore will be subjected to this flowsheet after screening at 3 inches.

Table 13.14 - Comp 2: PUG Concentrates and Tailings

Streams	Wt. (%)	K80 (µm)	Reconciled Grade , % or g/t						
			SiO2	Al2O3	Fe2O3	TREO1	CREO2	U	Th
PP Feed	100.0	1,829	28.1	8.13	11.2	5.65	1.24	60	524
150 mesh U/S	25.8	59	19.5	5.62	11.0	8.92	1.94	75	835
Secondary 150 mesh U/S	32.0	61	27.7	7.89	11.2	5.21	1.15	62	468
Primary Ro Conc	3.7	209	17.8	5.06	16.0	10.3	2.14	71	797
Primary Scav Conc	0.6	281	26.5	7.76	9.34	7.08	1.54	57	616
Secondary Ro Conc	10.2	292	25.9	7.30	22.3	4.56	0.97	64	433
Secondary Scav Conc	2.1	265	27.5	7.90	17.8	3.67	0.87	59	390
Final PUG Conc	**74.3**	**-**	**24.1**	**6.88**	**13.0**	**6.64**	**1.44**	**67**	**606**
Primary Scav Tails	7.6	288	30.1	8.83	7.07	5.24	1.18	51	496
Secondary Scav Tails	18.1	440	44.0	13.0	5.45	1.78	0.43	34	202

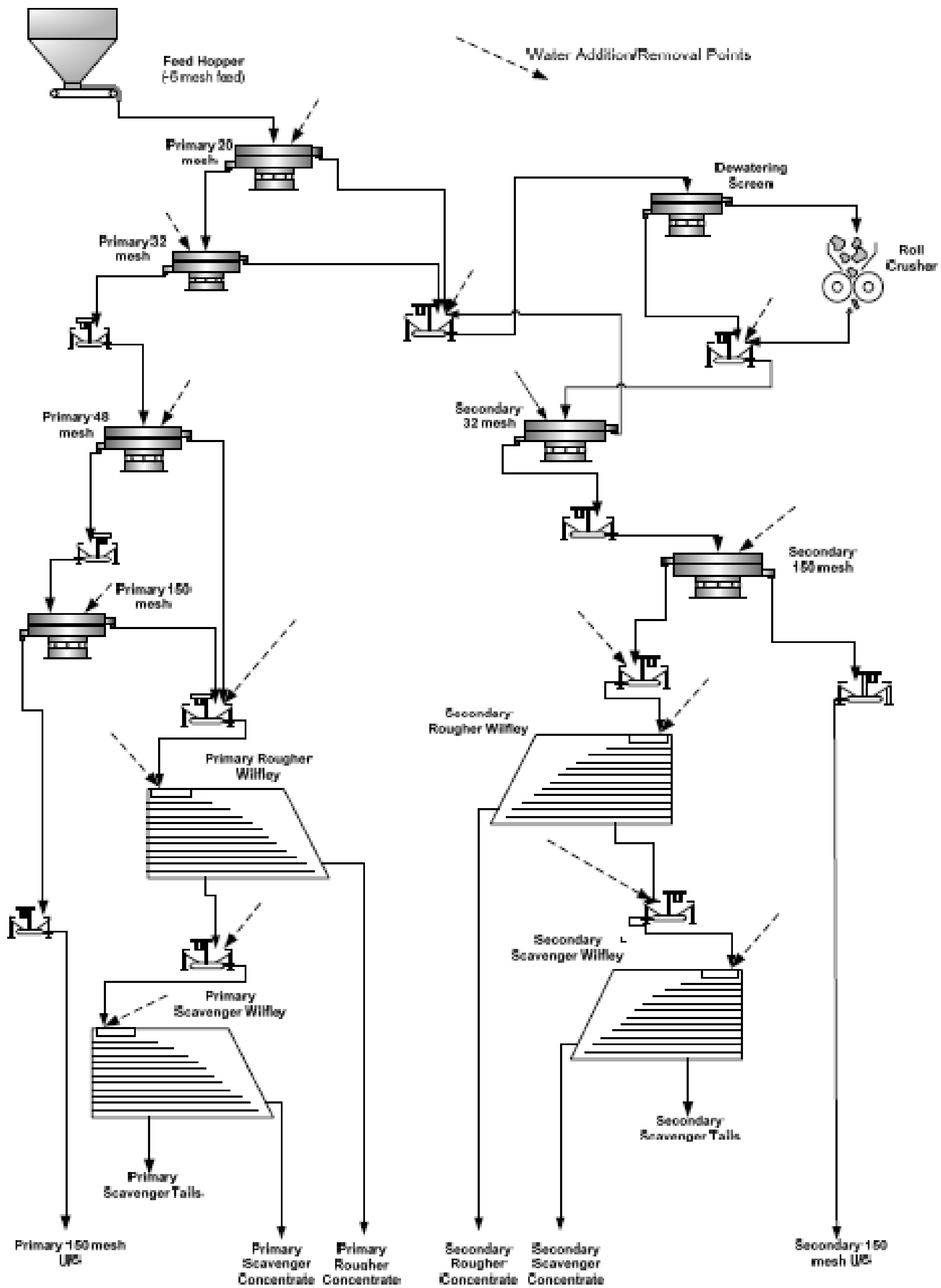
Streams	Reconciled Distribution, % or g/t						
	SiO2	Al2O3	Fe2O3	TREO1	CREO2	U	Th
PP Feed	100	100	100	100	100	100	100
150 mesh U/S	17.8	17.8	25.2	40.7	40.4	32.2	41.1
Secondary 150 mesh U/S	31.4	31.0	31.9	29.5	29.7	33.3	28.5
Primary Ro Conc	0.5	0.06	0.5	0.7	0.7	0.6	0.7
Primary Scav Conc	0.5	0.06	0.5	0.7	0.7	0.6	0.7
Secondary Ro Conc	9.3	9.1	20.2	8.2	7.9	10.8	8.4
Secondary Scav Conc	2.0	2.0	3.3	1.3	1.4	2.0	1.5
Final PUG Conc	**63.5**	**62.8**	**86.4**	**87.2**	**86.5**	**83.3**	**85.8**
Primary Scav Tails	8.1	8.3	4.8	7.0	7.3	6.5	7.2
Secondary Scav Tails	28.3	28.9	8.8	5.7	6.2	10.2	7.0

[1] TREO represents total rare earth oxides and includes Y_2O_3

[2]CREO represents the following rare earth oxides, as specified by RER: Pr_2O_3, Nd_2O_3, Dy_2O_3, Eu_2O_3, Tb_2O_3 and Y_2O_3

(SGS Lakefield, 2013)

Figure 13.6 - Comp 2 Flowsheet



(SGS Lakefield, 2014)

13.6.4 Pilot PUG Test on COMP 3

The flowsheet for Whitetail ore consists of primary and secondary screening followed by primary and secondary magnetic separation. This flowsheet is illustrated in Figure 13.7. A scavenger gravity separator is coupled to the primary magnetic separator.

Table 13.15 presents the recovery data for each of the streams in the flowsheet. The overall recovery of REOs is 89.4% to 65.4% of mass. Again, the mass pull was on the high side.

In the PFS, Whitetail ore is screened at 24 and 6 inch screens to reject low grade ore before beneficiation. The mass pull was reduced significantly while recovery remained almost constant (refer to whole ore screening data, SGS report 2014).

Table 13.15 - PUG Concentrates and Tailings

Streams	Wt. (%)	K80 (µm)	Reconciled Grade , % or g/t						
			SiO2	Al2O3	Fe2O3	TREO1	CREO2	U	Th
PP Feed	100.0	2,053	39.9	11.8	12.4	2.40	0.71	82	779
150 mesh U/S	14.4	66	29.7	9.25	19.7	4.97	1.54	136	1,816
Secondary 150 mesh U/S	36.4	66	37.0	10.9	12.9	2.74	0.81	87	873
Primary Ro Conc	1.8	271	15.6	4.81	37.7	5.01	1.46	191	1,558
Primary Scav Conc	0.6	247	31.1	9.05	11.8	3.33	0.93	90	812
Secondary Ro Conc	12.1	297	25.9	7.59	24.0	2.80	0.73	132	705
Final PUG Conc	**65.4**	**-**	**32.7**	**9.75**	**17.1**	**3.31**	**0.97**	**109**	**1,068**
Primary Scav Tails	5.9	341	46.7	13.7	6.23	1.45	0.44	48	496
Secondary Scav Tails	28.7	418	54.9	15.9	2.89	0.53	0.17	26	177

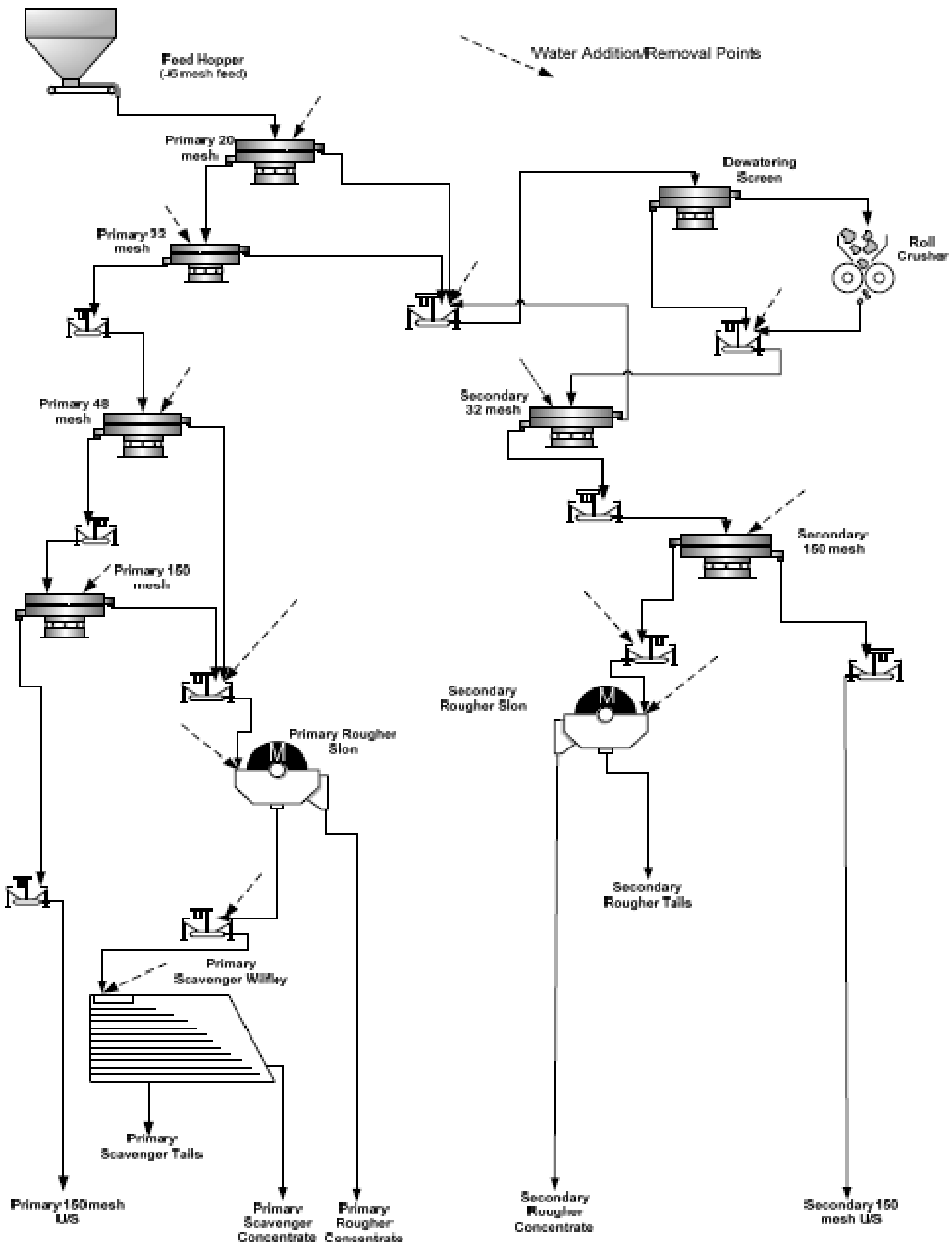
Streams	Reconciled Distribution, % or g/t						
	SiO2	Al2O3	Fe2O3	TREO1	CREO2	U	Th
PP Feed	100	100	100	100	100	100	100
150 mesh U/S	10.8	11.4	22.9	29.8	31.1	24.1	33.7
Secondary 150 mesh U/S	33.8	33.8	37.9	41.5	41.4	38.9	40.8
Primary Ro Conc	0.7	0.7	5.5	3.8	3.7	4.2	3.6
Primary Scav Conc	0.5	0.5	0.6	0.9	0.8	0.7	0.7
Secondary Ro Conc	7.9	7.8	23.5	14.1	12.4	19.6	11.0
Final PUG Conc	**53.6**	**54.3**	**90.4**	**90.1**	**89.4**	**87.6**	**89.7**
Primary Scav Tails	6.9	6.9	3.0	3.6	3.6	3.4	3.8
Secondary Scav Tails	39.5	38.8	6.7	6.4	7.0	9.0	6.5

[1] TREO represents total rare earth oxides and includes Y_2O_3

[2] CREO represents the following rare earth oxides, as specified by RER: Pr_2O_3, Nd_2O_3, Dy_2O_3, Eu_2O_3, Tb_2O_3 and Y_2O_3

(SGS Lakefield, 2014)

Figure 13.7 - Comp 3 Flowsheet



(SGS Lakefield, 2014)

A fourth composite, Composite 4 was also submitted to pilot-scale testing. This was a high-grade composite, which did not require any beneficiation processes beyond coarse screening. After scalping out the plus 3" material, only crushing and screening to produce a -48 mesh product is required. The pilot-scale results are summarised in Table 13.16.

Table 13.16 - PUG Composites – Pilot Scale Results Summary

Comp	Reconciled Feed Grade, % or g/t						
	SiO2	Al2O3	Fe2O3	TREO1	CREO2	U	Th
Comp 1A	40.3	11.9	13.5	7.22	1.60	105	1,416
Comp 2	28.1	8.13	11.2	5.65	1.24	60	524
Comp 3	39.9	11.8	12.4	2.40	0.71	82	779
Comp 4	30.8	9.06	16.5	17.1	3.67	208	3,026

Comp	Reconciled Conc Grade, % or g/t						
	SiO2	Al2O3	Fe2O3	TREO1	CREO2	U	Th
Comp 1A	36.0	10.8	16.1	8.51	1.88	120	1,644
Comp 2	24.1	6.88	13.0	6.64	1.44	67	606
Comp 3	32.7	9.75	17.1	3.31	0.97	109	1,068
Comp 4	29.6	8.91	16.4	18.2	3.93	218	3,253

Comp	Reconciled Conc Recovery, % or g/t							
	wt	SiO2	Al2O3	Fe2O3	TREO1	CREO2	U	Th
Comp 1A	80.5	72.0	72.7	96.1	94.8	94.5	92.3	93.4
Comp 2	74.3	63.5	62.8	86.4	87.2	86.5	83	86
Comp 3	65.4	53.6	54.3	90.4	90.1	89.4	87.6	89.7
Comp 4	88.1	84.7	86.5	87.5	94.0	91.3	92.1	94.7

[1] **TREO represents total rare earth oxides and includes Y_2O_3**

[2]**CREO represents the following rare earth oxides, as specified by RER: Pr_2O_3, Nd_2O_3, Dy_2O_3, Eu_2O_3, Tb_2O_3 and Y_2O_3**

(SGS Lakefield, 2014)

13.6.5 Material Handling Testing

Jenike and Johanson (J&J) performed material handling testing at their laboratory in Canada to determine the flow characteristics of pre-concentrates in storage facilities. Most of the tests showed that less than 15% pre-concentrate moisture is required for the material to be stored in silos. At moistures above 15% it will be cemented and fail to flow. J&J tests are focused on mechanical engineering and construction of storage bins for mineral concentrates and fine ore.

SGS performed belt filter filtration tests using pre-concentrate pulp and could not achieve less than 15% moisture in the final filter cake. J&J tested the initial pre-concentrate cakes (22-25% moisture) from SGS. All samples failed the flow characteristics tests indicating that if the slurry is filtered using a belt filter, we cannot store the resulting filter cake in bins. Subsequent filtration tests on PP1-PP3 pre-concentrates were performed by SGS using pressure filters. Testing showed that by using a pressure filter, all slurries could be filtered to produce a filter cake that is below 15% moisture with the exception of Comp 1A (Bull Hill oxide ore). Comp 1A showed borderline moisture content data as far as the prerequisite (demand) to meet 15%moisture target is concerned. In operations, Comp 1A (pure BH HG ox) will not be processed alone for too long. Comp 1 A to will be blended with other ores that filter well to achive an acceptable filter cake moisture. Note that Comp 4 filter cakes all had moisture contents of around 30%. This is not an issue as there will never be a need to store Comp 4 as a filter cake in a bin.

The data was found to be on borderline for White Tail but not good for Bull Hill precon. Jenike and Johanson recommended keeping moisture below 15% to store the pre-concentrate in a silo.

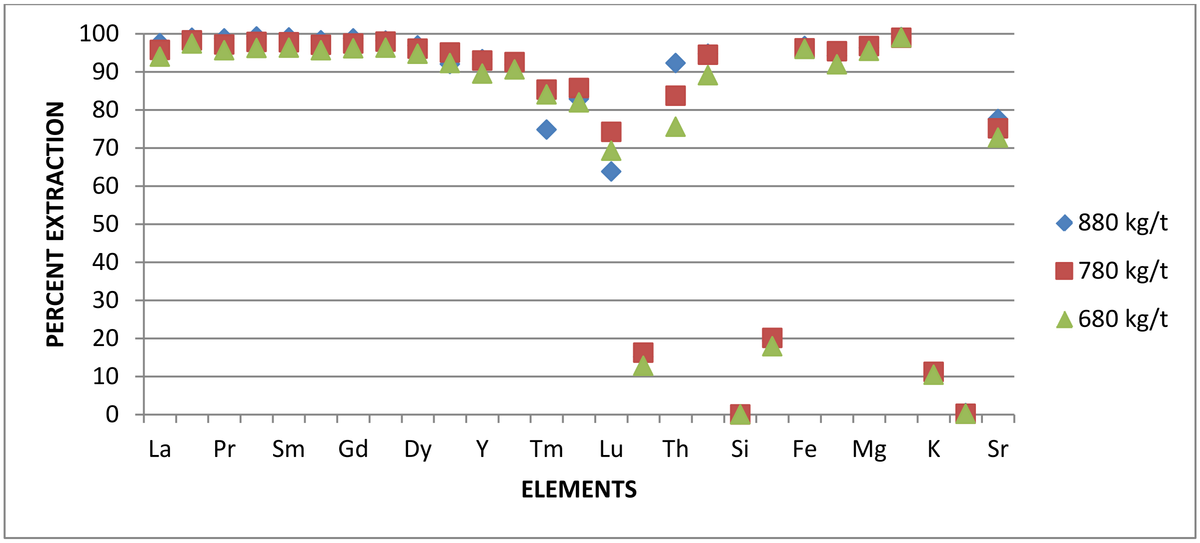
13.6.6 SGS – Hydromet Plant Testing

Process Flow Diagrams (PFDs) for the Hydromet Plant are found in Chapter 17, Figures 17.10 to 17.30. These illustrate the process flows and the process equipment in the Hydromet Plant.

13.6.6.1 Leach Testing

Using samples generated in the PUG pilot tests, Hydromet bench scale and pilot testing were undertaken. Three major pilot testing campaigns took place. In the initial campaign, co-current leaching was carried out at high temperature. Testing was also carried out to optimize the leach temperature and the concentration of hydrochloric acid used in the leach to maximize recovery of REO. Figure 13.8 illustrates the recovery of REO using various acid dosages at 90°C.

Figure 13.8 - Rare Earth Extraction vs Acid Dosage (kg/t)



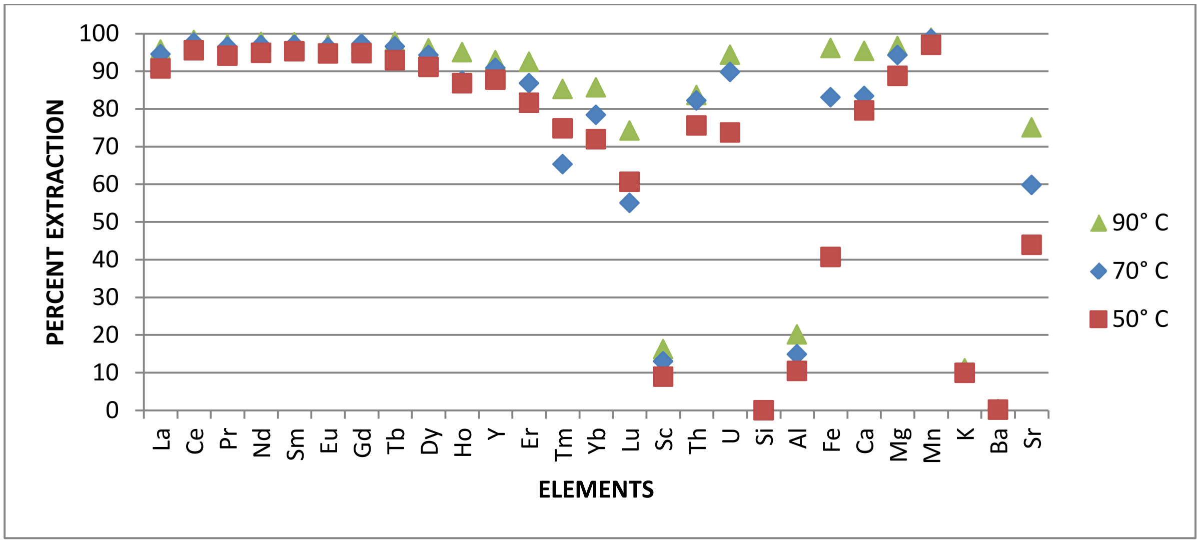
(SGS Lakefield, 2013)

As can be seen in Figure 13.8, hydrochloric acid dosage rate ranged between 880 to 680 kg/t. Based on acid dosage rates in this range, it was found that the acid consumption was unacceptably high. Alternatives were investigated to reduce reagent cost. Figure 13.8 illustrates that the extraction efficiency in general increased with higher acid dosing rates. However, there is minimal loss in extraction efficiency when the acid dosage is reduced.

The second testing campaign focused on counter current leaching. As expected, this change reduced reagent consumption because the counter current leaching utilizes hydrochloric acid more efficiently than co-current leaching with no loss of REO extraction. The hydrochloric acid dosage rate was reduced to 669 kg/t. Reagent costs were reduced and project economics were improved.

Additional economic optimization was evaluated in the final testing campaign which examined leaching the REO at a lower temperature. Figure 13.9 illustrates the rare earth extraction as a function of temperature. As can be seen, higher temperature provides a higher level of REO extraction. While this condition could be used to maximize REO recovery, it was also found to leach high levels of iron. Iron ions combine with chloride ions resulting in the loss of chloride ion, high acid consumption and unacceptably high reagent cost. Chloride ions that combine with rare earths are recovered later in the process and returned to the leach. All pilot testing used recycled hydrochloric acid from the process in the leach. While REO recovery was slightly lower in the low temperature leach, the amount of iron leached was far less resulting in lower reagent consumption. Overall, the economics of low temperature counter current leaching proved to be far superior to the high-temperature leach.

Figure 13.9 - Rare Earth Extraction vs. Temperature (°C)



(SGS Lakefield, 2013)

The final low temperature counter-current test work was carried out using a new set of ore composites as the prior test work had consumed the available sample. Eight samples of 50mm drill core weighing a total of nine tons was submitted for testing. An inventory of these samples is presented in Table 13.17.

Table 13.17 - Sample Inventory Summary

Sample Name	TREO Content, %	Ore Type	# Drums Received	Total Wt. (t)
Sample 1	1.5% - 2.5%	Ox	16	4.09
Sample 2	2.5% - 3.5%	Ox	7	1.86
Sample 3	3.5% - 5.0%	Ox	3	0.77
Sample 4	>5.0%	Ox	3	0.61
Sample 5	1.5% - 2.5%	OxCa	2	0.36
Sample 6	2.5% - 3.5%	OxCa	2	0.34
Sample 7	3.5% - 5.0%	OxCa	1	0.31
Sample 8	>5.0%	OxCa	2	0.45
Total	-	-	36	8.80

(Rare Element, 2014)

These samples were crushed to approximately 80% passing 2" and then screened to remove the 2" material which became a reject stream. The minus 2" material was further ground to minus 48 mesh. A sub-sample of Sample 1 was submitted to bench-scale PUG processing using gravity separation only. The concentrate from this gravity separation became Composite E. The final PUG concentrate, Comp E, graded 2.66% REO, 41.0% SiO_2, 12.9% Al_2O_3, and 1.16% CaO. 87.8% of the REO was recovered in 65.0% of the weight with an upgrade factor of 1.35. Other composites were generated by blending the eight samples to generate four composites with steadily increasing TREO content as shown in Table 13.18.

Table 13.18 - Compositing Ratios for Hydromet Testing Composites

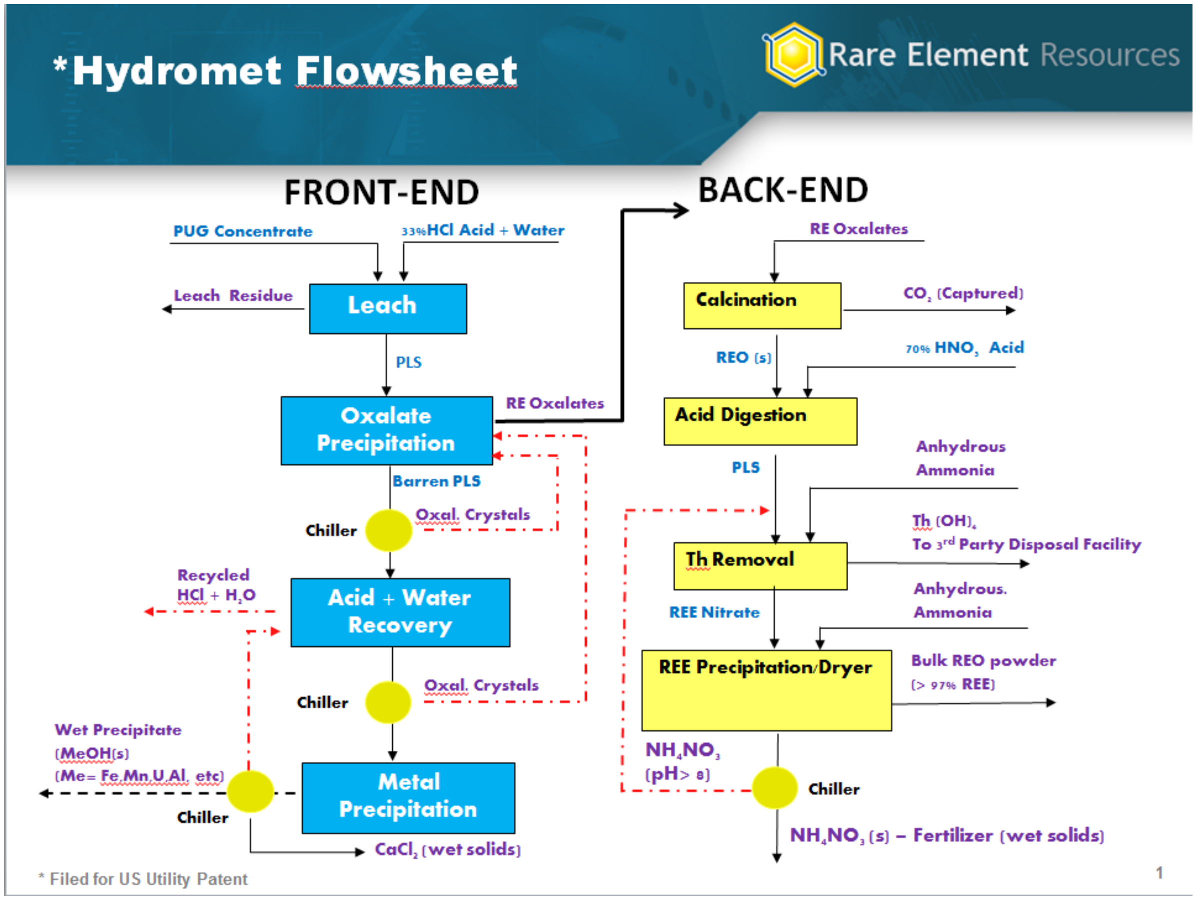
Composite Name	TREO Content, %	Component				Total %	Wt Req. (kg)
		Sample Number	Proportion %	Sample Number	Proportion %		
Comp A	1.5% - 2.5%	1	33.3	5	66.7	100	95
Comp B	2.5% - 3.5%	2	57.1	6	42.9	100	90
Comp C	3.5% - 5.0%	3	66.7	7	33.3	100	60
Comp D	5.00%	4	66.7	8	33.3	100	60

(SGS Lakefield, 2014)

Comps B, C, D and E were processed at the PUG plant to produce mineral concentrates for processing at the Hydromet pilot plant in February 2014. After the mine plan was finalized, composites were assigned to represent various years of the mine life as shown in Table 13.2.

Figure 13.10 illustrates the flowsheet that was simulated in the counter-current leach pilot testing.

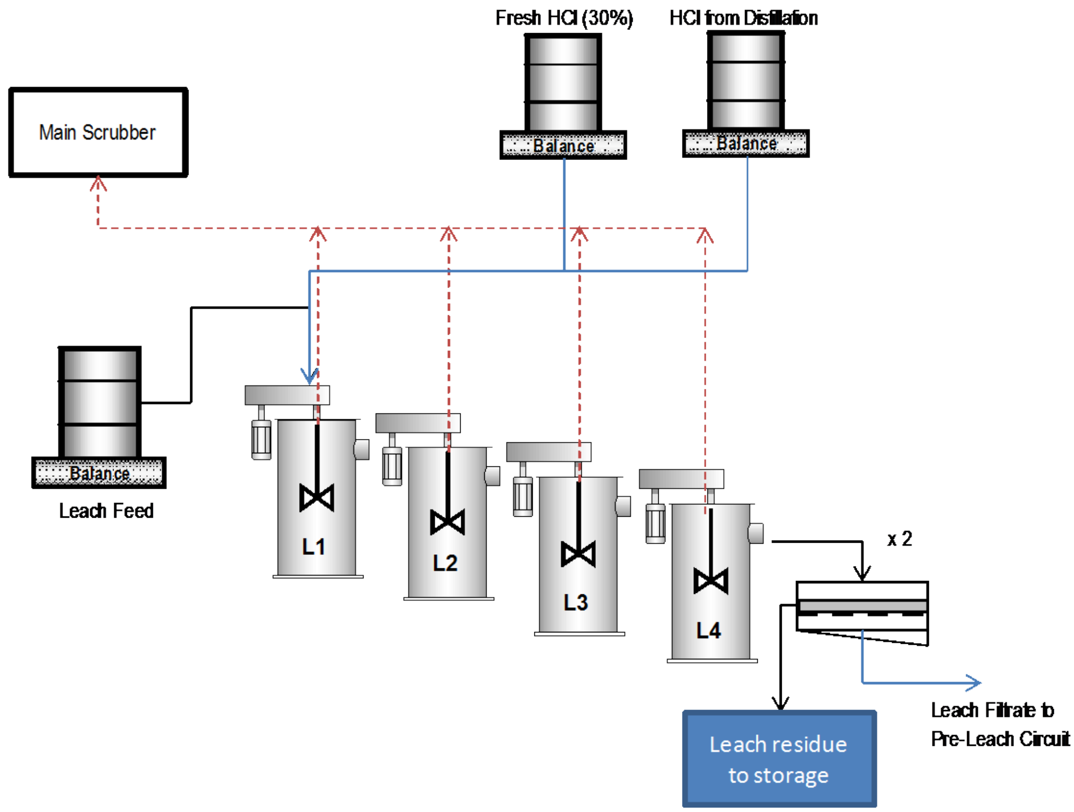
Figure 13.10 - Hydrometallurgical Flowsheet complete with recycles



(Rare Element, 2014)

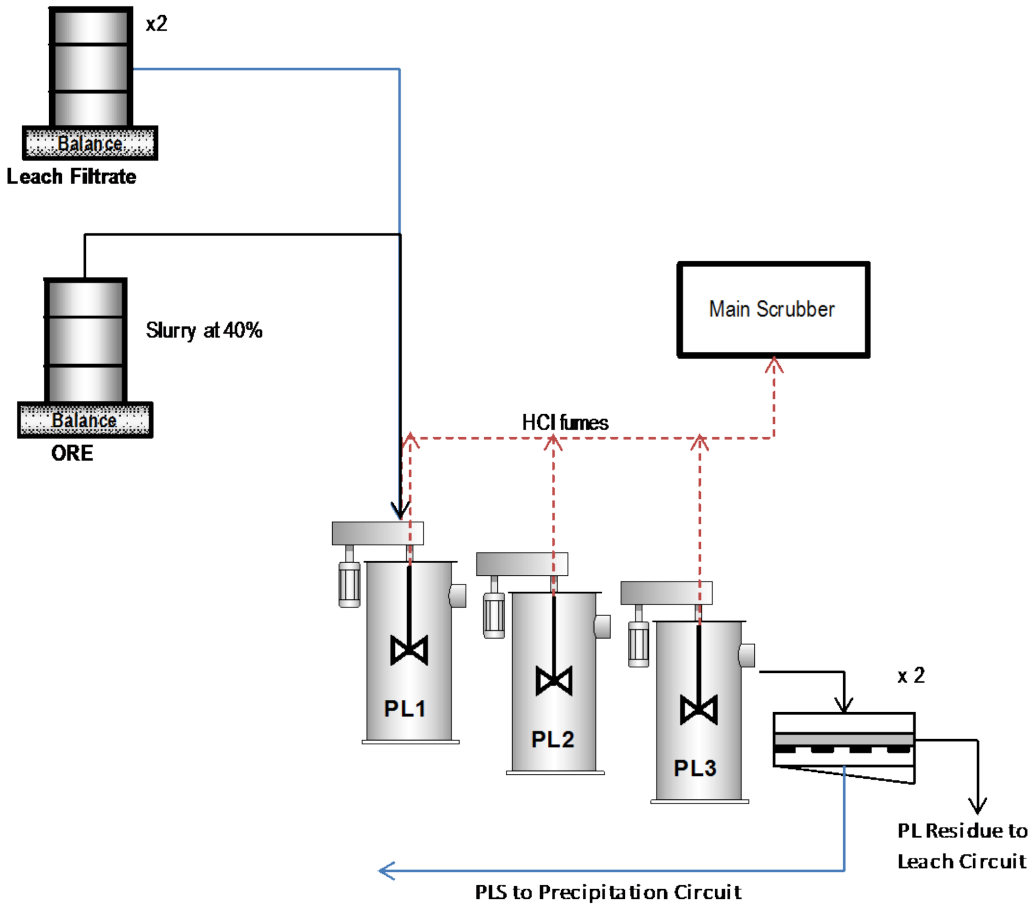
Figures 13.11 and 13.12 illustrate the leach and pre-leach flowsheets respectively. Note that fresh pre-concentrate is introduced into the pre-leach and flows into the leach. Barren leach solution is introduced into the leach and flows into the pre-leach.

Figure 13.11 - Flowsheet of the Leach Circuit



(SGS Lakefield, 2014)

Figure 13.12 - Flowsheet of the Pre-Leach Circuit



(SGS Lakefield, 2014)

Oxalates were effectively recycled in PP6 and PP7 campaigns to lower the fresh reagent requirement. The reagent consumptions in the PP6 and PP7 campaigns were 36% to 59% lower than PP5. Oxalates were not recycled under the PP5 campaign. In general, oxalic acid consumption ranged from 296 kg/t in PP5 (COMP B) to 121 kg/t in PP6 (COMP C). When RE oxalates are not recycled, high losses of REEs may occur in barren PLS.

COMP B

Overall Recovery

The overall recoveries of CREEs from Comp B, that were ultimately transferred into the oxalate precipitate cake were: 87% Dy, 93% Eu, 95% Nd, 95% Pr, 89% Tb and 81% Y. In this PFS, overall recovery calculations combine REE extraction and precipitation efficiencies. Also, overall circuit recovery did not include rare earths that should be captured downstream as oxalate crystals and recycled back to the process.

Counter –Current Leach

The specific REE recoveries in the counter current leach stream ranged from 85% to 99% (averaging 93%). But, acid digestion of base metals was comparatively low at the same temperature (45 ^{o}C). Leach efficiencies of Iron, Mn, Al, Ba, Mg and Ba are listed below.

Iron :	96% to mid-20%.
Aluminum:	27% to 7%
Barium	28% to 7%,
Magnesium	97% to 73%
Manganese	99% to 65%

At steady state leach conditions (297 kg/t, acid, at 45°C), the recoveries of CREEs were as follows: 89% Dy, 88% Eu, 96% Nd, 97% Pr, 92% Tb and 86% Y. The corresponding extraction of iron was 44% using a full HCl recycle system, acid consumption averaged 393 kg/t (100% HCl per ton of ore) for Comp B. Residence time in the pre-leach and leach units were 1.4 and 1.95 hr, respectively.

The final leach residue cake assayed: 0.27% TREE, 96 g/t Th, 38 g/t U, 7.68% Al, 6.09% Fe, 9.44% K and 26.0% Si indicating selective digestion of REEs over base metals and silicates.

Precipitation Cascade

In the oxalate precipitation circuit, the specific recoveries of CREEs at steady state conditions were: 98% Dy, 99% Eu, 96% Nd, 95% Pr, 98% Tb and 91% Y. Thorium was co-precipitated with rare earths (99.8%) but uranium and base metals were rejected. In terms of product purity, rare earth oxalate cakes contained +97%TREE (44.6%TREE) with impurities averaging 1.24 wt.% calcium, 0.9 wt.% silica and 0.497 wt.%Th.

For Comp B, oxalic acid consumption averaged 76.2 g/L (grams of oxalic acid per liter of feed solution to the precipitation circuit) equivalent to 239 kg/t concentrate solids without any oxalate recycling. Significant amount of non-precipitated REEs were crystallized in the barren PLS thickener (post precipitation circuit) but were not recycled. The solid oxalate crystals that settle out to the bottom of the thickener at room temperature, contain between 4.7% - 48.1% rare earth oxalates and can be recovered to reduce losses. Therefore, overall recoveries of REEs were slightly low due to non-recycled rare earth oxalates during this test campaign.

COMP C

Overall Recovery

The overall recoveries of CREEs from the COMP C composite included: 84% Dy, 90% Eu, 90% Nd, 89% Pr, 86% Tb and 80% Y.

Counter –Current Leach

Leach efficiencies during steady state conditions (317 kg/t at 45°C) were 81% Dy, 89% Eu, 86% Nd, 86% Pr, 84% Tb and 77% Y with iron extraction averaging 18%. HCl acid addition to the leach plant was 308 kg/t; however, actual consumption of fresh hydrochloric acid was 217 kg/t due to acid recycling.

REE extraction increased with residence time implying that a longer retention is required in the preleach section (>4hours) for Comp C. In the leach section, a residence time of 1.37 hours was sufficient to achieve higher REE extractions. Average composition of the leach residue was 0.80% TREE, 242 g/t Th, 55 g/t U, 6.86% Al, 8.72% Fe, 8.27% K and 24.0% Si.

Precipitation Cascade

Precipitation of REEs with oxalic acid averaged 95% throughout the test campaign. Critical rare earths were 100% precipitated at steady state conditions (72 gpL, oxalate dosage) except for Tb (99%) and thorium was completely sequestered from the PLS.

In this test campaign, significant amounts of calcium were co-precipitated with REEs due to low acidity (< 22 gpL) in the feed solution to the oxalate precipitation circuit. The RE oxalate product contained 18.1 wt.%Ca, 0.071%Th and other metal traces

(<0.5 wt.%). In subsequent tests, calcium was significantly reduced in the REO product.

High precipitation rate of REEs was attributed to a recycle of oxalate crystals from the thickener which contained 2.2% – 6.3%TREE. However, calcium content in these crystals was high and hence lowered the purity of RE oxalate cakes in the main circuit.

COMP E

Overall Recovery

The overall recovery of REEs from COMP E, which was ultimately transferred to a final oxalate product, feed into a precipitation cake that included 88% Dy, 93% Eu, 94% Nd, 94% Pr, 90% Tb and 79% Y.

Counter –Current Leach

Leach efficiencies of CREEs at steady state conditions (total acid 434 kg/t, 45 ^{o}C) were 89% Dy, 94% Eu, 95% Nd, 95% Pr, 91% Tb and 83% Y. Digestion of REEs was selective over base metals. Average base metals extractions were 17% Fe, 7% Al, 63% Mg, 46% Mn and 96% Ca.

Overall hydrochloric acid dosage was 401 kg/t. However, actual consumption of fresh hydrochloric acid was 224 kg/t due to acid recycling. Extraction of REEs increased with time in the preleach circuit indicating that a longer residence time would be required (> 4hours) to enhance leach efficiency.

The final leach residue composition averaged 0.57% TREE, 134 g/t Th, 42 g/t U, 7.33% Al, 10.4% Fe, 8.51% K and 23.2% Si, supporting the concept of selective digestion of REEs over base metals and silica.

Precipitation Cascade

The precipitation campaign for Comp E was limited to a few days and therefore, two 12-hr composite samples were evaluated. Precipitation efficiency of REEs averaged 95% but, steady state precipitation efficiencies of CREEs (Total 82 g/L oxalate dosage) were 99% Dy, 99% Eu, 99% Nd, 98% Pr, 99% Tb and 95% Y. Thorium precipitation was 100%.

Selective oxalate precipitation of REE was exceptionally better during this campaign. The average oxalic acid dosage was 85 g/L, but the actual consumption of fresh oxalic acid was 40.7 g/L equivalent to 175 kg/t concentrate due to recycle of oxalates.

- A combined residence time of 2.3 hours was sufficient to precipitate REEs selectively at elevated temperature (85-95 ^{o}C) and high acid strength.
- The RE oxalate precipitates contained 36.9% TREE, 37.4% oxalate, 2980 g/t Th and only 0.58% Ca.
- The captured RE oxalates from the post-precipitation circuit for recycling contained 25% TREE, 34.8% oxalate, 491 g/t Th and 5.9% Ca with traces of base metals (< 0.5%)

COMP D

Overall Recovery

This composite represents the feed ore in years 1-9 of the Life of Mine (LoM).

Overall recoveries of REEs from ore to oxalate precipitate cake included 84% Dy, 88% Eu, 88% Nd, 88% Pr, 87% Tb and 78% Y.

Counter –Current Leach

Leach tests were fairly steady during the pilot campaign and 85-90% (average 87%) of total REEs was extracted. The average base metal extraction was 24% Fe, 16% Al, 83% Mg, 79% Mn and 99% Ca. At steady state conditions, the extraction of CREEs (total acid 529 kg/t at 45 oC) were 82% Dy, 88% Eu, 89% Nd, 89% Pr, 85% Tb and 78% Y with 21% iron extraction.

The overall hydrochloric acid dosage was 480 kg/t , however actual consumption of fresh hydrochloric acid was 350 kg/t due to internal acid recycling. A retention time of 2.46 hours for the pre-leach step plus 1.09 hours for the leach step was sufficient to leach the REE for this material (COMP D) and to keep base metal extraction to a minimum.

The final leach residue composition averaged 1.10% TREE, 437 g/t Th, 77 g/t U, 5.29% Al, 16.5% Fe, 6.43% K and 19.1% Si.

Precipitation Cascade

REE precipitation averaged 97% throughout the test campaign. The highest average co-precipitations were thorium and calcium at 100% and 35%. Overall precipitation efficiencies of critical REE were 99% Dy, 99% Eu, 98% Nd, 99% Pr, 99% Tb and 93% Y.

The average oxalic acid dosage was 102 g/L, but actual fresh oxalic acid consumption was 55.1 g/L equivalent to 189 kg/t concentrate. Based on reactor profile sampling, a total retention time of 1.14 hours would be sufficient to precipitate REEs.

At the start of the precipitation campaign, calcium contamination in the rare earth oxalate solids was around 15.2% but decreased steadily throughout the test period. By the end of the campaign, the RE oxalate cakes contained 1.25% Ca, 45.9% TREE, 25.5% oxalate and 3270 g/t Th, with traces of base metals (< 0.1%) confirming the selective nature of the process.

Leach efficiency was found to vary by ore type. Table 13.19 presents the steady state pilot plant leach efficiency results for various ore composites.

Table 13.19 - Leach Efficiency Results for Various Ore Composites, Low Temperature Counter Current Leach

COMP ID	wt. loss %	HCl Dosage (kg/t) Fresh	HCl Dosage (kg/t) Total	La %	Ce %	Pr %	Nd %	Sm %	Eu %	Gd %	Tb %	Dy %	Ho %
B	45%	276	382	97%	85%	97%	96%	95%	94%	93%	93%	89%	87%
C	41%	187	293	88%	86%	87%	87%	87%	88%	87%	86%	84%	82%
A	34%	159	232	94%	74%	93%	93%	91%	91%	90%	88%	86%	83%
E	17%	307	509	95%	83%	95%	95%	94%	94%	94%	91%	89%	87%
D	54%	351	473	89%	87%	89%	89%	88%	88%	87%	85%	82%	80%

Y %	Er %	Tm %	Yb %	Lu %	Sc %	Th %	U %	Al %	As %	Ba %	Be %	Ca %	Fe %
86%	84%	83%	79%	72%	11%	82%	67%	11%	27%	10%	28%	99%	44%
81%	79%	78%	75%	70%	11%	55%	60%	12%	30%	16%	84%	99%	21%
82%	79%	74%	74%	54%	4%	68%	62%	6%	19%	5%	77%	99%	26%
83%	83%	78%	75%	66%	7%	73%	67%	12%	30%	7%	50%	96%	22%
78%	77%	75%	74%	70%	15%	55%	61%	14%	15%	7%	38%	98%	21%

K %	Mg %	Mn %	Mo %	Na %	P %	Pb %	Si %	Sr %	Ti %	V %	Zn %	TREE %	LREE %	HREE %
8%	84%	85%	52%	18%	83%	86%	0%	78%	10%	56%	55%	92%	92%	90%
9%	72%	55%	19%	22%	77%	62%	1%	91%	7%	39%	45%	87%	87%	85%
6%	76%	71%	27%	18%	80%	72%	0%	62%	6%	50%	37%	85%	85%	87%
10%	81%	81%	27%	31%	79%	77%	1%	64%	5%	47%	40%	90%	90%	90%
11%	82%	69%	16%	20%	70%	77%	0%	92%	4%	31%	45%	88%	88%	84%

(SGS Lakefield, 2014)

Barium was removed from the pregnant leach solution (PLS) in the last tank of the leach circuit by adding a solution of sodium sulphate, leaving less than 1% of total barium in solution.

A photograph of the leach and precipitation pilot apparatus used in counter-current pilot testing is shown in Figure 13.13.

Figure 13.13 - Counter Current Leach (30 kg/day) and Precipitation Units

(SGS Lakefield, 2014)

13.6.7 Precipitation Testing

13.6.7.1 Oxalate Precipitation Bench Scale Testing

ANSTO (Australian Nuclear Science and Technology Organization) performed tests in 2012 using RER's protocols to confirm the concept of selective precipitation of REEs from base metals at elevated temperature and acidity.

ANSTO's results are shown in the Table 13.20.

Table 13.20 - Confirmation Test Results for Rare Earth Precipitation Using Oxalic Acid

Test ID	OX3	OX4	OX5	OX6	OX7	OX10	OX11	OX12	OX13	OX14	OX17	OX18	OX19	OX20	OX21	OX22	OX23	OX24
Feed HCl (M)	0.93 M					0.5 M					1.5 M					0.93 M		
Initial $[H_2C_2O_4.2H_2O]$ In Mix (M)	0.55	0.81	0.93	1.13	1.51	0.44	0.64	0.73	0.88	1.17	0.43	0.64	0.73	0.88	1.17	1.23	1.23	1.27
Temp.	85-95°C															50°C	70°C	95°C
Element	(wt%)																	
Al	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.01	0.08	0.08	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01
Ba	0.03	0.08	0.35	0.22	0.01	0.57	0.4	0.47	0.56	1.14	0.2	0.11	0.15	0.5	0.69	1.35	0.72	1.3
Ca	0.08	0.07	0.06	0.08	0.14	0.1	<0.1	<0.1	<0.1	0	0.08	0.06	<0.1	<0.1	<0.1	0.09	0.03	0.01
Ce	16.6	15.8	16.2	17.2	17	15.34	16.95	16.74	16.44	17.03	16.18	17.9	15.76	17.59	17	16.53	16.9	17.03
Fe	0.08	0.13	0.04	0.08	0.04	0.45	0.35	0.3	0.36	0.01	0.13	0.07	0.3	0.29	0.27	0.14	0.07	0.04
K	0.07	0.06	0.06	0.07	0.05	<1	<1	<1	<1	0.02	0.52	<0.1	-	<1	<1	0.03	0.02	0.02
La	8.77	9.94	9.88	10.83	11.25	7.3	9.06	9.84	10.3	11.55	7.81	9.69	8.99	10.63	11.1	11.25	11.37	11.2
Mg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	-	-	<0.01
Mn	0.02	0.01	<0.01	<0.01	0.02	<0.1	<0.1	<0.1	<0.1	0.01	0.03	0.02	<0.1	<0.1	<0.1	0.05	0.03	0.02
Na	0.04	0.04	0.04	0.04	0.04	<0.1	<0.1	<0.1	<0.1	0.04	0.04	0.05	<0.1	<0.1	<0.1	-	-	0.03
Nd	6.24	5.83	5.41	5.45	5.29	6.38	6.08	5.5	5.24	5.27	6.83	6.57	5.59	5.91	5.31	5.14	5.25	5.46
P	0.03	0.03	0.03	0.02	0.03	0.1	<0.1	0.22	<0.1	-	<0.01	<0.01	<0.1	0.12	<0.1	-	-	-
Pb	0.02	0.02	0.02	0.02	0.02	<0.1	<0.1	<0.1	<0.1	0.02	0.03	0.02	<0.1	<0.1	<0.1	0.05	0.02	0.02
Pr	1.99	1.91	1.8	1.83	1.8	2.1	2.1	1.96	1.89	1.61	2.03	2.08	2.07	2.1	1.92	1.56	1.59	1.63
Th	0.42	0.3	0.27	0.26	0.25	0.67	0.37	0.28	0.25	0.27	0.64	0.33	0.33	0.29	0.24	0.25	0.26	0.28
Ti	0.02	0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	0.01	0.02	0.02	-	<0.1	<0.1	0.02	0.01	0.01
U	0.005	0.004	0.003	0.004	0.004	0.005	0.004	0.004	0.005	0.01	0.01	0.01	0.003	0.004	0.004	0.005	0.005	0.004
Zn	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.01	0.01	-	<0.1	<0.1	<0.1	<0.1	<0.1
LRE	33.6	33.5	33.3	35.3	35.3	31.1	34.2	34	33.9	35.5	32.9	36.2	32.4	36.2	35.3	34.5	35.1	35.3
MRE	1.73	1.47	1.36	1.31	1.26	1.76	1.45	1.12	1.09	1.15	1.84	1.58	1.42	1.2	1.1	1.26	1.28	1.02
HRE	0.24	0.21	0.2	0.19	0.18	0.28	0.18	0.16	0.19	0.16	0.25	0.22	0.2	0.2	0.18	0.19	0.2	0.16

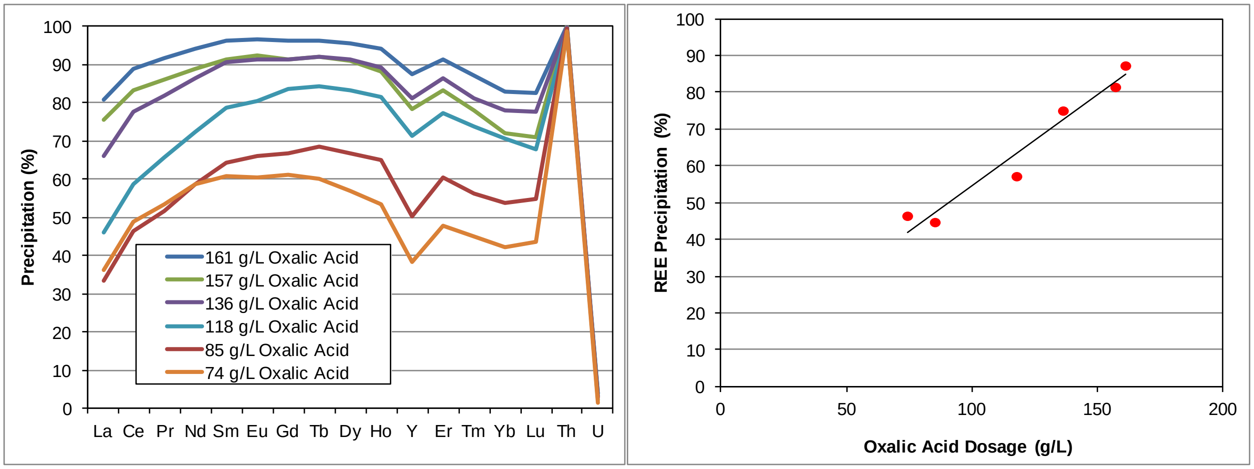
(ANSTO, 2013)

13.6.7.2 Oxalate Precipitation Testing - SGS

All precipitation testing at SGS was performed using oxalic acid as it is selective toward REE precipitation. This selectivity was thought to produce a nearly pure REO product with the exception of thorium contamination. Oxalic acid also provides the opportunity to produce a product in relatively few steps compared to precipitating a carbonate.

Bench testing followed by pilot testing confirmed that oxalic acid is an excellent reagent to precipitate REE. The test-work found that differences in REE precipitation are related to oxalic acid addition as REE precipitation increased considerably when the oxalic acid dosage was increased. Figure 13.14 illustrates precipitation efficiency as a function of oxalic acid dosage.

Figure 13.14 - PP1 Precipitation efficiency vs. Oxalic Acid Dosage (g/L feed solution). Excess oxalates were not recycled.



(SGS Lakefield, 2014)

Thorium precipitation was close to 100% regardless of oxalic acid dosage and uranium precipitation was below 5% throughout the campaign. Oxalic acid selectivity against base metals was proven during this campaign. Base metals precipitation efficiencies were close to zero for most of them. Occasionally, low precipitation efficiency was observed due to the lack of oxalic acid recycling (crystal pump failure) or blocked pipes and unscheduled pilot plant maintenance.

Table 13.21 - Reagent consumption in oxalate precipitation circuit

Campaign ID		PP5 COMP B	PP6 COMP C	PP6 COMP A	PP7 COMP E	PP7 COMP D
PL Run + Downtime	h	109	51	60	38	72
Precipitation Feed	L/h*	2.01	2.10	2.15	1.89	2.11
Pre-Leach Feed	kg/h*	0.52	0.60	0.71	0.44	0.62
Reagent		$H_2C_2O_4$	$H_2C_2O_4$	$H_2C_2O_4$	$H_2C_2O_4$	$H_2C_2O_4$
Reagent usage	kg/h*	0.15	0.07	0.11	0.08	0.12
Consumption	g/L**	76.2	34.9	51.1	40.7	55.1
Consumption	kg/t***	296	121	155	175	189

* rates are averages from entire campaign; normalized to PL Run + Down Time

** g of reagent @ 100% per liter of precipitation feed

*** kg of reagent @ 100% per tonne of dry composite

(SGS Lakefield, 2014)

Oxalates were effectively recycled in PP6 and PP7 campaigns to lower the fresh reagent requirement. The reagent consumption in PP6 and PP7 campaigns was 36% to 59% lower than PP5. Oxalates were not recycled in the PP5 campaign. In general, oxalic acid consumption ranged from 296 kg/t in PP5 (COMP B) to 121 kg/t in PP6 (COMP C). When RE oxalates are not recycled, high losses of REEs may occur in barren PLS.

The precipitation by element is presented in Table 13.22. Average acid consumption was equivalent to 2.91 t/t concentrate. After precipitation, the precipitate is filtered from solution and the solution is allowed to cool in a thickener where excess oxalic acid is precipitated, settled out of solution and recycled to the beginning of the precipitation circuit. Additional REE is captured in this recycle making the precipitation efficiency close to 100% for most REE metals. Because excess oxalic acid is recycled, a significant excess can be used in precipitation to insure a high precipitation percentage of REE. A total retention time of 4 hours was sufficient to precipitate the REE from the PLS for all ore types. Average thorium levels are from 0.5% to 2.0%, while uranium levels were below 35 g/t. Base metals are mostly below detection limit, which indicates that high selectivity oxalic acid was successful against most base metals. Note that the ore type has no impact on precipitation efficiency.

Table 13.22 - Precipitation with Oxalic Acid

La %	Ce %	Pr %	Nd %	Sm %	Eu %	Gd %	Tb %	Dy %	Ho %	Y %	Er %	Tm %	Yb %
98%	100%	100%	100%	100%	100%	100%	99%	100%	99%	100%	99%	93%	99%

Lu %	Sc %	Th %	U %	Al %	As %	Ba %	Be %	Ca %	Fe %	K %	Mg %	Mn %	Mo %
93%	92%	100%	4%	3%	43%	15%	1%	45%	0%	10%	0%	0%	29%

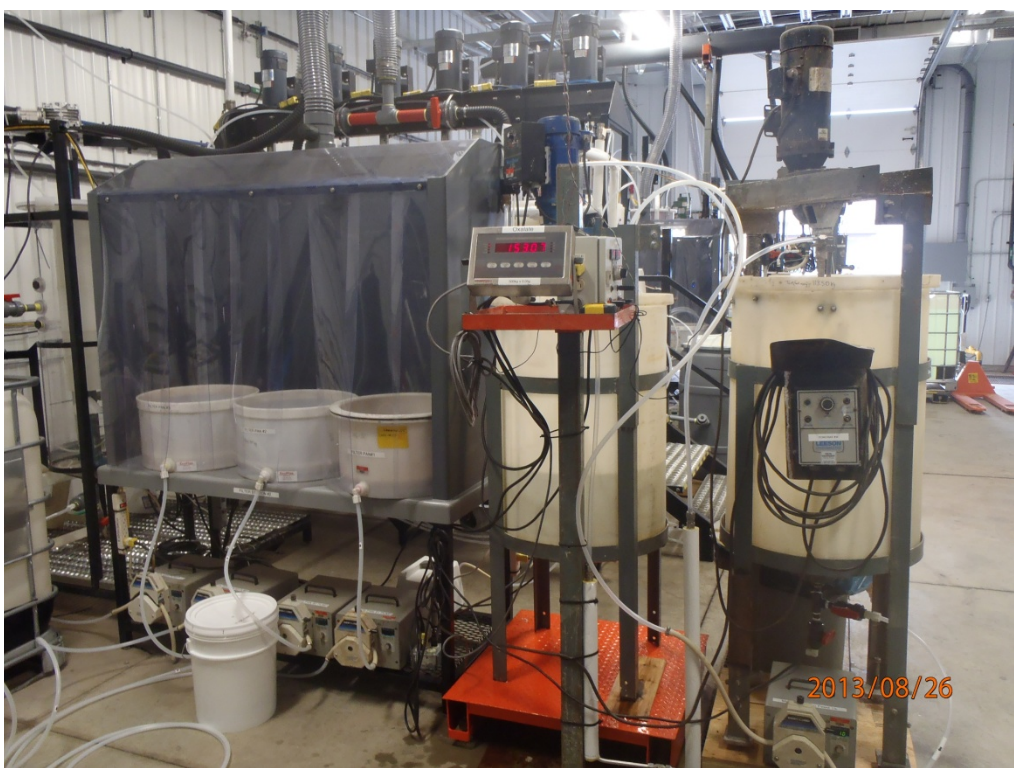
Na %	P %	Pb %	Si %	Sr %	Ti %	V %	Zn %	TREE %	LREE %	HREE %
1%	1%	42%	14%	7%	14%	4%	0%	99%	99%	100%

(SGS Lakefield, 2014)

Consumption of oxalic acid can vary greatly depending on the composition of the PLS. Aluminium and iron increase oxalic acid consumption by forming aluminum oxalate and iron oxalate that are eventually sent to tailings. The low temperature leach minimizes the leaching of iron which reduces oxalic acid consumption.

Figure 13.15 shows the precipitation pilot plant unit that was used for testing in 2013.

Figure 13.15 - Pilot Precipitation Apparatus at SGS – 2013



(SGS Lakefield, 2014)

13.7 Conversion of Rare Earth Oxalates

A kiln has been found to provide the most economic conversion of Rare Earth oxalates to rare earth oxides. At 700°C the rare earth oxalates are decomposed releasing CO2 and converting the rare earths to oxides. In bench scale and pilot testing, this was found to function satisfactorily.

In pilot testing, the average composition of the kiln discharge was 74.1% TREE (71% LREE and 3.1% HREE). Thorium levels were between 1.0% and 3.1% with uranium levels below 70 g/t. Carbon concentrations in the kiln discharge solids were around 0.6% once the operation was steady. The base metals in the kiln discharge solids were below 1% with the exception of silicon, which was as high as 8%, though this was not related to the kiln operation but rather to the precipitation circuit operation.

13.8 Acid/Water Recovery

Acid Recovery and Oxalic Acid Crystallization

- The barren PLS was vaporized to recover a mixture of acid and water (Azeotropic conditions) under a vacuum (-21 inches Hg) and 87 °C.
- The mixed vapor was selectively condensed in order to split acid (HCl) and water (H_2O) streams.
- Total acid recovered to the azeotropic acid and water streams ranged from 19 to 58% (average 33%), depending on the feed rate. Low acid recovery was attributed to initial lower acid concentration in the feed to the distillation column.
- The residual solution at the bottom of the distillation column was passed through a chiller. Oxalic acid crystals were recovered from the chiller containing 87.5% oxalate, 0.2% TREE and 5% Ca.
- The filtrate from the chiller contained several metal ions including 1.8 g/L TREE, 22 g/L Ca and 19.7 g/L Fe and 13.9 g/L Mn. This filtrate was subjected neutralization with lime rock and quicklime to precipitate all base metals.

  Figure 13.16 shows a photograph of the pilot distillation column used for distilation testing at SGS Lakefield.

Figure 13.16 - Pilot Distillation Column at SGS

(SGS Lakefield, 2014)

The weight of acid in feed solution to the distillation and final products (bottom and top) for each cycle is shown in Table 13.23 below. Table 13.24 shows which distillation column cycles correspond to each test campaign. Feed to the column is shown in Table 13.25. The bottom product is a metal rich residue with appreciable amounts of oxalic acid. The oxalic acid is crystallized out leaving base metals in the filtrate with some HCl acid. At start up, before Azeotropic conditions, more water than acid is recovered. Each distillation cycle operated for 16 hrs. from start-up to Azeotropic point. From each cycle, the mass of oxalic acid crystallized is recorded. Distillate acid streams collected during the pre-azeotropic and azeotropic periods of operation were collected separately. Although ideal azeotropic conditions would be marked by distillate acid strengths of 17%, for the purposes of this table, distillate acid over 15% was considered azeotropic. Cycles 4, 9 and 14 did not reach the azeotropic state (15% HCl) and thus have no azeotropic acid data.

Table 13.23 - Distillation column performance

Cycles	Feed IN			Acid collected (pre-azeotropic)		Acid collected (Azeotropic)		Water collected (Total)		Bottoms				
	kg	SG	% HCl	kg	% HCl	kg	% HCl	kg	% HCl	Total kg	% Solids	Filtrate kg	Filtrate SG	Filtrate HCl
1	37.9	1.087	8.5%	2.20	7.0%	6.60	16.4%	13.6	0.2%	12.9	7.5%	11.9	1.233	6.3%
2	38.7	1.116	10.2%			7.40	16.1%	14.5	3.5%	13.7	4.8%	13.0	1.259	11.7%
3	40.5	1.091	8.6%	4.60	9.3%	6.40	18.6%	15.6	2.7%	12.7	3.6%	12.2	1.091	11.9%
4	47.2	1.071	7.7%	9.52	10.6%			23.9	0.9%	11.2	3.2%	10.9	1.213	12.4%
6	40.1	1.076	8.1%	6.70	3.3%	1.86	17.5%	17.1	0.3%	12.2	7.9%	11.3	1.188	12.1%
7	50.8	1.077	8.2%	4.26	5.5%	4.21	17.7%	27.6	1.7%	13.2	11.2%	11.7	1.225	12.1%
8	50.0	1.072	7.0%	5.14	6.3%	4.12	17.3%	28.6	0.9%	12.3	12.1%	10.8	1.229	8.9%
9	56.4	1.049	4.0%	9.12	7.9%			33.3	0.4%	12.8	1.8%	12.6	1.199	11.5%
10	58.2	1.058	5.2%	7.30	5.3%	1.92	15.8%	34.2	0.6%	12.7	5.3%	12.0	1.233	8.0%
11	48.4	1.076	6.6%	5.46	6.5%	2.12	16.8%	26.5	0.8%	13.3	7.1%	12.4	1.243	11.8%
12	53.2	1.072	6.7%	6.29	6.6%	3.11	18.0%	28.8	0.4%	12.9	9.7%	11.6	1.226	11.9%
13	51.3	1.066	6.6%	6.23	5.3%	2.64	16.6%	29.1	0.4%	12.5	8.1%	11.5	1.224	12.5%
14	44.1	1.056	5.7%	5.30	2.5%			25.3	0.0%	12.4	7.8%	11.4	1.157	12.5%
15	53.0	1.072	6.7%	6.80	4.8%	2.80	16.2%	28.3	1.8%	13.4	10.8%	11.9	1.228	12.5%
16	50.6	1.092	6.4%	4.80	6.4%	4.40	16.0%	26.4	0.6%	13.0	8.2%	11.9	1.272	10.4%
17	44.4	1.076	5.6%	7.40	4.4%	1.10	16.3%	23.1	0.1%	9.9	6.4%	9.3	1.257	11.3%
AVG/TOTAL	765	1.074	6.8%	91.1	6.2%	48.7	16.9%	396	0.9%	201	7.3%	186	1.217	11.1%

(SGS Lakefield, 2014)

Table 13.24 - Number of Cycles Operated per Composite sample

Campaign	PP5	PP6	PP6	PP7	PP7
PL Feed ID	COMP B	COMP C	COMP A	COMP E	COMP D
Cycles	1 - 7	7 - 8	9 - 12	13	14 - 17

(SGS Lakefield, 2014)

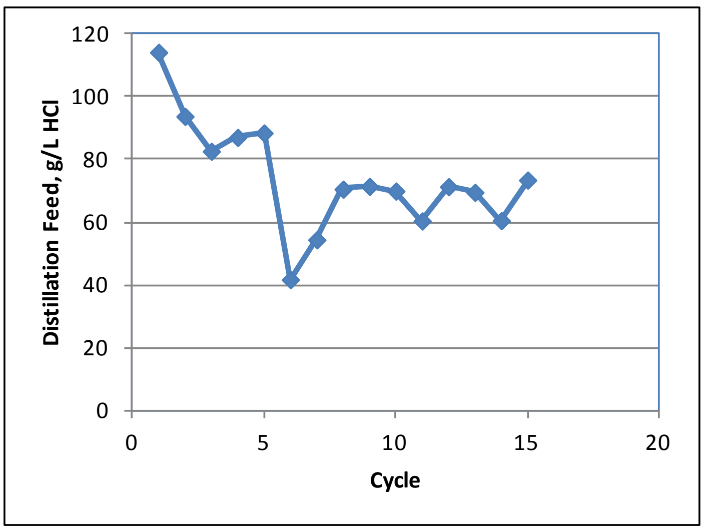
The barren PLS from each hydromet pilot campaign was fed continuously to the distillation column for 16 hours to recover water, HCl acid and oxalic acid crystals (solids), The column operated under azeotropic conditions successfully generating a >16%HCl stream and water stream (< 0.9%HCl). The filtrate contained some acid which should be recovered by recycling some filtrates. Ultimately, the filtrate is neutralized to produce base metal hydroxides and Calcium chloride (a resource of chloride). The column operated under steady state conditions and heat was balanced.

Table 13.25 - Feed (Barren PLS) Composition to Distillation Column contains recoverable acid and REEs

Cycle	HCl g/L	La mg/L	Ce mg/L	Pr mg/L	Nd mg/L	Sm mg/L	Eu mg/L	Gd mg/L	Tb mg/L	Dy mg/L	Ho mg/L	Y mg/L	Er mg/L	Tm mg/L	Yb mg/L	Lu mg/L	Sc mg/L	Th mg/L	U mg/L
1	92.8	372	296	28.3	78.4	6.62	1.41	3.32	0.26	0.97	0.14	5.87	0.31	0.05	0.21	0.04	0.09	0.41	9.84
2	114	990	1250	115	360	37.2	7.84	18.3	1.52	4.92	0.62	19.9	1.11	0.14	0.78	0.11	0.26	2.01	12.8
3	93.8	*990*	*1250*	*115*	*360*	*37.2*	1.21	3.13	0.29	1.14	0.18	9.21	0.41	0.05	0.31	0.04	0.10	0.44	9.08
4	82.7	114	51.5	3.20	6.37	0.34	0.07	0.19	0.03	0.09	0.02	1.09	0.06	0.04	0.04	0.03	0.08	0.08	6.94
6	87.1	157	87.9	6.00	13.2	0.74	0.14	0.33	0.04	0.15	0.02	1.57	0.05	0.04	0.04	0.03	0.07	0.08	7.20
7	88.5	177	107	8.04	18.5	1.27	0.25	0.68	0.06	0.28	0.04	2.40	0.10	0.04	0.09	0.03	0.07	0.06	6.98
8	74.9	28.8	10.3	0.85	2.13	0.12	0.03	0.07	0.03	0.05	0.02	0.11	0.04	0.04	0.02	0.03	0.07	0.03	7.32
9	41.8	22.8	10.2	0.71	1.66	0.12	0.03	0.06	0.03	0.05	0.02	0.18	0.04	0.04	0.02	0.03	0.07	0.03	6.19
10	54.5	22.8	8.70	0.47	1.08	0.07	0.03	0.03	0.03	0.05	0.02	0.09	0.04	0.04	0.02	0.03	0.07	0.05	8.22
11	70.6	82.6	43.0	2.22	4.67	0.30	0.06	0.15	0.03	0.05	0.02	0.69	0.04	0.04	0.02	0.03	0.07	0.05	10.5
12	71.5	27.0	10.0	0.63	1.46	0.11	0.03	0.05	0.03	0.05	0.02	0.13	0.04	0.04	0.02	0.03	0.07	0.14	8.75
13	70.0	102	55.3	5.22	13.2	0.99	0.21	0.53	0.05	0.21	0.04	1.81	0.09	0.04	0.08	0.03	0.07	0.08	8.45
14	60.5	94.0	39.7	2.96	6.23	0.37	0.08	0.21	0.03	0.10	0.02	1.60	0.07	0.04	0.06	0.03	0.09	0.06	7.41
15	71.4	163	88.1	6.72	15.5	1.02	0.18	0.48	0.04	0.22	0.04	2.95	0.13	0.04	0.13	0.03	0.16	0.15	8.78
16	69.6	157	57.2	3.31	6.59	0.34	0.07	0.18	0.03	0.06	0.02	1.07	0.04	0.04	0.03	0.03	0.07	0.16	14.0
17	60.6	64.1	21.0	1.03	2.11	0.12	0.03	0.07	0.03	0.05	0.02	0.30	0.04	0.04	0.02	0.03	0.07	0.03	12.3
AVERAGE	73.5	195	178	15.6	46.1	4.46	0.59	1.41	0.13	0.44	0.07	2.63	0.14	0.05	0.10	0.03	0.09	0.21	8.94
MIN	41.8	22.8	8.70	0.47	1.08	0.07	0.03	0.03	0.03	0.05	0.02	0.09	0.04	0.04	0.02	0.03	0.07	0.03	6.19
MAX	114	990	1250	115	360	37.2	7.84	18.3	1.52	4.92	0.62	19.9	1.11	0.14	0.78	0.11	0.26	2.01	14.0
REVSTD	23%	140%	194%	204%	216%	230%	266%	261%	235%	231%	193%	167%	168%	52%	165%	55%	55%	202%	25%

(SGS Lakefield, 2014)

Figure 13.17 - Feed HCl acid to distillation column (recoverable)



(SGS Lakefield, 2014)

Free acid is determined by a free acid titration with sodium hydroxide solution and is represented as grams of hydrochloric acid per liter of solution. Figure 13-17 shows that acid levels in the feed were high initially (90-100 g/L HCl), but drop down to 41 g/L by Cycle 9. The situation improved and acid in the feed rose back to 60 - 70 g/L HCl for the remainder of the pilot operations.

Acid addition to the leach circuit affects free acid availability in the feed to the distillation column. Changes in acidity of PLS are also affected by changes in oxalic acid addition or a drop in Fe III ions assays in the leach solution.

Table 13.26 - Composition of Oxalate Crystals Recovered from Distillation Residual Solution (Recycled)

Cycle	La g/t	Ce g/t	Pr g/t	Nd g/t	Sm g/t	Eu g/t	Gd g/t	Tb g/t	Dy g/t	Ho g/t	Y g/t	Er g/t	Tm g/t	Yb g/t	Lu g/t	Sc g/t	Th g/t	U g/t	TREE g/t
2	977	1230	114	350	40.6	8.40	20.3	0.80	5.30	1.20	23.0	1.90	0.60	1.50	0.80	<25	6.50	6.10	2775
3	1400	1800	173	521	63.6	14.0	30.2	3.70	12.0	2.20	49.0	3.90	1.10	2.80	1.10	<25	13.3	15.3	4078
4	3570	3050	291	695	66.0	12.6	28.7	3.60	15.4	2.50	140	7.10	1.10	5.90	1.00	<25	4.70	27.3	7890
6	1000	688	62.5	169	19.4	4.20	10.6	1.00	3.40	0.60	20.0	1.10	<0.3	0.70	<0.5	<25	7.60	7.20	1981
7	802	492	38.3	92.5	6.60	1.90	3.70	<0.5	0.90	0.70	16.0	<0.5	0.6	<0.5	0.6	<25	1.00	6.30	1457
9	578	358	37.6	119	15.8	3.60	8.50	0.60	2.60	0.30	13.0	0.80	<0.3	0.60	<0.5	<25	6.00	15.4	1139
10	235	113	8.00	22.0	2.10	0.50	1.90	<0.5	1.20	0.30	<10	0.50	<0.3	0.60	<0.5	<25	0.70	10.0	396
11	581	421	30.3	79.0	9.00	2.30	5.30	1.20	2.10	1.00	11.0	1.40	0.80	1.00	0.7	<25	3.80	22.6	1147
12	243	151	9.50	27.0	2.00	0.90	2.00	5.00	2.70	0.60	10.0	1.20	0.30	0.90	0.5	<25	2.00	6.40	457
13	538	322	31.6	81.0	7.10	1.50	4.00	<0.5	1.90	0.40	19.0	1.00	<0.3	0.80	<0.5	<25	0.90	6.00	1010
14	170	104	10.1	28.0	3.80	1.00	2.30	<0.5	1.10	0.40	<10	0.60	<0.3	0.60	<0.5	<25	1.70	3.30	333
15	626	335	27.4	63.0	5.80	2.00	4.40	1.20	2.10	1.20	14.0	1.50	1.10	1.70	1.10	<25	2.00	6.90	1088
16	3300	1600	102	225	13.0	2.40	9.00	5.00	3.60	0.80	44.0	2.30	0.40	1.80	0.50	<25	2.30	42.2	5310
17	315	110	5.8	13.0	1.00	0.30	1.00	5.00	0.60	0.30	10.0	0.50	0.30	0.50	0.50	<25	0.50	3.60	464
AVERAGE	1213	818	67.6	175	17.1	3.89	9.40	2.64	3.92	1.07	28.8	1.87	0.73	1.57	0.86	33	4.02	15.55	2109
MIN	170	104	5.80	13.0	1.00	0.30	1.00	<0.50	0.60	0.30	<10.0	<0.50	<0.30	<0.50	<0.50	<25	0.50	3.30	333
MAX	3570	3050	291	695	66.0	14.0	30.2	5.00	15.4	2.50	140	7.10	1.10	5.90	1.10	25	13.3	42.2	7890
REVSTD	105%	112%	120%	117%	121%	112%	105%	92%	112%	78%	125%	103%	60%	102%	36%	0%	95%	87%	105%

(SGS Lakefield, 2014)

Table 13.26 shows the composition of REEs (average = 0.21%TREE) in the crystallized oxalates out of the distillation bottom liquor. Recycling oxalates improves overall recovery of REEs depending on the mass of solids recycled.

Table 13.27 - Composition of Filtrate after the Oxalate Crystals are Filtered from distillation bottom liquor

Cycle	La mg/L	Ce mg/L	Pr mg/L	Nd mg/L	Sm mg/L	Eu mg/L	Gd mg/L	Tb mg/L	Dy mg/L	Ho mg/L	Y mg/L	Er mg/L	Tm mg/L	Yb mg/L	Lu mg/L	Sc mg/L	Th mg/L	U mg/L	TREE mg/L
1	1520	1300	128	368	33.9	7.11	17.0	1.41	4.90	0.67	25.7	1.37	0.18	0.94	0.14	0.39	1.88	35.9	3409
2	2930	3660	346	1080	120	25.1	59.6	4.81	15.6	1.94	62.0	3.68	0.41	2.23	0.31	0.81	8.58	38.9	8312
3	3530	3800	361	1070	104	21.3	47.8	4.11	12.8	1.78	64.2	3.56	0.40	2.23	0.32	0.69	4.57	43.6	9024
4	935	571	41.8	94.5	5.90	1.10	2.58	0.23	0.85	0.14	9.59	0.36	0.05	0.26	0.05	0.29	0.14	31.0	1663
6	518	291	20.5	45.1	2.56	0.51	1.39	0.13	0.57	0.09	5.63	0.22	<0.04	0.16	<0.03	0.11	0.22	24.1	886
7	834	504	39.0	87.5	5.89	1.12	2.88	0.29	1.06	0.18	10.7	0.45	0.06	0.33	0.05	0.25	0.32	32.6	1488
8	365	153	10.0	21.6	1.18	0.22	0.62	0.05	0.18	0.03	2.46	0.07	<0.04	0.05	<0.03	0.09	0.05	34.9	555
9	115	52.3	3.60	8.68	0.64	0.12	0.30	<0.03	0.10	<0.02	0.95	0.04	<0.04	0.02	<0.03	<0.07	0.11	29.6	182
10	122	48.4	2.55	5.59	0.32	0.06	0.16	<0.03	0.05	<0.02	0.48	<0.04	<0.04	<0.02	<0.03	<0.07	0.10	46.5	180
11	293	137	6.44	13.5	0.74	0.14	0.35	<0.03	0.10	0.02	1.84	0.05	<0.04	0.05	<0.03	0.15	0.08	47.5	453
12	119	45.4	2.64	6.12	0.46	0.09	0.22	<0.03	<0.05	<0.02	0.58	<0.04	<0.04	<0.02	<0.03	<0.07	0.11	44.7	175
13	436	225	20.0	49.2	3.50	0.71	1.64	0.16	0.62	0.12	7.01	0.30	0.04	0.23	0.04	0.15	0.23	38.4	745
14	355	152	11.9	26.2	1.66	0.31	0.86	0.08	0.39	0.08	6.23	0.26	0.04	0.24	0.04	0.30	0.19	29.2	555
15	743	399	30.8	71.5	4.81	0.92	2.52	0.22	1.06	0.21	13.7	0.67	0.10	0.63	0.09	0.35	0.14	46.0	1269
16	314	72.4	2.96	5.09	0.23	0.04	0.11	<0.03	<0.05	<0.02	0.31	<0.04	<0.04	<0.02	<0.03	<0.07	0.21	59.7	395
17	156	37.9	2.02	4.62	0.42	0.10	0.24	<0.03	0.10	<0.02	0.33	<0.04	<0.04	<0.02	<0.03	<0.07	0.15	55.7	202
AVERAGE	876	771	69.7	201	19.6	4.03	9.44	0.80	2.61	0.36	14.2	0.75	0.11	0.50	0.08	0.26	1.16	39.7	1843
MIN	115	38	2.02	4.62	0.23	0.04	0.11	<0.03	<0.05	<0.02	0.31	<0.04	<0.04	<0.02	<0.03	<0.07	0.05	24.1	175
MAX	3530	3800	361	1080	120	25.1	59.6	4.81	15.6	1.94	64.2	3.68	0.41	2.23	0.32	0.81	8.58	59.7	9024
REVSTD	122%	170%	182%	194%	211%	213%	210%	206%	199%	184%	155%	170%	125%	158%	120%	92%	217%	25%	151%

(SGS Lakefield, 2014)

Table 13.27 tabulates the composition of the filtrate after the oxalate crystals are filtered from the distillation bottom liquor. Note that the REEs are depleted in the filtrate liquor after oxalates are recovered. The remaining REEs represent a loss to final metal hydroxide precipitates.

Table 13.28 - Composition of major base metals precipitated from the final distillation residual liquor

Cycle	Al mg/L	As mg/L	Ba mg/L	Be mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	P mg/L	Pb mg/L	Sr mg/L	Ti mg/L	V mg/L	Zn mg/L
1	3820	<5	27.0	0.70	19700	21300	3540	3070	15900	15.0	184	1450	509	792	282	56.0	704
2	4260	15	195	1.10	20200	31000	3820	3420	19900	42.0	301	1710	733	914	392	95.9	910
3	5060	13	195	1.20	27900	34800	5000	4260	17500	41.0	245	2030	811	1110	421	110	930
4	3640	6	86.3	0.80	25400	18600	3150	3250	8260	15.0	277	1630	464	977	293	69.3	592
6	3280	<5	105	0.50	16900	13200	3170	2970	8540	13.0	5760	1380	420	798	233	59.3	478
7	4080	<5	88.4	0.80	23500	17300	3890	3690	11100	16.0	6600	1720	533	1110	290	74.8	585
8	4230	<5	70.1	1.00	25700	16000	3990	3980	11000	14.0	6520	2200	477	2740	244	66.9	653
9	3130	<5	120	<0.8	27000	10100	2860	3100	8810	6.00	6440	2190	184	4630	141	33.8	627
10	5060	<5	251	1.20	26400	15000	4880	5040	12400	13.0	7570	2690	401	3930	251	73.0	890
11	5410	<5	257	1.20	23700	18900	5350	5160	14900	24.0	7690	2460	597	1510	298	93.0	799
12	4880	<5	68.6	1.10	21600	19300	4850	4680	12500	23.0	5430	2540	442	934	248	81.3	623
13	4440	<5	88.6	1.00	24100	17900	4320	4160	9890	15.0	5550	2720	384	940	227	65.5	512
14	2930	<5	80.1	0.70	11800	11300	2630	2680	5180	6.00	4880	1710	283	601	159	34.2	357
15	4490	<5	158	1.20	14800	19000	4490	3980	16500	15.0	7060	2490	730	1490	249	60.3	750
16	4800	<5	278	1.60	24100	28400	4230	4390	25300	12.0	8970	2270	1100	4570	181	50.6	1430
17	3740	<4	19	2.61	20600	22000	3370	3200	27400	13.9	8070	1792	1070	4030	18	51.7	1440
AVERAGE	4216	<6	134	1.07	22138	19755	3988	3825	13932	18.1	5000	2065	565	1911	251	67.9	760
MIN	2930	<4	19.3	0.50	11800	10100	2630	2680	5180	6.00	184	1380	184	601	18	33.8	357
MAX	5410	15	278	2.61	27900	34800	5350	5160	27400	42.0	8970	2720	1100	4630	421	110	1440
REVSTD	18%	51%	63%	44%	21%	35%	21%	20%	44%	58%	60%	21%	45%	77%	39%	31%	40%

(SGS Lakefield, 2014)

The base metal precipitates are recovered after neutralizating the oxalate crystals filtrate with limerock and quicklime. Table 13.28 shows the composition of the major base metals that are precipitated. The neutralization filtrate is rich in calcium chlorides which can be crystallized out of the concentrated solution by gradual crystallization. Ultimately, a small stream of ion-depleted solution, which is mainly water, is recycled to the distillation column for water recovery.

13.9 Thorium Removal

Thorium removal is the final step to produce the final rare earth hydroxide product. Initially, REO containing thorium is dissolved in a nitric acid leach and then filtered to remove undissolved solids. The leach solution is then reacted with ammonium hydroxide. This REE loss is approximately 1 to 2% of the REE fed to thorium removal.

In a downstream vessel, additional ammonium hydroxide is added to precipitate the balance of the thorium in a mixed thorium/REE hydroxide precipitate. This precipitate is recycled to the nitric acid leach. The filtrate from this process is transferred to a downstream vessel where additional ammonium hydroxide is added to precipitate the balance of the rare earths as a hydroxide that is essentially free of thorium. This precipitate is filtered, dried and calcined. An analysis of the final product is shown in Table 13.29.

Table 13.29 - Analysis of REE product

SAMPLE ID	Tare g	Gross g	Net g	TREO %	La2O3 %	Ce2O3 %	Pr2O3 %	Nd2O3 %	Sm2O3 %	Eu2O3 %	Gd2O3 %	Tb2O3 %
C1	13.20	464.90	451.70	88.10	20.90	43.60	4.66	15.40	1.99	0.45	1.04	0.10
C2	13.40	340.90	327.50	86.00	11.80	46.70	5.28	17.60	2.42	0.57	1.42	0.15
C3	6.30	63.80	57.50	86.50	5.90	38.50	6.09	25.00	5.86	1.54	3.28	0.41
C4	6.40	382.80	376.40	86.80	18.80	45.10	4.61	14.90	1.88	0.43	1.04	0.10
C5	20.70	302.70	282.00	86.80	20.10	44.60	4.58	14.30	1.74	0.40	0.99	0.10
C6	6.40	128.50	122.10	84.80	7.40	45.30	5.82	20.30	3.15	0.74	1.86	0.21
C7	6.40	83.90	77.50	87.70	21.20	44.00	4.52	14.50	1.86	0.42	1.04	0.11
Average	10.40	252.50	242.10	86.67	15.16	43.97	5.08	17.43	2.70	0.65	1.52	0.17

SAMPLE ID	Dy2O3 %	Ho2O3 %	Er2O3 %	Tm2O3 %	Yb2O3 %	Lu2O3 %	Y2O3 %	Sc2O3 %	Th %	U g/t	C(t) %	SiO2 %
C1	0.37	0.04	0.07	0.01	0.02	-	0.98	<0.01	0.15	0.00	0.73	0.26
C2	0.59	0.08	0.13	0.01	0.05	0.01	1.87	<0.01	0.10	0.00	0.66	0.77
C3	1.66	0.19	0.31	0.03	0.11	0.01	3.05	<0.01	0.03	0.00	0.66	0.62
C4	0.40	0.05	0.08	0.01	0.03	-	1.08	<0.01	0.24	0.00	0.54	0.45
C5	0.37	0.05	0.07	0.01	0.03	-	1.07	<0.01	0.17	0.00	0.58	0.37
C6	0.86	0.11	0.20	0.02	0.08	0.01	3.04	<0.01	0.02	0.00	0.77	1.42
C7	0.40	0.05	0.08	0.01	0.03	0.01	1.19	<0.01	0.02	0.00	0.64	0.65
Average	0.66	0.08	0.13	0.01	0.05	0.01	1.75	< 0.01	0.10	0.00	0.65	0.65

SAMPLE ID	Al2O3 %	Fe2O3 %	MgO %	CaO %	Na2O %	K2O %	TiO2 %	P2O5 %	MnO %	Cr2O3 %	V2O5 %	LOI %
C1	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.11	< 0.01	0.01	3.09
C2	0.06	0.03	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.11	< 0.01	0.02	3.37
C3	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	0.06	< 0.01	0.02	2.96
C4	0.04	0.03	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.12	< 0.01	0.01	2.64
C5	0.05	0.07	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.12	< 0.01	< 0.01	2.66
C6	0.08	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.10	< 0.01	0.01	3.93
C7	< 0.01	0.04	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.11	< 0.01	< 0.01	3.05
Average	0.04	0.04	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	0.10	< 0.01	0.01	3.10

(SGS Lakefield, 2014)

The potential for significant additional reduction in thorium concentration to below a thousandth of a percent is thought to be possible but was not proven in the laboratory at the time of this writing. Therefore, an ultra-low thorium product has not been included in this study.

14 Mineral Resource Estimates

14.1 Introduction

This mineral resource estimate was prepared by Ore Reserves Engineering (ORE) to update the previous resource estimates for the Bull Hill rare earth deposits. These estimates were described in the report titled, "Technical Report on the Mineral Reserves and Resources and Development of the Bull Hill Mine", dated May 2, 2013, and amended on June 26, 2013. A further update to the resource estimate was reported in a press release dated December 19, 2013 and added data from drilling conducted through September 2013 at the Whitetail deposit. The resource estimate was again updated in the Rare Element 10K in March 2014 to include PQ core drilling conducted in late 2013 on the Bull Hill deposit.

The current estimate, dated May 2014, updates the resource estimate to include geological information and assay data for all drilling completed during the 2013 field season, including drilling at the Whitetail and Bull Hill deposits. In addition, the estimate was modified to include dilution consistent with a 20x20x20-foot selective mining unit. Estimation was done using 307 core holes and 20,491 assay intervals that totaled 186,221.5 feet (56,774.85 meters) of drilling. Resource modeling and estimation were done using CAE Mining Studio 3 (formerly Datamine) software by Alan Noble, PE of O.R.E., who is the independent QP for the resource estimate. Mr. Noble is a resource estimation consultant, who has 44 years of experience in the minerals industry, and who has worked on resource estimation and mine planning for more than 153 mineral deposits throughout the world.

14.2 General

A three-dimensional block model using 10x10x10-foot (3x3x3-meter) blocks was created for use in resource estimation. While the 10-foot (3-meter) blocks were used to provide better geometric resolution of the high-grade veins, IDP estimation parameters were adjusted to provide a selective mining unit of 20x20x20 feet (6.1x6.1x6.1 meters). The 10-foot blocks were not sub-celled on geological boundaries to provide better compatibility with the MineSight software used for mine planning. The block model location parameters remain the same as for previous models, and the survey coordinate system remains as UTM Zone 13, NAD 83. Size and location parameters for the block model are summarized in Table 14.1.

Table 14.1 - Block Model Size and Location Parameters

Axis	Origin (UTM ft.)	Maximum (UTM ft.)	Block Size (feet)	Block Size (meters) approx.	Number of Blocks	Model Size (feet)	Model Size (meters) approx.
X	1,781,500	1,786,900	10	3.05	540	5,400	1,646
Y	16,160,700	16,166,000	10	3.05	530	5,300	1,615
Z	5,000	6,520	10	3.05	152	1,520	462
Coordinates are UTM Zone 13, NAD 83, NAVD 88, US survey feet							

(A. Nobel 2014)

14.3 Resource Estimation Geometric Controls

Bounding solids were defined for nine estimation domains, as listed in Table 14.2. The domain boundaries were constructed from cross-sectional-view strings defined to enclose areas with consistent overall grades and grade zoning. Cross-sections were spaced at 50-to-100-ft intervals and were aligned roughly perpendicular to the overall trend of mineralization in each domain. (Note: Domain boundaries for Northwest Bull Hill and the Whitetail 2 domains were drawn in plan view.) Since the boundaries between domains are generally indistinct and/or gradational, the domain boundaries are drawn with a slight overlap. The domain boundaries were linked to form wireframed solids, and the solids were filled with 10x10x10-foot blocks to create the domain block model.

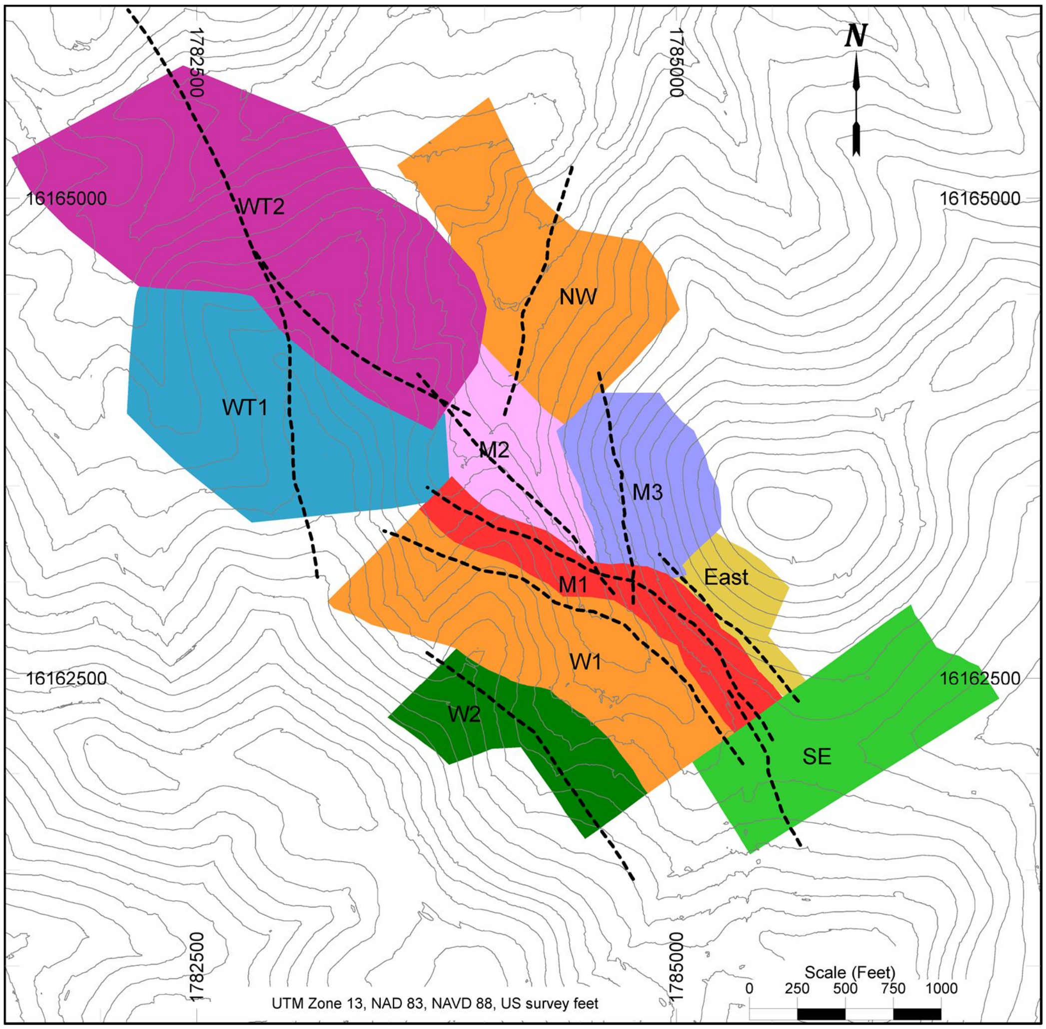
The overlapping boundaries were resolved for the block model by overprinting the individual models with the Studio 3 ADDMOD process in the order of the priorities listed in Table 14.2. Thus, W2 is overprinted onto NW; WT1 is overprinted onto the NW+W2 result; and so on.

Composites were selected within the entire volume of each domain for resource estimation. Thus, the domain boundaries were treated as semi-soft boundaries for composite selection. The use of semi-soft boundaries for composite selection is justified by the indistinct/gradational nature of the domain boundaries.

14.4 Trend Surfaces

Good continuity is generally indicated for the REE-bearing veins, but continuity is not planar in either the vertical or horizontal view. Accordingly, trend surfaces were created to define the continuity of mineralization within each resource domain. The trend surfaces were defined using the same cross-sectional alignment as was used for interpretation of the domains. After linking the trend strings to form wireframed surfaces, the intersection of the trend surfaces in plan view was checked to ensure consistency of trend surfaces, both laterally and vertically. The intersections of the trend surfaces with the 5700-ft level are shown as dashed lines in Figure 14.1.

