TECHNICAL REPORT FOR THE GREENS CREEK MINE, JUNEAU, ALASKA, USA

NI 43-101 Report

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CAUTIONARY STATEMENT ON FORWARD-LOOKING INFORMATION

This Technical Report contains forward-looking statements within the meaning of the U.S. Securities Act of 1933 and the U.S. Securities Exchange Act of 1934 (and the equivalent under Canadian securities laws), that are intended to be covered by the safe harbor created by such sections. Such forward-looking statements include, without limitation, statements regarding the Company's expectation of the Greens Creek Mine and its expansions, including estimated capital requirements, expected production, cash costs and rates of return; mineral reserve and mineral resource estimates; estimates of silver, lead and zinc grades; and other statements that are not historical facts. We have tried to identify these forward-looking statements by using words such as "may," "might", "will," "expect," "anticipate," "believe," "could," "intend," "plan," "estimate" and similar expressions.

Forward-looking statements address activities, events or developments that Hecla Mining Company expects or anticipates will or may occur in the future and are based on information currently available. All forward-looking statements in this Technical Report are necessarily based on opinions and estimates made as of the date such statements are made and are subject to important risk factors and uncertainties, many of which cannot be controlled or predicted. Material assumptions regarding forward-looking statements are discussed in this Technical Report, where applicable. In addition to, and subject to, such specific assumptions discussed in more detail elsewhere in this Technical Report, the forward-looking statements in are subject to the following assumptions: (1) there being no signification disruptions affecting the operation of the Greens Creek Mine; (2) the availability of certain consumables and services and other key supplies being approximately consistent with current levels; (3) labour and materials costs increasing on a basis consistent with current expectations; (4) that all environmental approvals, required permits, licenses and authorizations will continue to be held on the same or similar terms and obtained from the relevant governments and other relevant stakeholders within the expected timelines; (5) certain tax rates; (6) the timelines for exploration activities; and (7) assumptions made in Mineral Resource and Mineral Reserve estimates, including geological interpretation grade, recovery rates, metal price assumptions, and operational costs; and general business and economic conditions. Although Hecla management believes that its expectations are based on reasonable assumptions, it can give no assurance that these expectations will prove correct.

Important factors that could cause actual results to differ materially from those in the forward-looking statements include, among others, risks that Hecla's exploration and property advancement efforts will not be successful; risks relating to fluctuations in the price of silver, lead and zinc; the inherently hazardous nature of mining-related activities; uncertainties concerning Mineral Reserve and Mineral Resource estimates; uncertainties relating to obtaining approvals and permits from governmental regulatory authorities; and availability and timing of capital for financing exploration and development activities, including uncertainty of being able to raise capital on favorable terms or at all; as well as those factors discussed in Hecla's filings with the SEC, including Hecla's latest Annual Report on Form 10-K and its other SEC filings (and Canadian filings) including, without limitation, its latest Quarterly Report on Form 10-Q. Hecla does not intend to publicly update any forward-looking statements, whether as a result of new information, future events, or otherwise, except as may be required under applicable securities laws.

CAUTIONARY STATEMENTS TO INVESTORS ON MINERAL RESERVES AND MINERAL RESOURCES

Reporting requirements in the U.S. for disclosure of mineral properties are governed by the SEC and included in the SEC's Securities Act Industry Guide 7, entitled “Description of Property by Issuers Engaged or to be Engaged in Significant Mining Operations” (Guide 7). Although the SEC has recently issued new rules rescinding Guide 7, the new rules are not binding until January 1, 2021, and at this time the Hecla still reports in the U.S. in accordance with Guide 7. However, Hecla is also a “reporting issuer” under Canadian securities laws, which require estimates of mineral resources and mineral reserves to be prepared in accordance with Canadian National Instrument 43-101 (NI 43-101). NI 43-101 requires all disclosure of estimates of potential mineral resources and mineral reserves to be disclosed in accordance with its requirements. As a result, information in this Technical Report concerning the properties and operations of Hecla has been prepared in accordance with Canadian standards under applicable Canadian securities laws and may not be comparable to similar information for U.S. companies.

Reporting requirements in the United States for disclosure of mineral properties under Guide 7 and the requirements in Canada under NI 43-101 standards are substantially different. This Technical Report contains a summary of certain estimates of the Company, not only of proven and probable mineral reserves within the meaning of Guide 7, but also of mineral resource and mineral reserve estimates estimated in accordance with the definitional standards of the Canadian Institute of Mining, Metallurgy and Petroleum referred to in NI 43-101. Under Guide 7, the term "mineral reserve" means that part of a mineral deposit that can be economically and legally extracted or produced at the time of the mineral reserve determination. The term "economically", as used in the definition of mineral reserve, means that profitable extraction or production has been established or analytically demonstrated to be viable and justifiable under reasonable investment and market assumptions. The term "legally", as used in the definition of mineral reserve, does not imply that all permits needed for mining and processing have been obtained or that other legal issues have been completely resolved. However, for a mineral reserve to exist, Hecla must have a justifiable expectation, based on applicable laws and regulations, that issuance of permits or resolution of legal issues necessary for mining and processing at a particular deposit will be accomplished in the ordinary course and in a timeframe consistent with Hecla's current mine plans. The terms “measured mineral resources”, “indicated mineral resources,” and “inferred mineral resources” are Canadian mining terms as defined in accordance with NI 43-101. These terms are not defined under Guide 7 and are not normally permitted to be used in reports and registration statements filed with the SEC in the United States, except where required to be disclosed by foreign law. The term “mineral resource” does not equate to the term “mineral reserve”. Under Guide 7, the material described herein as “indicated mineral resources” and “measured mineral resources” would be characterized as “mineralized material” and is permitted to be disclosed in tonnage and grade only, not ounces. The category of “inferred mineral resources” is not recognized by Guide 7. Investors are cautioned not to assume that any part or all of the mineral deposits in such categories will ever be converted into proven or probable mineral reserves. “Mineral Resources” have a great amount of uncertainty as to their existence, and great uncertainty as to their economic and legal feasibility. It cannot be assumed that all or any part of such a “mineral resource” will ever be upgraded to a higher category or will ever be economically extracted. Investors are cautioned not to assume that all or any part of a “mineral resource” exists or is economically or legally mineable. Investors are also especially cautioned that the mere fact that such mineral resources may be referred to in ounces of silver and/or gold, rather than in tons of mineralization and grades of silver and/or gold estimated per ton, is not an indication that such material will ever result in mined mineral reserve which is processed into commercial silver or gold.

DATE AND SIGNATURE PAGE

This report titled “Technical Report for the Greens Creek Mine, Juneau, Alaska, USA,” prepared by Hecla and dated April 1, 2019, was prepared and signed by the following authors:

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Text Abbreviations

Abbreviation/ Symbol	Explanation
®	Registered name
43-101, NI43-101	Canadian National Instrument 43-101
AIPG	American Institute of Professional Geologists
ARD	Acid rock drainage
BLM	US Bureau of Land Management
CIM	Canadian Institute of Mining, Metallurgy, and Petroleum
CPG, P. Geo	Certified or registered Professional Geologist
E	East
GPS	Global Positioning System
ICP-ES	inductively coupled plasma emission spectroscopy
ID	Inverse Distance (estimation algorithm)
IRR	Internal rate of return
LOM	Life of mine
MMSA	Mining and Metallurgical Society of America
N	North
n, or N	Number (count)
NN	Nearest neighbor (estimation algorithm)
NPV	Net present value
NSR	Net smelter return
OK	Ordinary kriging (estimation algorithm)
PE, P. Eng	Registered Professional Engineer
QA/QC	Quality assurance and quality control
QP	‘Qualified Person’ as per NI43-101
RC	Reverse circulation
RM	Registered Member (of SME or MMSA)
RQD	Rock quality designation
S	South
SG	Specific gravity
SME	Society for Mining, Metallurgy, and Exploration
SMU	Selective mining unit
SRM	Standard reference material (refers to QA/QC of assay data)
TDF	tailings disposal facility
TDS	total dissolved solids
TR	Technical Report, as defined by NI43-101
TSS	total suspended solids
USFS	United States Forest Service
USGS	United States Geological Survey
W	West

Chemical Symbols

Chemical Symbol	Element
Ag	silver
Al	aluminum
As	arsenic
Au	gold
Ba	barium
Bi	bismuth
B	boron
C	carbon
Ca	calcium
$CaCO_3$	calcium carbonate
Cd	cadmium
CO	carbon monoxide
Co	cobalt
Cr	chromium
Cu	copper
Fe	iron
FeOx	iron oxides
H	hydrogen
Hf	hafnium
Hg	mercury
K	potassium
Li	lithium
Mg	magnesium
Mn	manganese
Mo	molybdenum
N	nitrogen
Na	sodium
Ni	nickel
O2	oxygen
Pb	lead
S	sulfur
Sb	antimony
Se	selenium
Si	silicon
Sn	tin
SO2	sulfur dioxide
Tl	thallium
Zn	zinc

Abbreviations of Unit Measurement

Abbreviation/ Symbol	Explanation
“	inch or inches
‘	foot or feet
#	number
%	percent
$	US dollars
/	per
<	less than
>	greater than
µm	micrometer (micron)
a	annum/ year
Å	angstroms
asl	above sea level
B	billion
BQ	1.44-inch core size
c.	circa
cfm	cubic feet per minute
cm	centimeter
d	day
d/wk	days per week
dmt	dry metric tonne
dst	dry short ton
fineness	parts per thousand of gold in an alloy
ft	feet
ft^3	cubic foot/cubic feet
ft^3/ton	cubic feet per ton
g	gram
g/m^3	Grams per cubic meter
Ga	billion years ago
gpm	gallons per minute
ha	hectare
HP	horsepower
HQ	2.5-inch core size
in or in.	inches
km	kilometer
km^2	square kilometer
koz	thousand ounces
kV	kilovolt

Abbreviation/ Symbol	Explanation
kVA	kilovolt–ampere
kW	kilowatt
kWh	kilowatt hour
lb	pound
M	million
m	meter
m^2	square meter
m^3	cubic meter
Ma	million years ago
mesh	size based on the number of openings in one inch of screen
Mft	million feet
mi	mile/miles
Mlb	million pounds
mm	milimeter
Moz	million ounces
Mt	million tons
Mt/a	million tons per annum
MW	megawatts
NQ	1.87-inch core size
º	degrees
ºC	degrees Celsius
ºF	degrees Fahrenheit
oz	ounce/ounces (troy ounce)
oz/ton, opt	ounces per ton
pH	measure of the acidity or alkalinity of a solution
pop	population
ppb	parts per billion
ppm	parts per million
PQ	3.35-inch core size
Q	flowrate
t	US ton (short ton), 2000 pounds
t/a	tons per annum (tons per year)
t/d or tpd	tons per day
t/h	tons per hour
USD	US dollars
wt%	weight percent
yr	year

1.0 SUMMARY

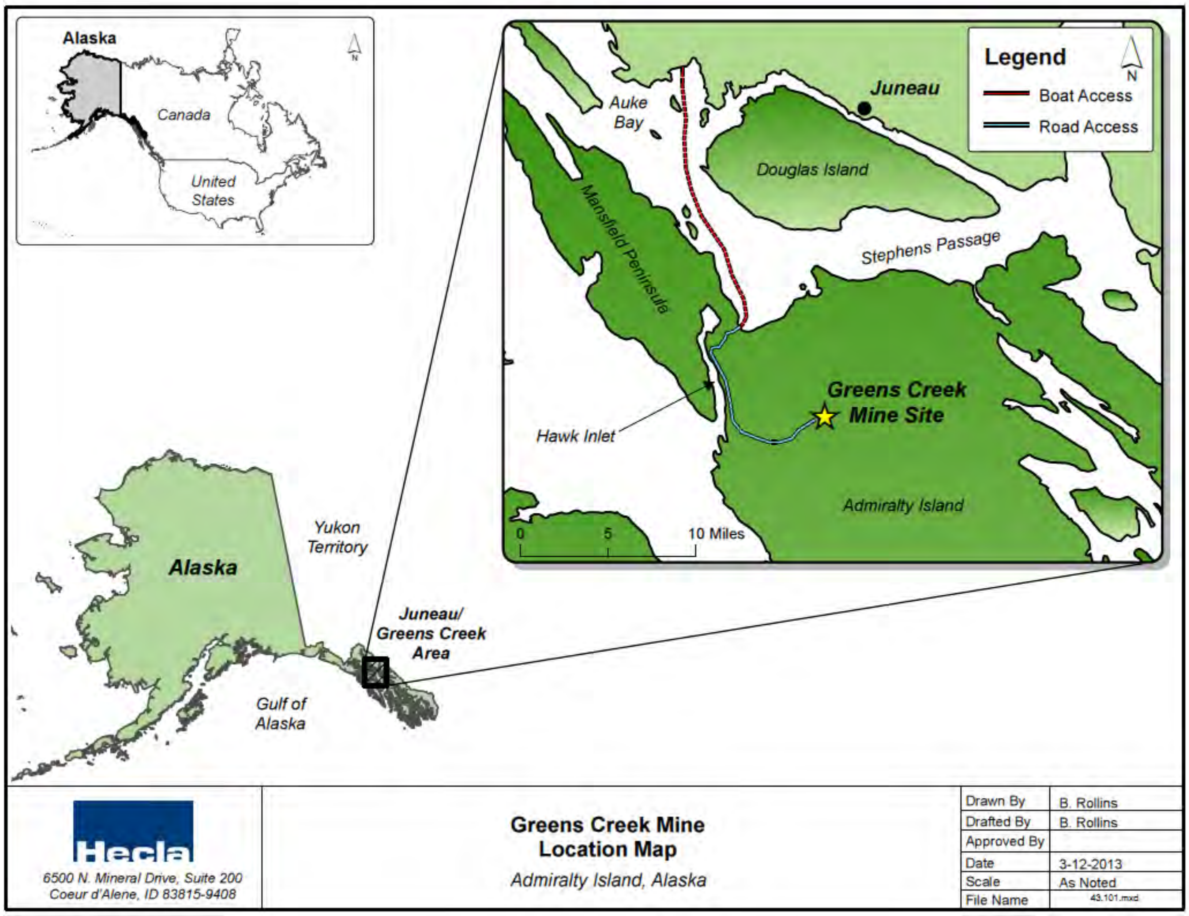
Hecla Mining Company (Hecla, or the Company) has prepared an updated Technical Report (TR, or the Report) in accordance with National Instrument 43-101 (NI 43-101) of the Canadian Securities Administrators on the Greens Creek polymetallic mining operation (the Project) located on Admiralty Island in southeast Alaska, United States. In a news release dated February 14, 2019, Hecla reported a new Mineral Resources and Mineral Reserve estimate, effective December 31, 2018 for the Greens Creek Mine. The updated Mineral Resource and Mineral Reserve represents a material increase from the previous 43-101 TR published in 2013. This 43-101 Technical Report summarizes the scientific and technical information that supports the new life of mine (LOM) plan based on the December 31, 2018 Mineral Reserves for the mine. Unless otherwise stated, all information in the report is effective as of December 31, 2018. All currencies in this document are expressed in U.S. dollars and all units of measurement are expressed in US imperial units unless otherwise noted.

1.1 Property Description and Location

The Greens Creek Mine is a producing 2,300 t/d underground mining operation located in the southeastern part of Alaska on Admiralty Island (Figure 1-1), within the confines of Admiralty Island National Monument (Monument). The mine portal is at an elevation of 920 ft (280 m) above sea level.

Hecla holds a 100% interest in the Greens Creek polymetallic (Au, Ag, Pb, Zn) mining operation through its indirectly-held subsidiaries Hecla Greens Creek Mining Company, Hecla Juneau Mining Company and Hecla Alaska LLC. In this report, the name Hecla is used interchangeably for the parent and subsidiary companies.

Figure 1-1: Project Location



1.1.1 Mineral Tenure, Surface Rights, and Royalties

The land comprising the Greens Creek Mine, inclusive of all Admiralty Island facilities, consists of both publicly and privately-owned land. The Greens Creek Project includes 440 unpatented lode mining claims, 58 unpatented mill site claims, 17 patented lode claims, one patented millsite and other fee lands, notably the Hawk Inlet historic cannery site. There are approximately 8,072 acres, or 3,267 hectares (ha), of unpatented claims and 328 acres (133 ha) of patented claims. The total land package encompasses 16,140 acres (6,530 hectares).

Hecla also holds title to mineral rights on 7,301 acres (2,955 ha) of federal land acquired through a land exchange (the Land Exchange) with the United States Forestry Service (USFS). Hecla leases parcels from the United States on both the Monument and non- monument lands. Hecla uses other public lands pursuant to special use permits issued by the USFS and leases issued by the State of Alaska. The land exchange confers restricted surface usage rights.

Bristol Bay Resources holds a 2.5% net smelter return (NSR) royalty based on its original 11.2142% interest in the Greens Creek Joint Venture.

Per the Greens Creek Land Exchange Act of 1995, (Public Law 104-123), properties in the land exchange are subject to a royalty payable to the USFS that is calculated on the basis of net island receipts (NIR). Net island receipts are equal to revenues from metals extracted from the Land Exchange properties less transportation and treatment charges (e.g., smelting, refining, penalties, assaying) incurred after loading at Admiralty Island. The Net Islands Receipt royalty is 3% if the average value of the mineral reserve during a year is greater than $120 per ton ($132/tonne), in 1994 dollars, of ore, and 0.75% if the value is $120 per ton ($132/tonne) or less. The benchmark of $120 per ton ($132/tonne) was adjusted annually according to the US Gross Domestic Product (GDP) Implicit Price Deflator until the year 2016, after which time it became a fixed rate of $161/ton.

1.1.2 Environment, Permits, and Social Impact

The Greens Creek Mine is currently regulated by approximately 70 separate permits and approvals issued by various Federal, State and Municipal agencies covering activities at and around the Greens Creek operation. The operation of the mine and associated facilities are authorized in part under a series of leases and other land use authorizations from the USFS and are carried out in accordance with the General Plan of Operations (GPO) approved by the USFS. Certain areas of the mine’s operation are also subject to other Federal and State permits, and approvals issued by other Federal and State agencies. Hecla holds all required permits for mine operation. The permits are sufficient to ensure that mining activities are conducted within the regulatory framework required by Alaskan State and Federal regulations.

An extensive environmental monitoring system is in place and additional monitoring is proposed during mine closure activities. Compliance monitoring is undertaken to verify that the Project operates within permit limitations thereby minimizing impact to the environment during operations and post closure. Monitoring activities include: surface, ground, process, and drinking water monitoring; geochemical characterization of tailings, waste rock, and construction rock; geotechnical monitoring of Site 23 and the tailings disposal facility (TDF), including Ponds 7 and 10; and biological monitoring of activities during operations and closure.

Hecla has prepared a reclamation and closure plan to address interim, concurrent, final reclamation and post-mining land use of the Greens Creek Mine. The reclamation and closure plan and closure cost estimates are submitted to the USFS, the Alaska Department of Natural Resources (ADNR) and the Alaska Department of Environmental Conservation (ADEC). The estimated cost of reclamation and closure, net of salvage, at the end of mine life, is $89.9 million.

The mine currently holds the appropriate social licenses to operate. Hecla has developed a communities’ relations plan to identify and ensure an understanding of the needs of the surrounding communities and to determine appropriate programs for filling those needs. The company monitors socio-economic trends, community perceptions and mining impacts.

1.2 Accessibility, Climate, Local Resources, Infrastructure and Physiography

The mine and concentrator are accessible via passenger ferry originating from Auke Bay, Juneau, to Young Bay on Admiralty Island, and then by private road. A marine terminal is located on the island at Hawk Inlet for supplies and concentrates load-out. Seaplane service is available from the Juneau airport to Hawk Inlet.

The key Project infrastructure consists of the mine, a processing plant, tailings impoundment area, a ship-loading facility, camp facilities and a ferry dock.

Winters are moist, long, but only slightly cold; spring, summer, and fall are cool to mild. Snowfall occurs chiefly from November to March. Mining activity occurs year-round; however, exploration activities are typically conducted over five months, between May to October.

The ecology of Admiralty Island is dominated by temperate rainforest that is primarily made up of Sitka spruce, and western hemlock interspersed with small areas of muskeg.

1.3 History

The Greens Creek deposit was discovered by the Pan Sound Joint Venture in 1973. The original joint venture partners included Noranda Exploration, Marietta Resources International, Exhalas Resources Corporation, and Texas Gas Exploration. In 1978, following the involvement of the Bristol Bay Native Corporation, the Pan Sound Joint Venture was dissolved and replaced by the Greens Creek Joint Venture in which Bristol Bay Resources held an interest on behalf of the Native Corporation. Over subsequent years, the makeup of the joint venture partners in the Greens Creek Joint Venture changed, such that by 2008, the partners comprised Hecla, Kennecott Greens Creek Mining Company, and Kennecott Juneau Mining Company. In 2008, Hecla bought out the two Kennecott interests.

1.4 Geology and Mineralization

The Greens Creek deposit is a volcanogenic massive sulfide (VMS) deposit with a relatively high precious metal content compared to other deposits of its type. The host rock consists predominantly of marine sedimentary and mafic to ultramafic volcanic and plutonic rocks, which have been subjected to multiple periods of deformation. These deformational episodes imposed intense tectonic fabrics and folds within the deposit area.

The deposit lies at the contact between Mississippian-age mafic meta-volcanic footwall and a hanging wall of Triassic-age argillite and basalt. Extensive hydrothermal alteration occurred within the meta-volcanic footwall prior to and during mineral deposition, converting the basalts to sericite-rich, phyllitic schist. At mineral deposition, thick and extensive lenses of base and precious metals formed at the footwall-hanging wall contact.

The mineral zones are complex and locally discontinuous because of regional metamorphism, folding and faulting following mineral deposition. The metamorphism remobilized some of the precious metals into fold related structures adjacent to the main mineral body. Strike-slip faulting cut the massive sulfide deposit, displacing mineral zones up to 2,750 feet horizontally and 650 feet vertically.

The sulfide mineralization at Greens Creek is divided into two general types, "massive" (mineralization in which sulfides exceed 50 volume percent) and "white" (mineralization in which sulfides are below 50 volume percent). The two general types are sub-divided into three subtypes each. The "massive" types are distinguished according to their texture and mineralogy while the "white" types are separated into baritic, carbonate and silica rich sub-types.

Greens Creek mineralization is segregated into nine separate mineralized zones, all of which have declared Mineral Reserves. From northeast to southwest these mineral bodies are East, West, 9A, 5250, Northwest West, Upper Plate, Southwest, 200 South and Gallagher zones. The boundaries between the various zones and mineralized areas are defined by faults, shear zones, or changes in the thickness of the mineralized horizon.

Metal zonation is apparent with mineralization centers having copper and iron rich cores grading outwards to iron and zinc and then to zinc and lead. The most distal zones are polymetallic and precious metal rich. Major sulfide minerals are pyrite, sphalerite, galena, and tetrahedrite/tennantite. Electrum and ruby silver (proustite-pyrargyrite) are common. Barite, quartz and carbonate gangue are common to the mineralized material.

1.5 Exploration

Work completed prior to Hecla's 100% interest in the project comprised surface reconnaissance exploration, geological and structural mapping, geochemical sampling, airborne, ground and down-hole geophysical surveys, surface and underground drilling, engineering studies and mine development. Mining operations ran from 1989 to 1993, when the mine was placed on care-and-maintenance due to low metal prices. In 1996, the mine re-opened, and has operated continuously since.

Under Hecla's ownership, work has included geological and structural mapping programs, geochemical sampling, ground and down-hole geophysical surveys, surface and underground drilling, engineering studies and mining activities. A number of prospects have been discovered during ongoing surface and underground exploration efforts in the Greens Creek district and provide upside project potential.

1.6 Drilling

A total of 8,041 drillholes (3,846,373 ft or 1,172,374 m) have been completed over the entire Project area in the period 1975 through 2018. Of these drillholes, 418 (510,499 ft or 155,600 m) are surface holes drilled for exploration or mineral resource development purposes, 5,147 (2,832,264 ft or 863,274 m) are underground mineral resource definition or exploration drillholes, which are typically drilled on 50 to 200 ft (15 to 60 m) spaced vertical sections respectively, and 2,476 (503,609 ft or 153,500 m) are underground pre-production drillholes that are drilled on cross- and plan-sections spaced from 20 to 50 ft (15 to 60 m).

All bedrock drilling has been completed using core methods. Surface drillholes collaring into unconsolidated sediments utilize reverse circulation (RC) methods until bedrock is encountered (typically less than 100 ft or 60 m), then completed using core methods. Core recovery is generally high because of the compact nature of the greenschist- facies metamorphic rocks. Approximately 80% of drilled intervals have core recovery greater than 95%.

Drillholes are designed to intersect the mineralization as perpendicular as possible. Definition drilling is generally on sections spaced 50 ft apart along strike of the mineral zone and drilled up or down dip at 50 to 75-ft spacing. This density of drilling normally converts inferred mineral resource to indicated mineral resource classification. Throughout the drilling programs, downhole surveys were completed using industry standard techniques.

The current system of logging employed by Hecla has been used with minor modifications since 1987. Underground drill core is logged for recovery, rock quality description (RQD), lithology, alteration, mineralization, structure and fabric. Surface core is logged for recovery, lithology, alteration, mineralization, structure and fabric.

A significant number of geotechnical and hydrological drillholes were completed in support of construction and operations of the Greens Creek surface facilities and in support of ongoing mining activity.

1.7 Sampling and Analysis

All drillholes are sampled on intervals ranging from 1 to 5 ft (0.3 to 1.5 m) that do not cross lithological boundaries. Historically definition and exploration samples were cut in half by rock saw as indicated on the core by the logging geologist. Beginning in 2018 definition drill samples were taken on whole core similar to pre-production samples.

Procedure for measuring SG of core at Greens Creek relies on the weight in water versus weight in air method. The weighing takes place after the core has been logged, before the core is cut, and occurs in the underground core cutting facility. Exploration and definition core holes are considered for density sampling.

Many laboratories have been used historically. From 1987 to 2015, samples were sent to Acme Analytical Laboratories Ltd in Vancouver. Acme was ISO 9001 certified in 1997 and successfully maintained that certification until its acquisition by Bureau Veritas in 2015, samples are now sent to Bureau Veritas (BV).

The current preparation procedure consists of crushing to 70% passing 10 mesh (2 mm), riffle splitting approximately 250 g, then ring pulverizing to 95% passing 150 mesh (106 microns). Additional cleaning of the preparation equipment is requested after high base metal content samples. Of the pulverized material 115 to 120 g is sent for analysis, and the remaining 115 to 120 g were stored as a master pulp.

Currently, all mineralized definition and exploration drill core is assayed at BV for Au, Ag, Pb, Zn, Cu, Fe, and Ba. Silver and base metal assays for Pb, Zn, Cu, and Fe are performed using inductively coupled plasma emission spectroscopy (ICP-ES) on 1.0 g samples digested in hot aqua regia. Silver is re-assayed by fire-assay with gravimetric finish if the initial ICP-ES results are greater than 300 ppm and by metallic-screen fire assay if the original over-limit assay is greater than 80 oz/ton.

The standard assay package employed consists of fire assay for Au on a 30 g sample with an AA finish. Gold is re-assayed by gravimetric finish if the initial fire assay results return values above 7 ppm. A metallic-screen fire assay is performed on all samples with the original over-limit assay greater than 7 ppm.

Hecla conducts industry standard QA/QC on all samples used in mineral resource estimation. Historic sample data was reviewed for QA/QC and is considered acceptable for use in mineral resource estimation. Currently, QA/QC on drill samples is reviewed quarterly by the QP and any necessary re-assaying is completed.

1.8 Data Verification

Regular data verification programs have been undertaken by third-party consultants from 1995 to 2013. Currently, the acQuire® database is managed and verified regularly by Hecla staff. The QP considers that as a result of the audit findings as well as current data verification efforts, the database quality is acceptable for Mineral Resource and Mineral Reserve estimation, and mine planning.

1.9 Mineral Processing and Metallurgical Testing

Metallurgical testing programs are continually conducted to evaluate possible changes in feed types from new mining areas, proposed changes in processing to improve recoveries and/or concentrate grades and to investigate factors causing lower than desired recoveries and concentrate grades. The Mineral Reserve estimate takes the most current recovery information into account. Industry-standard studies were performed as part of process development and initial Greens Creek mill design. Subsequent production experience and focused investigations, as well as marketing requirements, have guided mill expansions and process changes.

1.10 Mineral Resource Estimate

Greens Creek develops cross-sections, long-sections and level plans showing drillhole intercepts of the massive sulfide zones. Geologists interpret the mineralized envelope using a combination of: 1) geologic criteria such as the mine contact and ore-type logging; 2) metal grades or NSR-values; and 3) metal zoning.

Advanced modeling techniques employing Leapfrog Geo software were used for the first time in 2018. These techniques take advantage of the software's organic and realistic wireframe-creation process, as well as consideration of all face sampling data gathered during the mining process and the complete drillhole database. Datamine software was used for block model creation and kriging, and new semi-variograms were created for each remodeled zone. During 2018, seven zones were remodeled: East, West, 9A, 200S, Southwest Bench, Gallagher and Upper Plate. Mineralized zone block models were created using 5 ft x 5 ft x 5 ft blocks based on block centroids lying within the wireframe.

Wireframes are created based on $50NSR composite intervals, and within these a higher-grade $140NSR composite wireframe was created. Greens Creek considers

$50NSR to represent the mineralized horizon. Wireframes were extrapolated approximately 100 ft beyond composite intervals where not constrained by unmineralized drillholes. Face sample data, which convey geology, bedding orientations and metal grade data, was also honored when creating the wireframes.

Block models are created for stope design based on the minimum selective mining unit (SMU) of 10 ft x 10 ft x 15 ft (3 m x 3 m x 4.6 m) in x, y and z axes, respectively. A 10 ft (3 m) model buffer is created around the core mineralized blocks to allow calculation of metal values and density immediately surrounding the mineralized wireframe.

Block models based on wireframes only use whole blocks (5 ft x 5 ft x 5 ft or 1.5 m x 1.5 m x 1.5 m) which are generated when block centroids lie inside the wireframe. After estimation, but prior to mineral resource tabulation or stope design, blocks (mineralized and buffer) are regularized back to 15 ft (4.6 m) high to meet the minimum mining height of the SMU.

Drillhole samples were composited to varying intervals ranging from 3 to 5 feet. Variograms were modelled for each metal component (gold, silver, lead, zinc). Ordinary kriging (OK) was used to interpolate, using dynamic anisotropy to determine local orientation of the search ellipse. Dynamic anisotropy allows each block to have a unique search direction that honors the true dip direction and true dip angle of the mineralized horizon. Grade capping by zone is used to limit the spatial extrapolation of the occasional anomalous, but isolated, precious metal grades.

Models are validated using visual inspection, a comparison of OK to nearest neighbor (NN) distributions, and swath plots.

Mineral Resources are classified using the variogram ranges of the two major metals (silver and zinc), as well as the number of samples and number of drillholes used for the estimate. Assessment of reasonable prospects of economic extraction is based on a consideration of metal prices, set by Hecla corporate staff; consideration of a minimum NSR cut-off; and mining parameters.

1.11 Mineral Resource Statement

Mineral Resources are classified in accordance with the 2014 CIM Definition Standards for Mineral Resources and Mineral Reserves and the 2003 CIM Best Practice Guidelines. The QP is of the opinion that Mineral Resources for the Project have been estimated using industry best practices, and conform to the requirements of CIM (2003, 2014).

The Qualified Person for the Mineral Resource estimate is Paul Jensen, CPG, a Hecla employee. Mineral Resources are reported exclusive of Mineral Reserves. Hecla cautions that Mineral Resources that are not Mineral Reserves and have not demonstrated economic viability. Measured and Indicated Mineral Resources are reported in Table 1-1. Inferred Mineral Resources are summarized in Table 1-2.

Table 1-1: Measured and Indicated Mineral Resource Statement Dec. 31, 2018

Measured Resources	Tons	Gold (Oz/ton)	Silver (Oz/ton)	Lead (%)	Zinc (%)	Gold (Ounces)	Silver (Ounces)	Lead (Tons)	Zinc (Tons)
East	500	0.041	6.71	5.56	11.84	20	3,300	30	60
West	600	0.091	6.59	2.32	8.95	60	4,200	20	60
9A	2,300	0.087	12.68	4.62	10.44	200	28,800	110	240
NWW	260,900	0.118	8.31	2.52	9.90	30,800	2,169,100	6,570	25,830
SW	20,000	0.093	22.73	3.30	6.65	1,900	455,500	660	1,330
200S	5,600	0.125	10.11	2.73	13.28	700	56,500	150	740
5250	44,000	0.041	11.16	2.54	7.02	1,800	491,300	1,120	3,090
Gallagher	4,600	0.136	5.23	3.21	7.53	600	24,300	150	350
Upper Plate	-	-	-	-	-	-	-	-	-
Total Measured	**338,600**	**0.107**	**9.55**	**2.60**	**9.36**	**36,100**	**3,233,000**	**8,800**	**31,700**

Indicated Resources	Tons	Gold (Oz/ton)	Silver (Oz/ton)	Lead (%)	Zinc (%)	Gold (Ounces)	Silver (Ounces)	Lead (Tons)	Zinc (Tons)
East	454,800	0.089	12.60	2.94	7.86	40,600	5,731,200	13,390	35,760
West	2,206,600	0.120	11.37	3.14	9.47	264,700	25,082,700	69,370	208,980
9A	456,500	0.077	10.68	3.76	9.26	35,300	4,877,100	17,150	42,250
NWW	740,200	0.095	10.08	2.63	8.17	70,100	7,462,900	19,430	60,500
SW	1,031,700	0.084	18.61	3.54	7.14	87,100	19,194,600	36,500	73,620
200S	1,323,100	0.108	15.86	2.80	7.20	142,700	20,979,500	37,070	95,210
5250	490,800	0.043	11.80	2.59	6.55	21,000	5,790,200	12,730	32,150
Gallagher	177,500	0.119	6.89	3.46	7.73	21,100	1,223,000	6,130	13,710
Upper Plate	247,300	0.032	15.59	2.90	6.26	7,800	3,856,000	7,180	15,470
Total Indicated	**7,128,300**	**0.097**	**13.21**	**3.07**	**8.10**	**690,300**	**94,197,200**	**218,950**	**577,650**
Total Measured and Indicated	**7,466,900**	**0.097**	**13.05**	**3.05**	**8.16**	**726,400**	**97,430,200**	**227,740**	**609,350**

Table 1-2: Inferred Mineral Resource Statement Dec. 31, 2018

Inferred Resources	Tons	Gold (Oz/ton)	Silver (Oz/ton)	Lead (%)	Zinc (%)	Gold (Ounces)	Silver (Ounces)	Lead (Tons)	Zinc (Tons)
East	635,500	0.101	13.48	2.71	8.06	64,100	8,566,600	17,250	51,190
West	111,200	0.107	11.84	2.62	7.12	12,000	1,316,800	2,910	7,920
9A	389,000	0.079	11.73	4.17	9.41	30,600	4,561,600	16,230	36,600
NWW	387,000	0.081	15.59	3.24	8.09	31,500	6,032,900	12,540	31,300
SW	45,300	0.124	15.30	2.43	4.95	5,600	692,400	1,100	2,240
200S	322,700	0.108	22.76	1.97	3.96	35,000	7,345,200	6,370	12,770
5250	145,700	0.051	11.87	3.04	7.06	7,400	1,728,900	4,430	10,280
Gallagher	256,800	0.096	10.02	3.34	6.99	24,700	2,571,800	8,570	17,960
Upper Plate	176,700	0.043	17.92	2.83	6.30	7,700	3,166,300	5,000	11,140
Total Inferred	**2,469,900**	**0.088**	**14.57**	**3.01**	**7.34**	**218,500**	**35,982,400**	**74,410**	**181,400**

Notes to Accompany Mineral Resource Tables:

1. The Qualified Person for the Mineral Resource estimates is Paul Jensen, CPG, a Hecla employee.
2. Mineral Resources are exclusive of Mineral Reserves and do not have demonstrated economic viability.
3. Mineral Resource block models have a number of database cut-off dates from 2017 to 2018; all Mineral Resources have been depleted for mining as of December 31, 2018.
4. Mineral Resources are based on the following metal prices and cut-off assumptions: $1,350/oz Au, $21/oz Ag, $1.10/lb Pb, $1.20/lb Zn, NSR cut-off of $190/t for all zones except the Gallagher Zone, which used a $200/t cut-off.
5. Totals may not agree due to rounding.
6. Reporting units are imperial, Tons: dry short tons (dst); Au (troy ounces/dst); Ag (troy ounces/dst); Pb and Zn percent (%).