Figure 14.1 - Domains and Trends for Resource Estimation



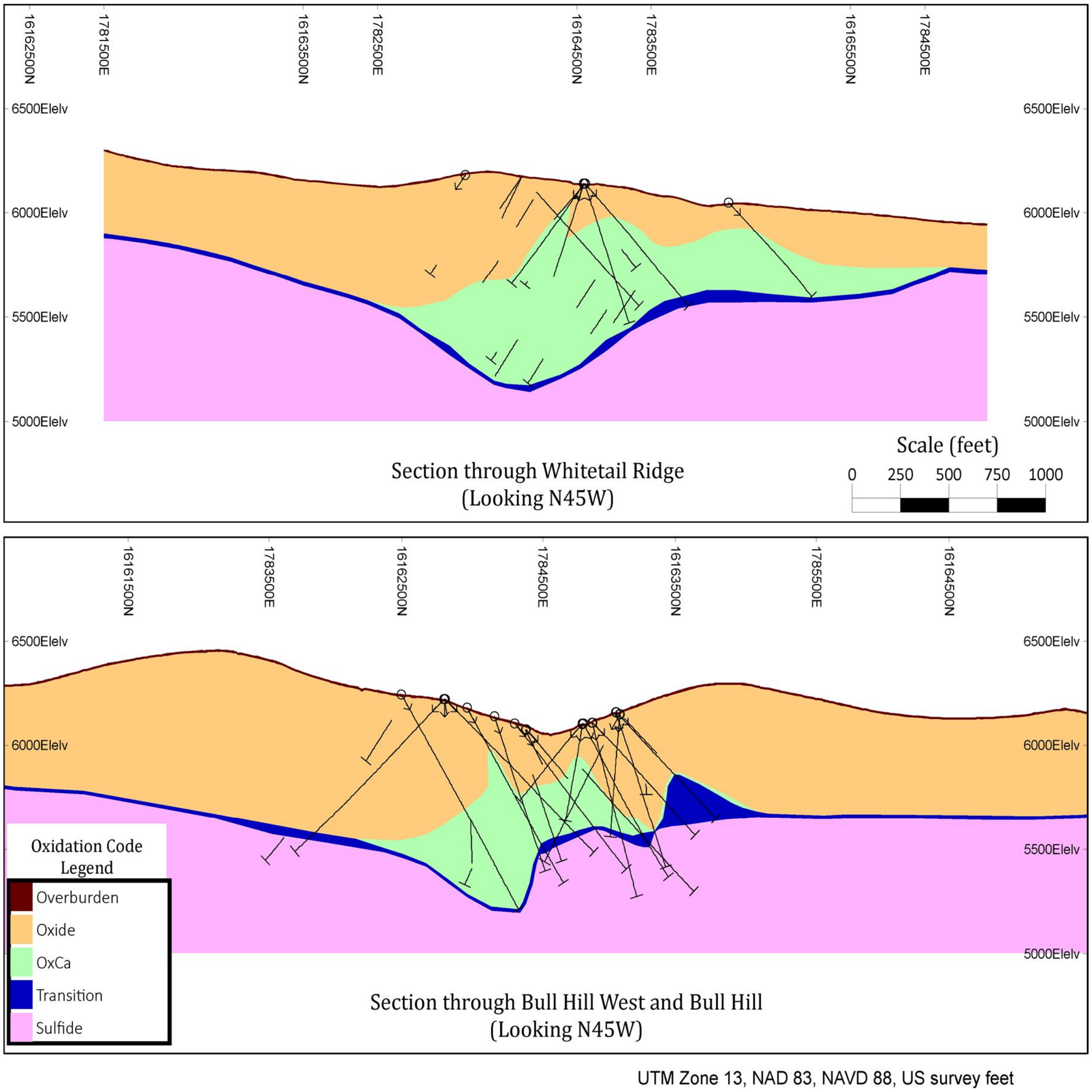
(A.Noble, 2014)

Table 14.2 - Bull Hill Resource Estimation Domains

Domain Code	Priority	Description
M1	9	**Main 1**: This is the main domain of mineralization with the best continuity, the widest veins, and the highest REE grades. It is characterized by strong, near vertical, high-grade veins with excellent continuity and a NW-SE trend. As it continues to the northwest it splits into 3 zones, of which the west-most branch is interpreted as the continuation of Main 1. The Main 1 Zone contains high-grade mineralization in a vein/dike with widths of 20 to over 100 feet that is the focus of mining during the first 9 years of production.
M2	6	**Main 2**: This is the center of the three branches off of Main 1. Mineralization is not as continuous nor as high grade as Main 1 or Main 3. The northwestern extension of Main 2 is poorly drilled, but appears to be mostly barren, although there may be a weak connection to Whitetail to the northwest.
M3	8	**Main 3**: This is the eastern-most splay off of Main 1. High-grade, near-vertical, north-south trending veins are present, but are narrower and less continuous than in Main 1, but more continuous than Main 2.
East	7	**East**: The East domain is located just to the east of Main 1 and terminates to its northwest on Main 3. The predominant mineralization is a single, narrow vein with a strike length of over 1000 feet that is sub parallel to Main 1.
NW	1	**Northwest Bull Hill**: Veins in this area are much less continuous than veins in the Main, East, and West 1 domains. Veins appear to strike about N15E and dip 65° to the NW. Continuity is poorly defined.
SE	10	**Southeast**: The Southeast Domain terminates the Main 1, West 1, and East domains on their southeast limits. This domain is defined by a sudden decrease in the intensity of REE mineralization across a discontinuity that dips approximately 80 degrees to the northwest, and strikes approximately N55E. The details of the discontinuity are not understood, but it may be a fault or intrusive contact.
W1	5	**West 1**: West 1 is immediately adjacent and similar to Main 1. Veins in West 1 are thinner, lower grade, less continuous, and more widely spaced.
W2	2	**West 2**: Mineralization in West 2 is poorly defined by only a few drill holes. It appears to be less continuous than West 1, and may trend more north-south than northwest-southeast.
WT1	3	**Whitetail 1**: This area is defined by only limited drilling. A single strong north-south striking vein is defined by the drilling.
WT2	4	**Whitetail 2**: Mineralization in Whitetail 2 strikes northwest-southeast. Although total REE grades are not as high as in Main 1, the grades of the more valuable heavy REEs are significantly higher than Main 1.

(A.Noble, 2014)

Figure 14.2 - Typical Cross Sections through the Oxidation State Model



(A.Noble, 2014)

The oxidation state model was prepared using the oxidation state codes in the drill-hole database, which designate drill-hole intervals as oxidized (Ox), oxidized with calcite (OxCa), transition (Tran), or non-oxidized (Sulf). The initial interpretation was done on cross-sections by drawing lines along the bottom of oxidized material, the top of transition material, and the top of non-oxidized material. These lines were then linked to form three-dimensional surfaces used to create the oxidation state model. The top of the oxidized zone is defined as ten feet below the topographic surface, leaving a 10-foot (3.1 meter) thick layer below the surface for soils, alluvium, and colluvium. Rare-earth element grades were not estimated in the Soils-alluvium-colluvium layer, which is assumed to be waste for resource estimation purposes. Typical sections showing the oxidation state interpretation are shown in Figure 14.2.

14.5 Trend-Oriented Modeling

Because the shape of all mineralized zones is too irregular for the use of simple search ellipses, trend models were developed to allow interpolation to follow the shape of the mineralized zone. The trend models are based on the general shape of the zones and on a visual interpretation of the continuity of mineralization. The primary objective in developing the trend shapes was to provide generally reasonable shapes, rather than to simply connect high-grade samples to other high-grade samples.

The trend surfaces were used to flatten and iron-out the wrinkles in the mineralization trends using a set of "trend-flattened" coordinates to replace the normal UTM coordinates. The method used to create the trend-flattened coordinates from the trend models is summarized in Table 14.3, and the parameters are summarized in Table 14.4.

Table 14.3 - Procedure for Calculating Trend-Flattened Coordinates

1.	The distance between the trend surface and the block model block centroids was measured by calculating the perpendicular distance between the block center and the nearest face in the trend surface wireframe. The same procedure was repeated for the center point location of composites.
2.	The block model centroids were rotated so that the model was as close to a horizontal plane as possible. The composite center-point locations were rotated using the same parameters.
3.	After rotation, the Z coordinate for the model and composites was replaced with the distance from the trend surface. At this point, the rotated model is analogous to projecting the mineralized zone into a longitudinal view and flattening it parallel to the trend surface.
4.	The final trend flattened coordinate space is roughly equivalent to viewing each domain as a longitudinal cross section.

(A.Noble, 2014)

Table 14.4 - Rotation Parameters to Flatten Trend Models

Domain	Rotation Point (UTM-Feet)			Rotation Angle Around Axis (left-hand rule)	
	X	Y	Z	Z-axis	Rotated X-axis
East	1785264	16162820	5600	48	-90
Main 1	1784704	16162935	5600	35	-90
Main 2	1784121	16163655	5600	48	-90
Main 3	1784715	16163514	5600	90	-90
Northwest	1784160	16164376	5600	107	-64
Southeast	1785477	16162036	5600	68	-90
West 1	1784551	16162845	5600	33	-90
West 2	1784307	16162132	5600	40	-90
Whitetail 1	1782980	16163885	5630	84	-90
Whitetail 2	1782842	16164688	5600	45	-90

(A.Noble, 2014)

14.6 Statistical Analysis

14.6.1 Density vs. Oxidation Zones

Oxidation of carbonatite mineralization removes substantial quantities of carbonates and sulfides, leaving behind FMR mineralization that is much lighter because of increased pore space. Thus, density is highly dependent on the degree of oxidation and the fraction of lighter FMR mineralization, or heavier carbonatite mineralization, relative to the surrounding wall rocks. Through the 2013 drilling seasons, 340 density measurements were made to determine the density of mineralization and wall rocks from all oxidation states. The density data are summarized in Table 14.5. The density measurement and calculation procedure is documented in Table 14.6.

Table 14.5 - Summary of Density Measurements

Rock Type	Count	Min Density	Max Density	Average Density	Std. Dev. Density	Std. Error of Mean	Average $\%H_2O$	Resource Estimate Density
Oxide FMR	66	0.918	3.069	1.814	0.434	0.054	18.9	1.77
OxCa FMR	67	0.878	2.859	2.158	0.415	0.051	11.2	2.20
Transition Carbonatite	3	2.070	2.547	2.322	0.433	0.250	7.4	2.32
Sulfide Carbonatite	17	2.116	3.700	2.909	0.437	0.106	0.8	2.91
Siliceous Carbonatite	2	2.807	2.834	2.820	0.433	0.306	0.4	X
Host Rock Oxide	93	1.692	2.585	2.261	0.132	0.014	3.8	2.26
Host Rock OxCa	46	1.945	2.652	2.324	0.143	0.021	3.6	2.34
Host Rock Transition	7	2.280	2.942	2.545	0.253	.096	1.9	2.41
Host Rock Non-Oxide	36	2.348	2.845	2.588	0.096	0.016	0.7	2.59
All Rock Types	340	0.878	3.700	2.24	0.402	0.022	7.7	X

(A.Noble, 2014)

Table 14.6 - Method for Measuring and Calculating Density

1	A sample of intact core was selected such that the core was unbroken and contained only one lithology and oxidation type. Thus, oxide FMR samples were only oxide FMR, and oxide wall-rock samples were only oxidized wall rock. Samples averaged approximately 1kg, but ranged from 0.23 kg to 2.26 kg.
2	The sample was vacuum-sealed in a plastic wrapper. The wrapped sample was weighed on a digital balance with a resolution of 1 g and an accuracy of 2 g. This weight is$W_{WRAPPED}$.
3	The wrapped sample was weighed again while submerged in water using the same digital balance. This weight is W_{WATER}.
4	The sample was unwrapped and weighed without the wrapper. This weight is W_{AIR}.
5	The sample was dried for 22 to 48 hours in a 90°C oven.
6	The dried sample was weighed. This weight is W_{DRY}.
7	Sample dry density is computed as follows: a. The weight and volume of the plastic wrapper is computed: $W_{WRAPPER} = W_{WRAPPED} - W_{AIR}$ $V_{WRAPPER} = {W_{WRAPPER}}/{\delta_{WRAPPER}}$ Where $\delta_{WRAPPER}$ is the density of the wrapper (0.8 g/cc for FoodSaver 8” rolls) b. The volume of the sample is computed: $V_{SAMPLE} = W_{WRAPPED} - W_{WATER} - V_{WRAPPER}$ c. The dry density of the sample is computed: $\delta_{SAMPLE} = {W_{DRY}}/{V_{SAMPLE}}$ d. The moisture content of the original sample is computed: $\%Moisture = 100 \times {(W_{AIR} - W_{DRY})}/{W_{AIR}}$

(Noble et al 2013)

This density measurement procedure works very well for difficult samples, such as vuggy/porous samples, samples with high clay content, and samples with poor cohesiveness. A point of caution is that the sample must not be broken or highly irregular, or the wrapper will not fit tightly to the sample, leaving gaps that cause the measured density to be too low. In addition, the accuracy of this procedure drops dramatically as the weight of the sample goes down. For example, when using an electronic balance with an accuracy of +/-2 grams (0.07 ounce), the measuring accuracy for a 1000 gram sample is about 2%, while the measuring accuracy for a 100 gram sample is only 18%.

14.6.2 Core Recovery

Core recovery is highly variable, primarily because the low strength of the FMR mineralization allows it to be easily broken and washed from the core sample. In general, core recovery is lower in oxidized, high FMR zones and is higher in the wall rocks and carbonatite zones. Overall, average core recovery is 85.8%, but oxide mineralization has lower average recovery than OxCa mineralization, which in turn has lower recovery than transition and sulfide mineralization, as shown in Table 14.7. In addition, there is an inverse relationship between core recovery and FMR content, and samples with FMR content below 30% have higher recoveries than samples above 30% FMR. (Note: for purposes of this report, %FMR in transitional and sulfide mineralization is used to refer to percent carbonatite.)

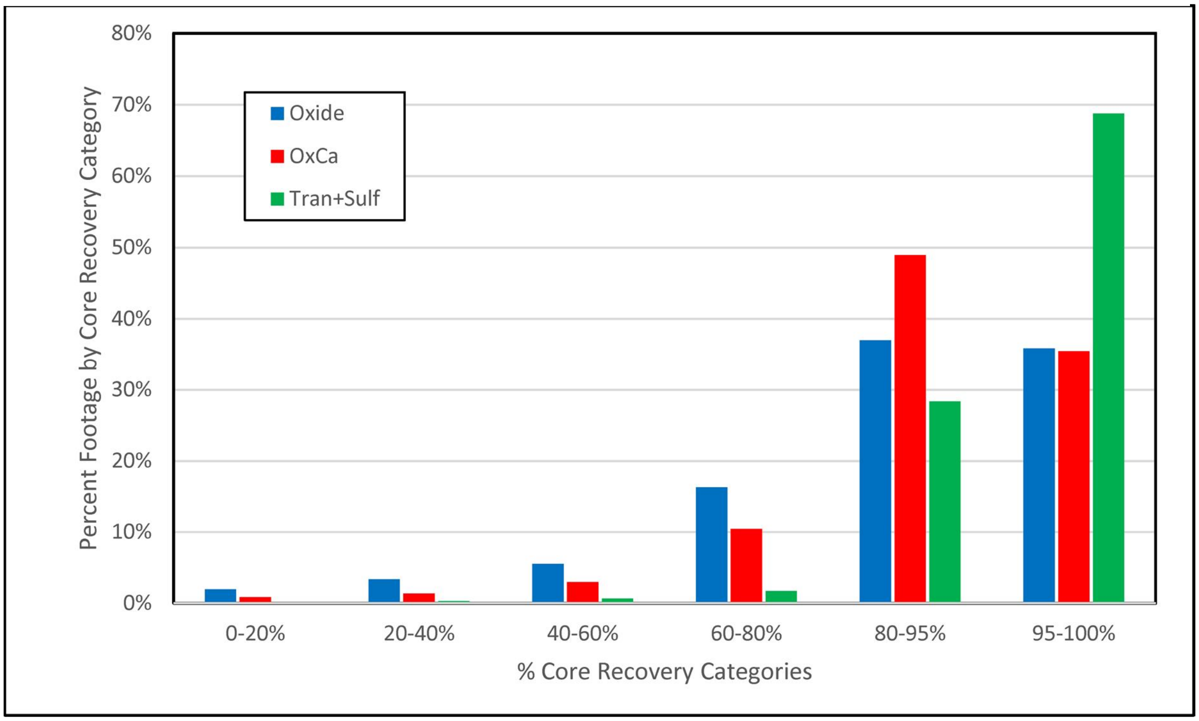
Table 14.7 - Core Recovery by Oxide Type and FMR Content

Oxide	%FMR	Footage	Meters	Average Recovery
Oxide	<30	99,885	30445	85.5
Oxide	>30	13,915	4241	77.5
Oxide	0-100	113,800	34686	84.5
OxCa	<30	35,687	10877	89.8
OxCa	>30	9,184	2799	83.6
OxCa	0-100	44,871	13677	88.5
Trans	<30	4,461	1360	93.9
Trans	>30	640	195	94.1
Trans	0-100	5,102	1555	93.9
Sulfide	<30	11,425	3482	96.3
Sulfide	>30	1,734	529	95.9
Sulfide	0-100	13,158	4011	96.2
Total	<30	151,458	46164	87.5
Total	>30	25,472	7764	81.4
Total	0-100	176,930	53928	86.6

(A.Noble, 2014)

Core recovery for the different oxide types is generally above 80% Figure 14.3. Transition and sulfide samples have the highest recoveries, and more than 60% of non-oxidized samples have greater than 95% core recovery. The distribution of core recovery for oxide and OxCa samples is similar, but oxide samples are more heavily weighted towards recovery below 80%.

Figure 14.3 - Core Recovery Distribution by Oxidation Type



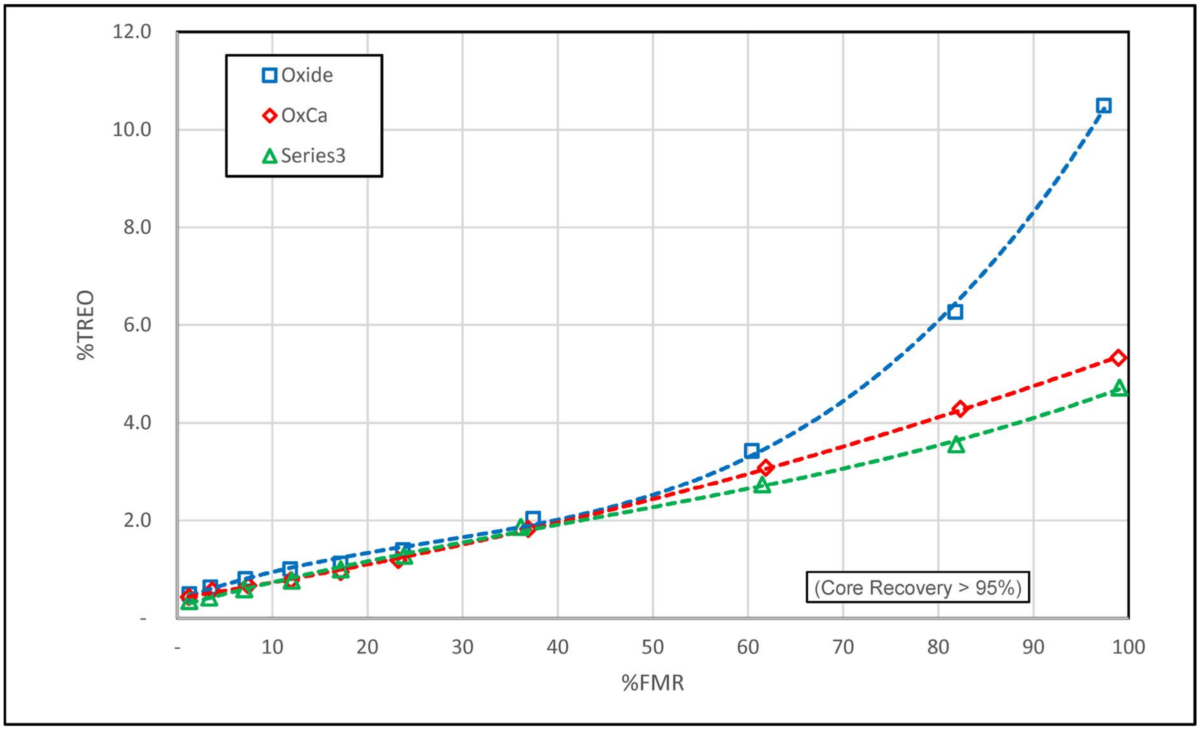
(A.Noble, 2014)

14.6.3 TREO Grade vs %FMR

Given that REO mineralization is primarily related to FMR/carbonatite veins and stockwork, there is a strong relationship between %FMR from core logging and TREO grade. In addition, oxidation of the original carbonatite to form FMR introduces strong enrichment effects. These relationships are shown graphically in Figure 14.4. This figure, which was prepared using only samples with greater than 95% recovery, shows that TREO grades are similar for all oxidation types below 30% FMR, but that the oxidation type is very significant above 30% FMR.

The regression curves are roughly linear below 30% FMR, and a background TREO grade of 0.25% TREO to 0.5% TREO is indicated by the Y-intercepts of those curves. The geological basis for the apparent background TREO grade should be further evaluated to determine whether it represents a different type of mineralization from FMR that would not be recoverable in the metallurgical process, or whether it is simply the result of measurement errors in percent FMR and TREO grade.

Figure 14.4 - TREO vs FMR Relationship by Oxidation Type



(A.Noble, 2014)

For practical purposes, there is no difference in the low-grade %FMR-%TREO regressions by oxidation type, although a slight enrichment of TREO grade is possible for oxidized mineralization. The linear relationships between FMR and TREO grade below 30% FMR are believed to represent rocks in which stockwork mineralization is predominant and grade increases in a direct relationship to the volume of FMR/carbonatite. In addition, enrichment effects of oxidation are minor.

Above 30% FMR, veins become increasingly more important, and the %TREO: %FMR grade relationship in oxide and OxCa changes from a linear to an exponential relationship. In addition, TREO grades increase significantly as degree of oxidation increases from sulfides to oxides, owing to the enrichment of TREO grades as carbonate and sulfide are removed through oxidation and dissolution. The exponential relationship between %TREO and %FMR is not understood, but a reasonable hypothesis is that the oxide-enrichment process is more effective in wider veins.

14.6.4 TREO Grade vs Core Recovery

Core recovery is a significant issue for resource estimation, since low recovery implies preferential loss of the softer, more friable rare earth mineralization, especially in the oxide zone. This issue was examined by comparing the average TREO grades of samples with similar FMR content, but different core recoveries, as shown in Figures 14.5 to 14.8.

Figure 14.5 - TREO Grade for Oxide Samples Grouped by Core Recovery

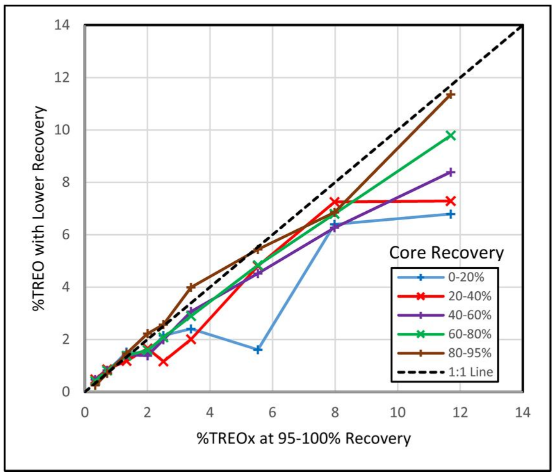


Figure 14.6 - TREO Grade for OxCa Samples Grouped by Core Recovery

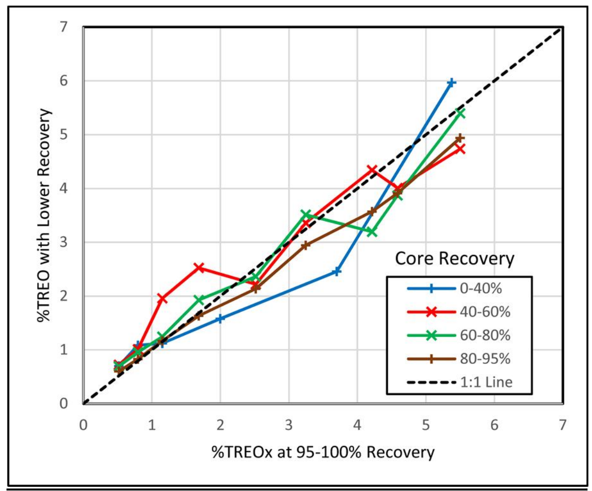


Figure 14.7 - Treo Grade for Low-Grade Oxide Samples Grouped by Core Recovery

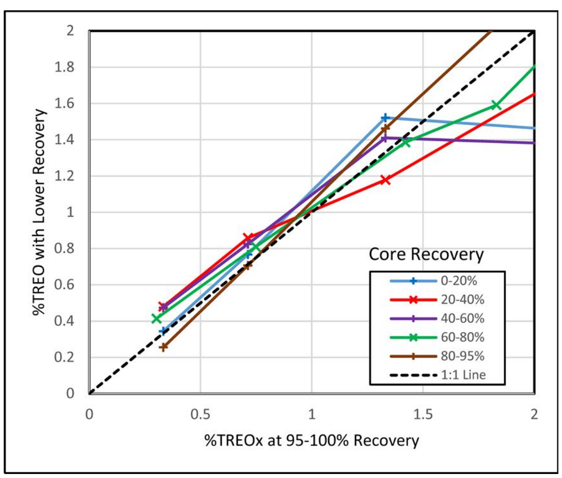
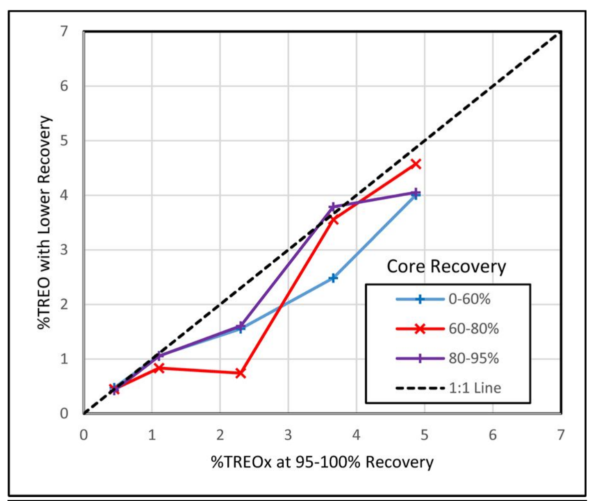


Figure 14.8 - TREO Grade for Tran+Sulf Samples Grouped by Core Recovery



(A.Noble, 2014)

Rather than a simple relationship where low core recovery equals low TREO, these figures indicate complex behavior, depending on oxidation type and grade. The hypothesis that low core recovery implies lower TREO grade appears to be correct for higher-grade oxide samples above 30% FMR; those samples with recovery below 95% average 12% lower TREO grade than samples with recovery above 95%.

The relationship between grade and low core recovery is poorly defined for lower-grade samples with less than 30% FMR, and low core recovery is associated with both higher and lower TREO grades than the high core-recovery samples. On an overall basis, however, low TREO-grade, poor core-recovery oxide samples average 9% higher grade than high recovery samples.

Samples from the OxCa zone show similar behavior to that of the oxide zone, although the individual curves are more erratic than those for oxide samples. On an overall basis, low-recovery, low-TREO OxCa samples average 17% higher grade than comparable high-recovery samples, and low-recovery, high-TREO OxCa samples average 9% lower TREO grade than comparable high-recovery samples.

Transition and Sulfide zone samples differ from the oxide and OxCa samples in that low-recovery, low-TREO samples average 7% lower grade than comparable high recovery samples, and low-recovery, high-TREO samples average 14% lower TREO grade.

14.6.5 Potential TREO Bias from Low Core Recovery

Considering the observations in Section 14.6.4, there appears to be a significant chance that TREO grade is biased low, especially for ore-grade mineralization. This bias was evaluated further by compiling footage-weighted average TREO grades for oxide and OxCa samples grouped by %FMR above and below 30%, and by core recovery above and below 95%. The 30% FMR cutoff was chosen because it corresponds roughly to the threshold between stockwork-dominant mineralization (below 1.5% TREO) and vein-dominant mineralization (above 1.5% TREO).

The results of this evaluation are shown in Figure 14.8 and suggest that low-core-recovery, low-%FMR samples are biased slightly high, and that high-%FMR samples are biased low, compared to high core recovery samples. When all samples are combined, however, the apparent bias is very small. The terminology apparent bias is used here, because it cannot be shown that the bias is an actual bias, rather than an artifact of some other parameter until large tonnages are mined and compared to the drill-hole grades. In addition, even if the bias is real, it may be larger or smaller than shown in Figure 14.8, if the estimate of %FMR is also biased.

Table 14.8 - Apparent TREO Grade Bias for Low- and High-Core-Recovery Samples

Grade Range	Oxidation Type	Low Recovery (0-95%)			High Recovery (>95%)			All Samples			Apparent Bias Relative to Low-Recovery Samples	Apparent Bias Relative to All Samples
		Footage	Meters	Average TREO	Footage	Meters	Average TREO	Footage	Meters	Average TREO		
<30% FMR	Oxide	64,399	19611	0.838	37,257	11356	0.770	101,656	30985	0.813	9%	3%
	OxCa	23,246	7085	0.817	13,455	4101	0.695	36,701	11186	0.772	18%	6%
	Ox+OxCa	87,646	26715	0.833	50,712	15457	0.750	138,358	42172	0.802	11%	4%
>30% FMR	Oxide	7,636	2327	3.953	3,440	1049	4.504	11,076	3376	4.124	-12%	-4%
	OxCa	5,662	1726	3.840	2,403	732	4.239	8,064	2458	3.959	-9%	-3%
	Ox+OxCa	13,297	4053	3.905	5,843	1781	4.395	19,140	5834	4.054	-11%	-4%
All Samples	Oxide	72,035	21956	1.169	40,698	12405	1.085	112,732	34361	1.138	8%	3%
	OxCa	28,908	8811	1.409	15,857	4833	1.232	44,766	13645	1.346	14%	5%
	Ox+OxCa	100,943	30767	1.237	56,555	17238	1.126	157,498	48005	1.197	10%	3%

(A.Noble, 2014)

14.7 Compositing

Given the highly variable orientation of drill holes with respect to the REE dikes, a method was developed to composite drill-hole samples into widths that approximate the horizontal true width of the veins. In addition, the composites were optimized to provide composite intervals that were above a specified cutoff grade and longer than a specified minimum width. There were two objectives for this procedure: first, the resulting composites should partition into low-grade and high-grade populations representing stockwork-dominant and dike-dominant mineralization, and second, the composites should have sufficient width to provide geometric dilution for a reasonable minimum mining width.

True width compositing was done using parameters specific to each estimation domain, as summarized in Table 14.9 and using the algorithm outlined in Table 14.10. Width and cutoff parameters were developed heuristically to provide subpopulations of low-grade and high-grade composites that were as close to lognormal populations as possible, subject to a minimum mining width of at least 20 feet.

Table 14.9 - Parameters for Optimized Grade-Zone Compositing

Domain	Minimum TRUE Width (Feet)	Minimum True Width (Meters)	Cutoff Grade (%TREOX)	Generalized Trend-Plane Dip Direction	
				Azimuth	Dip
East	20	6	1.5	48	90
Main 1	30	9	1.5	35	90
Main 2	20	6	1.4	48	90
Main 3	20	6	1.5	90	90
Northwest Bull	20	6	1.5	287	64
Southeast	20	6	1.5	68	90
West 1	30	9	1.2	33	90
West 2	30	9	1.2	40	90
Whitetail 1	20	6	1.5	84	90
Whitetail 2	20	6	1.5	45	90

(A.Noble, 2014)

Table 14.10 - Procedure for Optimized Grade-Zone Compositing

1.	The average orientation of the drill hole was compared to the generalized trend plane to compute the length of drill hole required to achieve the minimum true width perpendicular to the plane.
2.	The Studio 3 COMPSE process was used to compute composites with at least the minimum true width (from Step 1) that were also above the cutoff grade.
3.	An OREFLAG was set to one (1) to identify composite intervals above cutoff.
4.	The drill holes were composited again, using down-hole compositing that was set for a nominal 10-foot (3.05 meter), true-width composite within OREFLAG intervals of the same type. In this process, composites start and stop at OREFLAG boundaries, and the composite length is adjusted to include the entire interval defined by the OREFLAG zone, while maintaining a nominal 10-foot-wide, true-width composite length.

(A.Noble, 2014)

14.8 Grade-Zoned Composite Statistics

Basic statistics and grade distributions for TREO are shown in Table 14.11 and Figure 14.9, and indicate that the grade-zoning process partitions TREO into high-grade and low-grade populations.

The distribution of high-grade TREO is nearly lognormal, as shown by the nearly straight line in the lognormal cumulative frequency distribution. About 75% of the high-grade composites are above 1.5% TREO; an additional 25% of the composites are internal low-grade zones that are included to makeup the minimum mining width. Less than 3% of the low-grade OreZONE are above 1.5% TREO, and those composites represent patchy higher-grade stockwork mineralization.

The TREO OreZONE partitions also subdivide the distributions of FMR, iron oxide, manganese oxide, thorium, and uranium abundances into higher-grade and lower-grade populations, as shown in Figure 14.10, although the process is less efficient, and the ratio of grades in the high-grade OreZONE to the low-grade OreZONE is lower than for TREO. In addition, thorium shows a higher-grade population in the low-grade OreZONE that is attributable to higher thorium grades in the Whitetail deposit.

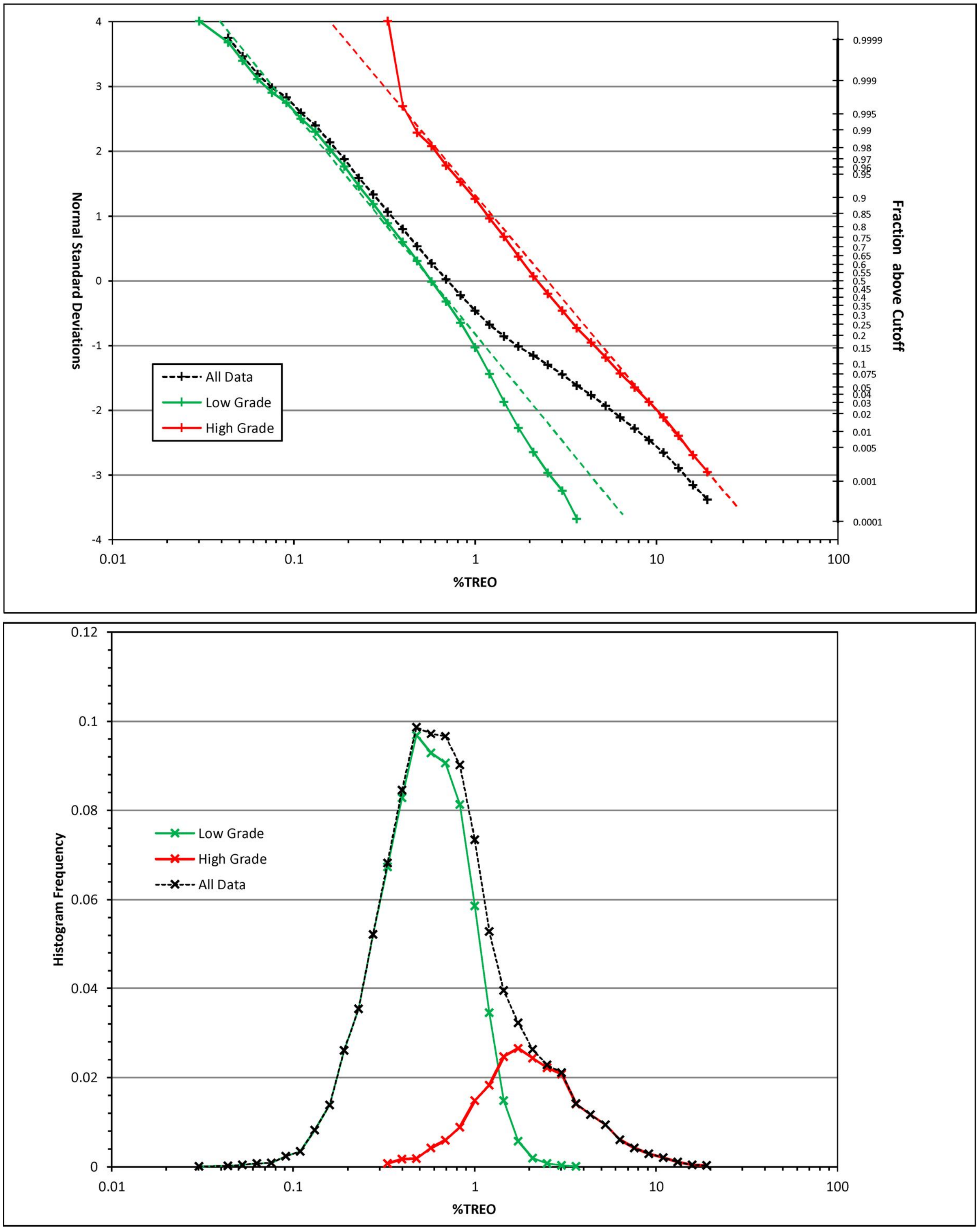
The TREO OreZONEs do not effectively partition CaO, however, as oxide type is the dominant factor in the CaO distribution. As shown in Figure 14.11, TREO OreZONE codes effectively partition the OxCa zone into low and high-grade CaO, but leaching of carbonates in the oxide zone reduces CaO grade to a level that is similar regardless of the TREO OreZONE code. A small number of high CaO assays in the oxide zone and low CaO assays in the OxCa zone are observed and should be checked in the next version of the model.

Table 14.11 - Basic Statistics for Grade-Zoned Composites

FIELD	OXIDE	Low-Grade OreZONE Number Samples	Low-Grade OreZONE Mean	Low-Grade OreZONE Coef of Variation	High-Grade OreZONE Number Samples	High-Grade OreZONE Mean	High-Grade OreZONE Coef of Variation	All Samples Number Samples	All Samples Mean	All Samples Coef of Variation	Ratio HG:LG
%TREO	Ox	5,527	0.646	0.549	1,492	2.988	0.906	7,019	1.143	1.403	4.63
	OxCa	2,236	0.679	0.551	893	2.837	0.668	3,129	1.295	1.112	4.18
	Tran	221	0.521	0.680	46	2.975	0.582	267	0.944	1.289	5.71
	Sulf	566	0.556	0.663	86	2.284	0.597	652	0.784	1.071	4.11
%FMR	Ox	5,497	9.144	1.066	1,481	27.842	0.820	7,596	13.653	1.205	3.04
	OxCa	2,233	11.347	0.942	893	45.299	0.703	3,309	21.679	1.158	3.99
	Tran	221	7.101	0.937	46	51.889	0.745	268	15.135	1.625	7.31
	Sulf	561	7.801	1.113	86	44.252	0.671	647	12.646	1.449	5.67
%CaO	Ox	3,939	0.645	1.759	1,049	1.171	2.452	4,988	0.756	2.213	1.81
	OxCa	1,949	4.809	0.755	659	13.998	0.685	2,608	7.131	0.982	2.91
	Tran	94	4.188	0.653	20	15.316	0.646	114	6.141	1.046	3.66
	Sulf	290	6.921	0.381	42	17.425	0.515	332	8.250	0.646	2.52
%Fe_2O_3	Ox	3,939	8.127	0.287	1,049	12.476	0.432	4,988	9.042	0.407	1.54
	OxCa	1,949	7.700	0.222	659	10.619	0.372	2,608	8.438	0.330	1.38
	Tran	94	6.733	0.204	20	9.060	0.145	114	7.141	0.228	1.35
	Sulf	290	7.036	0.244	42	8.844	0.288	332	7.265	0.267	1.26
%MnO	Ox	3,939	1.174	1.116	1,049	2.849	1.377	4,988	1.526	1.473	2.43
	OxCa	1,949	0.834	0.537	659	2.092	0.905	2,608	1.152	1.010	2.51
	Tran	94	0.731	0.761	20	2.086	0.549	114	0.969	0.894	2.86
	Sulf	290	0.805	0.453	42	1.835	0.369	332	0.935	0.577	2.28
ppm Th	Ox	5,527	154.076	0.944	1,492	399.282	1.228	7,019	206.199	1.353	2.59
	OxCa	2,236	244.003	0.745	893	390.651	1.007	3,129	285.855	0.940	1.60
	Tran	219	90.959	0.718	46	328.663	0.755	265	132.220	1.130	3.61
	Sulf	565	76.904	0.771	85	189.975	1.007	650	91.690	1.051	2.47
ppm U	Ox	5,527	34.180	0.736	1,492	92.241	0.674	7,019	46.522	0.933	2.70
	OxCa	2,236	34.398	0.613	893	88.081	0.578	3,129	49.719	0.816	2.56
	Tran	219	40.191	0.830	46	125.318	0.796	265	54.968	1.105	3.12
	Sulf	565	63.508	1.163	85	143.891	0.799	650	74.019	1.147	2.27

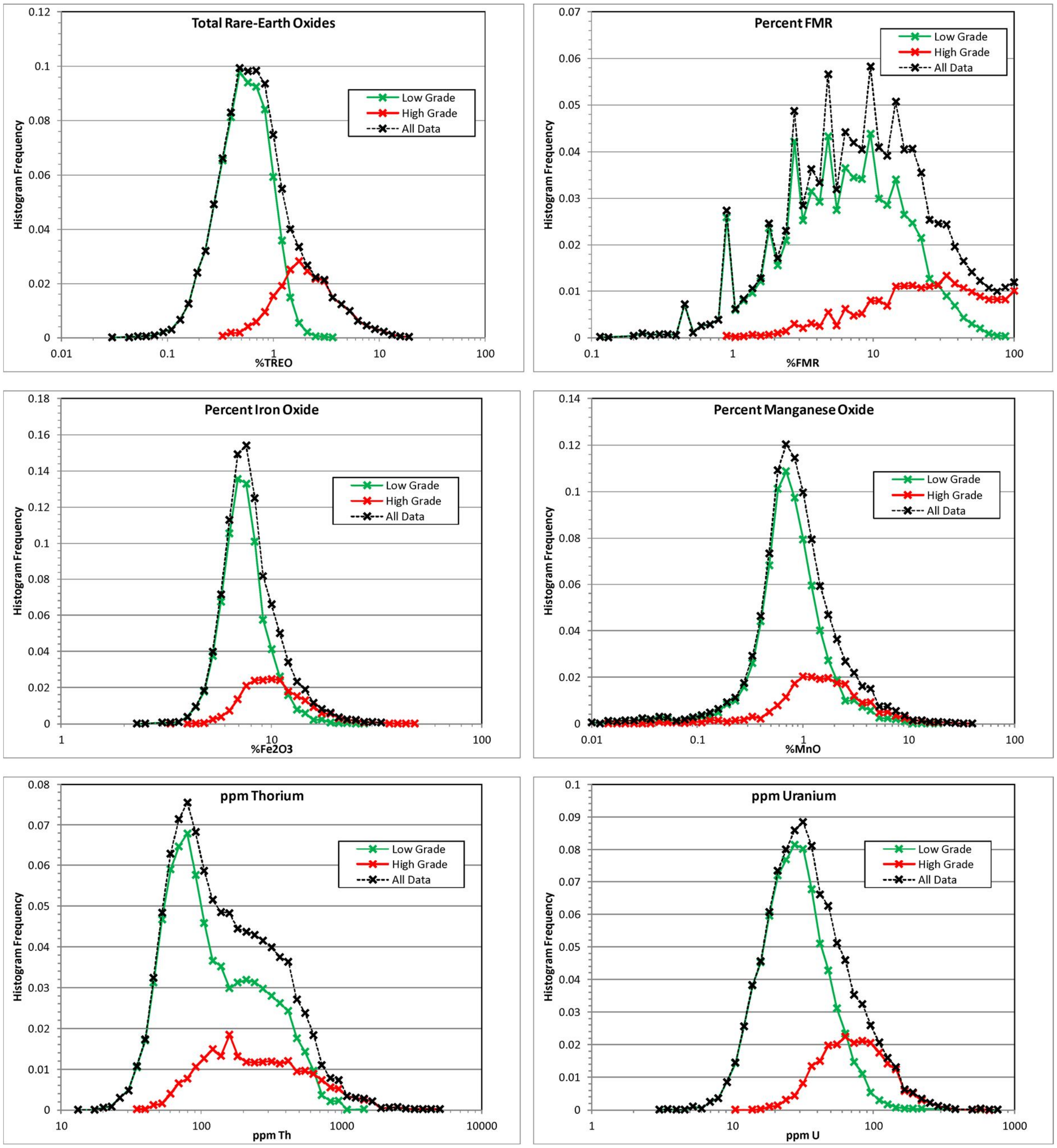
(A.Noble, 2014)

Figure 14.9 - Lognormal grade cumulative frequency distributions and histograms for TREO by OreZONE – Oxides and OxCa Composites



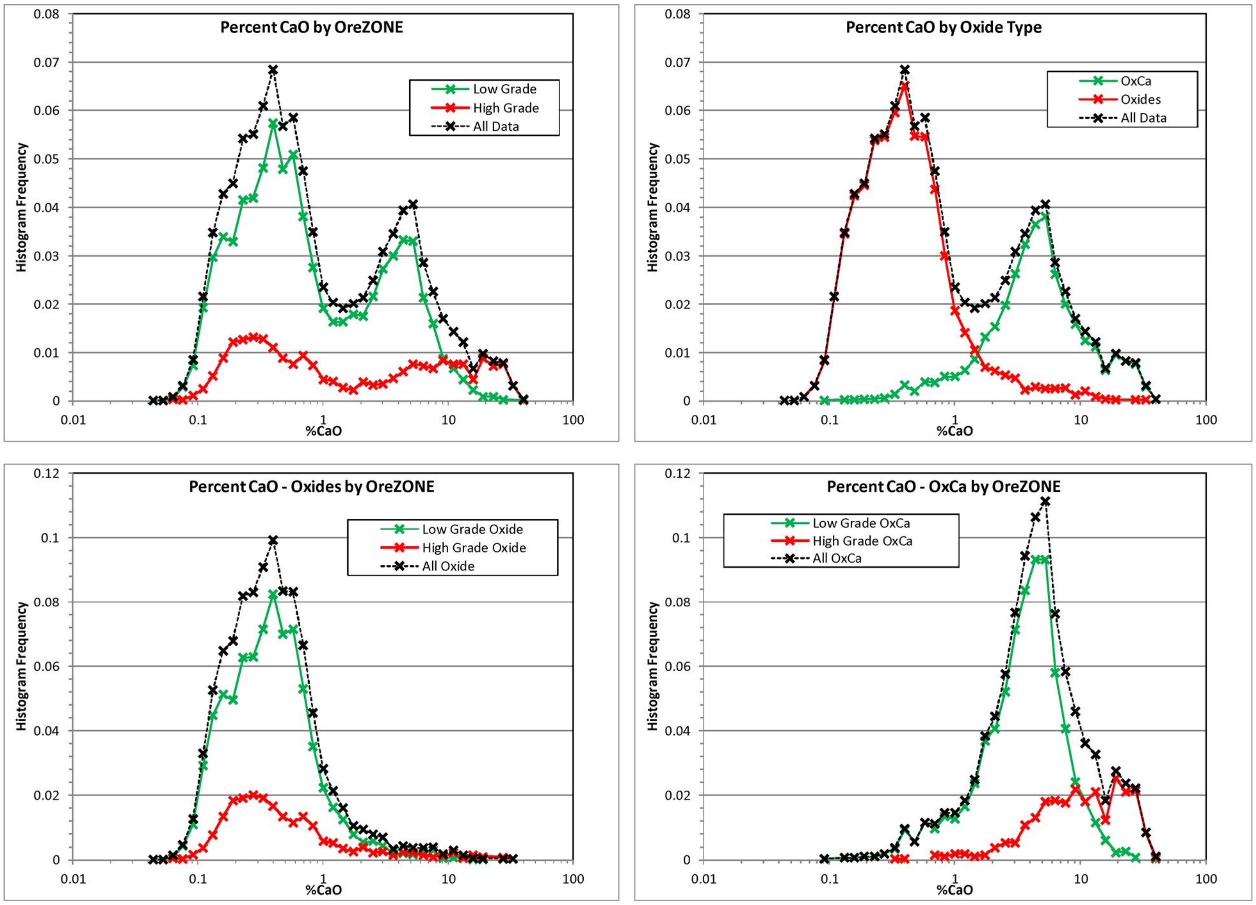
(A.Noble, 2014)

Figure 14.10 - Log-transformed Histograms for TREO, FMR, Iron Oxide, Manganese Oxide, Thorium and Uranium



(A.Noble, 2014)

Figure 14.11 - Log-transformed Histograms for Calcium Oxide by OreZONE and Oxide Type



(A.Noble, 2014)

14.8.1 TREO Grade Adjustments for Oxidation Zones

Statistical analysis shows that high-grade, oxide composites tend to be higher grade than composites from the high-grade zones of the other oxidation types. Thus, using oxide composites to estimate grades in the OxCa, transition, or sulfide zones would tend to overestimate grades in those lower-grade zones. Conversely, using OxCa, transition, or sulfide composites to estimate grades in the oxide zone would tend to underestimate grades in the oxide zone. Despite these issues, it is advisable to use as much of the data for estimation as possible to provide continuity of data for estimation. Accordingly, a conservative composite selection and discounting strategy was developed to minimize the risk of overestimation of REE grades while using as many samples as possible. The composite selection strategy is as follows:

1. Only composites from the low-grade zone were used to estimate low-grade blocks, and only composites from the high-grade zone were used to estimate high-grade blocks.
2. The adjustment factors summarized in Table 14.12 were used to adjust composite grades before block grade estimation. Where the adjustment factor for a block-composite oxide type is shown with an "x" in the table, that oxide-type pairing was not used for estimation.

Table 14.12 - Adjustment Factors for Grade Estimation – Block Zone And Composite Zone Combinations

Block Oxide	Composite Oxide	Low-Grade				High-Grade			
		REO	Fe_2O_3	MnO	CaO	REO	Fe_2O_3	MnO	CaO
Ox	Ox	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	OxCa	1.00	1.00	1.00	x	1.00	1.00	x	x
	Tran	x	x	x	x	x	x	x	x
	Sulf	x	x	x	x	x	x	x	x
OxCa	Ox	1.00	0.96	0.82	x	0.91	0.88	x	x
	OxCa	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Tran	x	x	x	x	x	x	x	x
	Sulf	x	x	x	x	x	x	x	x
Tran	Ox	0.94	0.95	0.76	x	x	x	x	x
	OxCa	1.00	1.00	0.84	1.00	0.81	0.78	0.66	1.00
	Tran	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Sulf	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Sulf	Ox	0.94	0.93	x	x	x	x	x	x
	OxCa	1.00	0.91	0.90	x	x	x	x	x
	Tran	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Sulf	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

(A.Noble, 2014)

14.9 Missing Grades for Fe_2O_3, MnO, and CaO

Whole rock assays were not done for early drill holes from 2009 and 2010, thus there are missing assays for Fe_2O_3, MnO, and CaO. Since those holes are critical to estimation of the Bull Hill Main Zones, the missing assays were estimated based on deposit, oxide type, and SumREOx (TREO) grade, as shown in Table 14.13. Because Fe_2O_3, MnO, and CaO are critical elements for acid consumption in the process, it is recommended that the pulps be retrieved for the intervals with missing assays and assayed for the full suite of elements used for later drilling.

Table 14.13 - Formulae for Estimation of Missing Fe_2O_3, MnO, and CaO Grades

Deposit	Oxidation	Formula
Whitetail	Oxide	Fe2O3pct = 9.226*SumREOx^0.2200 MnO_pct = 1.386*SumREOx^0.4844 CaO_pct = 0.487-0.013*SumREOx
	OxCa	Fe2O3pct = 8.510*SumREOx^0.1535 MnO_pct = 0.914*SumREOx^0.397 CaO_pct = 3.306+4.854*SumREOx
	Tran,Sulf	Fe2O3pct = 8.510*SumREOx^0.1535 MnO_pct = 0.914*SumREOx^0.397 CaO_pct = 3.306+4.854*SumREOx
Bull Hill	Oxide	Fe2O3pct = 9.884*SumREOx^0.3199 MnO_pct = 1.697*SumREOx^0.6985 CaO_pct = 0.498 + 0.031*SumREOx
	OxCa	Fe2O3pct = 8.335*SumREOx^0.3279 MnO_pct = 1.282*SumREOx^0.7024 CaO_pct = 0.820+4.712*SumREOx
	Tran,Sulf	Fe2O3pct = 7.879*SumREOx^0.1540 MnO_pct = 1.229*SumREOx^0.5982 CaO_pct = 2.181 + 6.844*SumREOx

(A.Noble, 2014)

14.10 Variograms

Sage variography software was used to compute variograms for evaluation of the spatial continuity of composited TREO grade, %FMR, %Fe_2O_3, %MnO, %CaO, and the OreZONE flag.

Variograms were computed using the trend-flattened coordinate space, thus the XY plane in variogram space is equivalent to a flattened longitudinal section that is subparallel to the ore zoning, and the Z-variogram axis is perpendicular to the ore zoning. In addition, the data from the individual zones were rotated before computation based on the generalized rotation of best continuity for each zone, as summarized in Table 14.14.

Using the trend-flattened coordinate space improves evaluation of continuity by allowing the variograms to follow the irregular shape of the vein trends. The ability to follow the zoning is particularly important for these deposits, since the anisotropy perpendicular to the trend can be more than 20:1, and a slight misalignment perpendicular to the trend introduces a large variability to the variogram. Z-axis coordinates were multiplied by a factor of 10 for variogram calculation to minimize the contribution of the Z component to variograms in the XY space. The distances for the Z-axis variograms were divided by 10 for fitting of variogram models, restoring them to the original scaling.

TREO and other grade variograms were computed using log-transformed correlograms within the high-grade and low-grade OreZONEs independently. Only data from the oxide and OxCa zones were used for variogram calculation. Variograms for %CaO were subdivided into oxide and OxCa as well as OreZONE. Variograms for the OreZONE indicator variable were computed using correlograms without any transformation of the zero/one (0,1) indicator. Only those composites from the oxide and OxCa zone were used for experimental variogram calculation. The resulting variograms are summarized in Table 14.15.

Variogram models were fitted to the experimental variograms using Sage and up to two nested, exponential variograms. The traditional convention for the exponential variogram range was used, which is approximately one-third of the practical range. Experimental variograms and models are shown for directions closest to the principal variogram axes in Figure 14.12 through Figure 14.16.

F-function values for 20x20x20-foot blocks were computed for each variogram for later use in validating the grade estimation. The F-function value is equal to the variance of samples within a block of a particular size and shape. Smoothing factors, which are the variance reduction factors that would be expected when moving from the distribution of samples to the distribution of blocks are listed in Table 14.15.

Table 14.14 - Rotations by Domain for Computation of Global Variograms

Domain	OreZONE	Rotation Around Z' Axis
Main1	LG	45
Main1	HG	30
M2,M3,East	LG	0
M2,M3,East	HG	45
NW,SE	LG	0
NW,SE	HG	0
West	LG	-90/0
West	HG	-90, -30 MnO
Whitetail	LG	-90, 60 MnO
Whitetail	HG	-55

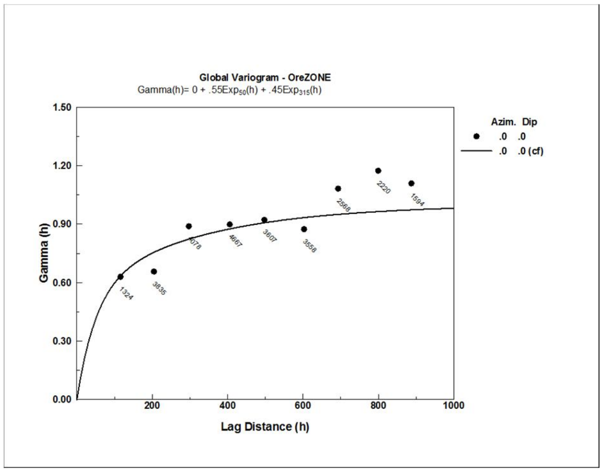
(A.Noble, 2014)

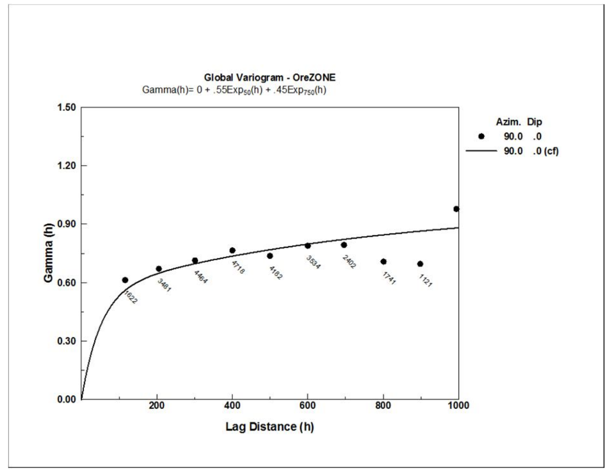
Table 14.15 - Summary of Global Variogram Models

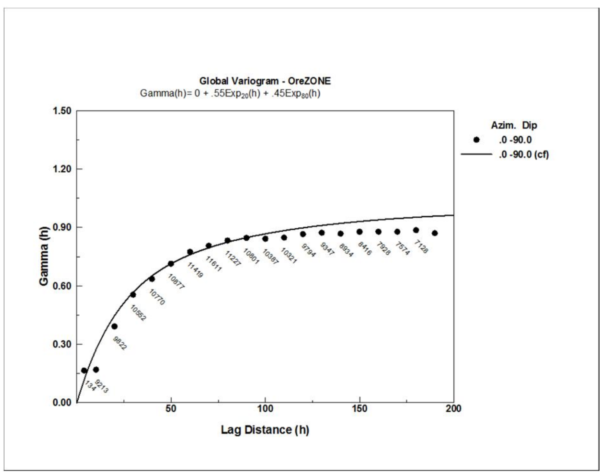
Variable	OreZONE	Exponential Variogram Parameters										20ft^3 Smoothing Factor
		Rotation	Nugget	Structure 1				Structure 2				
				Sill	Range X'	Range Y'	Range Z'	Sill	Range X'	Range Y'	Range Z'	
OreZONE	All	0	0.00	0.55	50	50	20	0.45	750	315	80	0.78
TREO	LG	0	0.20	0.58	50	50	20	0.22	630	155	330	0.60
	HG	0	0.20	0.46	60	60	5	0.34	550	550	27	0.44
MnO	LG	0	0.15	0.60	40	40	30	0.25	760	670	80	0.65
	HG	0	0.15	0.40	75	75	50	0.40	315	280	50	0.73
%FMR	LG	0	0.15	0.36	30	30	20	0.49	500	250	95	0.67
	HG	-60	0.20	0.50	30	30	11	0.30	880	410	60	0.52
%Fe2O3	LG	0	0.10	0.40	100	40	13	0.50	180	160	60	0.68
	HG	-60	0.10	0.70	90	70	8	0.20	110	355	105	0.53
%CaO - Oxide	LG	0	0.10	0.90	145	145	60	0.00	0	0	0	0.78
	HG	0	0.10	0.85	120	120	55	0.00	0	0	0	0.78
%CaO – OxCa	LG	0	0.20	0.50	50	50	23	0.30	150	150	63	0.59
	HG	0	0.20	0.80	230	230	23	0.00	0	0	0	0.61

(A.Noble, 2014)

Figure 14.12 - Experimental Variograms and Models for the OreZONE Indicator Flag





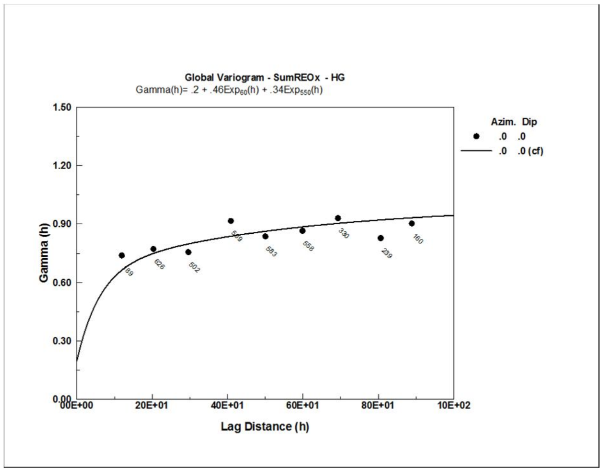


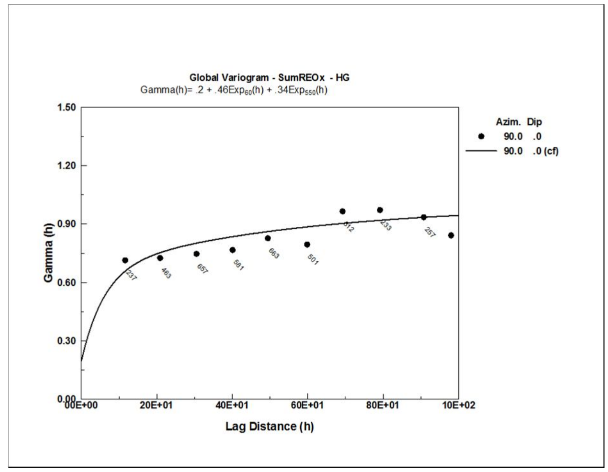
Variograms are computed using Sage2001 variogram software in the trend-flattened coordinate space. Plan view is equivalent to a longitudinal section oriented parallel to the trend of mineralized zones. "Vertical" variograms are oriented perpendicular to the trend.

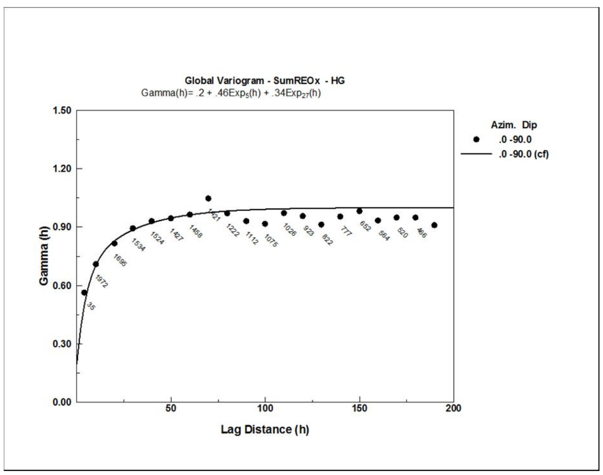
(A.Noble, 2014)

The OreZONE variograms in Figure 14.12 measure the continuity of the OreZONEflag, which is a zero/one (0,1) indicator variable that is used to define Low-Grade (0) and High-Grade (1) zones for the resource block model. Variograms are well defined, indicating continuity of 2250 feet in the primary axis (X'), 945 feet in the secondary axis (Y'), and only 240 feet in the tertiary axis (Z'-perpendicular to the trend). It should be noted that the actual direction of the primary axis varies according to the rotations in Table 14.14, thus the primary axis in the Zone M1 High-Grade OreZONE rakes 30° down to the southwest along the unfolded trend plane, but is vertical in the West and Whitetail Domains.

Figure 14.13 - Experimental Variograms and Models for TREO in the High-Grade Zone





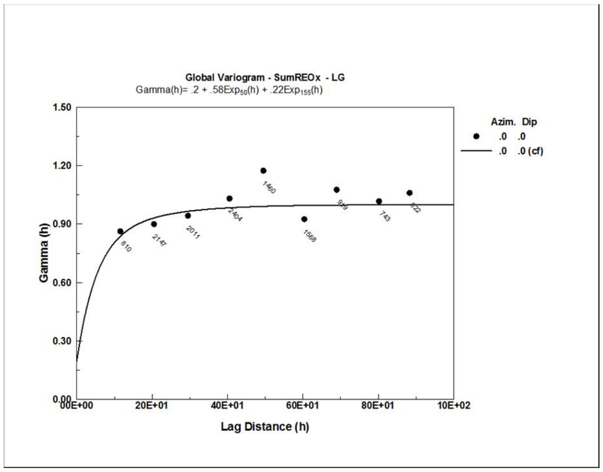


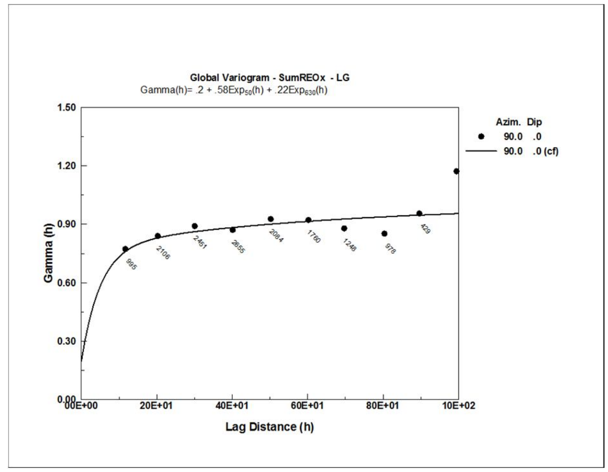
Variograms are computed using Sage2001 variogram software in the trend-flattened coordinate space. Plan view is equivalent to a longitudinal section oriented parallel to the trend of mineralized zones. "Vertical" variograms are oriented perpendicular to the trend.

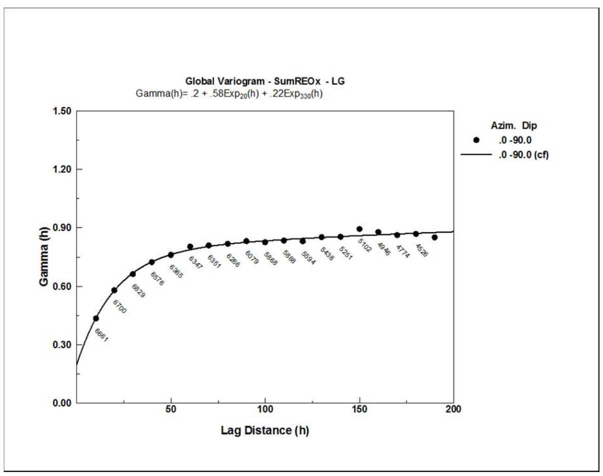
(A.Noble, 2014)

Variograms for TREO in the high-grade zone are nearly isotropic parallel to the trend of mineralization with a range of 1650 feet in a long-range structure and a shorter-range structure with a range of 150 feet, which accounts for 46% of total variability. There is a strong anisotropy with a much shorter range of about 80 feet perpendicular to the trend of mineralization.

Figure 14.14 - Experimental Variograms and Models for TREO in the Combined Low-Grade Zone





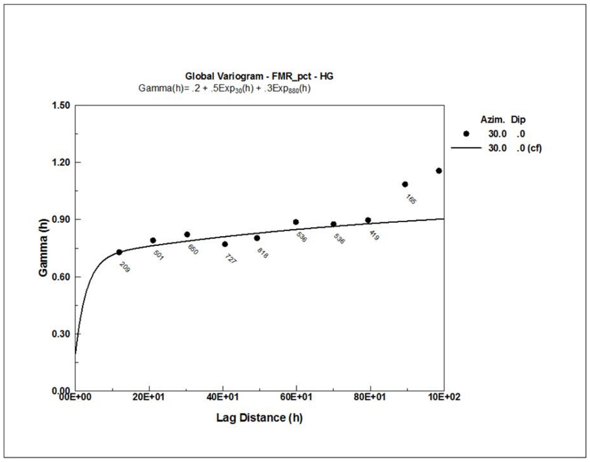


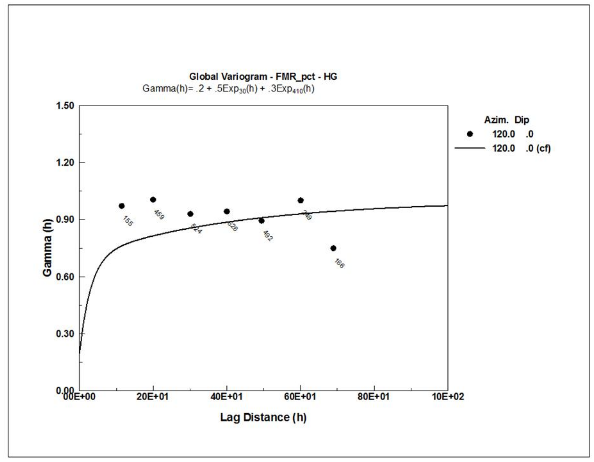
Variograms are computed using Sage2001 variogram software in the trend-flattened coordinate space. Plan view is equivalent to a longitudinal section oriented parallel to the trend of mineralized zones. "Vertical" variograms are oriented perpendicular to the trend.

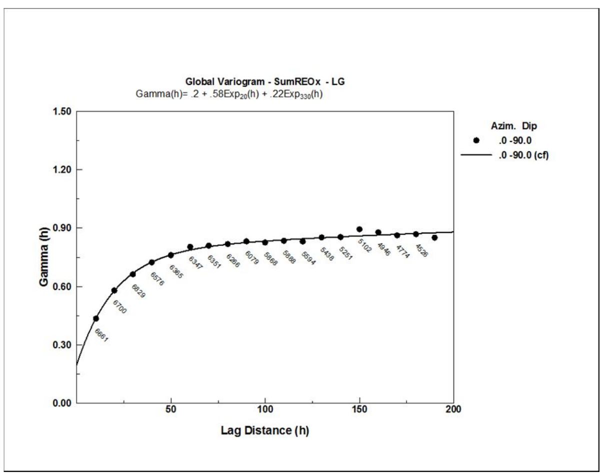
(A.Noble, 2014)

Variograms for TREO in the low-grade zone have much less continuity than those in the high-grade zone, and the variograms are poorly defined along the trend plane. The lesser continuity in the low-grade TREO variograms is attributable to less continuity in stockwork mineralization compared to vein mineralization. The variogram normal to the trend is well defined, with a short-distance range of about 60 feet and a long-distance range of nearly 1000 feet.

Figure 14.15 - Experimental Variograms and Models for FMR in the High-Grade Zone





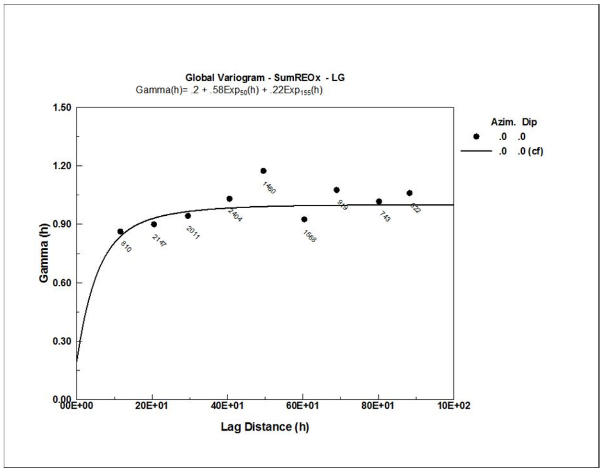


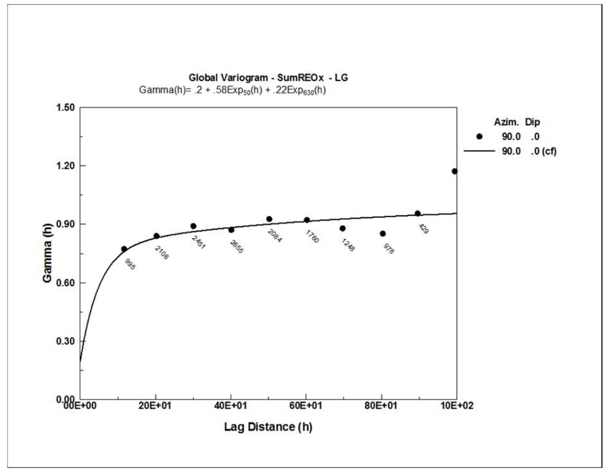
Variograms are computed using Sage2001 variogram software in the trend-flattened coordinate space. Plan view is equivalent to a longitudinal section oriented parallel to the trend of mineralized zones. "Vertical" variograms are oriented perpendicular to the trend.

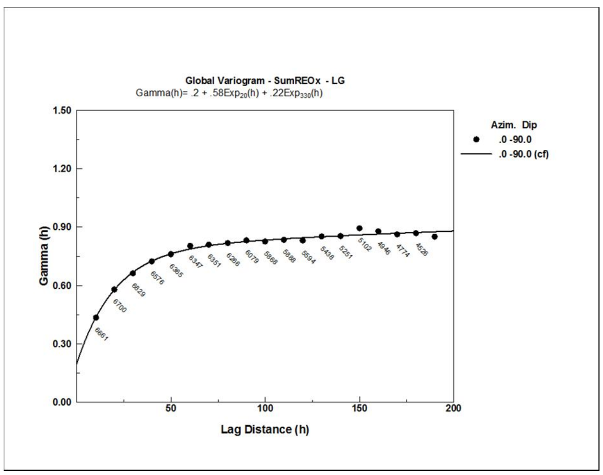
(A.Noble, 2014)

Variograms for FMR in the high-grade OreZONE are unusual compared to the variograms for OreZONE and TREO. First, the principal axis for the FMR is rotated 60 degrees, so that it is almost perpendicular to that for OreZONE and TREO. Second, the continuity of the experimental variogram in the secondary direction is very poor. It is noted that the poor continuity is limited to experimental variograms at azimuths of 120° and 150°, and that the experimental variograms are otherwise nearly isotropic and are well-fitted by the model variograms. Additional study is needed to explain the poor continuity on the secondary axis.

Figure 14.16 - Experimental Variograms and Models for FMR in the Low-Grade Zone







Variograms are computed using Sage2001 variogram software in the trend-flattened coordinate space. Plan view is equivalent to a longitudinal section oriented parallel to the trend of mineralized zones. "Vertical" variograms are oriented perpendicular to the trend.

(A.Noble, 2014)

Variograms for FMR in the low-grade OreZONE are generally similar to those for TREO, but with slightly less continuity.

14.11 OreZONE Block Model

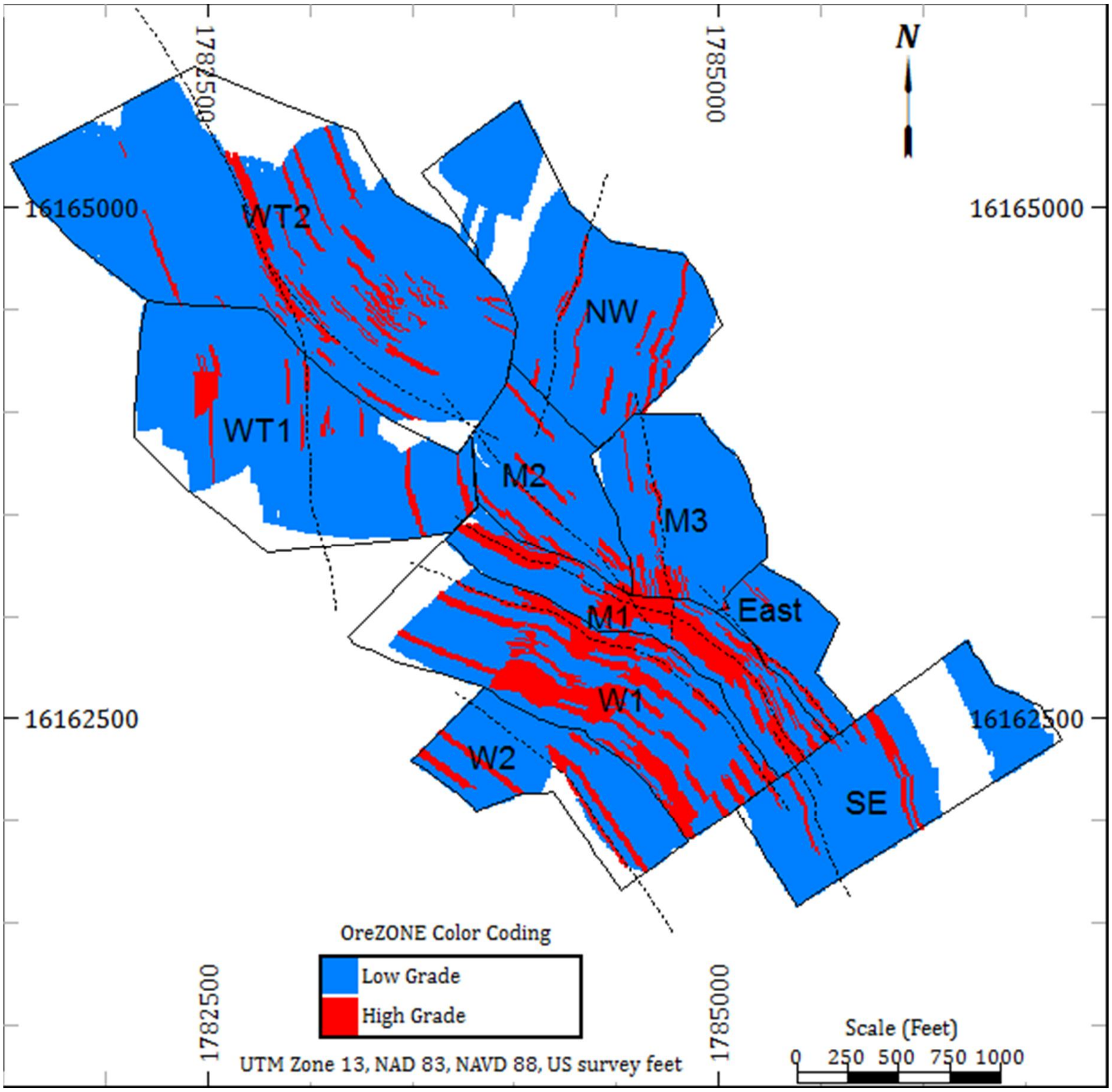
The OreZONE block model was created using nearest-neighbor assignment (NN) to assign the OreZONE from composites to blocks without regard to oxidation type. The OreZONE search ellipses were developed based on variogram ranges for the OreZONE flag parameter. Parameters for the NN assignment are summarized in Table 14.16. A typical plan map through the OreZONE block model is shown in Figure 14.17.

Table 14.16 - Parameters for NN Assignment of OreZONE

		Search Ellipse Radius		
Domain	Rotation	X	Y	Z
East	75	490	430	15
Main 1	30	570	315	15
Main 2	75	490	430	15
Main 3	75	490	430	15
Northwest Bull	-60	615	215	15
Southeast	0	460	460	15
West 1	-73	535	375	15
West 2	-73	535	375	15
Whitetail 1	-80	535	370	15
Whitetail 2	-80	535	370	15
Note – Rotations and search ellipse radii are relative to the trend-flattened coordinate system.				

(A.Noble, 2014)

Figure 14.17 - Typical Plan Map Showing the OreZONE Block Model at Elevation 5700



(A.Noble, 2014)

14.12 Grade Estimation

Estimation of rare-earth-element grades, %FMR, %Fe_2O_3, %MnO, %CaO, ppm U, and ppm Th was done using inverse-distance-power (IDP) interpolation with NN estimation to provide a comparison check for the IDP estimates and to evaluate the degree of smoothing of the estimates. Estimation was done in the trend-flattened coordinate space using estimation parameters specific to each combination of element, OreZONE, and estimation domain.

Search-ellipse parameters for all data are summarized in Table 14.17, and estimation parameters are summarized in Table 14.18 through Table 14.21. Generic search ellipses are used for all zones except M1, for which specific search ellipse parameters are defined. Search ellipses use the CAE Studio 3 search ellipse expansion option, which increases the search radius until the desired minimum number of samples are selected. A maximum of one composite was used for estimation from any given drill hole.

Grade estimation parameters are optimized for each element/zone/OreZONE combination and, in particular, the power is optimized to provide the desired smoothing factor for the block variance.

Table 14.17 - Search Parameters for IDP Estimation of Grades

Parameter		Domain/OreZONE			
		Ave LG	Ave HG	M1 LG	M1 HG
Rotation around Z-axis (degrees)		0	45	30	15
Search Radius	X'	420	390	410	330
	Y'	220	240	220	280
	Z'	30	15	20	15
Number Composites - Search Volume 1	Min	6	6	6	6
	Max	9	9	9	9
Search Pass 2 Expansion Factor		1.5	1.5	1.5	1.5
Number Composites - Search Pass 2	Min	6	6	6	6
	Max	9	9	9	9
Search Pass 3 Expansion Factor		3	3	3	3
Number Composites - Search Pass 3	Min	1	1	1	1
	Max	9	9	9	9

(A.Noble, 2014)

Table 14.18 - Parameters for IDP Estimation of Grades in the Oxide Zone

Zone	Domain		EAST	M1	M2	M3	NE	SE	W1	W2	WT1	WT2
Low-Grade OreZONE	Rotation		0	45	0	0	-60	0	-90	-90	-90	-90
	Anisotropy Factors REE	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73
		Z'	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
	Power	REE	3.8	3.2	3.2	3.7	3.2	3.2	2.8	2.8	2.9	3
	Note – REE parameters were used for all rare earth elements, plus thorium and uranium											
	Anisotropy Factors Fe_2O_3	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
		Z'	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	Power	Fe_2O_3	4	3.7	3.7	4	3.7	3.7	3.3	3.3	3	3.9
	Anisotropy Factors MnO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
		Z'	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
	Power	MnO	4	4	4	4	4	4	4	4	3.5	4
	Anisotropy Factors CaO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
	Power	CaO	4	4	4	4	4	4	4	4	4	4
High-Grade OreZONE	Rotation		45	30	45	45	-60	0	-90	-90	-55	-55
	Anisotropy Factors REE	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
	Power	REE	2.1	2	2	2	2	2	2	2	1.5	1.9
	Note – REE parameters were used for all rare earth elements, plus thorium and uranium											
	Anisotropy Factors Fe_2O_3	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
	Power	Fe_2O_3	2.1	2.3	2.3	2.1	2.1	2.1	2.2	2.2	2	2.4
	Anisotropy Factors MnO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
		Z'	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
	Power	MnO	2.8	3.2	3.2	3.6	3.2	3.2	3.3	3.3	2	2.9
	Anisotropy Factors CaO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
	Power	CaO	4	4	4	4	4	4	4	4	4	4

(A.Noble, 2014)

Table 14.19 - Parameters for IDP Estimation of Grades in the OxCa Zone

Domain			EAST	M1	M2	M3	NE	SE	W1	W2	WT1	WT2
Low-Grade OreZONE	Rotation		0	45	0	0	-60	0	-90	-90	-90	-90
	Anisotropy Factors REE	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73
		Z'	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
	Power	REE	3.8	3.2	3.2	3.7	3.2	3.2	2.8	2.8	2.9	3
	Note – REE parameters were used for all rare earth elements, plus thorium and uranium											
	Anisotropy Factors Fe_2O_3	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
		Z'	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	Power	Fe_2O_3	4	3.7	3.7	4	3.7	3.7	3.3	3.3	3	3.9
	Anisotropy Factors MnO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
		Z'	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
	Power	MnO	4	4	4	4	4	4	4	4	3.5	4
	Anisotropy Factors CaO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.46	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
	Power	CaO	4	2.9	2.9	3.6	2.9	2.9	2.5	2.5	3.5	3.2
High-Grade OreZONE	Rotation		45	30	45	45	-60	0	-90	-90	-55	-55
	Anisotropy Factors REE	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
	Power	REE	2.1	2	2	2	2	2	2	2	1.5	1.9
	Note – REE parameters were used for all rare earth elements, plus thorium and uranium											
	Anisotropy Factors Fe_2O_3	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
	Power	Fe_2O_3	2.1	2.3	2.3	2.1	2.1	2.1	2.2	2.2	2	2.4
	Anisotropy Factors MnO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
		Z'	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
	Power	MnO	2.8	3.2	3.2	3.6	3.2	3.2	3.3	3.3	2	2.9
	Anisotropy Factors CaO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Power	CaO	2.6	3	3	2.8	3	3	2.5	2.5	3.5	2.7

(A.Noble, 2014)

Table 14.20 - Parameters for IDP Estimation of Grades in the Transition Zone

Zone	Domain		EAST	M1	M2	M3	NE	SE	W1	W2	WT1	WT2
Low-Grade OreZONE	Rotation		0	45	0	0	-60	0	-90	-90	-90	-90
	Anisotropy Factors REE	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73
		Z'	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
	Power	REE	3.8	3.2	3.2	3.7	3.2	3.2	2.8	2.8	2.9	3
	Note – REE parameters were used for all rare earth elements, plus thorium and uranium											
	Anisotropy Factors Fe_2O_3	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
		Z'	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	Power	Fe_2O_3	4	3.7	3.7	4	3.7	3.7	3.3	3.3	3	3.9
	Anisotropy Factors MnO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
		Z'	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
	Power	MnO	4	4	4	4	4	4	4	4	3.5	4
	Anisotropy Factors CaO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.46	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
	Power	CaO	4	2.9	2.9	3.6	2.9	2.9	2.5	2.5	3.5	3.2
High-Grade OreZONE	Rotation		45	30	45	45	-60	0	-90	-90	-55	-55
	Anisotropy Factors REE	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
	Power	REE	2.1	2	2	2	2	2	2	2	1.5	1.9
	Note – REE parameters were used for all rare earth elements, plus thorium and uranium											
	Anisotropy Factors Fe_2O_3	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
	Power	Fe_2O_3	2.1	2.3	2.3	2.1	2.1	2.1	2.2	2.2	2	2.4
	Anisotropy Factors MnO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
		Z'	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
	Power	MnO	2.8	3.2	3.2	3.6	3.2	3.2	3.3	3.3	2	2.9
	Anisotropy Factors CaO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Power	CaO	2.6	3	3	2.8	3	3	2.5	2.5	3.5	2.7

(A.Noble, 2014)

Table 14.21 - Parameters for IDP Estimation of Grades in the Sulfide Zone

Domain			EAST	M1	M2	M3	NE	SE	W1	W2	WT1	WT2
Low-Grade OreZONE	Rotation		0	45	0	0	-60	0	-90	-90	-90	-90
	Anisotropy Factors REE	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73
		Z'	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
	Power	REE	3.8	3.2	3.2	3.7	3.2	3.2	2.8	2.8	2.9	3
	Note – REE parameters were used for all rare earth elements, plus thorium and uranium											
	Anisotropy Factors Fe_2O_3	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
		Z'	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	Power	Fe_2O_3	4	3.7	3.7	4	3.7	3.7	3.3	3.3	3	3.9
	Anisotropy Factors MnO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
		Z'	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
	Power	MnO	4	4	4	4	4	4	4	4	3.5	4
	Anisotropy Factors CaO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.46	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
	Power	CaO	4	2.9	2.9	3.6	2.9	2.9	2.5	2.5	3.5	3.2
High-Grade OreZONE	Rotation		45	30	45	45	-60	0	-90	-90	-55	-55
	Anisotropy Factors REE	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
	Power	REE	2.1	2	2	2	2	2	2	2	1.5	1.9
	Note – REE parameters were used for all rare earth elements, plus thorium and uranium											
	Anisotropy Factors Fe_2O_3	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
	Power	Fe_2O_3	2.1	2.3	2.3	2.1	2.1	2.1	2.2	2.2	2	2.4
	Anisotropy Factors MnO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
		Z'	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
	Power	MnO	2.8	3.2	3.2	3.6	3.2	3.2	3.3	3.3	2	2.9
	Anisotropy Factors CaO	X'	1	1	1	1	1	1	1	1	1	1
		Y'	1	1	1	1	1	1	1	1	1	1
		Z'	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Power	CaO	2.6	3	3	2.8	3	3	2.5	2.5	3.5	2.7

(A.Noble, 2014)

14.13 Block Model Verification – IDP vs NN

The IDP Model was verified in comparison with the NN model to ensure that estimates were unbiased on an overall basis, and to verify that the variance of the block estimates was similar to that predicted from the variogram F-Functions.

The comparison for TREO, tabulated in Table 14.22, was done using only those blocks classified as measured and indicated blocks, since the inferred blocks don't have sufficient reliability for this comparison. The results of NN vs IDP comparisons show that the difference between the average IDP and NN grades is generally better than 3.5% for individual zones, and is better than 1.5% for the average of any oxide zone/OreZONE combination. The variance reduction from NN block estimates is also generally in the expected range.

IDP vs NN comparisons for Fe_2O_3, MnO, and CaO are tabulated in Table 14.23 and show that those estimates are also unbiased, and that volume-variance effects are accounted for within reasonable limits.

Table 14.22 - Comparison of IDP vs. NN Estimates for Total REO

Oxide Type	OreZONE	Domain	IDP Estimates			NN Estimates		Ratio IDP:NN		Target Smoothing Ratio
			#Blocks	Average Grade	Relative Variance	Average Grade	Relative Variance	Average Grade	Rel. Var. (Smoothing Ratio)	
Oxide Zone	Low-Grade OreZONE	EAST	23987	0.59	0.22	0.59	0.35	1.007	0.62	0.62
		M1	103966	0.77	0.16	0.78	0.25	0.992	0.62	
		M3	77752	0.69	0.13	0.70	0.21	0.993	0.62	
		WT1	7478	0.79	0.08	0.79	0.13	0.995	0.64	
		WT2	81485	0.75	0.14	0.76	0.22	0.999	0.63	
		W1	90590	0.70	0.15	0.69	0.23	1.003	0.64	
		All	385258	0.72	0.15	0.73	0.24	0.997	0.63	
	High-Grade OreZONE	EAST	5846	2.43	0.12	2.38	0.27	1.022	0.44	0.42
		M1	50419	3.80	0.33	3.83	0.77	0.991	0.44	
		M3	16778	3.87	0.31	3.82	0.75	1.012	0.42	
		WT1	1884	2.39	0.12	2.41	0.23	0.990	0.50	
		WT2	27540	2.64	0.23	2.66	0.50	0.992	0.45	
		W1	52186	2.15	0.23	2.08	0.57	1.033	0.41	
		All	154653	2.97	0.27	2.96	0.63	1.005	0.43	
OxCa Zone	Low-Grade OreZONE	EAST	6553	0.70	0.27	0.72	0.45	0.976	0.59	0.62
		M1	45690	0.87	0.17	0.87	0.28	0.999	0.61	
		M3	16621	0.59	0.12	0.57	0.22	1.034	0.55	
		WT1	5969	0.79	0.11	0.81	0.18	0.973	0.64	
		WT2	209327	0.69	0.14	0.69	0.23	0.999	0.63	
		W1	6648	0.90	0.15	0.91	0.22	0.981	0.68	
		All	290808	0.72	0.15	0.72	0.24	0.999	0.62	
	High-Grade OreZONE	EAST	922	2.83	0.30	3.03	0.70	0.934	0.43	0.42
		M1	73607	3.33	0.17	3.28	0.38	1.014	0.45	
		M3	8185	3.41	0.24	3.39	0.51	1.008	0.48	
		WT1	962	1.92	0.03	2.06	0.15	0.928	0.21	
		WT2	36755	2.22	0.10	2.17	0.25	1.027	0.38	
		W1	9253	1.97	0.24	1.94	0.57	1.018	0.42	
		All	129684	2.91	0.16	2.87	0.37	1.015	0.44	

(A.Noble, 2014)

Table 14.23 - IDP:NN Ratios for Iron, Manganese, and Calcium

Oxide Type	OreZONE	Domain	$\%Fe_2O_3$ Average Grade	$\%Fe_2O_3$ Rel. Var. (Smoothing Ratio)	%MnO Average Grade	%MnO Rel. Var. (Smoothing Ratio)	%CaO Average Grade	%CaO Rel. Var. (Smoothing Ratio)
Oxide Zone	Low-Grade	Target Smoothing	0.68		0.73		0.78	
		EAST	1.00	0.63	1.02	0.58	1.00	0.65
		M1	1.00	0.65	0.99	0.70	1.01	0.68
		M3	1.00	0.64	1.00	0.63	0.99	0.69
		WT1	1.00	0.67	1.05	0.70	1.00	0.56
		WT2	1.00	0.69	1.00	0.67	0.99	0.72
		W1	1.00	0.68	1.00	0.71	1.00	0.71
	High-Grade	Target Smoothing	0.53		0.65		0.78	
		EAST	1.01	0.54	1.00	0.67	0.99	0.66
		M1	0.99	0.52	1.00	0.66	1.00	0.70
		M3	1.00	0.49	1.03	0.60	0.99	0.68
		WT1	1.00	0.60	0.98	0.67	1.06	0.85
		WT2	0.99	0.54	0.99	0.63	1.08	0.68
		W1	1.01	0.51	1.01	0.65	1.00	0.77
OxCa Zone	Low-Grade	Target Smoothing	0.68		0.73		0.59	
		EAST	0.99	0.58	1.00	0.65	0.99	0.60
		M1	1.00	0.63	1.00	0.73	1.03	0.60
		M3	1.02	0.57	1.05	0.63	1.03	0.58
		WT1	1.00	0.58	1.01	0.77	1.00	0.59
		WT2	1.00	0.69	1.00	0.66	1.00	0.59
		W1	1.00	0.72	1.00	0.81	1.02	0.58
	High-Grade	Target Smoothing	0.53		0.65		0.61	
		EAST	1.00	0.44	0.99	0.59	0.96	0.60
		M1	1.00	0.50	1.00	0.61	1.01	0.61
		M3	1.01	0.50	0.99	0.74	1.01	0.62
		WT1	1.01	0.34	0.98	0.34	1.00	0.63
		WT2	1.00	0.57	1.01	0.63	1.01	0.60
		W1	1.00	0.55	1.01	0.71	1.04	0.52

(A.Noble, 2014)

14.14 Block Model Density Estimation

Densities were estimated for each block based on the fraction of FMR/carbonatite mineralization, which was estimated using IDP estimation and the same procedure used for estimating the rare-earth-element grades. The formulae used for the block model density estimates are summarized in Table 14.24.

Table 14.24 - Formulae for Block Density Estimation

Oxidation Type	Density Formula (t/m^3)
Overburden & Clay	1.8
Oxide	0.01*(REminIDP*1.81 + (100-REminIDP)*2.26)
OxCa	0.01*(REminIDP*2.16 + (100-REminIDP)*2.32)
Trans	0.01*(REminIDP*2.32 + (100-REminIDP)*2.55)
Sulfide	0.01*(REminIDP*2.91 + (100-REminIDP)*2.59)
Where, REminIDP is the IDP estimate of the percentage of FMR and Carbonatite. Default density is assigned to blocks with no REminIDP estimate using a value of zero (0.00) for REminIDP.	
Metric densities are divided by 32.026735 to convert from t/m^3 to short tons/ft^3.	

(A.Noble, 2014)

14.15 Dilution

Dilution is incorporated into the resource model through two separate mechanisms: first, geometric dilution is incorporated by compositing; and second, volume-variance, or block-smoothing dilution is incorporated by adjusting the parameters of the inverse-distance-power grade estimation method.

The purpose of geometric dilution is to smooth out local geometric variability, to enhance overall continuity by defining larger, more regular shapes, and to group the data into higher-grade, primarily dike mineralization, and lower-grade, primarily stockwork mineralization. In addition, mineable-width mineralized zones are created for mine planning.

Geometric dilution is incorporated when true-width composites are computed using 20 to 30-foot minimum horizontal widths for definition of OreZONE codes. Compared to the original assays, which are nominally five-feet long and broken at major contacts, such as high-grade dikes, the OreZONE composites introduce 71% dilution and reduce ore grade by 33%. In addition, there is a 21% loss of ore-grade intervals that are diluted below cutoff grade. Because drilling typically intersects the mineralized zones at angles of 45° to 55°, a typical five-foot assay interval is only 3 to 3.5 feet of horizontal width, and dilution computed on the basis of raw assays tends to be exaggerated. When the 20 to 30-ft OreZONE composites are compared to composites with a ten-foot minimum width, dilution is 30% with an ore loss of 8%. Accordingly, it is believed that sufficient geometric dilution is included for mining 20-foot minimum mining widths. Composite dilution calculations are summarized in Table 14.25.

Table 14.25 - Compositing Dilution Summary

Grade Zone	Type of Assay Interval	Horizontal Widths of Assays With 10-foot Minimum Horizontal Width: Width (feet)	Width (Meters)	Average Grade (Total REO)	Percent Dilution/ Loss	Horizontal Widths of Assays With 20/30-foot Minimum Horizontal Width: Width (feet)	Width (Meters)	Average Grade (Total REO)	Percent Dilution/ Loss	Added Dilution from 10-foot to 20/30-foot Width: Width (feet)	Average Grade (Total REO)	Percent Dilution/ Loss
Ore Grade Zones	Total Interval Widths	19,072	5813	3.325		21,480	6547	2.928				
	Ore-Grade Intervals	13,913	4241	4.180		12,558	3828	4.358				
	Waste-grade Intervals	5,159	1572	1.019	37.1% [1]	8,922	2719	0.915	71.0% [1]	3,763	0.772	30.0% [3]
Waste-Grade Zones	Total Interval Widths	64,532	19669	0.656		62,091	18925	0.688				
	Waste Intervals	62,542	19063	0.615		58,783	17917	0.605				
	Lost Ore-Grade Intervals	1,990	607	1.925	12.5% [2]	3,308	1008	2.162	20.8% [2]	1,317	2.520	8.3% [4]

[1] Percent dilution is computed relative to the Ore-Grade Width in Ore-Grade Zones

[2] Percent ore loss is computed relative to Total Ore-Grade Width in Waste and Ore-Grade Zones

[3] Percent additional dilution is computed relative to the Ore-Grade Width in the Minable Width 20/30 ft Ore-Grade Zones

[4] Percent additional ore loss is computed relative to Total Ore-Grade Width in Waste and Ore-Grade Zones

(A.Noble, 2014)

The second source of dilution is called the volume-variance effect by geostatisticians and resource estimation professionals. In geostatistics and mineral resource estimation, the volume-variance effect refers to the effect of sample volume on the grade distribution of samples. Small volume samples tend to have greater sample variability than larger volume samples, thus the statistical variance is higher for small samples (e.g. assays) than for large samples (e.g. composites). A mining block is a very large sample, and the variance of minable blocks is generally much smaller than the variance of composites. The highest grade in a low variance population is lower than the highest grade in a higher variance population with the same average grade, thus volume-variance effects tend to dilute higher grades downward. Volume-variance effects also tend to upgrade lower grades, but that effect does not usually increase the tonnage of ore-grade mineralization.

Volume-variance effects are incorporated in the resource estimate through the averaging effects of inverse-distance-power (IDP) grade estimation, as follows: 1) composited assays are selected for grade estimation from the immediate area in and around the block that is estimated; 2) the block estimate is computed as the IDP-weighted average grade of the composites; and 3) the variance of the block estimates is lower than the variance of the original composites, thus adding dilution.

Volume-variance dilution is measured by comparing the tonnage and grade from the composited assays to the tonnage and grade of the IDP block estimates. The nearest-neighbor estimate assigns the grade of the nearest composite to each block and retains the grade distribution of the composites, while declustering them for variability in sample spacing. Thus, volume-variance dilution can be measured by comparing the tonnage-grade distribution of the NN-estimates to the tonnage-grade distribution of IDP-estimates. This comparison is made in Table 14.26, where tons and grade above and below cutoff are tabulated for the NN and IDP estimates at cutoffs of 1.5% and 3.0% TREO. Dilution is immediately apparent, since the grade above cutoff for the IDP estimates is lower than that of the NN estimates. The difference between the two estimates is not simply the dilution, but also includes ore-tonnage losses. Ore-tonnage losses and dilution are estimated based on the difference in tonnage and grade between the estimates and reasonable assumptions for the grades of the dilution and ore-loss tonnages. The amount of dilution and ore-tonnage losses depends significantly on the cutoff grade. Dilution is about 15%, and ore loss is 4% at a 1.5% TREO cutoff. When the cutoff grade is increased to 3.0% TREO, dilution and ore losses increase to 22% dilution and 21% ore loss.

Table 14.26 - Dilution from Inverse-Distance-Power Estimation

Cutoff Grade =			**1.5% TREO**				
	Tons Below Cutoff	Metric Tons Below Cutoff	Grade Below Cutoff	Tons Above Cutoff	Metric Tons Above Cutoff	Grade Above Cutoff	%Dilution /Loss[1]
NN Model	51,569	46783	0.728	15,258	13842	3.438	
IDP Model	48,935	44393	0.727	17,892	16231	3.075	
	Dilution			2,901	2632	1.114	19.0%[2]
	Ore-Grade Tonnage Lost			(267)	(242)	2.469	-1.8%[3]
	Net Dilution			2,634	2390	0.976	17.3%
Cutoff Grade =			**3.0% TREO**				
	Tons Below Cutoff	Metric Tons Below Cutoff	Grade Below Cutoff	Tons Above Cutoff	Metric Tons Above Cutoff	Grade Above Cutoff	%Dilution /Loss[1]
NN Model	60,298	54701	0.930	6,529	5923	5.190	
IDP Model	60,019	54448	0.998	6,808	6176	4.514	
	Dilution			2,016	1829	1.965	30.9%[2]
	Ore-Grade Tonnage Lost			(1,737)	(1576)	4.095	-26.6%[3]
	Net Dilution			279	253	(11.285)	4.3%

[1] - %Dilution/Loss computed relative to NN tonnage
[2] - Dilution Grade is estimated as the average of the cutoff grade and the NN grade below cutoff
[3] - Ore Lost Grade is estimated as the average of the cutoff grade and the NN grade above cutoff

(A.Noble, 2014)

Using a 1.5% TREO cutoff grade, overall dilution and ore losses from compositing and smoothing to a 20-foot equivalent block size adds 57% dilution to tonnage at about 0.9% TREO grade, and 11% ore is lost at 2.5% TREO grade. Thus dilution and ore losses are fully accounted for in the resource model, and no further dilution is needed for mine planning or scheduling.

It is noted that IDP dilution from volume-variance effects is significantly higher at a 3.0% TREO cutoff grade, and ore losses are much higher than at 1.5% cutoff grade.

14.16 Resource Classification

Resources are classified based on drill-hole spacing, which is measured in the trend-flattened coordinate space using the variance from kriging of a flag variable. A zero-nugget, linear variogram is used for the kriging runs which results in a kriging variance that is directly proportional to the drill-hole spacing. In addition, limits were placed on the estimation expansion volume to ensure that measured and indicated blocks were defined by at least 6 drill holes within the specified search volume.

Resources in the Main 1 Zone, which is the source of high-grade ore for the first nine years of mining, have excellent continuity and are locally drilled with closely spaced drilling. Where drilling is sufficiently closely spaced, Main 1 resource can be assigned resource classes up to measured. In all other zones, resources are assigned resource classes no better than indicated. In the Main 2, Northwest Bull Hill, Southeast, and West 2 zones, drill-hole spacing is much wider, and resources are assigned entirely to the inferred category. All resources in the transition and sulfide oxidation zones are assigned entirely to the inferred category. The parameters for resource classification are summarized in Table 14.27.

The variable RCLASS is used to identify the resource class in each block. RCLASS=1 is assigned to blocks in the measured category, and RCLASS=2 is assigned to blocks in the indicated category. RCLASS=3 is assigned to blocks in the inferred category, unless the drill-hole spacing is greater than 300 feet, in which case the block is assigned RCLASS=4. The subdivision of the inferred category is included as a convenience for drill planning and is not used for reporting purposes.

Table 14.27 - Parameters for Resource Classification

	Grid Spacing			Maximum Search Volume		
	Measured	Indicated	Inferred			
Domain	(RCLASS=1)	(RCLASS=2)	(RCLASS=3,4)	Measured	Indicated	Inferred
East	X	200	>200	X	2	3
Main 1	125	250	>250	1	2	3
Main 2	All Resources are Inferred			X	X	X
Main 3	X	200	>200	X	2	3
NW Bull Hill	All Resources are Inferred			X	X	X
Southeast	All Resources are Inferred			X	X	X
West 1	X	200	>200	X	2	3
West 2	All Resources are Inferred			X	X	X
Whitetail 1	X	200	>200	X	2	3
Whitetail 2	X	200	>200	X	2	3

(A.Noble, 2014)

14.17 Resource Summary

Estimated resources are summarized in Table 14.28 through Table 14.34. A base-case cutoff grade of 1.5% TREO is used for reporting of resources, consistent with previous reporting. Price assumptions for resource estimation are the same as those used for mineral reserve estimation and are documented in Chapter 15. A cutoff grade of 1.5% TREO is used for resource reporting to maintain consistency with previous resource reports.

Table 14.28 - Measured and Indicated Resources Using a Range of Cutoff Grades

Resource Class	Cutoff Grade (%REO)	Oxide Short Tons (million)	Oxide Metric Tons (million)	Oxide Grade (%TREO)	Oxide+Calcite Short Tons (million)	Oxide+Calcite Grade (%TREO)	Total Oxidized Short Tons (million)	Total Oxidized Metric Tons (million)	Total Oxidized Grade (%TREO)
Measured	0.5	3.9	3.5	2.00	2.02	2.95	6.0	5.4	2.32
	1	2.1	1.9	3.14	1.6	3.46	3.7	3.4	3.28
	1.5	1.5	1.4	3.89	1.5	3.73	3.0	2.7	3.81
	2	1.3	1.2	4.28	1.3	4.01	2.5	2.3	4.15
	2.5	1.0	0.9	4.77	1.1	4.33	2.1	1.9	4.54
	3	0.8	0.7	5.32	0.9	4.73	1.7	1.5	5.02
	3.5	0.6	0.5	5.95	0.7	5.16	1.3	1.2	5.54
	4	0.5	0.5	6.57	0.5	5.59	1.0	0.9	6.07
	4.5	0.4	0.4	7.15	0.4	6.13	0.8	0.7	6.66
	5	0.3	0.3	7.70	0.3	6.64	0.6	0.5	7.21
Indicated	0.5	27.0	24.5	1.45	23.35	1.44	50.3	45.6	1.44
	1	11.8	10.7	2.37	10.2	2.36	22.0	20.0	2.37
	1.5	7.7	7.0	3.00	7.2	2.85	14.9	13.5	2.93
	2	5.7	5.2	3.46	5.5	3.18	11.2	10.2	3.32
	2.5	3.9	3.5	4.03	3.8	3.61	7.7	7.0	3.82
	3	2.6	2.4	4.64	2.5	4.05	5.1	4.6	4.35
	3.5	1.8	1.6	5.23	1.6	4.56	3.4	3.1	4.92
	4	1.4	1.3	5.74	1.0	5.06	2.3	2.1	5.46
	4.5	1.0	0.9	6.25	0.6	5.65	1.6	1.5	6.04
	5	0.7	0.6	6.82	0.4	6.17	1.1	1.0	6.61
Measured + Indicated	0.5	30.9	28.0	1.52	25.37	1.56	56.3	51.1	1.53
	1	13.9	12.9	2.49	11.8	2.51	25.7	23.3	2.50
	1.5	9.2	8.3	3.14	8.6	3.00	17.9	16.2	3.08

	2	6.9	6.3	3.61	6.8	3.34	13.8	12.5	3.47
	2.5	4.9	4.4	4.18	4.9	3.77	9.8	8.9	3.97
	3	3.4	3.1	4.80	3.4	4.23	6.8	6.2	4.51
	3.5	2.5	2.3	5.41	2.2	4.74	4.7	4.3	5.09
	4	1.9	1.7	5.96	1.5	5.24	3.3	3.0	5.64
	4.5	1.4	1.3	6.50	0.9	5.84	2.3	2.1	6.24
	5	1.1	1.0	7.08	0.6	6.37	1.7	1.5	6.81
		Note – Measured and Indicated resources are ***inclusive*** of mineralized material that is also reported as reserves.							

(A.Noble, 2014)

Table 14.29 - Summary of Measured and Indicated Resource by Deposit

Resource Class		Cutoff = 1.5% TREO								
		Oxide			Oxide+Carbonate			Total		
	Zone	Short Tons (million)	Metric Tons (million)	Grade (%TREO)	Short Tons (million)	Metric Tons (million)	Grade (%TREO)	Short Tons (million)	Metric Tons (million)	Grade (%TREO)
Measured	Main	1.5	1.4	3.89	1.5	1.4	3.73	3.0	2.7	3.81
	Main - Center Fork	-	-	-	-	-	-	-	-	-
	Main NS Trending	-	-	-	-	-	-	-	-	-
	Total Main	1.5	1.4	3.89	1.5	1.4	3.73	3.0	2.7	3.81
	East	-	-	-	-	-	-	-	-	-
	Northwest Bull	-	-	-	-	-	-	-	-	-
	Southeast	-	-	-	-	-	-	-	-	-
	West 1	-	-	-	-	-	-	-	-	-
	West 2	-	-	-	-	-	-	-	-	-
	Whitetail SW	-	-	-	-	-	-	-	-	-
	Whitetail NE	-	-	-	-	-	-	-	-	-
	Total	1.5	1.4	3.89	1.5	1.4	3.73	3.0	2.7	3.81
	Tons REO (millions)	117	106		112	102		229	208	
Indicated	Main	1.8	1.6	3.66	3.6	3.3	3.19	5.4	4.9	3.35
	Main - Center Fork	-	-	-	-	-	-	-	-	-
	Main NS Trending	1.1	1.0	3.85	0.5	0.5	3.51	1.6	1.5	3.74
	Total Main	2.9	2.6	3.73	4.1	3.7	3.23	7.0	6.4	3.44
	East	0.4	0.4	2.50	0.1	0.1	2.81	0.5	.5	2.56
	Northwest Bull	-	-	-	-	-	-	-	-	-
	Southeast	-	-	-	-		-	-	-	-
	West 1	2.7	2.4	2.44	0.4	0.4	2.35	3.1	2.8	2.43
	West 2	-	-	-	-	-	-	-	-	-
	Whitetail SW	0.1	0.1	2.54	0.1	0.1	1.93	0.2	0.2	2.24
	Whitetail NE	1.7	1.5	2.78	2.4	2.2	2.31	4.1	3.7	2.50
	Total	7.8	7.1	3.00	7.1	6.4	2.84	14.9	13.5	2.92
	Tons REO (millions)	468	425		403	366		871	790	
Total Measured + Indicated	Main	3.3	3.0	3.76	5.1		3.35	8.4		3.51
	Main - Center Fork	-	-	-	-	-	-	-	-	-
	Main NS Trending	1.1	1.0	3.85	0.5		3.51	1.6		3.74
	Total Main	4.4	4.0	3.78	5.6		3.36	10.0		3.55
	East	0.4	0.4	2.50	0.1		2.81	0.5		2.56
	Northwest Bull	-	-	-	-	-	-	-	-	-
	Southeast	-	-	-	-	-	-	-	-	-
	West 1	2.7	2.4	2.44	0.4	0.4	2.35	3.1	2.8	2.43
	West 2	-	-	-	-	-	-	-	-	-
	Whitetail SW	0.1	0.1	2.54	0.1	0.1	1.93	0.2	0.2	2.24
	Whitetail NE	1.7	1.5	2.78	2.4	2.2	2.31	4.1	3.7	2.50
	Total	9.3	8.4	3.14	8.6	7.8	3.00	17.9	16.2	3.07
	Tons REO (millions)	584	530		516	468		1,100	998	

Note – Measured and Indicated resources are **inclusive** of mineralized material that is also reported as reserves.

(A.Noble, 2014)

Table 14.30 - Summary of Measured and Indicated Resource by Element

		Measured			Indicated			Measured + Indicated		
		Oxide	Oxide + Calcite	Total Oxide	Oxide	Oxide + Calcite	Total Oxide	Oxide	Oxide + Calcite	Total Oxide
Cutoff Grade	%TREO	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Short Tons Resource	millions	1.50	1.46	2.96	7.74	7.18	14.92	9.24	8.65	17.89
Metric Tons Resource	millions	1.36	1.32	2.69	7.02	6.51	13.54	8.38	7.85	16.23
Average Grade	%TREO	3.89	3.73	3.81	3.00	2.85	2.93	3.14	3.00	3.08
lbs REO	millions	117	109	226	464	410	874	581	519	1,100
kg REO	millions	53.07	49.44	102.5	210.5	186.0	396.4	263.5	235.4	499.0
%Cerium Oxide	Ce_2O_3	1.68	1.63	1.66	1.30	1.24	1.27	1.36	1.30	1.33
%Lanthanum Oxide	La_2O_3	1.14	1.03	1.08	0.81	0.74	0.78	0.86	0.79	0.83
%Neodymium Oxide	Nd_2O_3	0.65	0.67	0.66	0.53	0.53	0.53	0.55	0.55	0.55
%Praseodymium Oxide	Pr_2O_3	0.184	0.183	0.184	0.148	0.141	0.145	0.154	0.148	0.151
%Samarium Oxide	Sm_2O_3	0.103	0.105	0.104	0.087	0.088	0.087	0.089	0.091	0.090
%Gadolinium Oxide	Gd_2O_3	0.053	0.048	0.050	0.045	0.046	0.046	0.047	0.046	0.047
%Yttrium	Y_2O_3	0.038	0.029	0.034	0.033	0.034	0.034	0.034	0.033	0.034
%Europium Oxide	Eu_2O_3	0.022	0.021	0.022	0.019	0.019	0.019	0.020	0.020	0.020
%Dysprosium Oxide	Dy_2O_3	0.0126	0.0100	0.0113	0.0113	0.0119	0.0116	0.0115	0.0116	0.0116
%Terbium Oxide	Tb_2O_3	0.0043	0.0036	0.0040	0.0037	0.0039	0.0038	0.0038	0.0038	0.0038
%Erbium Oxide	Er_2O_3	0.0026	0.0021	0.0024	0.0021	0.0022	0.0021	0.0022	0.0022	0.0022
%Ytterbium Oxide	Yb_2O_3	0.0016	0.0014	0.0015	0.0012	0.0013	0.0013	0.0013	0.0013	0.0013
%Holmium Oxide	Ho_2O_3	0.00138	0.00107	0.00122	0.00120	0.00126	0.00123	0.00122	0.00123	0.00123
%Lutetium Oxide	Lu_2O_3	0.00020	0.00019	0.00019	0.00016	0.00017	0.00017	0.00017	0.00018	0.00017
%Thulium Oxide	Tm_2O_3	0.00025	0.00021	0.00023	0.00021	0.00022	0.00021	0.00021	0.00022	0.00021
ppm Thorium	Th	469	365	418	383	448	414	397	434	415
ppm Uranium	U	106	112	109	93	94	93	95	97	96
%Iron Oxide	Fe_2O_3	14.1	12.4	13.2	12.8	10.9	11.9	13.0	11.2	12.1
%Manganese Oxide	MnO	4.16	2.92	3.55	3.09	2.28	2.70	3.26	2.38	2.84
%Calcium Oxide	CaO	1	17	9	1	16	8	1	16	8
Total Light		3.754	3.612	3.684	2.883	2.733	2.811	3.024	2.882	2.955
Total Heavy		0.136	0.117	0.127	0.117	0.121	0.119	0.120	0.120	0.120
Critical REOs		0.912	0.914	0.913	0.748	0.740	0.744	0.775	0.769	0.772
Fraction Heavy		0.035	0.031	0.033	0.039	0.042	0.041	0.038	0.040	0.039
Note – Measured and Indicated resources are inclusive of mineralized material that is also reported as reserves.										

(A.Noble, 2014)

Table 14.31 - Total Inferred Resources Using a Range of Cutoff Grades

Resource Class	Cutoff Grade (%REO)	Oxide		Oxide+Calcite		Total Oxidized		Transitional		Sulfide		Total	
		Short Tons (million)	Grade (%TREO)	Short Tons (million)	Grade (%TREO)	Short Tons (million)	Grade (%TREO)	Short Tons (million)	Grade (%TREO)	Short Tons (million)	Grade (%TREO)	Short Tons (million)	Grade (%TREO)
Inferred	0.5	125.8	1.07	60.7	1.07	186.5	1.07	9.5	1.01	96.9	0.95	292.9	1.03
	1	34.4	2.08	18.3	1.93	52.7	2.03	2.6	1.91	22.1	1.89	77.3	1.98
	1.5	21.1	2.65	10.7	2.46	31.8	2.58	1.5	2.42	12.7	2.41	46.0	2.53
	2	13.0	3.20	6.3	2.97	19.3	3.12	0.8	2.94	7.3	2.91	27.4	3.06
	2.5	8.0	3.80	3.6	3.54	11.6	3.72	0.5	3.38	4.2	3.40	16.3	3.63
	3	5.1	4.41	2.1	4.09	7.2	4.32	0.3	3.93	2.4	3.92	9.9	4.21
	3.5	3.0	5.23	1.3	4.60	4.4	5.04	0.2	4.42	1.6	4.26	6.1	4.82
	4	2.2	5.84	0.9	5.08	3.0	5.63	0.1	4.88	0.8	4.71	4.0	5.41
	4.5	1.5	6.57	0.5	5.58	2.0	6.31	0.1	5.31	0.4	5.16	2.5	6.09
	5	1.1	7.14	0.3	6.10	1.5	6.91	0.0	5.80	0.2	5.60	1.7	6.72

Resource Class	Cutoff Grade (%REO)	Oxide		Oxide+Calcite		Total Oxidized		Transitional		Sulfide		Total	
		Metric Tons (million)	Grade (%TREO)	Metric Tons (million)	Grade (%TREO)	Metric Tons (million)	Grade (%TREO)	Metric Tons (million)	Grade (%TREO)	Metric Tons (million)	Grade (%TREO)	Metric Tons (million)	Grade (%TREO)
Inferred	0.5	114.1	1.07	55.1	1.07	169.2	1.07	8.6	1.01	87.9	0.95	265.7	1.03
	1	31.2	2.08	16.6	1.93	47.8	2.03	2.4	1.91	20.0	1.89	70.1	1.98
	1.5	19.1	2.65	9.7	2.46	28.8	2.58	1.4	2.42	11.5	2.41	41.7	2.53
	2	11.8	3.20	5.7	2.97	17.5	3.12	0.7	2.94	6.6	2.91	24.9	3.06
	2.5	7.3	3.80	3.3	3.54	10.5	3.72	0.5	3.38	3.8	3.40	14.8	3.63
	3	4.6	4.41	1.9	4.09	6.5	4.32	0.3	3.93	2.2	3.92	9.0	4.21
	3.5	2.7	5.23	1.2	4.60	4.0	5.04	0.2	4.42	1.5	4.26	5.5	4.82
	4	2.0	5.84	0.8	5.08	2.7	5.63	0.1	4.88	0.7	4.71	3.6	5.41
	4.5	1.4	6.57	0.5	5.58	1.8	6.31	0.1	5.31	0.4	5.16	2.3	6.09
	5	1.0	7.14	0.3	6.10	1.4	6.91	0	5.80	0.2	5.60	1.5	6.72

(A.Noble, 2014)

Table 14.32 - Summary of Oxide Inferred Resource by Deposit

Resource Class	Zone	Cutoff (%TREO) = 1.5								
		Oxide			Oxide + Carbonate			Total		
		Short Tons (million)	Metric Tons (million)	Grade (%TREO)	Short Tons (million)	Metric Tons (million)	Grade (%TREO)	Short Tons (million)	Metric Tons (million)	Grade (%TREO)
Total Measured + Indicated	Main	0.9	0.8	3.08	1.4	1.3	3.49	2.3	2.1	3.33
	Main - Center Fork	0.7	0.6	3.39	0.4	0.4	3.21	1.1	1.0	3.32
	Main NS Trending	0.4	0.4	3.29	-	-	3.16	0.4	0.4	3.29
	Total Main	2.0	1.8	3.23	1.8	1.6	3.43	3.8	3.4	3.32
	East	0.2	0.2	2.18	0.1	0.1	3.25	0.3	0.3	2.54
	Northwest Bull	1.1	1.0	2.36	0.1	0.1	1.78	1.2	1.1	2.31
	Southeast	0.6	0.5	2.78	0.1	0.1	2.93	0.7	0.6	2.80
	West 1	7.5	6.8	2.66	5.8	5.3	2.15	13.3	12.1	2.44
	West 2	4.3	3.9	2.24	0.4	0.4	2.03	4.7	4.3	2.22
	Whitetail SW	2.7	2.4	3.12	0.3	0.3	3.07	3.0	2.7	3.12
	Whitetail NE	2.6	2.4	2.47	2.3	2.1	2.47	4.9	4.4	2.47
	Total	21.0	19.1	2.65	10.9	9.9	2.46	31.9	28.9	2.59
	Tons REO (millions)	1,113	1010		536	486		1,649	1496	

(A.Noble, 2014)

Table 14.33 - Summary of Sulfide Inferred Resource by Deposit

Resource Class	Cutoff = 1.5									
		Transition			Sulfide			Total Trans. + Sulfide		
	Zone	Short Tons (million)	Metric Tons (million)	Grade (%TREO)	Short Tons (million)	Metric Tons (million)	Grade (%TREO)	Short Tons (million)	Metric Tons (million)	Grade (%TREO)
Total Measured + Indicated	Main	0.6	0.5	2.55	3.5	3.2	2.50	4.2	3.8	2.51
	Main - Center Fork	0.1	0.1	2.45	1.0	0.9	2.56	1.0	0.9	2.55
	Main NS Trending	0.1	0.1	2.55	2.2	2.0	2.57	2.3	2.1	2.57
	Total Main	0.9	0.8	2.54	6.6	6.0	2.53	7.5	6.8	2.54
	East	0.2	0.2	2.58	0.4	0.4	2.17	0.6	0.5	2.30
	Northwest Bull	0.2	0.2	2.27	1.5	1.4	2.46	1.7	1.5	2.44
	Southeast	0.1	0.1	2.26	1.9	1.7	2.39	2.0	1.8	2.39
	West 1	0.2	0.2	2.00	1.5	1.4	2.10	1.7	1.5	2.09
	West 2	-	-	-	-	-	-	-	-	-
	Whitetail SW	0.0	0.0	2.21	0.1	0.1	2.97	0.1	0.1	2.90
	Whitetail NE	0.1	0.1	1.92	0.7	0.6	1.88	0.7	0.6	1.89
	Total	1.5	1.4	2.42	12.7	11.5	2.41	14.2	12.9	2.41
	Tons REO (millions)	72	65		612	555		684	621	

(A.Noble, 2014)

Table 14.34 - Summary of Inferred Resource by Element

		Oxide	Oxide + Calcite	Total Oxide	Clay	Transition	Sulfide	Total Tran+ Sulfide	Total
Cutoff Grade	%TREO	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Short Tons Resource	millions	21.07	10.71	31.78	0.06	1.48	12.71	14.20	46.04
Metric Tons Resource	millions	19.11	9.72	28.83	0.05	1.34	11.53	12.88	41.77
Average Grade	%TREO	2.65	2.46	2.58	4.67	2.42	2.41	2.41	2.53
lbs REO	millions	1,115	527	1,643	6	72	612	684	2,332
kg REO	millions	505.76	239.04	745.25	2.72	32.66	277.60	610.26	1057.78
%Cerium Oxide	Ce_2O_3	1.14	1.07	1.12	1.96	1.07	1.07	1.07	1.10
%Lanthanum Oxide	La_2O_3	0.69	0.63	0.67	1.32	0.65	0.64	0.64	0.66
%Neodymium Oxide	Nd_2O_3	0.48	0.45	0.47	0.80	0.43	0.43	0.43	0.46
%Praseodymium Oxide	Pr_2O_3	0.130	0.122	0.127	0.223	0.118	0.118	0.118	0.125
%Samarium Oxide	Sm_2O_3	0.079	0.075	0.078	0.132	0.068	0.068	0.068	0.075
%Gadolinium Oxide	Gd_2O_3	0.044	0.041	0.043	0.068	0.033	0.033	0.033	0.040
%Yttrium	Y_2O_3	0.044	0.040	0.043	0.088	0.019	0.020	0.020	0.036
%Europium Oxide	Eu_2O_3	0.018	0.017	0.018	0.031	0.014	0.014	0.014	0.017
%Dysprosium Oxide	Dy_2O_3	0.0132	0.0122	0.0129	0.0252	0.0066	0.0070	0.0069	0.0111
%Terbium Oxide	Tb_2O_3	0.0039	0.0036	0.0038	0.0070	0.0024	0.0024	0.0024	0.0034
%Erbium Oxide	Er_2O_3	0.0029	0.0026	0.0028	0.0052	0.0013	0.0014	0.0014	0.0023
%Ytterbium Oxide	Yb_2O_3	0.0017	0.0015	0.0016	0.0026	0.0009	0.0009	0.0009	0.0014
%Holmium Oxide	Ho_2O_3	0.00155	0.00141	0.00151	0.00303	0.00069	0.00072	0.00072	0.00127
%Lutetium Oxide	Lu_2O_3	0.00022	0.00020	0.00021	0.00030	0.00012	0.00012	0.00012	0.00018
%Thulium Oxide	Tm_2O_3	0.00031	0.00027	0.00030	0.00053	0.00014	0.00014	0.00014	0.00025
ppm Thorium	Th	462	456	460	484	279	302	300	410
ppm Uranium	U	84	83	84	96	97	91	91	86
%Iron Oxide	Fe_2O_3	12.7	11.2	12.2	7.4	8.8	9.1	9.0	11.2
%Manganese Oxide	MnO	2.78	1.89	2.48	0.38	1.83	1.85	1.84	2.28
%Calcium Oxide	CaO	1.1	13.2	5.2	0.3	16.0	18.0	17.8	9.1
Total Light		2.516	2.342	2.457	4.439	2.338	2.328	2.329	2.420
Total Heavy		0.130	0.120	0.127	0.231	0.078	0.080	0.080	0.112
Critical REOs		0.686	0.644	0.672	1.176	0.592	0.589	0.589	0.647
Fraction Heavy		0.049	0.049	0.049	0.049	0.032	0.033	0.033	0.044

(A. Noble, 2014)

14.17.1 High-Grade Resource

High-grade resources, which are those resources above a cutoff grade of 3% TREO, are particularly important, since they are the focus of mining in the first nine years of production. The high-grade resource is summarized in Table 14.35. It occurs predominantly in the Main 1 and Main 3 Zones, which contain 78% of the total measured and indicated, high-grade resource. All of the high-grade, measured resource is in the Main 1 Zone, where it is exceptionally continuous and well-drilled. About 31% of the Main Zone M&I resource is currently in the measured category.

Table 14.35 - Summary of High-Grade Measured and Indicated Resource

Resource Class	Zone	Oxide Short Tons (million)	Oxide Metric Tons (million)	Oxide Grade (%TREO)	Oxide+Carbonate Short Tons (million)	Oxide+Carbonate Metric Tons (million)	Oxide+Carbonate Grade (%TREO)	Total Short Tons (million)	Total Metric Tons (million)	Total Grade (%TREO)
	Cutoff =3.00 %TREO									
Measured	Main (M1)	0.8	0.7	5.32	0.9	0.8	4.73	1.7	1.5	5.01
	Main (M3)	-	-	-	-	-	-	-	-	-
	Total Main	0.8	0.7	5.32	0.9	0.8	4.73	1.7	1.5	5.01
	East	-	-	-	-	-	-	-	-	-
	West 1	-	-	-	-	-	-	-	-	-
	Whitetail SW	-	-	-	-	-	-	-	-	-
	Whitetail NE	-	-	-	-	-	-	-	-	-
	Total Outside Main	-	-	-	-	-	-	-	-	-
	Total	0.8	0.7	5.32	0.9	0.8	4.73	1.7	1.5	5.01
	Tons REO (millions)	85	77		85	77		170	154	
Indicated	Main (M1)	1.0	0.9	4.94	1.9	1.7	4.02	2.9	2.6	4.34
	Main (M3)	0.6	0.5	5.16	0.3	0.3	4.77	0.9	0.8	5.03
	Total Main	1.6	1.5	5.02	2.2	2.0	4.12	3.8	3.4	4.50
	East	0.1	0.1	3.60	-	-	4.45	0.1	0.1	3.60
	West 1	0.5	0.5	4.09	0.1	0.1	4.10	0.6	0.5	4.09
	Whitetail SW	-	-	3.97	-	-	3.18	-	-	-
	Whitetail NE	0.5	0.5	4.14	0.3	0.3	3.57	0.8	0.7	3.93
	Total Outside Main	1.1	1.0	4.07	0.4	0.4	3.70	1.5	1.4	3.97
	Total	2.7	2.4	4.63	2.6	2.4	4.06	5.3	4.8	4.35
	Tons REO (millions)	250	227		211	191		461	418	
Total Measured + Indicated	Main (M1)	1.8	1.6	5.12	2.7	2.4	4.25	4.5	4.1	4.60
	Main (M3)	0.6	0.5	5.16	0.3	0.3	4.77	0.9	0.8	5.03
	Total Main	2.4	2.2	5.13	3.0	2.7	4.30	5.4	4.9	4.67
	East	0.1	0.1	3.60	-	-	4.45	0.1	0.1	3.60
	West 1	0.5	0.5	4.09	0.1	0.1	4.10	0.6	0.5	4.09
	Whitetail SW	-	-	3.97	-	-	3.18	-	-	-
	Whitetail NE	0.5	0.5	4.14	0.3	0.3	3.57	0.8	0.7	3.93
	Total Outside Main	1.1	1.0	4.07	0.4	0.4	3.70	1.5	1.4	3.97
	Total	3.5	3.2	4.80	3.4	3.1	4.23	6.9	6.3	4.52
	Tons REO (millions)	336	305		288	261		624	566	

(A. Noble, 2014)

14.17.2 Heavy Rare Earth (HREE) Enrichment

The Whitetail Ridge resource blocks (Whitetail SW and Whitetail NE exhibit significant HREE-enrichment relative to the Bull Hill Resource blocks (Total Main, East, Northwest Bull, Southeast, West 1, and West 2). HREE grade enrichment relative to TREE in the total Whitetail deposit is about 2.5 times that of the total Bull Hill deposit (Table 14.36).

Table 14.36 - Comparative LREE and HREE Abundances at Whitetail and Bull Hill

		Whitetail Only Indicated			Bull Hill Only Measured & Indicated		
		Oxide	Oxide + Calcite	Ox+OxCa	Oxide	Oxide + Calcite	Ox+OxCa
Cutoff (%REO)		1.5	1.5	1.5	1.5	1.5	1.5
Short Tons Resource	(millions)	1.77	2.49	4.26	7.47	6.16	13.63
Metric Tons Resource	(millions)	1.61	2.26	3.86	6.78	5.59	12.36
%TREO		2.76	2.30	2.49	3.24	3.28	3.26
Million lbs REO		98	115	212	483	405	888
Million kg REO		44.45	52.16	96.16	219.09	183.71	402.79
%Cerium Oxide	Ce_2O_3	1.10	0.94	1.01	1.43	1.45	1.44
%Lanthanum Oxide	La_2O_3	0.71	0.55	0.62	0.90	0.88	0.89
%Neodymium Oxide	Nd_2O_3	0.51	0.43	0.47	0.56	0.60	0.58
%Praseodymium Oxide	Pr_2O_3	0.133	0.111	0.120	0.159	0.163	0.161
%Samarium Oxide	Sm_2O_3	0.101	0.085	0.092	0.086	0.093	0.089
%Gadolinium Oxide	Gd_2O_3	0.071	0.059	0.064	0.041	0.042	0.041
%Yttrium	Y_2O_3	0.069	0.059	0.063	0.025	0.023	0.024
%Europium Oxide	Eu_2O_3	0.027	0.022	0.024	0.018	0.019	0.018
%Dysprosium Oxide	Dy_2O_3	0.0249	0.0205	0.0223	0.0084	0.0080	0.0082
%Terbium Oxide	Tb_2O_3	0.0075	0.0061	0.0067	0.0030	0.0029	0.0029
%Erbium Oxide	Er_2O_3	0.0042	0.0036	0.0038	0.0017	0.0016	0.0016
%Ytterbium Oxide	Yb_2O_3	0.0021	0.0018	0.0019	0.0011	0.0011	0.0011
%Holmium Oxide	Ho_2O_3	0.00266	0.00219	0.00238	0.00089	0.00084	0.00086
%Lutetium Oxide	Lu_2O_3	0.00026	0.00023	0.00024	0.00015	0.00015	0.00015
%Thulium Oxide	Tm_2O_3	0.00039	0.00035	0.00036	0.00017	0.00017	0.00017
ppm Thorium	Th	804	834	821	300	272	288
ppm Uranium	U	83	64	72	98	110	103
Total Light		2.553	2.128	2.305	3.136	3.186	3.159
Total Heavy		0.209	0.175	0.189	0.099	0.098	0.099
CREO		0.773	0.652	0.702	0.775	0.817	0.794
Fraction Heavy		0.076	0.076	0.076	0.031	0.030	0.030

(A.Noble, 2014)

14.18 Other Factors Affecting the Resource Estimate

No environmental, permitting, legal, titles, taxation, socio-economic, marketing, political, or other factors have been recognized that would detrimentally affect the mineral resource. However, it is possible that any of these factors could arise at any time in an unexpected form and detrimentally affect the project and the ability to economically mine the mineral resource.

15 Mineral Reserve Estimates

The reported mineral reserves in this Section 15 are derived from the same resource model upon which the mineral resource estimates in Section 14 are based. An economic pit shell was generated using the Lerchs-Grossmann algorithm. The optimized pit shell was then used to guide the design of an open pit for the deposit. The mineral reserve estimates are consistent with industry standards for a Preliminary Feasibility Study and the definitions described below.

15.1 Definitions

The Canadian National Instrument 43-101 (NI 43-101) regulation references the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards on Mineral Resources and Mineral Reserves (CIM Definition Standards) for definitions of mineral resource and mineral reserve. The definition of mineral reserves, as reported in the CIM Definition Standards, is the guiding definition for this section of the report. The following definitions are from those standards:

A Mineral Reserve is the economically mineable part of a Measured or Indicated Mineral Resource demonstrated by at least a Preliminary Feasibility Study. This Study must include adequate information on mining, processing, metallurgical, economic, and other relevant factors that demonstrate, at the time of reporting, that economic extraction can be justified. A Mineral Reserve includes diluting materials and allowances for losses that may occur when the material is mined.

Mineral reserve, as with mineral resource, is subdivided to indicate the degree of certainty that can be attached to the estimate. For mineral reserve, the following definitions are from the CIM Definition Standards and are applicable to this report:

A "Proven Mineral Reserve" is the economically mineable part of a Measured Mineral Resource demonstrated by at least a Preliminary Feasibility Study. This Study must include adequate information on mining, processing, metallurgical, economic, and other relevant factors that demonstrate, at the time of reporting, that economic extraction is justified.

A "Probable Mineral Reserve" is the economically mineable part of an Indicated, and, in some circumstances, a Measured Mineral Resource demonstrated by at least a Preliminary Feasibility Study. This Study must include adequate information on mining, processing, metallurgical, economic, and other relevant factors that demonstrate, at the time of reporting, that economic extraction can be justified.

In this study, mineral reserve is defined as the measured and indicated mineral resource that would be extracted by the mine design and which can then be processed at a profit. All measured resources meeting that standard are herein classified as proven mineral reserves, while all indicated resources meeting that standard are classified as probable mineral reserves.

Proven and probable reserves are estimated in compliance with CIM Definition Standards and are not compliant with the U.S. Securities and Exchange Commission (SEC) Industry Guide 7. The mineral resource estimate, which is the basis for the engineering studies that estimate reserves, is compliant with CIM Definition Standards, but is not reconciled to SEC Industry Guide 7 within this technical report. The Company cannot be certain that any part of the deposit will ever be confirmed or converted into SEC Industry Guide 7 compliant reserves and makes no such determination within this technical report.

15.2 Parameters for Reserve Estimation

The reserve estimate is based on open-pit mining of the oxide and oxide-with-calcite (OxCa) portions of the mineral resource; all transition, sulfide and inferred mineral resources were excluded from contributing any revenue to the pit optimization analysis. A Lerchs-Grossmann (LG) pit shell was generated using MineSight® software from Mintec to guide the development of an open-pit design. The economic parameters used for the pit optimization are summarized in Table 15.1. Block values were discounted 1% per 10-ft model level, reflecting an annual time-value-of-money discount rate of 8%-12%.

REO recoveries are projected to vary by pit area and ore type (i.e., oxide vs OxCa), but are also dependent on the TREO grade. Table 15.1 lists a simplified range of recoveries that were computed on a block-by-block basis in the deposit model. Holmium, Lutetium, Thulium and Ytterbium oxides are present in the deposit, but at very low concentrations and are not included in projected revenue estimates at the present time.

Provisions for mining dilution have been incorporated into the block model, reflecting a selective mining unit of about 20 x 20 x 20 ft. No additional dilution or ore loss factors have been applied to the reserve estimates.

Table 15.1 - Economic Parameters for Pit Optimization

REO Prices		
REO	US $/lb.	US $/kg
Ce_2O_3	2.87	6.33
Dy_2O_3	338.64	746.56
Er_2O_3	21.42	47.21
Eu_2O_3	379.35	836.33
Gd_2O_3	15.82	34.88
La_2O_3	2.50	5.51
Nd_2O_3	24.04	53.00
Pr_2O_3	34.93	77.02
Sm_2O_3	3.06	6.75
Tb_2O_3	254.55	561.17
Y_2O_3	8.31	18.32

REO Recoveries	
Pit / Ore Type	% Recovery
Bull Hill Oxide	76-82
Bull Hill OxCa	79-90
Whitetail All	69-74

Costs		
Cost Type	$/ton	Basis
Mining	4.50	per ton mined
Incremental Haulage	0.01	per ton mined*
Mine Sustaining Capital	0.40	per ton mined
Stockpile Reclamation	1.10	per ton of crusher feed
Crushing/Screening	11.99	per ton of crusher feed
Physical Upgrade Plant	18.20	per ton of PUG feed
Highway Transport	11.26	per ton of Hydromet feed
Hydrometallurgical Plant	364.00	per ton of Hydromet feed
General & Admin	27.25	per ton of Hydromet feed

* Per 10-ft bench below 6010 elevation

(Rare Element, 2014)

Ten slope sectors were defined by a geotechnical analysis performed by Sierra Geotechnical in a report dated December 6, 2013. The first five sectors pertain to the Bull Hill (southeastern) portion of the deposit and four apply to the Whitetail (northwestern) area. The tenth sector is for all material within approximately 150 ft. of the topographic surface. Table 15.2 summarizes the overall slope angles used in the LG evaluation, which include provisions for internal haul roads.

Table 15.2 - Overall Slope Angles for Pit Optimization

Sector	Pit Area & Wall Location	OSA Degrees
1	Bull Hill NW wall	32
2	Bull Hill N wall	34
3	Bull Hill NE-E wall	34
4	Bull Hill S wall	37
5	Bull Hill W wall	29
6	Whitetail W wall	30
7	Whitetail N wall	34
8	Whitetail E wall	30
9	Whitetail S wall	34
10	All areas, 150 ft. depth	30

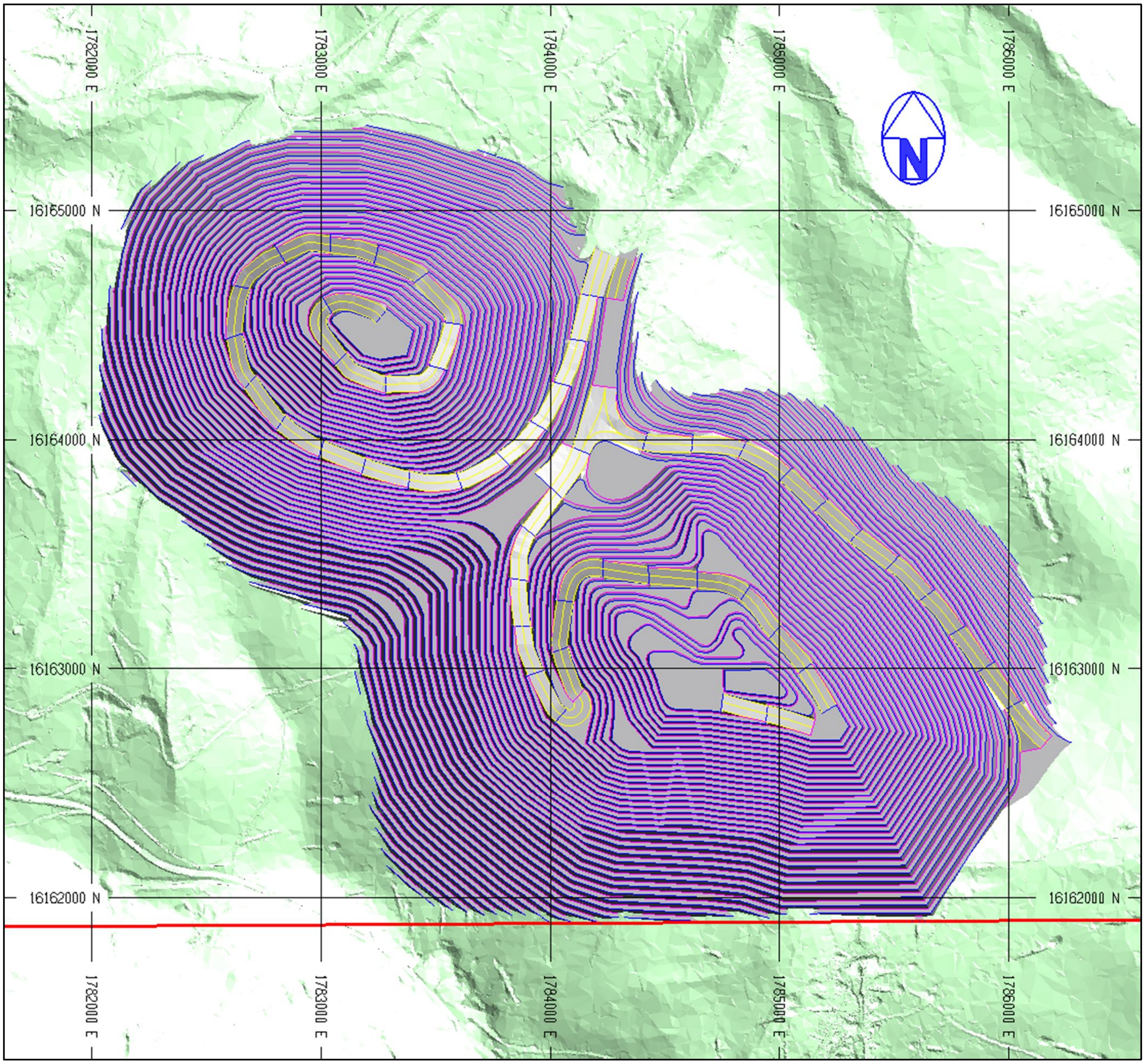
(WLRC, 2014)

A restriction was made on the south side of Bull Hill to prevent the LG pit shell from crossing into Section 20 of T52N, R63W (Sixth Principal Meridian). Mining excavations are not permitted in Section 20 at this time. Restrictions were also placed on sulfide material, including a 100-ft buffer zone above the sulfide contact, to prevent exposure of sulfides in the pit walls for environmental reasons.

In the pit design, walls were smoothed from the basic LG shell to minimize noses and notches that could affect slope stability. Internal 70-ft-wide haulage ramps were included to allow for truck access to working faces. Figure 15-1 illustrates the resulting ultimate pit design; the red line marks the northern edge of Section 20. Grid lines are shown on 1000-ft intervals. The pit length is approximately 4700 ft. along the NW-SE trending long axis, with a maximum width of about 2800 ft. along an orthogonal SW-NE direction.

Mineral reserves are reported inside the designed pit using a cutoff grade of 1.5% TREO for Bull Hill oxide, 1.75% TREO for Bull Hill OxCa and 1.0% for all Whitetail material. These TREO cutoffs vary according to the anticipated performance of the physical upgrade plant for the different ore types and are equal to or higher than the computed breakeven cutoffs.

Figure 15.1 - Ultimate Pit Design



(WLRC, 2014)

15.3 Mineral Reserve Statement

Table 15.3 summarizes the estimated mineral reserves for the Bear Lodge Project, which are based on the criteria and pit design discussed within this section. The effective date of the mineral reserve estimate is June 30, 2014. All of the mineral reserves are included in the estimates of total mineral resources.

Table 15.3 - Bear Lodge Mineral Reserve Estimates

		High Grade			Mid Grade			Total		
		Proven	Probable	Proven + Probable	Proven	Probable	Proven + Probable	Proven	Probable	Proven + Probable
Short Tons	x 1000	1,400	3,900	5,300	1,200	9,100	10,300	2,600	13,000	15,600
Tonnes	x 1000	1,270	3,540	4,810	1,090	8,260	9,340	2,360	11,790	14,150
Average Grade	% TREO	5.17	4.13	4.41	2.36	1.89	1.94	3.87	2.56	2.78
Contained lbs REO	millions	144	319	463	57	343	400	201	662	863
Contained kgs REO	millions	65	145	210	26	156	181	91	300	391
%Cerium Oxide	Ce_2O_3	2.24	1.78	1.90	1.03	0.81	0.83	1.68	1.10	1.19
%Lanthanum Oxide	La_2O_3	1.50	1.13	1.23	0.64	0.48	0.50	1.10	0.67	0.74
%Neodymium Oxide	Nd_2O_3	0.87	0.73	0.77	0.43	0.35	0.36	0.67	0.46	0.50
%Praseodymium Oxide	Pr_2O_3	0.245	0.203	0.214	0.119	0.093	0.096	0.186	0.126	0.136
%Samarium Oxide	Sm_2O_3	0.138	0.119	0.124	0.067	0.061	0.062	0.105	0.078	0.083
%Gadolinium Oxide	Gd_2O_3	0.069	0.063	0.065	0.030	0.036	0.036	0.051	0.044	0.045
%Yttrium Oxide	Y_2O_3	0.049	0.048	0.048	0.018	0.031	0.030	0.035	0.036	0.036
%Europium Oxide	Eu_2O_3	0.029	0.027	0.027	0.014	0.014	0.014	0.022	0.018	0.019
%Dysprosium Oxide	Dy_2O_3	0.0163	0.0169	0.0168	0.0061	0.0108	0.0103	0.0116	0.0126	0.0125
%Terbium Oxide	Tb_2O_3	0.0056	0.0055	0.0055	0.0022	0.0033	0.0032	0.0040	0.0040	0.0040
%Erbium Oxide	Er_2O_3	0.0034	0.0030	0.0031	0.0013	0.0019	0.0018	0.0024	0.0023	0.0023
ppm Thorium	Th	605	549	564	217	431	406	426	466	459
ppm Uranium	U	121	108	112	93	69	72	108	80	85
Cutoffs:										
Bull Hill Oxide	% TREO	>= 3.00			>= 1.50 & < 3.00			>= 1.50		
Bull Hill OxCa	% TREO	>= 3.25			>= 1.75 & < 3.25			>= 1.75		
Whitetail All	% TREO	>= 2.50			>= 1.00 & < 2.50			>= 1.00		

(WLRC, 2014)

Sub-grade and waste rock are estimated at nearly 133 MM tons, for an average stripping ratio of 8.5 (tons waste per ton of mineral reserve). Total material within the ultimate pit, including the above mineral reserves, is estimated at over 148 MM tons.

While treated as waste rock in this study, approximately 12 MM tons of inferred mineral resources grading 2.41% TREO are estimated within the ultimate pit design (above 1.50, 1.75 and 1.00% TREO cutoffs for BH Ox, BH OxCa and WT Ox+OxCa ore types, respectively).

Mineral resources that are not mineral reserves do not have demonstrated economic viability. Inferred mineral resources have a great amount of uncertainty as to their existence and as to whether they can be mined legally or economically. There is no certainty that the any of the estimated inferred mineral resources will be converted to measured or indicated mineral resources.

15.4 Sensitivity of Reserves to Mining, Metallurgical, and other Factors

Higher than expected mining dilution could reduce ore grades, localized siliceous zones may result in some ore losses during processing, flatter pit slopes and wider haul roads could increase the stripping ratio, and higher mining costs would adversely affect project economics. None of these factors, however, are expected to materially affect the tonnage of mineral reserves or the quantity of REO product.

Rare earth prices and metallurgical recoveries have more significant impacts. A 25-30% decrease in net overall prices, recoveries, or a combination thereof would reduce total proven and probable mineral reserves by about 10%. A 40-45% price/recovery decrease would reduce mineral reserves by over 30% and a 55-60% price/recovery decrease would reduce mineral reserves by nearly 80% from the total quantities listed in Table 15.3.

Difficulty in developing markets for the REO products may significantly impact prices, with the affects as noted above. Failure to obtain the necessary approval and/or permits from environmental and other regulatory agencies could eliminate all of the estimated mineral reserves.

16 Mining Methods

16.1 Introduction

The exploitation plan for the Bear Lodge Project utilizes conventional truck and excavator open pit mining methods, focusing on the near-surface, oxidized portions of the deposit. Excavators and/or front-end loaders with bucket sizes ranging from 9-11 cubic yards would load off-highway haul trucks with payload capacities of about 60 tons. Operating bench faces would be 20 ft. high for the proposed scale of operations.

The mine design was created using Mintec's MineSight® software package, which includes a three-dimensional Lerchs-Grossmann (LG) algorithm for pit optimization and extraction sequence analyses. The deposit block model was originally developed by O.R.E. using CAE's Studio 3 software and transferred to WLR Consulting, Inc. (WLRC) in the form of ASCII CSV files containing block grades, tonnage factors, geologic codes, ore types, resource classifications and other data. The model and topographic surface were then loaded into MineSight and the accuracy of the model transfer validated.

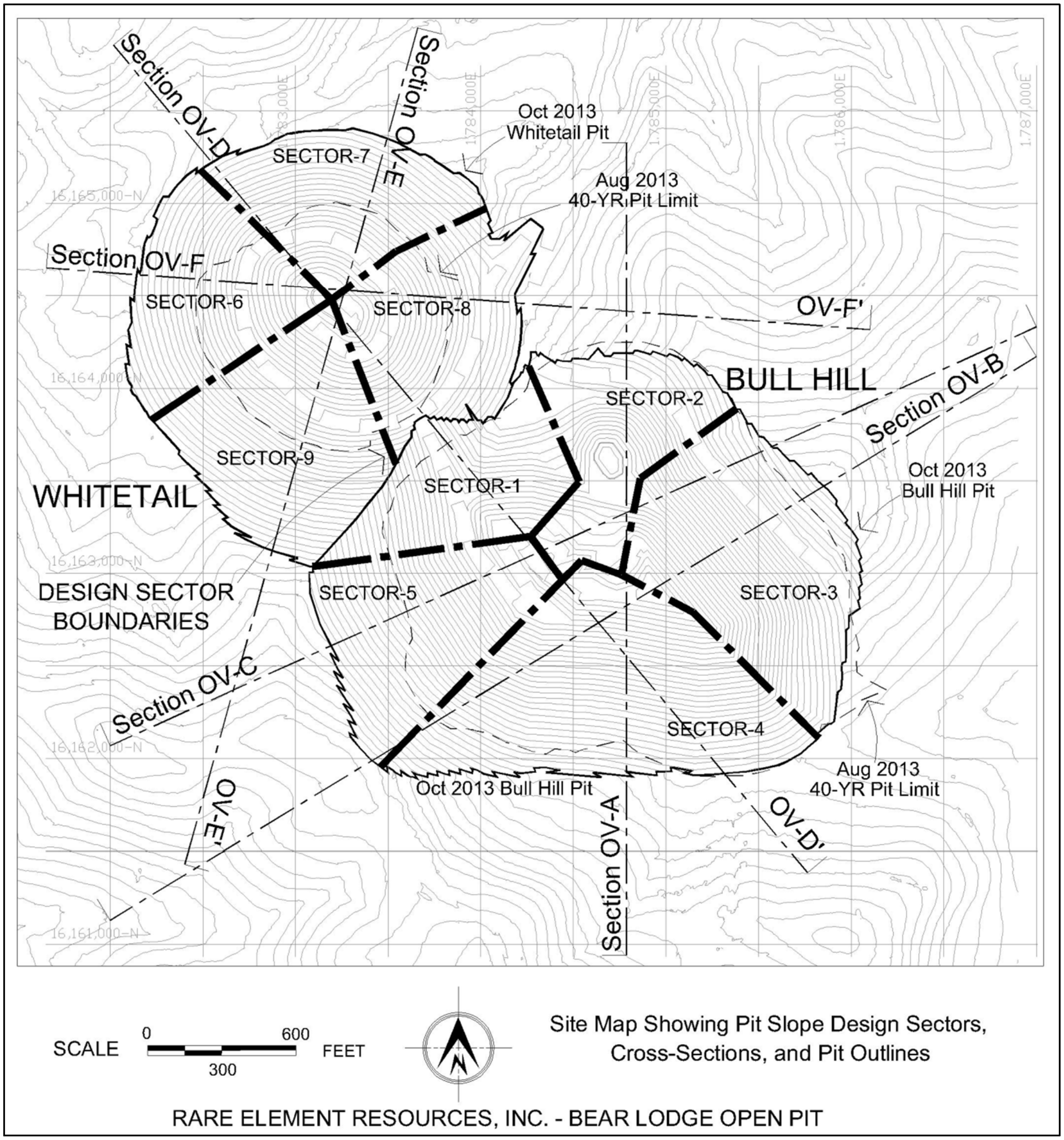
The open pit development sequence was evaluated using the economic and overall slope angle parameters and mining restrictions described in Section 15.2. The REO prices were progressively discounted to lower levels in order to target the mineralized zones with the highest grades for initial development. Only oxide and OxCa measured and indicated mineral resources were considered to be potentially economic in these analyses; transition, sulfide materials are not being mined, and all inferred mineral resources were treated as waste. A series of LG pit shells were generated for use in guiding the design of internal mining phases.

16.2 Mining Phase Designs

Marc Orman of Sierra Geotechnical, based in Chicago Park, California, performed geotechnical data collection and slope stability analyses for the Bear Lodge Project with the purpose of providing pit slope design recommendations.

Recommendations were made for nine slope sectors, plus a near surface zone, based on deposit area, pit wall orientation and the depth below the topographic surface. Figure 16.1 illustrates the slope sector boundaries superimposed on a previous ultimate pit design for the project.

Figure 16.1 - Pit Slope Design Sectors



(Sierra Geotechnical, 2013)

Table 16.1 lists the bench face angles (BFA) and inter-ramp angles (IRA) used in the design of the internal mining phases and ultimate pit. Catch bench intervals are on 20-ft intervals (i.e., single benching) due to generally weak rock mass strengths.

Table 16.1 - Pit Design Inter-Ramp and Bench Face Angles

Sector	Pit Area & Wall Location	IRA Degrees	BFA Degrees
1	Bull Hill NW wall	35	64
2	Bull Hill N wall	39	72
3	Bull Hill NE-E wall	39	72
4	Bull Hill S wall	37	68
5	Bull Hill W wall	35	64
6	Whitetail W wall	35	64
7	Whitetail N wall	39	72
8	Whitetail E wall	35	64
9	Whitetail S wall	39	72
10	All areas, 150 ft depth	30	52

(WLRC, 2014)

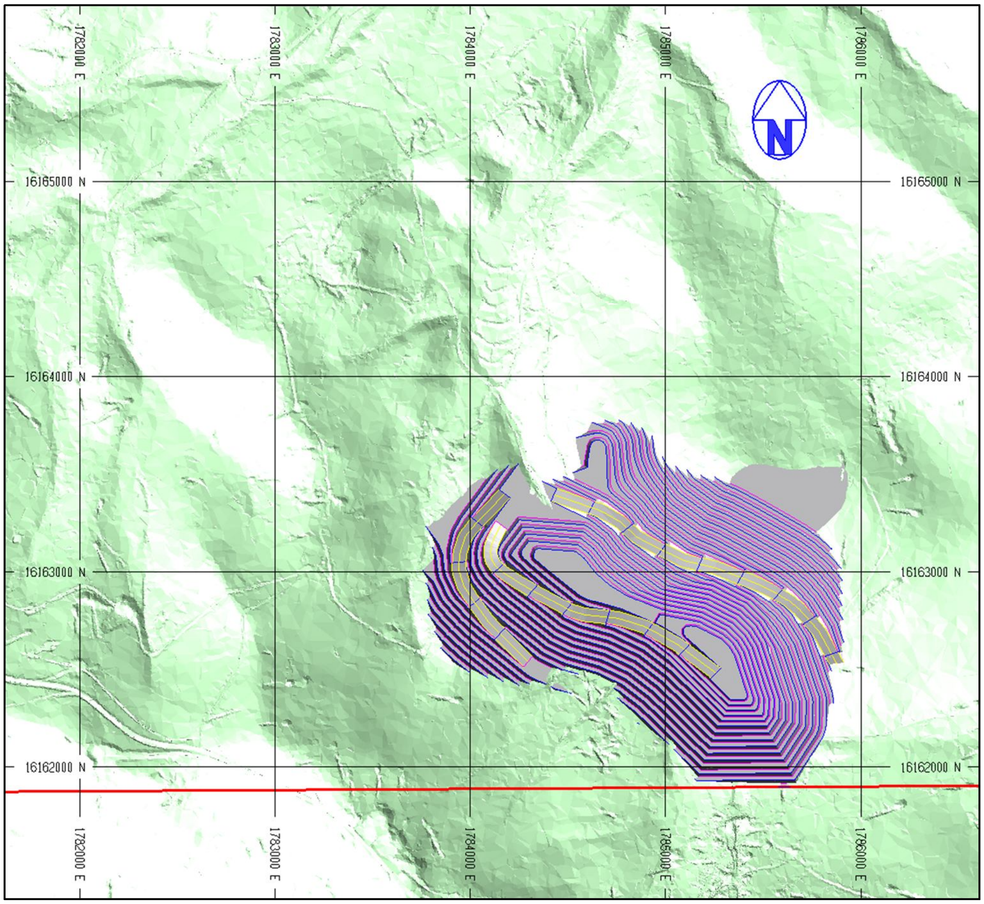
WLRC modified Sierra Geotechnical's IRA recommendations in sectors 2, 3, 7 and 9 by flattening 40+° inter-ramp slopes to a maximum of 39°. Additionally, some bench face angles were adjusted to provide 18- to 19-ft minimum catch bench widths for worker safety and to reflect typical excavation faces left by mining shovels.

Pit walls were designed to fit selected LG shells, minimizing noses and notches for slope stability reasons and incorporate internal haulage ramps to allow truck access to working faces. Ramps were limited to a maximum gradient of 10%. A minimum pushback (phase) width of 150 ft. was used throughout the design process, with typical widths ranging from 200 to 250 ft.

16.3 Mineral Reserve Summary By Phase

Seven mining phases were developed and are identified in the order of mining as: BH1, BH2, WT1, BH3, WT2, BH4, and WT3 (BH signifies Bull Hill phases and WT refers to Whitetail pushbacks). Phase BH2 is subdivided into two parts: the first, BH2a, incorporates a temporary ramp on the east wall; and the second, BH2b, mines out the temporary ramp and deepens the pit bottom. The starter pit, designed to minimize pre-production stripping, is BH1 and is illustrated in Figure 16.2.

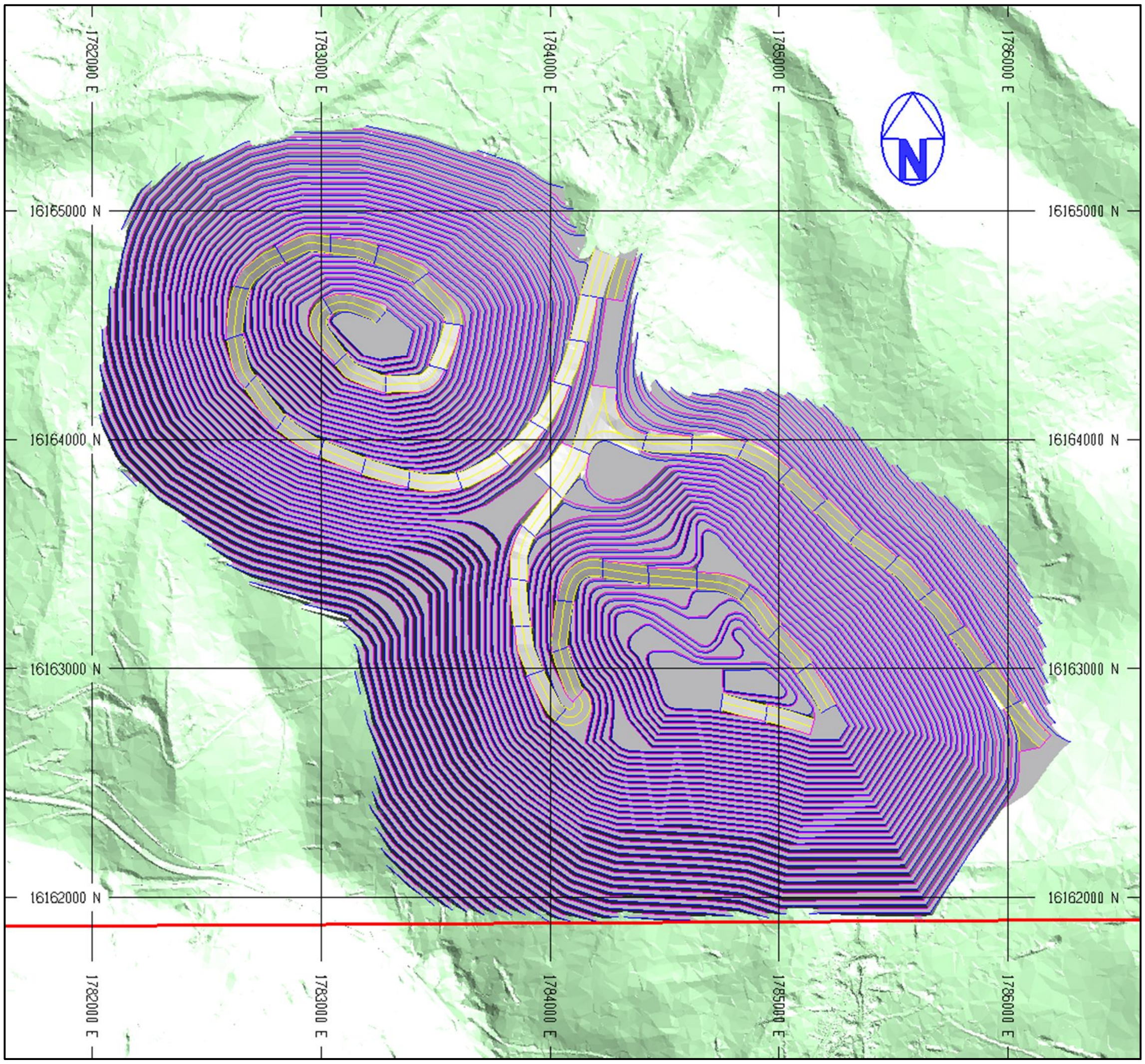
Figure 16.2 - Mining Phase BH1 (Starter Pit)



(WLRC, 2014)

The ultimate pit, defined by the extents of BH4 and WT3 and shown in Figure 16.3, is approximately 4700 ft. along the NW-SE trending long axis, with a maximum width of about 2800 ft along an orthogonal SW-NE direction. The Bull Hill pit bottom is at an elevation of 5580 ft, while the Whitetail pit reaches the 5500 ft bench. The maximum pit wall height is about 840 ft in Bull Hill and 720 ft in Whitetail. The projected groundwater table is at an approximate elevation of 5930 ft, thus requiring pit dewatering as mining progresses below this elevation.

Figure 16.3 - Ultimate Pit Extents (Phases BH4 and WT3)



(WLRC, 2014)

To simplify mineral reserve estimates for the mining phases and subsequent production scheduling analyses, a modified TREO grade (MTREO) was computed to account for variations in the performance of the physical upgrade (PUG) plant on the ore types listed below. The PUG plant is expected to be very effective for Whitetail ore types, but less so for Bull Hill OxCa material.

BH, Oxide:	MTREO% = TREO%
BH, OxCa:	MTREO% = TREO% – 0.25%
Whitetail, Ox & OxCa:	MTREO% = TREO% + 0.50%

Mineral reserves contained within each phase were estimated using the tonnage factors stored in the block model, ranging between 11.01 and 17.79 ft^3/ton (i.e., densities of 2.91 and 1.80 tonnes/m^3, respectively) and averaging 14.52 ft^3/ton (2.21 tonnes/m^3) within the ultimate pit limits. No additional dilution or ore loss factors were applied outside of the provisions already made within the block model.

Table 16.2 summarizes the proven plus probable mineral reserves contained within each of the mining phases above a 1.50% MTREO cutoff. The sum of the mineral reserves by phase agrees with the total proven and probable mineral reserve estimates presented in Section 15.

Table 16.2 - Mineral Reserves by Mining Phase

	Proven+Probable Reserves >= 1.50% MTREO			Waste	Total	Strip
Phase	Ktons	MTREO%	REO%	Ktons	Ktons	Ratio
BH1	2,260	3.69	3.70	14,890	17,150	6.59
BH2a	990	3.29	3.32	13,250	14,240	13.38
BH2b	590	3.31	3.37	2,230	2,820	3.78
WT1	3,020	2.69	2.19	11,690	14,710	3.87
BH3	2,690	3.11	3.21	11,780	14,470	4.38
WT2	2,020	2.29	1.79	17,200	19,220	8.51
BH4	2,740	2.89	3.04	35,320	38,060	12.89
WT3	1,240	2.38	1.88	26,470	27,710	21.35
Total	15,550	2.93	2.78	132,830	148,380	8.54

(WLRC, 2014)

16.4 Mine Production Schedule

A mine production schedule was developed to feed about 179,000 stpy (500 stpd) of upgraded mineral reserves (crushing/screening plus PUG beneficiation) to the hydro-metallurgical plant through the first nine years of operation, after which the plant would be expanded to accept nearly 216,000 stpy (600 stpd) of feed. The Hydromet plant would operate 24 hours per day, 360 days per year.

The mine and highway haulage trucks, for transporting the upgraded mineral reserves to the Hydromet plant, would operate five days per week. Pit operations would be scheduled for two 10-hour shifts per day.

Prior to delivery to the Hydromet plant, some metallurgical ore types would be simply crushed (BH OxCa), most would require crushing and screening (BH oxide and all WT mineral reserves), and most would also be processed through the PUG plant (excluding high grade BH oxide and BH OxCa). Section 17 describes the overall process flow sheet in more detail. In order to calculate the quantity of upgraded mineral reserves delivered to the Hydromet plant, hereafter referred to as "pre-concentrate", WLRC developed a computer program to calculate rock mass and REO recoveries for each metallurgical ore type on a block-by-block basis in the deposit model. WLRC's proprietary open pit mining simulation program was then used to read these recoveries to compute pre-concentrate tonnages and head grades when generating a mine production schedule.

A declining cutoff strategy was employed to maximize the present value of the mining schedule. This strategy incorporated stockpiling lower grade material (proven and probable reserves below the year's cutoff grade, but above the 1.5% MTREO cutoff) for reclamation later in the mine's life. A starting cutoff grade was set at 3.0% MTREO, gradually declining to the near breakeven cutoff of 1.5% MTREO by Year 16. The mining simulator reads in target ore production rates and MTREO cutoffs by time period, and then proceeds to schedule detailed proven plus probable mineral reserve estimates by bench, by mining phase. The program estimates advanced stripping requirements, respecting user controls of ore exposure markers for each phase, phase dependencies (no undercutting previous pushbacks) and sinking rates. The resulting production schedule is reported and the user then reviews the estimated Hydromet plant feed and makes corrections to the targeted ore tonnages by time period. Through successive iterations, a mine production schedule can be developed that feeds pre-concentrate at the Hydromet plant's capacity, while meeting advance stripping requirements for continuous ore development in the open pit.

Table 16.3 summarizes the proposed mine production schedule for the Bear Lodge Project for the pre-production period and annually thereafter. Pre-production stripping requirements are estimated at just over 6.9 million tons of material, including 19 ktons of high-grade stockpile and 63 ktons of low-grade stockpile. Pre-concentrate feed rates would be 179 ktons per annum through Year 9, then 216 ktons per annum thereafter. Open pit mining would last through the end of Year 38, after which 2.85 million tons of stockpiled low-grade mineral reserves would be processed until depleted in Year 45. No sulfide or transitional material would be mined over the course of open pit operations; consequently, no surfaces in the ultimate pit walls are expected to expose sulfide mineralization.

Total mine production during Years 2-14 would generally range between 3.5 and 3.9 million tpy, or about 14,000 to 15,600 tpd for 250 pit operating days per year. Peak mining rates during Years 15-28 would range between 4.5 and 4.7 million tpy of total material, or about 18,000 to 18,800 tpd. Over the life of the project, total material handling is estimated at 151.2 million tons, including 19 ktons of high-grade stockpile and 2.85 MM tons of low-grade stockpile recovery.

Excluding the pre-production stripping period, the open pit mine life is estimated at 38 years under the proposed mine production schedule. Hydromet plant operations are projected for 45 years.

A one year pre-production stripping period is planned to remove approximately 7 million tons of waste material to allow access for production mining. The waste stripping will be performed by a contractor at an estimated cost of $3.40 per ton, totaling $23.4 million. Blasting operations, loading, hauling, dozing waste into lifts, mobilization/de-mobilization and contractor profit are included in this unit cost. The contractor assumes a fleet of nine to ten 100-ton trucks and an average one-way haul distance of about 5,000 feet.

Table 16.3 - Bear Lodge Mine Production Schedule

Time	MTREO%	Proven and Probable Mineral Reserves Mined and/or Processed (>= declining MTREO cutoffs)																Pre-Concentrate		Low Grade Stockpile (>= 1.5% MTREO Cutoff)						Waste	Total	Strip
Period	Cutoff	Ktons	MTREO%	REO%	Ce_2O_3%	Dy_2O_3%	Er_2O_3%	Eu_2O_3%	Gd_2O_3%	La_2O_3%	Nd_2O_3%	Pr_2O_3%	Sm_2O_3%	Tb_2O_3%	Y_2O_3%	Th ppm	U ppm	Ktons	REO%	Ktons	MTREO%	REO%	Ce_2O_3%	La_2O_3%	Nd_2O_3%	Ktons	Ktons	Ratio
PP	3.00	19	5.14	5.14	2.16	0.0288	0.0055	0.037	0.097	1.57	0.77	0.228	0.146	0.0093	0.087	1050	77			63	2.18	2.18	0.97	0.59	0.38	6,827	6,908	366.5
1	3.00	220	5.95	5.96	2.58	0.0213	0.0046	0.033	0.082	1.80	0.93	0.281	0.148	0.0070	0.066	775	118	179	6.73	257	2.14	2.14	0.94	0.58	0.38	3,514	3,990	17.1
2	3.00	219	5.44	5.45	2.36	0.0173	0.0037	0.030	0.071	1.62	0.89	0.258	0.138	0.0058	0.052	607	120	179	6.15	286	2.15	2.16	0.94	0.58	0.39	3,364	3,869	16.7
3	3.00	219	5.24	5.25	2.27	0.0161	0.0033	0.029	0.067	1.53	0.88	0.252	0.136	0.0054	0.048	542	122	179	5.91	265	2.16	2.17	0.95	0.58	0.40	3,385	3,869	16.7
4	2.75	226	4.95	4.96	2.14	0.0151	0.0030	0.028	0.064	1.44	0.85	0.240	0.131	0.0051	0.045	493	126	179	5.71	190	2.05	2.05	0.89	0.54	0.38	3,460	3,876	16.2
5	2.75	212	5.22	5.29	2.30	0.0185	0.0037	0.031	0.073	1.55	0.86	0.248	0.139	0.0062	0.057	748	117	179	5.85	149	2.12	2.14	0.93	0.58	0.39	3,501	3,862	17.2
6	2.50	236	4.05	4.07	1.84	0.0081	0.0016	0.020	0.044	1.13	0.69	0.202	0.102	0.0031	0.024	314	116	179	4.86	142	2.04	2.05	0.91	0.55	0.37	3,108	3,486	13.8
7	2.50	232	3.88	3.89	1.70	0.0104	0.0019	0.022	0.049	1.08	0.70	0.192	0.107	0.0038	0.028	375	117	179	4.75	136	1.99	1.91	0.84	0.50	0.35	3,114	3,482	14.0
8	2.25	251	3.70	3.66	1.57	0.0119	0.0021	0.022	0.051	1.00	0.66	0.182	0.106	0.0041	0.032	426	118	179	4.80	100	1.83	1.66	0.72	0.42	0.31	3,150	3,501	12.9
9	2.25	275	3.63	3.53	1.51	0.0129	0.0023	0.023	0.053	0.97	0.63	0.175	0.104	0.0044	0.035	470	103	179	4.92	135	1.84	1.66	0.72	0.43	0.30	3,115	3,525	11.8
10	2.00	392	3.37	3.12	1.30	0.0181	0.0031	0.025	0.060	0.83	0.57	0.152	0.102	0.0057	0.048	637	93	216	5.09	160	1.69	1.31	0.55	0.32	0.24	3,090	3,642	8.3
11	2.00	424	3.31	3.00	1.23	0.0203	0.0035	0.025	0.063	0.78	0.55	0.146	0.101	0.0063	0.056	641	92	216	5.20	220	1.70	1.29	0.54	0.32	0.23	3,031	3,674	7.7
12	2.00	536	3.29	2.82	1.13	0.0246	0.0042	0.027	0.070	0.72	0.52	0.136	0.102	0.0073	0.069	723	86	216	5.65	341	1.68	1.22	0.51	0.30	0.22	2,909	3,786	6.1
13	1.75	549	3.04	2.54	1.02	0.0233	0.0041	0.025	0.065	0.64	0.47	0.122	0.093	0.0069	0.067	717	82	216	5.14	198	1.60	1.10	0.45	0.28	0.19	3,052	3,799	5.9
14	1.75	444	2.89	2.58	1.09	0.0162	0.0030	0.021	0.052	0.66	0.48	0.128	0.086	0.0050	0.048	526	84	216	4.53	147	1.60	1.26	0.53	0.32	0.23	3,103	3,694	7.3
15	1.75	328	3.06	3.06	1.36	0.0068	0.0013	0.017	0.038	0.83	0.55	0.154	0.084	0.0025	0.020	220	94	216	4.04	60	1.63	1.63	0.71	0.42	0.31	4,140	4,528	12.8
16	1.50	322	2.93	2.95	1.31	0.0072	0.0013	0.017	0.038	0.79	0.53	0.147	0.082	0.0026	0.021	273	90	216	3.83							4,200	4,522	13.0
17	1.50	293	3.39	3.46	1.52	0.0089	0.0017	0.019	0.043	0.97	0.60	0.168	0.093	0.0032	0.026	358	94	216	4.17							4,200	4,493	14.3
18	1.50	285	3.36	3.44	1.51	0.0089	0.0017	0.019	0.042	0.97	0.60	0.167	0.093	0.0032	0.026	345	97	216	4.11							4,200	4,485	14.7
19	1.50	286	3.24	3.30	1.45	0.0091	0.0018	0.019	0.041	0.92	0.59	0.162	0.091	0.0032	0.026	344	96	216	3.97							4,200	4,486	14.7
20	1.50	292	3.13	3.15	1.38	0.0096	0.0019	0.018	0.040	0.87	0.56	0.154	0.087	0.0032	0.028	359	93	216	3.85							4,200	4,492	14.4
21	1.50	302	3.02	3.00	1.31	0.0102	0.0020	0.017	0.040	0.82	0.53	0.147	0.083	0.0033	0.030	377	90	215	3.77							4,200	4,502	13.9
22	1.50	325	2.81	2.73	1.19	0.0106	0.0021	0.017	0.040	0.74	0.49	0.133	0.077	0.0034	0.031	401	84	216	3.61							4,200	4,525	12.9
23	1.50	459	2.38	2.02	0.86	0.0143	0.0025	0.016	0.042	0.52	0.36	0.097	0.064	0.0042	0.042	561	63	216	3.56							4,200	4,659	9.2
24	1.50	321	2.69	2.74	1.23	0.0066	0.0014	0.015	0.035	0.73	0.49	0.137	0.076	0.0024	0.020	215	94	216	3.59							4,200	4,521	13.1
25	1.50	299	2.87	2.94	1.30	0.0073	0.0015	0.016	0.036	0.78	0.53	0.148	0.081	0.0026	0.022	254	98	216	3.67							4,200	4,499	14.0
26	1.50	547	2.35	1.85	0.76	0.0173	0.0030	0.017	0.047	0.45	0.34	0.088	0.066	0.0050	0.050	703	55	216	3.73							4,200	4,747	7.7
27	1.50	547	2.33	1.83	0.75	0.0169	0.0029	0.018	0.047	0.44	0.34	0.088	0.067	0.0050	0.048	718	56	216	3.70							4,200	4,747	7.7
28	1.50	414	2.57	2.31	1.00	0.0123	0.0021	0.017	0.042	0.59	0.42	0.115	0.073	0.0039	0.035	512	70	215	3.71							4,200	4,614	10.1
29	1.50	293	3.04	3.15	1.41	0.0068	0.0014	0.017	0.037	0.84	0.57	0.159	0.084	0.0025	0.020	232	88	216	3.83							4,000	4,293	13.7
30	1.50	274	3.09	3.24	1.44	0.0071	0.0015	0.018	0.039	0.88	0.58	0.162	0.088	0.0027	0.020	245	92	215	3.77							4,000	4,274	14.6
31	1.50	268	3.11	3.26	1.43	0.0082	0.0017	0.018	0.040	0.89	0.59	0.161	0.089	0.0029	0.024	273	104	216	3.76							4,000	4,268	14.9
32	1.50	331	2.80	2.70	1.17	0.0127	0.0023	0.018	0.043	0.71	0.49	0.133	0.080	0.0039	0.037	488	85	216	3.76							4,000	4,331	12.1
33	1.50	535	2.40	1.92	0.79	0.0174	0.0029	0.018	0.049	0.46	0.36	0.092	0.070	0.0052	0.050	754	55	216	3.81							3,436	3,971	6.4
34	1.50	293	2.85	2.89	1.26	0.0097	0.0019	0.018	0.042	0.76	0.53	0.144	0.084	0.0033	0.028	367	97	217	3.59							535	828	1.8
35	1.50	246	2.95	3.19	1.41	0.0072	0.0015	0.018	0.039	0.85	0.59	0.160	0.089	0.0027	0.021	229	114	215	3.43							358	604	1.5
36	1.50	246	2.85	3.09	1.37	0.0072	0.0015	0.017	0.038	0.81	0.58	0.156	0.088	0.0026	0.021	222	115	216	3.32							258	504	1.0
37	1.50	333	2.56	2.46	1.06	0.0116	0.0021	0.018	0.043	0.62	0.46	0.123	0.078	0.0037	0.033	459	90	216	3.48							737	1,070	2.2
38	1.50	422	2.43	2.11	0.89	0.0139	0.0024	0.018	0.046	0.52	0.40	0.104	0.075	0.0044	0.039	625	69	216	3.54							1,044	1,466	2.5
39	1.50	422	1.91	1.73	0.75	0.0078	0.0014	0.012	0.029	0.45	0.31	0.086	0.053	0.0025	0.023	313	67	216	2.83							0	422	0.0
40	1.50	422	1.91	1.73	0.75	0.0078	0.0014	0.012	0.029	0.45	0.31	0.086	0.053	0.0025	0.023	313	67	216	2.83							0	422	0.0
41	1.50	422	1.91	1.73	0.75	0.0078	0.0014	0.012	0.029	0.45	0.31	0.086	0.053	0.0025	0.023	313	67	216	2.83							0	422	0.0
42	1.50	422	1.91	1.73	0.75	0.0078	0.0014	0.012	0.029	0.45	0.31	0.086	0.053	0.0025	0.023	313	67	216	2.83							0	422	0.0
43	1.50	422	1.91	1.73	0.75	0.0078	0.0014	0.012	0.029	0.45	0.31	0.086	0.053	0.0025	0.023	313	67	216	2.83							0	422	0.0
44	1.50	422	1.91	1.73	0.75	0.0078	0.0014	0.012	0.029	0.45	0.31	0.086	0.053	0.0025	0.023	313	67	216	2.83							0	422	0.0
45	1.50	315	1.91	1.73	0.75	0.0078	0.0014	0.012	0.029	0.45	0.31	0.086	0.053	0.0025	0.023	313	67	161	2.83							0	315	0.0
Total		**15,562**	**2.93**	**2.78**	**1.19**	**0.0125**	**0.0023**	**0.019**	**0.045**	**0.74**	**0.50**	**0.136**	**0.083**	**0.0040**	**0.036**	**459**	**85**	**9,328**	**4.01**	**2,847**	**1.91**	**1.73**	**0.75**	**0.45**	**0.31**	**132,829**	**151,239**	**8.7**

Notes: The 19 ktons of mineral reserves mined during preproduction would be placed into a ROM stockpile and reclaimed to augment hydromet plant feed in Year 38.
The 2.85 MM tons of low grade mineral reserves stockpiled during PP-Y15 would be reclaimed, upgraded and delivered to the hydromet plant in Y39-Y45 as shown above.
All mineral reserves shown in this table are included in the estimates of mineral resources.

(WLRC, 2014)

16.5 Waste Rock Facility Design

A preliminary design of a Waste Rock Facility (WRF) has been developed over the eastern slope of the ridgeline that runs north-south between the WRF and the open pit mine to the west. The proposed WRF layout has the capacity to store up to 133 million tons of mine waste and PUG reject material. Additionally, a low-grade ore stockpile will be located in the northwest corner of the WRF with a capacity of approximately 3 million tons of low-grade ore. The layout of the WRF and associated sediment control features are within the Section 16 parcel to avoid disturbance of USFS land. The crest of the waste rock dump is designed to an elevation of 6,260 ft. above mean sea level (amsl). This elevation is equal to or less than the ridgeline elevations that runs between the open pit mine and the WRF.

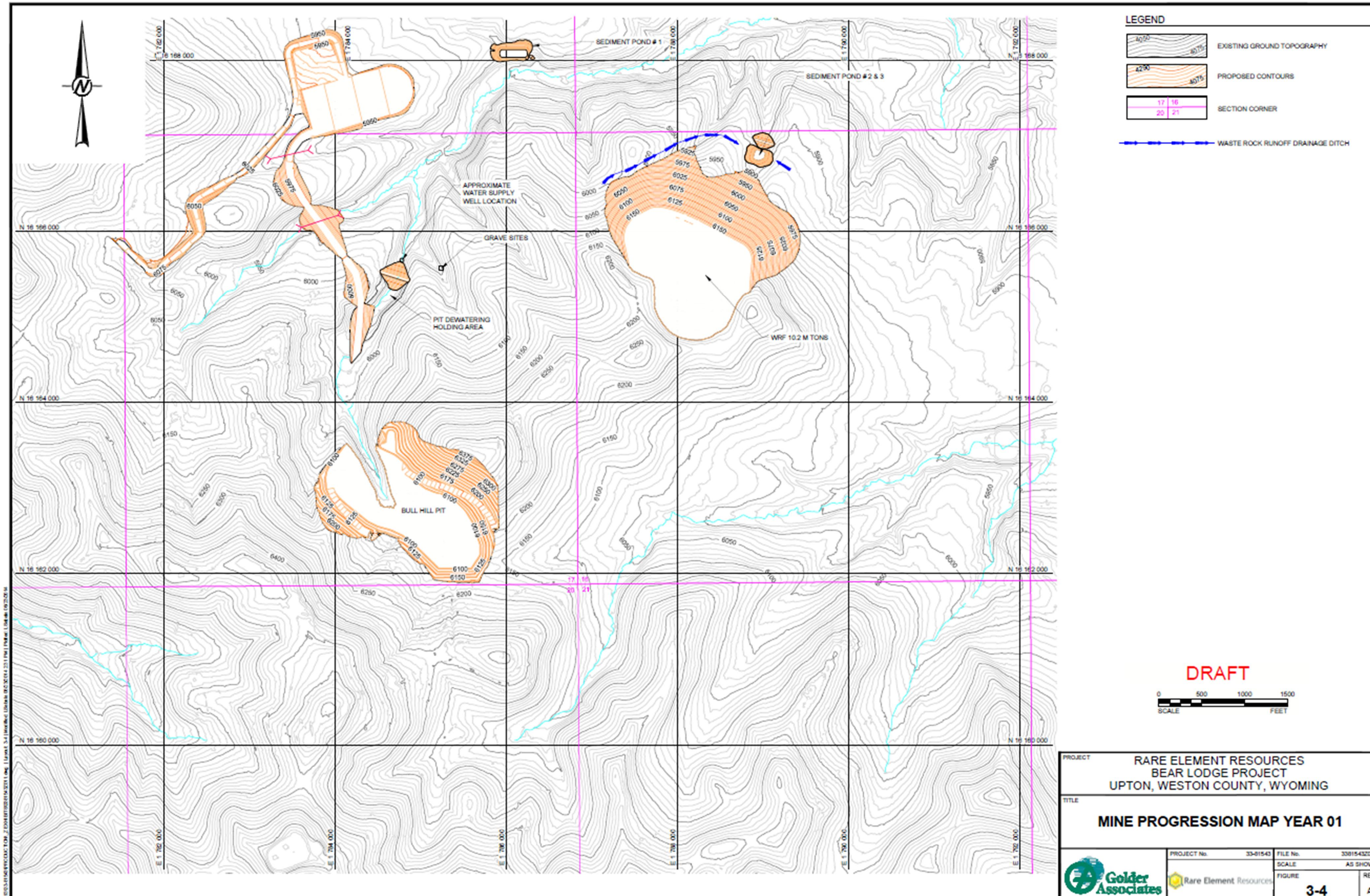
The WRF design capacity assumed a 30% swell factor for the waste material. Construction of the WRF will be completed by benching the waste material in lifts up to 50 ft. in height with bench face slopes being constructed at the angle of repose (approximately 1.4H:1V). Benches will be constructed in such a manner as to maintain an overall side slope of 3H:1V. Closure of the facility will include laying back the bench face slopes to a 3H:1V angle. Concurrent reclamation will be incorporated in areas where dumping activities have been completed and will be shaped to blend the natural topography surrounding the WRF. Based on the existing topography within Section 16 and a maximum height of the WRF set at 1650 ft., the southern portion of the WRF will extend across Beaver Creek. Therefore, a permanent diversion of Beaver Creek around the WRF is included in the WRF surface water management plan.

Development of the WRF will be staged in a manner to delay the diversion of Beaver Creek until after operation Year 15. Initially, the north area of the WRF will be developed to keep surface water runoff and sediment control requirements out of the Beaver Creek drainage. As the waste rock dump area expands and extends into the Beaver Creek drainage area, temporary WRF runoff diversion ditches will be constructed to route and collect runoff away from Beaver Creek. Progress maps showing the staging of the WRF and surface water diversion/sediment control structures over the LOM are shown in Figures 16.4 through 16.13.

The preliminary WRF design includes foundation preparation and surface water management features. Foundation preparation will involve cutting and removing trees and underbrush, removal of topsoil for reclamation, and removal of any unsuitable material for slope stability purposes. An underdrain collection system will be installed in drainages within the footprint of the waste rock dump as needed to intercept water from naturally occurring seeps and springs, as well as seepage from the dump. The underdrains will be routed to discharge into sediment control structures for water quality sampling purposes prior to discharge into the receiving drainage/stream. Surface water diversion ditches along the toe of the waste rock are located as needed to collect and route runoff from the waste dump to a sediment control structure to prevent direct discharge into receiving waters. Based on the Wyoming Department of Environmental Quality, Land Quality Division Guidelines, the runoff conveyance structures (ditches, pipes, spillways, etc.) are sized to convey peak flows generated for the 100-year, 6-hour design storm event. The sediment control structures are to have sufficient capacity to accumulate one year of sediment generation from the contributing catchment area, plus average monthly operations, plus containment of the 10-year, 24-hour storm event, plus safely route and discharge peak flow from the 100-year, 6-hour design storm event. The sediment control structure capacities will be confirmed in later designs to meet these requirements. Low level outlet works for normal operations will consist of a manually-operated gated outlet structure at the upstream toe and buried discharge pipeline under the dam.

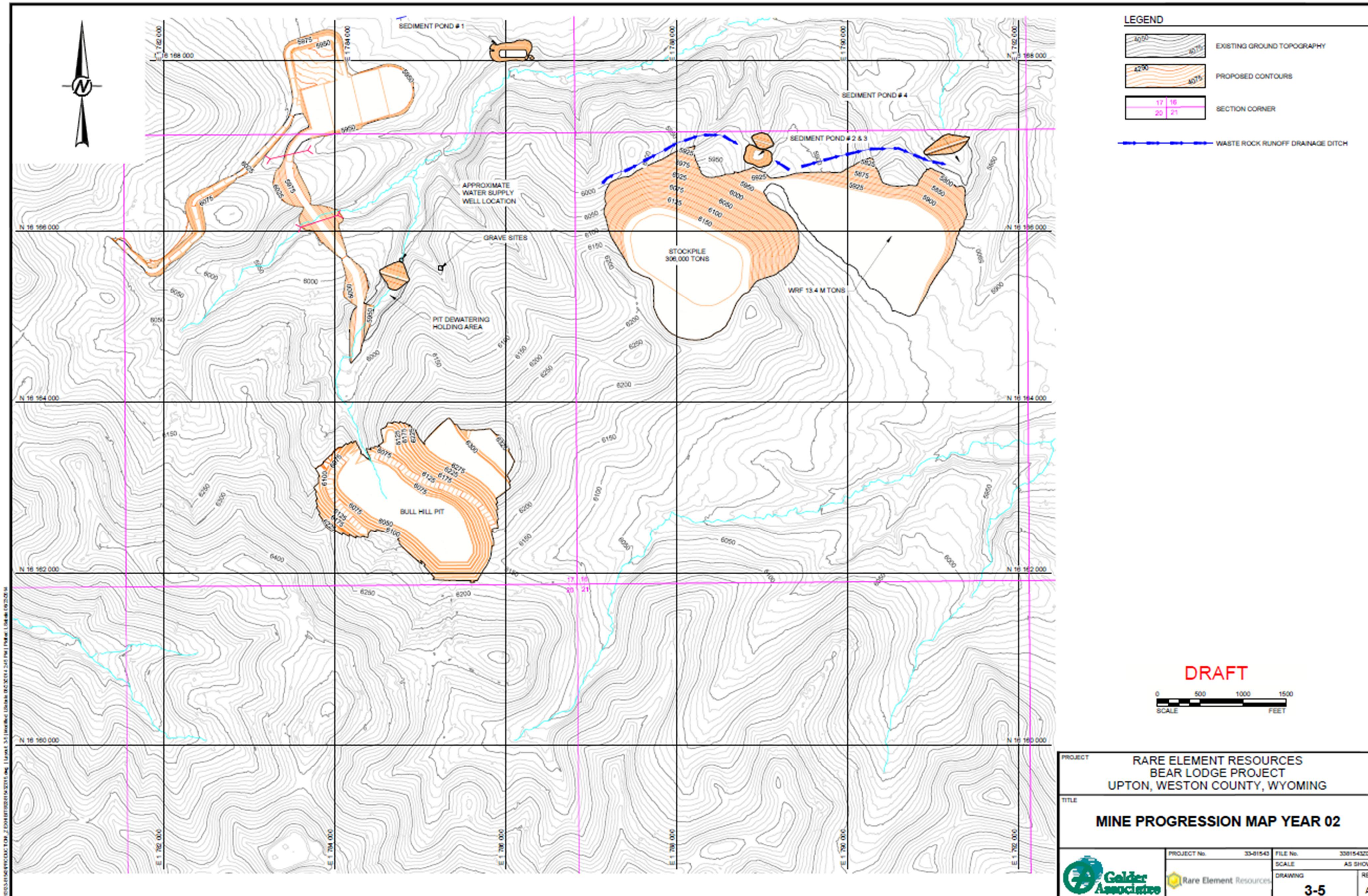
Waste material will report to the WRF starting with the pre-production period through Year 38. Low-grade ore will report to the low-grade ore stockpile within the WRF between preproduction and Year 15. Table 16.3, presented in Section 16.4, is a LOM summary of the waste mining schedule and of low-grade ore placement in and recovery from the WRF.