1.12 Mineral Reserve Estimate

Mineral Reserves have been estimated from the geological mineral resource block model, which is developed by the geology department and updated regularly to incorporate new information. The following criteria were used to convert Mineral Resources to Mineral Reserves:

- Only Measured and Indicated Mineral Resources are considered;
- Dilution is included in the Mineral Reserve estimate;
- Mineral Reserves are supported by an economic mine plan applying an NSR cut-off of $190-$200 per ton (depending on zone). This cut-off value includes operating costs, allocations for sustaining capital, and royalties (where applicable);
- The reference point for Mineral Reserves is the mill feed. Metallurgical process losses are not considered when determining the contained metal within the Mineral Reserves;
- All mineral reserves which have not yet been mined are classified as "probable". The only "proven" mineral reserves are the mill stockpiles located on surface.

The Greens Creek NI 43-101 Mineral Reserves Estimate was created with Deswik software using similar methodologies and basic assumptions as previous annual mineral reserve estimates. All areas are designed for either longhole stoping (where the mineral zone is sufficiently vertical), drift-and-fill stoping, or overhand cut-and-fill stoping. Metal price assumptions used for the mineral reserve determination are expressed in US dollars (USD) as follows: $14.50/oz silver; $1200/oz gold; $0.90/lb lead; and $1.15/lb zinc.

Table 1-3: Greens Creek Mineral Reserve Estimate December 31, 2018

Probable Mineral reserves	Ore MTons	Gold (Oz/ton)	Silver (Oz/ton)	Lead (%)	Zinc (%)	Gold Kozs	Silver Mozs	Lead Ktons	Zinc Ktons
200S	2.13	0.110	13.16	2.39	6.23	233.0	28.0	50.8	132.4
5250	1.11	0.048	13.78	2.56	6.57	53.0	15.3	28.4	72.9
9A	1.28	0.076	9.47	3.54	8.77	96.9	12.1	45.4	112.4
East	0.87	0.086	12.81	2.56	6.43	75.1	11.2	22.3	56.1
Gallagher	0.24	0.129	5.50	3.60	8.34	30.7	1.3	8.6	19.9
NWW	2.30	0.102	9.07	2.58	8.66	234.9	20.9	59.4	199.2
SW	0.33	0.084	15.29	3.43	8.10	27.4	5.0	11.2	26.5
Upper Plate	0.13	0.039	13.32	2.36	4.78	4.9	1.7	3.0	6.0
West	0.89	0.094	12.96	3.79	9.07	83.6	11.5	33.7	80.6
Total Probable Mineral reserves	**9.27**	**0.091**	**11.54**	**2.83**	**7.62**	**839.5**	**107.0**	**262.8**	**706.0**
Proven Mineral reserves (Stockpile)	**0.01**	**0.100**	**13.81**	**2.85**	**7.04**	**0.6**	**0.1**	**0.2**	**0.4**
Total Proven and Probable Reserves	**9.28**	**0.091**	**11.54**	**2.83**	**7.62**	**840.1**	**107.1**	**262.9**	**706.5**

Notes to Accompany Mineral Reserve Table:

1. The Qualified Person for the Mineral Reserve estimates is Mr. Kyle Mehalek, P.E.
2. Mineral Reserves are based on the following metal prices and cut-off assumptions: $1,200/oz Au, $14.50/oz Ag, $0.90/lb Pb, $1.15/lb Zn, NSR cut-off of $190/t for all zones except the Gallagher Zone which used a $200/t cut-off.
3. Reporting units are imperial, Tons: dry short tons(dst); Au (troy ounces/dst); Ag (troy ounces/dst); Pb and Zn percent (%).
4. Totals may not agree due to rounding.
5. Mineral Reserves are reported fully diluted.

Reconciliation results comparing produced grades to Mineral Reserve grades are favorable. A substantial proportion of production in recent years has been mined from Inferred Mineral Resource not included in Mineral Reserve. Approximately 43% of mineral reserve tons mined in 2018 were produced from outside of Mineral Reserve.

In the opinion of the QPs, Mineral Reserves for the Project, which have been estimated using core drill data, appropriately consider modifying factors, have been estimated using industry best practices, and conform to the CIM Definition Standards (2014).

1.13 Mining Methods and Mine Plan

1.13.1 Underground Mining Operations

The mine is primarily accessed via the 920-level portal in the same general area as the mill, stockpile pad and administration building. This portal also serves as the primary air intake. A second portal adjacent to the 920 Portal serves as a secondary escapeway and an additional air intake. A third portal located at the 1350 elevation serves as the primary ventilation exhaust and an additional escapeway. There is also a raisebored ventilation raise to the 1350 portal area which serves as an additional exhaust.

The working areas are accessed via ramp. Most ramps are connected with cross-cuts at various locations, therefore most working areas have multiple options for equipment access in the event a particular ramp is blocked for rehab or utility work. Two of the ramp systems have a single route for mobile equipment access. These ramps feature laddered escapeway raises to enable airflow and a secondary means of egress.

Mine production and development are undertaken with modern mechanized trackless equipment. Ore and waste are hauled to the surface using trucks. Backfill is achieved using a combination of three methods: paste pumped from the underground paste plant, cemented tailings trucked and jammed and into the heading, and development waste placed into the area to be backfilled. In addition to the conventional trackless mining equipment, the Greens Creek fleet contains one LHD capable of semi-autonomous operation and another LHD capable of tele-remote operation. This equipment enables production activities to continue during the shift change and post-blasting periods when no personnel are allowed underground.

The current production rate is 2,300 t/d of which approximately 2,000 t/d is produced by cut-and-fill with the remaining 300 t/d from longhole stoping. Longhole Mineral Reserves are projected to be depleted approximately halfway through the remaining mine life, at which point the mine plan calls for 2,300 t/d of production from cut-and-fill mining.

Underground communications systems include a leaky-feeder radio system, mine phones, and an underground Wi-Fi network. There is a stench alert system for emergency use. Refuge chambers are located at strategic locations throughout the mine.

Ground support at Greens Creek is governed by a Ground Control Management Plan (GCMP). Both the ore and waste rock can be highly corrosive to ground support due to the high proportion of sulfides. Primary support consists of split sets and Swellex installed in conjunction with wire mesh. Galvanized split sets are used for longer-term openings to reduce corrosion. Greens Creek has also begun installing fully-grouted rebar bolts in life-of-mine excavations such as haulage ramps in order to provide permanent ground support with a very high degree of corrosion resistance. Older ramp areas are in the process of being upgraded to rebar support.

Greens Creek is considered to be a dry mine with groundwater inflows typically less than 50gpm. Water is collected in centralized sumps where solids are allowed to settle. The water is then pumped out of the mine to the 920 water treatment facilities and the solids are gobbed underground.

High-voltage power enters the mine at 4160V and is distributed via three switchgear rooms and a network of mine power centers which reduce the voltage to 480V for use by drills, fans, pumps and other equipment. A fourth switchgear room is currently under development to serve the deeper areas of the mine.

1.13.2 Mine Plan

The Greens Creek Mine plan was optimized in 2018 with the goal of reducing required development footage and achieving earlier access to higher-grade ore. All planned development was redesigned and optimized, with large reductions to development footage including the removal of a major ramp system after it was determined that the targeted mineral reserve could be accessed via crosscuts developed from existing workings.

The new mine plan results in a declining grade profile, with the highest-grade mineral reserves mined earlier in the mine life in order to optimize NPV (Table 1-4). Previous mine plans had a relatively flat grade profile over the mine life, with an increase near the very end caused by mining of high-grade mineral reserve that was unable to be extracted earlier due to proximity of critical mine infrastructure (see discussion of “59 Bypass” in Section 16.16.6).

Table 1-4: Mine Plan – Mine Production Overview

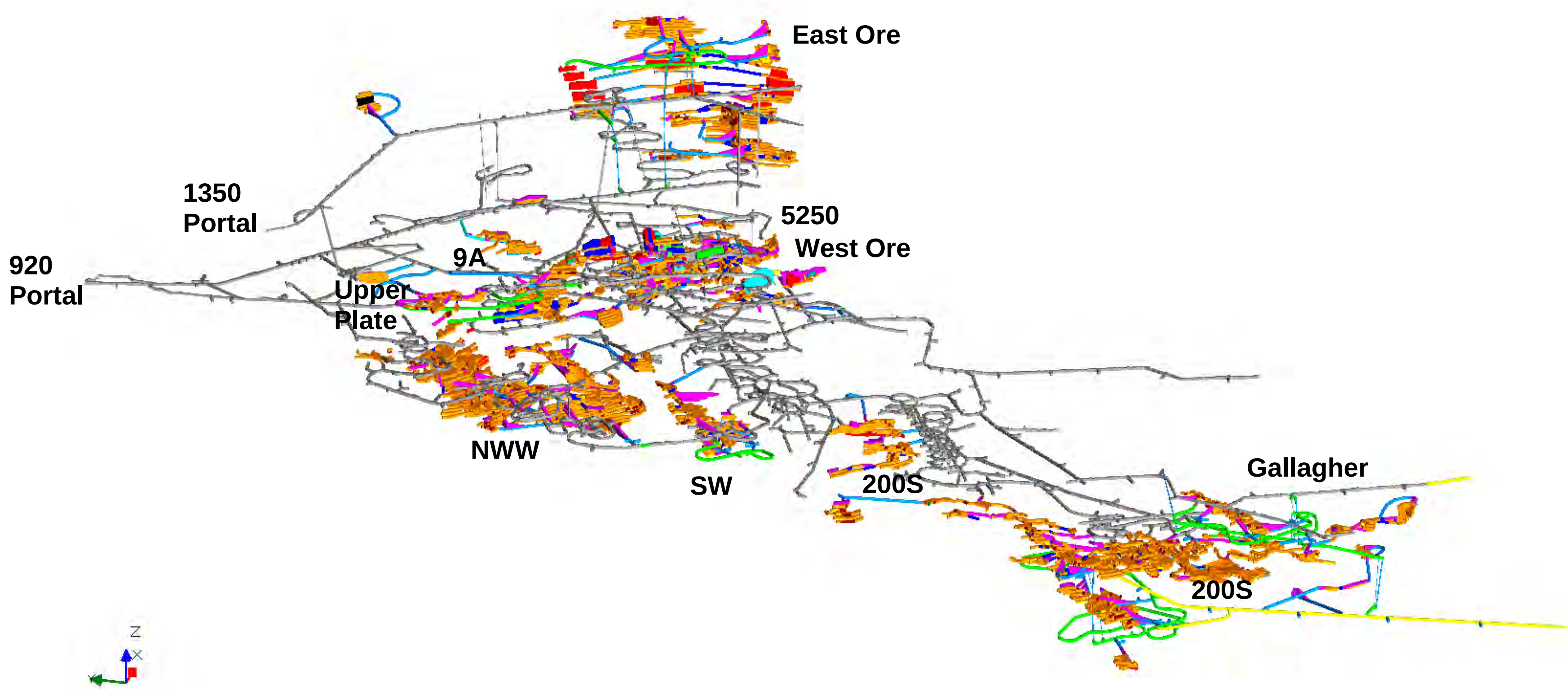
	Silver (opt)	Gold (opt)	Lead (%)	Zinc (%)	NSR $/ton*
Next 5 Years (2019-2023)	12.7	0.090	3.06%	7.71%	$292
LOM Average (2019-2030)	11.5	0.091	2.83%	7.62%	$276

*NSR based on reserve prices and 2019 mine planning NSR estimation formula

Due to the optimization of development designs (Figure 1-2), the new mine plan displays relatively consistent yearly development footage requirements over the mine life. Previous plans required higher rates of capital development which were heavily front-loaded during the first few years of the remaining mine life.

Ore production is sourced from a number of different mineral reserve zones throughout every year of the mine life. This reduces the potential for equipment traffic congestion or infrastructure bottlenecks in any one zone. Tonnage from the 200S Zone never exceeds 30% of overall production in any given year. The 200S Zone is the deepest zone in the mine and limiting tonnage from this area to a reasonable proportion of overall production is desirable to keep average haulage distances from increasing significantly which could require additional trucking capacity.

Figure 1-2: Existing and Planned Mine Development including Mineral Reserves – 3D View



1.14 Recovery Methods

The Greens Creek mill produces three saleable flotation concentrates and a gravity concentrate. A carbon concentrate is produced as part of the process but is discarded as part of tailings. Concentrates are separately hauled and stored to a storage–loadout facility at Hawk Inlet, which is approximately eight miles (10 km) from the mine. At the Hawk Inlet facility concentrates are stored indoors in piles until being loaded periodically into ocean-going ships for transport to a variety of smelters. The Greens Creek LOM production plan for the mill assumes similar throughputs, recoveries, and concentrate grades to those achieved in recent years, based on projected mill feed grades provided by geology and mine staff for the life-of-mine.

1.15 Project Infrastructure

The Greens Creek mining operation includes a significant amount of existing infrastructure primarily at two locations: the 920/860 mine area and the Hawk Inlet camp, which are connected by an 8.5-mile-long road. Key existing infrastructure includes the following:

920/860 Mine Area:

- Underground mine portals;
- Administration and support buildings;
- Mill building and associated processing facilities;
- Mobile equipment repair shop;
- Warehouse facilities;
- Water collection and treatment facilities;
- Development waste rock storage ("Site 23").

Hawk Inlet Area:

- Personnel housing and dining buildings;
- Concentrate storage and shipping facilities;
- Materials receiving dock and warehouse;
- Dry stack tailings disposal facility (TDF);
- Water collection and treatment facilities (Pond 7/10 Dam System);
- Fully-permitted discharge facilities for treated water (APDES 002).

Other Areas:

- High-voltage electrical intertie to the Juneau power grid via undersea cable;
- Young Bay crew ferry terminal;
- Over 13.5 miles of mine roads.

The current dry stack tailings disposal facility has sufficient capacity to accommodate tailings to the end of the current mine life in 2030. Early-stage engineering studies are underway to determine modifications to the plan of operations in order to accommodate additional material beyond the current Greens Creek mineral reserve life.

1.16 Market Studies and Contracts

The mine has now been operational for a 30-year period, and continuously operational for the last 23 years, and has current contracts in place for concentrate sales, doré refining, concentrate transportation, metals hedging, and other goods and services required to operate an underground mine.

1.17 Environmental Studies, Permitting, and Social or Community Impact

The Greens Creek Mine is currently regulated by approximately 70 separate permits and approvals issued by various Federal, State and Municipal agencies. Greens Creek mines a mineralized body that is made up of massive sulfides in a temperate rainforest environment. Proper management of the waste materials from the mining process is of primary importance due to potential acid rock drainage (ARD) and metals leaching considerations.

Further extensions to the mine life will require increased tailings storage capacity. While capacity remains through the end the current mine life in 2030, plans are in development for modifications to the tailings disposal facility (TDF) Plan of Operations intended to accommodate tailings beyond the current Greens Creek mineral reserve life.

Final reclamation of the mine facilities will consider anticipated post-mining land uses associated with the Admiralty Island National Monument. The estimated cost of reclamation and closure, net of salvage, at the end of mine life, is $89.9 million.

Hecla has a communities' relations plan in place to identify and ensure an understanding of the needs of the surrounding communities and to determine appropriate programs for meeting those needs. The company monitors socioeconomic trends, community perceptions and mining impacts.

1.18 Costs and Economic Analysis

Total life-of-mine (LOM) capital costs are estimated at $256.0 million in 2019 US dollars. Future capital costs are estimated based on expected sustaining capital requirements of the mine. Development costs are estimated based on past experience and are adjusted for any future anticipated changes in factors which would affect cost and amount of development.

Total LOM operating costs are anticipated to be $1.5 billion, or $165.39/ton ($182.32/tonne) milled. The operating costs included in the LOM are derived from the 2019 budget for the near-term and adjusted for factors regarding expected cost changes in the later years. The budget is built using various cost inputs including operating experience, quotes from various service providers, anticipated personnel changes, and changes in production. Fuel and power costs are variable by year, averaging about 6% and 10%, respectively, of total production costs in 2018, but ranged from 3 to 10% each in the last five years. Table 1-5 shows the estimated costs per ton and costs per ounce of silver.

Table 1-5: Greens Creek Mine Costs Per Unit

Cost per Unit	Unit	Cost
Operating	US$/Ton	165.39
Capital	US$/Ton	27.6
All-in Sustaining Cost	US$/Ton	192.99
Cash Cost*	US$/Oz Ag	0.37
Total Cost*	US$/Oz Ag	5.67

*Net of byproduct credits, includes royalties.

To support declaration of Mineral Reserves, Hecla completed an economic analysis which confirmed positive economics based on the Mineral Reserves using mineral reserve price assumptions.

The Project was further evaluated at a base case scenario using a 5% discount rate, and all costs prior to 31 December 2018 were treated as sunk costs. The base case metals prices used in this evaluation were:

- Gold: $1,303.70/oz;
- Silver: $15.32/oz;
- Lead: $0.91/lb;
- Zinc: $1.30/lb.

As of the filing date of this report, these prices represented applicable current prices. Operating and capital costs and cash flow resulting from this assessment are shown in Table 1-6. The analysis indicated positive Project economics until the end of mine life. The total gross revenue is $3.2 billion. Estimated treatment and freight charges total $474 million (Table 1-7), and estimated production/operating costs total $1.5 billion, resulting in a LOM net cash flow, before taxes, of $829 million. The 5% discounted pre-tax net cash flow is $658.8 million; the post-tax discounted (5%) net cash flow is $638.3 million.

Mining companies doing business in Alaska are primarily subject to U.S. corporate income tax, Alaska State income tax and Alaska Mining License tax. The State of Alaska levies a mining license tax on mining net income received in connection with mining properties and activities in Alaska, at a rate of $4,000 plus 7% over $100,000. The effect of this tax is approximately $27 million undiscounted and $20.5 million discounted at 5% over the life of the mine.