Figure 16.4 - Year 1 WRF Layout



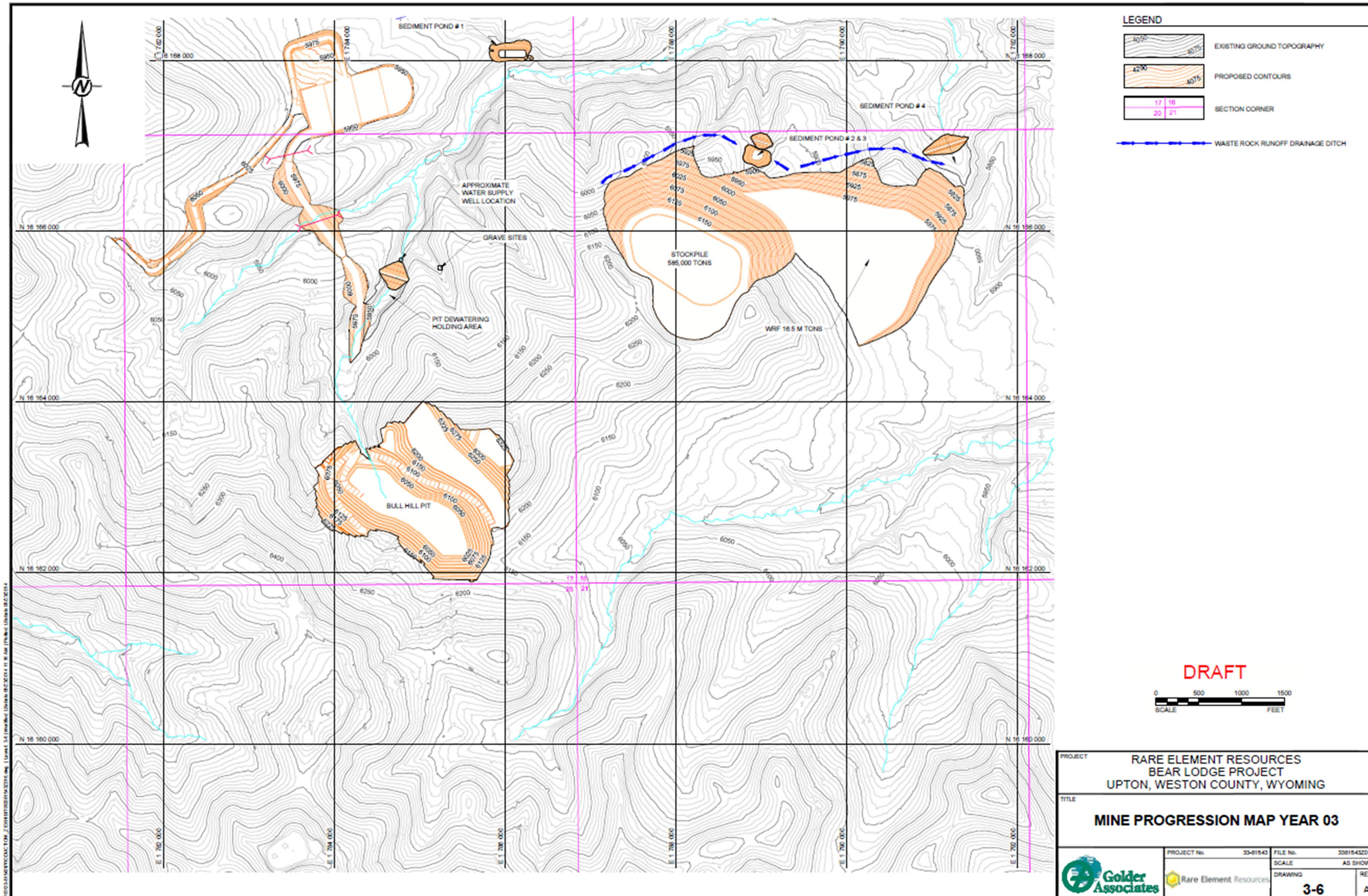
(Golder, 2014)

Figure 16.5 - Year 2 WRF Layout



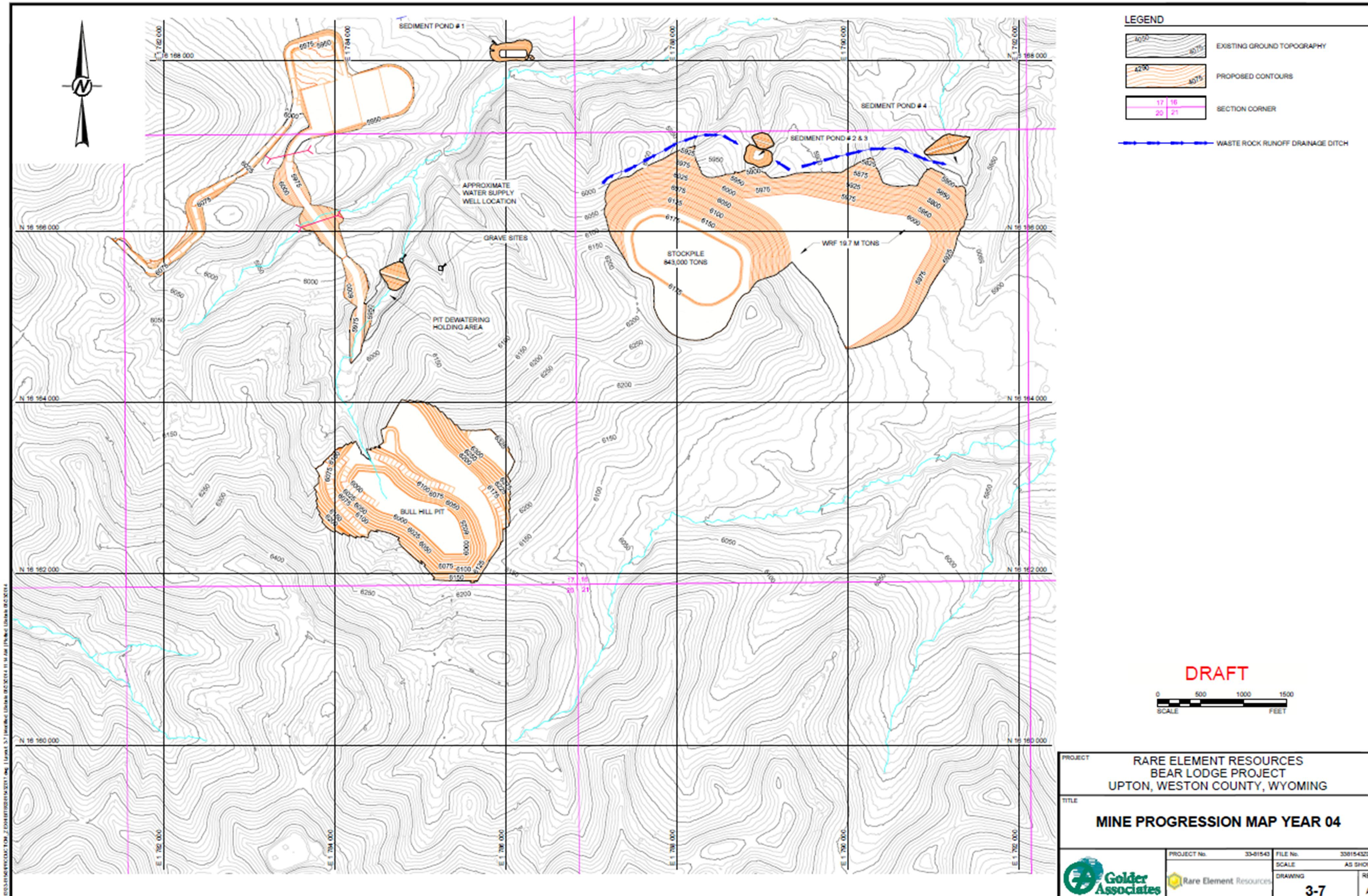
(Golder, 2014)

Figure 16.6 - Year 3 WRF Layout



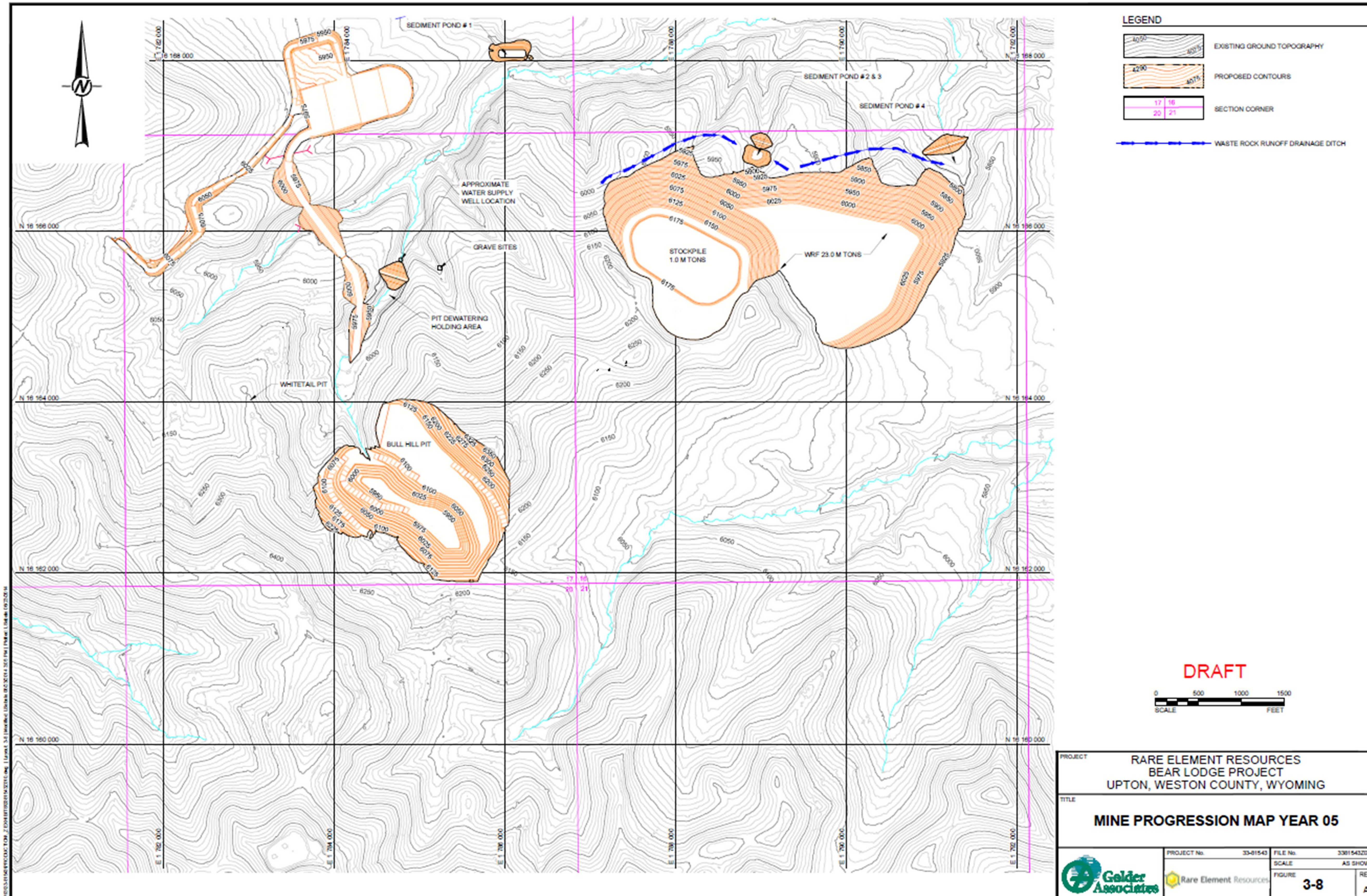
(Golder, 2014)

Figure 16.7 - Year 4 WRF Layout



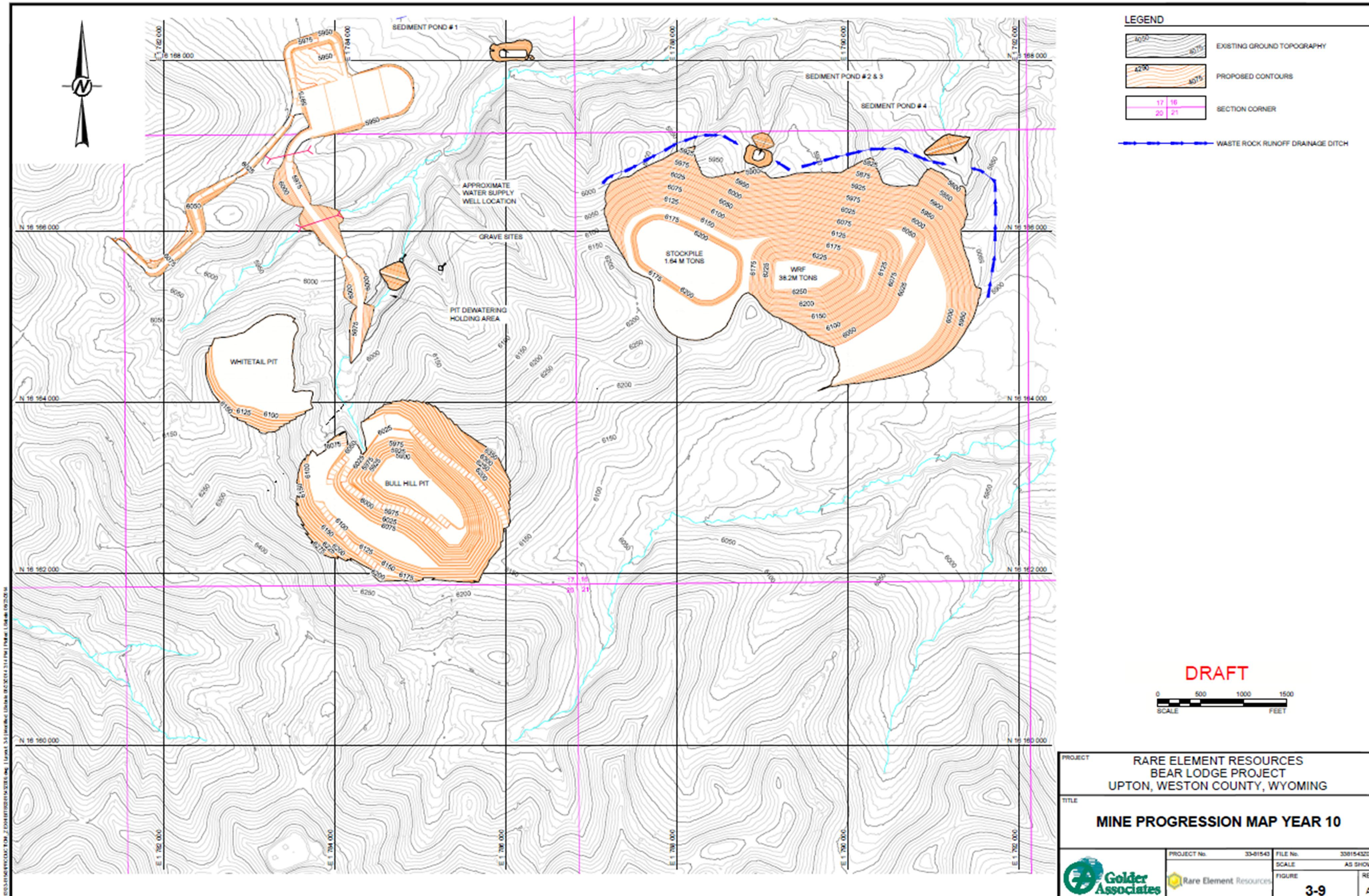
(Golder, 2014)

Figure 16.8 - Year 5 WRF Layout



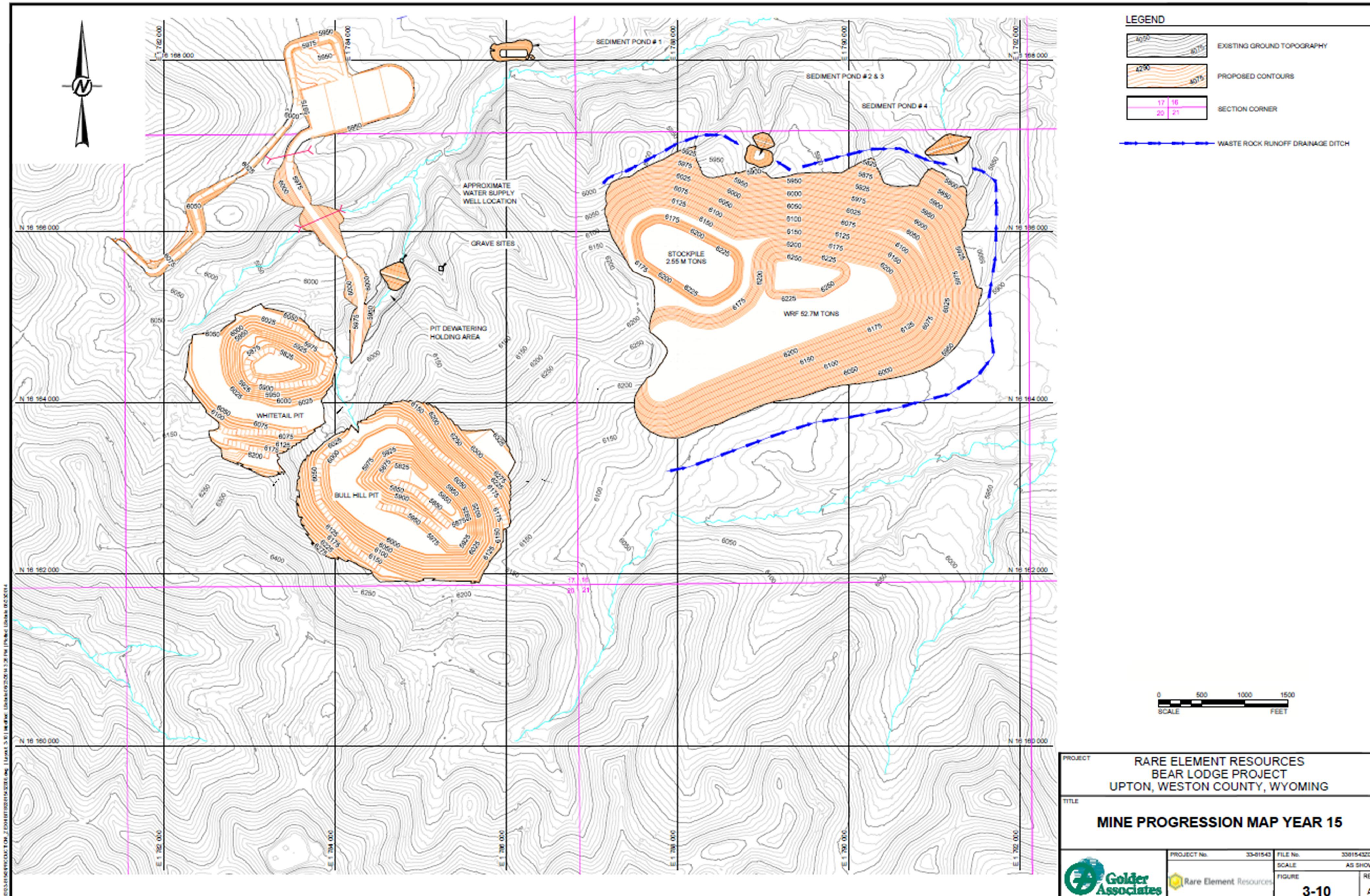
(Golder, 2014)

Figure 16.9 - Year 10 WRF Layout



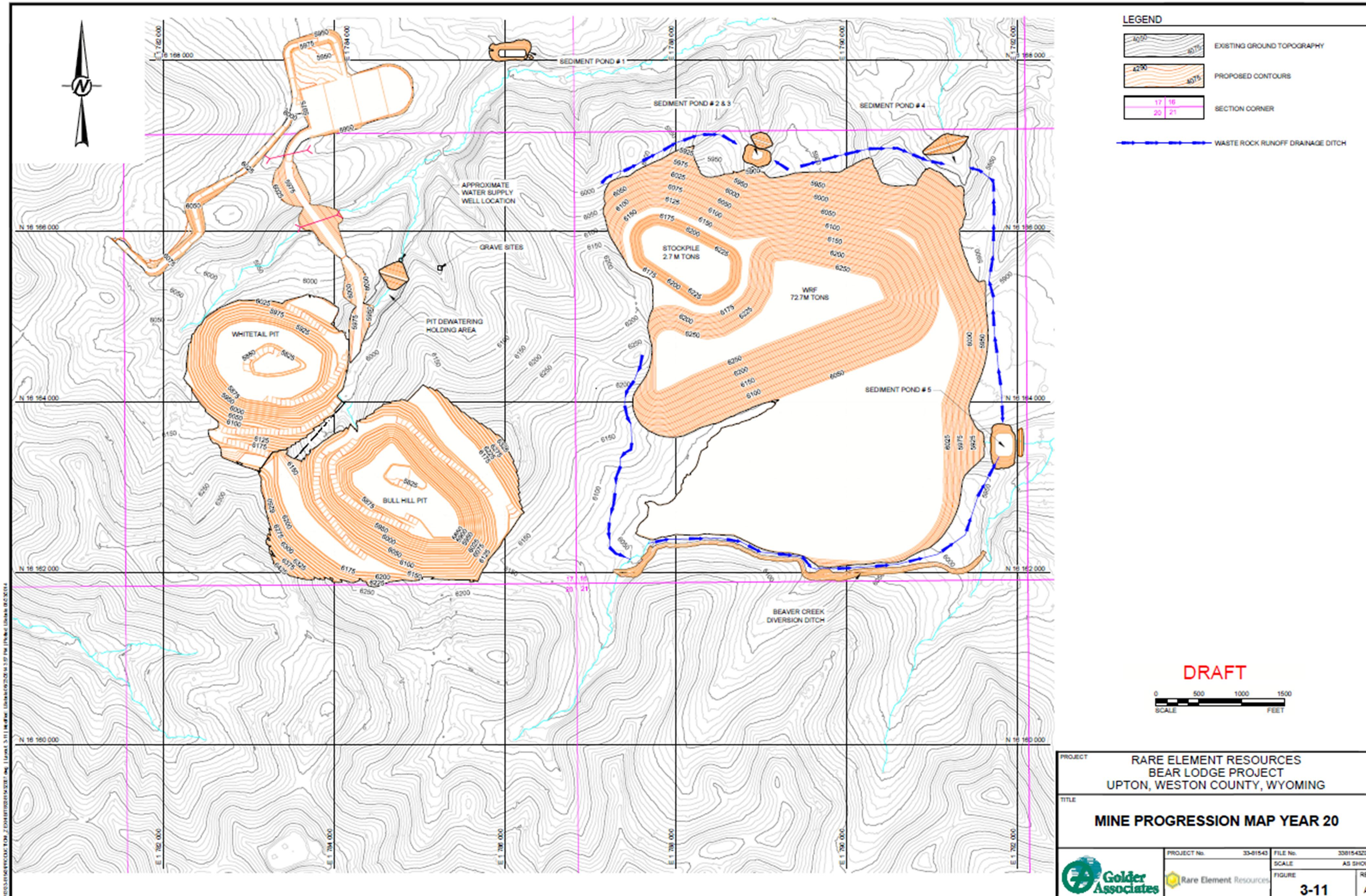
(Golder, 2014)

Figure 16.10 - Year 15 WRF Layout



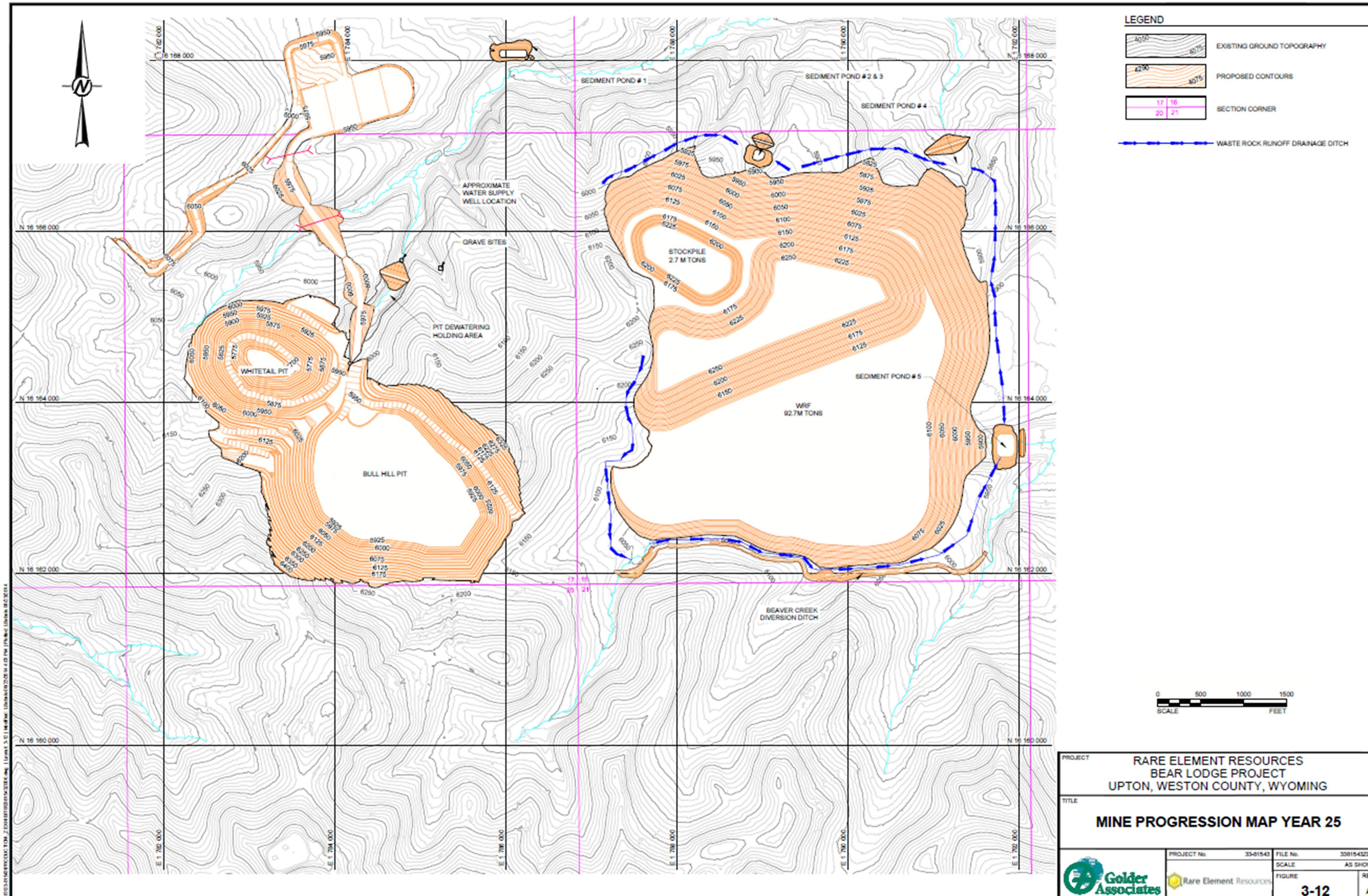
(Golder, 2014)

Figure 16.11 - Year 20 WRF Layout



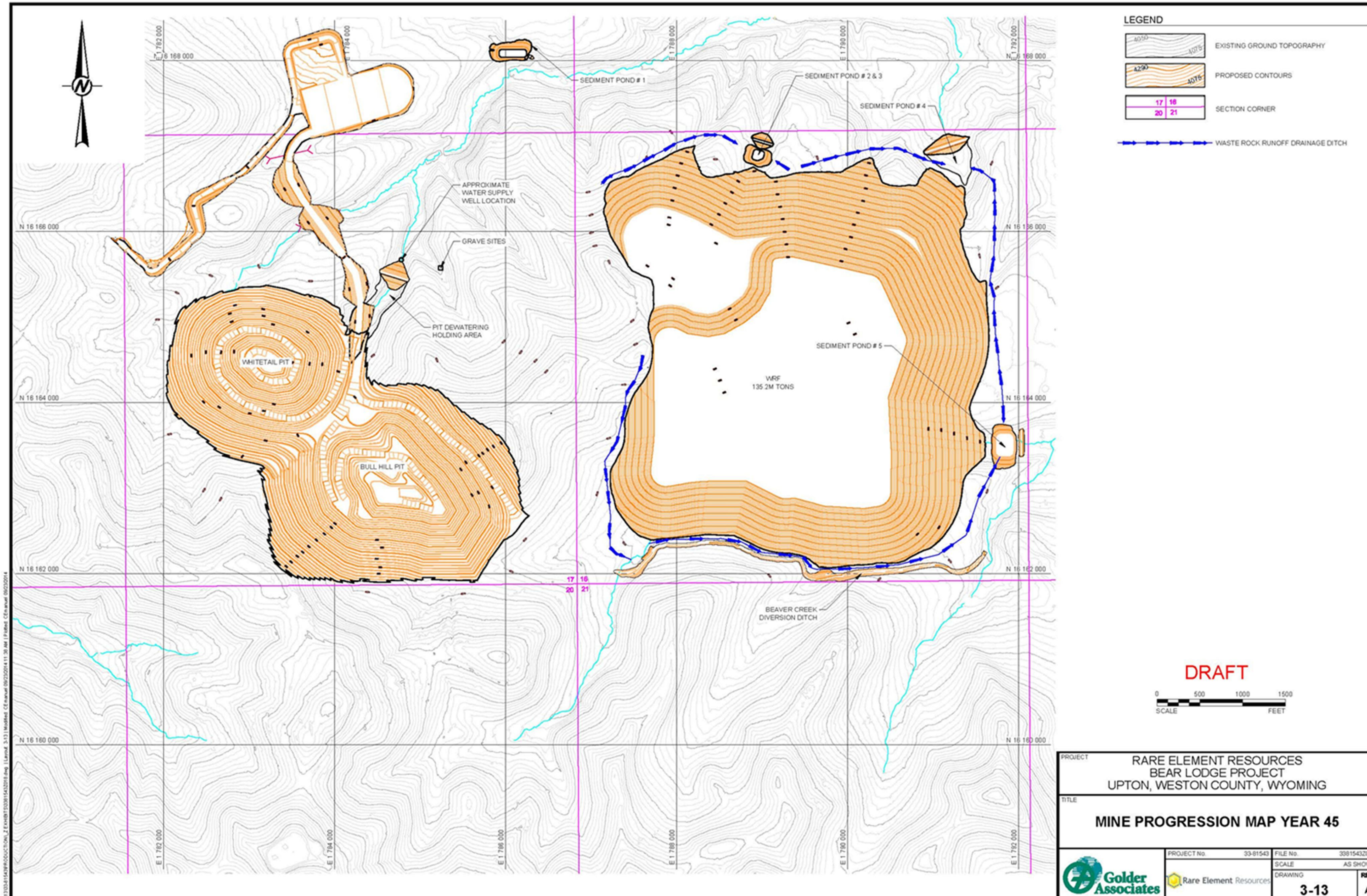
(Golder, 2014)

Figure 16.12 - Year 25 WRF Layout



(Golder, 2014)

Figure 16.13 - Year 45 WRF Layout



(Golder, 2014)

16.6 Mining Equipment Selection and Fleet Requirements

The capital costs of both equipment and support items are reported in Chapter 21. A mining equipment list is presented in Table 16.4. It was assumed that each piece of mobile equipment would be rebuilt according to the manufacturers' specifications, and the equipment would be replaced at the end of its typical service life. Replacement capital is included in the mining capital cost estimate.

Table 16.4 - Mining Equipment List

Machine / Item	Initial Equipment Year -1	Sustaining Equipment LOM
	Units	Units
STRIPPING & LOADING MACHINES		
Caterpillar 6015B - Shovel	1	1
Caterpillar 988K - Wheel Loader	1	1
Caterpillar D8T - Dozer	2	3
HAUL TRUCKS		
Caterpillar 770G - End Dump Truck	8	32
MOBILE EQUIPMENT		
Caterpillar Drills MD5090, MD6290	2	3
Caterpillar 14M - Motor Grader	1	2
5000 gallon Water Truck	1	2
SERVICE & SUPPORT EQUIPMENT		
Caterpillar 416E - Backhoe Loader	1	2
Fuel/Lube Truck	1	2
Mechanic's Truck	4	2
Pickup Truck	5	2
Mobile Crane	1	2
2-tonne Forklift	1	2
Welding Machine	1	2
Buses	4	2
Light Plant	7	2

(Roche, 2014)

16.7 Mine Personnel Requirements

The projected personnel requirements vary with mine production rates and pit depth. Total employment ranges between 25 and 106 through the project's 45-year life. In the first five years, total mine employment is 71. As the open pit deepens, additional haul trucks are added to maintain production levels. In Year 16, employment increases to 94 people as the mine production rate increases. During Years 21 through 33, total employment reaches 106 and subsequently tapers off as mine production decreases and low grade stockpile processing begins.

Tables 16.5 through 16.7 indicate the workforce demographics during the maximum employment period of Years 21-33.

Table 16.5 - Operations Hourly Workforce

Category	Number
Shovel/Loader Operators	5
Truck Drivers	56
Drillers	4
Dozer/Grader Operators	6
Total	71

(Golder, 2014)

Similarly, the maintenance hourly workforce of 16 is distributed as presented in Table 16.5.

Table 16.6 - Maintenance Hourly Workforce

Category	Number
Heavy Equipment Mechanics	10
Fuel/Lube – Light Vehicle	5
Electrician	1
Total	16

(Golder, 2014)

The salaried personnel requirements are distributed as presented in Table 16.6.

Table 16.7 - Salaried Personnel

Category	Number
Mine Superintendent	1
Maintenance Foreman	1
Shift Boss	3
Maintenance Planner	1
Sr. Mine Engineer	1
Ore Control/Geology	2
Surveyor	2
Clerk	2
Security	6
Total	19

(Golder, 2014)

Operating costs were developed using equipment operating costs and consumptions, and associated labor costs on an annual basis. The total mining operating cost thus varies on an annual basis, but averages $4.42 per ton of material mined. (Refer to Chapter 21 – Capital and Operating Costs for more details on the capital and operating costs.)

17 Recovery Methods

17.1 Process Summary

The Rare Earth processing facility is designed with two distinct unit operations, a Physical Upgrading (PUG) plant, which is designed to maximize the rare earth recovery into a pre-concentrate; and a Hydrometallurgical plant (Hydromet), which is designed to extract the rare earths and produce a pure mixed REO powder.

In order to defray capital and operating expenditures, most of the PUG plant will not be constructed until year 9 of the project. The mine plan employs selective methods to provide the Hydromet plant with higher grade ores in the first nine years of operation that do not require pre-concentration. Therefore, the construction and operation of the PUG and Hydromet plants will be conducted in two phases.

PHASE I - Years 1-9
Ore will be dry crushed and screened to 3” size at the PUG plant. Plus 3” material will be stored in a low grade stockpile. Minus 3” material will be transported to the Hydromet plant for wet crushing and screening to -48 mesh size, and then fed to the Hydromet process (no pre-concentration).

PHASE II - Years 10+
Prior to production year 10, the PUG plant construction will be completed, and the processing of lower & medium grade ores will begin.

The PUG process employs a series of crushing, washing, screening, and separation steps to concentrate the REO minerals and reduce the physical mass of the ore sent to the Hydromet plant. As discussed in Chapter 8, Deposit Types, there are four major ore types, Bull Hill Oxide Carbonate (OxCa), Bull Hill Oxide (Ox), White Tail Oxide Carbonate (OxCa) and White Tail Oxide (Ox). These ore types are further classified as High-Grade (HG), Mid-Grade (MG), and Low-Grade (LG). Each of these ore types has a different upgrade percentage and mass reduction in the PUG circuit.

Because the mining plan will encounter each of these ore types within any given bench, the PUG circuit is designed with the flexibility to process each ore type with a nominal capacity of 1,600 short tons (1,451 tonnes) per day.

The Hydromet plant is designed for a nominal capacity of approximately 9,000 short tons per year REO product that will vary year to year depending on feed grades and feed tonnage. The Hydromet process uses hydrochloric acid to leach the REE from the ore. Rare Earth Oxalates are then precipitated from the pregnant leach solution by the addition of oxalic acid and converted to REO in a kiln. Thorium and other impurities are removed from the REO by a nitric acid leach and double hydroxide precipitation method. Ammonium hydroxide is used for the hydroxide precipitation steps and produces an ammonium nitrate by product. The REE hydroxides are converted back to REO in a final dryer.

Hydrochloric acid and oxalic acid are recovered and recirculated back into the process for a significant reduction in the cost of these reagents. The hydromet process also includes treatment of the base-metal loaded waste solution from the bottom of the distillation column (or evaporator) by the addition of lime-rock and quicklime to produce the mixed metal hydroxide solids. The filtrate from the neutralization process contains excess calcium chloride which is a potential chemical by-product. Leach residue is also treated with limestone & quicklime prior to shipment to the tailings storage facility (TSF).

17.2 Process Description Unit 100 – Physical Upgrade Plant

Figures 17.1 thru 17.8 are Block Flow Diagrams which illustrate the Physical Upgrade Plant Process Flows.

The PUG process is designed to produce a rare earth oxide pre-concentrate. PUG pre-concentrate will be sent to the Hydromet plant for further processing.

Most of the PUG plant will not be constructed until year 9 of the project. The mine plan employs selective methods to provide the Hydromet plant with higher grade ores in the first nine years of operation that do not require pre-concentration. Therefore, the construction and operation of the PUG and Hydromet plants will happen in two phases as described in section 17.1 Process Summary.

The run of mine ore is stockpiled (100-STO-001/002) by grade and mineralization prior to the crushing circuit. The stockpiles are individually reclaimed to feed the plant through the dump hopper (100-HOP-001).

17.2.1 Size Reduction (common for all ore types)

Run-of-mine (ROM) ore from a stockpile (100-STO-001) is transported onto a 24” grizzly screen (100-GRZ-001). Oversized material is sent to a stockpile (100-STO-005) while undersized material passes under the grizzly feeder and is crushed in a 24” jaw crusher (100-JCR-001). The material is conveyed to a 3” screen (110-VIS-

001). (For Phase I, this is the only part of the PUG plant that will be constructed and the minus 3” size material will be trucked to the Hydromet plant. The wet crushing and sizing equipment will be temporarily located at the Hydromet plant until year 9. Oversized material is sent to a low grade stockpile for potential future processing while undersized material is sent to a 3/4” cone crusher (110-CCR-001). Material is then passed through a 6 mesh roll crusher (110-RCR-001) and sent to a 6 mesh wet screen (110-VIS-002). Oversized material is recycled back to the 6 mesh roll crusher (110-RCR-001) while undersized slurry is sent to a 32 mesh screen (120-SCR-003). From this point forward, the PUG is dependent on which ore composition (Comp) is processed. The following sections discuss the process flows for the different comps in chronological order: Comp 4 followed by mixed Comps 1 and 2 and ending with Comp 3.

17.2.2 Ore Comp 4

Oversized material from the 32 mesh screen (120-SCR-003) is sent to the 32 mesh roll crusher (130-RCR-002). This material is recycled back to the 32 mesh screen (120-SCR-003). Undersized material from the screen (120-SCR-003) is sent to the 48 mesh screen (120-SCR-004). Oversized material from this screen is sent to the pre-tailings belt filter (160-BLF-001) for dewatering while undersized material is sent to thickener (170-THK-001). Thickener overflow is filtered with an inline filter (170-IFL-001) and used as process water while thickener underflow is sent to the press filter (170-FPR-001). Liquids from the filter are recycled back into the thickener (170-THK-001) while solids are stored in bin (175-BIN-003) prior to transport to the Hydromet plant via truck.

17.2.3 Ore Comp 1 & 2

Oversized material from the 32 mesh screen (120-SCR-003) is sent to the 32 mesh roll crusher (130-RCR-002) followed by a secondary 32 mesh screen (130-SCR-005). Oversized material from this screen is recycled back to the roll crusher (130-RCR-002) while undersized material is sent to the 150 mesh screen (130-SCR-006). Oversized material from this screen is sent to the spiral gravity classifier (140-SCL-001) while undersized material is sent to the thickener (170-THK-001).

Oversized material from the 150 mesh screen (130-SCR-006) is separated in the spiral gravity classifier (140-SCL-001). Light material is sent to the pre-tailings belt filter (160-BLF-001) for dewatering while heavy material is sent to the 48 mesh grinding mill (145-MCR-001).

Undersized material from the 32 mesh screen (120-SCR-003) is sent to the 48 mesh screen (120-SCR-004). Oversized material is sent to the 48 mesh grinding mill (145-MCR-001) and is subsequently recycled back to the 48 mesh screen (120-SCR-004). Undersized material from screen (120-SCR-004) is sent to the thickener (170-THK-001).

Undersized material from the 150 mesh screen (130-SCR-006) and 48 mesh screen (120-SCR-004) are thickened (170-THK-001). Thickener overflow is filtered with an inline filter (170-IFL-001) and used as process water while thickener underflow is sent to the press filter (170-FPR-001). Liquids from the filter are recycled back into the thickener (170-THK-001) while solids are stored in a bin (175-BIN-003) prior to transport to the Hydromet plant via truck.

17.2.4 Ore Comp 3

Oversized material from the 32 mesh screen (120-SCR-003) is sent to the 32 mesh roll crusher (130-RCR-002) followed by a secondary 32 mesh screen (130-SCR-005). Oversized material from this screen is recycled back to the roll crusher (130-RCR-002) while undersized material is sent to the 150 mesh screen (130-SCR-006). Undersized material from the 32 mesh screen (120-SCR-003) is also sent to the 150 mesh screen (120-SCR-006) in this scenario.

Oversized material from the 150 mesh screen (130-SCR-006) is sent to magnetic separator (150-MGS-001) while undersized material is sent to the thickener (170-THK-001).

Nonmagnetic material from the magnetic separator (150-MGS-001) is sent to the 48 mesh screen (120-SCR-004) while magnetic material is sent to the spiral gravity separator (150-SCL-002). Heavy material from the gravity separator is sent to the 48 mesh screen (120-SCR-004) while light material is sent to the pre-tailings belt filter (160-BLF-001) for dewatering.

The spiral gravity separator heavies are sent to the 48 mesh screen (120-SCR-004). Oversized material is sent to a 48 mesh grinding mill (145-MCR-001) and is subsequently recycled back to the 48 mesh screen (120-SCR-004). Undersized material from screen (120-SCR-004) is sent to the thickener (170-THK-001).

Undersized material from the 150 mesh screen (130-SCR-006) and 48 mesh screen (120-SCR-004) are thickened in thickener (170-THK-001). Thickener overflow is filtered with an inline filter (170-IFL-001) and used as process water while thickener underflow is sent to the press filter (170-FPR-001). Liquids from the filter are recycled back into the thickener (170-THK-001) while solids are stored in bin (175-BIN-003) prior to transport to the Hydromet plant via truck.

17.2.5 Reagent Preparation

Flocculent material is stored in a hopper (190-HOP-002) prior to mixing in a mixing tank (190-TAK-009). The mixed flocculent is stored in a distribution tank (190-TAK-010) and is used in the PUG thickener (170-THK-001).

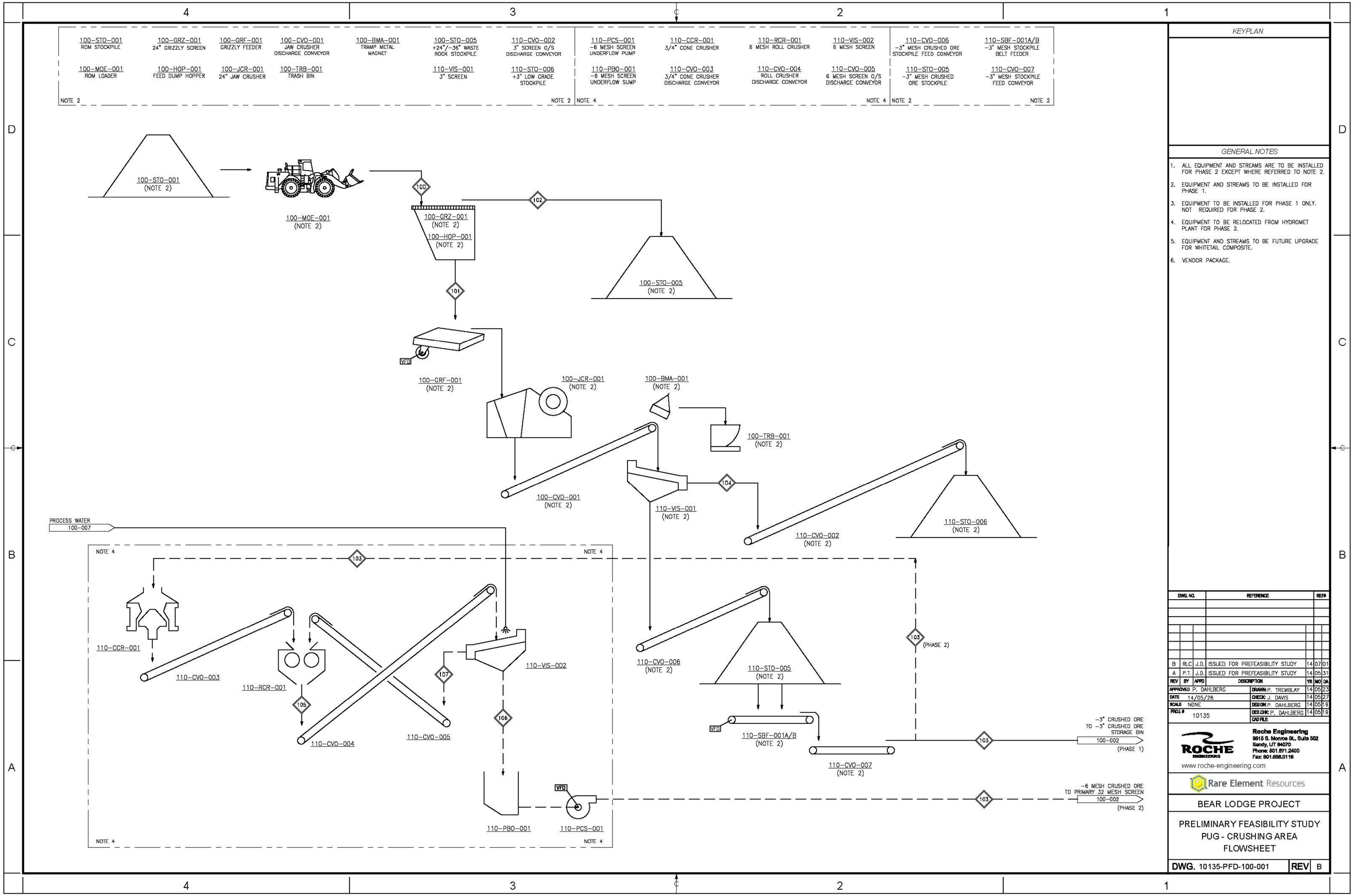
17.2.6 Reject Rock Management

Reject material from the different ore types and processing scenarios is processed through a vacuum belt filter (160-BLF-001) for dewatering. The solids from the filter are stored in a bin (165-BIN-001) prior to trucking to the reject material stockpile.

17.2.7 Water Supply

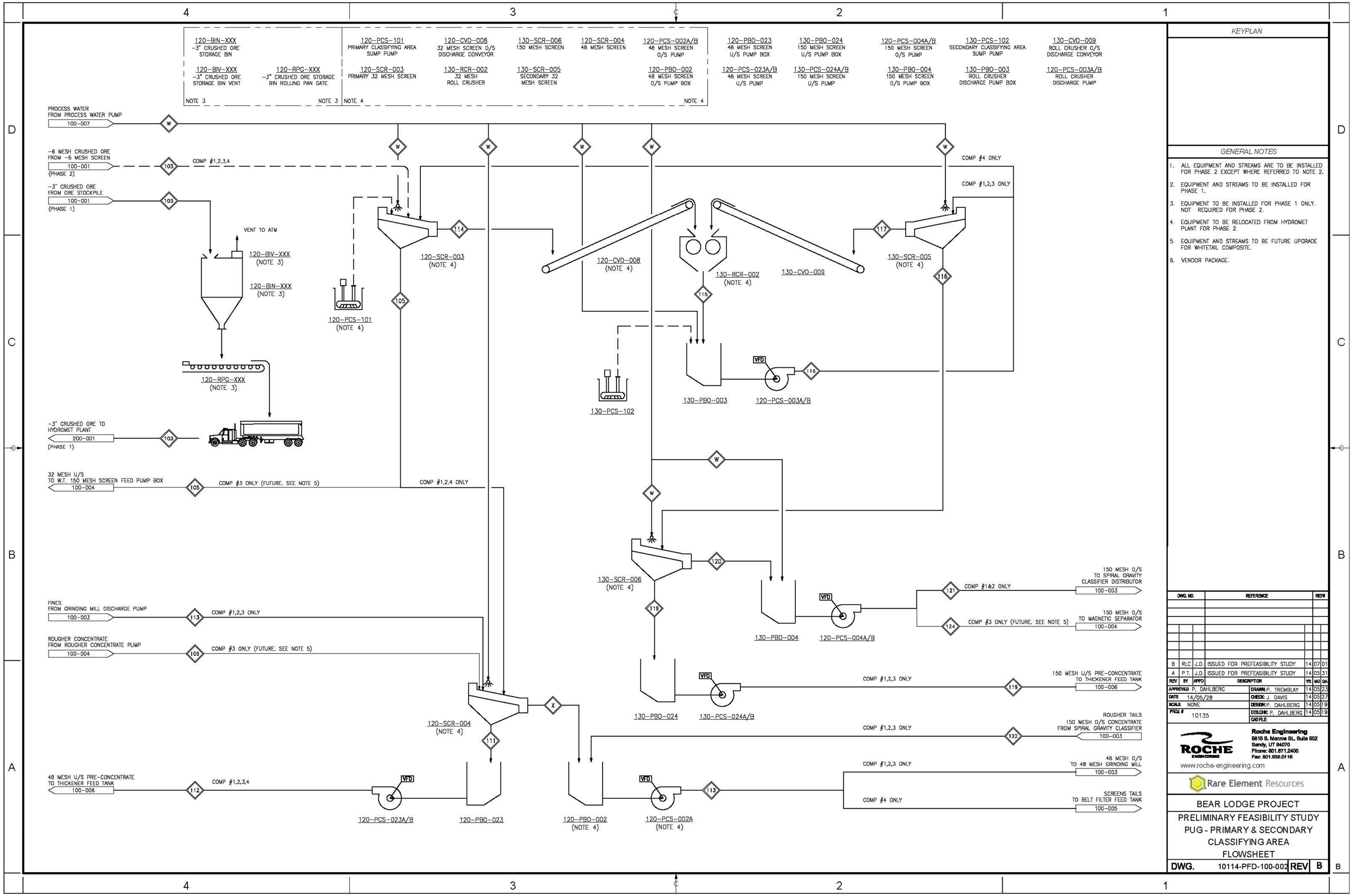
Water used throughout the PUG process is stored in on-site tanks 180-TAK-007 and 180-TAK-008 for raw/fire and process water, respectively.

Figure 17.1 - Drawing No. 10135-PFD-100-001 – PFS PUG – Crushing Area Flowsheet



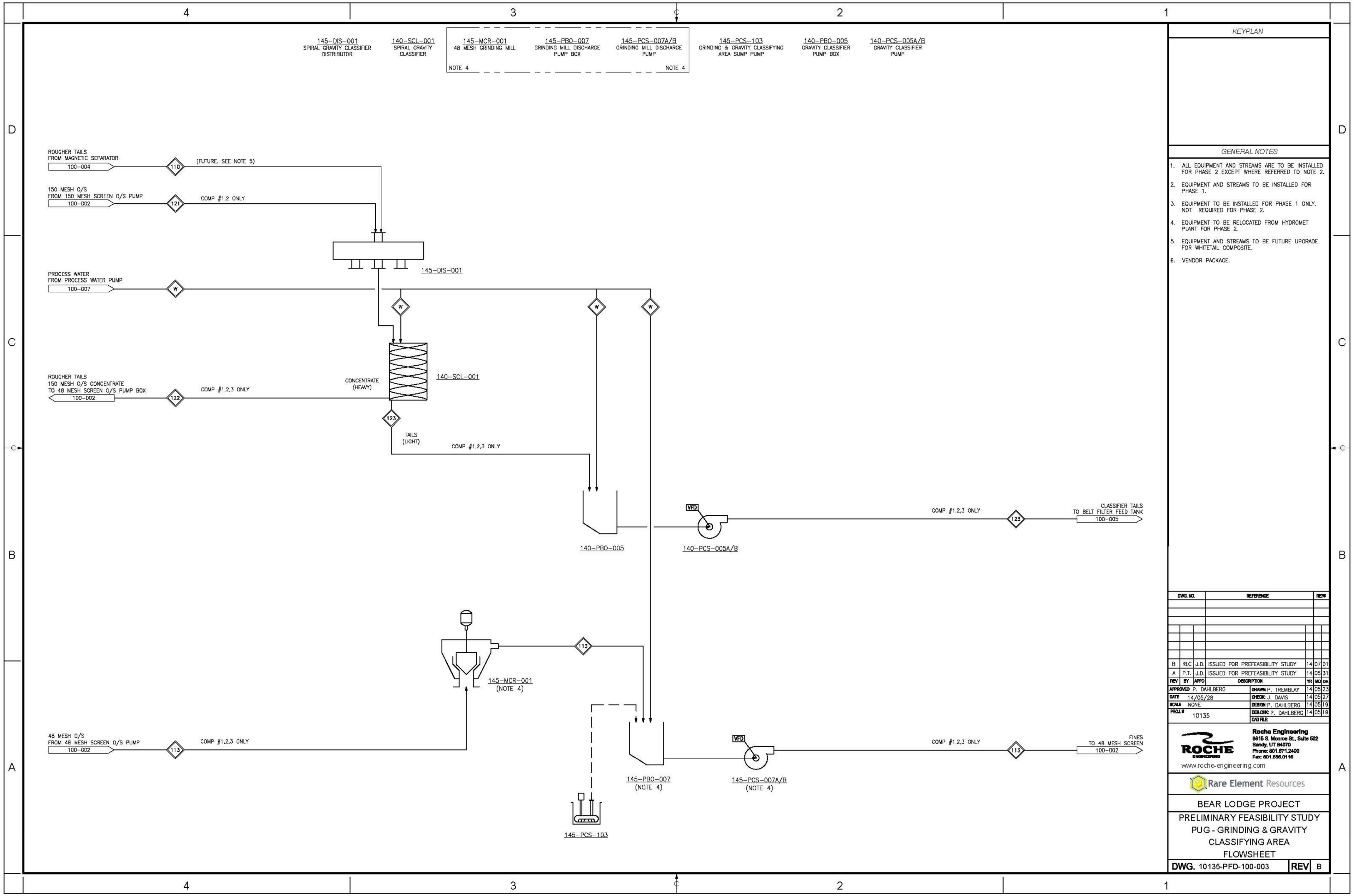
(Roche, 2014)

Figure 17.2 - Drawing No. 10114-PFD-100-002 – PFS PUG – Primary & Secondary Classifying Area Flowsheet



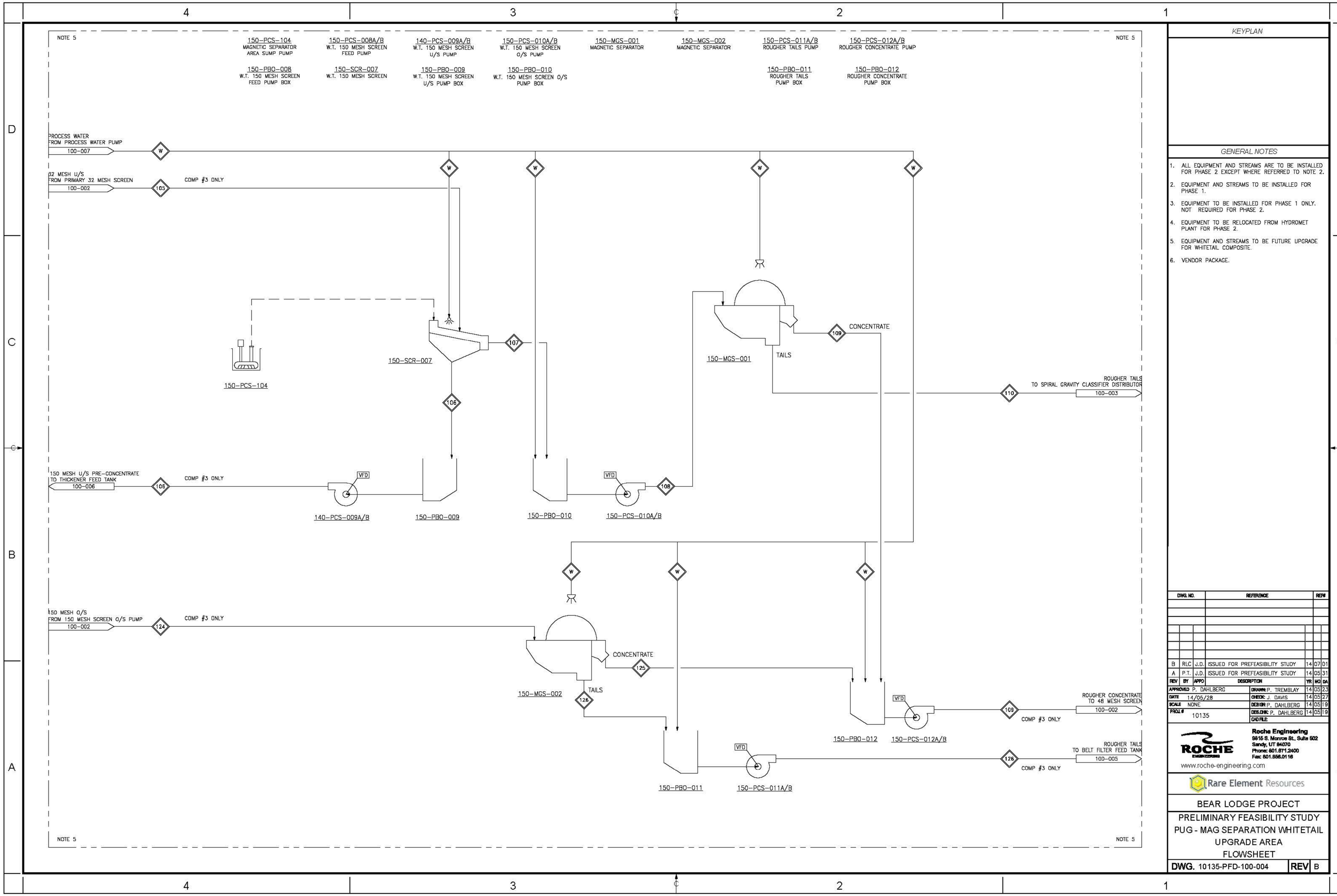
(Roche, 2014)

Figure 17.3 - Drawing No. 10135-PFD-100-003 – PFS PUG – Grinding & Gravity Classifying Area Flowsheet



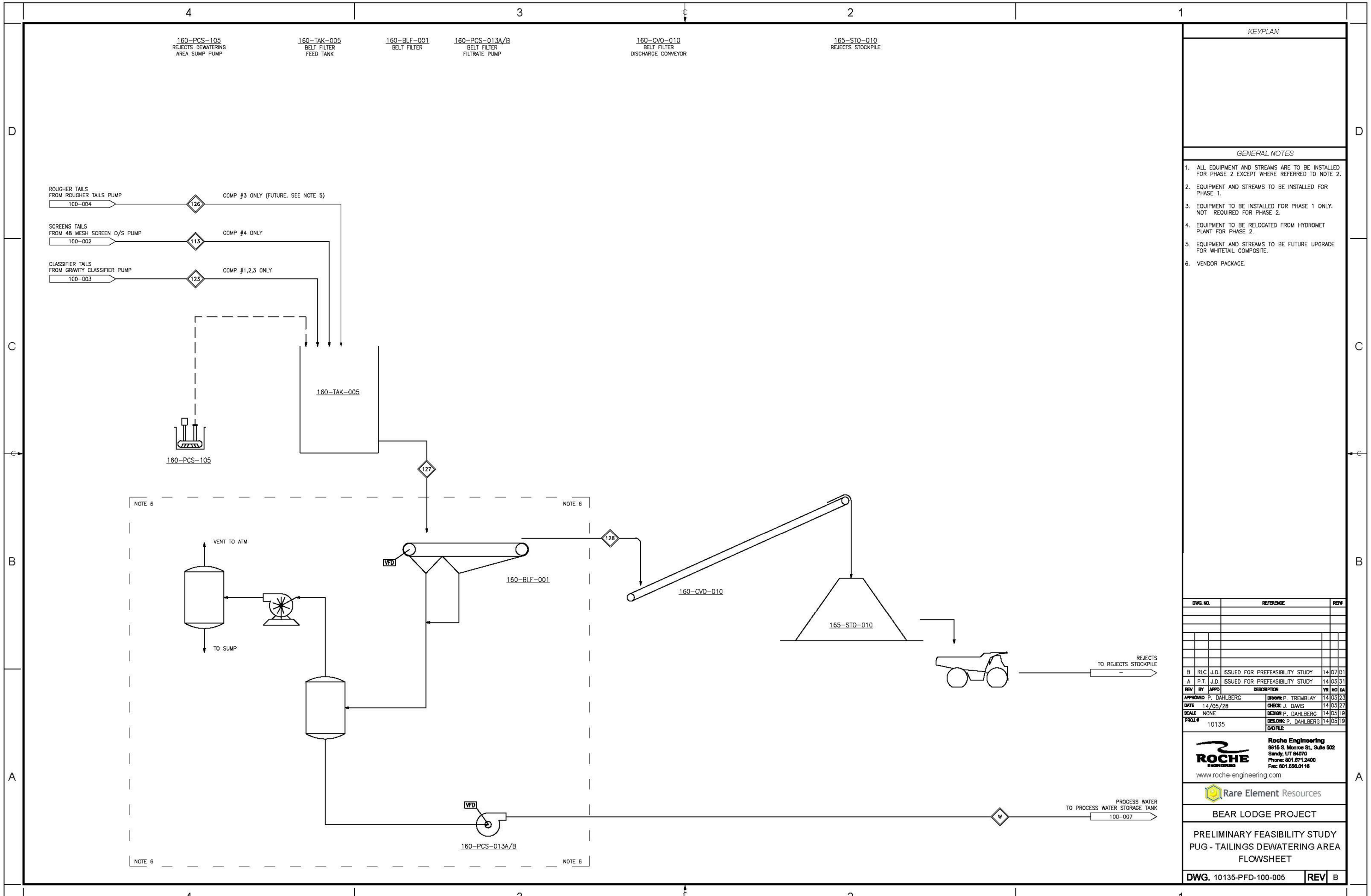
(Roche, 2014)

Figure 17.4 - Drawing No. 10135-PFD-100-004 – PFS PUG – Mag Separation Whitetail Upgrade Area Flowsheet



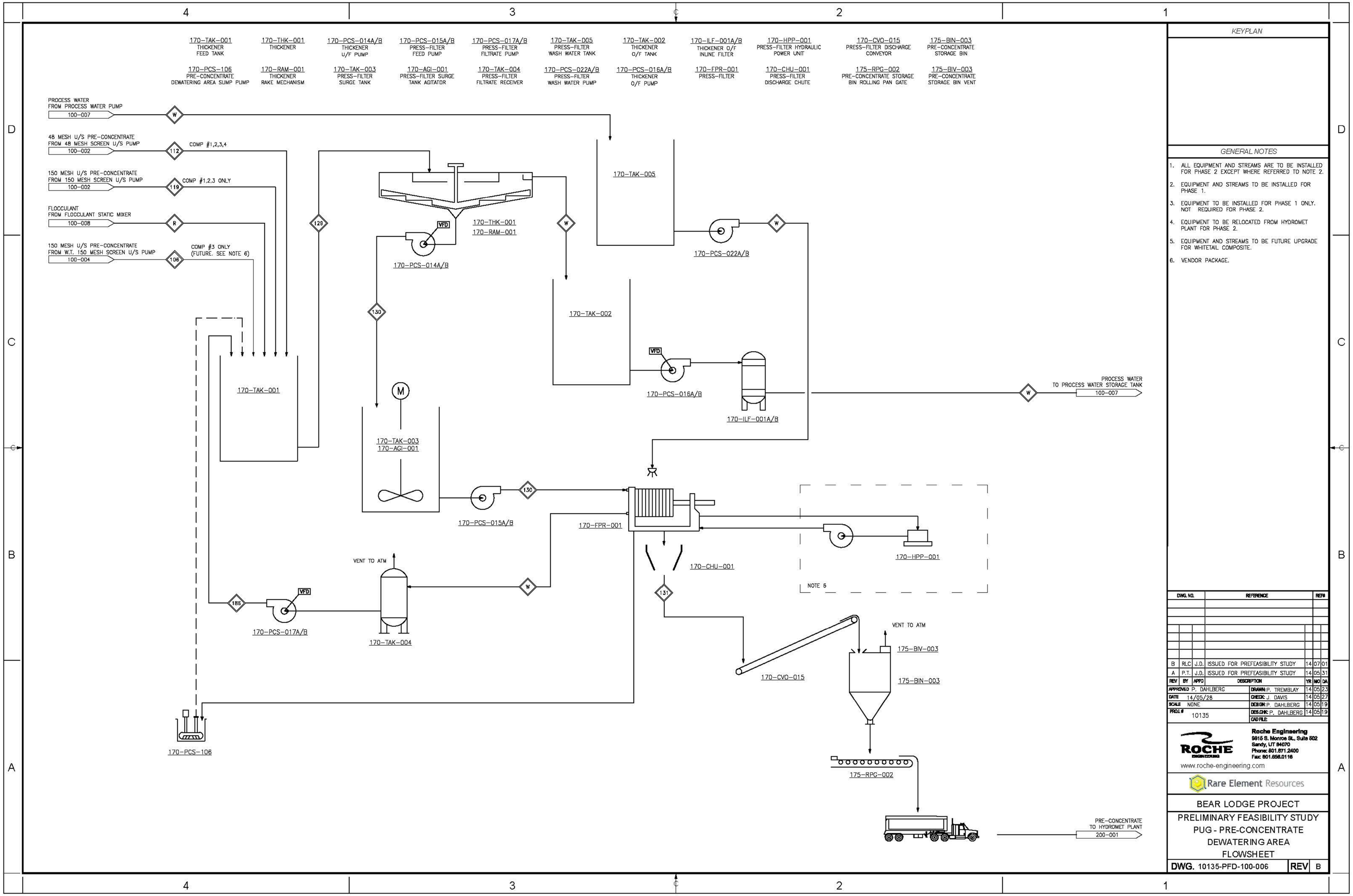
(Roche, 2014)

Figure 17.5 - Drawing No. 10135-PFD-100-005 – PFS PUG – Tailings Dewatering Area Flowsheet



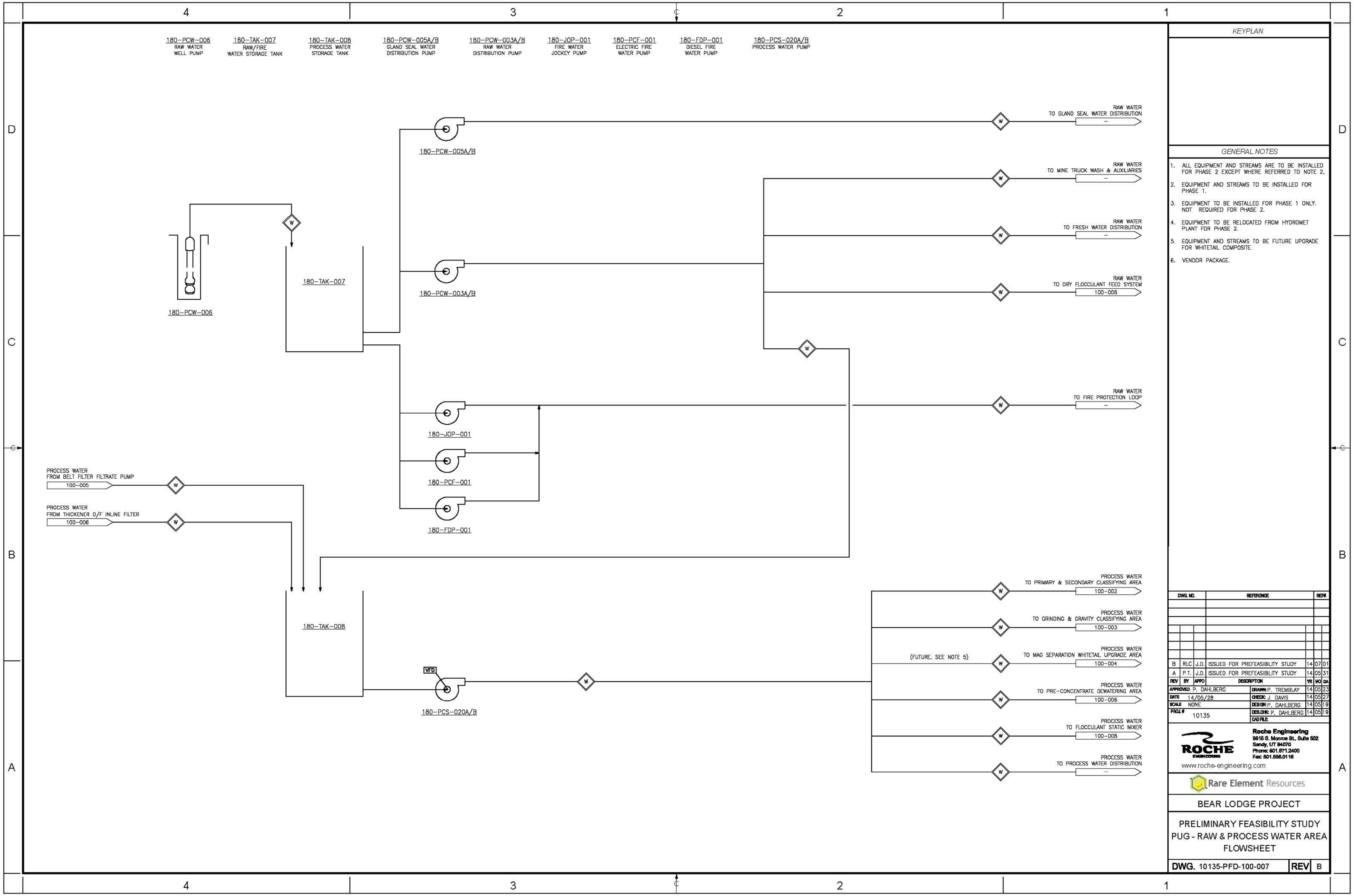
(Roche, 2014)

Figure 17.6 - Drawing No. 10135-PFD-100-006 – PFS PUG – Pre-Concentrate Dewatering Area Flowsheet



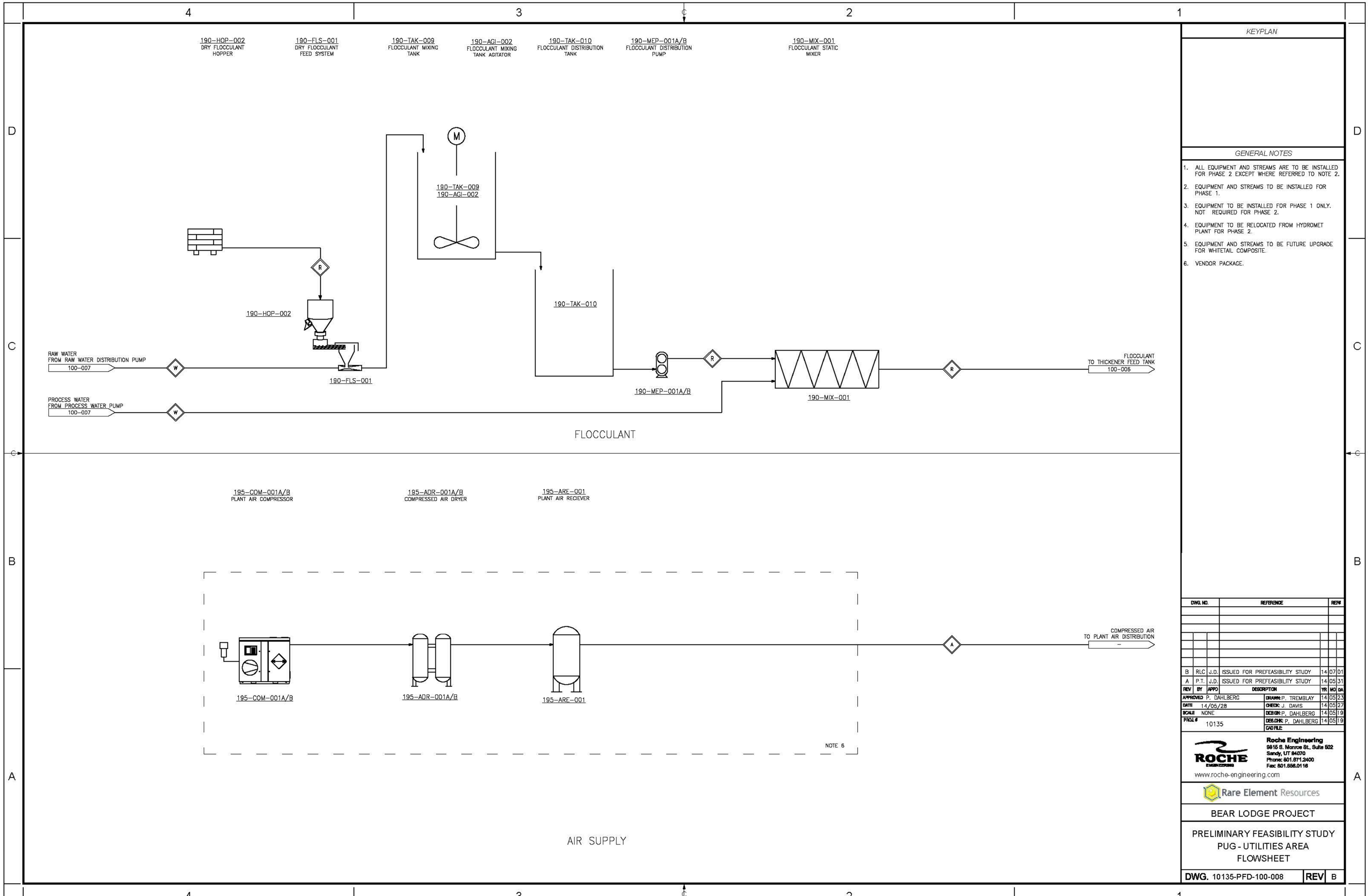
(Roche, 2014)

Figure 17.7 - Drawing No. 10135-PFD-100-007 – PFS PUG – Raw & Process Water Area Flowsheet



(Roche, 2014)

Figure 17.8 - Drawing No. 10135-PFD-100-008 – PFS PUG – Utilities Area Flowsheet



(Roche, 2014)

17.3 Process Description Unit 200 – Hydromet Plant Leach

Figures 17.9 thru 17.32, Roche, 2014 are Block Flow Diagrams which illustrate the Hydromet Plant Process Flows.

The Leach Unit is designed to leach the rare earth compounds from the pre-concentrate material using hydrochloric acid in a counter current two-stage process.

Upon arrival at the Hydromet plant, the pre-concentrate transport trucks are emptied in the underground chute (200-CHU-001). From the bottom of the chute an ore apron feeder (200-APF-001 discharges onto an inclined conveyor (200-CVO-001) to the top of the pre-concentrate feed silos (200-SIL-001A/B). The pre-concentrate is then conveyed (200-CVO-002 & 003) to the leach slurry surge tank (200-TAK-001). (In Phase I, the minus 3" ore is fed to a ¾" cone crusher (110-CCR-001) and through the wet grinding and screening circuit down to minus 48 mesh size). Recycled water (acid water) from the HCl recovery process is also added to the leach slurry surge tank to make a 40% solid slurry. The dust generated in the conveying process is controlled using bin vents and bag houses with standard cartridges at every transfer / drop point.

The leach reactors are organized in 2 rows of 3 agitated reactors in series (200-REA-001 – 006). Each row operates as two independent stages. The slurry flows through the leach reactors by overflow. Any one of the three leach tanks may be taken out of service and bypassed for maintenance. The remaining two leach tanks are sized to provide the required residence time of 4 hours. Pre-concentrate 65% solids slurry from the leach slurry surge tank is pumped to the first stage of leach reactors and combined with the filtered leach solution from the second leach reactor stage to formulate a 22% solids slurry. The overflow from the 3rd leach reactor is filtered (PLS) and sent to the oxalate reactors (300-REA-001,2,3,4). Fresh 35% HCl, 18% recovered HCl, and acid water as needed is combined with the filtered solids from the first leach reactor stage to formulate a 24% solids slurry feed to the second leach reactor stage (200-TAK-004).

Two belt filters running in parallel are required for each stage to handle the volume of solids that need to be filtered. A spare leach reactor solids 2 belt filter system has been included in the design for a total of six belt filters. (200-BLF-001A/B, 200-BLF-002A/B, 200-BLF-003A/B). Also, as a general practice, all slurry and liquid pumps will be in duplicate with the second pump on standby as a spare. The extra equipment is included to minimize process down time and maximize the on-line operating factor for the Hydromet plant.

The leach reactors will operate at 45° C. Most of the energy to maintain this temperature will come from the already hot acid and water additions coming from the HCl recovery circuit. The leach reactor tanks are equipped with steam coils to pre-heat the reactors on start-up and maintain temperature as needed during operation.

The leach reactors are vented to a common condenser to remove most of the acid vapor and return the condensate to one of the leach reactors, and thus minimize the consumption of neutralizing reagents in the neutralizer scrubber (500-SCR-001).

A neutralization scrubbing system (500-SCR-001) is used to prevent harmful gases from being released to the atmosphere. The scrubbing system is designed to remove any chlorine gas, ammonia gas, or hydrochloric and oxalic acid gas from the ventilation systems of the various reactors and chemical storage tanks.

The scrubbing system uses a solution of sodium hydroxide to neutralize the acidic vapors. Trace ammonia gasses will also react with chlorides and sulfates to form soluble ammonia salts. The high pH aqueous bleed from the scrubber is sent to the metal carbonate reactor #1 (350-REA-001) and eventually to tailings disposal through that process.

Instrumentation will be installed in the Hydromet plant to provide quantitative information on the plant operation (flow rates, temperatures, pH, production rate, etc.)

17.3.1 Chemistry

A) Leach reactors

Rare Earth Oxides Leaching Reaction

$RE_2O_3 + 6*HCl \rightarrow 2*RECl_3 + 3*H_2O$

Reaction Extent: 85-92% TREE

In the above reaction, RE is a rare earth element or Yttrium present in the pre-concentrate.

Table 17.1 presents leach efficiency by element for various ore composites.

Table 17.1 - Leach Efficiency for Various Ore Composites

COMP ID	wt. loss %	HCl Dosage (kg/t) Fresh	Total	La %	Ce %	Pr %	Nd %	Sm %	Eu %	Gd %	Tb %	Dy %	Ho %
B	45%	276	382	97%	85%	97%	96%	95%	94%	93%	93%	89%	87%
C	41%	187	293	88%	86%	87%	87%	87%	88%	87%	86%	84%	82%
A	34%	159	232	94%	74%	93%	93%	91%	91%	90%	88%	86%	83%
E	17%	307	509	95%	83%	95%	95%	94%	94%	94%	91%	89%	87%
D	54%	351	473	89%	87%	89%	89%	88%	88%	87%	85%	82%	80%

Y %	Er %	Tm %	Yb %	Lu %	Sc %	Th %	U %	Al %	As %	Ba %	Be %	Ca %	Fe %
86%	84%	83%	79%	72%	11%	82%	67%	11%	27%	10%	28%	99%	44%
81%	79%	78%	75%	70%	11%	55%	60%	12%	30%	16%	84%	99%	21%
82%	79%	74%	74%	54%	4%	68%	62%	6%	19%	5%	77%	99%	26%
83%	83%	78%	75%	66%	7%	73%	67%	12%	30%	7%	50%	96%	22%
78%	77%	75%	74%	70%	15%	55%	61%	14%	15%	7%	38%	98%	21%

K %	Mg %	Mn %	Mo %	Na %	P %	Pb %	Si %	Sr %	Ti %	V %	Zn %	TREE %	LREE %	HREE %
8%	84%	85%	52%	18%	83%	86%	0%	78%	10%	56%	55%	92%	92%	90%
9%	72%	55%	19%	22%	77%	62%	1%	91%	7%	39%	45%	87%	87%	85%
6%	76%	71%	27%	18%	80%	72%	0%	62%	6%	50%	37%	85%	85%	87%
10%	81%	81%	27%	31%	79%	77%	1%	64%	5%	47%	40%	90%	90%	90%
11%	82%	69%	16%	20%	70%	77%	0%	92%	4%	31%	45%	88%	88%	84%

(SGS Lakefield, 2014)

Iron (III) Oxide Leaching Reaction

$Fe_2O_3 + 6*HCl \rightarrow 2*FeCl_3 + 3*H_2O$

Reaction Extent: 21-44%

The extent of the iron oxide leaching reaction varies with feed composite. Testing results have shown that iron oxide is only partly leached by hydrochloric acid under the current low temperature leach operating conditions.

Carbonates Leaching Reaction

$\Psi CO_3 + 2*HCl \rightarrow \Psi Cl_2 + CO_2 + H_2O$

Reaction Extent: 96-99% for CaCO3

Ψ is a cation present in the pre-concentrate.

Although a +2 valence cation is shown, any cation valence could be present in the pre-concentrate. Therefore, the chemical reaction is for illustration purposes only.

Thorium Oxide Leaching Reaction

$ThO2 + 4*HCl \rightarrow ThCl_4 + 2*H_2O$

Reaction Extent: 55-82%

The reaction extent varies with feed composite. Testing results have shown that the thorium oxide compound is partly leached by hydrochloric acid under the current leach unit operating conditions and, therefore, requires additional processing to remove it.

Uranium Oxide Leaching Reaction

$U_3O_8 + 4*HCl \rightarrow 2*UO_2Cl_2 + UO_2 + 2*H_2O$

Reaction Extent: 61-67%

Testing results have shown that uranium oxide is partly leached by hydrochloric acid. The most recent test data indicate maximum uranium content will be below 35 g/ton in the final product.

Other Elements

Other elements such as Aluminum, Potassium, Magnesium, Manganese, Lead, etc., are present in the pre-concentrate and are partly leached by hydrochloric acid. See Table 17.1 for reaction extents of various other elements.

17.4 Process Description Unit 300 – Precipitation & Calcination

The Precipitation Unit is designed to selectively precipitate the rare earths as oxalates from the leach solution by the addition of oxalic acid.

The Pregnant Leach Solution (PLS) is pre-heated to 85°C in a heat exchanger (200-HTX-002) using reclaimed heat energy and a secondary steam heat exchanger (200-HTX-001), (used mainly for startup). The PLS and Oxalic Acid are combined in the first of four agitated precipitation reactor tanks operated in series (300-REA-001,2,3,4). The reactants flow through the reactors by overflow. After the first tank, the temperature is raised to 90°C using steam coils in the first three tanks. Any one of the four reactor tanks may be taken out of service and bypassed for maintenance. The remaining three tanks are sized to provide the required residence time of three hours. See Table 17.2 for precipitation test results.

Table 17.2 - Precipitation with Oxalic Acid

La %	Ce %	Pr %	Nd %	Sm %	Eu %	Gd %	Tb %	Dy %	Ho %	Y %	Er %	Tm %	Yb %
98%	100%	100%	100%	100%	100%	100%	99%	100%	99%	100%	99%	93%	99%
Lu %	**Sc %**	**Th %**	**U %**	**Al %**	**As %**	**Ba %**	**Be %**	**Ca %**	**Fe %**	**K %**	**Mg %**	**Mn %**	**Mo %**
93%	92%	100%	4%	3%	43%	15%	1%	45%	0%	10%	0%	0%	29%
Na %	**P %**	**Pb %**	**Si %**	**Sr %**	**Ti %**	**V %**	**Zn %**	**TREE %**	**LREE %**	**HREE %**			
1%	1%	42%	14%	7%	14%	4%	0%	99%	99%	100%			

(SGS Lakefield, 2014)

The precipitated oxalates settle and filter easily. The slurry is first passed through a high rate thickener (300-THK-001) to concentrate the solids, and then will be filtered on a belt filter (300-BLF-001). The filtrate is sent to thickener (300-THK-002) to cool and crystallize oxalic acid. The thickener overflow is sent to the Hydrochloric Acid Regeneration Unit. The cake containing the rare earth oxalates is dried and converted into REE oxides in two steps. The first drying step removes water and residual HCl in screw dryer (300-SCD-001). In the second step, RE oxalates are converted to oxides at 700°C in a kiln (300-KLN-001). The vapor from screw dryer (300-SCD-001) is sent to scrubber (300-SCF-001). The condensate from scrubber (300-SCF-001) is bled off to tailings treatment and the scrubbed vapor discharged to the atmosphere (300-STA-001). The vapor from kiln (300-KLN-001) is cooled (300-HTX-005) and sent to scrubber (300-SCR-002). The condensate from scrubber (300-SCF-002) is bled off to tailings treatment and the scrubbed vapor discharged to the atmosphere (300-STA-001).

Two heat recovery loops are part of the calcination step. The first loop recovers heat by cooling the kiln exit gas in heat exchanger (300-HTX-005). This heat is used to pre-heat the PLS. The second loop recovers heat by cooling the REO solids in rotary cooler (300-CLR-001). This heat is used to heat the nitrate reactors.

17.4.1 **Oxalate Precipitation Chemistry**

17.4.1.1 **Precipitation Reactors**

Rare Earth Oxalate Precipitation

$2*RECl_3 + 10H2O + 3*C_2H_2O_2 \rightarrow RE_2(C_2O_2)_3$ 10H2O+ 6*HCl
Reactions Extents: 90-100% depending on the element

Other ions will also precipitate as oxalates, namely thorium, and reduce the rare earth oxalate purity. Regenerating hydrochloric acid is also a byproduct of the oxalate reaction.

17.4.1.2 **RE Oxide Kiln**

Rare Earth Oxide Calcination

$2*RE_2(C_2O_2)_3 10H2O + 9*O_2 + Heat\ (700^oC) \rightarrow 2*RE_2O_3 + 10H2O + 12*CO_2$
Reactions Extents: 100%

17.5 Process Description Unit 350 – Acid Regeneration, Metal Carbonates, and Calcium Chloride

The Acid Regeneration Unit is designed to recover and reuse water, hydrochloric and oxalic acid and includes precipitation of waste metal carbonates for tailings disposal.

The precipitation filtrate solution contains small but valuable amounts of hydrochloric acid, significant residual oxalic acid together with un-precipitated metal chlorides. Hydrochloric acid is recovered by flash vaporization of HCl and H_2O from the filtrate solution (350-CFL-001) followed by distillation (350-CDI-001) to obtain 18% HCl solution and water. The water contains a minor amount of HCl (< 0.5%). Both 18% HCl and water are reused in the process to reduce HCl cost and reduce water consumption.

The flash column bottoms contain residual HCl, concentrated oxalic acid, and metal chlorides. This solution is cooled and oxalic acid is crystallized (350-CRY-001) and centrifuged (350-CFG-001). The oxalic acid crystals are recycled back to the precipitation reactors by re-dissolution in the oxalic acid dissolution tank (500-TAK-008). The recovery of oxalic acid reduces consumption of purchased oxalic acid by

40%. The rare earths recovered by recovery and recycling of oxalic acid are included in precipitation efficiency values shown in Table 17.2.

The oxalic acid centrifuge liquid is sent to the neutralization reactors (350-REA-001, 2) and combined with a calcium carbonate slurry plus quicklime to neutralize any remaining acid and subsequently precipitate metal carbonates and hydroxides. The metal carbonates are filtered on two parallel belt filters (350-BLF-002A/B). The filtrate is partially evaporated (350-SCD-001) to produce calcium chloride hydrates, a potential byproduct. The metal carbonates are sent to the tailings disposal conveyor (250-CVO-001).

CaCO3 produces metal carbonates (CO3), quicklime produces small mass of metal hydroxides (OH). Quicklime precipitates metals that otherwise would not be precipitated at the maximum pH achievable with limerock.

17.5.1 Metal Carbonate Precipitation Chemistry

17.5.1.1 Metal Carbonate Precipitation

$2*FeCl_3 + 3*CaCO_3 + XH_2O \rightarrow Fe_2(CO_3)_3 + 3*CaCl_2.XH_2O$

Reaction Extent: 100%

All other metal chlorides will also follow similar chemistry.

17.6 Process Description Unit 400 – Utilities

17.6.1 Plant Water Supply Facilities

PUG Plant Raw/Fire Water

A Raw/Fire water tank of 135,670 gallons (513.6 m^3) will be installed at the PUG to supply raw water to the process and water to the fire protection system. The raw water will also be used for flocculant preparation, gland seal water pump and for truck wash, dust control, and auxiliaries. The water supply will be provided by raw water well.

A minimum level will be maintained in the Raw/Fire water tank to provide sufficient fire water protection.

PUG Plant Process Water

A process water tank of 30,300 gallons (114.7 m^3) will be installed at the PUG to supply process water as required. The process water tank will be supplied from the PUG Thickener overflow and from raw water make-up.

Hydromet Plant Water Supply Facilities

Process Water/Gland Seal, Water/Potable and Water/Fire Water will be directly connected to the city of Upton, WY water supply.

17.6.2 Compressed Air Supply Facilities

Physical Upgrade Plant

Compressed air will be provided by three rotary screw compressors, two in operation and one on stand-by. The compressed air package will also include two receivers, one for plant air, one for dry instrument air, and one heatless desiccant air dryer.

Hydromet Plant

Compressed air will be provided by three rotary screw compressors, two in operation and one on stand-by. The compressed air package will also include two receivers, one for plant air, one for dry instrument air, and two heatless desiccant air dryers.

17.6.3 **Steam and Cold Water Utilities**

Hydromet Plant Steam Boilers

Two natural gas fired boilers will supply steam to the process.

Hydromet Plant Cooling Towers

One multi cell cooling tower will supply cooling water to the process.

Hydromet Plant Chillers

Three chillers are planned to supply chilled water for the oxalic acid cooling crystallizer.

17.7 Process Description Unit 500 – Chemical Reagent Storage Facilities

35% Hydrochloric Acid

Concentrated HCl will be piped into the plant from the UTRAN Supply Station located nearby and stored in Tank (500-TAK-002) until fed to the process.

18% Hydrochloric Acid

Recycled 18% hydrochloric acid from the acid regeneration unit is stored in Tank (500-TAK-001) until fed to the process.

Nitric Acid Storage

Nitric acid (65%) will be shipped to the plant and stored in Tank (500-TAK-014) until fed to the process.

Limestone Powder

Crushed limestone (-1/2”) is produced locally. The crushed limestone will be pulverized to -250 mesh in a vendor supplied package plant and stored in silo (500-SIL-002) until fed to the process.

Quicklime Powder

Quicklime powder is only needed in small volumes, and so will be shipped in super sacs and stored in silo (500-SIL-003) until fed to the metal carbonate reactor #2 (350-REA-002). Quicklime in very small volumes will also be used for final tailings pH adjustment after the PUG mill (250-MIL-001), and will be supplied in 80 lb. bags.

Oxalic Acid Storage

Anhydrous Oxalic acid will be shipped to the plant in super sacs and stored. The super sacs will be transferred into Silo (500-SIL-004) and continuously fed to oxalic acid Dissolution Tank (500-TAK-08). Crystallized oxalic acid from centrifuge (350-CFG-001) and oxalic acid slurry from thickener (300-THK-002) are also fed to the Dissolution Tank and re-dissolved. The oxalic acid solution is then fed to the precipitation process.

Ammonia and Ammonium Hydroxide Storage

Anhydrous ammonia will be delivered and stored in tank (500-TAK-011). 20% ammonium hydroxide solution is produced by feeding anhydrous ammonia and condensate water to absorption column (500-CAB-001). Recycled ammonium nitrate solution may also be used to produce ammonium hydroxide solution.

17.7.1 Ammonium Hydroxide Chemistry

Ammonium hydroxide absorption column

Ammonium hydroxide reaction

NH_3 + H2O → NH4(OH)

Reaction Extent: 100%

17.8 Process Description Unit 600 – High Purity REO Product

17.8.1 Nitric Acid Leach

The REE oxide from calcination (300-KLN-001) is re-dissolved in nitric acid. The REE oxide is first slurried with condensate water or ammonium nitrate solution in agitated tank (600-TAK-001). From tank (600-TAK-001) the slurry overflows to the first nitrate reactor (600-REA-010) where 65% nitric acid is added. The nitrate reaction takes place in three reactor tanks (600-REA-010, 011, 012) operated in series. The slurry flows through the nitrate reactors by overflow. Any one of the three reactor tanks may be taken out of service and bypassed for maintenance. The remaining two reactor tanks are sized to provide the required residence time of 4 hours. The REE oxide slurry is almost completely re-dissolved by nitric acid. The nitrate leach reactor output is filtered to remove the solid residue in filter press (600-PFT-003).

The nitrate reactors will operate at 90°C. Most of the energy to maintain this temperature will come from heat transfer loop #2. Heat transfer loop #2 recovers heat by cooling the REO solids in the rotary cooler (300-CLR-001). Heating coils inside the mix tank (600-TAK-001) and reactor tanks (600-REA-010, 011) will be used to heat the slurry. The nitrate tanks will also be equipped with steam coils to pre-heat the reactors on start-up and maintain temperature as needed during operation.

Nitrate Leach Chemistry

Typical Rare Earth Nitrate reaction

$RE_2O_3 + 6*HNO_3 \rightarrow 2*RE(NO_3)_3 + 3*H_2O$

Reaction Extent: 100%

In the above reaction, RE is a rare earth element or Yttrium.

17.8.2 Thorium Removal

Thorium precipitation is accomplished in two stages by the addition of ammonium hydroxide. The REE nitrate solution is combined with a limited amount of 20% ammonium hydroxide solution in reactor (600-REA-020). Thorium hydroxide is precipitated along with small amounts of REE hydroxides. The precipitate is filtered in filter press (600-PFT-001) and placed in containers for disposal. The REE nitrate solution from filter (600-PFT-001) is combined a second time with a limited amount of 20% ammonium hydroxide solution to complete the precipitation of thorium from the REE nitrate solution. This precipitate is filtered in filter press (600-PFT-002) and recycled back to the nitric acid leach reactor #1 (600-REA-010). The second precipitate is recycled back into the process because it contains a significant percentage of REE hydroxides. The thorium removal process is unique and a patent application titled: "Extraction of Metals from Metallic Compounds" was filed by Rare Element Resources Ltd. on January 18, 2014. Dr. Henry Kasaini, Director of Science and Technology for Rare Element Resources, is named as inventor on the patent. This patent combines an initial provisional patent on the "Rare Earth Element Extraction" process technology, filed in January 2013, with another patent titled: "Extraction of Thorium from Rare Earth Compounds and Related Methods" provisional patent, filed in November 2013.

Thorium Precipitation Chemistry

Thorium hydroxide precipitation

$Th(NO_3)_4 + 4*NH_4(OH) \rightarrow Th(OH)_4 + 4*NH_4NO_3$

Reaction Extent: 100%

The reaction extent is for both stages.

17.8.3 **Rare Earth Hydroxide Precipitation**

Complete precipitation of REE hydroxides essentially free of thorium is finally accomplished by the addition of excess ammonium hydroxide solution in reactor (600-REA-020). The precipitate is filtered in filter press (600-PFT-004) and dried in screw dryer (600-SCD-001). The filtrate is an ammonium nitrate solution that is sent to storage tank (650-TAK-001) for reuse and recovery of ammonium nitrate byproduct.

<u>REE Precipitation Chemistry</u>

Typical REE hydroxide precipitation reaction

$RE(NO_3)_3 + 3*NH_4(OH) \rightarrow RE(OH)_3 + 3*NH_4NO_3$

Reaction Extent: 100%

In the above reaction, RE is a rare earth element or Yttrium.

17.8.4 **Rare Earth Oxide Final Product**

Conversion to the final REE oxide product occurs in screw dryer (600-SCD-001) and then stored in bin (600-BIN-004). The screw dryer operates at 250^{o}C and the dryer vapor stream is condensed in scrubber (600-SCR-001) using cooling water. The condensate is reused in the process to reduce water consumption. The product is packaged in bagging machine (600-BGM-001) and stored until sold.

<u>Rare Earth Hydroxide to Oxide Conversion Chemistry</u>

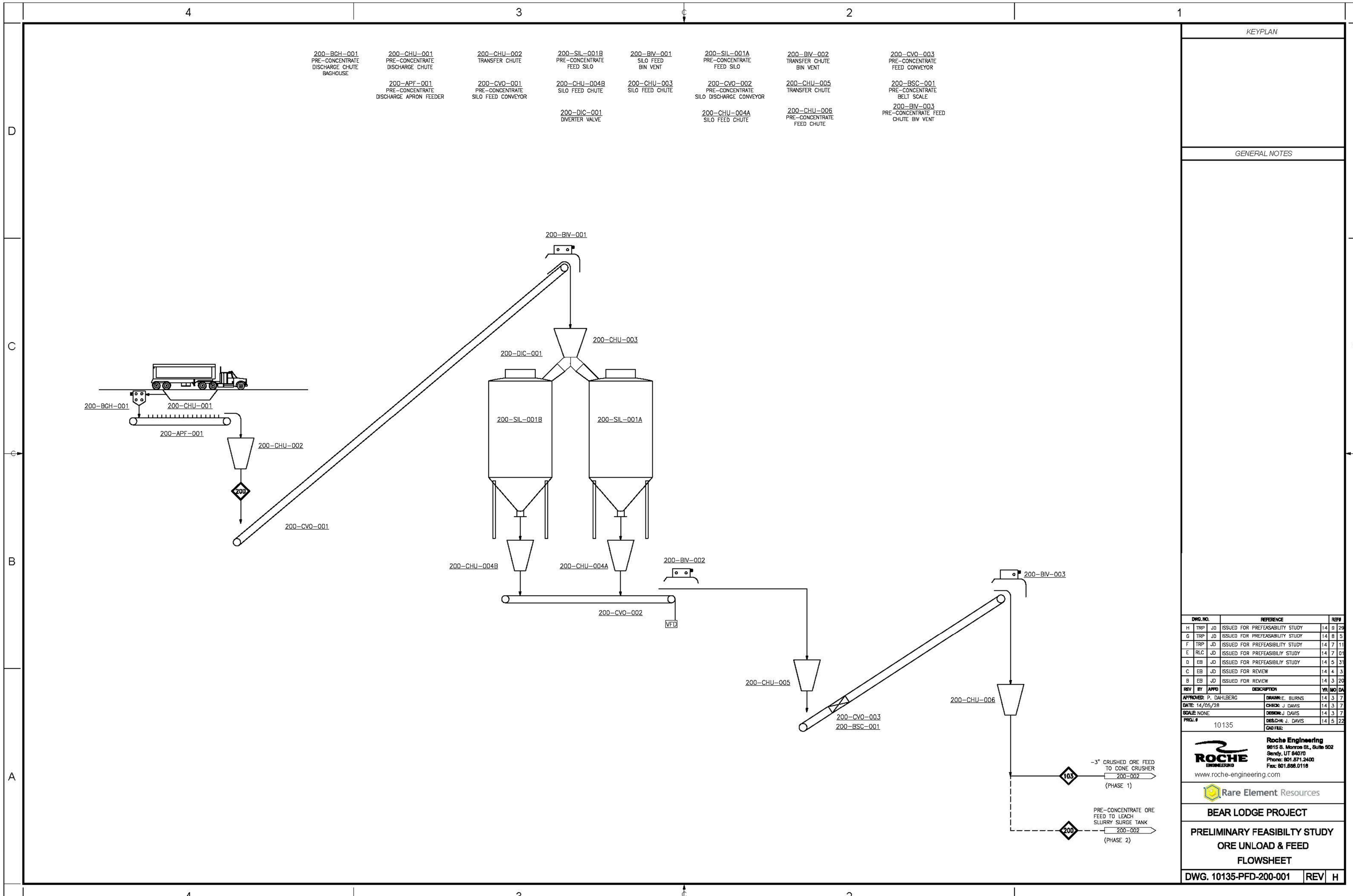
Typical REE hydroxide to oxide conversion reaction

$2*RE(OH)_3 + Heat \rightarrow RE_2O_3 + 3*H_2O$

Reaction Extent: 100%

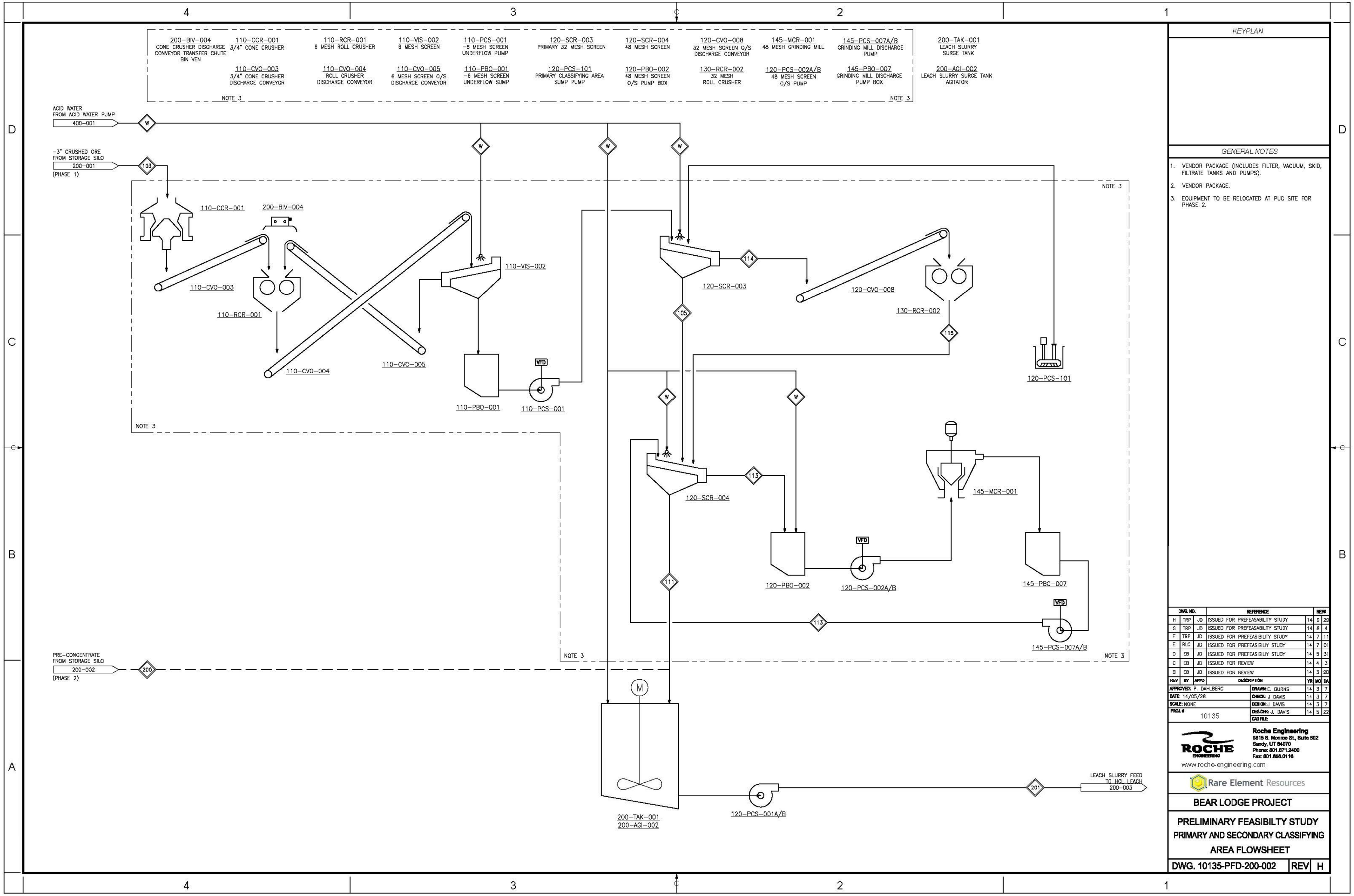
In the above reaction, RE is a rare earth element or Yttrium.

Figure 17.9 - Drawing No. 10135-PFD-200-001 – PFS – Ore Unload & Feed Flowsheet



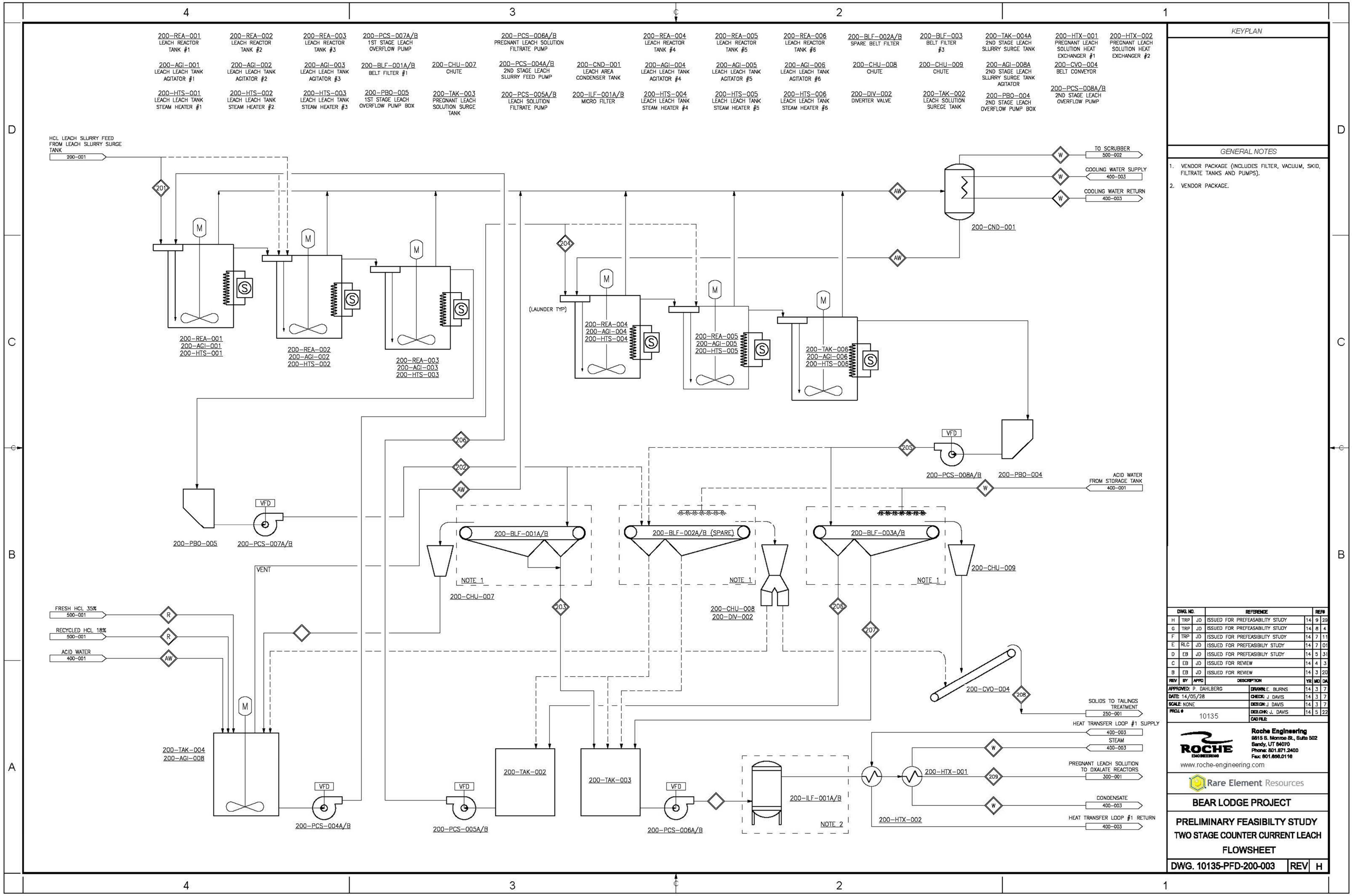
(Roche, 2014)

Figure 17.10 - Drawing No. 10135-PFD-200-002 – PFS – Primary and Secondary Classifying Area Flowsheet



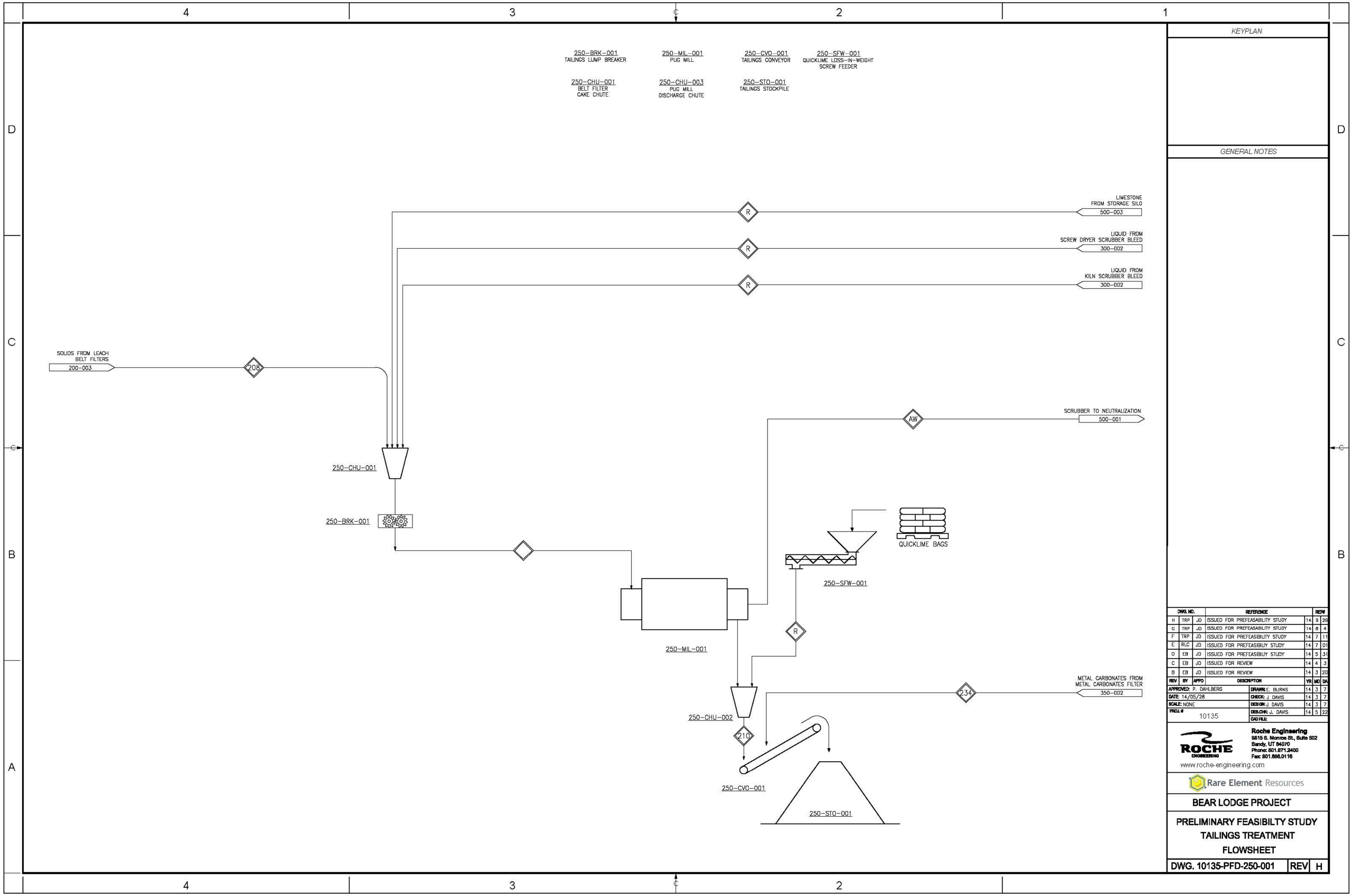
(Roche, 2014)

Figure 17.11 - Drawing No. 10135-PFD-200-003 – PFS – Two Stage Counter Current Leach Flowsheet



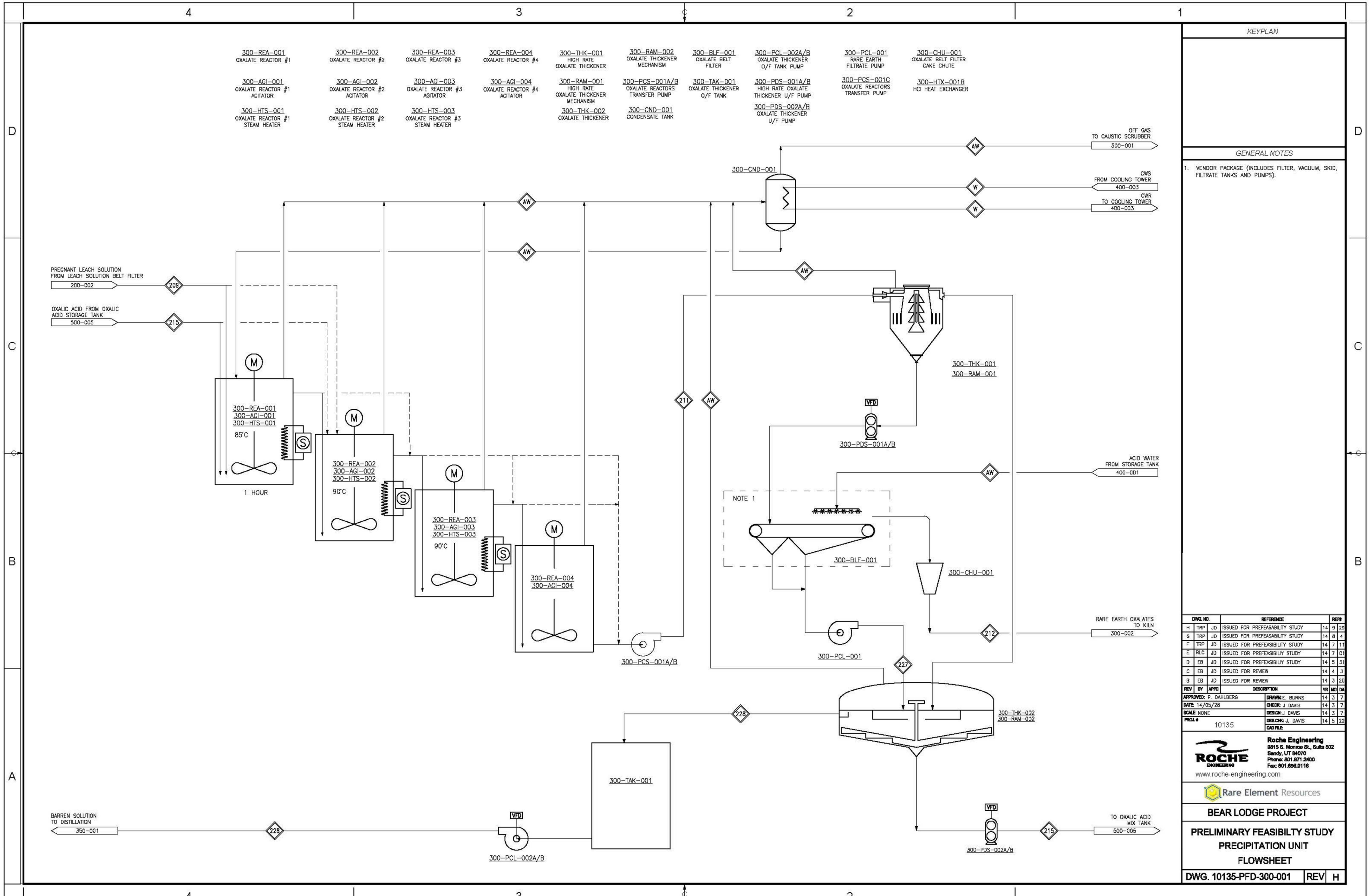
(Roche, 2014)

Figure 17.12 - Drawing No. 10135-PFD-250-001 – PFS – Tailings Treatment Flowsheet



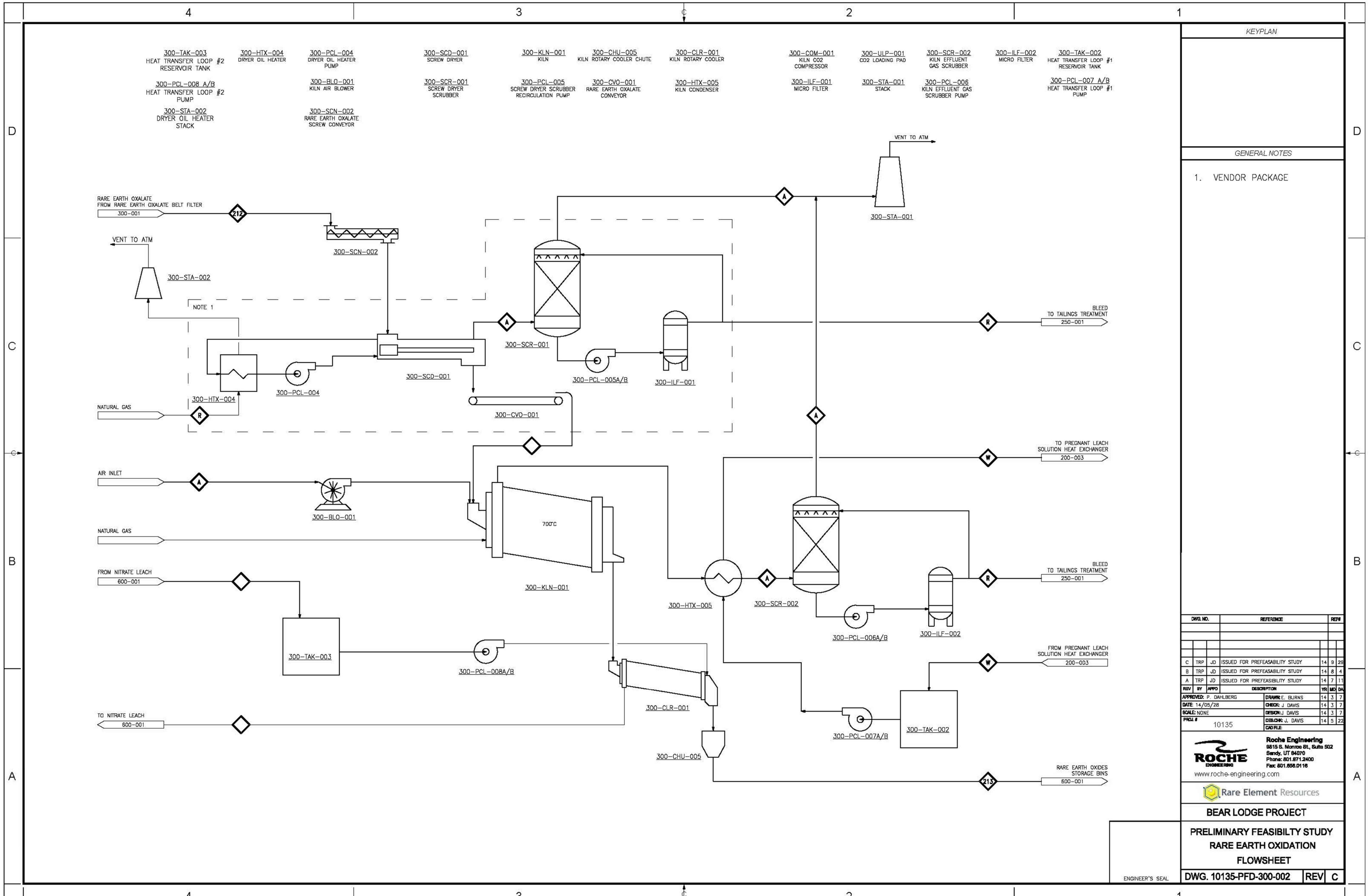
(Roche, 2014)

Figure 17.13 - Drawing No. 10135-PFD-300-001 – PFS – Precipitation Unit Flowsheet



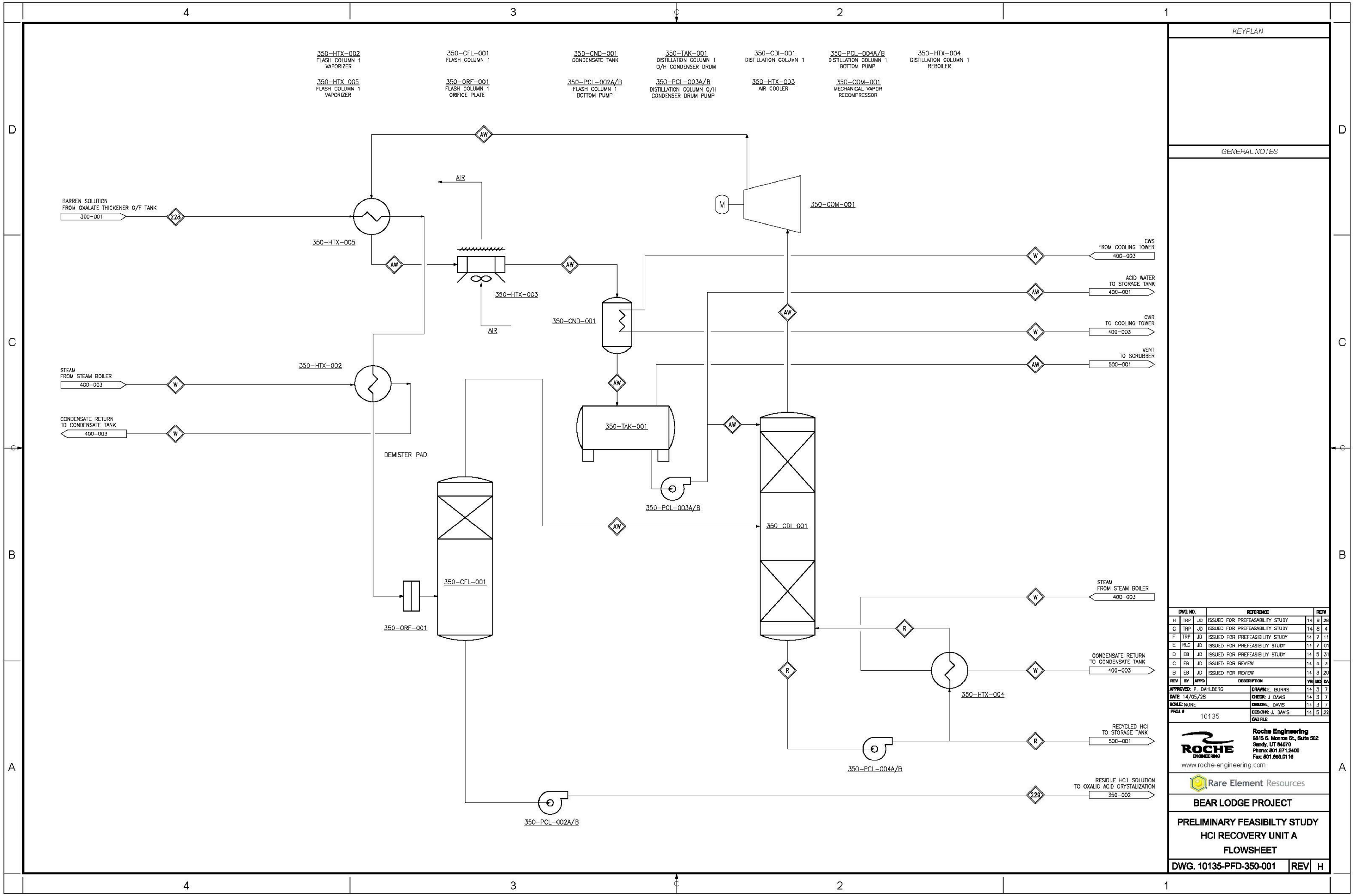
(Roche, 2014)

Figure 17.14 - Drawing No. 10135-PFD-300-002 – PFS – Rare Earth Oxidation Flowsheet



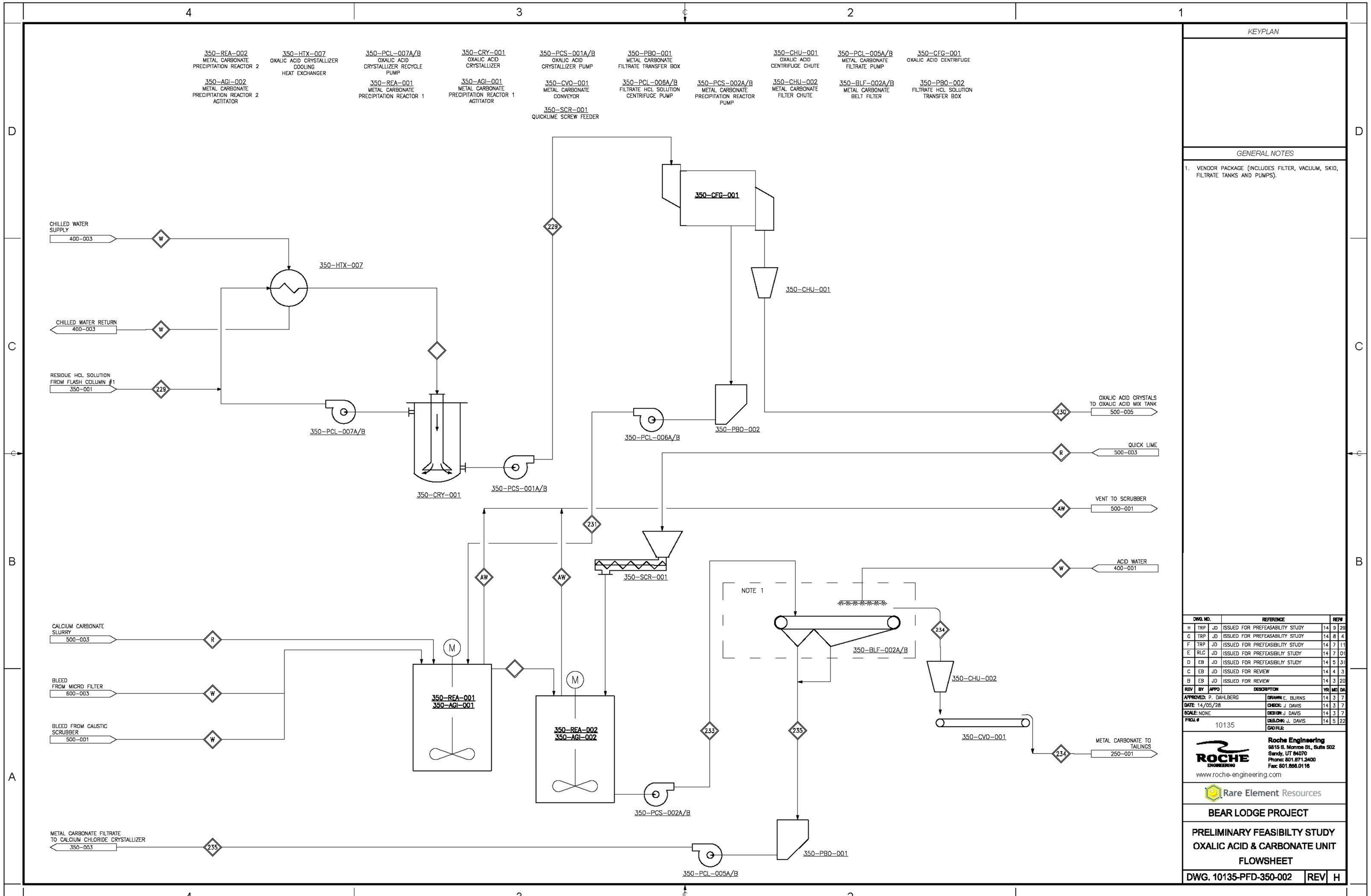
(Roche, 2014)

Figure 17.15 - Drawing No. 10135-PFD-350-001 – PFS – HCl Recovery Unit A Flowsheet



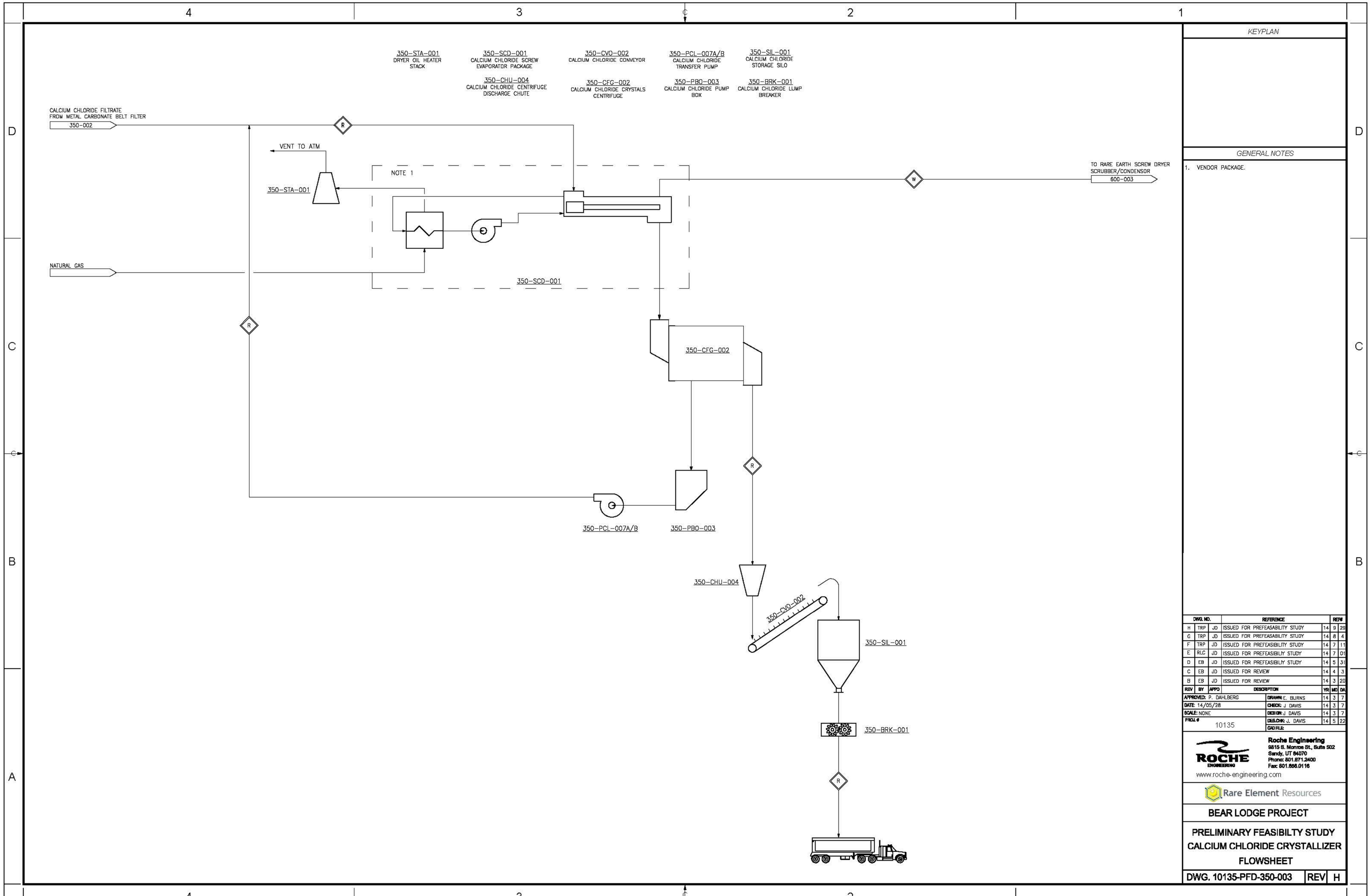
(Roche, 2014)

Figure 17.16 - Drawing No. 10135-PFD-350-002 – PFS – Oxalic Acid & Carbonate Unit Flowsheet



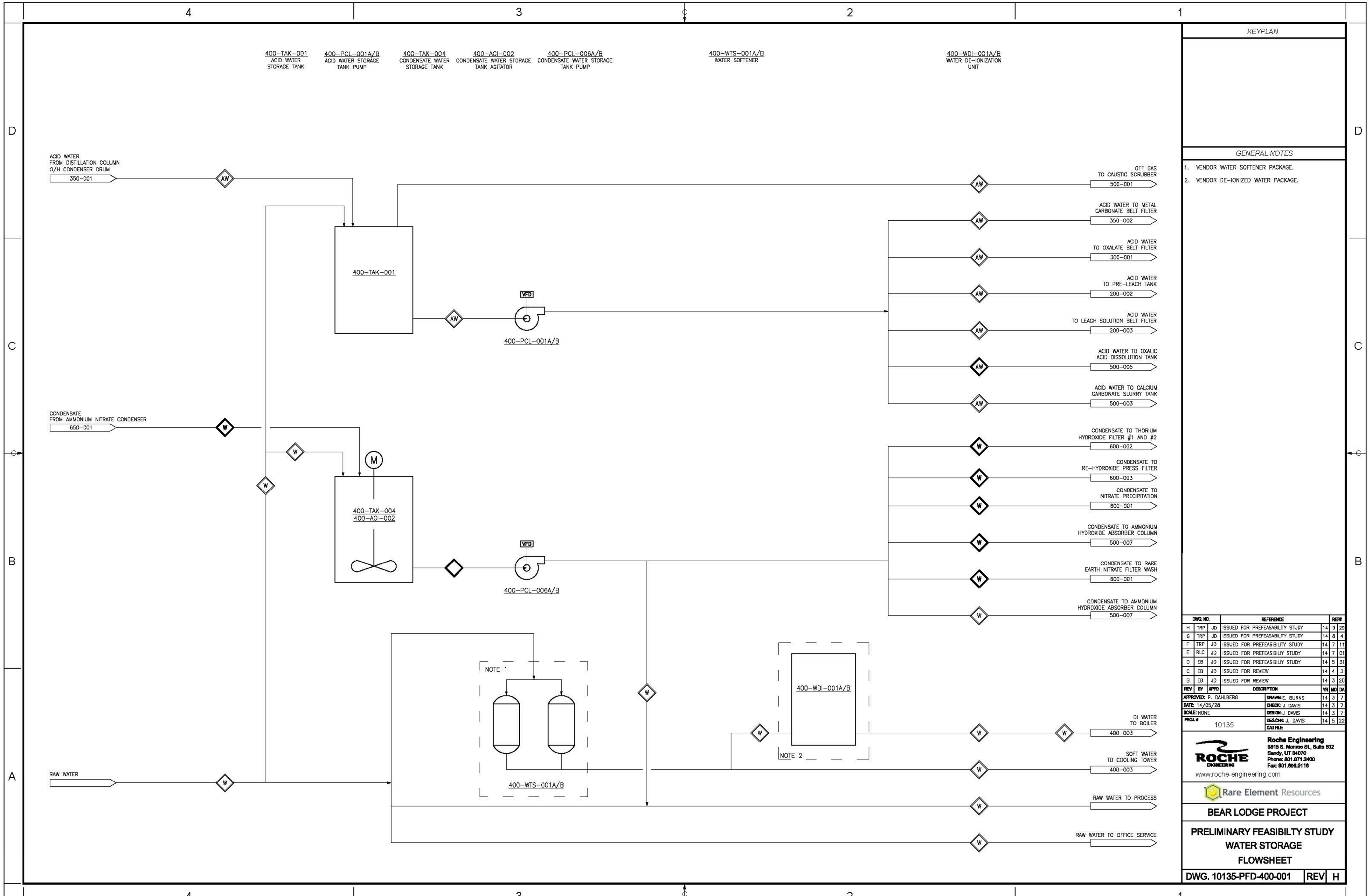
(Roche, 2014)

Figure 17.17 - Drawing No. 10135-PFD-350-003 – PFS – Calcium Chloride Crystallizer Flowsheet



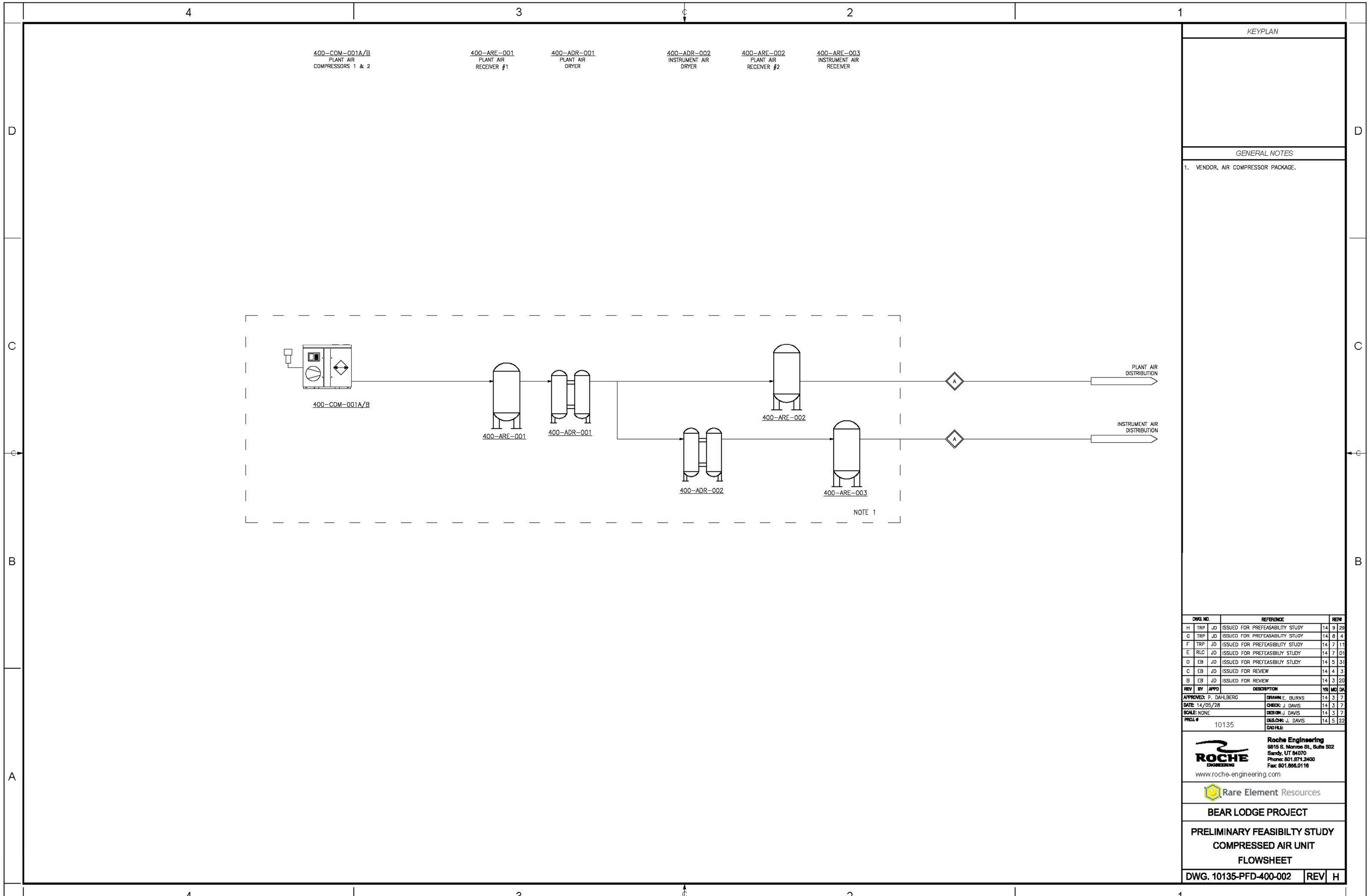
(Roche, 2014)

Figure 17.18 - Drawing No. 10135-PFD-400-001 – PFS – Water Storage Flowsheet



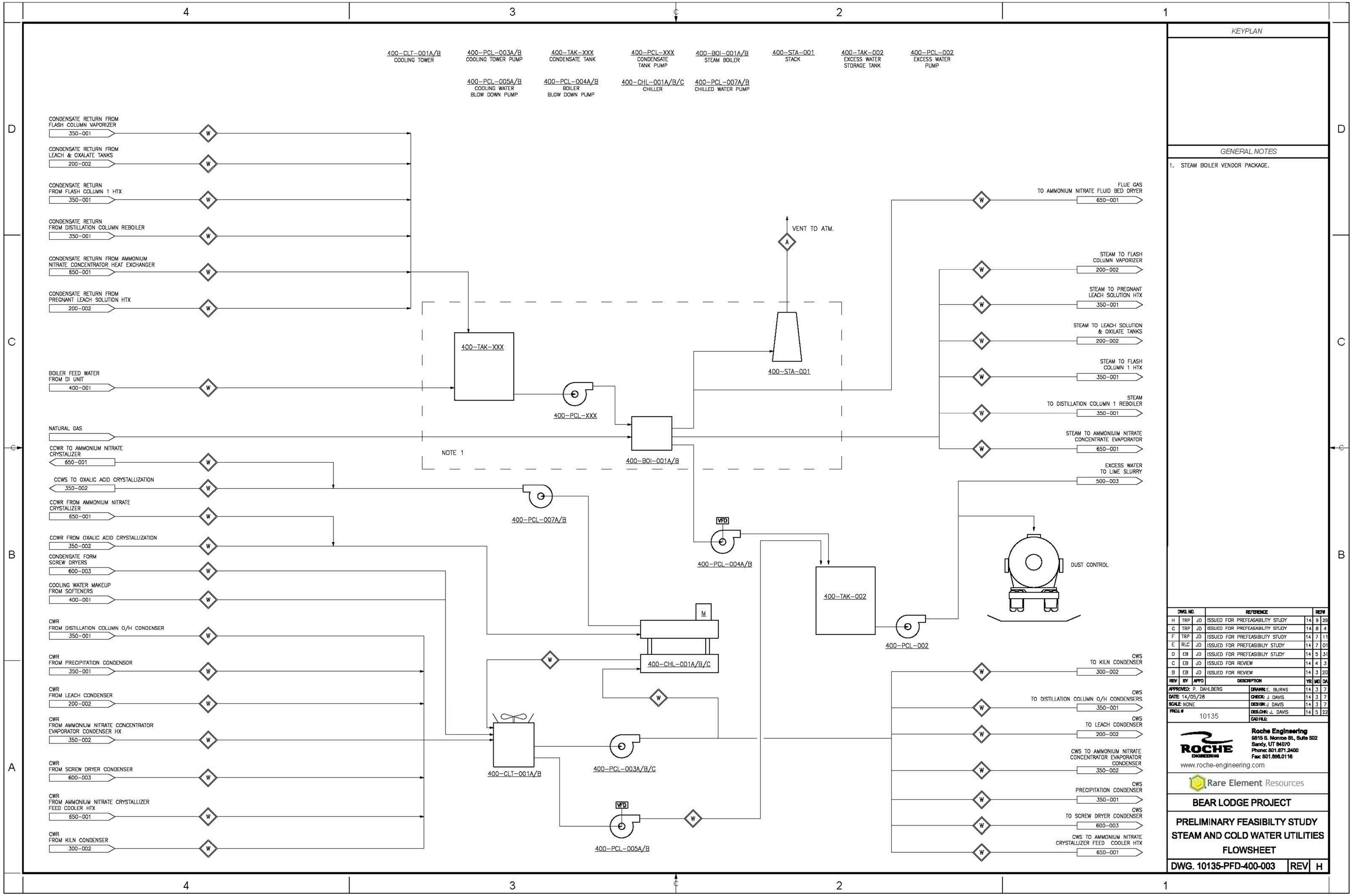
(Roche, 2014)

Figure 17.19 - Drawing No. 10135-PFD-400-002 – PFS – Compressed Air Unit Flowsheet



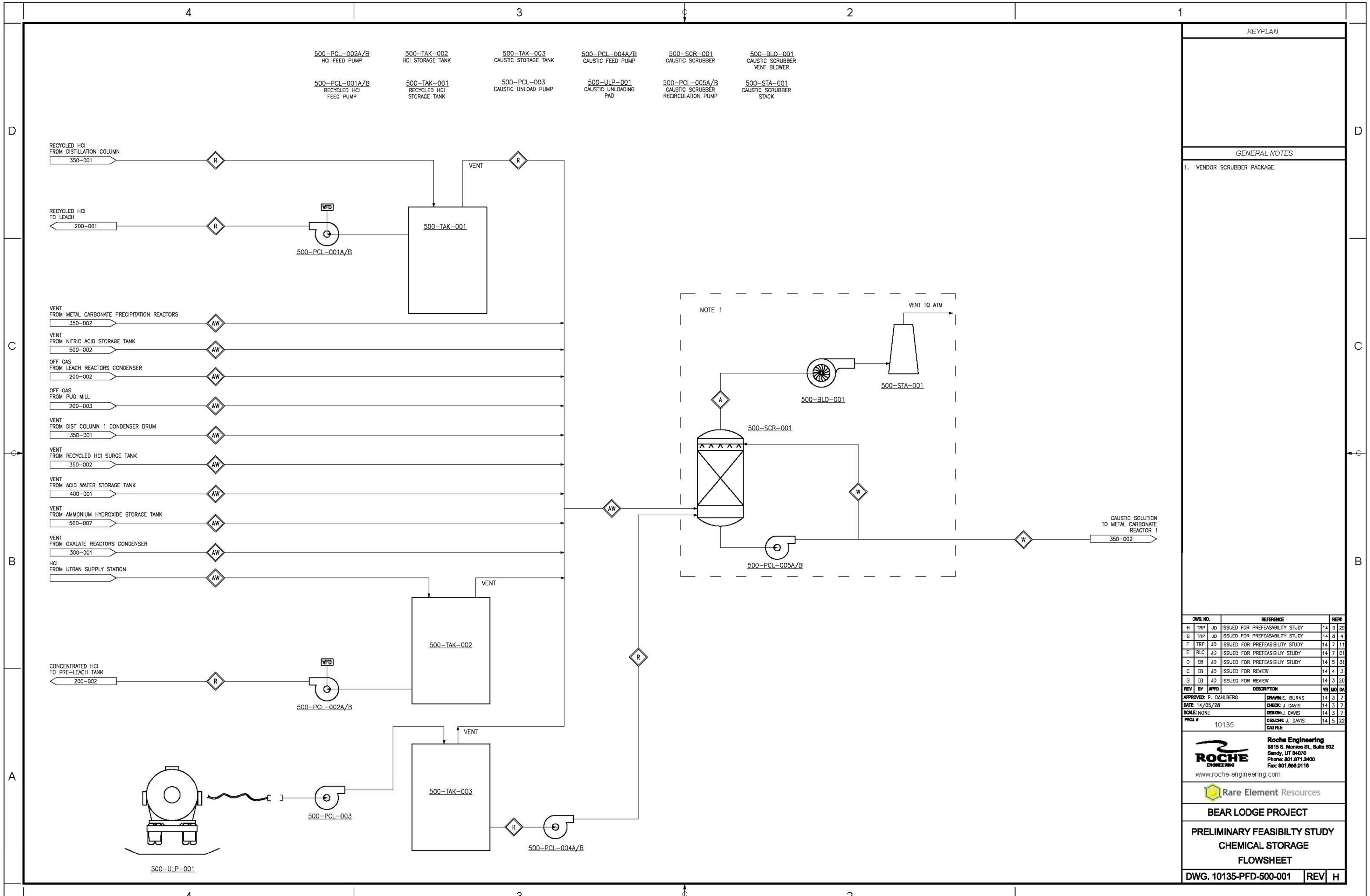
(Roche, 2014)

Figure 17.20 - Drawing No. 10135-PFD-400-003 – PFS – Steam and Cold Water Utilities Flowsheet



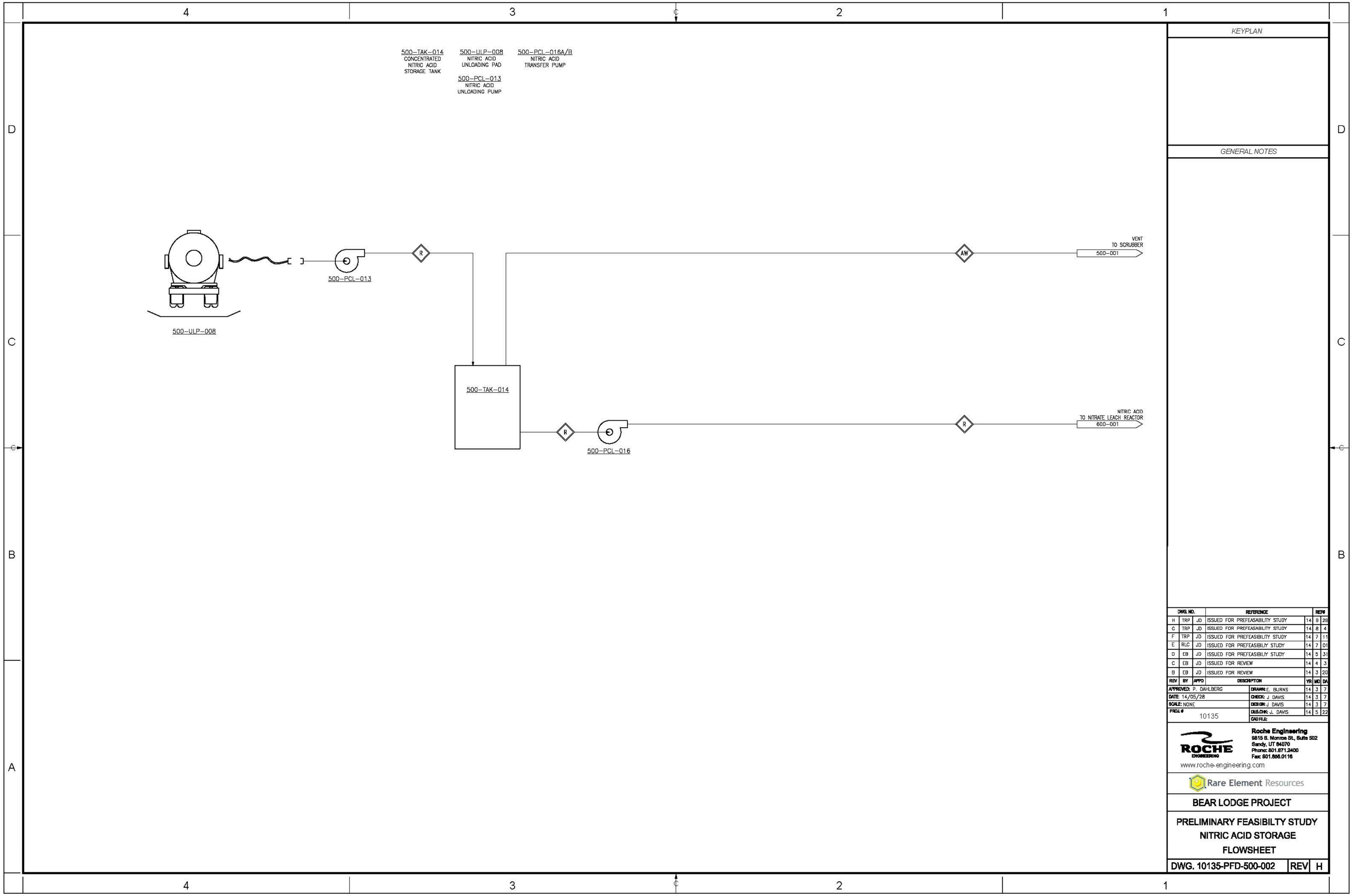
(Roche, 2014)

Figure 17.21 - Drawing No. 10135-PFD-500-001 – PFS – Chemical Storage Flowsheet



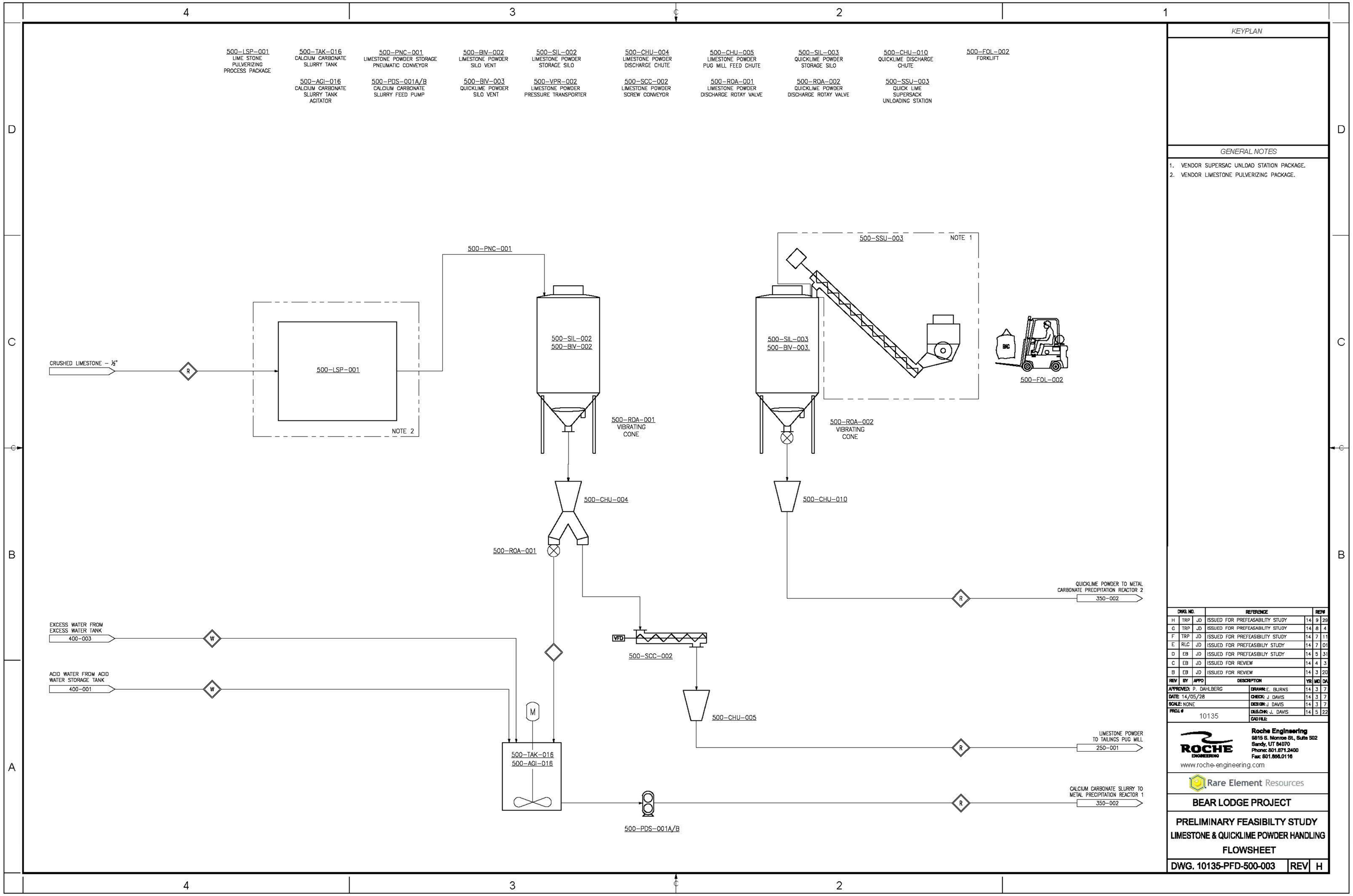
(Roche, 2014)

Figure 17.22 - Drawing No. 10135-PFD-500-002 – PFS – Nitric Acid Storage Flowsheet



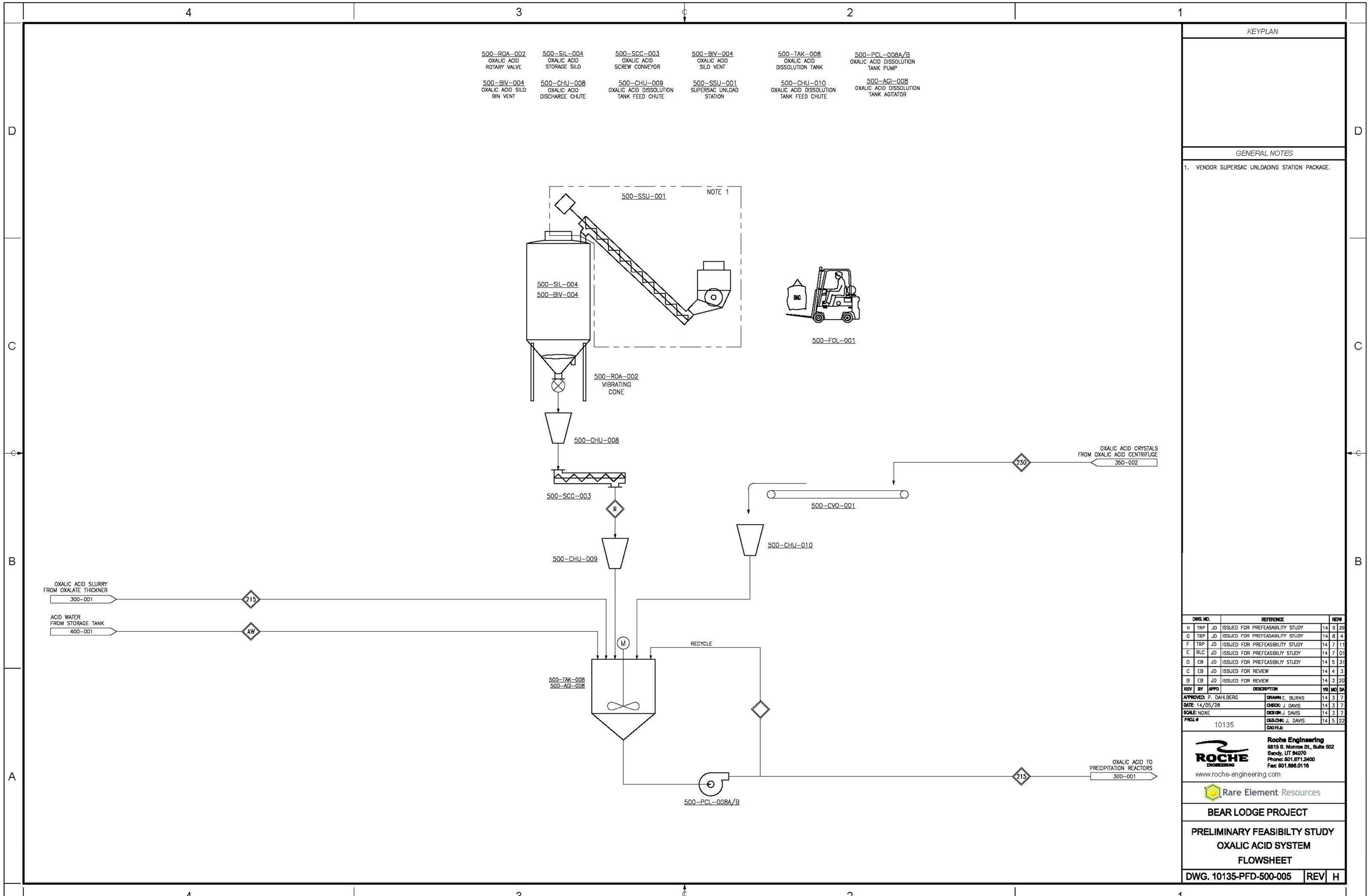
(Roche, 2014)

Figure 17.23 - Drawing No. 10135-PFD-500-003 – PFS – Limestone & Quicklime Powder Handling Flowsheet



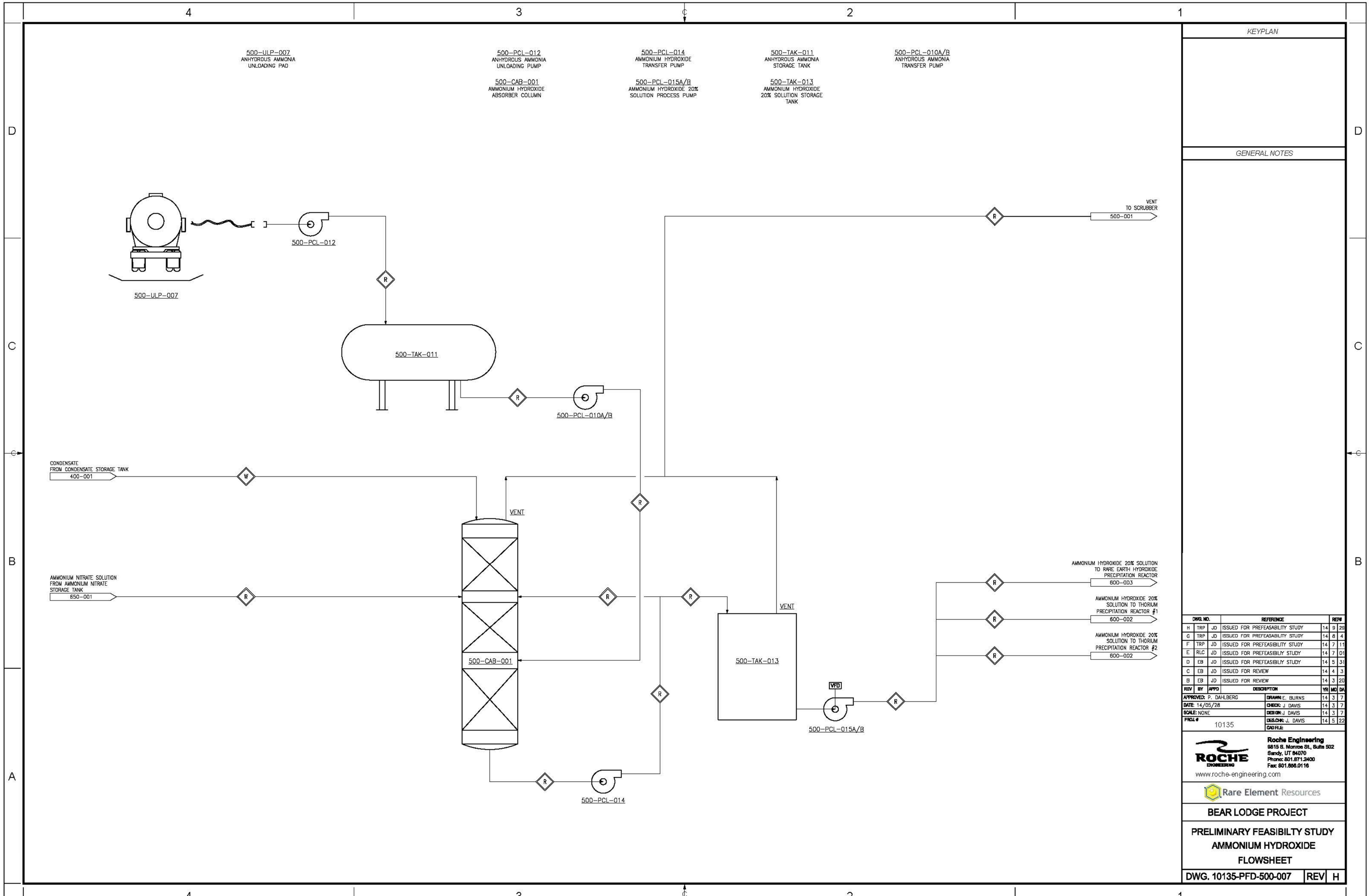
(Roche, 2014)

Figure 17.24 - Drawing No. 10135-PFD-500-005 – PFS – Oxalic Acid System Flowsheet



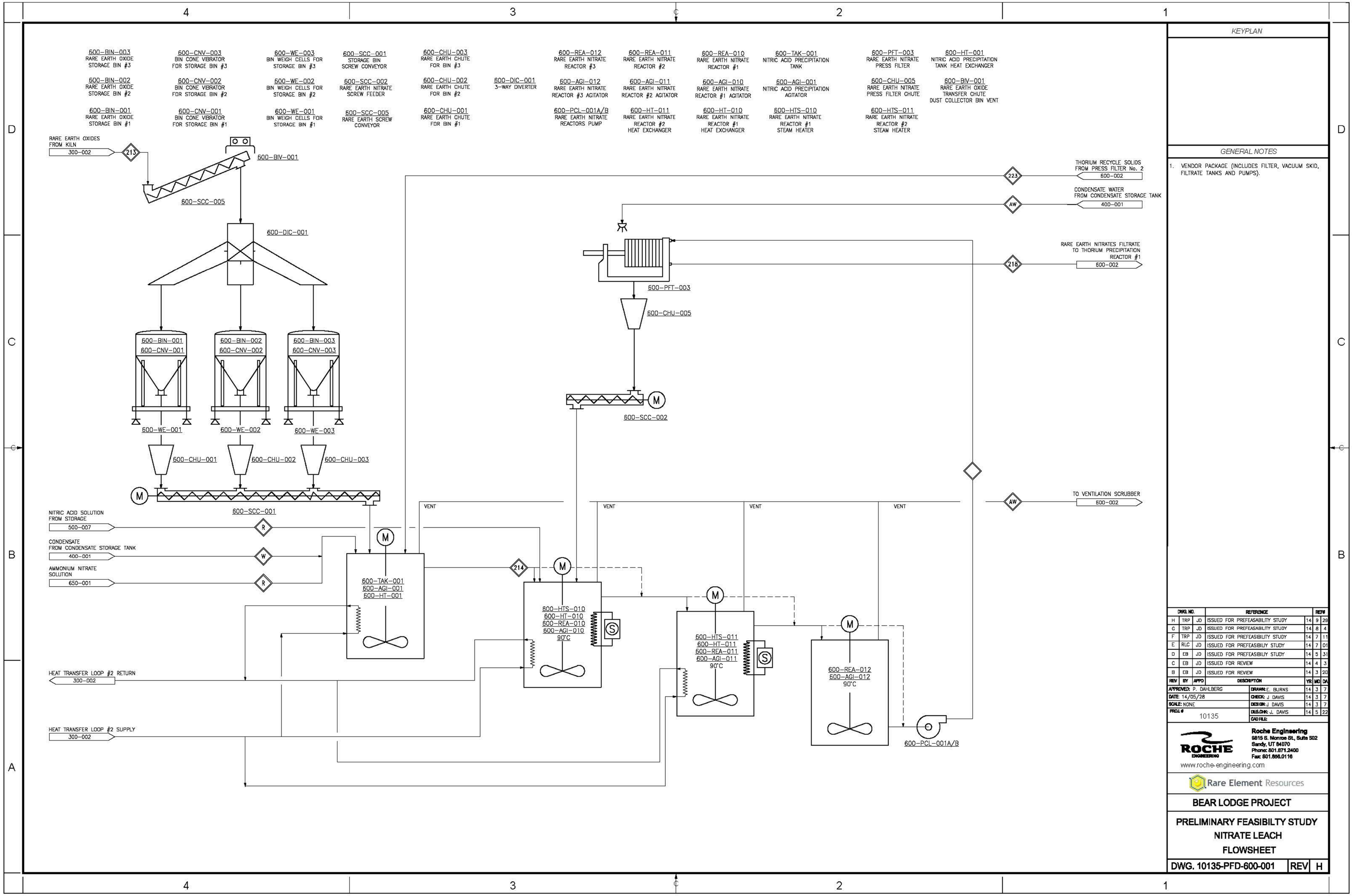
(Roche, 2014)

Figure 17.25 - Drawing No. 10135-PFD-500-007 – PFS – Ammonium Hydroxide Flowsheet



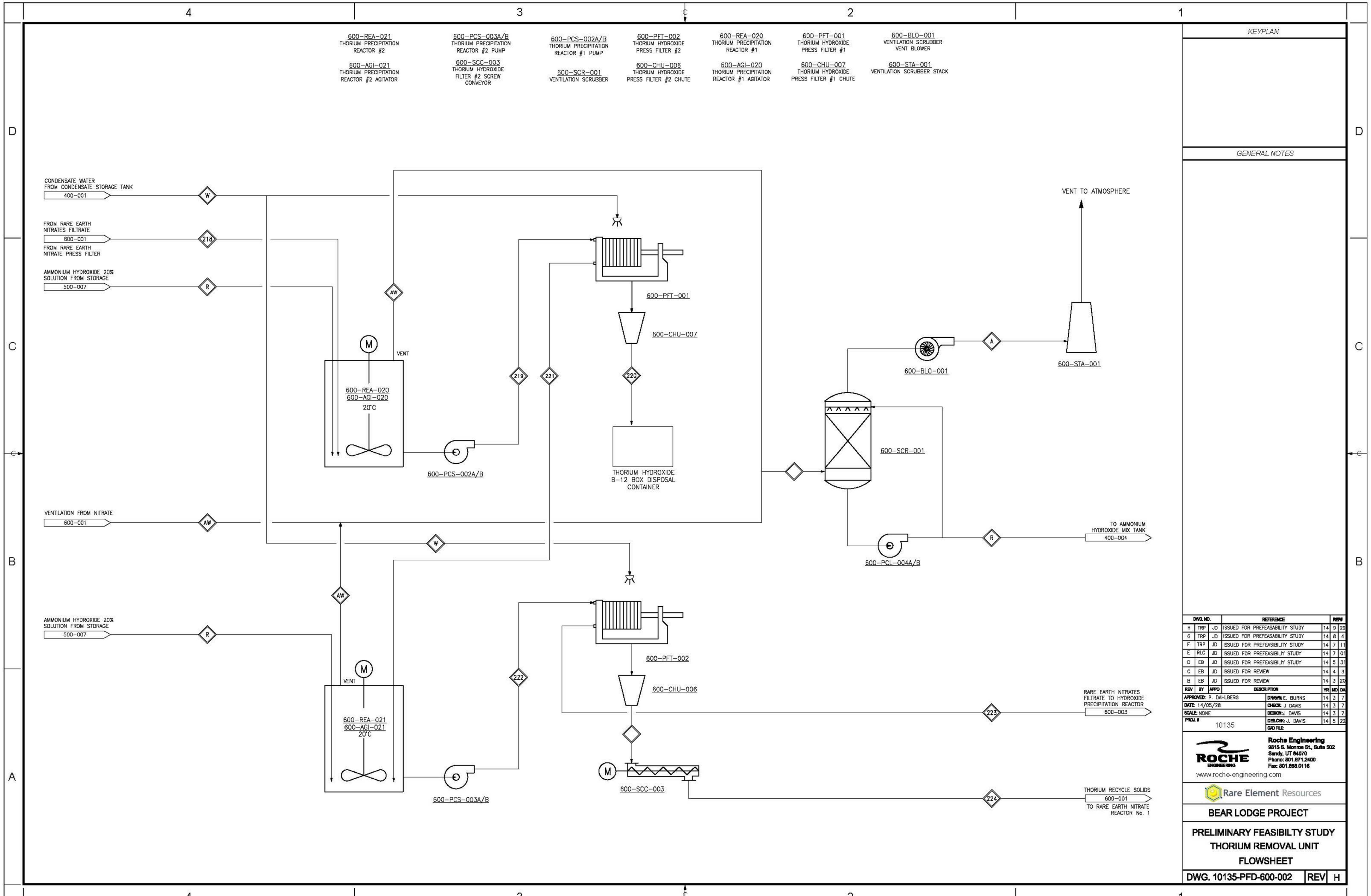
(Roche, 2014)

Figure 17.26 - Drawing No. 10135-PFD-600-001 – PFS – Nitrate Leach Flowsheet



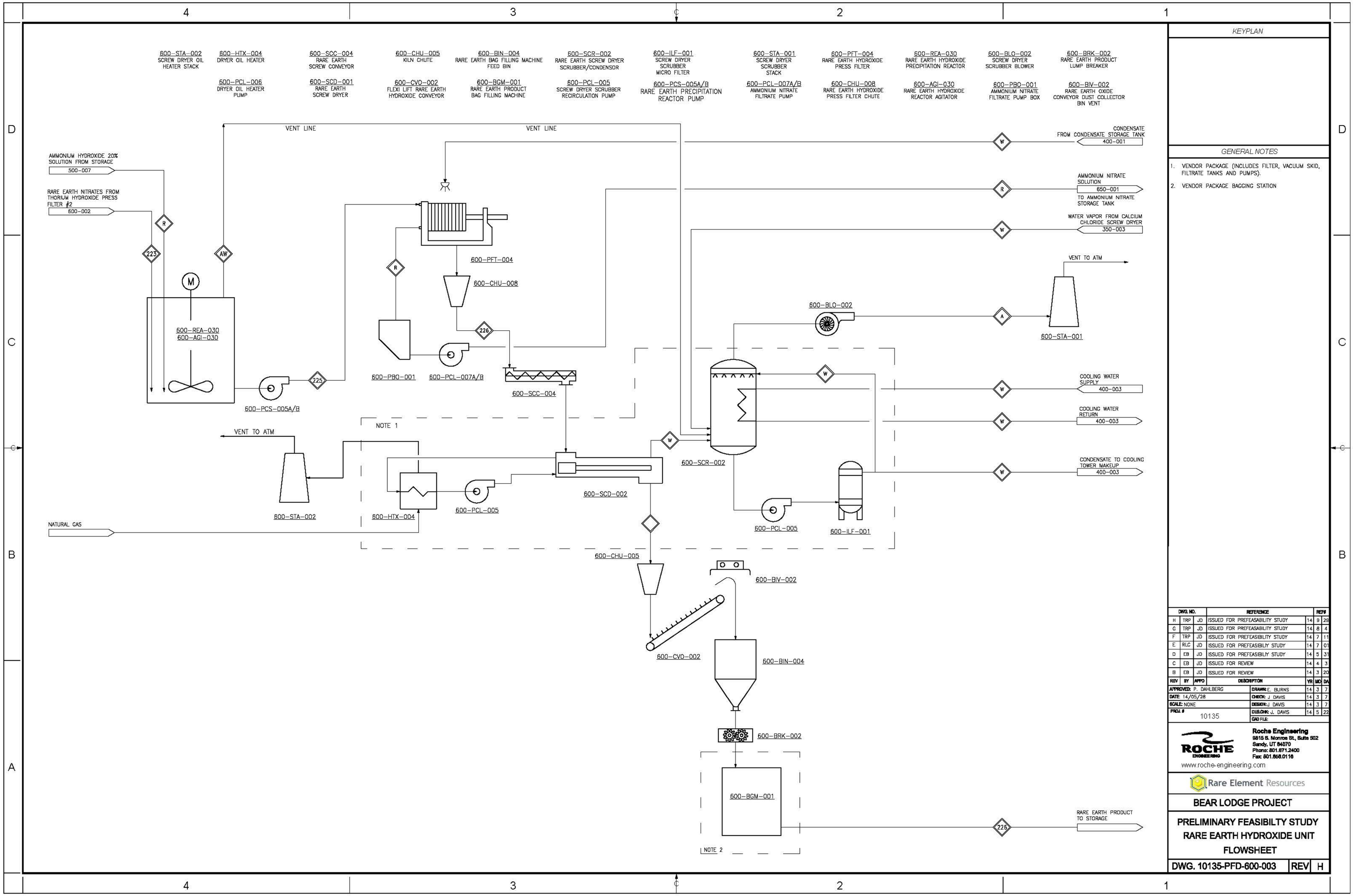
(Roche, 2014)

Figure 17.27 - Drawing No. 10135-PFD-600-002 – PFS – Thorium Removal Unit Flowsheet



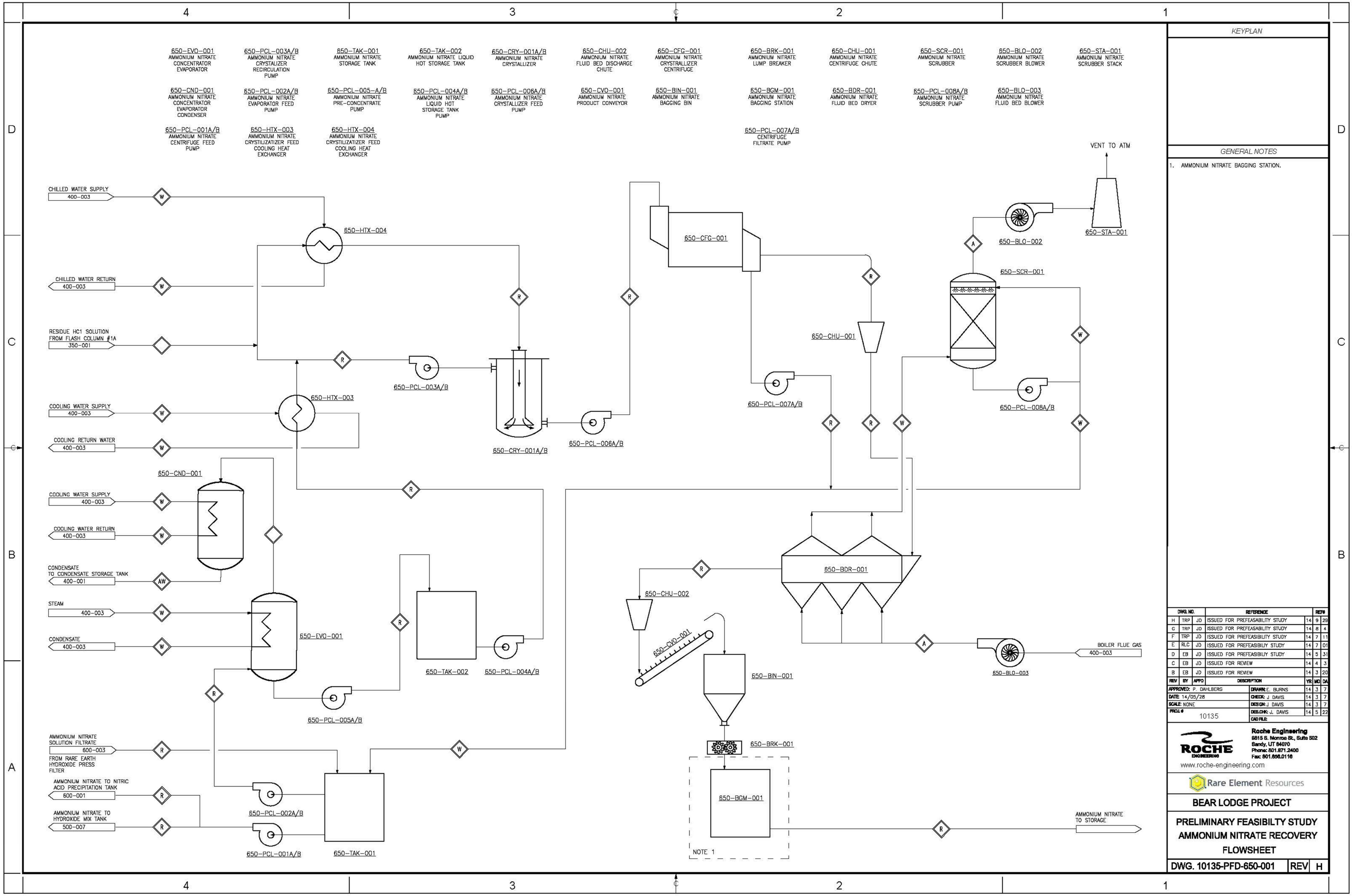
(Roche, 2014)

Figure 17.28 - Drawing No. 10135-PFD-600-003 – PFS – Rare Earth Hydroxide Unit Flowsheet



(Roche, 2014)

Figure 17.29 - Drawing No. 10135-PFD-650-001 – PFS – Ammonium Nitrate Recovery Flowsheet



(Roche, 2014)

Figure 17.30 - Drawing No. 10135-PFD-700-001 – PFS – Hydromet Plant Mass Balance Sheet 1 of 3

DESIGN
Regular Process Comp B R2 - YR-14

PFD Rev G DWG #		200-001		200-002		200-003 Two Stage HCl Counter Current Acid Leach												
PFD Stream #		200	200		201		202					205		208	207	203	209	
METSIM Stream #		213	213	174	71	11	2	7	12	18	110	8	10	9	161	162	6	13,14
Name		PUG Pre-concentrate	Pre-concentrate Feed	Recycled Acid Water	Leach Slurry Feed	2nd Stage Leach Filtrate	1st Stage Leach Slurry	1st Stage Leach Filter Solids	35% HCl Feed	18% Recycle HCl Feed	Recycled Acid Water	2nd Stage Leach Slurry	2nd Stage Acid Water Cake Wash	Leach Residue Solids	2 nd Stage Cake Wash Filtrate	1st Stage Leach Filtrate	PLS Preg-nant Leach Solution	Leach Reactors Vent Line
Solid	ST/Yr	216,518	216,518		216,518		155,257	155,257				141,217		141,217				
Liquid	ST/Yr	11,396	11,396	105,191	116,587	391,807	550,455	51,752	184,673	141,270	47,201	438,879	117,681	46,368	118,385	498,703	617,088	
Gas	ST/Yr																	19,256
Total	ST/Yr	227,914	227,914	105,191	333,105	391,807	705,712	207,009	184,673	141,270	47,201	580,096	117,681	187,585	118,385	498,703	617,088	19,256
Solid	ST/Hr	25.78	25.78	-	25.78	-	18.48	18.48	-	-	-	16.81	-	16.81	-	-	-	-
Liquid	ST/Hr	1.36	1.36	12.52	13.88	46.64	65.53	6.16	21.98	16.82	5.62	52.25	14.01	5.52	14.09	59.37	73.46	-
Gas	ST/Hr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.29
Total	ST/Hr	27.13	27.13	12.52	39.66	46.64	84.01	24.64	21.98	16.82	5.62	69.06	14.01	22.33	14.09	59.37	73.46	2.29
Temp.	Deg. C	AMB	AMB	90.0	68.0	45.0	45.0	45.0	20.0	90.0	90.0	45.0	90.0	76.0	76.0	45.0	45.0	45.0
Liquid	usgpm	-	-	51.72	-	161.97	-	-	75.06	64.06	23.21	-	57.86	-	54.46	198.61	252.70	-
Slurry	usgpm	-	-	-	88.14	-	241.97	43.37	-	-	-	202.85	-	43.96	-	-	-	-
Gas	CFM																	723.39
Solid	Wt. %	95.00%	95.00%	-	65.00%	-	22.00%	75.00%	-	-	-	24.34%	-	75.28%	-	-	-	-
S.G.	Solid	3.258	3.258	-	3.258	-	3.244	3.244	-	-	-	3.135	-	3.135	-	-	-	-
S.G.	Liquid	0.998	0.998	0.967	0.981	1.150	1.194	1.194	1.170	1.049	0.967	1.150	0.967	0.978	1.034	1.194	1.161	-
S.G.	Gas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00169
S.G.	Total	2.926	2.926	0.967	1.797	1.150	1.387	2.270	1.170	1.049	0.967	1.360	0.967	2.029	1.034	1.194	1.161	0.00169

PFD Rev G DWG #		250-001 Tailings Treatment									
PFD Stream #		208					210	234			
METSIM Stream #		9	151	152		154,155	150	173	167	142	
Name		Leach Residue Solids	Limestone CaCO3 Addition	Quicklime CaO Addition	Scrubbers Bleed Water	PUG Mill Gas	PUG Mill Output	Filtered Metal Carbonates	CaCL2XH20 Crystrals	Metsim Tailings Disposal	Excess Water to Tailings Disposal
Solid	ST/Yr	141,217	1,806	4			141,250	22,889	192,744	358,928	358,928
Liquid	ST/Yr	46,368	0	0	3,862		47,177	29,057	0	74,188	127,177
Gas	ST/Yr					405					
Total	ST/Yr	187,585	1,806	4	3,862	405	188,427	51,946	192,744	433,117	486,105
Solid	ST/Hr	16.81	0.21	0.0004	-	-	16.82	2.72	22.95	42.73	42.73
Liquid	ST/Hr	5.52	-	-	0.46	-	5.62	3.46	-	8.83	15.14
Gas	ST/Hr	-	-	-	-	0.05	-	-	-	-	-
Total	ST/Hr	22.33	0.21	0.0004	0.46	0.05	22.43	6.18	22.95	51.56	57.87
Temp.	Deg. C	76.0	AMB	AMB	50.0	AMB	AMB	AMB	AMB	AMB	AMB
Liquid	usgpm	-	-	-	1.86	-	-	-	-	-	-
Slurry	usgpm	43.96	0.29	0.0005	-	-	43.48	13.09	43.22	96.25	120.47
Gas	CFM					13.03					
Solid	Wt. %	75.28%	100.00%	100.00%	-	-	74.96%	44.06%	100.00%	82.87%	73.84%
S.G.	Solid	3.135	2.930	3.310	-	-	3.134	2.189	2.121	2.436	2.436
S.G.	Liquid	0.978	1.000	1.000	0.988	-	1.017	1.702	1.519	1.348	1.200
S.G.	Gas	-	-	-	-	0.00197	-	-	-	-	-
S.G.	Total	2.029	2.930	3.310	0.988	0.00197	2.061	1.887	2.121	2.140	1.919

DESIGN
Regular Process Comp B R2 - YR-14

PFD Rev G DWG #		300-001 Rare Earth Oxalate Precipitation									
PFD Stream #		209	215	211			212	227	228	215??	
METSIM Stream #		6	20	23	105	25	24	26	29	30	81
Name		PLS Preg-nant Leach Solution	Oxalic Acid Feed	Oxalate Precip. Output	Oxalate Reactors Vent Line	Acid Water Cake Wash	Filtered RE Oxalates	RE Oxalates Filtrate	Oxalate Thickener O'Flow	Oxalate Thickener U'Flow	Oxalate Thickener Vent Line
Solid	ST/Yr		53	18,777			18,777			0	
Liquid	ST/Yr	617,088	120,522	718,886		13,477	4,121	728,241	728,241	0	
Gas	ST/Yr				0						0
Total	ST/Yr	617,088	120,574	737,662	0	13,477	22,898	728,241	728,241	0	0
Solid	ST/Hr	-	0.01	2.24	-	-	2.24	-	-	-	-
Liquid	ST/Hr	73.46	14.35	85.58	-	1.60	0.49	86.70	86.70	-	-
Gas	ST/Hr	-	-	-	-	-	-	-	-	-	-
Total	ST/Hr	73.46	14.35	87.82	-	1.60	2.73	86.70	86.70	-	-
Temp.	Deg. C	85.0	40.0	90.0	90.0	90.0	90.0	90.0	15.0	15.0	15.0
Liquid	usgpm	252.70	-	-	-	6.63	-	305.49	295.07	-	-
Slurry	usgpm	-	50.00	304.80	-	-	5.84	-	-	-	-
Gas	CFM				-						-
Solid	Wt. %	-	0.04%	2.55%	-	-	82.00%	-	-	82.00%	-
S.G.	Solid	-	2.302	2.343	-	-	2.343	-	-	2.357	-
S.G.	Liquid	1.161	1.146	1.136	-	0.967	0.967	1.134	1.174	0.967	-
S.G.	Gas	-	-	-	0.00097	-	-	-	-	-	0.00103
S.G.	Total	1.161	1.147	1.151	0.00097	0.967	1.865	1.134	1.174	1.873	0.00103

PFD Rev G DWG #		300-002 Rare Earth Oxidation							350-001 HCl Recovery						350-002 Oxalic Acid Recovery		
PFD Stream #								213	228		229				229	230	231
METSIM Stream #		185	186		189	188		187	50	52	53	18	54??		58	57	133
Name		Dried RE Oxalates	Oxalate Dryer Vapor	Oxalate Scrubber Bleed	Oxide Kiln Intake	Oxide Kiln Vapor	Kiln Scrubber Bleed	Kiln RE Oxides	RE Barren Solution	HCl Flash Column 1 Vapor	HCl Flash Column 1 Residue	Distillation Column 18% HCL	Distillation Column Vapor	Acid Water Output	Oxalic Acid Crystallizer Output	Centrifuged Oxalic Acid Crystrals	Centrifuged Oxalic Acid Liquid
Solid	ST/Yr	18,777						8,720							23,113	23,113	
Liquid	ST/Yr	0		412			3,450	0	728,241		188,076	141,270		398,895	164,963	4,079	160,884
Gas	ST/Yr		4,122		8,450	18,507				540,166			398,895				
Total	ST/Yr	18,777	4,122	412	8,450	18,507	3,450	8,720	728,241	540,166	188,076	141,270	398,895	398,895	188,076	27,191	160,884
Solid	ST/Hr	2.24	-	-	-	-	-	1.04	-	-	-	-	-	-	2.75	2.75	-
Liquid	ST/Hr	-	-	0.05	-	-	0.41	-	86.70	-	22.39	16.82	-	47.49	19.64	0.49	19.15
Gas	ST/Hr	-	0.49	-	1.01	2.20	-	-	-	64.31	-	-	47.49	-	-	-	-
Total	ST/Hr	2.24	0.49	0.05	1.01	2.20	0.41	1.04	86.70	64.31	22.39	16.82	47.49	47.49	22.39	3.24	19.15
Temp.	Deg. C	130.0	130.0	90.0	AMB	700.0	50.0	700.0	15.0	116.0	116.0	90.0	90.0	90.0	0.0	0.0	10.0
Liquid	usgpm	-	-	0.20	-	-	1.66	-	295.07	-	56.37	64.06	-	196.14	-	-	44.19
Slurry	usgpm	3.81	-	-	-	-	-	0.59	-	-	-	-	-	-	51.96	7.78	-
Gas	CFM		479.83		448.72	3,360.96				59,299.97			41,909.24				
Solid	Wt. %	100.00%	-	-	-	-	-	100.00%	-	-	-	-	-	-	12.29%	85.00%	-
S.G.	Solid	2.343	-	-	-	-	-	7.011	-	-	-	-	-	-	1.651	1.651	-
S.G.	Liquid	2.091	-	0.988	-	-	0.988	0.706	1.174	-	1.587	1.049	-	0.967	1.731	1.731	1.731
S.G.	Gas	-	0.00055	-	0.00120	0.00035	-	-	-	0.00058	-	-	0.00061	-	-	-	-
S.G.	Total	2.343	0.00055	0.988	0.00120	0.00035	0.988	7.011	1.174	0.00058	1.587	1.049	0.00061	0.967	1.721	1.663	1.731

DESIGN
Regular Process Comp B R2 - YR-14

PFD Rev G DWG #		350-002 Metal Carbonate Precipitation								350-003 Calcium Chloride Crystallizer			
PFD Stream #					233			235	234				
METSIM Stream #		141	168	178	180	182	171	169	173	172		167	170
Name		CaCO3 Slurry	Metal Carbonate Reactor #1	CaO Quicklime	Metal Carbonate Reactor #2	Reactor Gas	Acid Water Cake Wash	Metal Carbonate Filtrate	Filtered Metal Carbonates	Screw Evap. Vapor	Screw Evap. Condensate	Centrifuged CaCL2XH20 Crystrals	Centrifuge Liquid
Solid	ST/Yr	43,412	10,994	22	22,889				22,889			192,744	
Liquid	ST/Yr	22,364	214,387	0	189,746		58,857	238,793	29,057		26,802	0	19,248
Gas	ST/Yr					14,047				26,802			
Total	ST/Yr	65,775	225,381	22	212,635	14,047	58,857	238,793	51,946	26,802	26,802	192,744	19,248
Solid	ST/Hr	5.17	1.31	0.0026	2.72	-	-	-	2.72	-	-	22.95	-
Liquid	ST/Hr	2.66	25.52	-	22.59	-	7.01	28.43	3.46	-	3.19	-	2.29
Gas	ST/Hr	-	-	-	-	1.67	-	-	-	3.19	-	-	-
Total	ST/Hr	7.83	26.83	0.0026	25.31	1.67	7.01	28.43	6.18	3.19	3.19	22.95	2.29
Temp.	Deg. C	AMB	AMB	AMB	AMB	AMB	90.0	AMB	AMB	?	AMB	AMB	AMB
Liquid	usgpm	-	-	-	-	-	28.94	75.25	-	-	12.90	-	4.41
Slurry	usgpm	17.90	61.43	0.0031	58.57	-	-	-	13.09	-	-	43.22	-
Gas	CFM					494.12				1,350.99			
Solid	Wt. %	66.00%	4.88%	100.00%	10.76%	-	-	-	44.06%	-	-	100.00%	-
S.G.	Solid	2.930	1.641	3.310	2.189	-	-	-	2.189	-	-	2.121	-
S.G.	Liquid	0.980	1.750	1.000	1.683	-	0.967	1.509	1.702	-	0.988	1.519	2.075
S.G.	Gas	-	-	-	-	0.00181	-	-	-	0.00126	-	-	-
S.G.	Total	1.747	1.745	3.310	1.726	0.00181	0.967	1.509	1.887	0.00126	0.988	2.121	2.075

PFD Rev G DWG #		400-001 Acid Water								
PFD Stream #										
METSIM Stream #			174	110	10	131	25	171	176	
Name		Total Acid Water Input	1st Stage Leach Acid Water	2nd Stage Leach Acid Water	2nd Stage Acid Water Cake Wash	Oxalic Acid Dissolution Acid Water	Oxalate Acid Water Cake Wash	Carbonate Acid Water Cake Wash	Acid Water to Lime Slurry Tank	Makeup to Acid water Tank
Solid	ST/Yr									
Liquid	ST/Yr	398,895	105,191	47,201	117,681	60,829	13,477	58,857	0	4,341
Gas	ST/Yr									
Total	ST/Yr	398,895	105,191	47,201	117,681	60,829	13,477	58,857	0	4,341
Solid	ST/Hr	-	-	-	-	-	-	-	-	-
Liquid	ST/Hr	47.49	12.52	5.62	14.01	7.24	1.60	7.01	-	0.52
Gas	ST/Hr	-	-	-	-	-	-	-	-	-
Total	ST/Hr	47.49	12.52	5.62	14.01	7.24	1.60	7.01	-	0.52
Temp.	Deg. C	90.0	90.0	90.0	90.0	-	90.0	90.0	90.0	AMB
Liquid	usgpm	196.14	51.72	23.21	57.86	29.91	6.63	28.94	-	2.07
Slurry	usgpm	-	-	-	-	-	-	-	-	-
Gas	CFM									
Solid	Wt. %	-	-	-	-	-	-	-	-	-
S.G.	Solid	-	-	-	-	-	-	-	-	-
S.G.	Liquid	0.967	0.967	0.967	0.967	0.967	0.967	0.967	0.967	0.998
S.G.	Gas	-	-	-	-	-	-	-	-	-
S.G.	Total	0.967	0.967	0.967	0.967	0.967	0.967	0.967	0.967	0.998