The U.S. corporate and Alaska State income tax rates are 21% and a graduated rate from 0% to 9.4%, respectively, and are not included in the economic model. Income tax is typically not incorporated at the local level and is calculated for all the sites together; however, Hecla's U.S. consolidated group provides tax benefits as well as net operating losses that are expected to offset the project's taxable income in the foreseeable future.

Table 1-6: Operating and Capital Costs and Cash Flow for the Greens Creek Mine

	Five Year Annual Average (2019-2023)	Life of Mine (2019-2030)
OPERATING COSTS:	In thousands of US dollars ($000s)	
Mine	61,318	684,809
Mill	28,615	317,116
Surface Operations	20,858	234,850
Environmental	2,730	30,165
Administration	24,140	267,505
TOTAL OPERATING COSTS ($000s)	**137,661**	**1,534,445**
OPERATING CASH FLOW	**131,929**	**1,216,346**

	Five Year Annual Average (2019-2023)	Life of Mine (2019-2030)
CAPITAL COSTS:	In thousands of US dollars ($000s)	
Mine	7,368	51,138
Mill	1,621	12,353
Surface Infrastructure - Amortizable Assets	5,080	41,602
Surface Infrastructure - Other Assets	1,532	7,662
Surface Mobile Equipment	2,133	15,917
Environmental	160	1,450
Administration	160	1,250
Capitalized Mine Development and Rehab	12,126	98,121
Definition Drilling	5,315	26,573
TOTAL CAPITAL COSTS ($000s)	**35,495**	**256,066**
CASH FLOW BEFORE RECLAMATION AND OTHER COSTS	**96,434**	**960,280**
OTHER COSTS:		
RECLAMATION	135	92,763
ROYALTY	756	7,712
CAPITAL LEASE FINANCING	(1,992)	(9,990)
WORKING CAPITAL	(1,465)	(21,030)
TOTAL OTHER COSTS ($000s)	**4,348**	**131,495**
CUMULATIVE NET PRE-TAX CASH FLOW	**92,086**	**828,785**
Alaska Mining License Tax	2,670	26,680
Federal and State Income Taxes	-	-
CUMULATIVE NET AFTER-TAX CASH FLOW	**89,416**	**802,105**

Throughout the LOM (2019 to 2030), 9.28 million tons of mineral reserve will be processed at the mill. The average LOM mill grades for zinc and lead are 7.62% and 2.84%, respectively, resulting in 1.25 billion pounds of recovered zinc and 427.17 million pounds of recovered lead. Silver production is estimated at 83.69 million ounces and gold production is estimated at 542,400 ounces (Table 1-7).

Table 1-7: Life of Mine Production and Revenue

	Unit	Five Year Annual Average (2019-2023)	Life of Mine (2019-2030)
PRODUCTION:			
Tons Milled	Tons	840,000	9,280,000
Zinc Grade	%	7.71	7.62
Lead Grade	%	3.06	2.84
Silver Grade	OPT	12.70	11.54
Gold Grade	OPT	0.090	0.091
Avg. Zinc Metallurgical Recovery	%	88.82	88.51
Avg. Lead Metallurgical Recovery	%	81.85	81.20
Avg. Silver Metallurgical Recovery	%	79.10	78.17
Avg. Gold Metallurgical Recovery	%	65.98	64.55
Recovered Zinc	Pounds	115,008,000	1,250,872,000
Recovered Lead	Pounds	42,057,000	427,165,000
Recovered Silver	Ounces	8,437,700	83,694,800
Recovered Gold	Ounces	49,700	542,400
REVENUE:			
GROSS REVENUE	US $000s	307,399	3,224,831
Smelting and Refining Costs	US $000s	27,840	368,666
Freight and Selling Expenses	US $000s	9,969	105,374
NET TOTAL REVENUE	**US $000s**	**269,590**	**2,750,791**

The QP has reviewed the capital and operating cost provisions for the LOM plan that support the Mineral Reserves and considers it appropriate to the known mineralization, mining and production schedules, marketing plans, and equipment replacement and maintenance requirements. Appropriate provision has been made in the estimates for the expected mine operating usages and for closure and environmental considerations. Capital cost estimates include appropriate Owner, sustaining and contingency estimates.

The QP has reviewed the economic analysis and confirms that the Project has positive economics until the end of mine life, which supports Mineral Reserve declaration.

1.19 Conclusions and Recommendations

In the opinion of the QPs, the Greens Creek Mine is a long-established operation with a clear understanding of the mining, metallurgical, and infrastructural requirements to successfully extract the Greens Creek mineral deposits. Mining and milling operations are performing as expected, and reconciliation between mine production and the Mineral Resource model is acceptable. This indicates that the data supporting the Mineral Resource and Mineral Reserve estimates were appropriately collected, evaluated, and estimated.

Aside from those risks expressly stated in this and other sections of this report, the QPs are not aware of any other environmental, permitting, legal, title, taxation, socio-economic, marketing, political, mining, metallurgical, infrastructure, permitting, or other factors that could materially affect the Mineral Resources, Mineral Reserves, or LOM plan described in this report.

1.20 Risks

Factors that may materially affect the Mineral Resource estimate include:

- Metals price assumptions;
- Changes to design parameter assumptions that pertain to stope design;
- Changes to geotechnical, mining and metallurgical recovery assumptions;
- Changes to the assumptions used to generate the NSR cut-off;
- Changes in interpretations of mineralization geometry and continuity of mineralization zones;
- Changes to the assumptions related to mineral tenure rights and royalty assumptions associated with the Land Exchange properties.

Factors that may materially affect the Mineral Reserve estimate include:

- Metals price assumptions;
- Variations in short-term marketing and sales contracts;
- Changes to the mineral resource block model;
- Changes to the assumptions that go into defining the NSR cut-off;
- Assumptions relating to the geotechnical and hydrological parameters used in mine design;
- Metallurgical recovery factors: recoveries vary on a day to day basis depending on the grades and mineralization types being processed. These variations are expected to trend to the forecast LOM recovery value for monthly or longer reporting periods;
- Variations to the permitting, operating, or social license regime.

Additional risks which may affect the life-of-mine plan, production schedule, or economic results are shown in Table 1-8.

Table 1-8: Possible Risks to the Green's Creek Project

Risk	Mitigation
Metals prices are volatile and inherently difficult to predict. Actual prices will differ to some extent from the forecasts used in this report. Smelter terms are volatile and may change substantially over time. Mining costs may be higher or lower than expected.	The grade of the Greens Creek mineral deposits is not uniform and has distinct higher- and lower-grade areas. This provides opportunities to defer the mining of lower-grade areas and prioritize production from higher-grade areas in the event of decreased metal prices or higher economic cutoff grade. Metal price assumptions used to evaluate Greens Creek mineral reserves and economics are conservative, utilizing a base case silver price significantly less than the three-year trailing average. Sensitivity analysis indicates that the mine plan maintains a positive NPV even with a 20% decrease in metal prices compared to the base case.
Ground support at Greens Creek experiences significant sulfide corrosion. Failure of ground support may result in temporary loss of access through travelways.	Most mining areas have several access options due to the presence of multiple parallel ramp systems. Greens Creek has an active and ongoing rebar rehab program which is upgrading existing ramps with LOM corrosion-resistant support. Areas which cannot be rehabbed with rebar (such as raises) are closely monitored.
Mine development may not meet targets due to equipment availability or other challenges	Nearly 80% of mineral reserves are located in proximity to existing haulage ramps, requiring only a short ore-access crosscut in order to be brought into production. Delays in advancement of haulage ramps can be mitigated by bringing this near-mine mineral reserve into production, with a slight negative effect on grades.
Water inflows from development of certain shallower mineral reserves (Upper East Ore) could result in: • Mining difficulties/reduced rates • Need for additional underground and surface water handling infrastructure • Increased closure costs	A hydrological study is currently planned in order to define the nature and extent of the East Ore groundwater. This will inform the plan for prevention and mitigation, including possibly a campaign of pre-grouting. The proportion of mineral reserve which may be affected by this groundwater is very small (equivalent to 2.6% of overall mineral reserve)

1.21 Opportunities

Project opportunities include:

- Upside potential if some or all of the Inferred Mineral Resources estimated for the Project can be upgraded to higher confidence Mineral Resource categories and eventually to Mineral Reserves. Additional potential exists where existing Measured or Indicated Mineral Resource categories may be able to be upgraded to Mineral Reserves.
- Future exploration potential which, with appropriate drilling and modelling, may result in additional Mineral Resources.
- Digitization and evaluation of historic face mapping and sampling data. A large amount of geological data from early in the Greens Creek Mine life exists only as archival hardcopy and is not included in current geological models. Incorporation of this data may result in better geological understanding and identification of opportunities for remnant mining, possibly leading to increased Mineral Reserves.
- Continued metallurgical test work may show mineral treatment adjustments that could increase metal recoveries or create more attractive metal

concentrates to the target smelters. Improvements made in the processing plant could have a positive impact on costs and recovery, improving the mine's profitability.

- Further development and application of automated and tele-remote equipment may result in additional efficiencies, particularly the ability to continue work between shifts while the mine is cleared for blasting.

The QPs recommend that exploration, mining, engineering, and operations activities continue as planned.

2.0 INTRODUCTION

2.1 Terms of Reference

Hecla has prepared a technical report (the Report) on the wholly-owned Greens Creek polymetallic mining operation (the Project) located on Admiralty Island in southeast Alaska, US. The purpose of the Report is to support public disclosure of Mineral Reserves and Mineral Resources by Hecla as of December 31, 2018; as provided in a news release dated February 14, 2019. This 43-101 Technical Report summarizes the scientific and technical information that supports the life of mine plan and the year-end 2018 Mineral Resources and Mineral Reserves.

Hecla holds a 100% interest in the Greeks Creek polymetallic (Au, Ag, Pb, Zn) mining operation through its indirectly-held subsidiary companies Hecla Greens Creek Mining Company, Hecla Juneau Mining Company, and Hecla Alaska LLC. In this Report, the name Hecla is used interchangeably for the parent and subsidiary companies.

2.2 Qualified Persons

The following mining professionals serve as the Qualified Persons (QPs) for this Technical Report as defined in Canadian National Instrument 43-101, Standards of Disclosure for Mineral Projects:

- Mr. Paul Jensen, M.Sc., C.P.G., Chief Geologist, Hecla Greens Creek Mining Company, is responsible for Sections 4 through 10, 14, and Appendix B.
- Dr. Dean McDonald, Ph.D., P.Geo, Vice President of Exploration, Hecla Mining Company, is responsible for Sections 1 through 3, Section 19, Sections 23 through 27, and the Appendices.
- Mr. Kyle Mehalek, M.Sc., P.E., Senior Mining Engineer, Hecla Greens Creek Mining Company, is responsible for Sections 15, 16, 21, and 22.
- Mr. Keith Blair, M.Sc., C.P.G., Chief Resource Geologist, Hecla Mining Company, is responsible for Sections 11 and 12.
- Mr. Bill Hancock, R.M., S.M.E., Principal, Argo Consulting LLC, is responsible for Sections 13 and 17.
- Mr. Dale Butikofer, P.E., Senior Civil Engineer, Hecla Greens Creek Mining Company, is responsible for Section 18.
- Mr. Paul Glader, M.Sc., M.B.A., P.E., Corporate Environmental Director, Hecla Mining Company, is responsible for Section 20.

2.3 Site Visits and Scope of Personal Inspection

All Qualified Persons (QPs) have either visited site on the dates indicated below or are full-time employees at the mine.

Mr. Paul Jensen, a Certified Professional Geologist (CPG) with the American Institute of Professional Geologists (AIPG), has worked at the Greens Creek Mine for 4½ years. His QP scope of personal inspection of the site has been undertaken as part of his role as both Senior Exploration Geologist and Chief Geologist. Mr. Jensen has inspected outcrops across the claim block, underground workings and the drilling operations. He manages the drilling, mapping and production geology programs carried out on surface and underground. He also manages and participates in the mineral resource modeling work at Greens Creek.

Dr. McDonald, a Professional Geologist (P.Geo) registered with the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC), has visited the Project on a number of occasions, most recently on August 28, 2018. During his site visits, he has inspected drill core, visited and inspected surface outcrops, drill platforms and sample cutting and logging areas; discussed geology and mineralization with Project staff; reviewed geological interpretations with staff; reviewed modeling efforts; audited and reviewed on-site data including reviews of quarterly and annual budgets; visited the underground workings, and viewed the locations of key infrastructure.

Mr. Kyle Mehalek, a Professional Engineer (PE) registered with the US state of Colorado, has been employed at the Greens Creek mine for approximately two years. His QP scope of personal inspection of the site has been undertaken as part of his role as Senior Mining Engineer. Mr. Mehalek has inspected the underground workings on a regular basis as well as the relevant components of underground and surface infrastructure. He is responsible for mine design, long-range mine planning, annual mineral reserves determination, and development of the annual life-of-mine plan.

Mr. Keith Blair, CPG, AIPG, is the Chief Resource Geologist for Hecla Limited. He has visited the Greens Creek Mine many times and does so on an ongoing basis as a function of his normal duties. His most recent visit was from November 14 to 16, 2018. He is responsible for Sections 11 and 12 of this report.

Mr. Bill Hancock, a registered member (RM) of the Society of Mining Engineers (SME) and a QP with Mining and Metallurgical Society of America (MMSA), has conducted projects at Greens Creek beginning with operations training before the mill startup and thereafter on a periodic basis for companies and clients conducting metallurgical lab and plant tests and having on-site discussions with Hecla personnel assessing process responses and results and flowsheet performance. His last visit was March 14, 2019, specifically related to process and metallurgical review for this NI 43-101 report. He was also the plant and metallurgy reviewer for the March 2013 Hecla Greens Creek NI 43-101 Technical Report.

Mr. Dale Butikofer, PE, has worked at the Greens Creek Mine for almost 9 years. His QP scope of personal inspection of the site has been undertaken as part of his role as Senior Civil Engineer. Mr. Butikofer has inspected the infrastructure on the surface including the road system, TDF, water systems, and marine facilities. He manages the water systems and takes an active role in maintaining rest of the surface infrastructure. He has managed several capital projects site-wide to improve surface infrastructure.

Mr. Paul Glader, PE, first personally inspected the Greens Creek Mine in 2006 and continues to do so on an ongoing basis as a function of his position as Corporate Environmental Director for Hecla. His last visit was on April 18, 2018. He has been closely involved in the review of permitting, environmental compliance, reclamation, and closure planning.

2.4 Effective Dates

The following effective dates pertain to database closure and supporting assumptions for block modeling efforts:

- East Zone: November 2018
- West Zone: May 2018
- 9A Zone: June 2017
- Northwest West Zone: July 2017
- Southwest Zone: October 2018
- 200S Zone: October 2018
- 5250 Zone: October 2016
- Gallagher Zone: September 2018
- Upper Plate Zone: November 2018
- Stockpile: 31 December 2018

The following effective dates pertain to Mineral Resource estimation:

- East Zone: 31 December 2018
- West Zone: 31 December 2018
- 9A Zone: 31 December 2018
- Northwest West Zone: 31 December 2018
- Southwest Zone: 31 December 2018
- 200S Zone: 31 December 2018
- 5250 Zone: 31 December 2018
- Gallagher Zone: 31 December 2018
- Upper Plate Zone: 31 December 2018
- Stockpile: 31 December 2018

Mineral Reserve estimates have an effective date of 31 December 2018. The financial analysis that supports the Mineral Reserves was effective 31 December 2018. The overall Report effective date is taken to be 31 December 2018, based on the date of the Mineral Reserve estimates.

2.5 Information Sources and References

Hecla has used reports prepared by Hecla staff in support of United States Securities and Exchange Commission (SEC) filings, and internal company spreadsheets and reports in support of this Report.

Hecla has also used the information and references cited in Section 27 as the basis for the Report. Additional information on the operations was provided to the QPs from other Hecla employees in specialist discipline areas.

Hecla is reporting the Proven and Probable Mineral Reserves, and Measured, Indicated, and Inferred Mineral Resources in Sections 14 and 15 using the definitions and categories set out in the Canadian Institute of Mining, Metallurgy, and Petroleum 2014 Definition Standards for Mineral Resources and Mineral Reserves (2014 CIM Definition Standards).

All measurement units used in this Report are imperial units, and currency is expressed in US dollars unless stated otherwise. All figures have been prepared by Hecla unless otherwise noted.

2.6 Previous Technical Reports

Hecla last filed a Technical Report for the Greens Creek operation on April 12, 2013, which was the first Mineral Resource and Mineral Reserves 43-101 Technical Report by Hecla for the project.

3.0 RELIANCE ON OTHER EXPERTS

This Report is prepared without reliance on other experts. The Report has been prepared using the reports and documents, as noted in Section 27 “References”. The authors do not disclaim any responsibility for this Report.

4.0 PROPERTY DESCRIPTION AND LOCATION

The Greens Creek Mine is located on Admiralty Island, approximately 18 miles (29 km) to the southwest of Juneau, Alaska. The mine is 100% owned and operated by Hecla subsidiaries (refer to Section 4.2). The total land package encompasses 16,140 acres (6,530 hectares). The property location is displayed in Figure 4-1. The mine layout is shown in Figure 4-2.

The mine coordinates in UTM North American Datum of 1983 (NAD 83) Zone 8V are:

- US Survey Feet
  - Northing: 21121755.473
  - Easting: 1710158.573
- Meters
  - Northing: 6437923.944
  - Easting: 521257.376

Figure 4-1: Project Location

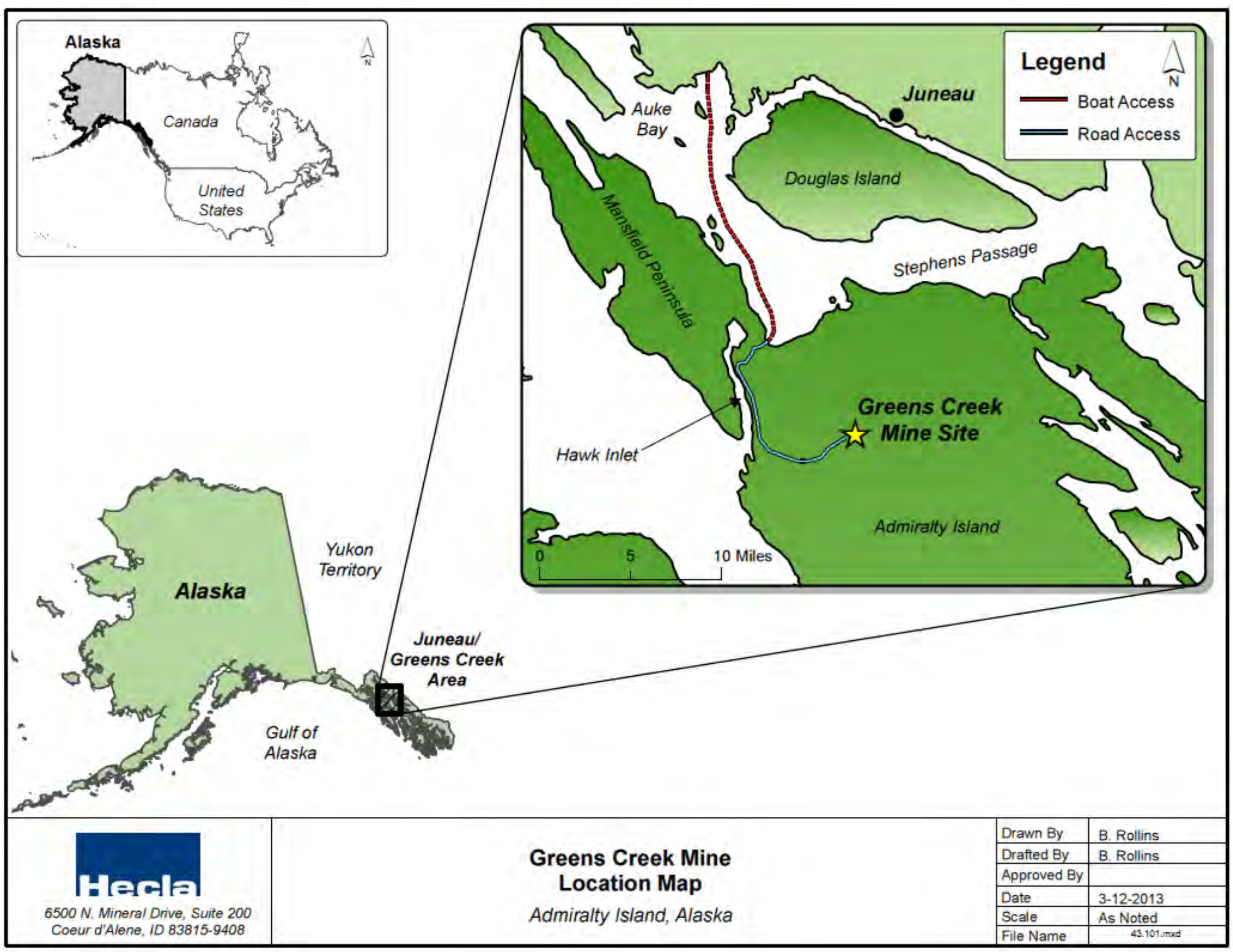
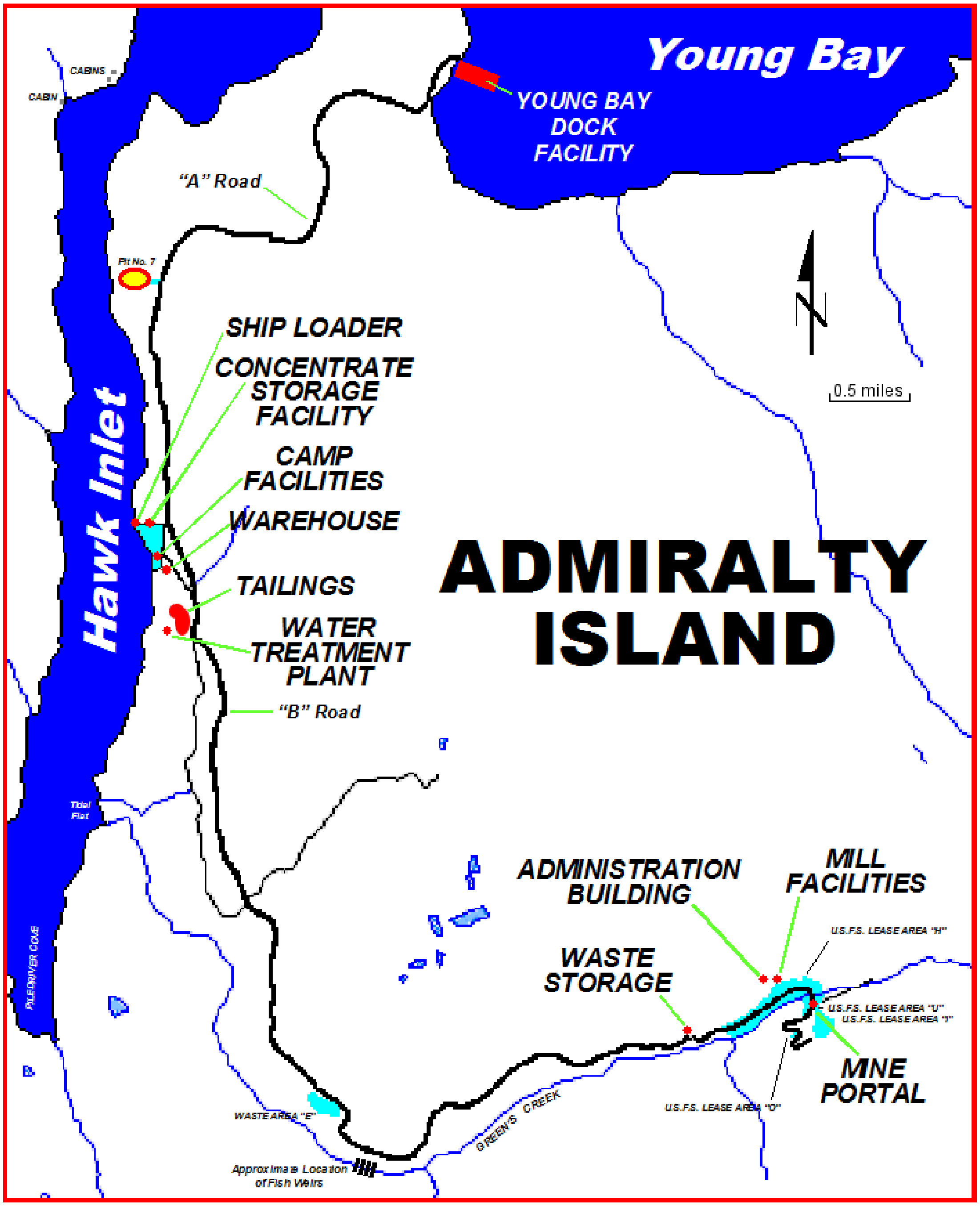


Figure 4-2: Mine Layout Plan



4.1 Property and Title in Alaska

Information included in the following subsections is summarized from Alaska Department of Natural Resources (2009), Alaska Division of Mining, Land and Water (2012), Bureau of Land Management (2011a, 2011b, 2012), and the Alaska Department of Revenue (2012).

4.1.1 Mineral Tenure

Mineral tenure can be held either under Alaskan State law, or under Federal permits.

Federal Mineral Titles

Alaska is one of the 19 US states where there are federally-administered lands that allow for staking of mining claims.

There are three basic types of minerals on Federal lands:

- Locatable (subject to the General Mining Law of 1872, as amended);
- Leasable (subject to the various Mineral Leasing Acts);
- Saleable (subject to mineral materials disposed of under the Materials Act of 1947, as amended).

The General Mining Law of May 10, 1872, as amended (30 U.S.C. §§ 22-54 and §§ 611-615) is the major Federal law governing locatable minerals. The General Mining Law allows for the enactment of State laws governing location and recording of mining claims and sites that are consistent with Federal law.

The Bureau of Land Management (BLM) manages the surface of public lands and the USFS manages the surface of National Forest System lands. The BLM is responsible for the subsurface on both public lands and National Forest System lands.

Mining claims may not be located on lands that have been:

- Designated by Congress as part of the National Wilderness Preservation System;
- Designated as a wild portion of a Wild and Scenic River;
- Withdrawn by Congress for study as a Wild and Scenic River.

Areas also withdrawn from location of mining claims include National Parks, National Monuments, Native American reservations, most reclamation projects, military reservations, scientific testing areas, most wildlife protection areas (such as Federal wildlife refuges), and lands withdrawn from mineral entry for other reasons.

Claim and Entry Types

Two main claim types can be granted, lode mining and placer mining claims.

Federal lode mining claims are defined by the BLM as:

Deposits subject to lode claims include classic veins or lodes having well-defined boundaries. They also include other rock in- place bearing valuable minerals and may be broad zones of mineralized rock. Examples include quartz or other veins bearing gold or other metallic minerals and large volume, but low-grade *disseminated gold deposits. Descriptions are by feet and bounds surveys beginning at the discovery point on the claim and including a reference to natural objects or permanent monuments. Federal statute limits their size to a maximum of 1,500 feet in length, and a maximum width of 600 feet (300 feet on either side of the vein). The end lines of the lode claim must be parallel to qualify for underground extralateral rights. Extralateral rights involve the rights to minerals that extend at depth beyond the vertical boundaries of the claim.*

The boundaries of a claim based on staking and located after January 1, 1985, shall run in the four cardinal directions unless the claim is a fractional claim or the commissioner determines that staking in compliance with this paragraph is impractical because of local topography or because of the location of other claims; a claim established in this manner may be known as a non-MTRSC (meridian, township, range, section and claim) location.

Federal placer mining claims are defined by the BLM as:

Including all forms of deposit, excepting veins of quartz, or other rock in-place. In other words, every deposit, not located with a lode claim, should be appropriated by a placer location. Placer claims, where practicable, are located by legal subdivision (aliquot part and complete lots). The maximum size is 20 acres per locator, and the maximum for an association placer is 160 acres for 8 or more locators. The maximum size in Alaska is 40 acres. The maximum size for a corporation is 20 acres per claim. Corporations may not locate association placers unless they are in association with other locators or corporations as co-locators.

Federal lode and placer mining claims are administered by the BLM under the 1872 General Mining Law. After physically staking the boundaries with six posts a minimum of 1 m tall, new claims are filed with the local county and with the BLM.

Maintenance requirements are based on the assessment year which begins September 1, at noon, and ends the following September 1, at noon. An annual $140 maintenance fee per claim is required to be filed or postmarked (if mailed) on or before September 1 of the year preceding an assessment year. These BLM fees are increased from time to time.

Claimants who perform assessment work must spend a minimum of $100 in labor or improvements on each claim, and record evidence of such with the BLM by December 30 of the calendar year in which the assessment year ended. Assessment work includes, but is not limited to, drilling, excavations, driving shafts and tunnels, sampling (geochemical or bulk), road construction on or for the benefit of the mining claim; and geological, geochemical, and geophysical surveys.

In addition to these claim types, there are kinds of two mineral entry claim.

Mill site entries are defined by the BLM as:

A mill site must be located on non-mineral land. Its purpose is to either (1) support a lode or placer mining claim operation or (2) support itself independent of any particular claim. A mill site must include the erection of a mill or reduction works and/or may include other uses reasonably incident to the support of a mining operation. Descriptions of mill sites are by metes and bounds surveys or legal subdivision. The maximum size of a mill site is 5 acres.

Tunnel sites are defined by the BLM as:

A tunnel site is where a tunnel is run to develop a vein or lode. It may also be used for the discovery of unknown veins or lodes. To stake a tunnel site, two stakes are placed up to 3,000 feet apart on the line of the proposed tunnel. Recordation is the same as a lode claim. An individual may locate lode claims to cover any or all blind (not known to exist) veins or lodes intersected by the tunnel. The maximum distance these lode claims may exist is 1,500 feet on either side of the centerline of the tunnel. This, in essence, gives the mining claimant the right to prospect an area 3,000 feet wide and 3,000 feet long. Any mining claim located for a blind lode discovered while driving a tunnel relates back in time to the date of the location of the tunnel site.

Federal Lode and Placer Patented Mining Claims

A patented claim is one for which the federal government has passed title to the claimant, making it private land. A person may mine and remove minerals from a mining claim without a patent; however, a mineral patent gives the owner title to the minerals, surface and other resources (timber, vegetative). Mineral patents can be issued for lode claims and placer claims.

Patenting requires the claimant to demonstrate the existence of a valuable mineral deposit. In addition, the applicant needs to:

- Survey, if required, subsequent to location;
    - Survey application requires initial fee of $750 plus $300 for each additional claim;
    - Approved survey plat and notice of intent to patent posted on claim.
- File patent application in BLM State Office accompanied by fees - $250 service charge (1 claim) and $50 for each additional claim;
- Provide evidence of title and citizenship;
- Provide statement of expenditures and improvements;
- Have BLM approval notice published in newspaper;
- Provide proofs of posting and publications, and corroborated statements.

Under current law, if all requirements have been satisfied, the applicant can purchase a lode claim at $5 per acre ($12 per ha) and placer claims for $2.50 an acre ($6.18 per ha).

Federal Conditions of Use

Activities that ordinarily result in no or negligible disturbance of the public lands or resources are termed “casual use.” In general, the operator may engage in casual use activities without consulting, notifying or seeking approval from the BLM.

For exploration activity greater than casual use and which causes surface disturbance of five acres (2 ha) or less of public lands; the operator must file a complete notice with the responsible BLM field office. Notice is for exploration only and only 1,000 tons (907 tonnes) may be removed for testing.

A Plan of Operations is required for surface disturbance greater than casual use, unless the activity qualifies for a Notice filing. Surface disturbance greater than casual use on certain special category lands always requires the operator to file a Plan of Operations and receive approval from the federal agency that administers the land (i.e. BLM, the USFS). An applicant for a plan of operations must pay a processing fee, and/or for a mineral examination on a case-by-case basis.

Anyone proposing to prospect for or mine locatable minerals that might cause disturbance of surface resources is required to file a "Notice of Intention to Operate" with the local USFS office or BLM. If the Federal Agency determines that such operations will cause a significant disturbance to the environment, the operator must submit a proposed Plan of Operations, from which the impacts of the operations will be assessed. The Plan of Operations must describe such things as the type of operation proposed and how it will be conducted; proposed roads or access routes and means of transportation; and the time period during which the proposed activities will take place. The Plan of Operations must also indicate the measures to be taken to rehabilitate areas where mining activities have been completed. An operator shall also be required to furnish a bond commensurate with the expected cost of rehabilitation.

There are no fees associated with processing notices of intent or plans of operations needed for locatable minerals. A bond is required for a plan of operations, in an amount that would be adequate to reclaim the surface resources. In addition, the USFS may require an applicant to submit environmental information and may authorize an applicant to prepare an environmental assessment.

State Mineral Titles

State-owned lands cover an area larger than the entire State of California, and most of these lands are open to mining under a location system which is a modem version of the Federal mining law.

Legislation relating to mining claims was enacted in 2000 as Senate Bill 175. State mining claims in Alaska use the meridian, township, range, section and claim (MTRSC) format. Two sizes of claim can be staked, quarter section (~160 acres or 65 ha), and quarter–quarter section (~40 acres or 16 ha). Claims require posting of corners, as the corner posts define the actual claim location and mineral rights acquired. Typically, such locators are defined using global positioning system (GPS) instruments.

Annual rental payments for a mining claim, leasehold location, or mining lease are based on the number of years since the concession was first located. Claims that were located before 31 August 1989 have that date as their commencement date for fee payment purposes.

Rental payments are required as follows:

- For all traditional mining claims and quarter–quarter section MTRSC locations, the annual rental amount is $35/year for the first five years, $70/year for the second five years and $170/year thereafter;
- For all quarter section MTRSC locations, the annual rental amount is $140/year for the first five years, $280/year for the second five years and $680/year thereafter;
- For all leases, the annual rent is $0.88/acre ($2.17/ha) per year for the first five years, $1.75/acre ($4.32/ha) for the second five years, and $4.25/acre ($10.50/ha) per year thereafter.

There is also a minimum labor requirement for each mining claim. Under Alaska legislation, "labor" includes geological, geochemical, geophysical, and airborne surveys conducted by qualified experts and verified by a detailed report lodged with the appropriate Alaskan authorities. Work such as drilling, excavations, driving shafts and tunnels, sampling (geochemical or bulk), and road construction on or for the benefit of the mining claim is considered "labor" under this requirement. In addition to the minimum labor requirement, the following commitments are required for maintenance of the claims:

- $100 per claim, leasehold location, or lease if the claim, leasehold location, or lease is a quarter–quarter section MTRSC claim, leasehold location, or lease;
- $400 for each quarter section;
- $100 for each partial or whole 40 acres (16 ha) of each mining claim, leasehold location, or lease not established using the MTRSC system.

If more work is performed than required to meet minimum commitments, then an application can be made to have the excess applied against the following year, or for as many as four years. There is provision for a cash payment to be made in lieu of work expenditure.

At any time in the exploration or production process, a claimholder may convert the mining claim to a mining lease. Mining leases have the same rental and production royalty rates do mineral claims, and require annual claim filing and recordation. Each lease title defines specific rights of control and tenure for that lease that may otherwise be open to conflict with third party claimants or other multiple use users of the State land. A mining lease shall be for any period up to 55 years and is renewable if requirements for the lease remain satisfied. Minerals on State lands cannot be patented.

4.1.2 Surface Rights

Federal Lands

Of the total area of Alaska, 60% (222 million acres or 89.8 million ha) is classed as Federal lands. The USFS and BLM manage about 98 million acres (39.7 million ha) (20 and 78 million acres (8.1 million and 31.6 million ha) respectively) for multiple use purposes including timber production, fish and wildlife, recreation, water and mining.

Mineral tenure holders do not have surface rights but do have the rights to concurrent use of land to the extent necessary for the prospecting for, extraction of, or basic processing of mineral deposits once necessary permits have been obtained. Requirements for BLM land varies from those for USFS-administered lands.

State Lands

When Alaska became a state in 1959, the federal government granted the new state 28% ownership of its total area. Approximately 103,350,000 acres (41.8 million ha) were selected under three types of grants:

- Community (400,000 acres or 162,000 ha);
- National Forest Community (400,000 acres or 162,000 ha);

- General (102,550,000 acres or 41.5 million ha).

Additional territorial grants, for schools, university and mental health trust lands; totaling 1.2 million acres (486,000 ha) were confirmed with statehood.