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GENERAL NOTES

DWG. NO.			REFERENCE			REF#
A	TRP	JD	ISSUED FOR PREFEASIBILITY STUDY	14	9	5
REV	BY	APPD	DESCRIPTION	YR	MO	DA

APPROVED: J. DAVIS	DRAWN: TRP	14	9	5
DATE: 14/9/5	CHECK: J DAVIS	14	9	5
SCALE: NONE	DESIGN: J DAVIS	14	9	5
PROJ. # 10135	DES.CHK: J. DAVIS	14	9	5
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HYDROMET PLANT
MASS BALANCE SHEET 1 OF 3

DWG. 10135-PFD-700-001 | REV | A

(Roche, 2014)

Figure 17.31 - Drawing No. 10135-PFD-700-002 – PFS – Hydromet Plant Mass Balance Sheet 2 of 3

DESIGN – Regular Process Comp B R2 - YR-14

PFD Rev G DWG #		400-001 Condensate Water								400-001 Water Utilities					400-002		400-003 Steam and Cold Water Utilities						
PFD Stream #																							
METSIM Stream #			130	99		49		96										109					
Name		Ammonium Nitrate Condensate	To Ammonium Hydroxide (Condensate)	Nitrate Dilution Water (Condensate)	Nitrate Filter Wash (Condensate)	Thorium Filter Wash (Condensate)	Thorium Filter Wash (Condensate)	RE Hydroxide Filter Wash (Condensate)	Makeup to Condensate water Tank	Raw Water Input	Water Softener Output	Soft Water to Cooling Tower	DI Water Output	DI Water to Boiler	Plant Compressed Air	Instrument Compressed Air	CaCl2 Screw Evap. Condensate	RE Oxide Dryer Condensate	Cooling Tower Evaporation	Cooling Tower Blowdown	Boiler Blowdown	Blowdown To Limestone Slurry Tank	Excess Water Output
Solid	ST/Yr																						
Liquid	ST/Yr	45,216	24,227	11,236	250	242	242	15,136	6,116	405,024	394,567	338,467	56,100	56,100			26,802	4,092	323,100	46,260	25,230	22,364	49,126
Gas	ST/Yr																						
Total	ST/Yr	45,216	24,227	11,236	250	242	242	15,136	6,116	405,024	394,567	338,467	56,100	56,100			26,802	4,092	323,100	46,260	25,230	22,364	49,126
Solid	ST/Hr	-	-	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-
Liquid	ST/Hr	5.38	2.88	1.34	0.03	0.03	0.03	1.80	0.73	48.22	46.97	40.29	6.68	6.68			3.19	0.49	38.46	5.51	3.00	2.66	5.85
Gas	ST/Hr	-	-	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-
Total	ST/Hr	5.38	2.88	1.34	0.03	0.03	0.03	1.80	0.73	48.22	46.97	40.29	6.68	6.68			3.19	0.49	38.46	5.51	3.00	2.66	5.85
Temp.	Deg. C	50.0	AMB	50.0	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB			AMB	AMB	AMB	AMB	AMB	AMB	AMB
Liquid	usgpm	21.71	11.54	5.41	0.12	0.12	0.12	7.28	2.91	192.98	189.90	161.27	27.00	27.00			12.90	1.96	153.64	22.00	12.00	10.63	23.36
Slurry	usgpm	-	-	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-
Gas	CFM																						
Solid	Wt. %	-	-	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-
S.G.	Solid	-	-	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-
S.G.	Liquid	0.988	0.998	0.988	0.988	0.988	0.988	0.988	0.998	0.998	0.988	0.998	0.988	0.988			0.988	0.990	1.000	1.000	1.000	1.000	1.000
S.G.	Gas	-	-	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-
S.G.	Total	0.990	0.998	0.988	0.988	0.988	0.988	0.988	0.998	0.998	0.988	0.998	0.988	0.988			0.988	0.990	1.000	1.000	1.000	1.000	1.000

DESIGN – Regular Process Comp B R2 - YR-14

PFD Rev G DWG #		500-001 Chemical Storage & Caustic Scrubber												500-002 Nitric Acid Storage		500-003 Limestone Slurry System			500-005 Oxalic Acid Dissolution System				
PFD Stream #																							215
METSIM Stream #		12	18	135	13,14	153,154			105			136	137	46		175		141	22	131	30	57	20
Name		35% HCl	18% HCL	50% NaOH	Leach Reactors Vent Line	PUG Mill Gas	Distillation Condenser Drum Vent	Storage Tanks Vents	Oxalate Reactors Vent Line	Oxalate Thickeners Vent Line	Ammonium Hydroxide Vent	Scrubber Stack Vapor	Scrubber Discharge Solution	65% Nitric Acid	Vent to Caustic Scrubber	Limestone CaCO3 Addition	Slurry Water From Excess Water Tank	CaCO3 Slurry	Fresh Oxalic Acid Addition	Oxalic Acid Dissolution Acid Water	Oxalate Thickener U'Flow	Centrifuged Oxalic Acid Crystrals	Oxalic Acid Feed
Solid	ST/Yr															43,412		43,412	32,554		0	23,113	53
Liquid	ST/Yr	184,673	141,270	102									204	17,919		0	22,364	22,364	0	60,829	0	4,079	120,522
Gas	ST/Yr				19,256	405	0	0	0	0	0	19,661			0								
Total	ST/Yr	184,673	141,270	102	19,256	405	0	0	0	0	0	19,661	204	17,919	0	43,412	22,364	65,775	32,554	60,829	0	27,191	120,574
Solid	ST/Hr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.17	-	5.17	3.88	-	-	2.75	0.01
Liquid	ST/Hr	21.98	16.82	0.01	-	-	-	-	-	-	-	-	0.02	2.13	-	-	2.66	2.66	-	7.24	-	0.49	14.35
Gas	ST/Hr	-	-	-	2.29	0.05	-	-	-	-	-	2.34	-	-	-	-	-	-	-	-	-	-	-
Total	ST/Hr	21.98	16.82	0.01	2.29	0.05	-	-	-	-	-	2.34	0.02	2.13	-	5.17	2.66	7.83	3.88	7.24	-	3.24	14.35
Temp.	Deg. C	20.0	90.0		45.0	AMB	90.0	AMB	90.0	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB		15.0	0.0	40.0
Liquid	usgpm	75.06	64.06	0.03	-	-	-	-	-	-	-	-	0.07	5.93	-	-	10.63	-	-	29.91	-	-	-
Slurry	usgpm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.05	-	17.90	9.38	-	-	7.78	50.00
Gas	CFM				723.39	13.03	-	-	-	-	-	639.23			-								
Solid	Wt. %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100.00%	-	66.00%	100.00%	-	82.00%	85.00%	0.04%
S.G.	Solid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.930	-	2.930	1.650	-	2.357	1.651	2.302
S.G.	Liquid	1.170	1.049	1.532	-	-	-	-	-	-	-	-	1.343	1.438	-	1.000	1.000	0.980	1.000	0.967	0.967	1.731	1.146
S.G.	Gas	-	-	-	0.00169	0.00197	0.00097	0.00196	0.00097	0.00196	0.00196	0.00196	-	-	0.00196	-	-	-	-	-	-	-	-
S.G.	Total	1.170	1.049	1.532	0.00169	0.00197	0.00097	0.00196	0.00097	0.00196	0.00196	0.00196	1.343	1.438	0.00196	2.930	1.000	1.747	1.650	0.967	1.873	1.663	1.147

DESIGN – Regular Process Comp B R2 - YR-14

PFD Rev G DWG #		500-007 Ammonium Hydroxide								600-001 Rare Earth Nitrate Leach							
PFD Stream #										213		214		224		218	
METSIM Stream #		65		130	83		47	207	69	187	99	103	46	211		37	36
Name		Ammonium Nitrate Solution	100% Anhydrous Ammonia	Condensate Water Addition	100% Ammonium Hydroxide	Vent to Caustic Scrubber	20% Ammonium Hydroxide	20% Ammonium Hydroxide	20% Ammonium Hydroxide	Kiln RE Oxides	Dilution Water (Condensate)	Nitric Acid Reactor Output	65% Nitric Acid	Filtered Thorium Recycle	Condensate Water Filter Wash	Nitrate Reactors Filtrate	Nitrate Reactor Vapor
Solid	ST/Yr									8,720		8,720		361			
Liquid	ST/Yr	0	3,171	24,227	6,526		843	915	28,995	0	11,236	11,241	17,919	64	258	38,302	
Gas	ST/Yr					0											0
Total	ST/Yr	0	3,171	24,227	6,526	0	843	915	28,995	8,720	11,236	19,961	17,919	425	258	38,302	0
Solid	ST/Hr	-	-	-	-	-	-	-	-	1.04	-	1.04	-	0.04	-	-	-
Liquid	ST/Hr	-	0.38	2.88	0.78	-	0.10	0.11	3.45	-	1.34	1.34	2.13	0.01	0.03	4.56	-
Gas	ST/Hr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	ST/Hr	-	0.38	2.88	0.78	-	0.10	0.11	3.45	1.04	1.34	2.38	2.13	0.05	0.03	4.56	-
Temp.	Deg. C	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	700.0	50.0	50.0	AMB	AMB	AMB	90.0	90.0
Liquid	usgpm	-	2.44	11.54	3.61	-	0.39	0.43	13.58	-	5.41	-	5.93	-	0.12	10.57	-
Slurry	usgpm	-	-	-	-	-	-	-	-	0.59	-	5.59	-	0.06	-	-	-
Gas	CFM					-											-
Solid	Wt. %	-	-	-	-	-	-	-	-	100.00%	-	40.00%	-	85.00%	-	-	-
S.G.	Solid	-	-	-	-	-	-	-	-	7.011	-	7.011	-	4.387	-	-	-
S.G.	Liquid	1.140	0.617	0.998	0.860	-	1.016	1.016	1.016	0.706	0.988	1.128	1.438	1.731	0.988	1.723	-
S.G.	Gas	-	-	-	-	0.00196	-	-	-	-	-	-	-	-	-	-	0.00148
S.G.	Total	1.140	0.617	0.998	0.860	0.00196	1.016	1.016	1.016	7.011	0.988	1.697	1.438	3.567	0.988	1.723	0.00148

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GENERAL NOTES

A TRP JD ISSUED FOR PREFEASIBILITY STUDY 14 9 5

APPROVED: J. DAVIS
DATE: 14/09/05
SCALE: NONE
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HYDROMET PLANT
MASS BALANCE SHEET 2 OF 3

DWG. 10135-PFD-700-002 REV A

(Roche, 2014)

Figure 17.32 - Drawing No. 10135-PFD-700-003 – PFS – Hydromet Plant Mass Balance Sheet 3 of 3

DESIGN
Regular Process Comp B R2 - YR-14

PFD Rev G DWG #		600-002 Thorium Removal & Scrubber												
PFD Stream #			219			220	221		222		223	224		
METSIM Stream #		47	39	38	49	40	41	207	208		210	211	209	107
Name		20% Ammonium Hydroxide	Thorium Reactor #1 Output	Thorium Reactor #1 Vent	Condensate Water Filter Wash	Filtered Thorium for Disposal	Thorium Reactor #1 Filtrate	20% Ammonium Hydroxide	Thorium Reactor #2 Output	Condensate Water Filter Wash	Thorium Reactor #2 Filtrate	Filtered Thorium Recycle	Thorium Reactor #2 Vent	Scrubber Stack Gas
Solid	ST/Yr		228			228			361			361		
Liquid	ST/Yr	843	38,921		242	40	39,122	915	39,673	242	39,612	64		
Gas	ST/Yr			0									0	0
Total	ST/Yr	843	39,149	0	242	269	39,122	915	40,034	242	39,612	425	0	0
Solid	ST/Hr	-	0.03	-	-	0.03	-	-	0.04	-	-	0.04	-	-
Liquid	ST/Hr	0.10	4.63	-	0.03	0.00	4.66	0.11	4.72	0.03	4.72	0.01	-	-
Gas	ST/Hr	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	ST/Hr	0.10	4.66	-	0.03	0.03	4.66	0.11	4.77	0.03	4.72	0.05	-	-
Temp.	Deg. C	AMB	20.0	20.0	AMB	AMB	AMB	AMB	20.0	AMB	AMB	AMB	20.0	30.0
Liquid	usgpm	0.39	-	-	0.12	-	10.59	0.43	-	0.12	10.88	-	-	-
Slurry	usgpm	-	10.53	-	-	0.04	-	-	10.94	-	-	0.06	-	-
Gas	CFM			-									-	-
Solid	Wt. %	-	0.56%	-	-	85.00%	-	-	0.90%	-	-	85.00%	-	-
S.G.	Solid	-	5.029	-	-	5.029	-	-	4.387	-	-	4.387	-	-
S.G.	Liquid	1.016	1.761	-	0.988	0.989	1.756	1.016	1.731	0.988	1.731	1.731	-	-
S.G.	Gas	-	-	0.00100	-	-	-	-	-	-	-	-	0.00100	0.00148
S.G.	Total	1.016	1.767	0.00100	0.988	3.118	1.756	1.016	1.741	0.988	1.731	3.567	0.00100	0.00148

PFD Rev G DWG #		600-003 Rare Earth Hydroxide/Oxide Product									650-001 Ammonium Nitrate Recovery		
PFD Stream #			225				226						
METSIM Stream #		69	61	60	96	94	64		109	108			
Name		20% Ammonium Hydroxide	Hydroxide Reactor Output	Hydroxide Reactor Vapor	Condensate Water Filter Wash	Ammonium Nitrate Filtrate 20.8%	Filtered RE Hydroxide	RE Oxide Dryer Vapor	RE Oxide Dryer Condensate	Dried RE Oxide	Ammonium Nitrate Water Vapor	Ammonium Nitrate Condensate	57.1% Ammonium Nitrate Sol'n
Solid	ST/Yr		10,090				10,090			8,521			
Liquid	ST/Yr	28,995	58,512		15,136	71,125	2,523		4,092	0		45,216	25,909
Gas	ST/Yr			0				4,092			45,216		
Total	ST/Yr	28,995	68,603	0	15,136	71,125	12,613	4,092	4,092	8,521	45,216	45,216	25,909
Solid	ST/Hr	-	1.20	-	-	-	1.20	-	-	1.01	-	-	-
Liquid	ST/Hr	3.45	6.97	-	1.80	8.47	0.30	-	0.49	-	-	5.38	3.08
Gas	ST/Hr	-	-	-	-	-	-	0.49	-	-	5.38	-	-
Total	ST/Hr	3.45	8.17	-	1.80	8.47	1.50	0.49	0.49	1.01	5.38	5.38	3.08
Temp.	Deg. C	AMB	AMB	AMB	AMB	AMB	AMB	700.0	AMB	AMB	90.0	50.0	20.0
Liquid	usgpm	13.58	-	-	7.28	27.21	-	-	1.96	-	-	21.76	9.91
Slurry	usgpm	-	22.72	-	-	-	2.45	-	-	0.58	-	-	-
Gas	CFM			-				743.08			4,750.55		
Solid	Wt. %	-	14.71%	-	-	-	80.00%	-	-	100.00%	-	-	-
S.G.	Solid	-	3.875	-	-	-	3.875	-	-	6.979	-	-	-
S.G.	Liquid	1.016	1.295	-	0.988	1.243	0.989	-	0.990	1.000	-	0.988	1.243
S.G.	Gas	-	-	0.00100	-	-	-	0.00035	-	-	0.00061	-	-
S.G.	Total	1.016	1.436	0.00100	0.988	1.243	2.447	0.00035	0.990	6.979	0.00061	0.988	1.243

KEYPLAN

GENERAL NOTES

A TRP JD ISSUED FOR PREFEASIBILITY STUDY 14 9 5

APPROVED: J. DAVIS — DRAWN: TRP
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Rare Element Resources

BEAR LODGE PROJECT

PRELIMINARY FEASIBILTY STUDY
HYDROMET PLANT
MASS BALANCE SHEET 3 OF 3

DWG. 10135-PFD-700-003 REV A

(Roche, 2014)

17.9 Preliminary Design Basis

The purpose of the preliminary design basis is to establish the key design parameters that are to be used for the next stages of project development.

17.9.1 Production Capacity

The mine production schedule was developed to feed about 179,000 stpy (500 stpd) of upgraded mineral reserves (crushing/screening plus PUG beneficiation) to the hydro-metallurgical plant through the first nine years of operation, after which the plant would be expanded to accept nearly 216,000 stpy (600 stpd) of feed.

17.9.1.1 Physical Upgrade Plant

The PUG Plant has been designed to process 1,600 dry short tons (1,451 tonnes) per day, (590,000 dry short tons per year) (535,000 dry tonnes per year) of run of mine ore.

The Hydromet Plant is designed to process 591 dry short tons per day (216,000 dry short tons per year), (196,000 dry tonnes per year) of pre-concentrate and produce between 7,000 & 10,000 tons per year (6,349 & 9,070 tonnes per year) of high purity REO concentrates.

17.9.2 Product Specifications

17.9.2.1 Physical Upgrade Plant

The pre-concentrate produced by the PUG will have a Total Rare Earth Elements (TREE) content of >3% to 17% with a moisture content of 16% on a dry weight basis.

17.9.3 Feedstock

17.9.3.1 Physical Upgrade Plant

Run of Mine

The Physical Upgrade Plant has the ability for processing 1,600 dry short tons (1,451 dry tonnes) per day of ore from the mine, depending on ore variability. Four types of ore will be present: Bull Hill Oxide Carbonatite (OxCa), Bull Hill Oxide (Ox), White Tail Oxide Carbonatite (OxCa) and White Tail Oxide (Ox). These ore types are further classified as High Grade (HG), Mid-Grade (MG), and Low Grade (LG).

Flocculent

Flocculent will be added, based on the production rate, and ore type to increase the separation efficiency of the solid particles from the water medium. The type of flocculent used will be a medium to high molecular weight, non-ionic polyacrylamide type. The flocculent consumption rate is 0.34 pounds (0.15 kilogram) per short ton of dry pre-concentrate thickener feed.

Electricity

The expected power consumption for the PUG will vary considerably depending on which process circuits are running.

During the first 9 years of operation, only the coarse crushing and screening circuit will be installed. The power will be provided by diesel powered generating units. The estimated power consumption is 670 kW/h.

After the first nine years, the PUG will be connected to the power grid and the pre-concentration circuits will be completed and put into operation. The estimated power consumption will be 670 kW/h for crushing and screening only, 1,820 kW/h for Preconcentration operation, plus an additional 340 kW/h when magnetic separation is also running.

Table 17.3 presents the electrical consumption of the PUG by area.

Table 17.3 - PUG Plant Power Consumption by Area

Power Area	Installed kW/h	Operating kW/h
Crushing Circuit	697	270
Primary & Secondary Classifying	571	386
Grinding & Gravity Classifying	399	272
Magnetic Separation	891	340
Reject Dewatering	131	83
Pre-Concentrate Dewatering	431	205
PUG Water	336	71
Utilities & Services	399	170
Building (Lighting/HVAC)	600	360
Total	**4,455**	**2,157**

(Roche, 2014)

Water

Table 17.4 presents the estimated PUG water consumption. The mine will begin producing water in year 4 or 5. This water will displace well water at a rate that increases each year and eventually supply all of the water needs.

Table 17.4 - PUG Plant Water Balance

Water Balance	stpd	stpy	usgpm
Supply			
Water Wells	485	150,160	150
Consumption			
PUG Plant	220	57,280	44
Mine Truck Wash and Dust Control	265	92,880	106

(Metric units not reported)

(Roche, 2014)

17.9.3.2 Hydromet Plant

Pre-Concentrate

The Hydromet Plant is designed to process 591 short tons (536 tonnes) per day of pre-concentrate. Tables 17.5 and 17.6 present respectively, a weighted average of all the pre-concentrated ore types of the Hydromet feed elemental distribution and the rare earth element distribution within the rare earth elements group.

Table 17.5 - Hydromet Plant Feed Significant Component Distribution

Element	Distribution
REO	4.00%
Fe_2O_3	16.90%
$CaCO_3$	15.00%
Al_2O_3	11.20%
K_2O	8.72%
MnO	3.24%
BaO	0.97%
TiO_2	0.93%
MgO	0.83%
P_2O_5	0.77%
Na_2O	0.20%
ZnO	0.13%
PbO	0.07%
Th	0.060%
U	0.009%
SiO_2	36.00%

(SGS Lakefield, 2014)

Table 17.6 - Rare Earth Elements Distribution

Element	Distribution
Ce	43.245%
La	26.328%
Nd	18.234%
Pr	4.954%
Y	1.201%
Sm	3.032%
Gd	1.607%
Dy	0.413%
Eu	0.673%
Tb	0.135%
Er	0.076%
Ho	0.044%
Yb	0.045%
Tm	0.008%
Lu	0.006%

(Roche, 2014)

Hydromet Plant Reagents Consumption

Table 17.7 presents the Hydromet plant reagents consumption, averaged over the 45 year life of the plant.

Table 17.7 - Hydromet Plant Reagents Consumption

Reagent	Consumption		Ratio to Pre-Conc. Feed	Usage
	stpd	stpy		
Hydrochloric Acid**	146	51,221	0.25	Pre-concentrate Leach
Oxalic Acid**	67	23,534	0.11	Rare Earth Oxalates Precipitation
Nitric Acid (68%)	43	14,998	0.072	Rare Earth Oxide leach to soluble Rare Earth Nitrates
Ammonium Hydroxide**	16	5,714	0.027	Rare Earth Hydroxide Precipitation
Limestone Powder**	23	86,411	0.42	Metal Carbonates Precipitation
Quicklime**	0.14	48	0.0002	pH Control & Metal Oxide Precipitation
Sodium Hydroxide (50%w)	0.27	95	0.0004	Acid Vapor Neutralization

(Metric units not reported)

**Consumption is shown on 100% weight basis.

(Roche, 2014)

Electricity

The expected power consumption for the Hydromet Plant is approximately 1,750 kW/h.

Natural Gas

The expected natural gas consumption for the Hydromet Plant is 220 MM ft^3 (6.23 MM m^3). Natural gas will be used as the primary energy source for the hydrochloric acid regeneration process. This process involves the distillation of the hydrochloric acid, requiring a large amount of energy in the form of steam. Other significant uses of natural gas are for the Oxide kiln and various drying and evaporation operations.

Water

The Hydromet process is designed to recover and recycle water and chemical reagents for reuse. The plant will consume 1,142 tons per day of water, with the main consumption being the cooling tower evaporation. Evaporation in the process, and water of hydration in the tailings will also consume water. The plant is designed to be a zero discharge plant.

17.9.4 Operating Factor

The operating factor is defined below:
% Operating Factor = (Nominal Capacity/Design Capacity) x 100

Operating factor incorporates both planned and unplanned maintenance and hours lost when the process chemistry deviates from its design.

An Operating Factor of 80% was used to design the PUG.

An Operating Factor of 95.9%, or the equivalent of 350 days of operation per year was used to design the Hydromet Plant.

17.9.5 Storage Capacities

17.9.5.1 Physical Upgrade Plant

Run of Mine

Three stockpile areas will be installed upstream of the PUG Feed Hopper to accommodate mine schedule and ore type crushed. Two of these stockpiles areas will have a diameter of 300 feet (91 meters) and will be located near the Jaw crusher Feed Hopper. The third stockpile area will be used for storage of the low grade ore and will have a capacity of 1.6 million short tons.

Surge Storage Capacities

The crushed ore will be stockpiled by grade at the PUG site to accommodate unplanned downtime.

17.9.5.2 Hydromet Plant

Surge Storage Capacities

The Hydromet Plant surge storage capacities are designed to accommodate transportation delays between the source of the product and the Hydromet plant.

Transportation delays are expected from bad weather during the winter.

17.9.6 Control and Automation

The PUG and Hydromet Plants will be semi-automated. All equipment and stream flows will be automated and primarily controlled from the control room. Local controls will also be installed where required. Laboratory technicians will manually perform chemical analyses such as rare earth product element distribution and tailings elemental distribution.

Measurements such as pH will be automated, but a constant manual validation of the instruments will be required to ensure the proper processing of the rare earths.

A data historian system connected to the DCS will enable the collection of data centrally from across the plant.

17.9.7 Radionuclides

There are two main sources of radionuclides (thorium and uranium) the Bull Hill and Whitetail mine mineralization. These radionuclides are closely associated with rare earths and therefore will be transferred to the pre-concentrate together with REO minerals

At the acid digestion step, most of the radionuclides will be leached out of the solids and transferred to into the leach solution such that less than 0.05%Th+U will remain in the leach residue. Subsequently, all the thorium isotopes in the leach solution will be co-precipitated with rare earths into the final oxalate precipitate. The average assay of Th+U in the oxalates will vary from 0.4 to 1.9%Th+U.

A thorium removal step is incorporated in the Hydromet process. Thorium recovery from rare earth oxalate precipitates and handling of isolate thorium hydroxide will occur in a restricted access area of the plant and will be packaged and sealed in B-12 size containers and shipped to the Richland, WA radioactive disposal site.

Once processed in the Hydromet, the acidic tailings containing combined radionuclides will be neutralized with limestone and quick lime, and report to the tailings storage facility. The radionuclide content will be below 0.05%.

The radionuclide content reporting to the rare earth oxide concentrate is at levels below 0.0065%.

17.10 Recovery Calculation using METSIM

METSIM is commercially available non-predictive process simulation software recognized as one of the best simulation softwares for metallurgical processing simulation. Because of its non-predictive nature, the model needs to be programmed using real data from bench scale, pilot plant or real operation test work. The Bear Lodge Model was developed using bench scale and pilot plant data from various series of tests undertaken at SGS Canada Inc., in Lakefield Ontario, Canada.

A second commercially available process simulation software: ChemCAD was used to predict the non-ideal hydrochloric acid – water system in the distillation unit prior to modelling in METSIM.

17.11 Objectives of METSIM Model

The objective for the modelling of the Bear Lodge process is to define the plant operation and generate a basis for the sizing of the facilities.

In addition, the METSIM model enabled Roche Engineering to forecast the effect of the natural variation in feedstock on the plant operation throughout the project life.

17.12 Results

Roche Engineering used the METSIM model to determine the plant and equipment sizing, the consumption of reagents and the production and composition of products and waste streams from the Physical Upgrade and Hydromet Plants.

17.13 Model Inputs

17.13.1 Screening Recovery

Screening recoveries were calculated from screening test performed during the autumn 2013 PUG pilot plant held at SGS Canada Inc. in Lakefield, Canada and on follow-up screening tests performed at SGS Canada Inc. in April 2014. Screening recoveries are presented in Table 7-9.

Data was not available for each element present in the resource for each resource type. Screening recoveries for elements with no available data were determined by analogy with the recoveries of such element in other material types. As such, the comparative basis for the estimation of elements with no reported recoveries for the BHMGOx and BHLGOx materials is presented in Table 7-8.

Table 17.8 - Screening Recovery Comparative Basis

Element	Basis
Ba	Ca
Na, K, Mg, Ti	Al
Mn	Fe

(SGS Lakefield, 2014)

Table 17.9 - Screening Recoveries

Resource	BHOx			BHOx		WT Ox/OxCa
Grade / Element	HG	MG	LG	HG	MG / LG	MG / LG
Ce	91.75%	95.41%	93.70%	98.94%	100.00%	94.94%
Dy	89.18%	92.73%	91.07%	97.55%	100.00%	88.72%
Er	88.53%	92.06%	90.41%	97.00%	100.00%	88.28%
Eu	90.15%	93.74%	92.06%	97.93%	100.00%	91.31%
Gd	89.41%	92.97%	91.31%	97.86%	100.00%	89.83%
Ho	88.98%	92.52%	90.87%	97.10%	100.00%	88.14%
La	92.34%	96.02%	94.30%	99.08%	100.00%	91.54%
Lu	90.93%	94.55%	92.86%	95.79%	100.00%	89.53%
Nd	91.26%	94.89%	93.20%	98.51%	100.00%	92.68%
Pr	90.80%	94.42%	92.73%	97.85%	100.00%	92.46%
Sc	88.61%	92.14%	90.50%	97.35%	100.00%	86.70%
Sm	90.55%	94.15%	92.47%	98.16%	100.00%	91.73%
Tb	89.58%	93.14%	91.48%	97.52%	100.00%	89.29%
Tm	87.74%	91.24%	89.61%	96.06%	100.00%	88.14%
Y	88.61%	92.14%	90.50%	97.35%	100.00%	86.70%
Yb	88.56%	92.09%	90.44%	96.84%	100.00%	88.85%
Th	88.95%	92.49%	90.84%	98.26%	100.00%	91.86%
U	87.66%	91.15%	89.53%	96.48%	100.00%	84.77%
Fe	85.72%	88.60%	87.20%	95.83%	100.00%	77.96%
Al	76.92%	77.70%	77.30%	93.98%	100.00%	66.88%
Ba	89.20%	87.70%	83.40%	96.15%	100.00%	91.71%
Ca	89.20%	87.70%	83.40%	96.15%	100.00%	91.71%
K	76.01%	76.78%	76.39%	93.87%	100.00%	62.08%
Mg	80.12%	80.93%	80.51%	95.23%	100.00%	88.24%
Mn	85.91%	88.79%	87.39%	96.54%	100.00%	92.71%
Na	79.96%	80.77%	80.35%	93.77%	100.00%	71.62%
P	87.55%	90.49%	89.06%	96.29%	100.00%	84.07%
Pb	77.43%	77.98%	78.55%	93.06%	100.00%	69.13%
Si	77.43%	77.98%	78.55%	93.06%	100.00%	69.13%
Sr	89.20%	87.70%	83.40%	96.15%	100.00%	91.71%
Ti	79.79%	80.59%	80.18%	94.18%	100.00%	76.95%
Zn	77.43%	77.98%	78.55%	93.06%	100.00%	69.13%
Total	**80.25%**	**80.50%**	**79.90%**	**94.47%**	**100.00%**	**71.15%**

(SGS Lakefield, 2014)

17.14 Model Parameters

17.14.1 General

A model of the PUG process was build using METSIM (version 2013.12), a commercially available process simulation software. Three flow sheets, corresponding to the three PUG configurations were modeled and used to simulate the operation of the plant. Since recovery data was only available for the main component, minor components recoveries were estimated from the Hydromet feed assays. Since these component typically represent a very small fraction of the processed material, the implied error is negligible in the context of a pre-feasibility level engineering study.

The METSIM model is only representative of the expected mass balance for the metal components of the PUG.

No comminution parameters such as the minerals bond work index and breakability factors have been used.

Furthermore, the model was built using the oxides compounds of the elements present in the resource, and therefore cannot be relied upon to predict the effect of the PUG process on specific anions such as chloride, carbonate, phosphate and fluoride. The expected assays of these anions were estimated using the Hydromet pilot plant feed analyses.

The PUG feed has been defined by WLRC in the Bear Lodge Mine Production Schedule.

Only main components of each ore type are presented in this section. The complete data is available in “An Investigation into Pilot Scale Physical Upgrading Testing on Samples from the Bear Lodge Deposit”.

17.14.2 **Bull Hill Oxide PUG METSIM Flow Sheet**

Following are the inputs to the METSIM model for the Bull Hill Oxide ore:

17.14.2.1 BHOx Primary Screening

The recoveries for the primary screening step for the main components of the Bull Hill Oxide Resource are presented in Table 17-10.

Table 17.10 - BHOx Primary Screening Recoveries

Stream	Recovery (Wt %)								
	%	SiO2	Al2O3	CaO	MnO	Fe2O3	REO +Y	CREO +Pr	Th+U
-6+20M (Prim)	51.9	58.4	56.8	35.8	47.7	49.3	26.2	26.5	29.1
-20+32M (Prim)	12.5	12.8	12.5	10.6	14.2	13.5	9.51	9.31	9.55
-32+48M (Prim)	3.77	3.53	3.48	4.21	4.41	4.17	4.14	4.08	4.02
-48+150M (Prim)	8.07	7.41	7.31	10.2	8.77	8.33	10.6	10.8	9.65
-150M (Prim)	23.7	17.8	19.9	39.2	24.9	24.7	49.5	49.3	47.6

(SGS Lakefield, 2014)

17.14.2.2 BHOx Secondary Screening

The recoveries for the secondary screening step for the main components of the Bull Hill Oxide Resource are presented in Table 17-11.

Table 17.11 - BHOx Secondary Screening Recoveries

Stream	Recovery (Wt %)								
	%	SiO2	Al2O3	CaO	MnO	Fe2O3	REO +Y	CREO +Pr	Th+U
+150M (Sec)	52	55.5	53.9	34.5	51	50.5	31.3	29.8	30.2
-150M (Sec)	48	44.5	46.1	65.5	49	49.5	68.7	70.2	69.8

(SGS Lakefield, 2014)

17.14.2.3 BHOx Secondary Gravity Separation

The recoveries for the secondary gravity separation step for the main components of the Bull Hill Oxide Resource are presented in Table 17-12.

Table 17.12 - BHOx Secondary Gravity Separation Recoveries

Stream	Recovery (Wt %)								
	%	SiO2	Al2O3	CaO	MnO	Fe2O3	REO +Y	CREO +Pr	Th+U
Ro Gravity Conc (Sec)	16.9	9.91	9.8	22.2	42.7	37.1	29.1	25.9	29.4
Ro Gravity Tails (Sec)	83.1	90.1	90.2	77.8	57.3	62.9	70.9	74.1	70.6

(SGS Lakefield, 2014)

17.14.3 Bull Hill Oxide-Carbonate PUG METSIM Flow Sheet

Following are the inputs to the METSIM model for the Bull Hill Oxide-Carbonate ore.

17.14.3.1 BHOxCa Primary Screening

The recoveries for the primary screening step for the main components of the Bull Hill Oxide-Carbonate Resource are presented in Table 17-13

Table 17.13 - BHOxCa Primary Screening Recoveries

Stream	Recovery (Wt %)								
	%	SiO2	Al2O3	CaO	MnO	Fe2O3	REO +Y	CREO +Pr	Th+U
-6+20M (Prim)	52.9	61.6	61.6	47	42.3	54.4	34.1	34.1	35.3
-20+32M (Prim)	12.8	12.5	12.5	12.7	12.1	13.5	13.5	13.5	13.2
-32+48M (Prim)	5.1	5.02	5.02	5.21	4.85	4.89	5.73	5.86	5.3
-48+150M (Prim)	7.55	6.27	6.22	8.4	7.75	7.23	11.3	11.2	10.1
-150M (Prim)	21.6	14.6	14.7	26.7	33	19.9	35.4	35.4	36.2

(SGS Lakefield, 2014)

17.14.3.2 BHOxCa Secondary Screening

The recoveries for the secondary screening step for the main components of the Bull Hill Oxide-Carbonate Resource are presented in Table 17-14.

Table 17.14 - BHOxCa Secondary Screening Recoveries

Stream	Recovery (Wt %)								
	%	SiO2	Al2O3	CaO	MnO	Fe2O3	REO +Y	CREO +Pr	Th+U
+150M (Sec)	56.5	62.8	62.6	47	46.3	60.6	44.5	44.2	43.5
-150M (Sec)	43.5	37.2	37.4	53	53.7	39.4	55.5	55.8	56.5

(SGS Lakefield, 2014)

17.14.3.3 BHOxCa Secondary Gravity Separation

The recoveries for the secondary gravity separation step for the main components of the Bull Hill Oxide-Carbonate Resource are presented in Table 17-15.

Table 17.15 - BHOxCa Secondary Gravity Separation Recoveries

Stream	Recovery (Wt %)								
	%	SiO2	Al2O3	CaO	MnO	Fe2O3	REO +Y	CREO +Pr	Th+U
Ro Gravity Conc (Sec)	39	27.7	27.2	42.8	50.9	68.9	57.9	55.6	54.2
Ro Gravity Tails (Sec)	61	72.3	72.8	57.2	49.1	31.1	42.1	44.4	45.8

(SGS Lakefield, 2014)

17.14.4 Whitetail PUG METSIM Flow Sheet

Following are the inputs to the METSIM model for the White Tail ore.

17.14.4.1 WT Primary Screening

The recoveries for the primary screening step for the main components of the Whitetail Resource are presented in table 17-16.

Table 17.16 - WT Primary Screening Recoveries

Stream	Recovery (Wt %)								
	%	SiO2	Al2O3	CaO	MnO	Fe2O3	REO +Y	CREO +Pr	Th+U
-6+20M (Prim)	55.9	59.8	59.4	52.8	56.6	46.4	41.2	41.4	39.8
-20+32M (Prim)	18.4	18.8	18.7	17.5	20.4	18.2	15.8	15.1	15.3
-32+48M (Prim)	4.88	4.98	4.98	4.84	4.61	4.72	4.2	4.19	4.09
-48+150M (Prim)	6.44	5.95	5.98	7.72	6.31	7.18	7.01	7.04	6.99
-150M (Prim)	14.3	10.5	11	17.2	12.1	23.6	31.5	32.3	33.8

(SGS Lakefield, 2014)

17.14.4.2 WT Secondary Screening

The recoveries for the secondary screening step for the main components of the Whitetail Resource are presented in Table 17-17.

Table 17.17 - WT Secondary Screening Recoveries

Stream	Recovery (Wt %)								
	%	SiO2	Al2O3	CaO	MnO	Fe2O3	REO +Y	CREO +Pr	Th+U
+150M (Sec)	65.9	70.7	70.4	52.8	71.7	57.6	45.7	43.2	44.8
-150M (Sec)	34.1	29.3	29.6	47.2	28.3	42.4	54.3	56.8	55.2

(SGS Lakefield, 2014)

17.14.4.3 WT Secondary Magnetic Separation

The recoveries for the secondary magnetic separation step for the main components of the Whitetail Resource are presented in Table 17-18.

Table 17.18 - WT Secondary Magnetic Separation Recoveries

Stream	Recovery (Wt %)								
	%	SiO2	Al2O3	CaO	MnO	Fe2O3	REO +Y	CREO +Pr	Th+U
Magnetic Conc (Sec)	25.6	14	14.1	23.5	85.3	74.7	63.4	58.3	59.5
Magnetic Tails (Sec)	74.4	86	85.9	76.5	14.7	25.3	36.6	41.7	40.5

(SGS Lakefield, 2014)

17.14.4.4 WT Primary Magnetic Separation

The recoveries for the primary magnetic separation step for the main components of the Whitetail Resource are presented in Table 17-19.

Table 17.19 - WT Primary Magnetic Separation Recoveries

Stream	Recovery (Wt %)								
	%	SiO2	Al2O3	CaO	MnO	Fe2O3	REO +Y	CREO +Pr	Th+U
Ro Magnetic Conc (Prim)	18.2	7.21	7.54	7.64	61.2	54.6	40.3	40.3	39.3
Ro Magnetic Tails (Prim)	81.8	92.8	92.5	92.4	38.8	45.4	59.7	59.7	60.7

(SGS Lakefield, 2014)

17.14.4.5 WT Primary Gravity Separation

The recoveries for the primary gravity separation step for the main components of the Whitetail Resource are presented in Table 17-20.

Table 17.20 - WT Primary Gravity Separation Recoveries

Stream	Recovery (Wt %)								
	%	SiO2	Al2O3	CaO	MnO	Fe2O3	REO +Y	CREO +Pr	Th+U
Sc Gravity Conc (Prim)	13.2	9.27	9.18	17	38.7	22.4	25.9	24.6	21.7
Sc Gravity Tails (Prim)	86.8	90.7	90.8	83	61.3	77.6	74.1	75.4	78.3

(SGS Lakefield, 2014)

17.15 Outputs

The output of the METSIM PUG Model is a series of mass balances and pre-concentrate compositions that were used to size the equipment and define the Hydromet feed composition for each year of the facility operation.

17.16 Hydrometallurgical Processing

17.16.1 General

The hydrometallurgical processing plant (Hydromet) employs a series of leaching and selective precipitation steps to extract the valuable REE from the pre-concentrate and generate a pure, thorium-free mixed-REO product.

The Hydromet process is divided in 5 units:

1) Leach Unit
2) Oxalate Precipitation Unit
3) Thorium Removal Unit
4) Distillation Unit
5) Waste Neutralization Unit

A METSIM model of the Hydromet process was built using bench scale and pilot plant data from SGS Lakefield Inc., Specific data used in the Hydromet model will be referenced when applicable. The METSIM model was built to generate a heat and mass balance as a basis for the plant design, and to generate a forecasted production for the Hydromet facility. As such, it does not include all design related considerations that should be included in a typical process flow diagram sheet set and its mass balance.

In general, the pilot plant was operated for four to five days of continuous operation for each ore type and condition tested. Data was gathered for each 12 hour period of operation. For various reasons, the pilot plant operation was not considered to be in steady state operation for much of this time by SGS Lakefield Inc. SGS Lakefield Inc., in their reports, stated which time periods were considered to be in steady state. The data during these periods was averaged and is the data that was used in modeling and is presented in this report.

17.16.2 Inputs

Physical and Chemical Data for all components in the METSIM model were compiled and estimated from data tabulated in many databases:

1) METSIM internal Database
2) Perry's Chemical Engineer's Handbook 7th Edition
3) CRC Handbook of Chemistry and Physics
4) Lange's Handbook of Chemistry
5) Gmelin Database
6) HSC Chemistry Database
7) Handbook on the Physics and Chemistry of Rare Earths
8) Rare Earth Coordination Chemistry: Fundamentals and Applications
9) Dictionary of Inorganic Compounds
10) Victor Gilphin and W. C. McCrone. "Crystallographic Data 52. Lanthanum Oxalate Decahydrate La2 (C2O4)3.10H2O," *Analytical Chemistry* **1952** *24* (1), 225-226

The Hydromet feed was defined based on the PUG mass balance for each year of operation.

17.17 Model Parameters

17.17.1 Leach Unit

17.17.1.1 Total Hydrochloric Acid Addition

The total hydrochloric acid addition is adjusted to maintain a hydrochloric acid concentration of 40 grams per liter in the PLS. A PLS free acid of approximately 40 grams per liter is required to achieve optimal precipitation in the Oxalate Precipitation Unit. This is representative of results shown by the pilot plant PP6 operated by SGS Lakefield Inc..

17.17.1.2 Leach Reaction Temperature

The leach reaction temperature is established at 45 degrees Celsius as presented in the pilot plants PP5, PP6 and PP7 operated by SGS Lakefield.

17.17.1.3 Leach Reactor Density

The pre-leach reactor density was established at 22 % solids. The pilot plants PP5, PP6 and PP7 demonstrated that the leach reactor density was not a critical parameter and that good leach efficiencies were achieved at densities lower than 30% solids.

17.17.1.4 Leach Reaction Efficiency

Leach efficiencies were established by SGS Lakefield Inc. for five typical feed composites. Each mine year composition was compared to the composite composition and a leach efficiency dataset was attributed. The assigned leach efficiency datasets are presented below:

1) Years 1 to 6: Composite D
2) Years 7 to14: Composite C
3) Years 15 to 19 and 23 to 26: Composite B
4) Years 20 to 22 and 27 to 45: Composite E

Leach efficiency datasets are presented in Table 17-21.

Table 17.21 - Leach Efficiency Dataset

	Leach Efficiency				
Element	A	B	C	D	E
La	93.9%	97.0%	87.7%	89.2%	94.6%
Ce	73.7%	85.5%	86.1%	87.1%	82.9%
Pr	93.2%	96.7%	87.1%	88.7%	95.0%
Nd	92.9%	96.4%	87.5%	88.8%	95.1%
Sm	90.9%	94.6%	87.3%	88.1%	94.1%
Eu	90.7%	93.6%	87.7%	88.1%	93.7%
Gd	89.8%	93.1%	86.9%	86.9%	93.5%
Tb	88.4%	92.6%	86.3%	85.3%	90.8%
Dy	86.0%	89.0%	83.8%	82.4%	88.8%
Ho	83.2%	86.9%	81.7%	79.6%	86.7%
Y	81.8%	86.2%	80.6%	77.9%	83.3%
Er	78.8%	84.3%	78.9%	76.6%	82.7%
Tm	73.8%	83.3%	77.5%	75.1%	78.4%
Yb	73.7%	79.1%	75.3%	73.7%	75.0%
Lu	54.1%	71.7%	70.2%	70.0%	65.9%
Sc	4.4%	11.5%	10.8%	15.2%	6.9%
Th	67.8%	82.3%	55.0%	54.6%	73.4%
U	62.0%	67.4%	59.9%	61.5%	67.2%
Al	6.4%	10.8%	11.7%	14.5%	11.8%
As	19.1%	27.3%	30.1%	14.7%	30.4%
Ba	4.9%	9.8%	15.6%	6.8%	7.2%
Be	77.0%	27.8%	83.7%	37.9%	50.5%
Ca	99.3%	99.5%	99.2%	98.2%	96.2%
Fe	26.3%	44.5%	21.3%	20.9%	21.7%
K	5.6%	8.1%	8.7%	11.1%	10.3%
Mg	76.0%	84.3%	72.1%	82.3%	81.4%
Mn	71.2%	84.7%	54.8%	69.4%	80.8%
Mo	26.6%	52.0%	19.2%	15.7%	26.6%
Na	17.5%	17.7%	22.1%	20.2%	30.8%
P	80.4%	83.4%	77.1%	69.9%	78.8%
Pb	71.7%	85.8%	62.5%	76.7%	76.8%
Si	0.4%	0.4%	0.5%	0.5%	1.0%
Sr	62.2%	78.2%	91.5%	92.3%	64.2%
Ti	6.3%	9.7%	7.2%	3.7%	4.8%
V	49.7%	55.9%	39.1%	30.9%	47.3%
Zn	37.3%	55.3%	44.8%	44.7%	39.8%

(SGS Lakefield, 2014)

17.17.2 Oxalate Precipitation Unit

17.17.2.1 Precipitation Reaction Temperature

The precipitation reaction temperature is established at 90 degrees Celsius as presented in the pilot plants PP5, PP6 and PP7 operated by SGS Lakefield Inc..

17.17.2.2 Precipitation Reaction Efficiency

Precipitation Efficiencies were established by SGS Lakefield Inc. during the pilot plant PP6 operation. The precipitation efficiencies are presented in Table 17-22. Elements not presented in Table 17-22 do not precipitate under the conditions at which the precipitation reaction is undertaken.

Table 17.22 - Precipitation Efficiency Dataset

Element	Precipitation Efficiency
Ce	99.6%
Dy	99.7%
Er	99.2%
Eu	99.9%
Gd	99.9%
Ho	99.2%
La	98.4%
Lu	92.7%
Nd	99.9%
Pr	99.8%
Sc	92.2%
Sm	100.0%
Tb	99.5%
Tm	92.8%
Y	99.9%
Yb	99.3%
Th	100.0%
Ba	14.6%

(SGS Lakefield, 2014)

17.17.2.3 Rare Earths Oxalates Calcination Efficiency

The rare earths oxalates calcination reaction is a generic thermal oxidation reaction with a typical efficiency of 100% for each oxalate compound. The reaction extent is a function of the temperature of the calcination, the excess oxygen and the residence time of the equipment.

17.17.3 **Thorium Removal Unit**

17.17.3.1 Nitric Acid Leach Reaction Temperature

The nitric acid leach reaction temperature is established at 90 degrees Celsius.

17.17.3.2 Nitric Acid Leach Efficiency

The nitric acid leach reaction is a generic oxide acidic leach reaction and is well documented in the literature. The leach efficiency was established at 100% considering that enough residence time will be maintained in the leach reactors.

17.17.3.3 Thorium Precipitation Reaction Stage 1 and 2 Temperature

The thorium precipitation stage 1 reaction temperature is established at 25 degrees Celsius.

17.17.3.4 Thorium Precipitation Reaction Stage 1 and 2 Efficiency

Precipitation Efficiencies were established by SGS Lakefield Inc. during pilot plant operation. In this process, thorium is precipitated as thorium-hydroxide by neutralization of the nitric acid PLS using ammonium hydroxide. Stage 1 pH is controlled to 3.7 and Stage 2 pH is controlled to 4.8. The thorium precipitation efficiencies are presented in Table 17.23.

Table 17.23 - Thorium Precipitation Reaction Efficiencies

Precipitation Efficiency		
Element	Stage 1	Stage 2
Ce	0.24%	0.67%
Dy	0.72%	1.42%
Er	0.59%	1.86%
Eu	0.66%	2.09%
Gd	0.95%	3.48%
Ho	1.07%	3.77%
La	0.89%	3.42%
Lu	1.10%	4.04%
Nd	1.16%	4.48%
Pr	1.12%	4.05%
Sc	0.59%	2.68%
Sm	1.14%	3.87%
Tb	1.37%	4.97%
Tm	1.52%	5.98%
Y	1.91%	5.59%
Yb	42.22%	90.93%
Th	59.91%	99.44%

(SGS Lakefield, 2014)

17.17.3.5 Rare Earths Hydroxides Precipitation Reaction Temperature

The rare earth hydroxides precipitation reaction temperature is established at 25 degrees Celsius.

17.17.3.6 Rare Earths Hydroxides Precipitation Reaction Efficiency

The rare earths hydroxides precipitation reaction is a generic hydroxide precipitation reaction and is well documented in the literature. The precipitation efficiency was established at 100% considering that enough residence time will be maintained in the precipitation reactors and that the rare earths hydroxides solubility are negligible (~10^{-9} g per 100g water). Ammonium hydroxide is used as a neutralization reagent.

17.17.3.7 Rare Earths Hydroxides Calcination Reaction Efficiency

The rare earths hydroxides calcination reaction efficiency is 100% for each hydroxide compound.

17.17.4 Distillation Unit

The Distillation Unit was modeled using ChemCAD commercial software. ChemCAD has its own proprietary database for non-ideal mixtures. Validation of the ChemCAD predicted equilibrium composition was performed using the pilot plant data supplied by SGS Lakefield Inc..

17.17.5 Waste Neutralization Unit

The Waste Neutralization Unit uses generic neutralization reactions using limestone and quicklime. These reactions are well documented in the literature. Precipitation efficiencies for all metal hydroxides and carbonates were assumed at 100% because of their very low solubility. All alkali and alkali-earth metals are assumed non-reactive and are crystallized as chlorides by vaporization of the filtrate solution. These reactions are also well documented in the literature.

17.18 Output

The output of the Hydromet METSIM Model is a series of mass balances and products, potential by-product and waste streams compositions and quantities that were used to size the equipment and calculate the financial figures for the Hydromet operation. A METSIM mass balance was run for each year of mine operation. A summary of these mass balances is presented in Table 17.24.

Table 17.24 - Summary of METSIM Modeling Output

Excel	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Mass	PUG Feed Rate	220,200	219,000	219,000	226,000	212,000	220,150	216,800	220,150	225,650	392,000	424,000	536,100	549,100	444,000	328,000	322,000	292,900	285,000	286,000	292,000	302,100	324,900
Balance	Screening Feed Grade	0.060	0.055	0.052	0.050	0.053	0.042	0.040	0.038	0.038	0.031	0.030	0.028	0.025	0.026	0.031	0.030	0.035	0.034	0.033	0.032	0.030	0.027
	Ratio / SGS Composite	D	D	D	D	D	D	C	C	C	C	C	C	C	C	B	B	B	B	B	E	E	E
	Fresh HCl	37,214	37,134	36,939	38,377	45,294	36,399	39,436	37,807	34,885	44,413	44,096	46,761	59,923	64,635	40,511	43,069	50,621	53,948	56,516	57,801	58,459	56,178
	Fresh Oxalic Acid	23,827	22,550	21,966	21,923	21,295	19,348	18,266	17,829	17,918	24,789	25,303	27,201	25,569	23,253	37,172	35,524	35,267	34,329	33,583	20,431	20,236	20,160
	Fresh Iron Scraps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Fresh Nitric Acid (68%)	21,252	19,428	18,639	18,251	18,503	14,982	14,039	13,693	13,725	18,990	19,455	21,311	19,451	17,129	15,955	15,146	16,433	16,146	15,633	14,856	14,496	13,941
	Fresh Ammonium Hydroxid	8,097	7,402	7,101	6,954	7,049	5,708	5,349	5,217	5,229	7,235	7,412	8,120	7,411	6,526	6,079	5,771	6,261	6,152	5,956	5,660	5,523	5,312
	Fresh Sodium Hydroxide	102	100	98	99	95	1	1	1	1	1	103	108	103	102	108	106	105	102	100	94	93	92
METSIM	Fresh Limestone	89,988	88,276	86,963	88,323	83,992	82,876	78,184	76,344	77,379	96,341	95,099	95,948	91,065	90,441	99,027	96,408	94,682	92,066	90,072	85,538	84,251	83,870
Mass	Fresh Quicklime	51	50	49	50	48	46	44	43	44	54	51	54	52	51	54	53	52	51	50	47	46	46
Balance	Feed Rate	177,464	176,985	177,070	183,211	178,116	178,956	179,017	179,077	178,946	214,194	214,918	217,693	216,986	216,518	216,440	215,847	213,126	211,556	211,409	211,173	210,427	211,480
	REO Production	10,696	9,777	9,379	9,183	9,310	7,535	7,056	6,877	6,890	9,496	9,718	10,621	9,662	8,521	8,033	7,627	8,279	8,128	7,859	7,468	7,275	6,983
	Th Stream Production	161	149	143	141	140	118	119	124	129	230	249	303	294	228	161	152	160	164	170	166	175	181
	Pure Th production	55	52	50	49	48	42	46	50	54	112	125	159	158	118	70	67	69	72	78	78	85	92
	Pure Th(OH)4 Production	72	67	65	64	62	55	59	65	70	145	161	205	205	153	91	86	89	93	101	101	110	119
	Pure NH4NO3 Production	18,357	16,781	16,100	15,765	15,982	12,941	12,127	11,828	11,855	16,403	16,805	18,408	16,801	14,795	13,781	13,083	14,194	13,946	13,504	12,832	12,522	12,042
	Dry Tailings	294,354	293,393	291,991	301,377	303,734	290,908	292,452	288,739	284,656	348,316	347,907	355,625	372,232	378,222	357,600	358,682	365,570	367,095	369,533	358,872	358,486	356,109
	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	PUG Recovery	91.96%	92.09%	92.05%	92.31%	93.63%	92.73%	93.73%	93.66%	92.87%	89.08%	87.70%	80.60%	79.55%	85.12%	86.88%	86.95%	88.61%	89.83%	90.23%	89.90%	88.93%	87.27%
	Hydromet Recovery	88.69%	88.93%	88.69%	88.69%	88.70%	88.70%	87.42%	87.39%	87.38%	87.27%	87.24%	87.19%	87.19%	87.29%	92.22%	92.22%	92.21%	92.20%	92.19%	90.27%	90.26%	90.26%
	Total Recovery	81.56%	81.90%	81.64%	81.87%	83.04%	82.25%	81.94%	81.85%	81.15%	77.74%	76.51%	70.27%	69.36%	74.30%	80.13%	80.18%	81.71%	82.83%	83.18%	81.16%	80.27%	78.77%

Year	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
PUG Feed Rate	459,000	321,100	299,000	546,900	547,000	413,900	293,100	274,000	268,100	331,000	534,900	293,000	245,900	246,000	333,000	422,000	422,870	422,870	422,870	422,870	422,870	422,870	422,870
Screening Feed Grade	0.020	0.027	0.029	0.018	0.018	0.023	0.031	0.032	0.033	0.027	0.019	0.029	0.032	0.031	0.025	0.021	0.018	0.018	0.018	0.018	0.018	0.018	0.018
Ratio / SGS Composite	B	B	B	B	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
Fresh HCl	54,696	45,763	53,062	73,286	77,645	64,418	49,860	55,190	60,070	63,497	78,945	68,104	63,720	63,933	71,377	73,424	39,697	39,697	39,697	39,697	39,697	39,697	39,697
Fresh Oxalic Acid	35,727	33,877	32,851	35,846	21,770	21,302	20,734	19,955	19,594	20,411	21,976	19,344	18,005	17,712	19,413	20,490	19,630	19,630	19,630	19,630	19,630	19,630	19,630
Fresh Iron Scraps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fresh Nitric Acid (68%)	14,262	14,172	14,437	15,058	14,605	14,476	14,800	14,491	14,467	14,528	15,055	13,936	13,150	12,762	13,504	13,829	11,273	11,273	11,273	11,273	11,273	11,273	11,273
Fresh Ammonium Hydroxid	5,434	5,400	5,501	5,737	5,565	5,516	5,639	5,521	5,512	5,535	5,736	5,310	5,010	4,862	5,145	5,269	4,295	4,295	4,295	4,295	4,295	4,295	4,295
Fresh Sodium Hydroxide	97	102	99	94	89	93	98	92	92	91	90	90	88	88	88	88	1	95	95	95	95	95	95
Fresh Limestone	87,816	93,617	89,892	85,552	80,661	84,825	90,004	86,436	83,900	82,681	81,026	81,435	80,117	79,868	79,202	79,891	88,176	88,176	88,176	88,176	88,176	88,176	88,176
Fresh Quicklime	48	51	50	47	45	47	49	46	46	46	45	45	44	44	44	44	48	48	48	48	48	48	48
Feed Rate	215,700	215,209	212,736	216,117	216,156	215,306	214,640	212,312	210,621	211,615	216,199	211,761	208,978	209,409	211,821	213,413	219,544	219,544	219,544	219,544	219,544	219,544	219,544
REO Production	7,058	7,135	7,260	7,394	7,191	7,201	7,468	7,314	7,292	7,260	7,418	6,987	6,639	6,443	6,731	6,847	5,637	5,637	5,637	5,637	5,637	5,637	5,637
Th Stream Production	267	143	154	333	307	234	138	134	145	205	309	172	119	116	205	253	155	155	155	155	155	155	155
Pure Th production	156	63	70	204	185	130	57	55	63	108	185	85	48	47	112	147	81	81	81	81	81	81	81
Pure Th(OH)4 Production	202	81	91	263	239	168	74	71	81	140	240	110	62	60	144	190	104	104	104	104	104	104	104
Pure NH4NO3 Production	12,319	12,242	12,470	13,007	12,615	12,504	12,784	12,517	12,497	12,549	13,005	12,038	11,359	11,024	11,665	11,946	9,738	9,738	9,738	9,738	9,738	9,738	9,738
Dry Tailings	372,256	359,964	365,631	399,477	356,109	373,536	352,968	356,418	360,521	366,602	394,679	372,686	361,945	362,595	376,738	382,403	342,598	342,598	342,598	342,598	342,598	342,598	342,598
Year	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
PUG Recovery	82.57%	87.98%	89.74%	79.58%	79.58%	83.55%	89.60%	91.20%	92.56%	89.98%	80.15%	91.51%	93.79%	93.84%	91.22%	85.26%	83.68%	83.68%	83.68%	83.68%	83.68%	83.68%	83.68%
Hydromet Recovery	92.08%	92.21%	92.19%	92.01%	90.14%	90.21%	90.31%	90.30%	90.29%	90.24%	90.14%	90.25%	90.29%	90.29%	90.21%	90.18%	90.26%	90.26%	90.26%	90.26%	90.26%	90.26%	90.26%
Total Recovery	76.02%	81.12%	82.73%	73.22%	71.74%	75.37%	80.91%	82.35%	83.57%	81.20%	72.25%	82.59%	84.68%	84.73%	82.29%	76.88%	75.54%	75.54%	75.54%	75.54%	75.54%	75.54%	75.54%

(Roche Engineering, 2014)

18 Project Infrastructure

18.1 Physical Upgrade Plant

The Physical Upgrade Plant will be built in two phases. The PUG will process High high grade ore in the first nine years (Phase 1) of operation. In year 9, the PUG plant is expanded (Phase 2) to upgrade the Hydromet feed as the mine head grade reduces.

The work performed in Phase 1 or Phase 2 is identified in each section below.

18.1.1 Access and Site Roads (Phase 1)

A preliminary study on the Bull Hill access roads has been completed by Stetson Engineering. The study shows that the Miller Creek Road (Figure 18.1) is the preferred access route to the Physical Upgrade Plant (PUG) and the mine site.

The main access to the PUG is designed with a gate and will be controlled by the main guard post. This access leads to a parking area and to a network of access roads that enables circulation around the facility.

All roads will be maintained by Rare Element personnel with chemical dust control. Pre-concentrate haul trucks will be fitted with GPS to monitor vehicle speed and locations.

18.1.2 Communications (Phase 1)

A reliable, state-of-the art communication system will be installed at the PUG site to provide employees with voice and data communication channels.

A parallel wireless communication system based on hand-held mobile and fixed-base radios will also be available for the operation and maintenance personnel.

18.1.3 Power Supply Facilities (Phase 1 and 2)

Phase 1:
A diesel generator will be used to power the pug plant through a 480VAC Motor Control Center (MCC) (Figure 18.2).

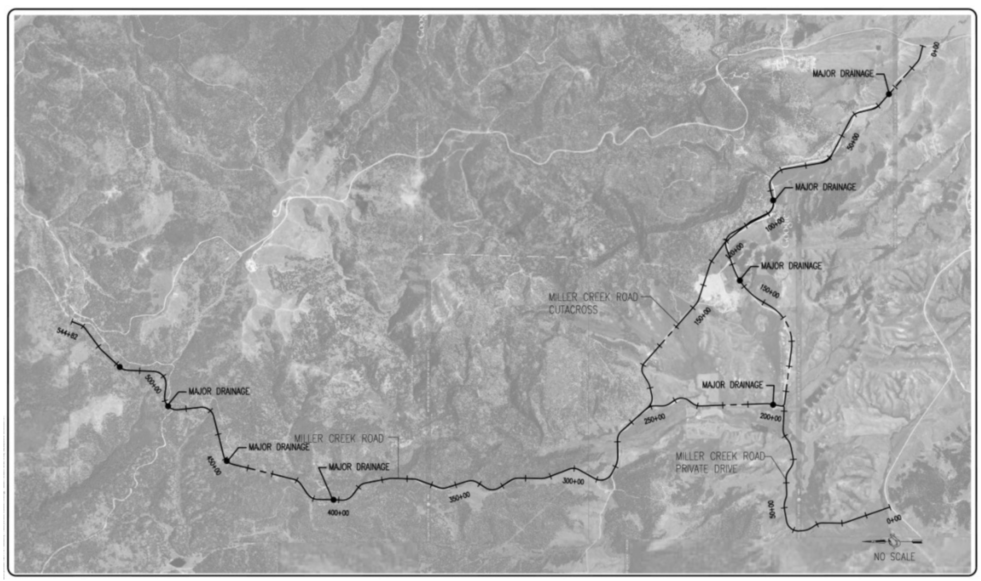
Phase 2:

Power to the Physical Upgrade site will be provided by PreCorp at 69KV. A 20 MVA 69kV/13.8KV transformer and its ancillary equipment will be installed.

The 13.8KV will power the truck shop and switch gear which will feed the Pug Plant. From the 13.8KV switch gear there will be a feed to a 13.8KV/4.16KV transformer which will power the larger motors. Two 2.4MVA 13.8KV/480VAC transformers will feed motor control centers in the Main Pug Process Building.

The fire water pump starter package will be fed from a 350KVA 13.8KV/480VAC transformer and will have a diesel-powered backup. The current design does not include redundancy to feed the plant in case of failure of the main transformer or power failure. However, the generator used to run the plant during phase 1 will be available to supply emergency power to critical equipment and utilities. The current design provides for 60% of available capacity.

Figure 18.1 - Miller Creek Road



(Oakley, 2012)

18.1.4 Buildings and Structures (Phase 1 and 2)

All facilities will be constructed and operated according to MSHA, local and state regulations. The site plans and general arrangement drawings for the PUG are presented in Figures 18.3 thru 18.6. Figure 18.4 provides detailed information about Phase 1 and Phase 2 for each facility.

18.1.4.1 Security Office, Fire Fighting and First Aid (Phase 1)

The security office, fire-fighting, and first aid building will be a pre-engineered structure, complete with insulated steel roof deck and steel wall cladding. The building will be divided into two sections. The first section, estimated at 30 ft. x 50 ft. (1,500 $ft^{2,}$ or 139 m^2) will be used as a security office and will have a safety training room. The second section, estimated at 50 ft. x 70 ft.) (3,500 ft^2, or 325 m^2) will be used as the firefighting and ambulance base, and will include a first aid center.

18.1.4.2 Crushing & Screening High Performance Fabric Building (Phase 1)

A high performance fabric building will host the jaw crusher and the coarse vibrating screen unit. The primary crusher will be fed from the power generator on the West side of the high performance fabric building. The building is estimated at 180 ft. x 180 ft. x 61 ft. height (32,400 ft^2, or 3,014 m^2).

18.1.4.3 Main PUG Plant Building (Phase 2)

The main PUG building will host the process equipment, administration area, showers and change room, laboratory, maintenance building, and the process area, including control and electrical room. The main PUG building is estimated at 185 ft. x 85 ft. x 80 ft. height (56.4 m x 25.9 m x 24.4 m) (15,725 ft^2) (1,461 m^2).

The administration area will host the offices for administrative and technical personnel. It will be built on a single floor estimated at 60 ft. x 40 ft. (2,400 ft^2, or 223 m^2) and will be located on the Southwest corner of the main building.

The change room and shower area will include lockers, change rooms, showers, and a lunch room. It will have two floors, each estimated at 40 ft. x 40 ft. (1,600 ft^2, or 148 m^2), and will be located on the south side of the main PUG building.

The laboratory area will host all equipment required to analyze samples from the mine and the processing, as well as a sample storage area. The laboratory will be built on two floors, each estimated at 20 ft. x 40 ft. (800 ft^2, or 74 m^2) and located on the south side of the PUG building.

The PUG maintenance building area will be used for maintenance on the various equipment and instruments of the facility, and will host a spare parts storage area. A 2-ton (1.8-tonne) jib crane will be installed in the maintenance room. This area will be built on a single floor estimated at 80 ft. x 40 ft. x 50 ft. height (3,200 ft^2, or 297 m^2) and located on the north side of the main PUG building.

The interior of the process area will be built using multi-level steel platforms for operation and maintenance needs. The plant ground floor is designed to segregate the containment areas. Major equipment will be installed on independent steel platforms. The platforms will be completed using grating and handrails. A 20-ton (18-tonne) overhead crane will be installed to support the maintenance operations.

In addition to the buildings, an outdoor laydown area will be built to receive and store large pieces of equipment.

The PUG facility is designed such that every building and equipment is contained, and any run-off material will be collected in a sump, and disposed of properly.

18.1.4.4 Pre-Concentrate Loading Building (Phase 1 and 2)

The pre-concentrate enclosed loading building will host the pre-concentrate loading bin and the truck load-out system. A scale will be installed to control the amount of pre-concentrate loaded on trucks. Phase 1 will require a building estimated at 80 ft. x 20 ft. x 60 ft. height (1,600 ft^2, or 148.8 m^2) and located on East side of the main PUG building. The building will be built using multi-level steel platforms for ongoing operation and maintenance needs. Major equipment will be installed on independent steel platforms. The platforms will be completed using grating and handrails. A 2-ton (1.8 tonne) monorail and hoist crane will be installed to support the maintenance operations.

A new building will be required for Phase 2 of the project near the Phase 1 building site. The existing equipment will be relocated and the capacity of the pre-concentrate holding silo will be increased. The building is estimated at 80 ft. x 30 ft. x 85 ft. height (2,400 ft^2, or 222 m^2) and located on West side of the main PUG building. The building will be built using multi-level steel platforms for ongoing operation and maintenance needs. Major equipment will be installed on independent steel platforms. The platforms will be completed using grating and handrails. A 2-ton (1.8 tonne) monorail and hoist crane will be installed to support the maintenance operations.

18.1.4.5 Mobile Equipment Maintenance Shop and Warehouse (Phase 1)

The mobile equipment maintenance shop will be used to repair and maintain the mining fleet. It will be located on the southern portion of the PUG facility. The building is estimated at 250 ft. x 100 ft. x 50 ft. height (25,000 ft^2, or 2,322 m^2). Adjacent to the building is a fenced laydown yard for large spare parts and consumables and a wash bay for cleaning mobile equipment. A 20-ton (18 tonne) overhead crane will be installed to support the maintenance operations. The building will also contain an indoor warehouse area for parts and consumables, as well as office space for maintenance personnel.

18.1.4.6 Mine Office and Change Room (Phase 1)

The mine office and change room building is estimated at 60 ft. x 100 ft. x 30 ft. height (6,000 ft^2, or 557.4 m^2). It will be located on the southern portion of the PUG facility. This building will also host the mine administrative personnel.

18.1.4.7 Explosive Storage (Phase 1)

Explosives will not be stored onsite. Instead, an explosives contractor will be responsible for transporting and placing explosives as required. It is estimated that a blast will be required once every two or three weeks to support mining operations.

18.1.4.8 Fuel and Lube Supply Facility (Phase 1)

A fuel filling station will be installed near the maintenance shop to provide fuel to mobile equipment. The facility will also store all lubricants used in the maintenance shop. The facility provides secondary containment to the storage vessels. The approximate capacity of the facility is 50,000 gallons.

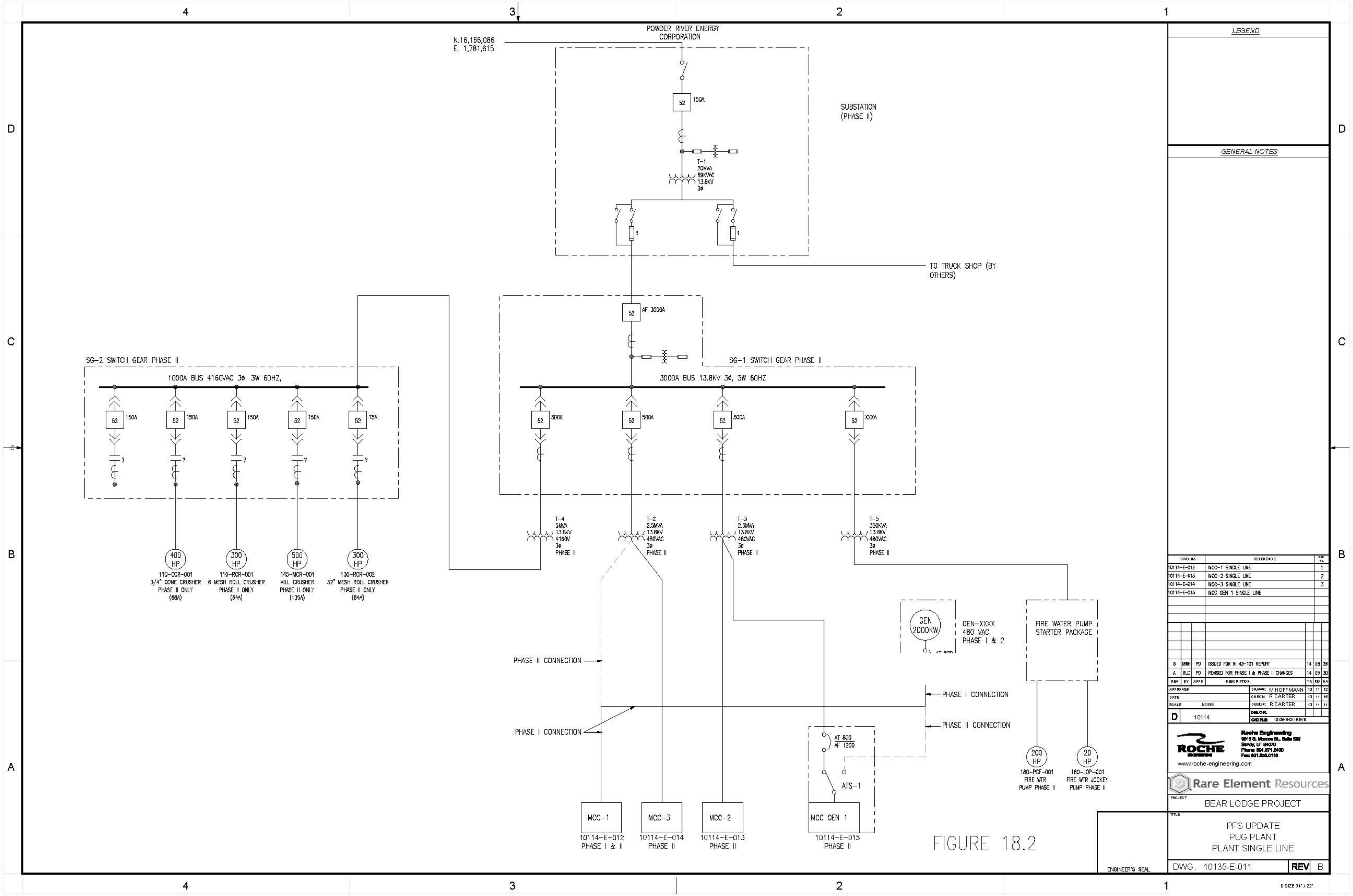
18.1.5 Water Supply Facilities (Phase 1)

Water to the PUG plant and the Mine facilities will be provided by wells located approximately 1,500 ft. (457.3 m) from the PUG site. A pump house will host the pumps, valves, emergency generator, and auxiliaries at the well. One HDPE waterline from the pump house will supply water to the water tank, located on a hill southwest of the Mobile Equipment Maintenance Shop building. The water tank will feed by gravity the PUG plant and the Mine facilities.

18.1.6 Waste Management (Phase 1)

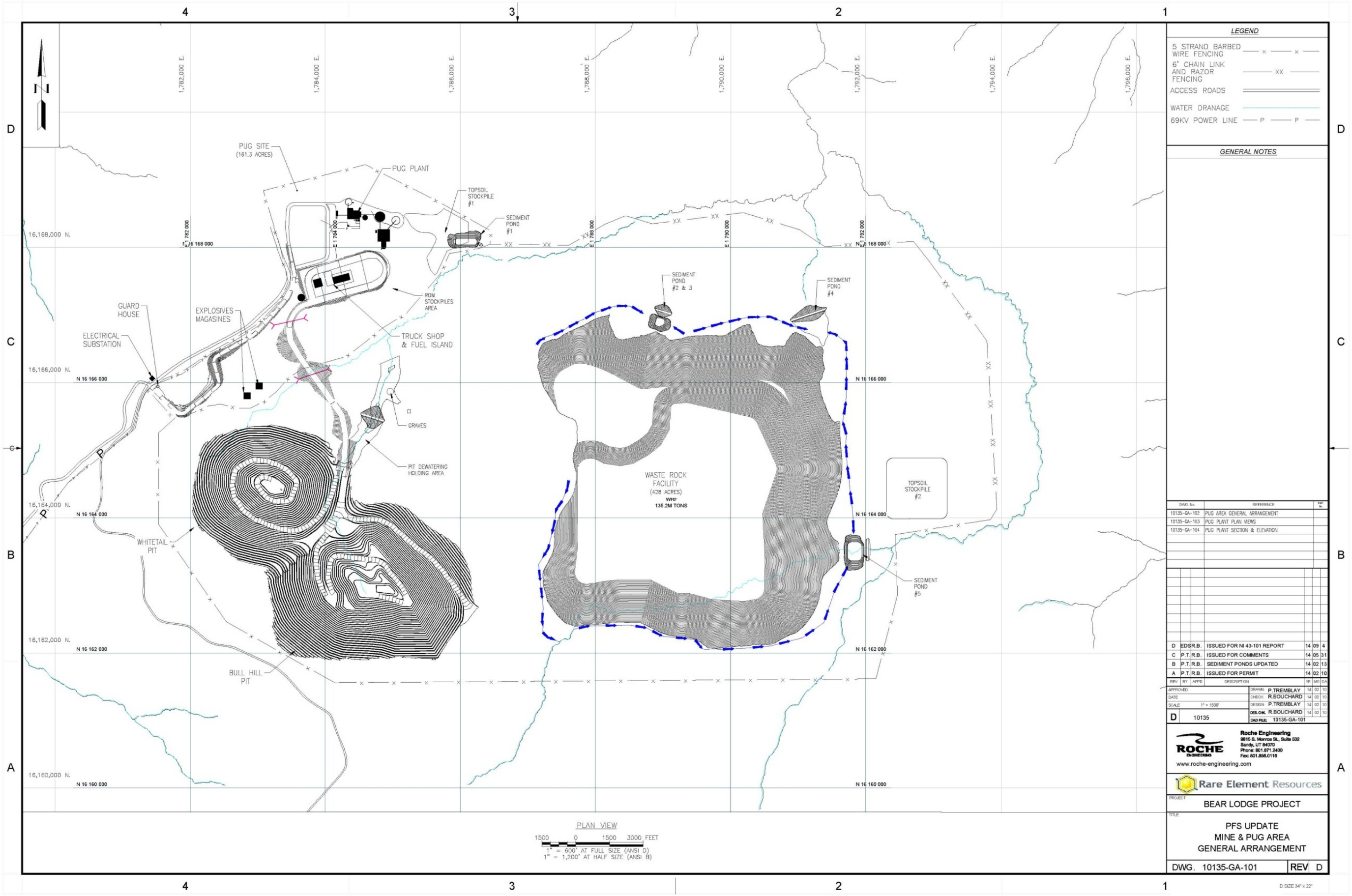
Solid waste generated by the mine will be stored in portable bulk refuse containers and transferred to the Sundance or Upton municipal solid waste transfer facility.

Figure 18.2 - Drawing No. 10135-E-011 - PFS Update Pug Plant Single Line



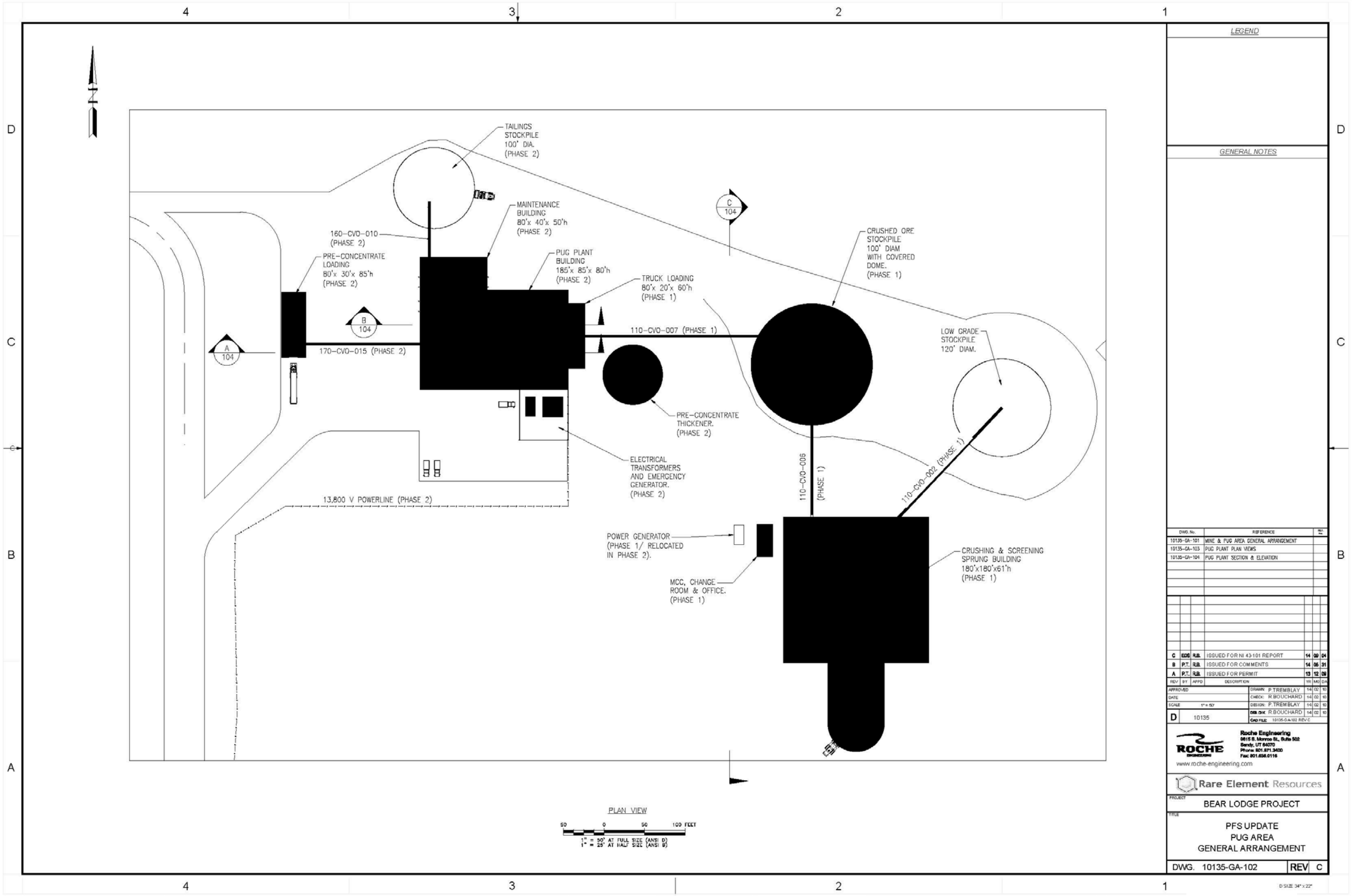
(Roche, 2014)

Figure 18.3 - Drawing No. 10135-GA-101 – PFS Update Mine & Pug Area General Arrangement



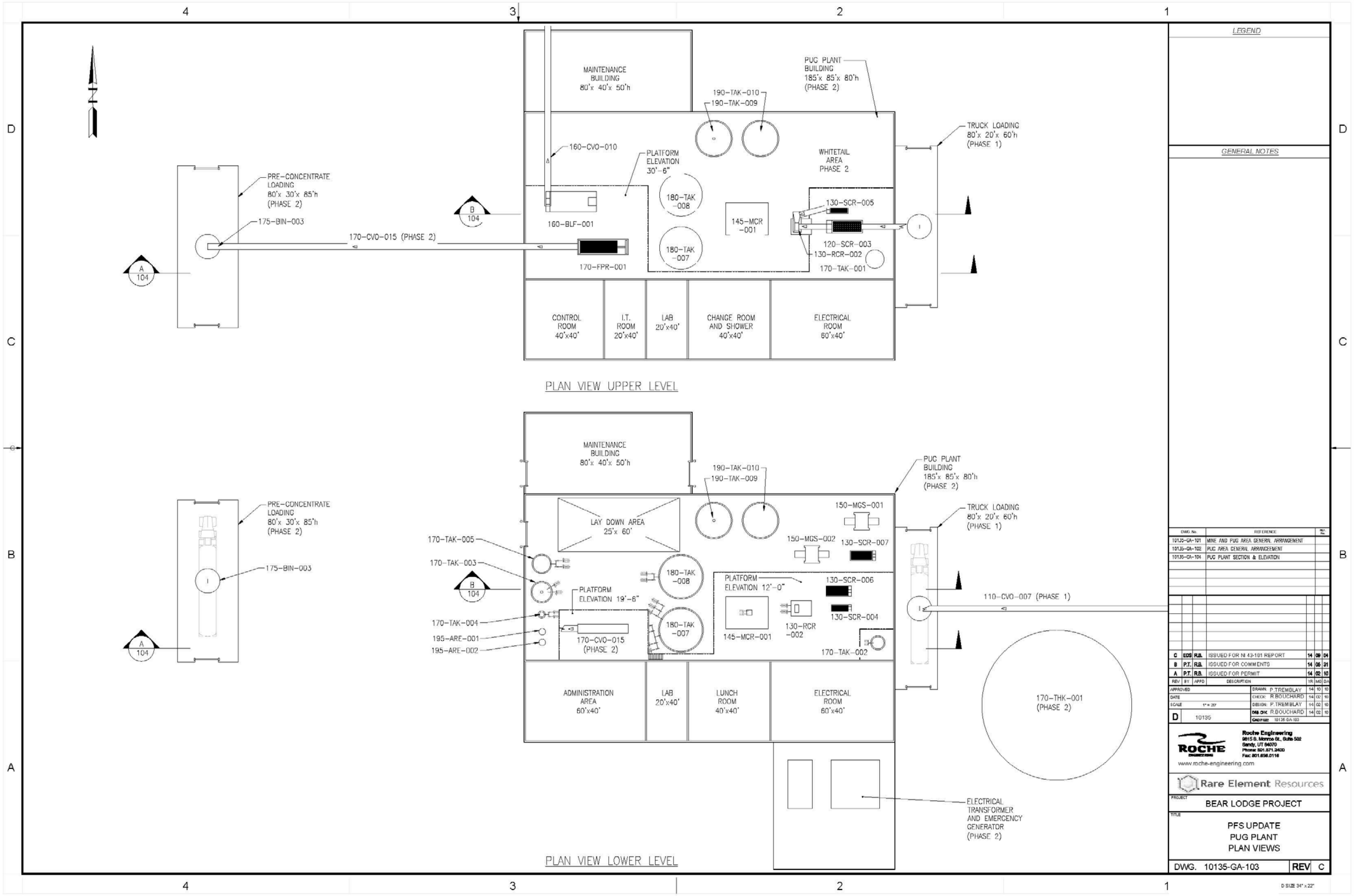
(Roche, 2014)

Figure 18.4 - Drawing No. 10135-GA-102 – PFS Update Pug Area General Arrangement



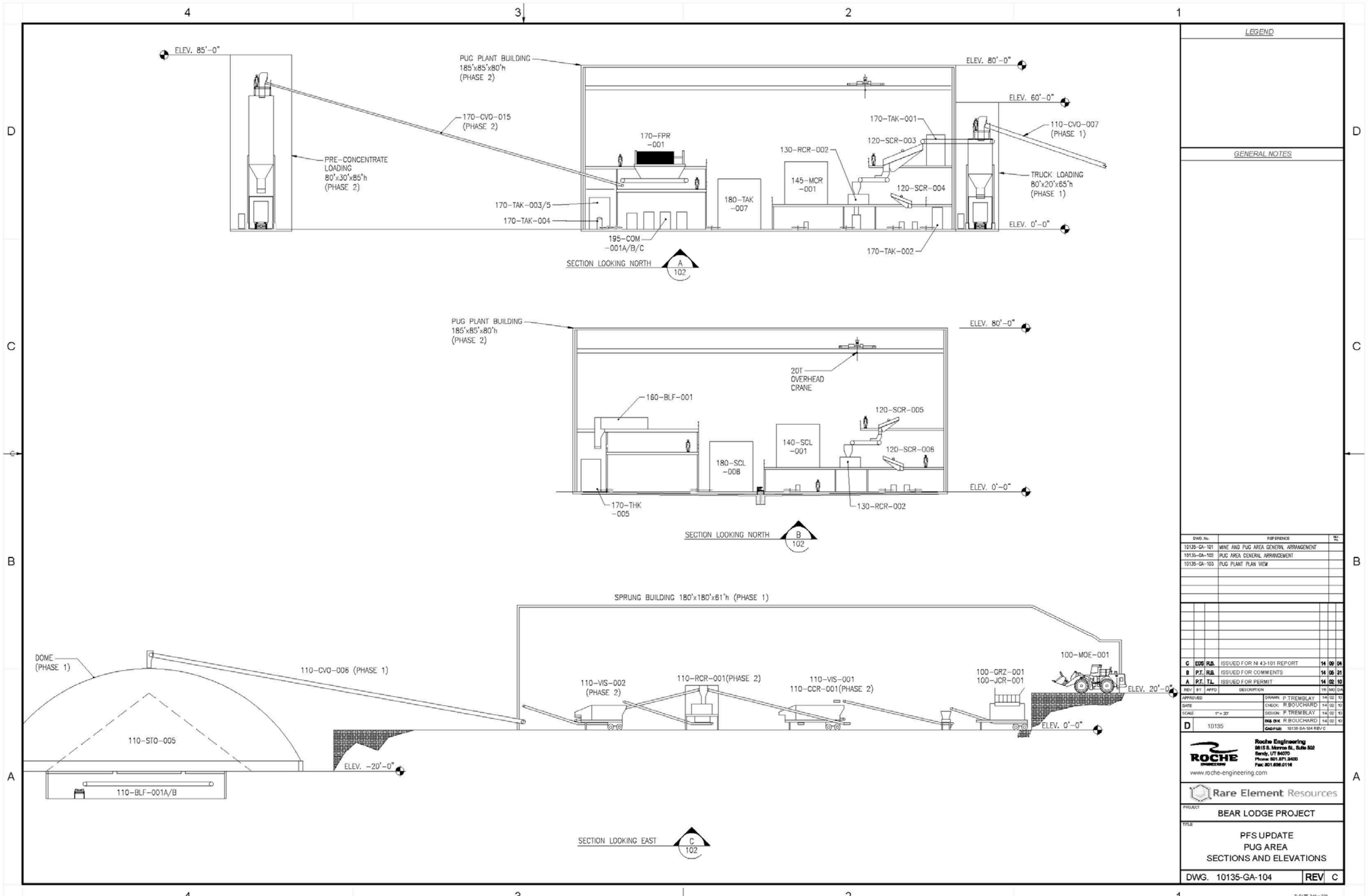
(Roche, 2014)

Figure 18.5 - Drawing No. 10135-GA-103 – PFS Update Pug Plant Plan Views



(Roche, 2014)

Figure 18.6 - Drawing No. 10135-GA-104 – PFS Update Pug Area Sections and Elevations



(Roche, 2014)

18.2 Upton Hydromet Plant

18.2.1 Access and Site Roads

Access from the Buffalo Creek road will be built to enter the Hydromet facility. The access will have a gate and be controlled by the main guard post. It will lead to a parking area and to access roads that will enable circulation around the facility.

18.2.2 Communications

A reliable, state-of-the art communication system will be installed at the Hydromet site to provide employees with voice and data communication channels.

A parallel wireless communication system based on hand-held mobile and fixed-base radios will also be available for the operation and maintenance personnel.

18.2.3 Power Supply Facilities

Power to the Hydromet site will be provided by PreCorp at 25kV. A 10 MVA 25kV/4.16kV transformer and its ancillary equipment will be installed to reduce the voltage to the distribution network voltage of 4.16kV. A capacitor bank will also be installed to correct the power factor. The current design does not include any redundancy to feed the plant in case of failure of the main transformer. An emergency generator will be installed to provide power to critical equipment and utilities only during a power failure.

A motor control center will be built in the mill building. Large motors will be directly fed from the distribution line, while small motors will be fed through three MVA 4.16kV/480V secondary step-down transformers at 480V. The HCl Regeneration Unit will be fed through a 3 MVA 4.16kV/480V secondary step-down transformer. The Hydromet plant single line drawing is presented in Figure 18.7.

18.2.4 Buildings and Structures

The site plans and general arrangement drawings for the Hydromet are presented in Figures 18.8 thru 18.11.

18.2.4.1 Security Office, Fire Fighting and First Aid

The security office, fire-fighting and first aid building will be a pre-engineered building complete with insulated steel roof deck and steel wall cladding. The building will be divided into two sections. The first section, estimated at 30 ft. x 50 ft. (1,500 ft^2, or 139 m^2) will be used as a security office and will have a safety training room. The second section, estimated at 50 ft. x 70 ft. (3,500 ft^2, or 325 m^2) will be used as the firefighting and ambulance base, and will include a first aid center.

18.2.4.2 Main Hydromet Building

The main Hydromet building will be divided into several areas: the administration, shower and change room, laboratory, vehicle maintenance, workshop and storage, and the process areas. Concrete masonry block walls will be built between each area.

The administration area will host the offices for administrative and technical personnel, as well as the employees' lunch room. It will have two floors; each estimated at 50 ft. x 50 ft. (2,500 ft^2, or 232 m^2) and is located on the North corner of the main Hydromet building.

The shower and change room area will include lockers, two change rooms, and two shower areas. It will be built on a single floor, estimated at 50 ft. x 75 ft. (3,750 ft^2, or 348 m^2), and will be located on the North side of the main Hydromet building.

The laboratory area will host all equipment required to analyze samples from the processing area as well as a sample storage area. The laboratory will be built on a single floor, estimated at 50 ft. x 50 ft. (2,500 ft^2, or 232 m^2), and be located on the north corner of the main Hydromet building.

The vehicle maintenance, workshop, and storage area will include a truck shop to perform maintenance on vehicles, a workshop to perform maintenance on the various equipment and instruments of the facility, and a spare parts storage area. A 2-ton (1.8 tonne) jib crane will be installed in the workshop. This area will be built on a single floor estimated at 50 ft. x 137 ft. (6,850 ft^2, or 635 m^2) located on the northwest side of the main Hydromet building.

The main Hydromet building will host the process units, the mechanical and electrical room, and the control room. The interior of the Hydromet building will be built using multi-levels of steel platforms for ongoing operation and maintenance needs. The building is estimated at 130 ft. x 360 ft. x 80 ft. height (46,800 ft^2, or 4,348 m^2). The plant ground floor is designed to segregate the containment areas. Major equipment will be installed on independent steel platforms. The platforms will be completed using grating and handrails. A 15-ton (13.6 tonne) overhead crane will be installed to support the maintenance operations.

In addition to the buildings, an outdoor laydown area will be built to receive and store large pieces of equipment.

The Hydromet facility is designed such that all process areas and process equipment are contained, and any run-off material will be collected in a sump, and disposed of properly.

18.2.4.3 Pre-concentrate Handling

The pre-concentrate handling system is composed of an enclosed unloading station, two storage silos, and three feed conveyors.

The pre-concentrate trucks will use the gate to reach the pre-concentrate unloading station, located on the southeast corner of the Hydromet facility. The trucks will discharge their load in an enclosed building to underground hopper. A conveyor will transport the pre-concentrate from the discharge hopper to the storage silos. The storage silos will feed the primary and secondary classification area.

18.2.4.4 Primary and Secondary Classification area

The primary and secondary classification system is composed of a cone crusher, roll crushers, grinding mill, screens, conveyors and tanks. All of the equipment will be installed at the Hydromet plant in Phase 1 of the project (first nine years of operation) and relocated to the PUG plant for Phase 2 (in year 10 of operation). The building is estimated at 80 ft. x 65 ft. x 75 ft. height (5,200 ft^2, or 483 m^2) and located on the southeast side of the main Hydromet building. The building will be built using multi-level steel platforms for ongoing operation and maintenance needs. Major equipment will be installed on independent steel platforms. The platforms will be completed using grating and handrails.

18.2.4.5 Oxalic Acid Handling

The oxalic acid handling system is composed of a storage silo, screw conveyors, and a dissolution tank. The oxalic acid will be received in bulk bags by truck. The building will be built on a single floor, estimated at 90 ft. x 120 ft. x 40 ft. height (10,800 ft^2, or 1003 m^2), and will be located on the northeast side of the main Hydromet building.

18.2.4.6 Ammonium Nitrate Recovery

The ammonium nitrate recovery system is mainly composed of crystallizers, concentrator-evaporator, centrifuge, fluid bed dryer, bagging system and air scrubber. The building is estimated at 100 ft. x 100 ft. x 60 ft. height (10,000 ft^2, or 930 m^2) and located on the West side of the main Hydromet building. The building will be built using multi-level steel platforms for ongoing operation and maintenance needs. Major equipment will be installed on independent steel platforms. The platforms will be completed using grating and handrails.

18.2.4.7 Ammonium Nitrate Storage Building

The building will store bulk bags of ammonium nitrate in multi-level storage racks. The building is estimated at 330 ft. x 330 ft. x 30 ft. height (108,900 ft^2, or 10,120 m^2) and located on the southeast side of the main Hydromet building.

18.2.4.8 Thorium Removal Unit

The thorium removal unit is composed of reactors, press filters, screw conveyor, and air scrubber. The building is estimated at 50 ft. x 50 ft. x 50 ft. height 2,500 ft^2, or 231 m^2) and located on the west side of the main Hydromet building. The building will be built using multi-level steel platforms for ongoing operation and maintenance needs. Major equipment will be installed on independent steel platforms. The platforms will be completed using grating and handrails. A 2-ton (1.8 tonne) monorail and hoist crane will be installed to support the maintenance operations.