Mineral tenure holders do not have surface rights but do have the rights to concurrent use of land to the extent necessary for the prospecting for, extraction of, or basic processing of mineral deposits.

Where surface rights are held by a third-party other than the State, appropriate compensation must be negotiated with the owner.

Alaska Native Claims Settlement Acts Lands

In 1971 Congress passed the Alaska Native Claims Settlement Act (ANSCA). This law granted 44 million acres (17.8 million ha) and $1 billion to village and native corporations created under the act. Generally, ANSCA gave Native selections priority over state land selections. Native lands are private lands. Thirteen regional corporations were created for the distribution of ANSCA land and money. Twelve of those shared in selection of 16 million acres (6.5 million ha), the 13th corporation, based in Seattle, received a cash settlement only. A total of 224 village corporations, of 25 or more residents, shared 26 million acres (10.5 million ha). The remaining acres, which include historical sites and existing native-owned lands, were allocated to a land pool to provide land to small villages of less than 25 people.

Agreements and compensation for land access and infrastructure construction must be separately negotiated with ANSCA holders.

4.1.3 Water Rights

The Alaska Water Use Act defines water rights as:

A water right is a legal right to use surface or groundwater under the Alaska Water Use Act (AS 46.15). A water right allows a specific amount of water from a specific water source to be diverted, impounded, or withdrawn for a specific use. When a water right is granted, it becomes appurtenant to the land where the water is being used for as long as the water is used. If the land is sold, the water right transfers with the land to the new owner, unless the Department of Natural Resources approves its separation from the land. In Alaska, because water wherever it naturally occurs is a common property resource, landowners do not have automatic rights to groundwater or surface water.

4.1.4 Permits and Environmental

Permits issued by federal agencies constitute “federal actions.” Any major federal action requires review under the National Environmental Protection Act (NEPA). A number of agencies can be involved in the review, at both the Federal and State levels. Other agencies are involved for specialist areas, such as transport of explosives, communication licenses, and landing strips for aircraft.

Typically, for larger metalliferous projects in Alaska, agencies involved in the permitting process can include:

- Bureau of Land Management (BLM);

- Federal Aviation Administration (FAA);
- United States Forest Service (USFS);
- National Marine Fisheries Service (NMFS);
- U.S. Coast Guard;
- U.S. Army Corps of Engineers (USACE);
- Environmental Protection Agency (EPA);
- Bureau of Alcohol, Tobacco, and Firearms (BATF);
- Federal Communications Commission (FCC);
- U.S. Department of Homeland Security;
- U.S. Department of Transportation (DoT);
- Mine Safety and Health Administration (MSHA);
- Alaska Department of Natural Resources (ADNR);
- Alaska Department of Environmental Conservation (ADEC);
- Alaska Department of Fish and Game (ADFG).

The federal agency with the predominant federal permit is usually designated the lead for the NEPA process. During the permitting process, the agencies identified as requiring input into the process will review the proposed Project, evaluate impacts associated with each facet of the Project, consider alternatives, identify compliance conditions, and ultimately decide whether or not to issue the requested permits.

Upon completion of the NEPA process, a Record of Decision is prepared that supports issuance of the permit for the preferred alternative for the Project, describes the conditions of the decision to issue the permit, and explains the basis for the decision. The state permitting process typically is not finalized until the NEPA process is completed. Each federal and state permit has compliance stipulations requiring review and possibly negotiation by the applicant and appropriate agency.

Reclamation

The US Mining Laws, specifically 43 CFR 3809 on the federal level, define the reclamation standards for mines operated since 1981. An Alaskan State law regulates the reclamation procedures on private, state, and federal lands for mines operated since mid-October 1991. The Department of Natural Resources and Division of Water and Mining issued the reclamation requirements. Briefly, requirements are that all mined land be returned to a stable state, that post-mining erosion be minimized, and that the potential for natural re-vegetation be enhanced. Before a mining permit can be issued, the mining company must first submit a plan for reclamation.

An approved reclamation plan from the appropriate Alaskan regulatory authority is required prior to mining operations commencement. An individual financial assurance is normally required, although for certain mining operations, the State will allow a bonding pool. However, a mining operation may not be allowed to participate in the bonding pool if the mining operation will chemically process material or has the potential to generate acid.

The Alaskan Commissioner determines the amount of the financial assurance needed after consideration of the reasonable and probable costs of reclamation for that operation. There are a number of methods of meeting the financial assurance requirements, including a surety bond, letter of credit, certificate of deposit, a corporate guarantee that meets the financial tests set in regulation by the commissioner, or payments and deposits into a specified trust fund. Typically, companies establish a fund under the Alaskan "Trust Fund for Reclamation, Closure & Post-Closure Obligations", such that the amount in the fund is sufficient to generate adequate cash flow to cover all reclamation, closure, and post-closure costs.

4.1.5 Royalties

Applying to State lands only, there is a 3% production royalty that is calculated on the same net profits basis as the mining license tax. This production royalty is payable on all State land production and does not include the 3.5-year grace period. Failure to file and pay this royalty will result in loss of claims.

No Federal taxes are currently levied; however, royalties are payable by Hecla to the Federal Government in certain instances (see Section 4.3).

4.2 Project Ownership

The Pan Sound Joint Venture, formed in 1973, consisted of joint venture partners Noranda Exploration (29.73%), Marietta Resources International (29.73%), Exhalas Resources Corporation (29.73%), and Texas Gas Exploration (10.81%). Under the Pan Sound Joint Venture, the first mineral claims were staked over the Big Sore vegetation and geochemical anomaly.

Bristol Bay Resources (Bristol), a company held by the Bristol Bay Native Corporation, joined the original partners in 1976.

In 1978, the Pan Sound Joint Venture was dissolved, and the Greens Creek Joint Venture created, with the same partners holding the interests in the Greens Creek Joint Venture.

Bristol sold its 11.2% interest in 1988 to Noranda and Hawk Inlet Company, with a half interest sold to each party. Bristol retained a 2.5% NSR royalty on its 11.2% share as part of the sale.

In 1982, Anaconda Minerals bought Marietta's interest and, in 1986, Amselco (a unit of BP Minerals) purchased both Anaconda's and Noranda's interests, subsequently selling off a portion to Hecla in 1987.

Texas Gas changed its name to CSX Alaska Mining Company, Inc. (CSX) in 1987. Following the merger of British Petroleum and Sohio, Kennecott Minerals (Kennecott) acquired Amselco in 1987.

The three remaining joint venture partners, Kennecott, Hecla, and CSX bought out Exhalas Resources Corporation in 1993. Kennecott Minerals bought out CSX in 1994, and CSX changed its name to Kennecott Juneau Mining Company (KJMC). At that time, the ownership was Kennecott Greens Creek Mining Company (KGCMC) with a 57.75% interest, KJMC with a 12.52% interest and Hecla with an interest of 29.73%.

In 1994, the Greens Creek Joint Venture (GCJV) agreement was restated in order to resolve certain issues between the Joint Venture participants.

KGCMC operated the mine up to 2008 with Hecla maintaining its 29.73% interest. On April 6, 2008, Hecla Mining Company completed its transaction to acquire KGCMC's 57.75% and KJMC's 12.52% interests in the Joint Venture (the Kennecott subsidiaries which held the remaining 70.27% interest in the Greens Creek Mine). As a result, Hecla subsidiaries now hold 100% of the Greens Creek Joint Venture.

The current ownership structure is illustrated in Figure 4-1.

4.3 Mineral Tenure

The Project core claims at Big Sore are held in the name of Hecla Greens Creek Mining Company, a wholly-owned Hecla subsidiary.

Figure 4-2 is a layout plan showing the breakdown of the various land holdings in the greater Project area. Table 4-1 and Table 4-2 present a summary of the Hecla ground holdings. Details of the unpatented claims are included in Appendix A. The holding obligations are summarized in Table 4-3. The annual maintenance fees of US$125 per claim required to hold the unpatented mining claims have been paid annually to the US Bureau of Land Management, and the required annual filing fees have been paid to Juneau Recording District, State of Alaska. The claims have been properly maintained and are in good standing. Hecla owns the patented mining and millsite claims and fee parcels, and pays the assessed property taxes, which payments are current as of the date of this report.

Figure 4-3: Ownership Structure of Greens Creek Mining Operations

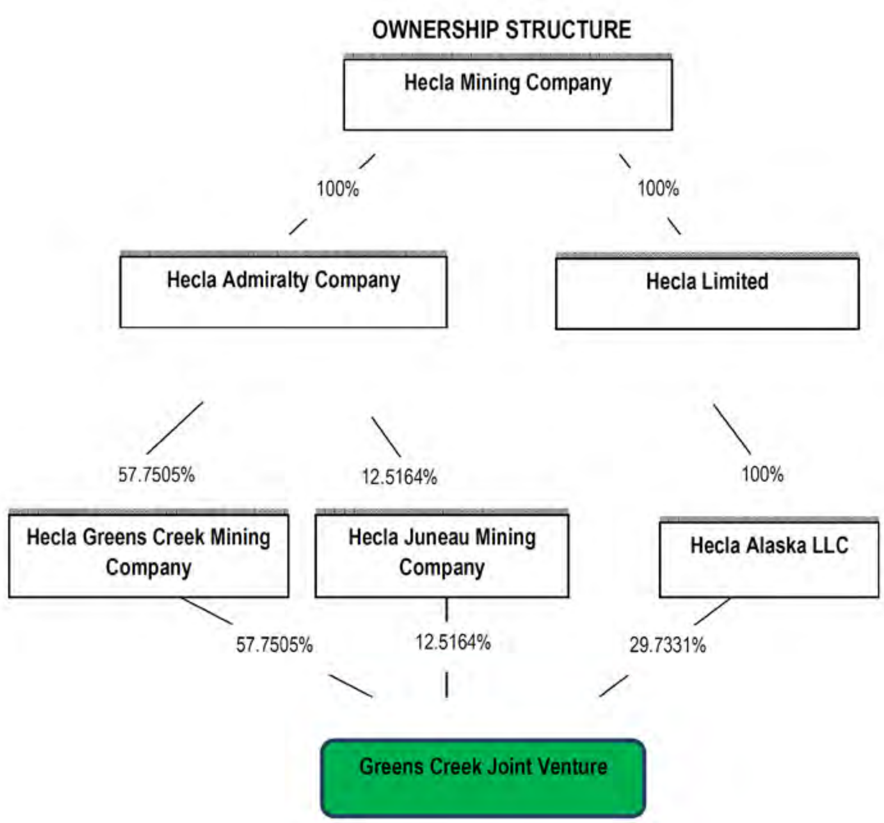


Figure 4-4: Project and Regional Land Holdings Layout Plan

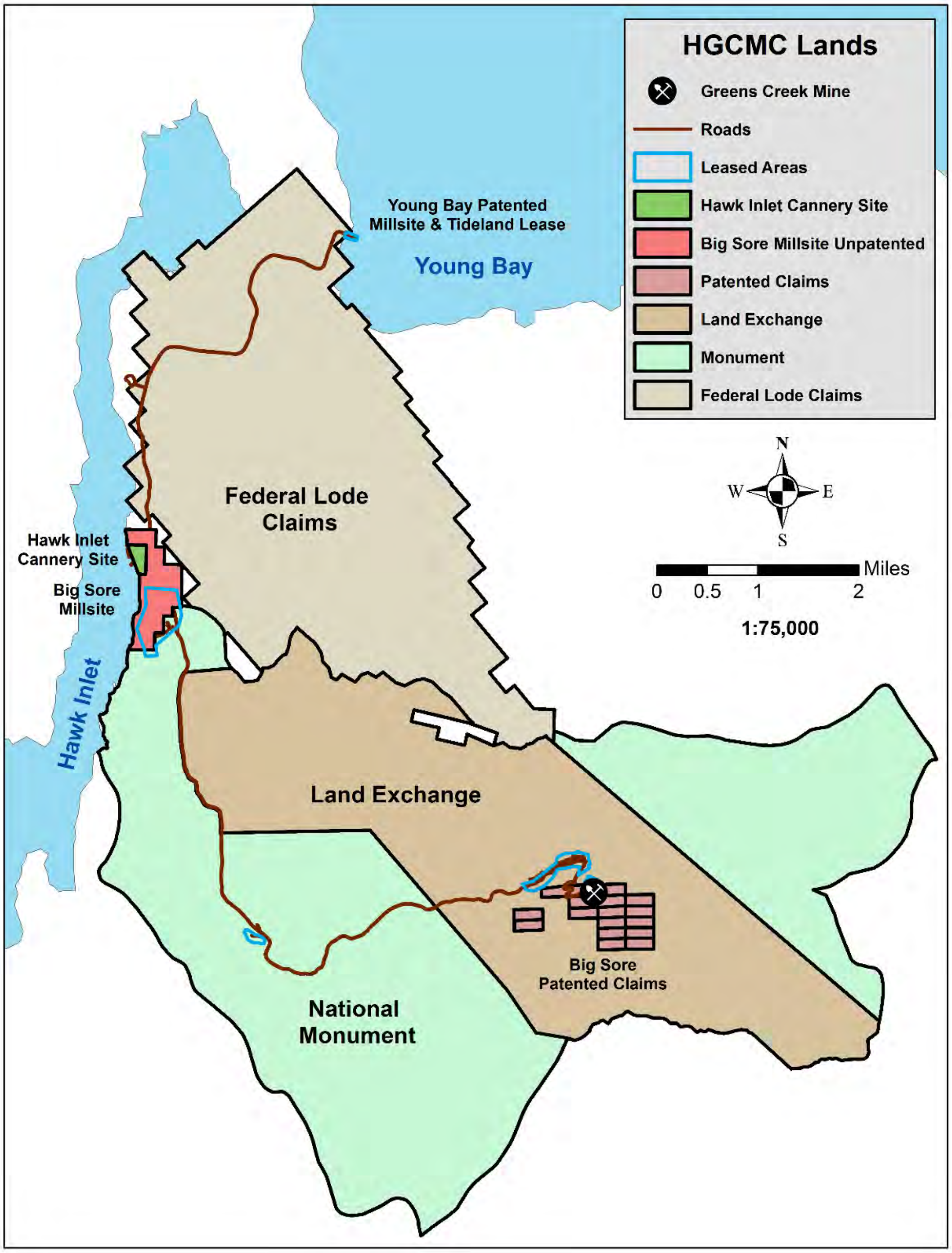


Table 4-1: Summary- Patented Claims and Mill Sites

Claim Names	Number	BLM Serial No. or Survey No. or ADL No.	Type	Acreage
Patented Claims				
Big Sore #s 902, 903, 904, 905, 906, 1006, 1007 and Big Sore #1305	8	Mineral patent Surveys: MS2402, MS2515	Patented surface and subsurface ("fee simple") lode mining claims	155.366 (62.874 ha)
Big Sore #s 1002, 1003, 1004, 1005, 1106, 1107; Big Sore #1105, 1207; and Big Sore #1304	9	Mineral Patent Surveys: MS2402, MS2515, MS2516	Patented lode	171.825 (69.535 ha)
Patented Millsite				
Young No. 1 millsite	1	Mineral Patent Survey: MS2514	Patented millsite, patented (surface) in Dec. 1992	0.6151 (0.2489 ha)

Table 4-2: Summary- Land Exchange and Other Fee Properties

Property Name	Number	BLM Serial No. or Survey No. or ADL No.	Type	Acreage
Exchange lands (Greens Creek Land Exchange Act of 1995)	N/A	Pat. No. 50-98-0434; U.S. Survey No. 11840, Alaska	Sub-surface mineral estate, surface considered AINM non-wilderness for mining development purposes	7,301.48 acres (2,954.80 ha)
Hawk Inlet Cannery site	1	U.S. Survey No. 793		16.83 acres (6.81 ha)
Hawk Inlet Cannery site tidelands	1	Alaska Tidelands Survey No. 57/ Serial No. 63-1523		21.019 acres (8.5 ha)
Exchange lands (Greens Creek Land Exchange Act of 1995)	N/A	Pat. No. 50-98-0434; U.S. Survey No. 11840, Alaska	Sub-surface mineral estate, surface considered AINM non-wilderness for mining development purposes	7,301.48 acres (2,954.80 ha)
Hawk Inlet Cannery site	1	U.S. Survey No. 793		16.83 acres (6.81 ha)
Hawk Inlet Cannery site tidelands	1	Alaska Tidelands Survey No. 57/ Serial No. 63-1523		21.019 acres (8.5 ha)

Table 4-3: Summary- Claims Holding Obligations

Names	Number	Type	Acreage	Holding Costs	Royalties	Comments
Big Sore #'s 902, 903, 904, 905, 906, 1006, 1007 (MS 2402) and Big Sore # 1305 (MS 2515)	8	patented surface and sub-surface ('fee simple') Federal lode mining claims	155.366 (62.874 ha)	property taxes	none	within Exchange Lands; represents so-called "perfected" claims in the immediate mine area (core claims with valid discoveries **as of** 12/1/78)
Big Sore #'s 1002, 1003, 1004, 1005, 1106, 1107 (MS 2402); Big Sore # 1105, 1207 (MS 2516); and Big Sore # 1304 (MS 2515)	9	patented sub-surface Federal lode mining claims	171.825 (69.535 ha)	property taxes	none	within Exchange Lands; represent so-called "unperfected" claims in the immediate mine area (core claims with valid discoveries made **after** 12/1/78)
Young No. 1 Millsite	1	Federal millsite claim, fully patented (surface) in Dec. 1992	0.6151 (0.2489 ha)	property taxes	none	outside of AINM within standard Tongass National Forest lands; claim provides a site for Young Bay dock and parking facility
Big Sore 1321-1324, 1421-1424, 1521-1524, 1623-1627, 1723-1728, 1824-1827	27	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 540 acres (219 ha); valid acreage is **much less**	$125/year/claim BLM rental fees, plus filing/recording fees	none	Mariposite Ridge area (abutting the Mammoth claims) within Tongass National Forest lands but overlapping **into** AINM; a portion of this claim block is invalid
Mariposite 1-77, 79-87, 100-114	101	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 2,020 acres (817 ha); because of overlaps actual valid acreage will be l**ess**	$125/year/claim BLM rental fees, plus filing/recording fees	none	multiple groups staked in 80's; on Tongass Nat'l Forest lands; portions may be invalid due to overlaps, especially with Lil Sore block
West Mariposite 115-123, 128-156, 159-165, 168-171	49	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 980 acres (397 ha); because of overlaps actual valid acreage will be l**ess**	$125/year/claim BLM rental fees, plus filing/recording fees	none	staked in 1996; on Tongass Nat'l Forest land:

Names	Number	Type	Acreage	Holding Costs	Royalties	Comments
Lil Sore 41-48	8	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 160 acres (65 ha); because of overlaps actual valid acreage will be less	$125/year/claim BLM rental fees, plus filing/recording fees	none	staked in 1996; on Tongass Nat'l Forest land; borders Lil' Sore block to W, Fowler block to N, Young Bay Experimental Forest to E
Fowler 543-558, 643-658, 743-758, 843-858, 943-958, 1043-1047, 1143-1147	90	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 1,800 acres (728 ha); because of overlaps actual valid acreage will be less	$125/year/claim BLM rental fees, plus filing/recording fees	none	staked in 1985; on Tongass Nat'l Forest land; bordered by West Fowler, North Fowler, & East Fowler; Lil Sore and Mariposite blocks to S
North Fowler 41, 141-144, 226-246, 250-251, 336-358, 363, 436-461	75	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 1,660 acres (672 ha); because of overlaps actual valid acreage will be less	$125/year/claim BLM rental fees, plus filing/recording fees	none	93 claims staked in 1996; on Tongass Nat'l Forest land; 10 claims were declared Null and Void Ab Initio (and portions of 12 others) by BLM in February 1997 (State Selected Land)
West Fowler 559-561, 659-664, 759-767, 859-865, 959-966	33	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 660 acres (267 ha); because of overlaps actual valid acreage will be less	$125/year/claim BLM rental fees, plus filing/recording fees	none	staked in 1996; on Tongass Nat'l Forest land; 7 claims abandoned in April 1997 that overlapped new mill sites claims, 1 declared Null and Void Ab Initio (and portions of 10 others) by BLM in February 1997 (State Selected Land)
East Fowler 538-542, 641-642, 741-742, 841-842, 941-942, 1042	14	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 280 acres (113 ha); because of overlaps actual valid acreage will be less	$125/year/claim BLM rental fees, plus filing/recording fees	none	41 claims staked in 1996; on Tongass Nat'l Forest land;
Big Sore Mill Site Nos. 798, 802-803, 899-902, 904-907, 996, 1001-1010, 1096-1097, 1103-1108, 1202-1205, 1505-1508, 1509-1511, 1514, 1516-1517,	58	unpatented Federal mill site mining claims	claimed acreage, @ 5 acres/claim, is 290 acres (117 ha)	$125/year/claim BLM rental fees, plus filing/recording fees	none	25 were re-staked in Fall 1993; on Tongass Nat'l Forest land; covers main tailings area; 33 sites to the north and east were re-staked in May 2002 (originally staked in Fall 1996)

Names	Number	Type	Acreage	Holding Costs	Royalties	Comments
1610-1614, 1710-1718						
HIP 010, 020, 030, 040, and 050	5	Alaska State Prospecting Sites	claimed acreage is 800 acres (324 ha) (1/4 section, 160 acres, per pros. site), 'valid' acreage is roughly 1/2 that due to shoreline	no rentals, no fees, no filings required **until land tentatively approved,** costs thereafter would be same as the state tideland claims	3% net income production royalty	staked in Feb 1996; on State selected lands along E side of Hawk Inlet, **status in limbo**; no development allowed until state selections are tentatively approved (has not happened as of Sept, 2005)
Hawk Inlet Cannery site	1	fee simple land (US survey 783)	16.83 acres (6.81 ha)	property taxes	NA	acquired from Bristol Resources, Inc.
Hawk Inlet Cannery site tidelands	1	Alaska Tidelands Survey No. 57	21.019 acres (8.50 ha)	property taxes	NA	acquired from Bristol Resources, Inc.
Exchange Lands (Greens Creek Land Exchange Act of 1996)	NA	sub-surface mineral estate, surface remains AINM non-wilderness	7,301 acres (2,955 ha)	none	3% net island receipts (NIR) production royalty; 3/4% NIR when NIR value is less than $120/ton ore	Completed in 1998; no surface mining allowed; 100-year expiration of conveyance
East Ridge #'s 1011-1015, 1111-1115, 1210-1215, 1310-1315, 1408-1417, 1510-1515, 1611-1615,	43	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 860 acres (348 ha); because of overlaps actual valid acreage will be less	$125/year/claim BLM rental fees, plus filing/recording fees	none	
The total unpatented and patented claims and mill sites, state prospecting sites and tideland claims; including Exch. Lands, **approximately 16,410 acres** (6,530 ha) encompassed			approximate total direct holding costs, excluding property taxes, are **$87,750 plus approx. $1720** in recording costs			***** excluding Forest Service leases and State tideland leases (approx. 113 acres (46 ha) total) ****** AINM is Admiralty Island National Monument

The Greens Creek property includes 440 unpatented lode mining claims, 58 unpatented millsite claims, 17 patented lode claims, one patented millsite and other fee lands, notably the Hawk Inlet historic cannery site. Hecla also holds title to mineral rights on 7,301 acres (2,955 ha) of Federal land acquired through a land exchange with the USFS.

4.3.1 Patented and Unpatented Claims

The patented lode claims, containing approximately 327 acres (132 ha), are located in Sections 4, 8, 9 and 10, Township 44 South, Range 66 East, Copper River Meridian, Juneau Recording District, Alaska. The 0.62-acre (0.25 ha) mill site claim is located in Section 1, Township 43 South, Range 65 East.

The unpatented lode and millsite mining claims are situated in Sections 1-3, 10-15, and 22-27, Township 43 South, Range 65 East, and Sections 7, 17-20 and 29-33, Township 43 South, Range 66 East, Copper River Meridian. The unpatented lode and millsite claims encompass approximately 8,072acres (3,267 ha).

4.3.2 Leasehold Lands

Greens Creek leases parcels from the United States on both the Monument and non-monument lands. It uses other public lands pursuant to special use permits issued by the USFS and leases issued by the State of Alaska. Some areas within the Monument required for the road right-of-way, mine portal and millsite access, campsite, mine waste area and a tailings impoundment are governed by USFS leases. Alaska National Interest Lands Conservation Act (ANILCA) is the legal basis for these leases and others which may be required.

4.3.3 Land Exchange Properties

Pursuant to “The Federal Greens Creek Land Exchange Act of 1995” (Pub. L. 104-123 April 1, 1996), 7,301 acres (2,955 ha) of mineral lands (subsurface estate and certain restricted surface use rights) surrounding the core group of 17 patented claims were conveyed to the Greens Creek Joint Venture in exchange for $1.0 million of private lands purchased by the Venture and a royalty on mineral production from the Land Exchange properties. Previously patented claims, including associated extralateral rights, are not subject to the royalty. The property extents are approximately from Section 26, Township 43 South, Range 65 East, to Section 13, Township 44 South, Range 66 East, Copper River Meridian.

The Land Exchange properties conveyed are subject to:

(i) Restrictive covenants limiting surface use; and
(ii) A future interest held by the United States which pertains to the Land Exchange properties, the core claims and other Greens Creek properties.

The future interest vests with the United States upon the earlier of:

(i) Abandonment of the properties;
(ii) January 1, 2045 (absent good faith mineral exploration, production or reclamation); or
(iii) January 1, 2095.

4.4 Surface Rights and Property Agreements

The land comprising the Greens Creek Mine, inclusive of all Admiralty Island facilities, consists of both publicly- and privately-owned land. It owns land on Admiralty Island both as a result of patenting mining and millsite claims and through transfer of private lands in the historic cannery area from its predecessor.

As noted in Section 4.3.2, Hecla leases parcels from the United States on both the Monument and non-monument lands. Hecla uses other public lands pursuant to special use permits issued by the USFS and leases issued by the State of Alaska. Additionally, Hecla holds subsurface and restricted surface use rights under the Land Exchange.

4.4.1 USFS Agreement

Kennecott and the USFS began discussing the possibility of the existence of extralateral rights at Greens Creek in about 1990. In 1994, Kennecott prepared a comprehensive geologic and legal analysis of extralateral rights at the Greens Creek Mine based upon the geologic information then available. Based upon that analysis, the USFS agreed that extralateral rights exist with respect to the Big Sore claims.

At Greens Creek, underground mining has progressed outside of the vertical boundaries of the mining claims under the extralateral rights. Hecla and predecessor companies have also conducted underground exploration beyond the mining claims' vertical boundaries.

In addition to the right to mine inherent in the Big Sore claims and the extralateral rights acknowledged by the USFS, Kennecott was granted mining rights pursuant to US Patent No. 50-98-0434 (AA-80626; the Patent) and the associated Agreement dated December 14, 1994 between Kennecott and the United States (the Patent Agreement). Hecla is also bound by these agreements and granted rights, and each of these rights carries with it somewhat different mining or possessory rights.

First, as it has done historically, Hecla can mine each and every mineral deposit found within the vertical boundaries of the Big Sore claims based upon the intraliminal rights that are inherent to every mining claim. Second, to the extent extralateral rights associated with the Big Sore claims can be demonstrated to exist, Hecla can mine "down dip" on a vein outside of the vertical boundaries of the claims. As long as Hecla stays within such vertical planes, there is no limit how far down dip Hecla can mine. And third, pursuant to the Patent and the Patent Agreement, Hecla is permitted to mine a specified area (the Agreement Area) outside of the vertical boundaries of the Big Sore claims even where no extralateral rights can be shown to exist.

To the extent Hecla mines pursuant to its intraliminal rights, i.e., the right inherent in the Big Sore claims, it is not obligated to make any royalty payment to the Federal Government. Likewise, to the extent Hecla mines pursuant to extralateral rights, i.e., down dip on a vein within vertical planes drawn through the end line of a claim that has extralateral rights, it is not obligated to make any royalty payment to the Federal Government.

When Hecla mines a mineral deposit located outside of the Big Sore claims where it cannot demonstrate extralateral rights, it must mine pursuant to the Patent and the Patent Agreement. The Patent and the Patent Agreement carry with them the obligation to pay a royalty to the Federal Government (the Federal Royalty, see Section 4.3). In addition, the area that can be mined is geographically limited to the Agreement Area.

From the statutory language of the General Mining Law, courts have established a number of requirements that must be met in order to obtain extralateral rights:

- The deposit involved must be a “lode” or a “vein”;
- The deposit must “apex” within the claim boundaries;
- The deposit must “dip”, and not be horizontal;
- The deposit must be “continuous”; and
- The deposit can only be pursued beyond the vertical boundaries of the side lines of a claim within planes parallel to the end lines of the claim.

These definitions of what constitute the basis for extralateral rights are being reviewed in relation to known mineralization, in particular the Gallagher Zone, which is adjacent to and appears to extend into, the Land Exchange boundaries. Hecla is currently exploring the relationships of the Greens Creek mineral bodies to the Gallagher Zone, and evaluating the influence of a major structural boundary, the Gallagher Fault, on mineralization continuity. If extralateral rights across the Gallagher Fault are not established, then the Gallagher Zone would be subject to a royalty to the US Government.

4.5 Royalties and Encumbrances

Bristol Resources holds a 2.5% net smelter return (NSR) royalty based on 11.2142% of the Greens Creek Joint Venture. This royalty is the sole responsibility of the Hecla Juneau Mining Company ownership interest (12.5164%; refer to Figure 4-1 for the ownership interest breakdown).

The royalty was payable once a calculated “capital recovery amount” of $26.5 million was recouped. The capital recovery amount is based on a percent of the capital investment related to the original feasibility study, the original purchase price of Bristol’s ownership share, and interest accumulated for a four-year period. Earnings applied to capital recovery were essentially calculated based on 11.2142% of net income before non-cash charges and income tax. The NSR value used in the Bristol Resources royalty is calculated as follows:

- Net proceeds from smelter;
- Less on-island concentrate transportation, storage, and ship loading costs;
- Less severance taxes.

Under the Land Exchange, production from new discoveries on the exchanged lands will be subject to Federal royalties included in the Land Exchange Agreement. The royalty is only due on production from Mineral Reserves that are not part of Greens Creek's extralateral rights. Thus far, there has been no production, and no payments of the royalty have been triggered.

Per the Greens Creek Land Exchange Act of 1995, (Public Law 104-123), properties in the land exchange are subject to a royalty payable to the USFS that is calculated on the basis of net island receipts (NIR). Net island receipts are equal to revenues from metals extracted from the Land Exchange properties less transportation and treatment charges (e.g., smelting, refining, penalties, assaying) incurred after loading at Admiralty Island.

The Net Islands Receipt royalty is 3% if the average value of the mineral reserve mined during a year is greater than $120 per ton ($132/tonne) of ore, and 0.75% if the value is $120 per ton ($132/tonne) or less. The benchmark of $120 per ton ($132/tonne) was adjusted annually according to the US Gross Domestic Product (GDP) Implicit Price Deflator until the year 2016, after which time it became a fixed rate of $161/ton.

4.6 First Nations

Hecla complies with all state and federal employment laws, which identify Native Alaskans as a protected minority classification. Hecla has no First Nations agreements in regard to Greens Creek and there are no outstanding First Nations claims in the project area.

4.7 Other Considerations

Permitting, environmental, and social considerations for the Project are discussed in Section 20.

4.8 Comments on Property Description and Location

In the opinion of the QPs, the information discussed in this section supports the declaration of Mineral Resources and Mineral Reserves, based on the following:

- The Project is wholly-owned by an indirectly held Hecla subsidiary;
- Information provided by Hecla land tenure experts supports that the mining tenure held is valid and is sufficient to support declaration of Mineral Resources and Mineral Reserves;
- Hecla holds sufficient surface rights in the Project area to support the mining operations, including access and power line easements;
- Royalties are payable on the Bristol and USFS Land Exchange lands; no royalty payment has yet been triggered on USFS lands;
- Hecla holds the appropriate permits under local, State and Federal laws to allow mining operations;
- The appropriate environmental permits have been granted for Project operation;
- At the effective date of this Report, environmental liabilities are limited to those that would be expected to be associated with an operating base metals mine where production occurs from underground sources, including roads, site infrastructure, waste dumps and disposal facilities;
- Hecla is not aware of any significant environmental, social or permitting issues that would prevent continued exploitation of the deposit;
- To the extent known, there are no other significant factors and risks that may affect access, title, or the right or ability to perform work on the property.

5.0 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE, AND PHYSIOGRAPHY

5.1 Accessibility

The mine site is situated partly within the Admiralty Island National Monument and completely within the municipal boundaries of the City and Borough of Juneau. The majority of the area of Admiralty Island is part of the Admiralty Island National Monument, which covers an area of more than 955,000 acres (3,860 km²). The mine and plant site are located approximately five miles (8 km) up the Greens Creek River valley with the mines' camp located at Hawk Inlet (refer to Figure 4-2).

Greens Creek employees are shuttled by ferry boat, which travels twice daily from Auke Bay, Juneau to Young Bay dock on Admiralty Island. Air transport is also available, for hire, through Ward Air originating at the Juneau airport and landing at the sea plane dock at Hawk Inlet camp. A number of helicopter services are also available for hire and may, with proper clearance, land at two landing pads; one at Hawk Inlet camp and the second at the mine site in the Greens Creek valley.

Freight services operate via weekly scheduled barge with service originating in Seattle, Washington and subsequent connections to Juneau. Once on Admiralty Island, buses are used to transport passengers along an improved dirt and gravel road from Young Bay dock to the Hawk Inlet camp or to the Greens Creek Mine.

5.2 Climate

Admiralty Island is a temperate rainforest featuring a cool temperate climate milder than its latitude may suggest, due to the influence of the Pacific Ocean. Winters are moist, long but only slightly cold: temperatures drop to 20º F (−6.7º C) in January, and highs are frequently above freezing. Spring, summer, and fall are cool to mild, with average highs peaking in July at 65º F (18.3º C).

Annual snowfall on Admiralty Island averages 98 inches (213 cm) and occurs chiefly from November to March. Precipitation occurs year-round, ranging from 55 inches (1,400 mm) to 90 inches (2,290 mm) annually. The months of May and June are the driest while September and October are the wettest. Admiralty Island's monthly temperature, precipitation and snowfall are summarized in Table 5-1.

Surface exploration at Greens Creek operates at elevations ranging from sea level to 3,300 feet (1,005 m). Weather is highly variable, ranging from sunny to week-long periods of low clouds and fog and because of this, exploration activities are conducted over five months; between May to October. Mining activity occurs year-round.

Table 5-1: Climate Summary Table

Month	Average Maximum Temp (ºF)	Average Maximum Temp (ºC)	Average Minimum Temp (ºF)	Average Minimum Temp (ºC)	Average Total Precipitation (in.)	Average Total Precipitation (mm)	Average Total Snowfall (in.)	Average Total Snowfall (mm)
January	29	-1.7	18.2	-7.7	4.26	108	26.8	681
February	34.2	1.2	23	-5	3.92	100	19.6	498
March	38.7	3.7	26.6	-3	3.48	88	14.4	366
April	47.5	8.6	32.4	0.2	2.93	74	2.8	71
May	55.3	12.9	39.2	4	3.53	90	—	—
June	61.6	16.4	45.3	7.4	3.13	80	—	—
July	64	17.8	48.4	9.1	4.29	109	—	—
August	62.7	17.1	47.6	8.7	5.34	136	—	—
September	56	13.3	43.2	6.2	7.21	183	—	—
October	47	8.3	36.9	2.7	7.86	200	1.1	28
November	37.7	3.2	28.5	-1.9	5.43	138	11.7	297
December	32.5	0.3	23.4	-4.8	5.09	129	21.8	554
Annual	**47.2**	**8.4**	**34.4**	**1.3**	**56.47**	**1,434**	**98.4**	**2,499**

5.3 Local Resources and Infrastructure

Juneau is the closest large city. Operating supplies are shipped via weekly barge service from Juneau, AK, and Seattle, WA. Project infrastructure and the infrastructure layout are discussed in Section 18 of the Report.

5.4 Physiography

Mine facility elevations range from the concentrate shipping facility, which is at sea level, to the 1350-adit at an elevation of 1,350 ft (412 m) above sea level. The mill and main mine portal are located at an elevation of 920 ft (280 m).