18.2.4.9 HCL Recovery & Byproduct Crystallizer

The HCL recovery & by-product crystallizer system is composed of reactors, belt filters, belt conveyor, centrifuge, crystallizer, heat exchangers, flash column and pumps. The building is estimated at 120 ft. x 200 ft. x 80 ft. height (24,000 ft^2, or 2,233 m^2) and located on the west side of the main Hydromet building. The building will be built using multi-level steel platforms for ongoing operation and maintenance needs. Major equipment will be installed on independent steel platforms. The platforms will be completed using grating and handrails.

18.2.4.10 Oxalate Thickener

The enclosed Oxalate thickener will be installed in a containment estimated at 180 ft. x 145 ft. x 4 ft. height (26,100 ft^2, or 2,427 m^2), and will be located on the west side of the main Hydromet building.

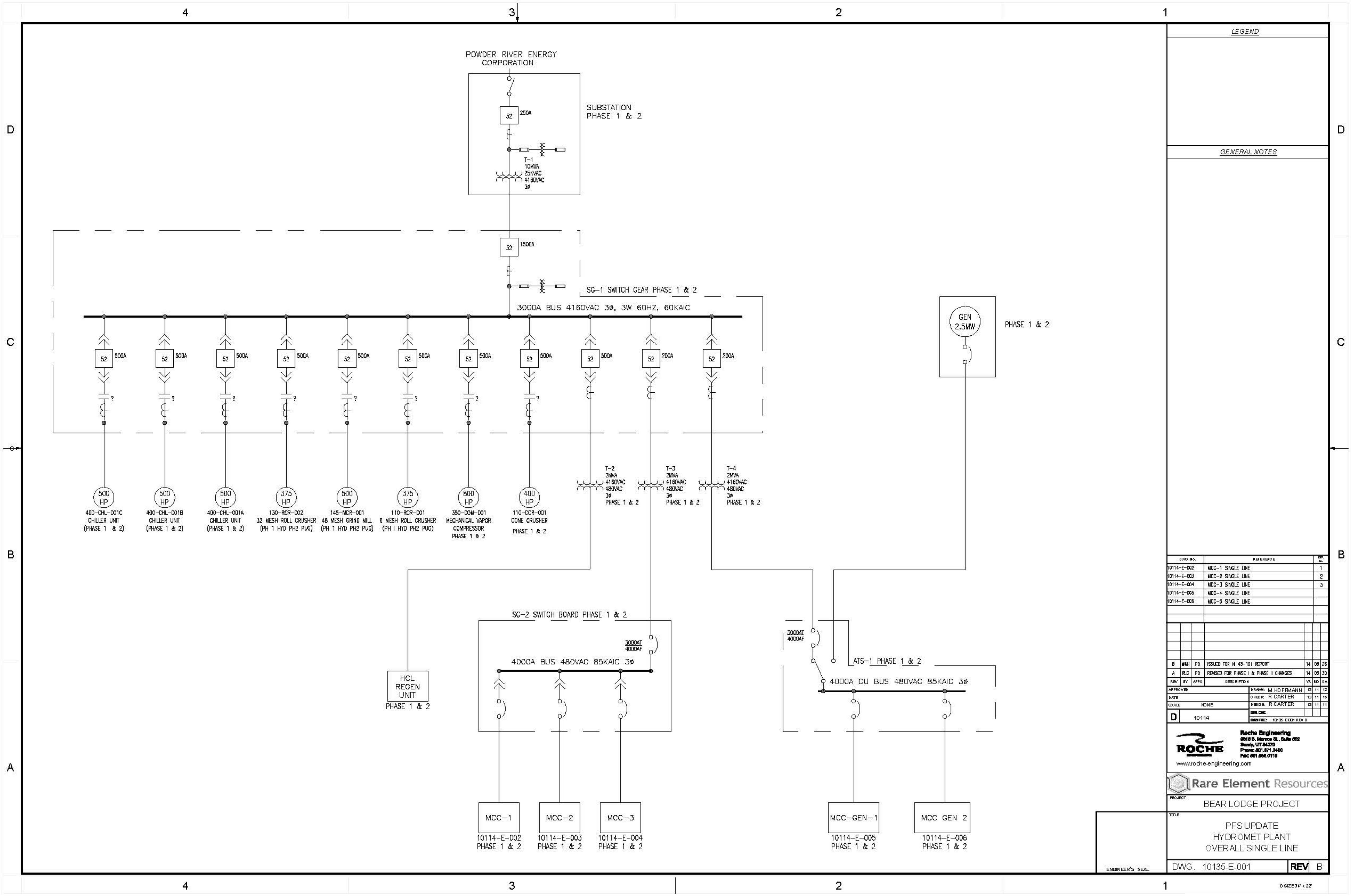
18.2.5 Water Supply Facilities

The Hydromet water supply will be provided by a connection to the Upton, WY municipal water network.

18.2.6 Natural Gas Supply

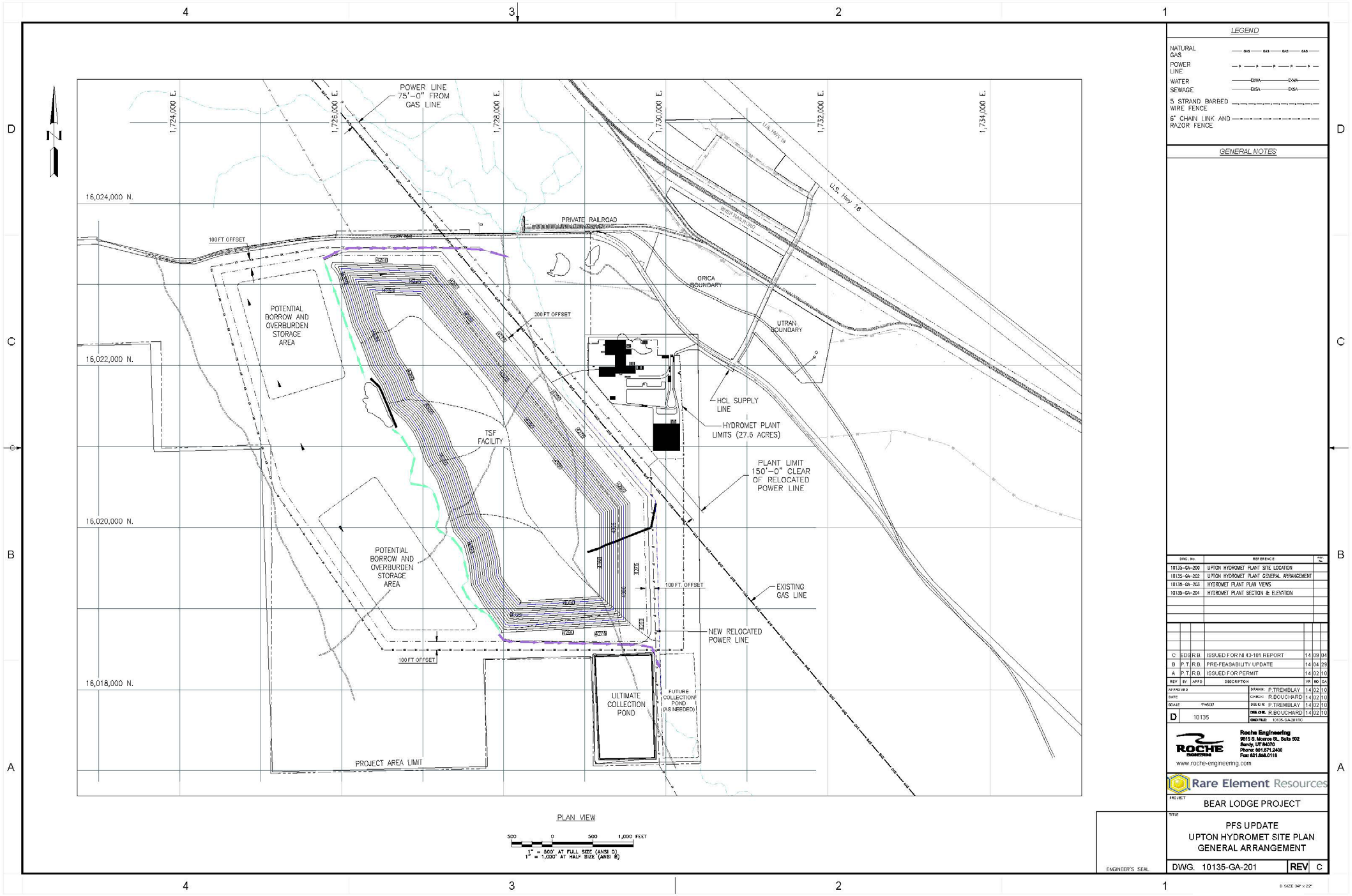
The Hydromet natural gas supply will be provided by a connection to the Upton industrial park natural gas network.

Figure 18.7 – Drawing No. 10135-E-001 - PFS Update Hydromet Plant Overall Single Line



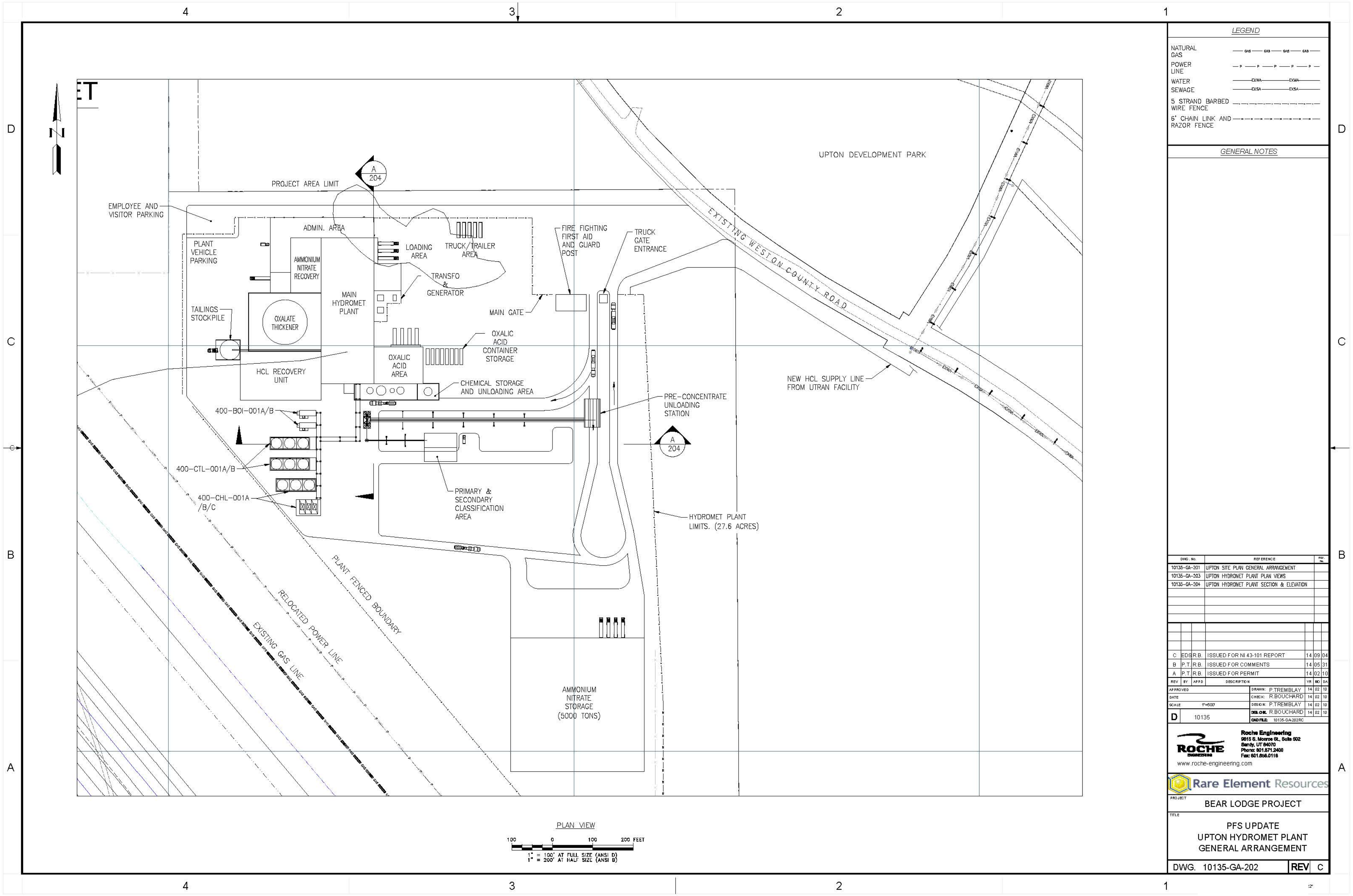
(Roche, 2014)

Figure 18.8 - Drawing No. 10135-GA-201 - PFS Update Upton Hydromet Site Plan General Arrangement



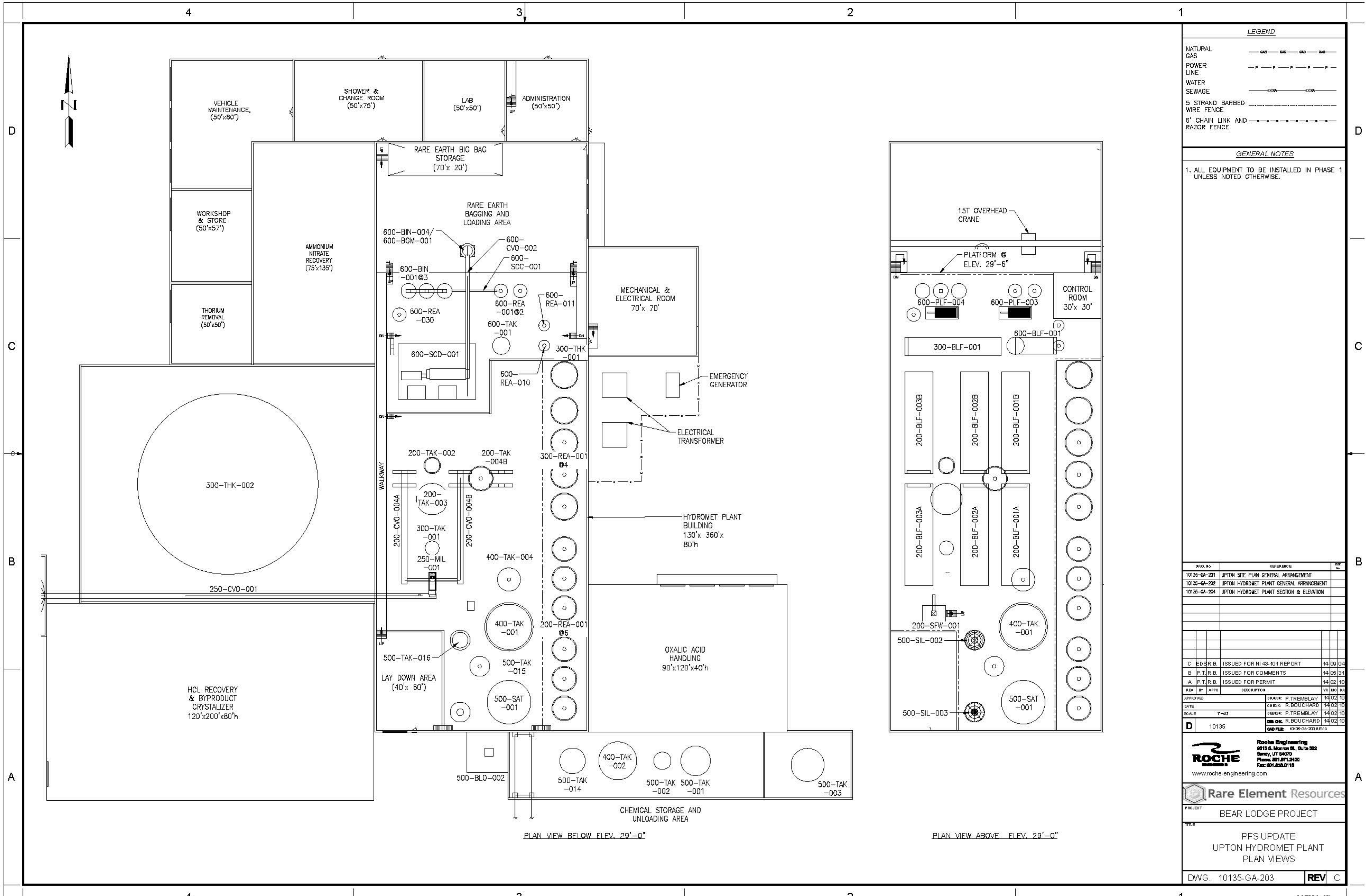
(Roche, 2014)

Figure 18.9 – Drawing No. 10135-GA-202 - PFS Update Upton Hydromet Plant General Arrangement



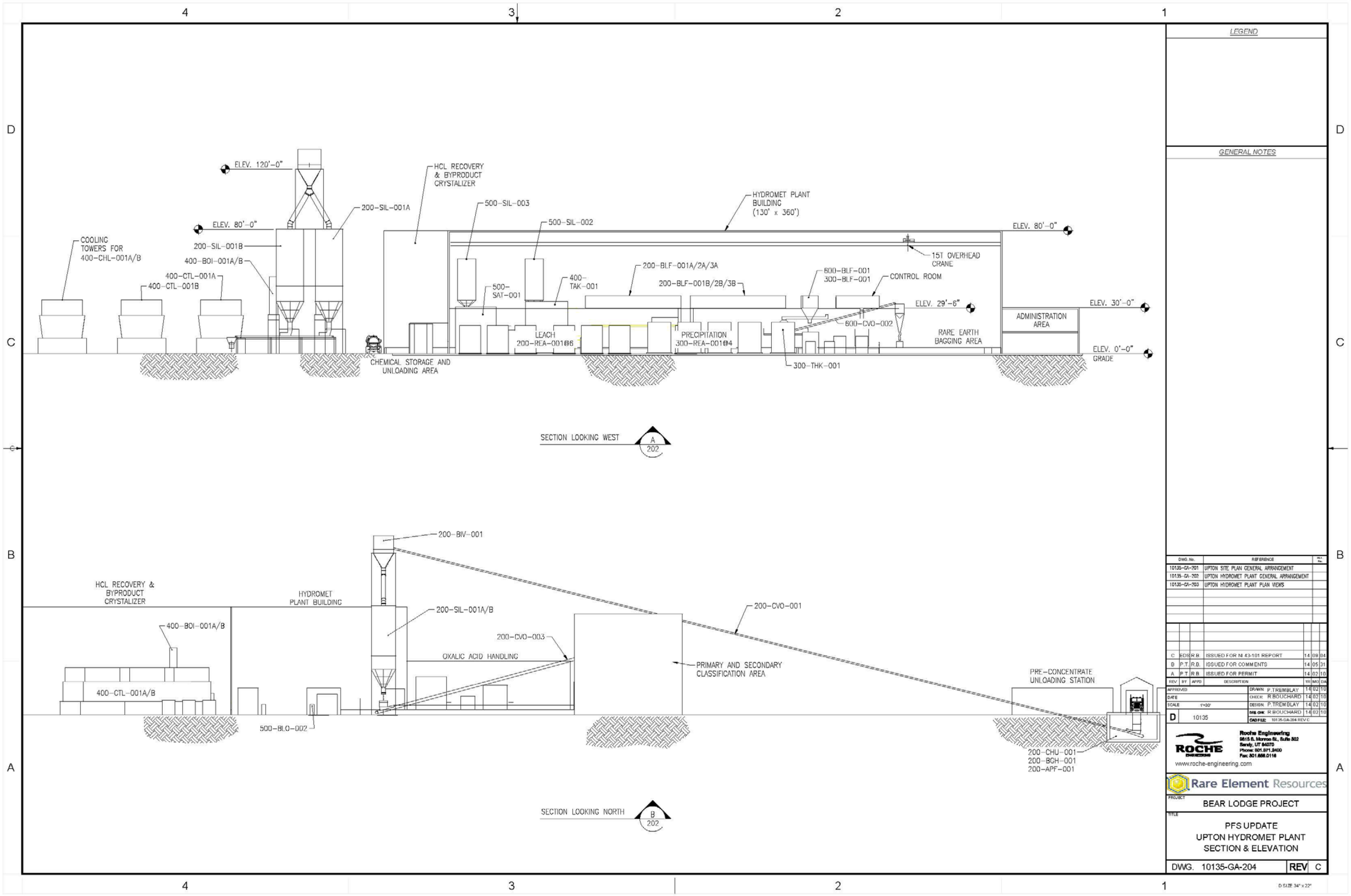
(Roche, 2014)

Figure 18.10 – Drawing No. 10135-GA-203 - PFS Update Upton Hydromet Plant Plan Views



(Roche, 2014)

Figure 18.11 – Drawing No. 10135-GA-2014 – PFS Update Upton Hydromet Plant Section & Elevation



(Roche, 2014)

18.2.7 Tailings Storage Facility

The tailings storage facility (TSF) pre-feasibility level design will operate as a ‘zero discharge’ facility such that no solution from the waste or contact surface water from the TSF will be released to surface waters or groundwater in a manner that violates permit conditions or adversely impacts receiving water quality. Design guidelines and criteria for the TSF presented in this report are in accordance with the Wyoming Department of Environmental Quality (WDEQ) Land Quality Division (LQD) Noncoal Mine Rules and Regulations. Rare Element has applied for an exemption from the U.S. Nuclear Regulatory Commission (NRC) guidelines for tailings impoundment design, operation, and closure requirements as radioactive elements in the ore will be removed from the waste streams to achieve acceptable residual levels prior to exiting the Hydromet plant for disposal in the TSF.

The tailings produced by the Hydromet plant are considered a non-hazardous waste based on current test data and understanding of the geochemical characteristics of the waste material. The tailings solids will be non-acid generating material; however, the residual moisture in the waste may be slightly acidic due to the rare element extraction process. Limestone and quick lime will be mixed with the waste streams to neutralize the material prior to transport to the TSF. In addition, the tailings product delivered to the TSF will be dewatered to a semi-dry, soil-like material suitable for truck hauling and deposition using conventional earthwork equipment.

The proposed site for the TSF is within private property boundaries to the west of the proposed Hydromet plant location. The TSF is situated on a broad, relatively flat, grass-covered slope that will require a side-hill type of embankment for containment of the tailings. Surficial soils generally consist of clay primarily derived from in-place weathering and erosion of the exposed shale formations in the area. The TSF is located pre-dominately over the Belle Fourche Shale, which contains marine fossils, limestone concretions, and several thick bentonite beds throughout the formation. A series of steeply dipping Upper Cretaceous aged shale beds appear in the northwest to southeast striking slopes that form the valley ridgeline west of the TSF footprint. These geologic conditions indicate that the TSF site is suitable for construction of the TSF and containment of the tailings.

The dewatered and neutralized tailings will be transported by truck to the TSF and placed within a lined facility as a ‘filtered’ tailings product using conventional earthmoving equipment. The TSF capacity is approximately 15.8 million tons, including both tailings and neutralization amendments, with an average in-place

density of 100 pcf. The TSF capacity can be increased as needed by placing the tailings to a higher elevation and/ or extending the TSF footprint westward.
The major components of the proposed TSF are:

- A perimeter containment berm;
- A composite liner system over the impoundment area;
- A collection pond for management of excess contact water (e.g., seepage and runoff) from within the TSF

The perimeter containment berm is designed as a side-hill, homogeneous earthen dam constructed of compacted clay soils excavated from within the TSF. The TSF liner system will be a composite liner system consisting of a 12-inch thick low permeability compacted soil liner directly overlain with an 80-mil HDPE liner. A protective cover layer overlies the liner system. The collection pond will be composite lined and will function as an evaporation pond to remove excess water from the system. Should the Hydromet plant require makeup water, the collection pond capacity can be reduced and excess water routed to the Hydromet plant for potential reuse.

Construction of the TSF will be phased over the life of the project with start-up facilities constructed at the north end of the TSF footprint and expanded southward. The rate of dry tailings reporting to the TSF, including neutralization amendments, will vary year to year with the minimum tonnage of 254,542 tons reporting in Year 45 and the maximum tonnage of 422,449 tons reporting in Year 10. The average yearly production of dry tailings, including neutralization amendments is 350,198 tons per year (tpy). The start-up TSF configuration will allow for approximately 1.5 years of operation of the Hydromet plant with a total dry tailings storage capacity of 464,158 tons. Expansions will occur in operating years 1 and 3 to provide sufficient space for continued operations through Year 8 with vertical expansion of the tailings pile. The next two expansions will be in operating years 7 and 16 and will provide storage through Year 20. The estimated TSF capacity includes amendments added to the tailings for neutralization prior to placement in the TSF. Starting in Year 20, it is assumed that expansions will be required approximately every four (4) years for preliminary planning and cost estimating purposes. It is estimated that in Year 7 plans will be developed for reclamation of completed tailings slopes and will then continue concurrently with tailings deposition operations. It is intended that the active area of the TSF not exceed 35 acres to limit the contact water management from the TSF and mitigate environmental concerns such as dust emissions from windblown tailings. The start-up configuration and initial expansion schedules are not likely to change, pending detailed designs and stacking plans. Thereafter the expansion plans may vary as detailed operating plans are developed and modified as needed over the life of the project.

The Upton TSF has been designed to operate as a dry-stack facility with transport of tailings to the TSF using haul trucks and then spread by low-presure track mounted equipment. Compaction of the tailings will occur from the haul trucks and low-pressure track equipment. An allowance is included in the TSF layout and design estimate for temporary cover placement as needed for runoff and moisture uptake control in the tailings. Access into and from the TSF will be by a network of designated haul roads established within and around the TSF footprint. TSF operations will generally consist of the following three activities:

- Tailings transport, deposition, and management;
- TSF embankment and liner construction;
- On-going TSF maintenance and reclamation;

The operations at the TSF must ensure the following:

- The basis of the design remains valid and design criteria are being achieved;
- Changes in tailings production are accounted for;
- Tailings geochemistry and physical properties are monitored and accounted for in the event of changes from initial design criteria and values;
- Tailings management and TSF construction planning takes into consideration the availability of construction materials and seasonal constraints and minimizes material handling.

18.2.7.1 Design Criteria

18.2.7.1.1 Regulatory Guidelines

The WDEQ LQD is the lead agency with respect to the design, operation, and closure of the proposed TSF. Specifically the LQD Noncoal Mine Rules and Regulations contain the guidelines for the TSF design and permit approval. Rare Element has applied for an exemption from the U.S. NRC guidelines for tailings impoundment design, operation, and closure requirements. The radioactive materials in the ore (e.g., small quantities of thorium and uranium) will be removed to acceptably low radionuclide levels (less than 0.05 percent) from the waste streams prior to exiting the Hydromet plant and prior to disposal in the TSF. The Wyoming State Engineer's

Office may also provide oversight regarding dam safety, surface water diversion, and water rights issues related to the TSF site.

18.2.7.1.2 Engineering Criteria

There are no prescriptive criteria presented in the Non-coal Rules and Regulations for mine waste management. However, it is stated in Chapter 3 of the regulations that “tailings impoundments, tailings disposal area shall be designed, constructed, and operated in accordance with established engineering principles using best technology currently available to ensure long term stability and to prevent contamination of surface or groundwater” (WDEQ 2006). This guideline served as the primary basis for developing the design criteria for the TSF pre-feasibility level design.

The tailings produced by the rare earth element processing plant will be a non-hazardous waste based on current test data and deduced geochemical characteristics of the waste stream. The tailings solids will be non-acid generating material; however, the residual moisture in the tailings may be slightly acidic because of the rare element extraction process. Lime stone and quick lime will be added to the tailings to neutralize the material prior to transport to the TSF. In addition, the tailings delivered to the TSF will be dewatered to semi-dry, soil-like material suitable for truck hauling and deposition using conventional earthwork equipment. Based on these waste characteristics and the TSF design guidelines referenced above, the following criteria were set for the pre-feasibility-level design study for the TSF.

- “Zero discharge” facility with respect to contact surface water management and any precipitation infiltration (i.e., seepage) emanating from the tailings stack at or above the base of the lined TSF;
- Non–contact surface water runoff diverted around the facility and into the current receiving stream;
- Composite liner system consisting of minimum 12-inch compacted low permeability soil liner exhibiting a hydraulic conductivity no greater than $1x10^{-7}$ cm/sec overlain by 80-mil high-density polypropylene (HDPE) geomembrane liner;
- Staged construction to minimize exposure of unused portions of TSF and limit active areas of disturbance;
- Capture, control, and separation of flow from groundwater springs within the TSF footprint by construction of an underdrain system to prevent impacts to groundwater quality and to convey the spring flows beyond the TSF boundary as non-contact or non-impacted waters;
- Truck haul and controlled dump plan for waste disposal;

- Factors of safety (FOS) for cut and fill slopes and embankments and stacked tailings slopes within TSF meet or exceed minimum allowable FOS as set by the State Engineer's office for like structures or as considered accepted industry standards for TSF operations and not covered under the State Engineer's Office regulations.

18.2.7.1.3 Operations Criteria

Once the TSF is in operation, the site operations criteria will be regulated by approved permit conditions and by health and safety regulations administered by the U.S. Mine Safety and Health Administration (MSHA). Allowances were incorporated in the TSF layout and design criteria for the TSF operations based on previous experience with MSHA and anticipated environmental permit conditions. In particular, the active tailings stacking area will be limited and the stability of the working area will meet factor of safety allowances typical for end construction conditions in earthen dams. It is assumed that placement of waste will be during day shift hours. Stockpile facilities will be sized to accommodate 24-hour plant operations and will allow for shut-down periods due to bad weather and for emergency equipment maintenance. The actual storage volume will be determined in final design of the project facilities. A temporary soil cover to limit runoff and moisture uptake control in the tailings during periods of bad weather or prolonged exposure will be placed over the tailings as needed.

18.2.7.2 Hydromet Waste Streams

Two waste streams will be discharged from the Hydromet plant and mixed with lime stone and quick lime for deposition into the TSF. They are identified as the acid leach tailings from an initial processing step and the precipitate residue from the rare earth element recovery process. Samples of these materials have been received from Rare Element. No summaries of data for neutralization or geotechnical characterization of the tailings are discussed at this time due to the incompleteness of the testing using recent samples from the Hydromet Plant, and the fact that additional testing is pending.

A) Mass Balance Estimates

Based on currently available production estimates, tailings from the Hydromet plant, including neutralization amendments, will discharge at an initial rate of 294,354 tpy. The rate of total tailings discharge from the Hydromet plant reporting to the TSF will vary year to year with the minimum tonnage of 284,656 tons reporting in year 8 and the maximum tonnage of 378,222 tons reporting in year 14. The average yearly production of dry tailings, including neutralization amendments is 350,198 tpy over an operating life of 45 years. The total tonnage of waste generated over the 45-year project life is estimated to be about 15.8 million tons, including neutralization amendments.

18.2.7.2.1 Initial Geochemical Characteristics

The Hydromet plant leach tailings and precipitate residue streams have associated paste pH values around 1 and 0, respectively, and are thus acidic. Geochemical analysis by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) methods indicates that both waste streams have metals concentrations. Furthermore, the residue appears as a soluble crystalline salt and likely to release most of its metal fraction upon contact with water (including barium, chromium, iron, lead, manganese, molybdenum, strontium, uranium, vanadium, and zinc).

However, the leach tailings contain a significant oxide (primarily iron oxide) and lesser carbonate component; both phases will solubilize over time if exposed to acidic solutions, and further metals release can be expected.

These tails will therefore be amendmended with alkali material which provides the following benefits:

- The amendment neutralizes waste acidity;
- The amended material may be less soluble;
- The tails will be dewatered and admixed with limestone and quick lime to achieve a neutral pH. The high iron (in the form of iron oxides) content of both waste streams is not likely to solubilize at neutral pH and will provide significant attenuation of most metals via surface complexation.

18.2.7.3 TSF Design

A) Description and Capacity

The planned TSF is located west of the proposed Hydromet plant and was sited to account for current property boundaries and adopted offsets from utility easements and public roads. In addition, Golder established the TSF limits east of the surface water drainage divide that runs along the west side of the TSF site and west of the gas line utility easement through the eastern side of Rare Element's property. The design of the planned TSF has been developed to accept the waste product from the Hydromet plant assuming a filtered (dewatered) and neutralized material suitable for truck transport to the TSF and placed as a dry-stacked material using small dozers to grade and maintain surfaces of the stacked tailings. The material will be graded to accommodate access for continuous operation and to achieve the proposed geometry as shown in the drawings. The TSF will be constructed in phases to accommodate continuous placement of material and limit active operating areas. Initial deposition of tailings will be in the northern end of the TSF and expanded as necessary from north to south in a manner similar to expansion layouts shown in the drawings. A detailed material stacking and expansion plan will be developed as part of feasibility design of the TSF.

The TSF footprint design has an ultimate capacity of approximately 33 million tons of waste material. The Hydromet plant operations over the current 45-year life-of-mine (LOM) including additives for neutralization of the tailings mass will produce about 15.8 million tons (almost one-half of the ultimate TSF site design capacity). The ultimate TSF capacity as shown on Figure 1 is approximately 33 million tons of waste material placed at an average in-place density of 100 pounds per cubic foot (pcf). The capacity of the ultimate TSF shown in Figure 1 may be increased by raising the height of the stacked material or by expanding the TSF to the west up the slope. Should the LOM capacity of the proposed TSF exceed 15.8 million tons due to changes in the Hydromet plant operation or an increase in ore reserves, the TSF footprint may be expanded as needed towards the ultimate configuration shown on Figure 1 or by increasing the height of stacked ore or expanding the footprint westward. The southern end berm and evaporation ponds would be adjusted as needed to accommodate any increase in the TSF footprint. Increasing the height of stacked tailings will not impact the evaporation pond layout.

18.2.7.3.1 TSF Design

The TSF is designed to operate as a dry-stack waste facility with the following key components:

- TSF main toe embankment;
  - 30-foot wide crest;
  - Approximately 60 feet tall (maximum height);
  - 2.5H:1V downstream slopes;
  - 3H:1V upstream slopes;
  - Constructed along the north and eastern boundaries of the TSF during operation.
- TSF intermediate toe berms:
  - 10-foot wide crest;
  - Approximately 5 feet tall;
  - 2.5H:1V downstream slopes;

- o 2.5:1V upstream slopes.
- Dry stack tailings:
  - o Maximum height of approximately 130 feet above existing grade;
  - o Ultimate side slopes of 5H:1V;
  - o Operational side slopes of 3.5H:1V.
- Underdrain, liner and contact water management systems:
  - o Underdrain system to manage and convey groundwater seeps and springs.
- Composite liner system consisting from bottom to top:
  - o 12-inch thick low-permeability soil liner;
  - o 80-mil HDPE smooth geomembrane.
- ▪ Seepage collection and contact water system management:
  - o Toe drain at the base and northern end of the TSF;
  - o Adjacent collection and evaporation ponds with ability to reclaim excess water for use as make-up water at the Hydromet Plant or for dust control of exposed tailings.

18.2.7.3.2 Surface Water Management

Surface water runoff from the undisturbed area west of the proposed TSF will be collected and diverted around the TSF and returned to Coyote Creek. The diversion ditch will be staged to match the expansion of the TSF. Temporary diversion ditches will be constructed above working areas not yet protected by the permanent perimeter diversion structures. Precipitation falling on the active surface of the TSF or within the lined footprint of the TSF will be conveyed to the collection pond where it will be allowed to evaporate or pumped back as reclaim water to the Hydromet plant, if necessary, or used for dust control of exposed tailings. Surface water diversion structures were designed for the Ultimate TSF Footprint and found also suitable for the current 45-year LOM footprint. The temporary and intermediate diversion structures noted in the drawings were modified as needed to optimize surface water runoff from undisturbed areas during operations relative to the 45-Year LOM phased construction and final footprint.

Perimeter surface water diversion channels will collect non-impacted runoff from areas up-gradient of the ultimate footprint of the proposed TSF and convey them around the TSF to Coyote Creek. The surface-water diversion channels will convey runoff to the north and south along the western side of the ultimate tailings footprint. The northern diversion channel will convey excess water from the existing stock pond north and then east along the TSF embankment to Coyote Creek. The southern diversion channel will collect runoff from areas south of the stock pond and convey it south and then east to Coyote Creek. To facilitate construction, the diversion channels will be a trapezoidal section with a 10-foot wide flat bottom and 3H:1V side slopes. The portions of the diversion channels that flow north and east along the footprint of the TSF have mild slopes and low velocities and channel revetment is not required. The portions of the diversion channels that flow east along the TSF embankment have steeper slopes and higher velocities and will require the use of riprap or a similar revetment layer to reduce the potential for scour and erosion.

Surface water runoff from direct precipitation within the lined TSF will be conveyed to the collection pond via the TSF toe drain system. Erosion control measures will be placed along the dry stack tailings out slope and elsewhere as required to prevent the erosion of the dry stack and TSF toe berm embankment material and reduce sediment transport into the collection pond.

18.2.7.3.3 Collection/Evaporation Pond

The TSF pre-feasibility design layouts include the use of collection ponds to manage contact water from the TSF in order to maintain a ‘zero discharge’ facility. The collection pond system described below is based on conservative assumptions including 100 percent runoff from the average monthly precipitation and reduced evaporation efficiency in average monthly evaporation estimates. The proposed system will be optimized during the feasibility design. The intent of this level of design is to demonstrate the feasibility of incorporating such a system for contact water management in place of treating contact waters prior to release from the property. Pending the final water balance of the Hydromet plant operations, contact water may be collected and returned to the plant for reuse to reduce fresh water demands, instead of being routed to evaporation ponds for dissipation from the TSF. The selection of a preferred contact-water management system in the TSF will be determined as the project is advanced. Either system (collection and reuse, or collection and evaporation) will allow operation of the TSF as a ‘zero discharge’ facility.

The collection pond(s) for the TSF will collect contact runoff water from the active areas of the TSF. Contact water is defined as precipitation that drains from, or over, un-reclaimed filtered tailings materials placed in the TSF. An initial pond will be constructed with sufficient capacity and surface area to store and evaporate runoff from the start-up facility, which will operate for about one year before operations expand into a larger area. The pond will be expanded again in Year 3 as the TSF is expanded and then in Year 7 to the final collection pond configuration required to provide capacity for the 45-year LOM TSF. Should the TSF expand beyond the 45-

year LOM TSF footprint, the pond area will be incorporated into the TSF grading plan and liner footprint and replaced with a new collection pond down-gradient of the TSF expansion. The conceptual pond layout and expansion sequence are shown on the drawings.

The collection pond will function as an evaporation pond, where inflows from the TSF from runoff and seepage approximately equal but do not exceed the potential evaporation from the pond(s) on an annual basis. The pre-feasibility-level design allows for operation and expansion plans for the TSF and assumes that no more than 35 acres of un-reclaimed areas will exist at any time within the TSF. A preliminary water balance indicates that an un-reclaimed area of about 35 acres will require a pond surface area of about 30 acres and an operating depth of about 2 feet to prevent accumulation of inflows. Based on the water balance simulations, a pond size of 30 acres will result in the pond drying up each fall, such that successive annual accumulations are cyclic and do not accumulate. In addition, the collection pond will have sufficient freeboard to store runoff from the 100-year, 24-hour design storm event. Dissipation of the contact water inflows to the collection pond will be by evaporation and reuse within the TSF for dust control.

18.2.7.4 TSF Operations

The Upton TSF is designed to operate as a dry stack facility and generally will include the following activities:

- Tailings transport, deposition, and management (including temporary cover placement as needed);
- TSF embankment and liner construction;
- On-going TSF maintenance and reclamation

The operations at the TSF must ensure the following:

- The basis of the design remains valid and design criteria are being achieved;
- Changes in tailings production are accounted for;
- Tailings geochemistry and physical properties are monitored and accounted for in the event of changes from initial design criteria and values;
- Tailings management and TSF construction planning takes into consideration the availability of construction materials and seasonal constraints.

A) General Description

It is proposed to transport the neutralized waste material from the Hydromet plant to the TSF using haul trucks. Waste blending and neutralization of the waste streams will occur at the Plant prior to transport to the TSF. Active disposal areas and reclamation of completed areas within the TSF will be accessed by means of a network of haul roads established within and around the TSF footprint. Tailings will be end-dumped and spread with a dozer. Compaction of the waste will occur through material settlement as well as truck and dozer traffic associated with waste placement.

The TSF will be developed in a progressive sequence beginning at the north end of the facility and expanded southward. Construction stages for the TSF starter facility, Year 3 facility, Year 8 facility, Year 16 facility and Year 45 (LOM) facility are presented on Figures 18.13 through 18.17, respectively. The main TSF embankment along the eastern side and the north and south abutment berms will buttress the waste for long-term stability and control contact water within the TSF limits. As the TSF expands both vertically and laterally, the TSF liner system will be expanded in a manner to create a continuous liner system in the TSF. Intermediate berms will be constructed along the southern and western limits of each stage of liner construction to facilitate liner connection, TSF expansions, provide toe support to the waste slope during placement of the waste, and minimize surface water run-on into the active TSF area from the area between the active area and the surface-water diversion ditch.

As part of the proposed liner system for the TSF, a 2- to 3-foot thick protective operations layer is included immediately over the geomembrane to protect against damage during placement of waste over the liner. No equipment will access the geomembrane liner directly and low ground pressure equipment will be used to place the protective cover material. Should high ground-pressure equipment be required to traverse over the operations layer prior to coverage with waste, the thickness of the operations layer soil in that traffic path should be increased by an additional 3 feet of material capable of supporting the vehicular loads.

Contact surface water runoff from active areas of the TSF will drain to collection pond(s) constructed down-gradient of the active area and within the TSF footprint. Sediment control from the active areas will be controlled as appropriate with silt fences, or other best management practices, with the collection pond being the final means to manage erosion from the active area of the TSF.

18.2.7.4.1 Tailings Transport and Deposition

The dewatered and neutralized tailings at the plant site will be loaded into haul trucks with a front-end loader and transported to the TSF. Based on an 8,000-foot average round-trip haul distance and a 15- to 20-minute cycle time, two 20-ton haul trucks should be sufficient for waste transport and deposition over the life of the facility, assuming operations during dayshift hours only.

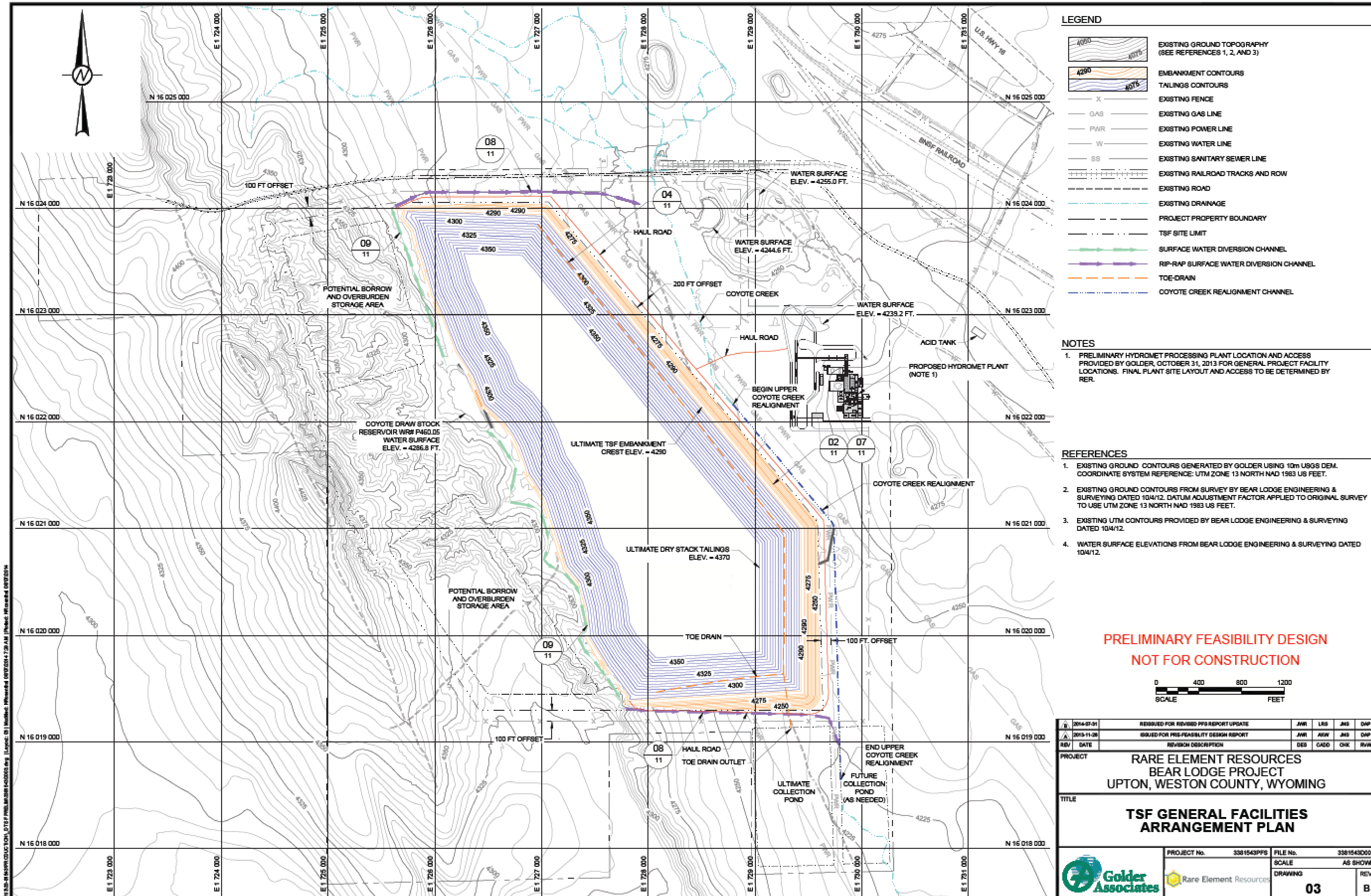
Deposition will generally be limited to an area commonly no more than 250 feet long extending either into the TSF area from the main embankment and progress southeastward or parallel to the TSF embankment alignment and progress southwestward. The tailings will be placed and spread in lifts about four to seven feet thick. In this way, the tailings dry stack will be developed using a bottom-up construction approach that will cover the active footprint area prior to expanding vertically by more than two or three lifts, pending detailed stacking plans. As the tailings pile rises vertically and horizontally to cover the lined area with at least one lift of material, tailings may be end-dumped near the crest of the working face and pushed outward. Temporary operational side slopes are estimated to be 3.5H:1V for operating stability purposes. The final design grade of permanent tailings slopes is estimated to be no steeper than 5H:1V.

18.2.7.4.2 TSF Cover

In order to minimize the potential for fugitive dust releases and/or erosion from runoff, active tailings deposition operations at the TSF (i.e., areas operationally prepared to receive tailings) will be limited to no more than 35 acres at any given time. Significant dust and/or particulate matter, originating from winds, vehicular traffic, and operational equipment, are not anticipated to be problematic due to the mineralogy and crystallization of the tailings from the Hydromet plant. Additionally, some degree of cementation is anticipated because of the neutralization of the tailings. Sections of the active area that remains dormant for more than 60 days will receive a 6-inch soil cover as needed to protect against wind and runoff erosion. This cover can remain in place when operations resume in the area.

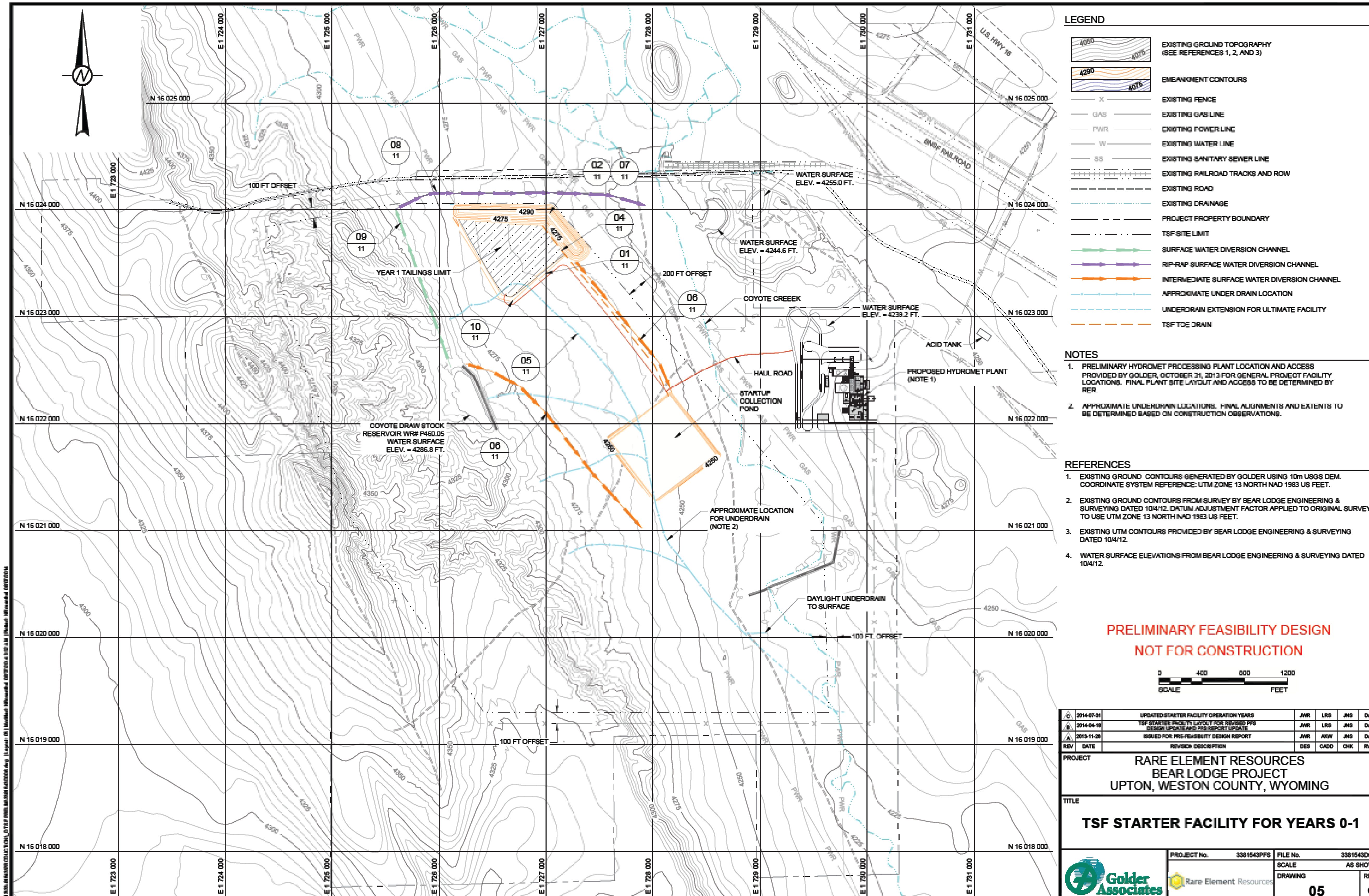
Once the TSF expands to the initial 35-acre active area, reclamation of completed areas will begin concurrently with the TSF expansion. The completed areas will be covered and reclaimed per guidelines in the LQD Non-coal Rules and Regulations and approved TSF permit conditions. Once initial reclamation catches up to the active TSF area, it is assumed that general TSF operations within the 35-acre active area will include up to 10 acres of ongoing reclamation.

Figure 18.12 - Drawing 03 TSF General Facilities Arrangement Plan



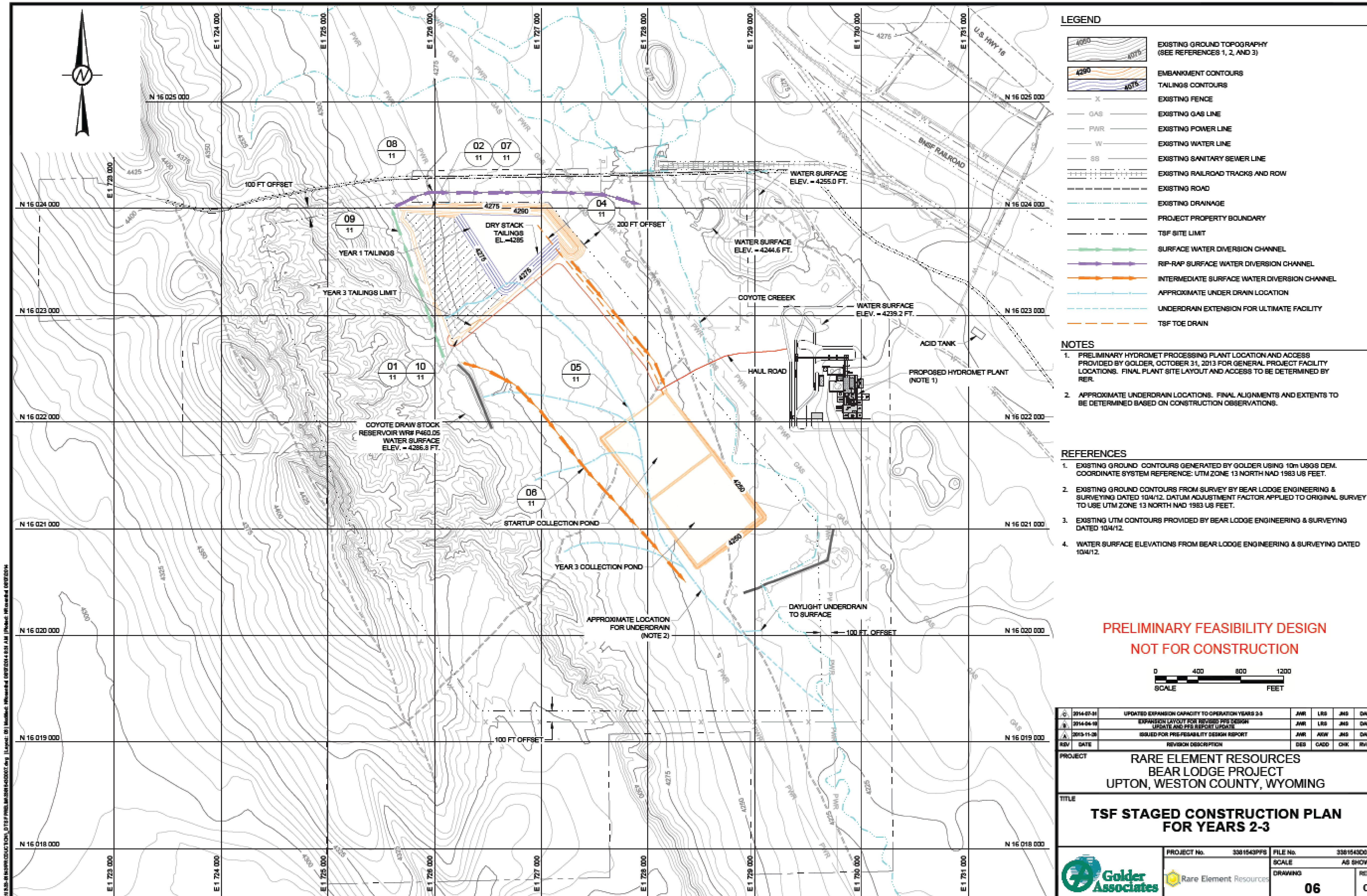
(Golder. 2014)

Figure 18.13 - Drawing 05 TSF Starter Facility for Years 0 – 1



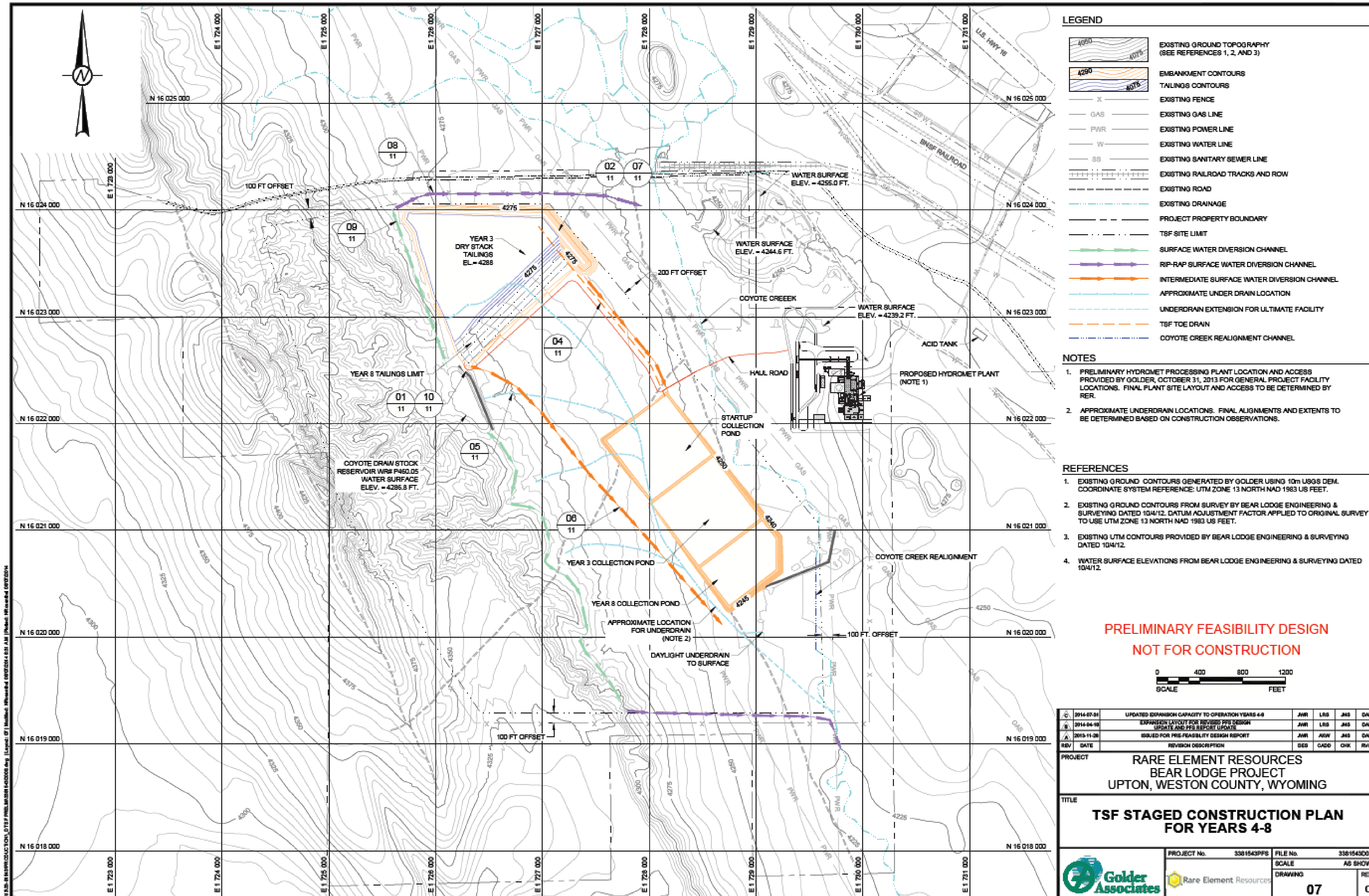
(Golder, 2014)

Figure 18.14 - Drawing 06 TSF Staged Construction Plan for Years 2 – 3



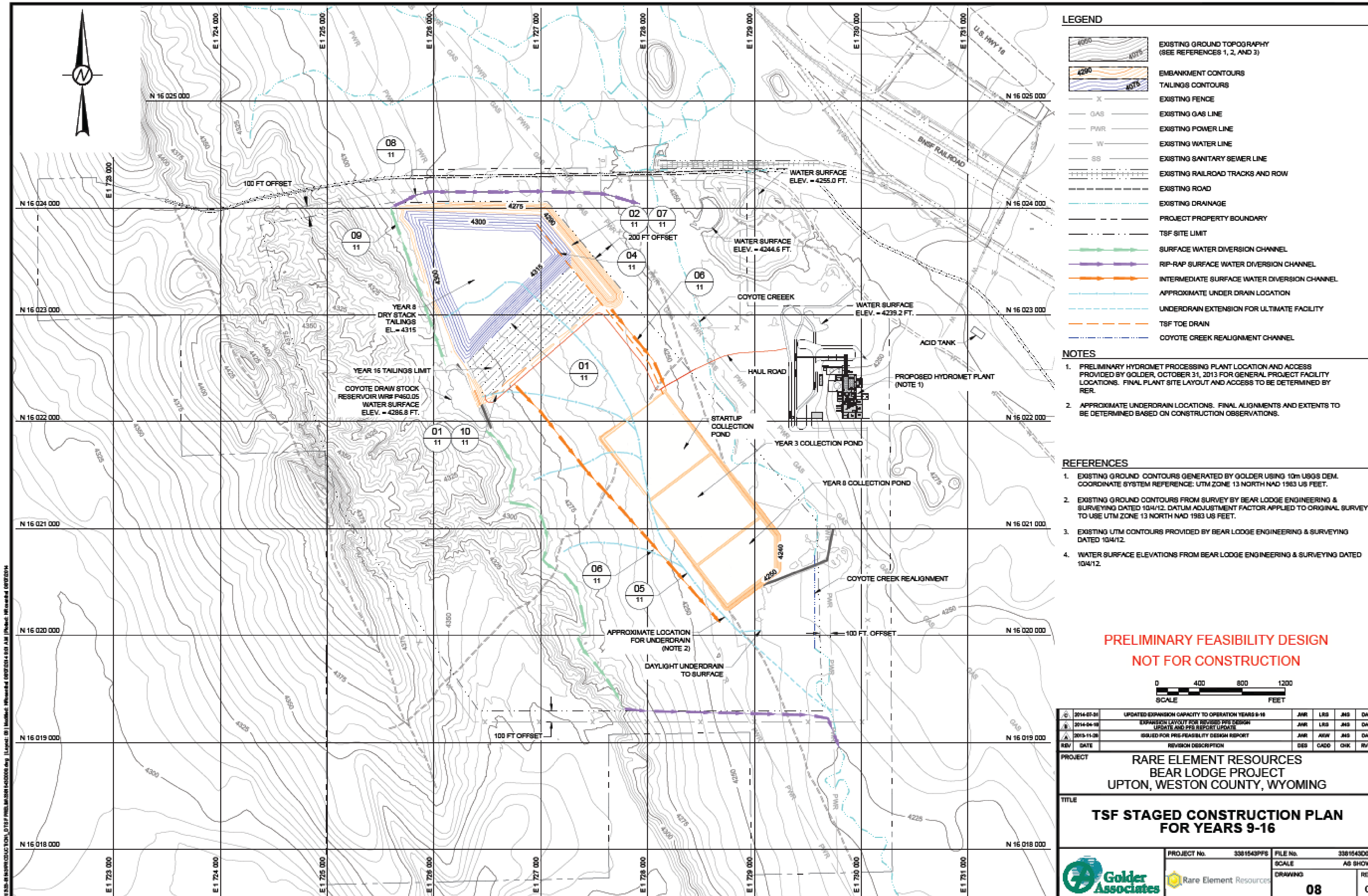
(Golder, 2014)

Figure 18.15 - Drawing 07 TSF Staged Construction Plan for Years 4 – 8



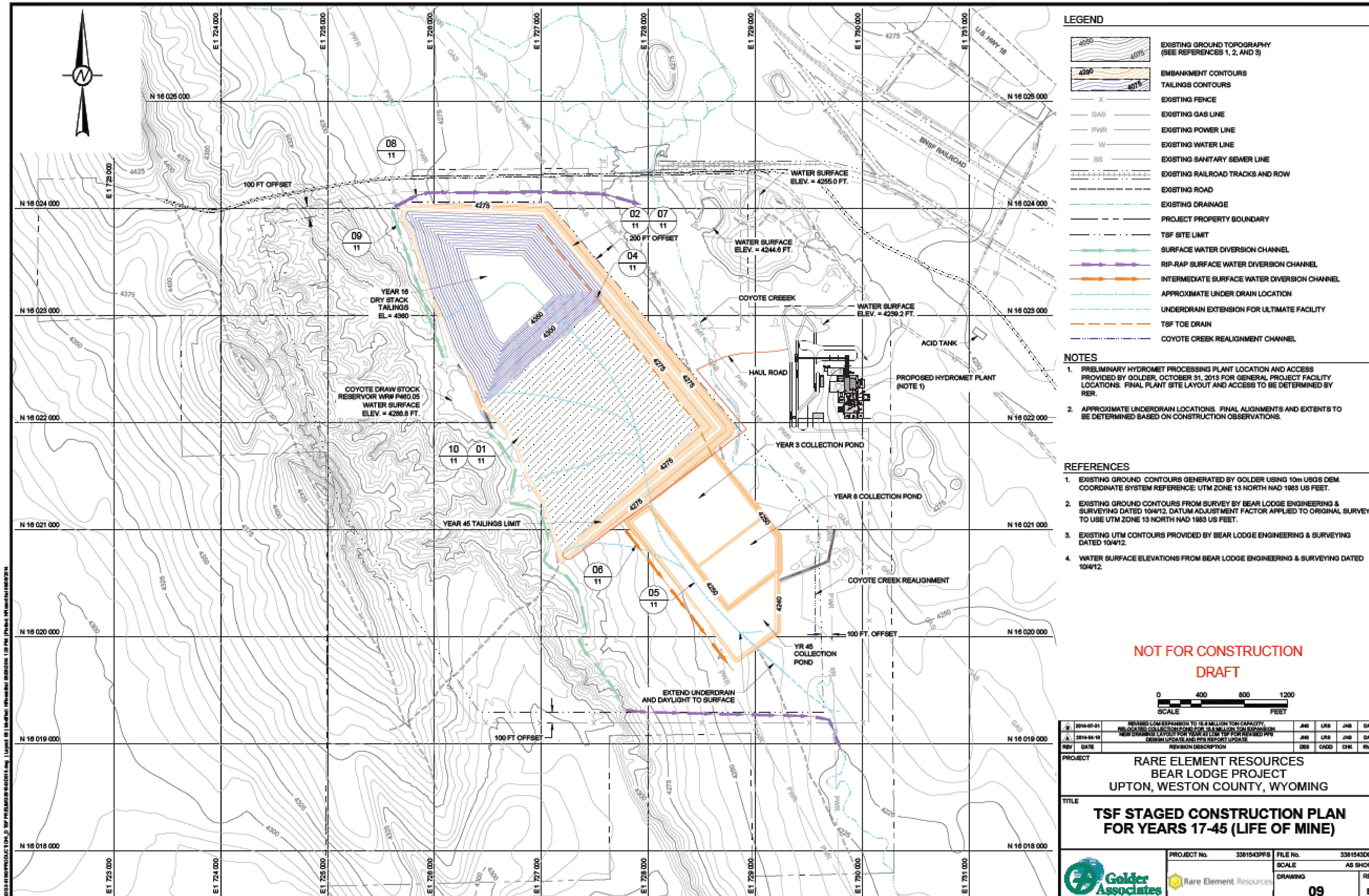
(Golder, 2014)

Figure 18.16 - Drawing 08 TSF Staged Construction Plan for Years 9 – 16



(Golder, 2014)

Figure 18.17 - Drawing 09 TSF Staged Construction Plan for Years 17 – 45 (Life of Mine)



(Golder, 2014)

19 Rare Earths Markets and Pricing

19.1 Overview

Since the dramatic decline from the extraordinary price spike in rare earths in 2010-11, supplies of rare earths are once again readily available, with prices seemingly overcorrected to the downside. Although it appears that the price spike encouraged some demand destruction from substitution and reduced consumption, rare earths still offer unique qualities for many uses that make them difficult to replace without sacrificing product performance or quality. Based on a consensus of industry experts, annual world demand for rare earths will likely grow in the range of 7%-10% for the next several years, assuming no new major downturn in the global economy.

According to most market sources, growth of the world's rare earth supplies will generally be sufficient to meet growing demand in the coming years. However, it is not clear that, at current RE prices and with the capital constraints faced by junior mining companies, the timing of new mine development will be such as to avoid periodic shortages of certain individual RE elements with attendant volatility in specific RE prices. The U.S. Departments of Defense and Energy cited several rare earth elements as "critical", including neodymium, dysprosium, europium, terbium and yttrium (all of which will be produced from the Bear Lodge project and which provide an average of approximately 49% of revenue). Several market observers (as well as US government reports) believe that neodymium and dysprosium, in particular, could face shortage situations over the next several years, unless additional sources of supply are developed.

A gradual upward trend in rare earth prices over the next several years is expected, rather than a return to the unsustainable price environment of 2010-11. This will likely be driven by several factors including:

- The incentive for several of the six major Chinese rare earth producers designated to consolidate the Chinese industry to show improved financial results;
- Falling Chinese ore grades causing increased operating costs in many operations;
- Pressure on Chinese rare earth mining companies to implement stricter environmental controls;
- Rapidly rising Chinese labor and safety costs;

- Government stockpiling of rare earths as strategic materials by countries including China, the U.S., and several European countries;
- Geopolitics, environmental considerations, remote locations, high capital costs, and limited access to capital, which could constrain new RE supply growth;
- The advent of secure rare earth supplies outside of China which could serve to increase efforts toward development of new applications for rare earths; and
- China becoming a net importer of certain rare earths within the next several years, due to the constraints noted above causing the Chinese RE industry to be unable to meet growing demand.

19.2 Supply

The estimated growth of annual global rare earth production over the past 30 years has averaged 5% per annum, with the bulk of this increase driven by China's expansion of domestic mine production. Most non-Chinese mine production of rare earths was shut down during this same timeframe, leaving the Chinese to dominate global RE supply over the past decade or more. Chinese deposits produced an estimated 90,000 tonnes of total RE in 2013, or approximately 86% of global mine production. China produces an even greater proportion of the world's heavy rare earths.

Stockpiles and a limited amount of recycling also contribute small amounts of supply to the global rare earths market. Stockpiling is a market phenomenon which affects apparent supply, but about which there is virtually no information available. From various market reports, it appears that stockpiles built up during the extraordinary 2010-11 spike in RE prices have reduced apparent demand since that time and contributed to the recent downward overcorrection in prices. Some market sources believe that stockpiled supplies are still an important factor in keeping rare earth prices depressed, but that these might be largely depleted sometime in 2015.

Because rare earths are typically used in small quantities and often alloyed within components that make up only a portion of the mass of larger products (e.g., they are key elements to allow for miniaturization of products), recovery of rare earth materials by recycling tends to be costly, inefficient and complex. It is estimated that only about 2% of rare earths used globally are recycled, so recycling provides a very limited source of supply.

19.2.1 China

China's rare earth industry is undergoing a number of significant changes and will likely continue its transformation over the next several years. To increase its control over the industry and pricing, in January 2014, the Chinese government announced a plan to consolidate the industry into six designated state-owned companies. The six companies, with substantially larger financial and mineral resources than many smaller Chinese rare earths producers, are expected to contribute to reducing illegal mining and environmental degradation. The larger enterprises will also be better able to absorb the continually escalating costs of labor, safety and environmental protection that are expected to have an impact on the Chinese rare earth industry. These larger enterprises should have the resources to mitigate the impact of falling ore grades that may affect many Chinese rare earth mining operations.

Chinese rare earth production growth should be rather modest for the next several years, as the six major Chinese rare earths companies focus resources on regional industry consolidation and deal with rapidly escalating costs for labor, safety and environmental protection. These companies' relatively poor recent financial results might also constrain capital available for expansion of their operations. Other potentially limiting factors include declining ore grades, other government attempts to control illegal mining, and the reported overcapacity in certain segments of China's rare earth supply chain.

19.2.2 Rest of World

Non-Chinese mine production of rare earths has revived over the past two years with the start-up of Lynas Corporation's Mt. Weld Mine in Australia and the LAMP processing plant in Malaysia, and the restart of Molycorp's mining and processing operation at Mountain Pass, California. Both projects have encountered significant ramp-up problems that are constraining production to well below designed capacity, but both are expecting to reach their nominal first phase production capacity (of approximately 19,050 tonnes of rare earth oxides (REOs) for Molycorp and 11,000 tonnes of REOs for Lynas) within the next year. Both projects are producers of predominantly light rare earths and are expected to be able to produce a majority of the non-Chinese world's demand for cerium, lanthanum and the magnet materials neodymium and praseodymium when they reach full production. However, with magnet materials expected to be the fastest growing segment of the rare earths market for the next several years and with China expected to become a net importer of certain rare earths in the second half of the decade, most industry sources believe that there is room for additional non-Chinese projects in the space, particularly those more weighted in the critical rare earths more susceptible to supply disruption. There is limited production of rare earths reported from a few other countries in the world, including Brazil, India, Russia and Vietnam.

There are many other rare earths prospects in the world that are reported to be moving toward development and production, but in the current constrained capital market for junior mining companies, and with the low rare earth pricing environment, it is hard to predict how many of these projects will reach operation. The successful developments will likely be determined by several of the following factors:

- Project sponsors' abilities to attract off-take customers willing to support development with long-term purchase commitments at floor prices;
- Proven processing capability to include thorium removal, and firm contractual arrangements for elemental separation of rare earths;
- Concrete plans and licensing, if necessary, to separate, handle and dispose of radionuclides (i.e., thorium and uranium) safely; and
- Potential explicit or implicit governmental support to assure the development and maintenance of a total supply chain for rare earths outside of China;
- The impact of geopolitical factors or very remote locations for most of these projects.

19.3 Demand

Demand for rare earths is driven by applications that rely on the unique magnetic, phosphorescent and catalytic characteristics of these elements. These materials have been called the "seeds of modern technology" by the Japanese and find many of their uses in consumer and specialized high-technology applications, including hybrid and electric cars, cellphones, wind turbines, energy-efficient lighting, speakers, lasers, medical imaging and other medical devices and high-tech defense applications. According to the Industrial Minerals Company of Australia (IMCOA), a well-known non-Chinese source of rare earths statistics and information, global demand for rare earths in 2013 was 115,000 tonnes with China accounting for approximately two-thirds (77,500 tonnes) of that. The balance of demand was estimated to come from Japan and NE Asia (mainly South Korea) – 16,000 tonnes, or 14%; the United States – 15,250 tonnes, or 13%; and Western Europe and other regions – 6,250 tonnes, or 5%. With the continuing rapid evolution of technology and the anticipated growth of the so-called "green economy", estimates for global rare earths demand growth are generally robust with consensus estimates in the 7%-10% per annum range.

Magnets – Rare earth magnets are generally considered to be the fastest growing segment of the market for rare earths with the elements neodymium, praseodymium, dysprosium, terbium and samarium being the most commonly used. Rare earth permanent magnets generate a particularly strong and consistent magnetic field relative to their size and, therefore, have been an important enabling technology for electronic miniaturization and for recent generations of particularly powerful electric motors. Use of rare earths in a magnet's formulation also generally enhances its resistance to de-magnetization. In many ways, permanent magnets and their design and fabrication are still an emerging technology, and several market sources suggest that the availability of more magnet materials from non-Chinese sources could actually drive demand and increase applications that use rare earth magnets ("supply-push" demand growth instead of the usual "demand-pull" growth).

The most common rare earth magnets are neodymium-iron-boron (NdFeB) magnets and samarium-cobalt (SmCo) magnets. Dysprosium and terbium are used mostly in NdFeB magnets to enable the use of these magnets in higher temperature applications. SmCo magnets are often used in applications where the magnets must be able to resist de-magnetization even when hit with strong electromagnetic pulses from outside sources. These magnets enable specialized defense applications.

A typical alloy composition (by weight) for a NdFeB magnet is approximately 29% Nd, 66% Fe, 1% B, 3% Dy, 0.75% Nb, and 0.25% Al. A typical SmCo alloy composition is 35% Sm, 60% Co, with Fe and Cu making up the remaining 5%.

Historically, the largest use of NdFeB magnets was in computer disk drives. As this technology gives way to solid-state data storage in personal computers and as alternative energy increases its share of global electrical power generation, it is thought that the largest future application will likely come from use of these magnets in wind turbines.

Many market sources predict that the most rapid growth in rare earth consumption will be in the magnet sector with most forecasts in the 8-10% per annum range between now and 2020.

Phosphors – Demand for rare earth phosphors, including europium, terbium and yttrium, has been driven mainly by the trend toward more energy-efficient lighting, particularly fluorescent lighting, and by the growth in worldwide demand for flat-screen televisions and other devices using glass screens. There is a widespread expectation that demand growth for rare earth phosphors will slow as use of fluorescent and compact fluorescent lighting is replaced by light-emitting diode (LED) lighting technology. LED lights still use rare earths, but only about a tenth of the amount used in fluorescent bulbs/tubes to generate the same amount of light. However, this declining trend may be slowed by the continued use of fluorescent lights in commercial lighting applications, the growing use of LEDs and by continued urbanization and the growing middle class in developing economies that drive increased demand for lighting overall. Consensus estimates for growth in rare earths consumption in phosphors seem to be in the 2%-3% per annum range over the next several years.

Catalysts – Rare earths are used in fluid cracking catalysts (FCC) for the petroleum refining industry (mainly lanthanum) and in auto emissions catalysts (primarily cerium) used by automakers in catalytic converters. Rare earths in FCC applications increase the hydrothermal stability of the catalyst and allow the catalyst to maintain its catalytic properties at high operating temperatures. In doing so, rare earths in FCCs also enhance the gasoline yield from a barrel of crude oil. As refineries process heavier and more sour crude oils, the need for catalysts should increase. Catalyst demand will also naturally increase with the number of gasoline-powered cars on the road, both for auto emissions catalysts in converters and for FCC use in refining the fuel to power the cars. With the Chinese now buying more cars each year than Americans, and as the middle class grows there and in other developing nations, annual catalyst demand for rare earths is expected to grow in the 5%-7% range over the next several years.

Other markets – There are many other markets for rare earths including metal alloys (mainly for battery applications, steel and aluminum alloys, and fuel cells), ceramics, glass and polishing powders, lasers, and medical applications. As additional secure, non-Chinese supplies of rare earths become available and technology continues to advance, particularly in consumer applications, it is widely expected that demand growth for rare earths in other markets will provide a significant boost to annual global RE demand.

19.4 Prices

As demonstrated above, the rare earths industry is dominated by Chinese producers and consumers with virtually all sales and purchases of rare earths products based on contract prices negotiated privately by buyers and sellers. There are a few relatively well-known sources of published estimated prices that are based on surveys of market participants by the websites or organizations that publish them. These include metal-pages.com, asianmetal.com and "Industrial Minerals" magazine. However, prices for individual RE elements among these sources can differ markedly even in the same timeframe and, according to some market participants, prices for actual market transactions in rare earths sometimes differ significantly from the prices quoted by these sources.

There are some specialized consulting firms in rare earths or industrial minerals that perform market studies in the rare earths business and create rare earths price forecasts for clients based on the individual project's rare earths distribution and intended products. These organizations tend to use conventional mineral economics approaches to forecasting, based on historical experience in the rare earths markets and the limited information available. Such studies and forecasts are hindered by the lack of information in rare earths markets that lack the transparency found in many other markets for the more common mineral commodities. The relatively recent start-up of newly created rare earths exchanges in China provides extremely limited data on exchange trades of certain physical RE metals, but there still is no futures market or forward price curve for rare earths that could inform RE price forecasting.

Given the opaque nature of much of the rare earths market and the limitations of the pricing methodologies noted above, Rare Element took an empirical approach to the assumed rare earths pricing for this preliminary feasibility study. Each month, China releases customs statistics on its exports that disclose the volumes in kilograms or metric tonnes of most individual rare earth oxides exported in a prior month, as well as the U.S. dollar value of those exports. The aggregated statistics do not give the level of detail to allow determination of various purities of oxides that might be included in those exports, but at least these statistics purport to be based on actual market transactions. Though the statistics are imperfect, they are one of the few available sources of empirical data on rare earth pricing from actual transactions.

As shown in Table 19.1, Rare Element has derived U.S. dollar prices per kilogram for individual rare earth elements from the published Chinese customs statistics and compiled a monthly time series of these prices for more than two years for most of the rare earth elements significant to the Bear Lodge Project. To eliminate any effects of price seasonality, the assumed prices for rare earth oxides used in this study to estimate the market price for Bear Lodge production are a trailing twelve months' ("TTM") average of export values for the individual oxides, based on reported Chinese customs data through June 2014. Because of the lack of available customs data for gadolinium oxide and samarium oxide, the preliminary feasibility study used spot prices FOB China from early July, 2014, as published on the metal-pages.com website for these materials.

The Company made a few downward adjustments to the TTM export values published in Chinese customs statistics to establish its assumed RE oxide prices for cerium, dysprosium, europium, and praseodymium, to account for recent market price weakness. Discounts of 45%, 10%, and 15% were applied to the TTM export values of cerium, europium and praseodymium, respectively. The large discount applied to the cerium value also reflects the widely held market expectation of an extended period of global oversupply of the material as Molycorp and Lynas Corporation ramp up to their designed production capacity, although this could be partially offset by the company's concerted efforts to grow demand for new applications.

For dysprosium, (Dy) seasonal 3-month spikes in the volume of export demand for dysprosium oxide from China have occurred in two of the past three years and driven reported Dy export values in those months to more than US$2,000 per kilogram. Therefore, Rare Element Resources discounted the TTM average export value for Dy oxide by 66.67% (1) to further mitigate the impact of this apparent seasonal demand, (2) to account for expected reduced demand for the material which has been a target of substitution in some RE permanent magnets, and (3) to reflect the potential impact of additional Dy becoming available as more non-Chinese sources of Dy are developed over the next several years.

Once the estimated prices for the individual rare earth oxides that make up Rare Element's very pure (97+% TREO) mixed REO concentrate were established, the Company pro-rated the value, based on the distribution of the expected recovered rare earth elements, normalized to 1,000 grams (i.e., one kilogram), to calculate a "basket price" for the material. Then, to recognize that the mixed REO material would still have to undergo separation into individual rare earth oxides before those prices could be obtained, the Company assumed an estimated 25% discount to reflect the cost of separation. The 25% discount was based upon a survey of various market sources whose estimates ranged from 20%-30%, and it also reflects the lack of impurities in Rare Element's high-purity concentrate product.

The reasonableness of the assumed level of the discount was further checked in several ways. First, the Company calculated a blended tolling charge, based on reported tolling charges in the RE market of $5.00/kg for light rare earth concentrates and $20-$25/kg for heavy rare earth concentrates. Based on the Company's rare earth distribution, this blended charge was estimated to be approximately $5.50-$5.70/kg. Second, metal-pages.com regularly quotes the price of only one concentrate in its market price survey, that of a cerium carbonate concentrate with a total REO content of 45%. Despite the much higher purity of Rare Element's concentrate relative to RE oxides, the quoted FOB China export prices for cerium carbonate concentrate were compared to the quoted FOB China export prices for cerium oxide (99% minimum purity) over the past two plus years through June 2014. The average differential between concentrate and oxide over this time period was 25.2%.

The third method used to check the validity of the discount assumption was to use the empirical data from recent financial results published by Molycorp, Inc. and Lynas Corporation, both of which produce rare earth products from minerals similar to those found at Rare Element's Bear Lodge Project. Although the rare earth distribution in each deposit is different, there are some similarities in the relative make-up of rare earths in these companies' projects that make them somewhat comparable to Bear Lodge. Molycorp has published segment information that is more useful than the overall "average selling price" (ASP) that Lynas discloses for its production. Lynas's ASP for the second half of 2013 was US$21.90 per kilogram, as reported in their financial statements.

Relative to Molycorp's disclosures, it is expected that the 97+% TREO concentrate produced at Bear Lodge should attract a market value somewhere between the 55%-60% TREO concentrate produced from Molycorp's Mountain Pass mine in California ($15.43 average price for the 7 quarters ended 6/30/14) and the average value per kilogram received by their Chemicals and Oxides segment ($31.66 average for the past 7 quarters) for more pure, upgraded material (heavily weighted toward cerium and lanthanum). For the trailing seven quarters ending June 30, 2014, the mean average value per kilogram of material sold from Mountain Pass and from the Chemicals and Oxide business segment was US$23.54. Again, based on empirical data, the assumed and Bear Lodge's more favorable mix of critical rare earths, market price for Bear Lodge production of US$24.60 appears reasonable.

The final perspective on pricing is based upon the behavior of markets broadly, not just the market for rare earths. It has been observed historically in many commodity and financial markets that prices which spike upward to unsustainable levels for whatever the reason are often followed by price declines which overcorrect to the downside and are often equally unsustainable. Thus, the following market factors are observed:

- Several of the six major Chinese rare earth producers designated to consolidate the Chinese industry are reporting poor financial results;
- Chinese companies are under significant pressure to implement stricter environmental and safety controls on their operations, and Chinese labor cost increases have been averaging 12%-15% per annum over the past few years. One market observer estimates that the cost of environmental compliance alone could require rare earth prices 20% higher than current levels;
- Ore grades for rare earths mined by many Chinese mining companies are declining, a phenomenon faced by producers of many mineral commodities;
- The Chinese government has announced purchase prices for a domestic stockpiling program of certain rare earths that could reduce available supplies. The premiums to current market prices vary by element, but reports indicate that the Chinese government is expecting to pay an overall premium of approximately 10% above current prices;
- Demand growth projections indicate that China, which currently consumes approximately two-thirds of the global rare earths supply, may be a net importer of many rare earths by 2020;
- Geopolitical considerations, increasing environmental regulations, permitting delays, remote locations, and high capital requirements for many potential new rare earth projects may serve to limit new supply; and
- Research and development efforts for new uses of rare earths are expected to accelerate, driven in part by manufacturers having access to secure, non-Chinese rare earth sources, like the Bear Lodge Project.

The use of rare earths prices from the past year appears to be a reasonable approach to pricing the Bear Lodge product. In fact, if it is correct that current RE prices reflect a market overcorrection; the prices might prove to be conservative.

The pricing used for rare earths in evaluating the economics of the Bear Lodge Project are shown in table 19.1 below:

Table 19.1 - TREO Product Pricing Used in PFS

Based on average LOM Project Output

Element	Recovered Distribution / Kg TREO (g/kg)*	Adjusted TTM Export Value / kg	Value / kg
Neodymium (Nd)	182	$71.26	12.97
Europium (Eu)**	7	$948.23	6.64
Praseodymium (Pr)**	50	$96.97	4.85
Dysprosium (Dy)**	4	$654.87	2.62
Lanthanum (La)	283	$6.77	1.91
Cerium (Ce)**	416	$4.54	1.89
Terbium (Tb)	1	$745.32	0.75
Gadolinium (Gd)	16	$46.50	0.74
Yttrium (Y)	10	$22.14	0.22
Samarium (Sm)	30	$5.50	0.17
Erbium (Er)	1	$50.36	0.05
	1,000 g	**Price / kilogram**	**$32.81**
After Discount 25%			**$24.60**

**Reflects concentrate grade, adjusted for anticipated recoveries and is based on a discounted basket price of $24.60/kg. Resources, reserves and economics were all calculated using a $24.60/kg basket price; however, elemental distribution and prices vary between resource models and the PFS economic model. Excludes ytterbium, holmium, thulium lutetium and scandium that occur in negligible amounts and were not considered in the calculation of a basket price.*

***Adjusted downward to reflect current market conditions*

(Rare Element, 2014)

It should be noted that the $24.60/kg discounted basket price shown above was used in the Bear Lodge economic model and is calculated using different RE prices for individual elements and an updated distribution of RE elements recovered, based on additional metallurgical testwork since the June 30, 2014 resource and reserve calculations (which used TTM export prices through April, 2014). The prices of certain RE elements were revised downward significantly to take into account continuing weak RE market conditions. For details of the $24.60 basket price used to calculate reserves and resources, see Chapter 15 of this report.

19.5 Contracts

Rare Element has not yet entered into contracts for the sale of rare earth concentrate or other products. However, the Company is engaged in multiple discussions with potential customers and/or strategic alliance partners. The Company has produced a quantity of its highly pure, mixed RE oxide concentrate as product samples during pilot plant test programs, and several parties have received this material for testing (mostly refiners with REE separation plants). This has elicited favorable responses with respect to the quality and grade of the concentrate. The Company is continuing its efforts to negotiate contractual arrangements with prospective off-takers and/or partners with the goal of putting these in place prior to project construction.

20 Environmental Studies, Permitting and Social or Community Impacts

20.1 Introduction

Rare Element will be required to obtain approvals and permits to operate the Bull Hill Mine and the Hydromet plant and tailings storage facility from the United States Forest Service (USFS) and the Wyoming Department of Environmental Quality (WDEQ), which includes air and water quality. In addition, a source materials possession license will be required from the United States Nuclear Regulatory Commission (NRC). In accordance with Rare Element's Environmental, Health, and Safety Policy, Rare Element will comply with applicable federal and state environmental statutes, standards, regulations, and guidelines in the permitting of the Bull Hill Mine and Hydromet plant/tailings storage facility (TSF). Environmental baseline studies were initiated in 2011 at both the mine and plant locations and are continuing in order to meet the federal and state permit requirements.

The approval to mine on USFS land will be a major federal action that is triggered because of the proposed mine's effects on the quality of the human environment in the project area. The approval process requires the preparation of an environmental impact statement (EIS) under the National Environmental Policy Act (NEPA), Council of Environmental Quality (CEQ) guidelines, and USFS NEPA procedures. The NRC will assess the environmental impacts of the Hydromet plant/TSF under their NEPA requirements.

The primary path of permitting is through the NEPA process that includes public scoping, identification of issues, alternative selection and impact analysis documented in the draft and final EIS. The results of the NEPA process will be documented in the Record of Decision issued by the USFS. There is a high degree of cooperation between the agencies taking part in the NEPA process that include the US Army Corps of Engineers, National Park Service, State of Wyoming regulatory agencies, and Weston and Crook County governments. These agencies conference weekly to discuss issues and receive updates on the progress of the EIS. Following the issuance of the Record of Decision, Wyoming DEQ permits will be issued.

The following sections provide more detailed information on the USFS Plan of Operations, the ongoing NEPA process, the ongoing baseline environmental monitoring program, WDEQ permit and NRC license requirements.

20.2 USFS Plan of Operations

A Plan of Operations for Mining Activities on National Forest Service System Lands (Plan of Operations) was submitted to the Black Hills National Forest, Bear Lodge Ranger District in Sundance, Wyoming in early 2012 and was accepted by the USFS as complete in May 2013. Minor updates were incorporated into the Plan of Operations and accepted by the USFS accordingly in February 2014. Since then, the USFS has selected a Project Manager and prime contractor for the preparation of the EIS.

The Plan of Operations includes a detailed description of the mine operations, including equipment specifications, sizes, capacity, and use frequency, as well as facility layouts for the pit, waste rock disposal, physical upgrade plant, low-grade ore storage, powder magazine, site access roads, electrical transmission lines, maintenance buildings, fuel storage, and sanitation facilities, such as raw water well and water conveyance system components.

In addition to the facilities located on USFS land, the Hydrometallurgical plant and TSF located in Upton, Wyoming are also addressed in the Plan of Operation since the operation of these facilities is connected to the Bull Hill Mine operations.

The ore from the Bull Hill Mine contains small quantities of uranium and thorium. The current beneficiation and tailings disposal methods will result in a low radionuclide level. A source materials license to possess low radionuclide levels (>0.05% U+Th) will be required from the NRC.

Environmental protection measures that will be implemented to mitigate impacts to air quality, surface and ground water, scenic values, social, fish and wildlife, vegetation, soils, and cultural resources during project operations are addressed in the Plan of Operations. Rare Element will assure that environmental resources are protected through the construction of engineered water diversion and erosion control structures, implementation of dust control measures, and the development of a contingency plan to address spills and hazardous substance emergencies. Routine environmental monitoring of air and water resources will provide first indication of changes in background conditions during mining and plant operations. Mitigation to cultural resources will be addressed through the identification of resources during ongoing archaeological surveys and coordination with the Wyoming State Historical Preservation Office. The identification of Traditional Cultural Properties is being addressed between the USFS and the tribal historical preservation offices through formal consultation processes as mandated by law.

A reclamation plan describing the final design standards and layouts for the permanent closure of mine and plant facilities has been prepared as part of the Plan of Operations. The reclamation plan also includes a final surface-grading plan defining post-mining topography and post-operation monitoring and site maintenance. The amount of the surety bond to cover the cost of reclamation will be determined according to WDEQ and USFS requirements, and unit costs have been included in the Plan of Operations.

20.3 NEPA/EIS Record of Decision

The USFS accepted the Plan of Operations as technically complete in May 2013 and triggered a NEPA review that requires the preparation of an environmental impact statement with the USFS as the lead agency. Rare Element has entered into a Memorandum of Understanding (MOU) with the USFS to prepare a Third Party EIS using an outside contractor (Tetra Tech) with no conflicts of interest. The MOU defines the roles of the USFS and Rare Element in the preparation of the EIS and requires a professional services agreement between Rare Element and the Third Party EIS contractor, a disclosure statement of no conflicts of interest from the EIS contractor, and a schedule for the completion of the EIS.

The USFS has selected a Project Manager and prime contractor for preparation of the EIS, published notice in the Federal Register and completed necessary scoping work. The USFS is currently working on the evaluation of the public comments, identification of alternatives and preparation of the draft EIS. The US Army Corps of Engineers (USACE), the National Park Service, and the appropriate state and local government agencies are involved in the EIS process as cooperating agencies. The schedule, as distributed by the USFS in its scoping documents, shows the completion of the draft EIS in the first quarter of 2015 and the final EIS by mid-2015. The culmination of the EIS process, following other federal agency and public review and comment, may result in a Record of Decision and subsequent approval of the Plan of Operations by the USFS which is currently expected in the fourth quarter of 2015.

20.4 US Army Corps of Engineers Permits

Rare Element will submit a Section 404 permit application to the USACE for the mining activities at the Bull Hill site. The USACE regulates the placement of dredged and fill material into waters of the United States in accordance with Section 404 of the Clean Water Act (33 U.S.C 1344).

Rare Element has prepared an Aquatic Resources Inventory for both the Bull Hill mine site and the Upton Hydrometallurgical plant site and requested a jurisdictional determination from the USACE. In December 2013, the USACE determined that Coyote Creek near Upton Hydrometallurgical plant location does not meet the standard and therefore will not require a permit. The USACE is still evaluating the Bull Hill mine site and a jurisdictional decision is expected in the second half of 2014.

20.5 United States Nuclear Regulatory Commission

The Nuclear Regulatory Commission (NRC) regulates radioactive materials subject to the Atomic Energy Act (AEA) as amended. This includes source, by-product, and special nuclear material. Of these three types of radioactive material, only source material could potentially apply to the Bear Lodge Project. The NRC defines source material in 10 Code of Federal Regulations (CFR) 40 as follows:

Source Material means: (1) uranium or thorium, or any combination thereof, in any physical or chemical form or (2) ores which contain by weight one-twentieth of one percent (0.05%) or more of: (i) uranium, (ii) thorium or (iii) any combination thereof. Source material does not include special nuclear material.

The NRC excludes from regulation source material in “unrefined or unprocessed ore” and “in any chemical mixture, compound, solution, or alloys in which the source material is by weight less than 0.05 percent of the mixture, compound, solution or alloy”. Based on this definition and exclusion, the Bull Hill unprocessed ore is not subject to NRC regulation. Pre-concentrates produced at the PUG and some waste streams from the Hydromet will meet the NRC’s definition of source material and therefore, will require a radioactive materials possession license.

Rare Element intends to submit a radioactive materials license application to the NRC consistent with the guidelines contained in NUREG-1556 Volume 12 “Program-Specific Guidance About Possession Licenses for Manufacturing and Distribution” and the requirements in 10 CFR 40. Accompanying this application will be an environmental report consistent with the guidelines contained in NUREG-1748, Environmental Review Guidance for Licensing Actions Associated with NMSS Programs” and the requirements in US Code of Regulations, 10 CFR 51.

The license application and environmental report will be submitted to the NRC in the second half of 2014. The environmental report will be used to evaluate impacts following NRC’s environmental review NEPA process.

20.6 Wyoming Department of Environmental Quality Permits

The Wyoming Department of Environmental Quality (WDEQ), Land Quality Division (LQD) in Sheridan, Wyoming is the responsible agency for the issuance of the state mining permit. The permit application will include both the Bull Hill Mine and the Upton Hydromet Plant/TSF under one mining permit. The application will consist of detailed information describing the mineable resource, adjudication of the lands in the proposed permit area, mine overburden (waste rock), topsoil, subsoil, surface waters, groundwater hydrology, water rights, cultural resources, mining plan, and a detailed reclamation plan, including costs for bonding based on post-mining topography and final land use. The WDEQ defers to the NRC on radiological impact analysis and licensing of source material.

Rare Element has initiated the pre-operational baseline environmental studies required under LQD mine permitting rules and regulations. The current baseline program follows LQD guidelines and includes an active network of 39 groundwater monitoring wells, 7 surface water gauging stations, numerous seeps and springs, 4 air monitoring stations and 1 meteorological station. Initial surveys to describe baseline soils, vegetation, wetlands, and wildlife were initiated in 2011 and will continue until the issuance of the permit. No endangered or threatened plant or wildlife species have been identified at either the mine or plant locations. Archaeological surveys were completed within the permit area to identify potential cultural resources eligible for listing on the National Register of Historic Places. The permit application is expected to be submitted to LQD in the fourth quarter of 2014.

Since construction of the mine facilities and Upton Plant/TSF will exceed the current monetary threshold trigger, an Industrial Siting Permit will be required under the Rules and Regulations of the Wyoming Industrial Siting Council. The permit application will include an evaluation of social and economic conditions and impacts, environmental impact analysis, assessment of public infrastructure and educational, health, police, fire, and transportation services. Site baseline environmental studies will be provided to meet permitting requirements. The Industrial Siting Permit will be issued for the life of the plant and TSF.

WDEQ permits from the Air Quality Division and Water Quality Division will be required for the Bull Hill Mine and Upton Plant/TSF operations. Data requirements for these permits are in progress and permit applications will be submitted prior to start-up.

21 Capital and Operating Cost

21.1 Initial Capital Cost Estimate

21.1.1 Basis of Estimate

21.1.1.1 Methodology

The estimate development methodology is based on major equipment supply cost factored to installed equipment cost. The estimate also includes building and construction costs estimated for the selected site using building specifications developed during the study. Indirect costs have been factored based on the direct costs and have magnitudes selected to account for the characteristics of the project. The major equipment items have been identified from the engineering component of the study and an equipment list developed. Where possible, budget pricing for major cost items has been obtained from vendors based on preliminary specifications developed during engineering. Alternatively, where recent and relevant project data enable an item to be estimated, it may be based on that information. When neither is possible, such as in equipment or infrastructure that will require design and fabrication, preliminary estimates of unit dimensions, material of construction and material quantities have been used, concurrently taking into account the nature and complexity of the equipment. When none of the above was available, allowances were assigned based on the experience and judgment of the engineers and estimators involved in the project. Some elements of the capital cost estimate were supplied by sub-contractors of Rare Element and have been included in the cost estimated by the sub-contractors.

These elements are:

- Access roads
- The Mine facilities and mining equipment
- The electrical power lines to the Mine site
- The electrical power lines to the Hydromet site
- The Tailings Storage Facility
- Mine closure costs
- Hydromet site closure costs
- Mine pre-strip costs

21.1.1.2 Accuracy

The highest proportion of the direct costs is based on budget pricing with the remaining costs based approximately equally on quantities and allowances, determined from engineering performed during the study. Budget pricing means that a budget equipment price is factored to an estimated installed cost. It does not mean a budget price was necessarily provided for the installed equipment cost.

This study has completed the necessary amount of engineering required for a pre-feasibility engineering phase, and as a result, the accuracy of the estimate provided is ± 25%.

21.1.1.3 Estimate Structure

Direct costs are conventionally structured in columns with line-item costs divided into equipment, material and labor. The unit costs and rates are shown for bulk material, man-hours, area, etc. The estimate is divided by areas. Within each area, sub-areas such as site preparation, civil/structural, mechanical, etc. are presented. At the most detailed level, line items are listed, with any additional components that are included in the line-item scope of supply.

Indirect costs are broken down into ten sub-areas:

- Engineering, procurement and construction management (EPCM) costs;
- Procurement and construction management;
- Temporary site facilities;
- Commissioning and start-up;
- Common construction equipment;
- Spare parts;
- Others;
- Owner's cost;
- Taxes and duties (not included);
- Access roads, environmental impact & permitting;
- Contractor profit.

21.1.1.4 Currency

All currency is in US Dollars and is not adjusted for inflation.

21.1.1.5 Labor

Labor is listed as man-hours for installation and construction activities. The hourly rate is based on recent Roche project experience and is estimated based on the type of activity. Actual labor rates used are listed in the estimate for each line item as may be applicable. The default construction rate for the Physical Upgrade and Hydromet Plants is $95.50 per hour. ($85.50 per hour base cost plus $10 per hour of pension cost.)

21.1.1.6 Installation

Installation costs are factored from the equipment cost according to the generic nature of the equipment. Some equipment requires no installation such as mobile vehicles while other equipment requires significant installation costs such as chemical process equipment. Installation cost includes supply of materials for connection to services as well as labor to perform the work.

21.1.2 Indirect Cost

Indirect costs are estimated as proportions of the direct cost as described below.

21.1.2.1 General Indirect Costs

The general indirect costs are estimated as follows:

The general indirect costs are estimated as follows:

- Engineering Fee (DFS and Detailed Engineering);
    - PUG Plant – 4% of consultant direct costs;
    - Hydromet Plant – 4% of consultant direct costs.
    - Access Roads – 5% of sub-consultant direct costs;
    - PreCorp PUG – 0% of sub-consultant direct costs;
    - PreCorp Hydromet – 0% of sub-consultant direct costs;
    - Tailings Storage Facility – 3% of sub-consultant direct costs;
    - Primary Mining Equipment – 3% of sub-consultant direct costs;
    - Mine Infrastructure and Misc. – 5% of sub-consultant direct costs;
    - Mine Closure Plan – LQD Guidance Item 12a - $100,000
    - Upton Site Closure Plan – LQD Guidance Item 12a - $100,000

- o Year -1 Mine Operating Costs – 5% of sub-consultant direct costs;
- o Contractors Pre-Strip Costs - 5% of sub-consultant direct costs;

- Procurement and Construction Management – 7% of total direct costs (excluding mining equipment);
- Temporary site facilities – 3% of sub-consultant direct costs;
- Commissioning and start-up – 3% of direct purchase cost;
- Spare Parts - 5% of sub-consultant direct costs;
- Others;
  - o First fills – $400,000.
  - o Capital Replacement Spares - 5% of sub-consultant direct costs;
- Taxes and duties– excluded.
- Access Roads Environmental Impact & Permitting - $100,000
- Contractor Profit/Overhead/Mobilization/Demobilization - 10% of sub-consultant direct costs.

21.1.2.2 Owner's Indirect Costs

The owner's indirect cost has been supplied by Rare Element and is estimated as follows:

- Capital spares for major equipment – 2% of direct purchase cost

21.1.2.3 Contingencies

Project contingency is calculated as a percentage of the direct and indirect costs. The contingency is varied for each item to account for unknowns at the time of the study. The contingencies are removed from the consultants' cost estimates to prevent adding multiple layers of contingencies. The following levels of contingency have been used for this study:

- PUG and Hydromet – 25% of direct and indirect cost;
- Access Roads – 20% of direct and indirect cost;
- Power Lines – 13% of direct and indirect cost;
- Mining Equipment and Mining Infrastructure – 5% of direct and indirect cost;
- Tailings Storage Facilities – 25% of direct and indirect cost;

- Capital Replacement Primary Mining and TSF Equipment – 5% of direct and indirect cost;
- Mine and Hydromet Site Closure – 4% of direct and indirect cost;
- Year -1 Mine Operating Costs – 5% of direct and indirect cost;
- Contractor Pre-strip Costs – 5% of direct and indirect cost.

21.1.2.4 Assumptions

A) Physical Upgrade Facility

- Knight Piesold provided the PUG closure cost ($8,669,000);
- The parking lot is not paved and has a gravel surface;
- Truck roads are drained with ditches and have gravel surfaces;
- Rock is two feet deep from the existing ground;
- The buildings' foundations will be rock (strip footings and spread footings) and structural concrete slab on ground;
- Raft footings will support the tanks and major equipment;
- The structural columns grid is 20 ft. x 20 ft. (6.1 m x 6.1 m) in office areas and 20 ft. x 100 ft. (6.1 m x 30.5 m) elsewhere;
- Concrete is available locally.

B) Hydromet Facility

- Knight Piesold provided the Upton site closure cost ($7,837,000) which includes 2 feet (0.61 meters) of radon cover over the tailings facility;.
- The septic and water pipes of the Upton industrial park are located outside of the roadway; no road repair has been included;
- No upgrade of the Upton industrial park water network is required;
- Excavation costs do not include the presence of rock in trenches;
- Topsoil stripping is limited in depth to one foot;
- The parking lot will be paved;
- A system of underground pipes will be installed to ensure proper drainage of the parking lot;

- The building foundation will be built on piles supporting grade beams (foundation walls) with a structural concrete slab on the ground;
- The indoor tanks and reactors are supported by a structural slab supported by a series of concrete columns on pile caps and piles;
- The average pile length is 25 ft. (7.6 m);
- The structural system consists of a steel structure (steel deck on open web steel joists, beams and steel columns);
- The structural columns grid is 25 ft. x 25 ft. (7.6 m x 7.6 m) in office areas and 40 ft. x 50 ft. (12.2 m x 15.2 m) elsewhere;
- No provision other than three sump pits is included for channel gutters or depressions in the floor concrete slab;
- A mezzanine is installed over the tanks. The mezzanine consists of fiber reinforced polymer grating installed on a coated structural steel structure;
- The exterior tanks are supported on a structural slab on piles;
- All concrete is protected from chemical attacks with an epoxy phenolic tank lining.
- The leach reactors are shop fabricated;
- The precipitation reactors are shop pre-fabricated and assembled on site.

C) Mining

- Contractor performed pre-stripping of 6.9MMt of waste in the year before production;
- Purchase of mining, mobile, and support equipment;
- Construction of truck shop/warehouse/office building;
- Construction of haulage roads, sediment control and site preparation;
- Indirect costs associated with the pre-stripping period;
- The capital costs for the mining area includes the initial capital costs incurred in the year before mining production and the sustaining capital costs incurred during the project.

D) Common Assumptions

- The excavation cost includes the transport and disposal of cuttings for up to three miles;

- The system for separation and removal of oils and greases is designed to comply with environmental standards;
- The building ground floor level is approximately 6 inches (15 centimeters) higher than the current ground level;
- The electricity supplier is able to provide power;
- PreCorp supplied any cost related to high voltage distribution and transformation.

21.1.3 Capital Cost Estimate Summary

Table 21.1 presents the capital cost estimate summary. For the cash flow analysis these costs were distributed in the years that they will be incurred. The bulk of the cost occurs during the first two years when the facilities are first constructed. Mining of lower grade ores beginning in year 10 will require the relocation of some crushing and screening equipment from the Hydromet plant to the PUG site. The mining rate is increased in order to keep the production of REO relatively constant, which requires the PUG plant to be expanded in year 9 to provide for enhanced concentration of ore using gravity separation and magnetic separation.

Table 21.1- Capital Cost Estimate Summary

Description	Initial Cost, ($000s)	Total Cost, ($000s)
Direct Cost	$ 206,349	$ 339,492
Area 1.0 - PUG Plant	$ 8,024	$ 44,819
Area 2.0 - Hydromet Plant	$ 120,974	$ 122,076
Area 3.0 - Sub-consultant:		
Access Roads *(Stetson Engineering Inc.)*	$ 10,804	$ 10,804
Electrical Power Lines to Mine & PUG *(Precorp)*		$ 6,026
Electrical Power Lines to Hydromet (Precorp)	$ 1,053	$ 1,053
Tailings *(Golder Associates)*	$ 5,212	$ 24,970
Mining Equipment *(Golder Associates)*	$ 15,296	$ 15,296
Mining Infrastructure and Miscellaneous *(Golder Associates)*	$ 14,016	$ 18,536
Mine Closure Plan *(Golder Associates)*		$ 8,669
Upton Site Closure Plan *(RER)*		$ 7,837
Year -1 Mine Operating Costs *(Golder Associates)*	$ 5,169	$ 5,169
Contractor Pre-Strip Costs	$ 23,461	$ 23,461
Road Maintenance during non-operating years	$ 230	$ 920
Area 4.0 - Others:		
Land/Property Acquisition (Upton)	$ 840	$ 840
Land Acquisition and Building Construction (Sundance)	$ 1,500	$ 1,500
Capital Replacement		$ 40,913

Indirect Cost	$ 36,698	$ 52,559
Engineering Fee (Feasibility and Detailed Engineering Phases)	$ 8,447	$ 10,982
Procurement and Construction Management	$ 11,175	$ 15,950
Temporary Site Facilities	$ 500	$ 500
Commissioning and Start-Up	$ 2,402	$ 2,723
Spare Parts	$ 4,003	$ 4,539
First Fills	$ 400	$ 400
Capital Replacement Spares (major)		$ 2,046
Capital Spares for Major Equipment	$ 1,601	$ 2,634
Access Roads Environmental Impact & Permitting	$ 100	$ 100
Contractor Profit/Overhead/Mobilization/Demobilization	$ 8,068	$ 12,685
Sub-Total Direct and Indirect Costs	$ 243,046	$ 392,051
Contingency	$ 47,127	$ 67,906
Total Direct and Indirect Costs with Contingency	**$ 290,404**	**$ 453,354**

(Roche, 2014)

Net working capital of $24.6 million is required for receivables, product inventory, materials and supplies inventory and payables.. This working capital recovered at the end of the project does not impact the total capital cost and is therefore not shown in this summary.

21.1.4 Cost Breakdown by Area/WBS

Table 21.2 Summary of yearly estimated capital expenditures, contains an annual breakdown of capital expenditures by item for mining for the first two years of mining, the sustaining capital and the total capital cost.

Table 21.2 - Summary of Yearly Mine Direct Capital Expenditures

Machine / Item	Year -1		Year 1		Sustaining Capital Total		Total Capital
STRIPPING & LOADING MACHINES	($000s)	Units	($000s)	Units	($000s)	Units	
Caterpillar 6015B - Shovel	$2,054	1			$2,054	1	$4,109
Caterpillar 988K - Wheel Loader	$1,263	1			$1,263	1	$2,525
Caterpillar D8T - Dozer	$2,029	2			$3,043	3	$5,072
Spare Parts Inventory (@ 5%)	$267				-		$267
HAUL TRUCKS					-		-
Caterpillar 770G - End Dump Truck	$6,934	8			$27,734	32	$34,668
Spare Parts Inventory (@ 5%)	$347				-		$347
MOBILE EQUIPMENT					-		-
Caterpillar Drills MD5090, MD6290	$2,228	2			$3,811	3	$6,039
Caterpillar 14M - Motor Grader	$651	1			$1,301	2	$1,952
5000 gallon Water Truck	$137	1			$273	2	$410
Spare Parts Inventory (@ 5%)	$151				$301		$452
SERVICE & SUPPORT EQUIPMENT					-		-
Caterpillar 416E - Backhoe Loader	$144	1			$287	2	$431
Fuel/Lube Truck	$191	1			$381	2	$572
Mechanic's Truck	$302	4			$605	2	$907
Pickup Truck	$201	5			$402	2	$603
Mobile Crane	$345	1			$690	2	$1,035
2-tonne Forklift	$52	1			$104	2	$156
Welding Machine	$25	1			$50	2	$75
Buses	$228	4			$457	2	$685
Light Plant	$167	7			$334	2	$501
INFRASTRUCTURE & MISC.					-		-
Truckshop, Warehouse,Lube and offices	$6,214				-		$6,214
Dewatering System	$565				$510		$1,075
Haul Road Construction	$1,000		$250		$250		$1,250
Mine Fencing and Security	$1,000				-		$1,000
Miscellaneous Capital Expenses	$3,282				-		$3,282
Engineering and Ore Control	$300				$450		$750
							-
Contractor pre-strip costs	$23,461				-		$23,461
Year -1 Mine Operating Costs	$5,169				-		$5,169
					-		-
TOTAL ESTIMATED CAPITAL EXPENDITURE ($000s)	**$58,704**		**$250**		**Sustaining Capital**		**Total Capital**
CUMULATIVE CAPITAL EXPENDITURE ($000s)	**$58,704**		**$58,954**		**$44,302**		**$103,006**

(Roche, 2014)

Tables 21.3 thru 21.4 present costs according to area and type.

Table 21.3 - Physical Upgrade Plant Direct Capital Cost Summary, ($000s)

Area	Direct Purchase	Contractor Purchase	Installation	Sub-Contractor	Total Cost
Site Preparation	$	$ 583	$ 226		$ 804
Civil / Structural		$ 19,635			$ 19,635
Mechanical	$ 10,715		$ 2,083		$ 12,798
Piping		$ 660	$ 1,343		$ 2,003
Electrical	$ 2,774	$ 3,721	$ 1,948		$ 8,443
Instrumentation		$ 705	$ 429		$ 1,135
Total	**$ 13,489**	**$ 25,304**	**$ 6,025**	**$**	**$ 44,819**

(Roche, 2014)

Table 21.4 - Hydromet Plant Direct Capital Cost Summary, ($000s)

Area	Direct Purchase	Contractor Purchase	Installation	Sub-Contractor	Total Cost
Site Preparation	$ 75	$ 2,578	$ 2		$ 2,655
Civil / Structural		$ 31,227	$ 38		$ 31,265
Mechanical	$ 59,618	$ 1,769	$ 7,250		$ 68,636
Piping		$ 4,308	$ 5,896		$ 10,204
Electrical	$ 867	$ 6,019	$ 983		$ 7,869
Instrumentation	$ 2	$ 903	$ 540		$ 1,446
Total	**$ 60,561**	**$ 46,804**	**$ 14,710**		**$ 122,075**

(Roche, 2014)

21.2 Sustaining Cost Estimate

Sustaining capital costs are included in this cost estimate. Sustaining capital includes costs associated with the replacement of equipment at the end of its useful life, such as the mining fleet and the periodic embankment raising on the tailings dam.

21.3 Operating Cost Estimate

21.3.1 Mining Operating Cost Estimate

The estimated mine production and operating costs are developed on an annual basis and based upon the mine production schedule. The mine operating costs consist of direct and indirect operating costs. The direct operating costs encompass all costs associated with excavating material from the open pit, transporting ore and stockpiled material to the PUG plant, building a waste rock facility and maintenance services. Indirect costs are costs associated with administration and other support costs.

21.3.2 Processing Plant Operating Cost Estimates

The processing plant operating costs for the PUG Plant and for the Hydromet Plant are calculated based on five generic cost categories:

- Labor
- Energy
- Consumables and reagents
- Maintenance
- Thorium disposal and other operating costs

Operation of the processing facilities involves the purchase of basic feedstock materials and reagents, which consist primarily of:

- Flocculant
- Hydrochloric Acid (HCl)
- Oxalic Acid ($H_2C_2O_4$)
- Nitric Acid (HNO_3)
- Ammonia (NH_3)
- Sodium Hydroxide (NaOH)
- Limestone ($CaCO_3$)
- Quicklime (CaO)

Motors installed on compressors, pumping, conveying and comminution equipment are the primary electricity consumers. The Hydromet plant also consumes natural gas as an energy source to supply heat to the acid regeneration unit (Unit 350), the kiln and three screw dryers.

Maintenance and consumables costs are primarily related to the following items:

- Preventive maintenance and repairs on equipment and instruments (spare parts);
- Preventive maintenance on buildings and structures (corrosion control);
- Replacement of the liners of the crushers and grinding mill.

Labor costs are estimated based on a comparative staffing analysis with similar plants. An organization chart has been created to identify the personnel that will be required. This includes administration, maintenance and site services personnel.

21.3.3 G&A Operating Cost Estimate

The G&A costs include the following items:

- G&A labor costs;
- G&A operating supplies and expenses;
- Exploration (within project boundaries);
- Environmental, Health & Safety Mine Site;
- Environmental, Health & Safety Upton Plant (includes radiation safety);
- Tailings storage facility;
- Access road maintenance;
- Wells and water lines maintenance.

21.3.4 Other Operating Cost Estimate

Other operating costs have also been added to the mine, PUG, Hydromet and Upton TSF operating cost estimates. These miscellaneous items include but are not limited to the pre-concentrate transportation, laboratory supplies, and research and development cost.

21.3.5 Estimate Structure

The operating cost estimate is divided into six items. Except for G&A and Miller Creek road maintenance, the operating costs are variable by year based on the operating plan. The items are:

- PUG operating costs;
- Hydromet operating costs;
- Mining operations;
- Upton TSF operations;
- G&A operating costs;
- Miller Creek road maintenance .

21.3.6 Raw Materials

The cost for raw materials was adjusted on a yearly basis depending on the ore type and quantity in a given year.

A) Flocculent

Roche estimated the cost of flocculent based on previous projects at $1.59/lb ($3.50/kg). The exact flocculent has not been determined. The type of flocculent expected to be used, will be a medium to high molecular weight, non-ionic polyacrylamide type.

B) Hydrochloric Acid (HCl)

Recent cost information indicates 35wt% HCl prices are currently very volatile (between $165 & $245). The price used in this report is quoted from Reagent Chemical on March 19, 2014 at $185.00/ton delivered in 100 ton railcars to Upton, WY, and includes applicable fuel surcharge at time of quote by the BNSF Railroad.

C) Oxalic Acid (H2C2O4)

Potential domestic chemical suppliers of oxalic acid quoted very high prices ($1,000+/ton). The reason for such high prices is that China is currently the Worlds' largest producer of oxalic acid and it must be imported. Another reason for high prices is that oxalic acid is not available in bulk form. Oxalic acid cannot be exposed to air for long periods of time, and must be packaged in sealed containers (bagged). The lowest prices were obtained by contacting directly the major producers in China. The price used in this report was obtained from Wuhan Yilijindi Chemical Product Co., China, $463/ton ($510/MT) in 1000 Kg super sacs, FOB Tianjin port dated 12/4/13. An additional freight cost of $150/ton was estimated for transportation to Upton, WY, for a total delivered cost of $613/ton.

D) Ammonia (NH_3)

Roche has determined that producing 20% ammonium hydroxide (NH_4OH) solution on-site from liquid anhydrous ammonia is significantly more cost effective than the option of purchasing 30% ammonium hydroxide solution off-site. The improved economics is achieved by a reduction of over 85% in the total tonnage that is shipped to the plant site for ammonium hydroxide.

On January 23, 2014, the Agricultural Marketing Service (an agency of the U.S. Department of Agriculture), reported average prices in Illinois of $651/ton for anhydrous ammonia. This constituted a 27% decrease in price from the previous year. Anhydrous ammonia prices are largely driven by natural gas process which can be quite volatile. For this study a price of $750/ton of ammonia delivered to Upton, WY is assumed.

E) Sodium Hydroxide (NaOH)

Sodium hydroxide consumption requirements are small, typically about 100 tons/year. A price of $397/ton for 50% sodium hydroxide solution is used for this study. This delivered bulk price was obtained from Thatcher Company on 1/29/13.

F) Limestone ($CaCO_3$)

There is a limestone quarry (Timberline Services) in the vicinity of the Bear Lodge Project near Upton, WY that has quoted $15/ton delivered of crushed limestone. Roche & Rare Element have roughly estimated a cost of $30/ton delivered for pulverized limestone that is to be produced from limestone mined from the local quarry.

G) Quicklime (CaO)

Quicklime consumption requirements are minimal and are to be supplied in 80 lb bags and super sacs. A price of $270/ton delivered is used for this study.

21.3.7 Energy

A) Electricity

PreCorp, the local electrical cooperative, provided a cost of electricity of $0.068 per kWh base rate.

B) Natural Gas

The cost of natural gas has been taken from the U.S. Energy Information Administration and is $3.96 per MMBTU.

21.3.8 Labor

The cost of labor is based on the 2010 Mining Industry Compensation and Benefits Survey escalated to 2014 costs. Tables 21.5 thru 21.8 present the initial staffing details for the mine, PUG, Hydromet and TSF.

Labor at the mine varies over the entire life of mine. Initially there are 71 persons operating the mine. This increases to a peak of 106 persons as the mining rate increases. In year 37 the ore will be mined out and mining operations will cease except for hauling ore from the low-grade stockpile. Only 25 persons are required to operate the mine during this period.

At the PUG plant, there are 7 persons initially. When the PUG plant is upgraded in year 10, twenty-six persons will be required for the duration of the project.

The Hydromet plant starts out with 55 employees. In year 10, some equipment moves to the PUG plant, and the labor force is reduced to 51 persons. Five persons are required for operating the TSF over the life of the project.

Administration of the project will require an additional 11 persons beyond those listed above. The total labor force will be 149 persons initially and the peak labor force will be 199 persons.

Table 21.5 - Mine Labor Cost

	Base Salary	Hourly Rate Normal	Burden 0.25	Benefits	Bonus	Total Cost /position
Salaried Labor Positions						
Mine Supt	$ 129,113	$ 62.07	$ 32,278	$ 12,911	$ 23,194	$197,497
Maintenance Foreman	$ 105,864	$ 50.90	$ 26,466	$ 10,586	$ 13,727	$156,643
Shift Boss	$ 79,100	$ 38.03	$ 19,775	$ 7,910	$ 12,107	$118,892
Maintenance Planner	$ 100,590	$ 48.36	$ 25,148	$ 10,059	$ 10,772	$146,569
Snr. Mine Engineer	$ 102,550	$ 49.30	$ 25,638	$ 10,255	$ 9,170	$147,613
Ore Control	$ 75,143	$ 36.13	$ 18,786	$ 7,514	$ 8,530	$109,973
Surveyors	$ 65,000	$ 31.25	$ 16,250	$ 6,500	$ 8,530	$ 96,280
Clerks - Mine/ Mnt/Ware	$ 40,831	$ 19.63	$ 10,208	$ 4,083	$ 3,860	$ 58,982
Security/Day Safety	$ 50,000	$ 24.04	$ 12,500	$ 5,000	$ 3,860	$ 71,360
Hourly Labor Positions						
Shovel or loader ops	$ 65,312	$ 31.40	$ 16,328	$ 6,531	$ 5,923	$ 94,094
Truck Drivers	$ 57,034	$ 27.42	$ 14,258	$ 5,703	$ 4,480	$ 81,475
Drillers	$ 60,424	$ 29.05	$ 15,106	$ 6,042	$ 5,453	$ 87,025
Dozer/Graders	$ 60,424	$ 29.05	$ 15,106	$ 6,042	$ 5,453	$ 87,025
Training	$ 52,000	$ 25.00	$ 13,000	$ 5,200	$ -	$ 70,200
HE Mechanics	$ 65,312	$ 31.40	$ 16,328	$ 6,531	$ 6,174	$ 94,345
Truck Mechanics	$ 60,424	$ 29.05	$ 15,106	$ 6,042	$ 5,668	$ 87,240
Light Vehicle	$ 58,448	$ 28.10	$ 14,612	$ 5,845	$ 4,364	$ 83,269
Fuel and Lube	$ 58,448	$ 28.10	$ 14,612	$ 5,845	$ 4,364	$ 83,269
Tire and Electrical	$ 62,691	$ 30.14	$ 15,673	$ 6,269	$ 4,364	$ 88,997
Training	$ 52,000	$ 25.00	$ 13,000	$ 5,200	$ -	$ 70,200

Note: Note Adjusted to Show Current Manpow er Costs using MSEC (Coal rates as competitive in region) - 2012 75%th

(Golder, 2014)

The cost of labor was held constant at the PUG Hydromet and TSF except for periods when there is a step change in the operation. In year ten the mine begins to produce a lower grade of ore. At that time, mining rates increase, the PUG plant will be upgraded to achieve greater concentration of the ore, and the feed to the Hydromet will increase to compensate for lower grade ore. At this time, some physical upgrading equipment will be moved to the PUG. As a result, the staffing at the PUG will increase and the staffing at the Hydromet will decline.

Table 21.6 - PUG Labor Cost

Title	Hourly (USD/hour)	Base Salary (USD/y)	Overtime (USD/y)	Incentive / Bonus (USD/y)	Fringe Benefits (USD/y)	Total Salary (USD/y)
Operation						
Metallurgist		85,000 $		6,800 $	31,450 $	123,250 $
General Foreman		95,306 $		7,625 $	35,263 $	138,194 $
Operation Team Leader	33.20 $	69,056 $	10,358 $	5,524 $	25,551 $	110,490 $
Ore Handling Operator	32.34 $	67,267 $	10,090 $	5,381 $	24,889 $	107,628 $
Crusher Operator	32.34 $	67,267 $	10,090 $	5,381 $	24,889 $	107,628 $
Classification Operator	32.34 $	67,267 $	10,090 $	5,381 $	24,889 $	107,628 $
Dewatering Operator	32.34 $	67,267 $	10,090 $	5,381 $	24,889 $	107,628 $
Magnetic Separation Operator	32.34 $	67,267 $	10,090 $	5,381 $	24,889 $	107,628 $
Operation support						
Safety Engineer / Trainer						
Secretary/Process Clerk		51,000 $		4,080 $	18,870 $	73,950 $
Accounting Clerk		48,000 $		3,840 $	17,760 $	69,600 $
Warehouse Personnel						
Maintenance						
Superintendent - Mech Eng. - Planner						
Mechanical Clerk		50,418 $		4,033 $	18,655 $	73,106 $
Mechanical Foreman		90,000 $		7,200 $	33,300 $	130,500 $
Mechanical	31.22 $	64,938 $	9,741 $	5,195 $	24,027 $	103,900 $
Maintenance Helper	30.14 $	62,691 $	9,404 $	5,015 $	23,196 $	100,306 $
Electrical Engineer - Planner						
Electrical Clerk						
Electrical Foreman						
Electrician	32.34 $	67,267 $	10,090 $	5,381 $	24,889 $	107,628 $
Intrumentation Tech.	32.34 $	67,267 $	10,090 $	5,381 $	24,889 $	107,628 $
Assay Laboratory						
Chief Analyst		88,484 $		7,079 $	32,739 $	128,301 $
Assay Lab Technician		46,277 $		3,702 $	17,122 $	67,101 $
Laborer	25.24 $	52,503 $		4,200 $	19,426 $	76,130 $

(Roche, 2014)

Table 21.7 - Hydromet Labor Cost

Title	Hourly (USD/hour)	Base (USD/y)	Overtime (USD/y)	Incentive / Bonus (USD/y)	Fringe Benefits (USD/y)	Total Salary (USD/y)
Operation						
Operation Team Leader	32.20 $	66,966 $	10,045 $	5,357 $	24,778 $	$ 107,146
Production materials receiving	30.14 $	62,691 $	9,404 $	5,015 $	23,196 $	$ 100,306
Pre-Concentrate handling Operator	32.34 $	67,267 $	10,090 $	5,381 $	24,889 $	$ 107,628
Leaching Operator	32.34 $	67,267 $	10,090 $	5,381 $	24,889 $	$ 107,628
Precipitation Operator	32.34 $	67,267 $	10,090 $	5,381 $	24,889 $	$ 107,628
Oxidation/HCl recovery operator	32.34 $	67,267 $	10,090 $	5,381 $	24,889 $	$ 107,628
Ammonium Nitrate Operator	30.14 $	62,691 $	9,404 $	5,015 $	23,196 $	$ 100,306
Operation Support						
Area Manager -Chemical Engineer		120,000 $		9,600 $	44,400 $	$ 174,000
Process engineer (Chemical)/Env.		95,000 $		7,600 $	35,150 $	$ 137,750
Geologist		80,076 $		6,406 $	29,628 $	$ 116,110
Technician-Env.		65,905 $		5,272 $	24,385 $	$ 95,563
Secretary/process clerk		51,000 $		4,080 $	18,870 $	$ 73,950
Accounting clerk				- $	- $	$ -
Warehouse personnel	28.94 $	60,195 $	9,029 $	4,816 $	22,272 $	$ 96,312
Security Guards		58,000 $		4,640 $	21,460 $	$ 84,100
Maintenance						
Superintendent-Eng.-Planner		109,040 $	- $	8,723 $	40,345 $	$ 158,108
Mechanical Planner						
Mechanical Clerk						
Mechanical foreman		90,000 $		7,200 $	33,300 $	$ 130,500
Mechanic	31.22 $	64,938 $	9,741 $	5,195 $	24,027 $	$ 103,900
Maintenance Helper	30.14 $	62,691 $	9,404 $	5,015 $	23,196 $	$ 100,306
Electrical Engineer-Planner						
Electrical Planner						
Electrical Clerk						
Electrical Foreman						
Electrician	32.34 $	67,267 $	10,090 $	5,381 $	24,889 $	$ 107,628
Instrumentation Tech.	32.34 $	67,267 $	10,090 $	5,381 $	24,889 $	$ 107,628
Assay Laboratory						
Chief Analyst-Environment		88,484 $		7,079 $	32,739 $	$ 128,301
Assay lab technician		52,338 $		4,187 $	19,365 $	$ 75,890
Laborer	25.24 $	52,503 $	7,876 $	4,200 $	19,426 $	$ 84,005

(Roche, 2014)

Table 21.8 - TSF Labor Cost

Item Description	Unit Rate	Yearly Cost
Haul Truck Driver	$ 65.00	$ 135,000
Haul Truck Driver	$ 65.00	$ 135,000
Dozer Grader Operator	$ 85.00	$ 177,000
Motor Grader Operator	$ 85.00	$ 177,000
Loader Operator	$ 85.00	$ 177,000

(Golder, 2014)

21.3.9 Operating Cost Estimate Summary

Operating costs vary from a low of $9.83/ kg of REO in the first year of operation to a high of $21.05/ kg in year twenty-six. Table 21.9 summarizes the operating cost estimate for these two years. Numerous factors cause the operating cost to vary over time with ore grade being the most influential factor. Ore type, stripping ratio and other factors also cause the operating cost to fluctuate.

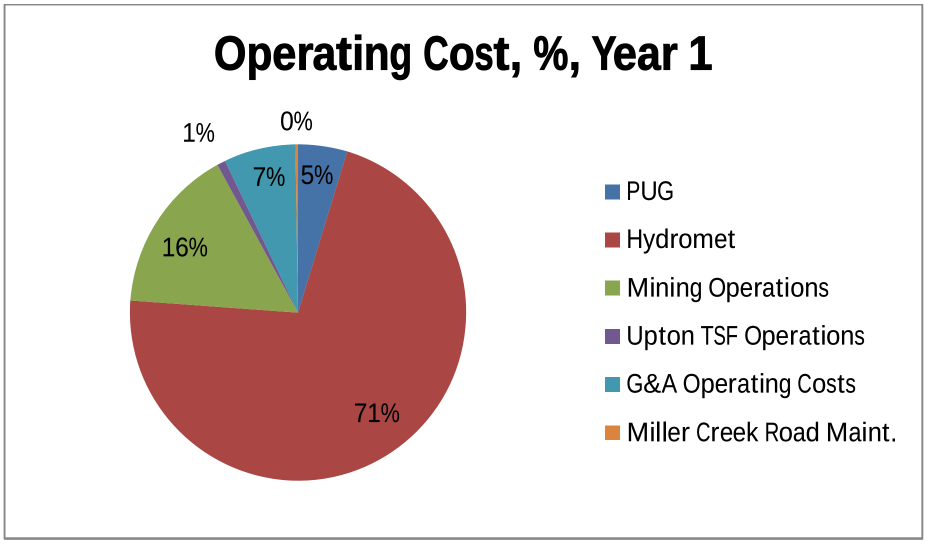
Table 21.9 - Bear Lodge Project: Operating Cost Estimate Summary

Unit	Year 1, ($000s)	Year 26, ($000s)	Year 1, $/kg	Year 26, $/kg
PUG	4,470	11,380	0.46	1.70
Hydromet	68,126	102,576	7.02	15.29
Mining Operations	15,133	19,598	1.56	2.92
Upton TSF Operations	804	801	0.08	0.12
G&A Operating Costs	6,603	6,603	0.68	0.98
Miller Creek Road Maint.	230	230	0.02	0.03
Total	95,368	141,189	9.83	21.05
REO Produced, tons	10,696	7,394		

(Roche, 2014)

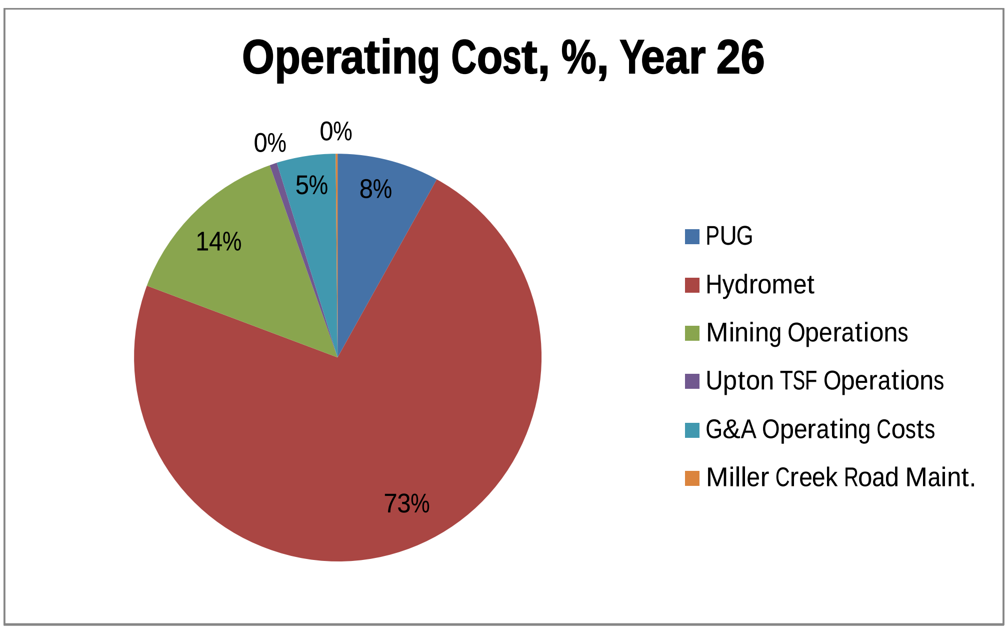
Figures 21.1 and 21.2 illustrate the percentage of operating cost that is attributed to the various units in years one and twenty-six respectively. As can be seen, for the most part the operating costs increase proportionally across most of the units with the Hydromet cost making up the majority of operating cost.

Figure 21.1 - Year One Operating Cost as a Percentage of the Total



(Roche, 2014)

Figure 21.2 - Year 26 Operating Cost as a Percentage of the Total



(Roche, 2014)

21.3.10 Operating Cost Estimate Area Summaries

Table 21.10 shows the operating costs for the Hydromet plant for the first year of operation. Note that Reagents are the main cost in the Hydromet plant, followed by energy cost, then labor cost.

Table 21.10 - Hydromet Operating Cost Estimate Summary

Cost Item	Year 1, ($000s)	Year 1, $/kg
HCl (100%)	19,670	2.03
Oxalic Acid (Anhydrous)	14,606	1.51
Iron Scraps	-	-
Nitric Acid (68%)	8,501	0.88
Ammonia	2,952	0.30
Sodium Hydroxide	41	0.00
Limestone	2,700	0.28
Quicklime	14	0.00
Reagents Total	48,482	5.00
Labor Cost	5,750	0.59
Energy Cost	8,940	0.92
Thorium Disposal Cost	1,312	0.14
Maintenance Supplies	3,328	0.34
Water Treatment Chemicals	89	0.01
Misc Other processing	225	0.02
Total	68,126	7.02

(Roche, 2014)

Table 21.11 shows the operating cost for the mine. Labor is the main cost in the mine followed by equipment fuel and maintenance.

Table 21.11 - Mining Operating Cost Estimate Summary

Cost Item	Year 1, ($000s)	Year 1, $/kg
Mining Equipment O&M	4,111	1.03
Hourly Labor	4,436	1.11
Blasting	1,263	0.32
Mine Supervision & Admin	1,535	0.38
DIRECT OPERATING COSTS	11,346	2.84
INDIRECT OPERATIONS SUPPORT	3,787	0.95
TOTAL MINE OPERATING COSTS	15,133	3.79
Total Effective Tons (000s ton)	3,990	

(Golder, 2014)

Table 21.12 shows the operation cost for the PUG. Note that transporting the PUG pre-concentrate from the mine area to the Hydromet plant at Upton is the greatest cost followed by labor and energy.

Table 21.12 - PUG Plant Operating Cost Estimate Summary

Cost Item	Year 1, ($000s)	Year 1, $/kg
Estimated Labor Cost	874	0.09
Estimated Energy Cost	773	0.08
Hydromet Feed Transport Cost	2,103	0.22
Consumables	414	0.04
Maintenance Supplies	211	0.02
Other Operating Costs	95	0.01
TOTAL PUG OPEX	4,470	0.46

(Roche, 2014)

22 Economic Analysis

22.1 Economic Analysis Summary

The economic analysis for the Bear Lodge Project was undertaken utilizing the Discounted Cash Flow (DCF) methodology and was based on the mine production schedule, capital and operating cost estimates for the mine, processing plant, and associated infrastructure. The mine plan was developed to produce a variable flow of ore to the PUG plant in order to balance the pre-concentrate delivery with the maximum design capacity of the Hydromet plant.

Capital costs include a factored cost for indirects and contingency. The initial capital cost has an indirect factor of 16.0% and a contingency of 19.0%. These factors were determined by calculating a weighted average of the indirects and contingency for individual cost items during the period. The replacement capital cost items consist mainly of mining equipment and continued expansion of the tailings storage facility. These items have a price that was more accurately identified and had less indirect cost associated with them. Therefore, the indirect factor and contingency dropped to 6.3% and 9.0% respectively.

The basket price for rare earth oxides is a critical input to the economic evaluation, and the derivation of this price is described in chapter 19. Capital and operating costs are another critical input and are described in chapter 21. The key economic assumptions and technical parameters that were used in the financial analysis are summarized in Table 22.1.

Table 22.1 - Economic Input Parameters

Parameter Description	Value	Unit
Rare Earths Basket Price	$22,317	$USD/short ton
	$24.60	$USD/Kg
Mill Rate	76	mills
Severance Tax Rate	2.0	(%)
Land Tax Rate	9.0	(%)
Industrial Property Tax Rate	11.5	(%)
Crook County Ad Valorum Tax	6.15	(%)
Federal/Alternative Min. Tax	35 / 20	(%)
Mine Life	45	Years
Discount Rates	8, 10 & 12	(%)

(Roche, 2014)

A cash flow forecast is presented in Table 22.2.

Table 22.2 - Cash Flow Forecast

Rare Element Resources

FINANCIAL MODEL
10135-001

RARE ELEMENT RESOURCES INC.
PREFEASIBILITY STUDY UPDATE

ROCHE Engineering

September 18, 2014

Revision: O

Rare Elements Earth Resources		All numbers 000	YrofProd	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Bear Lodge REE Project - Financial Analysis																										
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Mine Plan, Tons																										
PUG Feed Rate, STPY				220	219	219	226	212	220	217	220	226	392	424	536	549	444	328	322	293	285	286	292	302	325	459
PUG Feed Rate, STPY				**220**	**219**	**219**	**226**	**212**	**220**	**217**	**220**	**226**	**392**	**424**	**536**	**549**	**444**	**328**	**322**	**293**	**285**	**286**	**292**	**302**	**325**	**459**
Capital Costs																										
PUG	0	2,924	9,087	0	0	0	0	0	0	0	17,064	38,907	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydromet	0	62,825	93,687	9,862	0	0	0	0	0	0	0	1,852	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital Replacement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub Consultant Costs	840	1,504	102,888	7,427	0	4,538	368	0	2,688	3,969	700	7,476	1,402	0	0	491	0	16,263	1,814	0	174	0	5,863	7,876	0	0
Working Capital				24,603	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Cap cost	**840**	**67,254**	**205,662**	**41,892**	**0**	**4,538**	**368**	**0**	**2,688**	**3,969**	**17,764**	**48,235**	**1,402**	**0**	**0**	**491**	**0**	**16,263**	**1,814**	**0**	**174**	**0**	**5,863**	**7,876**	**0**	**0**
Operating Costs																										
PUG				4,470	4,452	4,453	4,601	4,390	4,488	4,452	4,489	4,547	8,410	9,062	11,064	11,420	9,508	7,118	7,052	6,390	6,262	6,311	6,457	6,694	7,216	9,444
Hydromet				68,126	65,868	64,790	65,468	68,633	60,177	60,643	59,211	57,773	71,289	72,629	80,503	84,155	79,637	74,134	73,786	78,423	79,316	79,845	71,451	71,453	69,910	82,469
Mining Operations				15,133	15,034	15,034	14,786	14,782	15,881	15,880	15,886	15,768	15,805	15,782	15,818	15,822	15,789	17,774	17,772	17,763	17,761	17,761	17,763	19,645	19,652	19,695
Upton TSF Operations				804	802	802	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801
G&A Operating Costs			0	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603
Miller Creek Road Maint.			0	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230
Annual Op Cost	**0**	**0**	**0**	**95,368**	**92,989**	**91,912**	**92,490**	**95,440**	**88,181**	**88,610**	**87,221**	**85,722**	**103,139**	**105,108**	**115,018**	**119,032**	**112,568**	**106,660**	**106,244**	**110,211**	**110,973**	**111,552**	**103,305**	**105,427**	**104,413**	**119,242**
Annual Revenue																										
Market Price per Kg	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60
Market Price per st	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317
Ore Grade,(% REO)				5.96	5.45	5.25	4.96	5.29	4.07	3.89	3.66	3.53	3.12	3.00	2.82	2.54	2.58	3.06	2.95	3.46	3.44	3.30	3.15	3.00	2.73	2.02
Overall Recovery,%				81.6%	81.9%	81.6%	81.9%	83.0%	82.2%	81.9%	81.8%	81.2%	77.7%	76.5%	70.3%	69.4%	74.3%	80.1%	80.2%	81.7%	82.8%	83.2%	81.2%	80.3%	78.8%	76.0%
Rare Earth Mineral, tons				10,696	9,777	9,379	9,183	9,310	7,535	7,056	6,877	6,890	9,496	9,718	10,621	9,662	8,521	8,033	7,627	8,279	8,128	7,859	7,468	7,275	6,983	7,058
Rare Earth Mineral, $	0	0	0	238,698	218,181	209,308	204,930	207,776	168,163	157,459	153,476	153,768	211,931	216,881	237,027	215,624	190,167	179,278	170,206	184,763	181,402	175,388	166,663	162,350	155,846	157,513
Annual Tot Rev				**238,698**	**218,181**	**209,308**	**204,930**	**207,776**	**168,163**	**157,459**	**153,476**	**153,768**	**211,931**	**216,881**	**237,027**	**215,624**	**190,167**	**179,278**	**170,206**	**184,763**	**181,402**	**175,388**	**166,663**	**162,350**	**155,846**	**157,513**
State Tax	**41**	**41**	**70**	**4,399**	**5,464**	**5,702**	**5,311**	**4,954**	**4,506**	**4,040**	**3,751**	**3,481**	**3,503**	**3,282**	**3,052**	**2,629**	**2,453**	**2,729**	**2,756**	**2,850**	**2,754**	**2,631**	**2,684**	**2,850**	**2,826**	**2,480**
Federal Tax	**0**	**0**	**0**	**2,033**	**18,900**	**15,161**	**14,309**	**14,619**	**8,662**	**6,747**	**5,903**	**6,719**	**17,793**	**19,787**	**21,909**	**16,971**	**13,288**	**12,098**	**10,231**	**12,375**	**11,968**	**11,586**	**11,525**	**10,085**	**8,921**	**6,360**
Taxes	**41**	**41**	**70**	**6,432**	**24,364**	**20,863**	**19,620**	**19,573**	**13,168**	**10,787**	**9,654**	**10,200**	**21,296**	**23,069**	**24,961**	**19,600**	**15,741**	**14,827**	**12,987**	**15,225**	**14,722**	**14,217**	**14,209**	**12,935**	**11,747**	**8,840**
Pre Tax Cash Flow	**-881**	**-67,295**	**-205,732**	**97,039**	**119,728**	**107,156**	**106,762**	**107,383**	**72,789**	**60,840**	**44,740**	**16,330**	**103,887**	**108,492**	**118,957**	**93,472**	**75,147**	**53,625**	**59,392**	**71,702**	**67,501**	**61,205**	**54,810**	**46,197**	**48,607**	**35,791**
After Tax Cash Flow	**-881**	**-67,295**	**-205,732**	**95,006**	**100,828**	**91,995**	**92,453**	**92,764**	**64,127**	**54,093**	**38,837**	**9,611**	**86,094**	**88,705**	**97,048**	**76,501**	**61,859**	**41,527**	**49,161**	**59,327**	**55,533**	**49,619**	**43,285**	**36,112**	**39,686**	**29,431**
Cumulative After Tax Cash Flow	-881	-68,176	-273,908	-178,902	-78,074	13,921	106,374	199,138	263,265	317,358	356,195	365,806	451,899	540,604	637,652	714,153	776,012	817,539	866,701	926,027	981,560	1,031,179	1,074,465	1,110,576	1,150,263	1,179,694
Annual Pre Tax Disc. Cash	**-881**	**-61,177**	**-170,027**	**72,907**	**81,776**	**66,536**	**60,264**	**55,104**	**33,957**	**25,802**	**17,249**	**5,723**	**33,102**	**31,426**	**31,325**	**22,377**	**16,354**	**10,609**	**10,682**	**11,724**	**10,034**	**8,271**	**6,733**	**5,159**	**4,935**	**3,303**
Annual Post Tax Disc. Cash	**-881**	**-61,177**	**-170,027**	**71,380**	**68,867**	**57,122**	**52,187**	**47,602**	**29,916**	**22,941**	**14,973**	**3,368**	**27,432**	**25,695**	**25,556**	**18,314**	**13,462**	**8,216**	**8,842**	**9,700**	**8,255**	**6,705**	**5,317**	**4,033**	**4,029**	**2,716**
Discount Rate	**8.00%**	**10.00%**	**12.00%**																							
Pre Tax NPV	**563,657**	**426,663**	**327,586**																							
After Tax NPV	**443,983**	**331,485**	**249,958**																							
Pre Tax IRR	**32.78%**																									
After Tax IRR	**28.70%**																									
	Note: Post tax refers to post Federal Taxes																									

Table 22.2 - Cash Flow Forecast – Continued

Rare Elements Earth Resource	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	
Bear Lodge REE Project - Financial Analysis																										
Year	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	Totals
Mine Plan, Tons																										
PUG Feed Rate, STPY	321	299	547	547	414	293	274	268	331	535	293	246	246	333	422	423	423	423	423	423	423	422	0	0	0	15,544
PUG Feed Rate, STPY	**321**	**299**	**547**	**547**	**414**	**293**	**274**	**268**	**331**	**535**	**293**	**246**	**246**	**333**	**422**	**423**	**423**	**423**	**423**	**423**	**423**	**422**	**0**	**0**	**0**	15,544
Capital Costs																										
PUG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67,982
Hydromet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	168,226
Capital Replacement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub Consultant Costs	1,814	0	0	0	1,814	0	20,027	0	3,280	0	0	0	1,814	0	0	0	2,267	0	0	0	0	0	3,656	11,176	5,021	217,146
Working Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-24,603				
Annual Cap cost	**1,814**	**0**	**0**	**0**	**1,814**	**0**	**20,027**	**0**	**3,280**	**0**	**0**	**0**	**1,814**	**0**	**0**	**0**	**2,267**	**0**	**0**	**0**	**0**	**-24,603**	**3,656**	**11,176**	**5,021**	453,354
Operating Costs																										
PUG	7,213	6,535	11,380	11,381	8,895	6,439	6,128	6,051	7,367	11,147	6,585	5,554	5,592	7,461	9,116	9,372	9,373	9,373	9,373	9,373	9,373	9,355	0	0	0	335,187
Hydromet	73,403	76,675	102,576	92,221	79,922	70,707	72,618	74,845	77,867	93,697	78,631	74,587	74,225	80,515	84,353	62,009	62,046	62,046	62,046	62,046	62,046	51,033	0	0	0	3,269,803
Mining Operations	19,651	19,644	19,598	19,598	19,556	19,454	19,448	19,446	19,466	19,352	11,904	8,952	8,917	9,096	9,222	6,229	6,229	6,229	5,837	5,837	5,837	5,837	0	0	0	668,123
Upton TSF Operations	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	0	0	0	36,053
G&A Operating Costs	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	6,603	5,431	0	0	0	295,983
Miller Creek Road Maint.	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	0	0	0	10,350
Annual Op Cost	**107,902**	**110,489**	**141,189**	**130,834**	**116,006**	**104,235**	**105,828**	**107,976**	**112,334**	**131,831**	**104,754**	**96,728**	**96,369**	**104,707**	**110,325**	**85,245**	**85,283**	**85,283**	**84,890**	**84,890**	**84,890**	**72,686**	**0**	**0**	**0**	4,615,498
Annual Revenue																										
Market Price per Kg	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60	$24.60				
Market Price per st	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317	$22,317				
Ore Grade,(% REO)	2.74	2.94	1.85	1.83	2.31	3.15	3.24	3.26	2.70	1.92	2.89	3.19	3.09	2.46	2.11	1.73	1.73	1.73	1.73	1.73	1.73	1.73				
Overall Recovery,%	81.1%	82.7%	73.2%	71.7%	75.4%	80.9%	82.4%	83.6%	81.2%	72.2%	82.6%	84.7%	84.7%	82.3%	76.9%	75.5%	75.5%	75.5%	75.5%	75.5%	75.5%	75.5%				
Rare Earth Mineral, tons	7,135	7,260	7,394	7,191	7,201	7,468	7,314	7,292	7,260	7,418	6,987	6,639	6,443	6,731	6,847	5,637	5,637	5,637	5,637	5,637	5,637	4,134				337,971
Rare Earth Mineral, $	159,231	162,021	165,005	160,474	160,704	166,665	163,219	162,731	162,031	165,548	155,930	148,152	143,778	150,205	152,813	125,809	125,809	125,809	125,809	125,809	125,809	92,250				7,542,411
Annual Tot Rev	**159,231**	**162,021**	**165,005**	**160,474**	**160,704**	**166,665**	**163,219**	**162,731**	**162,031**	**165,548**	**155,930**	**148,152**	**143,778**	**150,205**	**152,813**	**125,809**	**125,809**	**125,809**	**125,809**	**125,809**	**125,809**	**92,250**	**0**	**0**	**0**	7,542,411
State Tax	**2,726**	**2,690**	**2,108**	**2,198**	**2,465**	**2,839**	**2,721**	**2,840**	**2,694**	**2,349**	**1,778**	**1,407**	**1,346**	**1,308**	**1,253**	**931**	**905**	**902**	**847**	**840**	**836**	**57**	**54**	**52**		
Federal Tax	**8,907**	**9,096**	**3,846**	**5,015**	**7,957**	**11,406**	**10,284**	**9,674**	**8,738**	**5,575**	**9,207**	**9,357**	**8,551**	**8,152**	**7,576**	**7,300**	**7,475**	**7,653**	**7,775**	**7,809**	**7,810**	**3,596**	**-111**	**-246**		
Taxes	**11,633**	**11,786**	**5,954**	**7,213**	**10,422**	**14,245**	**13,005**	**12,514**	**11,432**	**7,924**	**10,985**	**10,764**	**9,897**	**9,460**	**8,829**	**8,231**	**8,380**	**8,555**	**8,622**	**8,649**	**8,646**	**3,653**	**-57**	**-194**		569,736
Pre Tax Cash Flow	**46,790**	**48,842**	**21,709**	**27,442**	**40,419**	**59,591**	**34,644**	**51,915**	**43,723**	**31,368**	**49,398**	**50,018**	**44,249**	**44,190**	**41,235**	**39,634**	**37,354**	**39,625**	**40,072**	**40,079**	**40,083**	**44,109**	**-3,709**	**-11,228**	**-5,021**	
After Tax Cash Flow	**37,883**	**39,746**	**17,863**	**22,427**	**32,462**	**48,185**	**24,360**	**42,241**	**34,985**	**25,793**	**40,191**	**40,661**	**35,698**	**36,038**	**33,659**	**32,334**	**29,879**	**31,972**	**32,297**	**32,270**	**32,273**	**40,513**	**-3,598**	**-10,982**	**-5,021**	1,903,822
Cumulative After Tax Cash Flow	1,217,577	1,257,322	1,275,185	1,297,612	1,330,074	1,378,260	1,402,619	1,444,860	1,479,845	1,505,638	1,545,829	1,586,490	1,622,187	1,658,225	1,691,884	1,724,218	1,754,097	1,786,069	1,818,366	1,850,637	1,882,910	1,923,423	1,879,311	1,868,329	1,863,309	53,324,719
Annual Pre Tax Disc. Cash	**3,926**	**3,726**	**1,505**	**1,730**	**2,316**	**3,105**	**1,641**	**2,235**	**1,711**	**1,116**	**1,598**	**1,471**	**1,183**	**1,074**	**911**	**796**	**682**	**658**	**605**	**550**	**500**	**500**	**-38**	**-105**	**-43**	
Annual Post Tax Disc. Cash	**3,179**	**3,032**	**1,239**	**1,414**	**1,860**	**2,510**	**1,154**	**1,819**	**1,369**	**918**	**1,300**	**1,196**	**954**	**876**	**744**	**649**	**546**	**531**	**487**	**443**	**403**	**459**	**-37**	**-103**	**-43**	331,442

(Roche, 2014)

22.2 Model Assumptions

The cash flow model (model) includes the following major assumptions:

- All amounts are constant dollars, not adjusted for inflation;
- Financial periods are equal to one year;.
- A constant basket price for the product is assumed over the life of the project The mixed REO material would still have to undergo separation into individual rare earth oxides before these prices could be obtained, therefore Company assumed an estimated 25% discount to reflect the average cost of separation. The 25% discount was based upon a survey of various market sources and also reflects the high-quality and low impurities in RER's product;
- Mining costs vary on a year–by-year basis depending on the mine production rate. Costs for power, labor and reagents are vary on a year-by-year basis depending on the constituents found in the ore and the quantity of ore in a given year. Tailings storage operating costs, General and Administrative costs as well as Miller Creek road maintenance costs were held constant over the life of the mine;
- High-grade ore is mined in the first nine years of operation. In year ten, the ore grade drops off and the mining rate increases to maintain a relatively constant level of REO production;
- Initial capital expenditures in years 0 through 3 total $291 million. In year 10 the PUG plant is expanded to upgrade the Hydromet feed as the head grade from the mine is reduced;
- Initial net working capital for receivables, material and supplies inventory, product inventory and payables total $24.6 million;
- Closure costs are assumed to begin after the final year of production with the closure extending three years beyond the final year of production;
- No perpetual costs related to closure are included;
- Except for the PUG expansion in year 10, no capitalized equipment replacements or upgrades requiring capitalization after the beginning of production are included other than the mining equipment replacement included in the mining capital cost;
- Periodic tailings dam raises have been added to the sustaining capital cost according to design engineers' recommendations;
- Working capital is assumed to cover operating costs that occur during initial operations while revenue from operations is delayed by 90 days. This working capital is recovered when operations cease.

22.3 Financial Risks / Sensitivity Analysis

There are numerous risks to the financial viability of the project, as discussed below. As such, sensitivity analysis has been performed to assess the impacts on the financial results of the project, given variations in these major risk factors. Because of the complexity of evaluating federal taxes, all sensitivity analysis was performed on a pre-federal tax basis.

22.3.1 Rare-Earths Pricing

As discussed in Section 19.2, the Pre-feasibility study assumes an average price of $24.60 per kilogram ($11.16 per pound) of bulk mixed RE concentrates with a grade of 97+% TREO. A sensitivity case that assumes a 20% lower price for the concentrate ($19.68 per kilogram or $8.93 per pound) demonstrates the economic feasibility of the project at substantially lower long-term price forecasts.

The global market price for rare earth minerals is not as large or well established as it is for commodity minerals. Because of the comparatively narrow markets for rare earth minerals, rare earth minerals cannot be considered commodities, and their markets may be subject to conditions and manipulations that would not be present in established commodity mineral markets.

Producers cannot be considered to be perfectly competitive price-takers in the market. While the designed production level may be considered a production level at which the global price will not be impacted, risks of market manipulation by other producers exists.

These market conditions can significantly impact the financial results of the project.

22.3.2 Rare-Earths Price Fluctuations

While current prices are assumed efficient and may be at equilibrium, market conditions in the long-term may shift in either direction, causing long-term change in the mineral prices. Mineral markets are assumed to be volatile, thus currently unforeseen price level changes are possible and could significantly impact the financial results of the project. Price fluctuations of -20%/+20% were computed in the model. Tables 22.3 and 22.4 present the results of these computations.

Table 22.3 - 20% Rare-Earths Base Price Increase

(Millions) Pre-tax	8%	10%	12%
NPV	$949	$735	$581
Model	$563	$426	$327
Variation	$386	$309	$254
Percent Change	**69%**	**73%**	**78%**

(Roche, 2014)

Table 22.4 - 20% Rare-Earths Base Price Decrease

(Millions) Pre-tax	8%	10%	12%
NPV	$176	$117	$73
Model	$563	$426	$327
Variation	($386)	($309)	($254)
Percent Change	**-69%**	**-73%**	**-78%**

(Roche, 2014)

22.3.3 Discrete Cost Fluctuations for Various Inputs

Costs for the inputs for operations, capital, power or acid/reagents may not fluctuate in step with the other inputs causing adverse financial results for the project. These risks are shown in the Table 22.5 thru 22.8.

Table 22.5 - 20% Operating Costs Increase

(Millions) Pre-tax	8%	10%	12%
NPV	$355	$264	$197
Model	$563	$426	$327
Variation	($208)	($161)	($130)
Percent Change	**-37%**	**-38%**	**-40%**

(Roche, 2014)

It should be noted that the described increase in all operating costs of 20 percent does not push any of the project NPVs below zero.

Table 22.6 - 20% Capital Cost Increase

(Millions) Pre-tax	8%	10%	12%
NPV	$502	$368	$272
Model	$563	$426	$327
Variation	($61)	($57)	($54)
Percent Change	**-11%**	**-13%**	**-17%**

(Roche, 2014)

Table 22.7- 20% Power/Energy Cost Increase

(Millions) Pre-tax	8%	10%	12%
NPV	$560	$424	$325
Model	$563	$426	$327
Variation	($3)	($2)	($2)
Percent Change	**-0%**	**-1%**	**-1%**

(Roche, 2014)

Table 22.8 - 20% Acid/Reagent Cost Increase

(Millions) Pre-tax	8%	10%	12%
NPV	$461	$347	$264
Model	$563	$426	$327
Variation	($102)	($79)	($63)
Percent Change	**-18%**	**-19%**	**-19%**

(Roche, 2014)

22.3.4 Sensitivity Analysis

A summary of the sensitivity analysis is presented in Table 22.9. It has been performed to assess the impacts on the financial results of the project given variations in the risk factors.

Table 22.9 - Sensitivity Analysis

Condition	Impact on NPV @ 10% Discount	NPV @ 10% Discount (Millions)
20% decrease in price	72% decrease	$117
20% increase in price	72% increase	$735
20% decrease in operating cost	38% increase	$264
20% increase in operating cost	38% decrease	$587
20% decrease in capital cost	13% increase	$483
20% increase in capital cost	14% decrease	$368
100% decrease in operating Power cost	2% increase	$437
100% increase in operating Power cost	3% decrease	$415
20% decrease in Acids and Reagents cost	19% increase	$505
20% increase in Acids and Reagents cost	19% decrease	$347
20% decrease in labor costs	1% increase	$429
20% increase in labor costs	1% decrease	$423
20% decrease in price, 20% increase in operating cost, capital cost, acids and reagents, labor costs and 100% increase in operating power costs	108% decrease	($34)
20% increase in price, 20% decrease in operating cost, capital cost, acids and reagents, labor costs and 100% decrease in operating power costs	107% increase	$883

(Roche, 2014)

22.4 Taxes

The model includes the following taxes on the project:

1. Property used for industrial purposes – 11.5% of asset book value and assumed 76 mil rate
2. All other property, real and personal – 9.0% of estimated value
3. Wyoming state severance – 2.0% of calculated state taxable revenue (see below)
4. Crook County Ad Valorem – 6.15% of calculated state taxable revenue (see below)
5. Federal - 35% regular/20% alternative minimum tax with mineral depletion

Property tax on land for the project is calculated as shown in Table 22.10.

Table 22.10 - Property Tax on Land Cost Summary

Site	Acreage	Value	Land Value	Mill Rate	Annual Tax
Mine	1000	$3,000	$3 million	76	$20,520
Upton	1000	$3,000	$3 million	76	$20,520
				Total:	**$41,040**

(Roche, 2014)

22.4.1 Taxes Calculation Assumptions

- The property tax on land calculation is assumed constant for the life of the project;
- Property tax on the plants is calculated as the book value of the capitalized assets multiplied by 11.5%, then assessed at the 76 mil rate;
- Severance and Ad Valorem taxes are computed by first calculating the percentage of total revenue considered taxable revenue. This is accomplished by identifying the percentage of mining costs (costs incurred prior to “mouth of mine”) as a percentage of total mining and processing product costs. This percentage is multiplied by total revenue to establish total taxable revenue (“state taxable revenue”). The resulting state taxable revenue is then multiplied by the severance and ad valorem rates to compute the respective taxes;
- Wyoming does not have a state income tax;
- Federal taxes are estimated based on estimated taxable income calculations within the model, taking into consideration the Company’s historical net operating loss carry-forwards as well as alternative minimum tax regulations. The estimates utilize a percentage depletion rate of 14%.

22.4.2 Tax Impacts

- The tax burden associated with property, severance and ad valorem taxes peaks in the first two years of production. As the capitalized assets depreciate and their corresponding book values decline, the liability for property tax on capitalized property decreases;
- The federal tax burden varies throughout the mine life based on factors driving revenues and expenses such as ore recovery and associated hydrometallurgical operating costs, sustaining capital expenditures and depreciation, among other factors.

22.5 Significant Risks

The following significant risks exist are not quantified in the cash flow model:

- Marketability of product;
- Variability in actual production of the various elements cause by variability in feed assays;
- Technical risk resulting from new technology developed for portions of the rare earth processing.

22.6 Conclusions

The economic analysis conducted for the Bear Lodge feasibility study is presented in Table 22.2 and yields an after-tax internal rate of return (IRR) of 29% and an after-tax net present value (NPV) of USD $330.7 million at a discount rate of 10%.

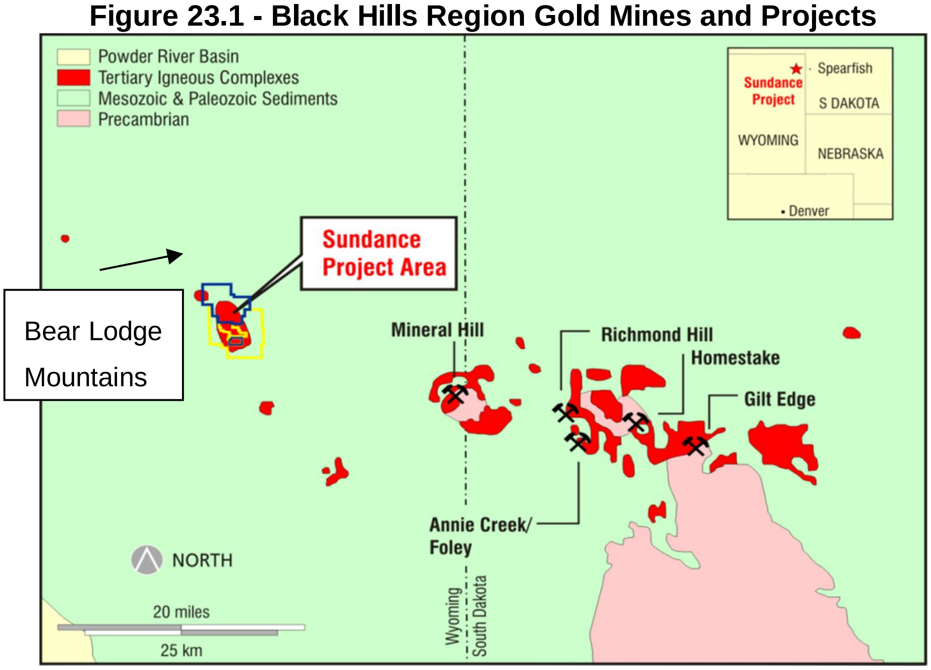
The project has a quick payback of initial capital of 2.9 years from the start of production.

23 Adjacent Properties

Rare Element's Bear Lodge Project area consists of 499 unpatented lode claims on 9,000 acres and includes all known significant rare earth occurrences in the Bear Lodge Mountains. The property hosts deposits of rare earths, as well as the Sundance Project gold deposits. There are no other known significant occurrences of rare earths in the region surrounding the Bear Lodge Mountains.

A number of precious metal mines and prospects are hosted in, and associated with, either Tertiary intrusions or Precambrian crystalline rocks in the surrounding Black Hills region of South Dakota and Wyoming. Gold deposits of Precambrian age, typified by the Homestake Mine near Lead, South Dakota, have been the dominant precious-metal producers in the northern Black Hills for more than 100 years. More recently, intrusive-hosted systems of Tertiary age in the northern Black Hills of South Dakota have produced several million ounces of gold and contain significant remaining resources. These younger deposits include Gilt Edge, Richmond Hill, Annie Creek, and Foley Ridge in South Dakota, and the Mineral Hill and Sundance (and Bear Lodge) deposits in Wyoming (Figure 23.1).

Figure 23.1 - Black Hills Region Gold Mines and Projects



(Modified from: DeWitt, Ed, Redden, J.A., Wilson, A.B., and Buscher, David, 1989, Geologic map of the Black Hills area, South Dakota and Wyoming: U.S. Geological Survey Map I–1910, scale 1:250,000.

The qualified person has been unable to verify the information and that the information is not necessarily indicative of the mineralization of the property.

24 Other Relevant Data and Information

24.1 Potential By-Products and Additional Revenue

The Bull Hill ore contains minor amounts of other minerals that could potentially be recovered. In addition, the process produces valuable by-products in the form of ammonium nitrate solution, calcium chloride and a thorium rich precipitate. Market studies have not been completed regarding the sale of these by-products.

Rare Element will need to complete a detailed investigation into the production and marketability of potential mineral by-products that could provide additional revenue for the Bear Lodge Mine.

The by-product recovery unit could be located within the Hydromet building located at the Upton processing site.

The hydrometallurgical process that has been developed by Rare Element has lower cost and produces a more pure combined rare earth oxide product that is very low in thorium content when compared to competing hydrometallurgical processes.

In addition, separate environmental and regulatory requirements may need to considered before implementing the recovery of some of these by-products.

24.2 By-product Recovery - Ammonium Nitrate and Calcium Chloride

High-purity ammonium nitrate and calcium chloride are by-products that will be produced by the hydrometallurgical process. In this pre-feasibility study, it was assumed that these by-products would have zero value.

A preliminary investigation into the value of these byproducts indicates that the ammonium nitrate if sold as a fertilizer would have a grade of 20-0-0.

A market study should be undertaken to identify potential consumers of ammonium nitrate and calcium chloride, the annual tonnage of each compound consumed, the specifications for each compound that need to be met, the location of potential markets and the price that is being paid for each compound.

24.3 Process Description

Conceptual process flow diagrams were developed that could be used to recover the by-products that have been identified. These processes would need to be validated using bench scale and pilot scale studies

24.3.1 By-Product Recovery - Gold

Measureable amounts of gold exist in both the Bull Hill and Whitetail mineralization. Gold could be recovered from the leach solution, right after the leach solution filter, by means of a solvent extraction process. Gold is selectively extracted into the organic phase using solvent extraction.

24.3.2 By-Product Recovery - Aluminum and Iron

Aluminum and Iron could be recovered as hydroxides by selective precipitation. The solid residue recovered from the distillation column bottom is dissolved in water and sent to the Al-Fe Neutralization reactor where the solution is neutralized to a pH of approximately 3.5 using sodium carbonate. Sodium carbonate was chosen in this design because it represents a significant cost savings over sodium hydroxide. The Al and Fe hydroxide solids are then filtered and disposed of in the tailings storage facility while the depleted solution is sent to the uranium recovery unit. If possible, the Fe/Al hydroxide mixture can be sold or given away (as a mixed metal) to reduce the amount of material going to the tailings unit.

24.3.3 By-Product Recovery - Uranium

Uranium could potentially be recovered through an ion exchange column containing uranium specific resin. Uranium is not currently considered as a product because its production would require additional licensing.

24.3.4 By-Product Recovery - Lead

Lead is separated from the main solution by selective precipitation using sodium hydroxide. The precipitation is achieved in a neutralization reactor where the solution is neutralized to a pH of 5.5. The solid precipitate is filtered and calcined to yield a lead oxide product. The lead-free solution is sent to the zinc recovery unit.

24.3.5 By-Product Recovery - Zinc

Zinc is separated from the main solution by selective precipitation. The main solution is neutralized to a pH of approximately 7.5 using sodium hydroxide. The solid is then filtered and calcined to yield a zinc hydroxide product while the zinc-depleted solution is sent to the manganese recovery unit.

24.3.6 By-Product Recovery - Manganese

Manganese is separated from the main solution by selective precipitation. The main solution is reacted with sodium carbonate to increase pH to 8.5 and precipitate manganese carbonate. The manganese carbonate solid is then filtered and dried before being sold as a manganese carbonate product while the depleted solution is sent to the barren solution crystallizer.

24.4 Potential Revenue from By-Products

Order of magnitude cost estimates were completed for the various process plants that would be required to recover the potential by-products and then an economic analysis was performed for each by-product. Based on this analysis, it is recommended that RER further investigate the production of the following by-products in the laboratory to confirm that their production is viable: barium-sulfate, gold, manganese, zinc, and lead. Table 24.1 provides the potential quantities of the various by-products that could be recovered from the pre-concentrate.

Table 24.1 - Bear Lodge Price Sensitivity ± 25% Summary (Million)

Element	Form	Tons/Ton of Pre-con
Barium Case		
Barium	$BaSO_4$	0.04
Gold Case		
Gold	Metal ppt.	0.023*
Mn/Zn/Pb Case		
Manganese	$MnCO_3$	0.12
Zinc	ZnO	0.01
Lead	PbO	0.01

* Troy ounces per ton (Roche, 2014)

Using current market pricing, it has been calculated that the potential revenue from the by-products listed above is in the range of $200 to $400 per ton of pre-concentrate treated, or on average, about $300 per ton in potential additional net revenue annually.

25 Interpretation and Conclusions

25.1 General

Several companies have explored the Bear Lodge area for rare earths since the 1970s, including Duval Corporation, Molycorp, Hecla, and Rare Element (through its wholly owned subsidiary Paso Rico (USA), Inc., now known as Rare Element). This pre-feasibility study captures revisions to the resource estimate, the mine, PUG plant, Hydromet plant, Tailings Storage Facility and numerous other project aspects that have been further developed and improved upon since the update of the resource estimate in 2013. The Qualified Persons listed herein have developed the conclusions presented in this section.

25.2 Geology

The Bear Lodge alkaline-igneous complex hosts one of the largest disseminated (low-grade) REE deposits in North America (M.H. Staatz, 1983, USGS Professional Paper 1049D). The Company is focused on exploring high-grade rare earth mineralized zones within this large low-grade mineralized system. The high-grade zones are strongly enriched in the most valuable critical rare earths, like neodymium, praseodymium, and europium. They contain important quantities of dysprosium, terbium, and yttrium, as well as abundant cerium and lanthanum, the most widely used REE. All of the known significant occurrences of REE mineralization in the Bear Lodge area are contained within the Rare Element claim block.

Past exploration work by Duval, Molycorp, Hecla, and Rare Element shows that potentially economic REE mineralization occurs in carbonatite dikes and their oxidized equivalents that are concentrated in an area of about 1.5 square-miles (3.9 square kilometers) near Bull Hill, in the central part of the Bear Lodge alkaline-igneous complex. The RE bearing dikes are hosted primarily within and adjacent to the western margin of the Bull Hill diatreme and within the Whitetail Ridge diatreme; both diatreme bodies consist mainly of heterolithic intrusive breccias. In the near–surface zone of weathering and oxidation, these dikes are altered to iron (Fe) oxide-manganese (Mn) oxide-REE-bearing bodies that are designated as “FMR” dikes and veins. The FMR bodies are interpreted to transition at depth into unoxidized, REE-bearing carbonatite. The FMR dikes and veins occur from the surface to a depth range of 300 to 600 feet (about 90 to 180 meters), where they progressively transition into unoxidized carbonatite over a depth interval of approximately 30 feet (9 meters). The REE mineralogy exhibits predictable variation through a series of zones delineated based on degree of oxidation and leaching of groundmass carbonate.

These zones are termed Oxidized (FMR), oxide-carbonate, transitional carbonatite, and carbonatite zones, and the zonal REE mineralogy in Bear Lodge mineralized carbonatite and derivative dikes and veins is summarized in Table 25.1:

Table 25.1 - Bull Hill Zonal REE Mineralogy

Zone	Mineralized Body	REE Mineralogy
Oxidized (FMR)	FMR dikes and veins, intensely oxidized carbonatite (Surface to appx. 5,600 feet elevation) (1,707 meters)	Bastnasite group minerals; variable monazite and cerianite.
Oxide-carbonate	Partly oxidized carbonatite and silicocarbonatite (Appx. 5,900 to 5,600 feet elevation) (1,798 to 1,707 meters) Significant matrix carbonate, but little disseminated sulfide.	Bastnasite group minerals; variable monazite, cerianite, and ancylite. Significant bastnasite formed from alteration of ancylite.
Transitional	Weakly oxidized carbonatite and silicocarbonatite (Narrow zone, 0 to 30 feet thickness) (9 meters) Significant matrix carbonate and sulfide.	Ancylite and subordinate bastnasite group minerals. Variable monazite and trace cerianite.
Unoxidized	Unoxidized carbonatite and silicocarbonatite (< 5750 feet elevation) (1,753 meters)	Ancylite and subordinate bastnasite group minerals. Variable monazite and minor carbocerianite.

(Rare Element, 2012)

The Bear Lodge REE project comprises three main resource areas: Bull Hill (includes Bull Hill West), Bull Hill Northwest, and Whitetail Ridge, plus several exploration targets that may contain resources, but which need further geological analysis (Figure 8.1). The three resource areas contain carbonatite-related dikes and veins that range in size from hairline fracture veinlets to dikes that may exceed 80 feet (24.4 meters) in width. The higher-grade REE-bearing dikes and veins are commonly enveloped in lower-grade zones of stockwork veinlets. Oxidized mineralization (FMR and oxide-carbonate) extends to depths of 500 to 600 feet (152 to 183 meters) and contains the mineable reserve (NI 43-101 basis) described in this updated technical report. The reserve is hosted entirely within the oxide and oxide-carbonate alteration zones, as described in Chapter 7.0 of this technical report.

Rare Element explored the Bull Hill area REE mineralization with 303 core holes and over 226,000 feet drilled from 2004 through 2013. All holes encountered varying quantities of rare earth mineralization in oxidized and unoxidized carbonatite dikes. Approximately sixteen drill holes were drilled in the area prior to commencement of the Company's activities in 2004. The 2013 drilling program consisted of 14 HQ-diameter drill holes at the Whitetail Ridge deposit designed to upgrade a significant portion of the resource from the Inferred to Indicated category, and 21 PQ diameter holes in the high-grade core of the Bull Hill deposit in order to upgrade part of that resource to the Measured category and develop a more detailed model of the REE grade distribution in that part of the deposit. The deposits are open for exploration in multiple directions, and further drilling is expected to substantially increase the resources. The resource area at Whitetail Ridge, and the target areas at Carbon and Taylor exhibit significantly higher enrichment in HREE than the Bull Hill area.

25.3 Mining

The exploitation plan for the Bear Lodge Project utilizes conventional truck and excavator open pit mining methods, focusing on the near-surface, oxidized portions of the deposit. A declining cutoff strategy is employed to maximize the present value of the mining schedule. This strategy incorporates the stockpiling of lower grade material (proven and probable reserves below the year's cutoff grade, but above the 1.5% TREO cutoff) for processing later in the mine's life. Mine design parameters, such as pit slopes, haul road width and grade, and minimum mining width were determined from geotechnical studies of the projected mining wall locations and the equipment selected to promote efficient mining. Mine planning is based only on the measured and indicated resources presented in the preliminary feasibility study, although significant resource (approximately 12 MMtons) is contained within the pit limits.

Total proven and probable mineral reserves are estimated at 15.6 MMtons (14.15 MMtonnes) grading 2.78% TREO. Subgrade and waste rock are estimated at nearly 133 million tons, for an average stripping ratio of 8.5. The life of the open pit is projected at 38 years, supplying 500-600 tpd of feed to the proposed Hydromet plant in Upton, WY. Total daily mining rates, including ore and waste rock, are projected to range between 14,000 and 18,800 tons using 9-yd^3 excavators and 60-ton haul trucks. Processing of a low-grade stockpile at the Bear Lodge site will extend the life of the Hydromet plant to 45 years.

25.4 Infrastructure

The Bear Lodge Project's required infrastructure is divided into two areas. The Bull Hill Mine and PUG plant site, and the Upton, WY Hydromet site and TSF.

The Bull Hill Mine and PUG plant will require construction and upgrade of Miller Creek road, upgrade of the power supply to the Bull Hill site, and installation of a well to supply the processing facility with fresh water.

The Hydromet site infrastructure will include connection to the Upton, WY municipal water network to supply the Hydromet plant with fresh water, a new connection to the industrial park natural gas network, and a new tailing storage facility located adjacent to and south of the Hydromet plant. Power to the site will be provided by PreCorp at 25 KV from an existing substation in the industrial park.

25.5 Economic Analysis

Table 25.2 presents the Bear Lodge Project financial summary, as taken from Chapter 22.

Table 25.2 - Bear Lodge Financial Summary (US$ Million)

Pre-tax / After-tax NPV @ 10% Discount Rate	$426 / $330
Pre-tax / After-tax IRR	32.7% / 28.6%
Project Payback After Start-up (years)	2.9
Assumed Discounted RE basket price/kg	$24.60
Estimated Annual Cash Operating Cost, LOM (US$ millions)	$102.6

(Roche, 2014)

25.6 Risks

The economics for the Company's Bear Lodge Project indicate a 2.9 year payback of the initial $290 million required to develop the project subject to the following factors.

25.6.1 Markets and Price

The global market and price for rare earth minerals is not as large or well established as it is for commodity minerals. The rare earths industry is dominated by Chinese producers and consumers with virtually all sales and purchases of rare earths products based on contract prices negotiated privately by buyers and sellers. There are a few relatively well-known sources of published estimated prices that are based on surveys of market participants by the websites or organizations that publish them. These include metal-pages.com, asianmetal.com and "Industrial Minerals" magazine. However, prices for individual RE elements among these sources can differ markedly even in the same timeframe and, according to some market participants, prices for actual market transactions in rare earths sometimes differ significantly from the prices quoted by these sources.

There are some specialized consulting firms in rare earths or industrial minerals that perform market studies in the rare earths business and create rare earths price forecasts for clients based on the individual project's rare earths distribution and intended products. These organizations tend to use conventional mineral economics approaches to forecasting, based on historical experience in the rare earths markets and the limited information available. Such studies and forecasts are hindered by the lack of information in rare earths markets that lack the transparency that can be found in many other markets for the more common mineral commodities. The relatively recent start-up of newly created rare earths exchanges provides extremely limited data on exchange trades of certain physical RE metals, and there is no futures market or forward price curve for rare earths that could inform RE price forecasting.

Because of the rapid evolution of technology, forecasts of future demand for rare earths overall and for individual RE elements are inherently uncertain. Rare earth elements are used for their unique magnetic, catalytic and phosphorescent properties, and they are a significant enabler in many high-technology applications. This often makes them particularly difficult to substitute without sacrificing product performance or quality. Rare earths tend to be used in small amounts in many of their applications, in conjunction with other materials or in smaller components that make up much larger products. For these reasons, they can also be challenging to recycle. New applications for rare earths and RE products are being developed continuously, and successful new applications can have an outsized impact on what are typically relatively small global markets. We expect these factors to continue to cause significant volatility in RE markets and prices from time to time.

Given the opaque nature of much of the rare earth market and the limitations of pricing methodologies noted, the Company took and empirical approach to the assumed rare earths pricing for this PFS to determine the discount to reflect the cost of separation as described in detailing Chapter 19, Rare Earths Markets and Pricing.

Because of the comparatively narrow markets for REs or REOs they cannot be considered commodities, and their markets may be subject to conditions and manipulations that would not be present in established commodity mineral markets.

The rare earths have been volatile, thus currently unforeseen price level changes are possible and could have a significant impact on the financial results of the project.

The Company currently does not have off-take agreements for the sale of the REO concentrate. Several rare earth separation facilities have been identified as potential customers.

25.6.2 Technology

On January 21, 2014, the company announced the filing of a utility patent for rare earth processing technology that produces nearly thorium free, pure rare earth concentrate.

The process was developed and tested successfully in both bench and pilot scale programs within the last year. These test programs were conducted at the SGS Laboratories in Lakefield Ontario Canada.

Technology risks include the optimization of these technologies and their associated economics including scale up risk. Cost risk exists if prices for equipment reagents, energy, or other inputs increase faster than the rate of overall inflation, in which case the project economics could be negatively impacted. Detailed engineering of several of the infrastructure and support facilities has not been completed. Remaining engineering tasks include the development of a raw water supply system and water rights at the mine site, establishment of access road easements along the county road, and the final power line routing to the mine site. These details will be finalized in the feasibility study.

25.6.3 Environmental and Permitting

One of the important project risks is with timely completion of the environmental and permitting process. The procedures for obtaining a mining permit from the Wyoming Department of Environmental Quality (WDEQ) are well established however, the timing could be impacted by a host of factors out of the Company's control.

The Environmental Impact Statement (EIS) process is also well established in the National Environmental Policy Act (NEPA), which is the formal process to review the impact of the proposed mining activities on federal public lands. A Plan of Operations was submitted to the United States Forest Service in 2012 and outlines the proposed disturbance and impacts associated with the project. This plan was accepted as complete in May 2013. While the Company is actively continuing to establish the environmental baseline conditions, there is a risk that the final Record of Decision (ROD) could be denied, contain conditions that would adversely affect the project economics, or be challenged. The Company is developing extensive impact studies and will establish the best available mitigation measures to meet regulatory agency requirements.

25.7 Opportunities

The limits of the REE-mineralized system on the Bear Lodge property have yet to be determined. The development of existing deposits outside of the Bull Hill mine area, the identification of areas peripheral to the Bull Hill deposit that carry significant enrichment in HREE, and excellent potential for the discovery of new REE exploration target areas all add significant upside potential to the project. Oxidized equivalents of carbonatite and carbonatite-related REE mineralization are widespread on the property. Current data indicate that the area proximal to the Bull Hill and Whitetail Ridge diatremes is likely to be the most prospective for the occurrence of significant REE-mineralized bodies, including those with higher HREE enrichment. RE mineralization of similar grade as the Bull Hill mine area is also found in targets beyond the immediate vicinity of the two diatremes.

Although the resources falling in the inferred category were not used in the preliminary feasibility study, they represent a significant opportunity for the project. As reported in Table 14.34, the total Inferred resource is 46.0 million tons (41.7 million tonnes) at an average grade of 2.53% TREO (1.5% cut off). Approximately 31.8 million tons (28.9 million tonnes) are high-grade oxide resources at a grade of 2.58% TREO. Future drilling campaigns will focus on converting this inferred resource into the measured and indicated categories, potentially extending the mine life, reducing the stripping ratio, and/or providing expansion opportunity.

While an attractive and viable process has been developed for processing Bear Lodge ore, further untested process improvement will be investigated that have the potential to decrease reagent usage and resulting costs and improve product quality. Recovery of by-products from the leach solution as well as sale of by-products that will be generated in the Hydromet process also have the potential to improve project economics.

The Company plans to move into more detailed metallurgical design and engineering to be reported in a feasibility study expected to commence in late 2014. The Company anticipates that the feasibility study will further confirm the economic viability of the Bear Lodge Project. The Company has also initiated a preliminary rare element separation test program.

26 Recommendations

Roche recommends that Rare Element Resources proceed with a program to prepare a feasibility study. This study should include additional investigations within the mine, the PUG and the Hydromet areas of the Bear Lodge project. In addition, the Company should continue to explore the development of individual element separation technology.

The Company solicited quotations form four select international engineering firms to complete the preparation of a feasibility study. These bids ranged from $2.54 million to $5.9 million. These cost estimates were exclusive of additional site investigation work, additional trade off studies, and additional metallurgical testwork. The cost estimates for the individual preparatory studies have been included.

26.1 Mining

26.1.1 Pit Grade Control Plan

Establishment of a good ore control program at the Bear Lodge Project will be important to minimize dilution and avoid misclassification of ore and waste. There are opportunities to improve ore control through better selectivity of mining at the bench face in the high-grade zones and utilizing the most appropriate mining equipment for the different mineralization characteristics across the ore body. Potential grade control concepts include:

- Visual on-the-spot ore/waste decisions at the bench face when in the high-grade ore at Bull Hill could reduce dilution, maintain mine grades, and avoid misclassification of material. The highest grade ore at Bull Hill is visually distinct and could be selectively mined based on color. The low-grade ore and waste can be easily distinguished from the darker FMR high-grade material;
- Sampling of vertical blast holes for ore control may be unreliable for the high-grade zone of the Bull Hill mineral system, dominated by steeply dipping veins. Substituting RVC drilling for core presents an opportunity to reduce cost and improve speed. Further testing is merited considering the potential benefits;
- Development of a pit grade control plan is recommended. The pit grade control plan must ensure a consistent feed to the PUG and the production of a consistent grade of pre-concentrate material. The pit grade control plan should be based on the REE and radionuclides content of various locations in the mine,

on the specific areas rock types, the distribution within the mine, and on the upgrade potential of various rock types.

26.1.2 Update the Pit Slope Stability Evaluation of the Bull Hill & Whitetail Ridge Open Pits

The current design recommendations for pit slopes are based on limited hydrogeological information of the pit area and limited geo-mechanical information. An additional groundwater modeling data study of the pit area has been completed and the pit slope stability evaluation should be updated to incorporate a new drilling and strength testing program. The ultimate pit design developed for the PFS will be used as the starting point for the slope stability update study, which will need to be completed prior to commencement of feasibility study mine planning work.

26.2 Waste Rock Facility

Additional geotechnical exploration and laboratory testing are required as part of the feasibility study to further evaluate the following:

- The foundation above Beaver Creek to confirm stability of the proposed waste dump plan or possible alternative layouts;
- The foundation and abutment areas of the sediment control structures (stability, outlet works, spillway alignment and borrow material);
- Diversion alignment to confirm constructability with respect to the bedrock topography, channel seepage, peak flow erosion potential and outward fill slope stability;
- Waste rock toe area stability in the event temporary inundation of the waste rock toe is required to achieve adequate storage capacity for the design storm event and maintain facility footprints within Section 16;
- Confirm the estimated density of the in-place waste rock. A higher density will allow reduction in height and/or footprint of the WRF.
- Confirm estimated waste rock strength parameters for use in the WRF feasibility study stability analysis.
- Confirm the pit expansion schedule and groundwater conditions to confirm that the final location and capacity of the pit dewatering pond (currently located between the pit and PUG Plant) is acceptable.
- Confirm whether Beaver Creek will be diverted or avoided in the WRF footprint.

- The company has received a budgetary quotation from an engineering company to complete these studies for $295 ,000

26.3 Physical Upgrade Plant

26.3.1 Large-Scale Pilot Plant

A larger-scale pilot plant is recommended mainly to provide confirmation of design parameters for engineering. This plant will identify material handling issues, if any, in conveying, gravity separation, magnetic separation, thickening, filtration and slurry pumping that were not already identified in pilot testing.

The large-scale pilot PUG plant will provide feed to a potential large scale pilot Hydromet plant that is also recommended. The estimated cost for the PUG pilot plant are included in the hydromet pilot plant cost estimate.

26.3.2 Pre-Concentrate Material Characterization

Various material handling tests will be required to design the PUG. These material handling tests include:

- Filtration testing;
- Settling testing;
- Slurry characterization and flow testing;
- Angle of repose for solids;
- Angle of discharge for solids;
- Solids flow characteristics.

The estimated costs for these programs are approximately $250,000.

26.4 Hydromet Plant

26.4.1 Large-Scale Pilot Plant

A large-scale pilot plant is recommended mainly to provide confirmation of design parameters for detailed engineering. The plant will confirm materials of construction selections, and identify material handling issues, if any, in mixing, thickening, filtration and slurry pumping.

A capital and operating cost estimate has been prepared by an engineering firm to construct and operate a large-scale pilot plant for up to one year. The capital cost has been estimated to be $8.75 million and the annual operating cost of $3.1

million. Additional infrastructure costs may also be needed depending on the final location of the plant.

26.4.2 Reagent Confirmation

Reagent consumption and concentration derived from pilot plant testing will be confirmed.

26.4.3 Process Characterization Confirmation

Process characterization confirmation will involve the characterization of the various streams of the process through large-scale pilot plant testing. The testing will involve:

- Characterization of the off-gases from the kiln as well as the treatment of these gases;
- Characterization of the effluents with regard to uranium and thorium abundances;
- Characterization of the chloride stream with regard to the cations present in solution.

26.4.4 Material Handling Confirmation

Various material handling steps will be required within the design of the Hydromet plant. Confirmation of these material handling steps will be done on the slurries from the Hydromet plant and will include:

- Filtration testing and wash efficiency;
- Settling testing;
- Slurry characterization and flow testing.

26.5 Process Studies Cost

Cost estimates for these studies are preliminary and will be refined once a more defined scope has been developed.

26.5.1 Separation of Rare Earth Oxide Product

Testing is required to determine the process required to separate the rare earth oxide product into either individual elements or groups of elements to increase the value of the products to be marketed. In conjunction with this work, market studies will be undertaken to determine what additional separation will provide the highest return on investment. The cost for bench scale tests to develop a process for specific strategic baskets is $55,000. After the baskets are known, the cost of bench scale tests to develop a process for individual separation of individual elements is approximately $30,000.

26.5.2 Ammonium Nitrate and Calcium Chloride Market Study

A market study should be undertaken to identify potential consumers of ammonium nitrate and calcium chloride. The PFS has assumed that these by-products have no value. A market study would determine a value and the optimal form for sale. The cost for this market study is estimated at $25,000.

26.5.3 Gold Recovery

Bench scale testing of a process for the recovery of gold should be completed to evaluate the recovery efficiency and process design parameters of a gold recovery unit. The low concentration of gold in solution may however, impact recovery to determine if it is economic. It is estimated that a study to develop a gold recovery process is expected to cost $10,000.

26.5.4 Uranium and Thorium Byproduct

A high-level market and permitting requirements study on the sale of radionuclides should be performed to evaluate the profitability of selling a thorium or uranium precipitate. In the PFS, the thorium precipitate is transported as a waste to a licensed disposal facility. A study of the beneficiation of manganese and valuable metal products is expected to cost $65,000 and would include an investigation of uranium and throium.

26.5.5 Manganese/Zinc/Lead Byproduct

A market study and bench scale testing of a potential manganese/zinc/lead by-product recovery process should be performed to evaluate the profitability of the installation of a manganese/zinc/lead recovery unit. The cost to study these potential byproducts is included in the study cost mentioned in Section 26.5.4.

26.6 Tailings Storage Facility

Some additional work will be required to complete the final design of the TSF. The Company has received a budgetary quotation from an engineering company to complete these studies for $420,000.

26.6.1 Tailings Characteristics and Handling

The tailings mass balance for production and neutralization, and the product geotechnical characteristics will need to be confirmed to verify the assumption used in the TSF preliminary feasibility design. These include the handling requirements for transport and placement of the tailings, and potential changes in characteristics and behavior over time and exposure to climatic conditions.

26.6.2 Tailings Geochemical Characteristics

Additional geochemical testing is needed to properly characterize the tailings once the final tailings product and neutralization mass balance are defined and representative samples in sufficient quantity are available for testing. Testing includes interaction/compatibility of tailings seepage with the foundation soils.

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Standard RSD's Generated from 2009-2013 Drill Standard Analyses
2009-2013 Drill Standard Analyses Results
Standard Analyses for % TREO
2009-2013 Drill Duplicates Results
Crush and Pulp Duplicate Analyses for % TREO
2010-2013 Check Analysis Results
2010-2013 Check Analysis for % TREO

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Feed HCl acid to distillation column (recoverable)
Composition of Oxalate Crystals Recovered from Distillation Residual Solution (Recycled)
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Bear Lodge Price Sensitivity ± 25% Summary (Million)

Chapter 25

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Chapter 26

N/A

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