The ecology of Admiralty Island is dominated by temperate rainforest that is primarily made up of Sitka spruce, and western hemlock interspersed with small areas of muskeg. The timberline is typically at an elevation of 2,000 to 2,500 ft (610 m to 762 m). Above the timberline the forest gradually changes to alpine-tundra with rock outcrops and permanent and semi-permanent snow fields.

5.5 Comments on Accessibility, Climate, Local Resources, Infrastructure, and Physiography

In the opinion of the QPs:

- There is sufficient suitable land available within the mineral tenure held by Hecla for tailings disposal, mine waste disposal, and installations such as the process plant and related mine infrastructure. All necessary infrastructure has been built and is sufficient for the projected LOM plan.
- A review of the existing power and water sources, manpower availability, and transport options indicate that there are reasonable expectations that sufficient labor and infrastructure will continue to be available to support declaration of Mineral Resources, Mineral Reserves, and the proposed LOM plan.

6.0 HISTORY

Information in this section is based on a summary prepared by West (2010) and by Hecla staff. Historical and current exploration work completed from 1973 to February 2019 is presented in Table 6-1. The localities discussed in Table 6-1 are indicated in Figure 6-1. Mineralization was discovered at the "Big Sore" copper sub-crop in 1974. Mining operations commenced in 1989 but closed in 1993 due to low metal prices. In 1996, the mine was re-opened, and production has continued to date.

Hecla obtained a 100% interest in the Project in 2008. Mine production from 1989 to 2012 is summarized in Table 6-2 in Imperial units and in Table 6-3 in metric units. An overall life-of-mine summary is included as Table 6-4. For a history of Mineral Reserves at Greens Creek Mine, see Section 15.

Table 6-1: Exploration Summary

Year	Operator	Work Completed/Company	Comment
1973	Pan Sound Joint Venture, a consortium vehicle of partners Noranda Exploration (29.73%), Marietta Resources (29.73%), Exhalas Resources (29.73%), and Texas Gas Exploration (10.81%)	Stream sediment sampling.	Identified a zinc and copper anomaly associated with Cliff Creek, but no claims were pegged.
1974		Air reconnaissance inspection.	Identified a large ferricrete zone that was vegetation free, the “Big Sore”; claims staking.
1974–1975		Additional stream sediment sampling, soil and rock sampling, Crone shoot-back electromagnetic (CEM) geophysical survey, surface magnetometer survey, geological mapping, trenching and blasting and drilling of three core holes.	PS0001 (first surface drillhole) intersects a wide zone of mineralization at Big Sore.
1976	Noranda assumed operatorship of the Pan Sound Joint Venture	Geochemical sampling, CEM and magnetic surveys, geological mapping at Big Sore, core (five holes) and Winkie (AQ size; eight holes) drilling.	First-time mineral resource estimate.
1977		22 holes totaling 8,810 ft (2,685 m) were completed at Big Sore, Killer Creek and Gallagher Creek. Additional soil sampling was undertaken over extensions to these areas, as was a CEM survey. Soil surveys, CEM and magnetic geophysical surveys, and geologic mapping were also carried out on the Zinc Creek and Mariposite Ridge prospects.	
1978	Pan Sound Joint Venture was dissolved		Greens Creek Joint Venture formed in its place to accommodate the involvement of the Bristol Bay Native Corporation.
1978	Greens Creek Joint Venture	Exploration drift was started; a total of 24 underground drill stations were established, from which 50 core holes were collared. Environmental baseline studies commenced.	By November 1979, 4,190 ft (1,277 m) of drift and a 219 ft (67 m) raise had been completed.
1980		33 core holes were completed, and an Environmental Impact Assessment commissioned.	The Alaska National Interest Land Conservation Act was passed, under which the Admiralty Island National Monument was created. The Greens Creek deposit and mineral tenure, although within the national monument zone, were excluded from the wilderness classification of the remainder of the national monument area. Section 504 of ANILCA allowed for exploration on previously located, unpatented claims that fell within three-quarters of a mile of Greens Creek, providing that exploration ceased in five years and any claims not “perfected” reverted to national monument status.
1981–1982		Metallurgical bulk sample. Surface core drilling (12 holes totaling 11,210 ft or 3,417 m) was conducted, with nine holes completed in the Big Sore area, two in Gallagher Creek, and one in Bruin Creek,	Development-support activities such as engineering and environmental studies. Mineral resource estimates updated.

Year	Operator	Work Completed/Company	Comment
		on the north side of Greens Creek. Detailed geological mapping at a scale of 1 inch = 500 ft was conducted in the Greens Creek area.	
1983	Anaconda purchased all of Martin-Marietta's interest in the Greens Creek Joint Venture in March 1983	17 holes drilled	Feasibility study completed.
1984	At the end of the year, Anaconda and Noranda equally bought out Bristol Bay Native Corporation's properties at Hawk Inlet for a cash payment and a 0.28-percent net smelter royalty. The land would revert back to Bristol Bay Native Corporation upon termination of the Greens Creek Joint Venture.	Surface drilling, mapping, trenching. Two bulk samples were mined, one of which was tested by Noranda, the second by Anaconda.	
1985		10 holes totaling 12,266 ft (3,739 m) were completed from surface, and 47 holes and 34,749 ft (10,591 m) of drilling from underground.	A 10-year lease with a drill commitment and royalty payment obligation on production was signed with the owners of the nearby Mammoth claims.
1986	Amselco (BP) become operator by buying out Anaconda and Noranda. Amselco sells portion to Hecla (%); CSX acquires Texas Gas.	Three surface holes, totaling 4,694 ft (1,431 m), and one underground exploration hole was drilled to 1,271 ft (387 m). Surface mapping and exploration at the Mammoth and Mariposite claim groups. Four EM and magnetic survey lines were flown. Mill and surface road construction begins.	No magnetic anomalies were delineated but six electro-magnetic anomalies were co-incident with known soil geochemical anomalies in the Big Sore area. At the end of the year, the Greens Creek Joint Venture lost all rights to the Big Sore claims except for the eight core claims and the nine additional perfected claims.
1987		Structural mapping and interpretation.	
1988–1989		Engineering and technical studies in support of mine development.	
1989	Rio Tinto Zinc buys Kennecott from BP(Amselco) and becomes operator.	Two surface holes were drilled in 1989, and underground exploration drilling conducted.	Mill start-up occurred in February 1989. Surface holes tested for down-dip extensions of the North mineral zone. Underground drilling, also testing the North mineral zone, identified mineralization at a previously unrecognized horizon at a lower elevation than the North mineral zone.
1990		10 holes totaling 23,287 ft (7.098 m) completed to validate claims to the west of the core claim group at Big Sore.	Underground drilling program intersected three new mineral bodies: the Central West, the Northwest West, and the Southwest zones. No additional surface drilling subsequently took place until the passage of the Land Exchange Act in 1996.
1990–1993		Underground drilling was continued to define the West, Northwest-West and Southwest zones.	Negotiations began on a new land-exchange proposal whereby private land in-holdings on Admiralty Island and other areas of the Tongass National Forest would be conveyed to the US Forest Service in return for the subsurface mineral rights to 6,875 acres (2,782 ha) surrounding the core claims. Greens Creek received title to

Year	Operator	Work Completed/Company	Comment
			the 17 core claims and one millsite claim in 1992 after the USDA Forest Service and Bureau of Land Management approved the final validity test in December.
1993	Exhalas share bought out by Kennecott/Hecla	Underground drilling was continued to define the Southwest Ore Zone.	Mine closure due to low metal prices.
1994	CSX bought out; Greens Creek Joint Venture now Kennecott (70.27%), Hecla (29.73%)		The land exchange agreement was with the US Forest Service concluded.
1996		Updated feasibility study. Airborne EM, radiometric, and magnetometer surveys were completed during 1996–1997 to determine which might be more effective in surface exploration. Geological mapping. Underground definition drilling in the Northwest West and 5250 mineral zones. Underground and surface gravity surveys were completed. Two test lines over the West and Northwest West mineral zones were surveyed by the controlled source audio-magnetotelluric (CSAMT) method. A time-domain electromagnetic (TEM) survey was completed over eight lines and measured a strong response from the West Ore. Down-hole TEM surveys were completed on surface and underground holes.	The land exchange agreement approved by Congress. A total of 745-line miles (1,200-line kilometers) of surveys covered the entire Greens Creek area, including the land exchange parcel. Distinct magnetic anomalies corresponded with already mapped ultramafic bodies. The EM survey proved useful in identifying graphitic rocks, such as the Hyd argillite. A completely revised 1 inch = 1,000-foot scale district map and numerous 1 inch = 200-foot scale mine geologic maps were compiled during 1996–1997, and the prospective mine stratigraphy was traced to the south and north. Milling operations re-commence in July.
1997		Nine holes (7,755.5 ft or 2,364 m) were completed, targeting extensions to known mineralization at the North Ore Zone, the Upper Plate Extension of the Northwest West Ore Zone, and a possible north extension of the West Ore. Four diamond drillholes (6,316 ft or 1,925 m) were completed in 1997 at Big Sore with limited results. Soil sampling, gravity, magnetic and TEM geophysical surveying, and geologic mapping on cut grids.	No high-priority, near-surface coincident gravity and TEM anomalies (possible shallow massive-sulfide bodies) were identified. Soil sampling and geologic mapping outlined drill targets or areas for detailed follow up work in Bruin, Gallagher, and Lower Zinc Creek prospects. However, underground drilling identified the very high-grade 200 South Zone.
1998		Four holes were drilled in Bruin Creek; grid extension and development, geochemical sampling and geophysical surveys.	One new grid (Upper Big Sore) and extensions of three 1997 grids (Lower Zinc, Bruin, and “A” Road) were geochemically sampled and geophysically surveyed. The work outlined numerous multi-element anomalies with coincident TEM anomalies; however, none were considered immediate drill targets.
1999		Grid expansion, geochemical sampling and geophysical surveys. Ten diamond drillholes were completed (12,715 ft or 3,875 m), seven at Bruin Creek and three at Killer Creek.	Grid expansion continued at Killer Creek, Upper Zinc Creek and Cub prospects. Numerous high-rank, multi-element soil anomalies were defined, and numerous sulfide-bearing outcrops and gossan zones were sampled and mapped. No mineralization was encountered in the Bruin Creek holes; the Killer Creek drilling intersected chalcopyrite and minor sphalerite mineralization.
2000		CSAMT geophysical survey; drilling	A CSAMT geophysical survey was completed along three lines in Bruin and Cub Creek prospects in 2000. Three lines were also surveyed in Killer Creek area. In conjunction with

Year	Operator	Work Completed/Company	Comment
			soil survey results, the identified Bruin and Cub Creek anomalies were tested by six core holes, with limited results. Five holes were drilled in Killer Creek. Four moderately southwest-dipping zones with silver and zinc enrichment were outlined.
2004		On surface 41 holes from 17 sites totaling 47,034 ft (14,335 m). Detailed geological mapping by John Proffett continued in the Gallagher Creek area. Down-hole electro-magnetic (DH-UTEM) and natural source audio-magnetotelluric geophysical surveys were completed.	Underground drilling identifies Gallagher mineral body. Four holes in Lower Gallagher Zone intersect sub-economic to economic -grade mineralization. Upper Gallagher Zone drilling identified mineralization on wide side of Gallagher Fault. Lower Zinc drilling identified silica and massive pyrite at contact.
2005		On surface 35 drillholes from seven sites totaling 36,100 ft (11,003 m). Soil geochemistry grids completed at Cliff Creek, and grid extensions to Killer Creek, Cub Creek and Upper Gallagher prospects. Geological mapping along Killer Creek, Cliff Creek and Cub Creek prospects. Larger scale Magneto-Telluric (MT) survey in the Upper Gallagher Zone that targeted the West Gallagher contact.	Intersection of mineralized intervals underground in Southwest West Bench (Middle Gallagher) and within East Ore. MT survey refines local geology and may extend West Gallagher horizons to the north, west, and south. Surface drilling at surface identified mineralization at Lower Zinc Creek and Lil' Sore.
2006		25 drillholes from six sites totaling 30,201 ft (9,205 m) on surface. Prospecting, geochemistry and mapping grids extended at Cliff Creek, High Sore and Killer Creek. Mobile metal-ion (MMI) sampling tested at Killer Creek, West Bruin, and Lil' Sore prospects. Detailed mapping at High Sore and Cliff Creek.	Northern projection of West Bench mineralization intersected underground. Minor mineralized intersections at West Gallagher and Lower Zinc prospects. Mine contact intersected at Bruin and Cub Creek prospects. Discovery of the 5250 North extension underground.
2007		Surface drilling from seven sites totaling 28,920 ft (8,815 m) on Lower Zinc Creek, Cub Creek, West Gallagher and Lil' Sore prospects. Mapping and geochemical sampling at Killer Creek and West Bruin prospects. CSAMT and AMT/MT geophysical surveys completed West Gallagher prospect.	Definition of the Deep 200 South Zone at depth and the identification of the Northeast contact below the current mine infrastructure. Weak mineralization defined at Lower Zinc and Cub Creek prospects along mine contact. Claims near Young Bay staked.
2008	Hecla buys out the Kennecott interest in the Greens Creek Joint Venture, becomes 100% owner-operator	Surface drilling from 7 sites totaling 20,649 ft (6,293 m) on North Big Sore, East Ridge, Cub (northwest contact) prospects, and East Ore Zone. LiDAR surveys, geological mapping and geochemical sampling initiated on newly staked Young Bay ground.	Deep 200 South Zone drilling defines two distinct zone or fold limbs and 5250 Zone extended to the south. Southern extension to East Ore Zone mineralization intersected from surface. Detailed mapping defined mine contact at Lower Zinc and Killer Creek prospects.
2009		20 drillholes from surface totaled 18,064 ft (5,506 m) on East Ore Zone and West Gallagher, Bruin and Northeast contact (Cub) prospects. Detailed mapping Bruin along projected northeast contact. Reconnaissance mapping and geochemical sampling at Young Bay claims.	Intersections of mineralization at south extent of East Ore Zone. Disseminated sulfides defined with drilling at Bruin and Cub prospects along projection of Northeast contact.
2010		Surface drilling of 17 holes totaling 21,217 ft (6,467 m) at Northeast contact (Cub and Bruin), East Ridge and Killer Creek prospects. Geochemical and MMI survey in the North Young Bay area. Compilation of historic geophysical data.	Expansion of the Deep 200 South, Northwest West and 5250 zone mineral resources. Mapping and drilling extend the Northeast contact to the northeast of the mine infrastructure. Weak mineralization along mine contact identified by drilling at East Ridge and Killer Gossan prospects.

Year	Operator	Work Completed/Company	Comment
2011		14 surface holes totaling 27,384 ft (8,346 m) at Northeast contact, West Bruin, and East Ore. 3D inversion analysis on portion of historic Aerodat airborne geophysical data. Surface and borehole Pulse EM surveys used to define targets. Reconnaissance mapping and geochemical sampling in North Young Bay area. Detailed mapping in Keller Creek area.	Continued expansion of the Deep 200 South, East Ore and 5250 mineral resources. Surface drilling continues to define the Northeast contact beyond Bruin and Cub prospects. Pulse EM identified conductor in sufficient detail to conduct drilling at Killer Creek and West Gallagher prospects.
2012		Eight surface holes totaling 17,710 ft (5,398 m) at Killer Creek, West Gallagher, West Bruin prospects and East Ore Zone. Reconnaissance and detailed mapping and geochemical sampling in North Young Bay area. Detailed mapping of Killer Creek area.	Strong mineralization intersected underground at Deep 200 South, Southwest Bench, and Northwest West zones. Surface drilling at Killer Creek identified a broad copper-rich vein zone which may represent a new mineralizing vent area. Drilling to the southeast identified zinc-rich zones near the mine contact.
2013		Ten surface drillholes totaling 28,746 feet at the Killer Creek target. Reconnaissance mapping of the anomalous Zinc Creek area and detailed structural mapping of Mariposite ridge.	Two silicified copper and zinc-rich zones were encountered near surface in the Killer Creek area. These broad zones likely represent a shallow feeder zone.
2014		Six surface drillholes totaling 23,214 feet in the Killer Creek target area. Reconnaissance mapping of the Killer-Lakes district area and detailed structural mapping of the Killer Creek - Mammoth areas. One downhole EM survey was conducted in Killer Creek to define mineralization and 'mine contact' in the area.	A deep mine argillite contact was encountered with weak mineralization. The upper portions of drillholes in Killer Creek target continued to define shallow copper and zinc-rich zones.
2015		Four surface drillholes totaling 8,085 feet were completed in the Lower Killer Creek and High Sore target areas. Mapping of the High Sore and Big Sore areas with a focus on local s2.5 shears. Physical property data (density), Magnetic Susceptibility and conductivity measurements were taken in every drillhole.	The Big Sore syncline was tested in Lower Killer Creek by a single drillhole between the Gallagher and Maki Faults. Though weak mineralization was encountered at the High Sore target, several s2.5 shears were encountered east of known locations.
2016		Two surface drillholes totaling 3,074 feet were completed in Big Sore Creek targeting potential offset mineralization. Reconnaissance mapping of the Big Sore Creek and East of the Mammoth claims was completed.	Anomalous zinc mineralization in hanging wall argillite indicated that the 'mine contact' hosting Greens Creek mineralization was likely eroded away above Big Sore Creek. A barren Northeast contact was also encountered in each drillhole.
2017		Nine drillholes totaling 20,419 feet were completed in the West Gallagher, Upper Gallagher and Big Sore prospects. Mapping was completed in the Lower Zinc Creek area with a focus on mapping shear zones.	Five drillholes west of the Gallagher Fault encountered bench mineralization in shear zones. Broad zinc mineralization was encountered at the 'Bench' Contact west of known mineral resources and east of the Gallagher Fault. Drilling south of the mine in Upper Gallagher encountered a weakly mineralized mine contact.
2018		Fifteen drillholes totaling 20,941 feet were completed in the West Gallagher and Lower Gallagher Areas targeting Southwest Bench - 200S Bench and the Upper Plate Zone respectively. Detailed mapping was completed in the Upper Gallagher and Mammoth ridge areas.	Upper Plate ore-grade mineralization was extended 150 feet west of known mineral resource. Four drillholes further defined western extensions of 'Bench' mineralization east of the Gallagher Fault and west of known mineral resources.

Figure 6-1: Plan Map with Land Exchange and Claims

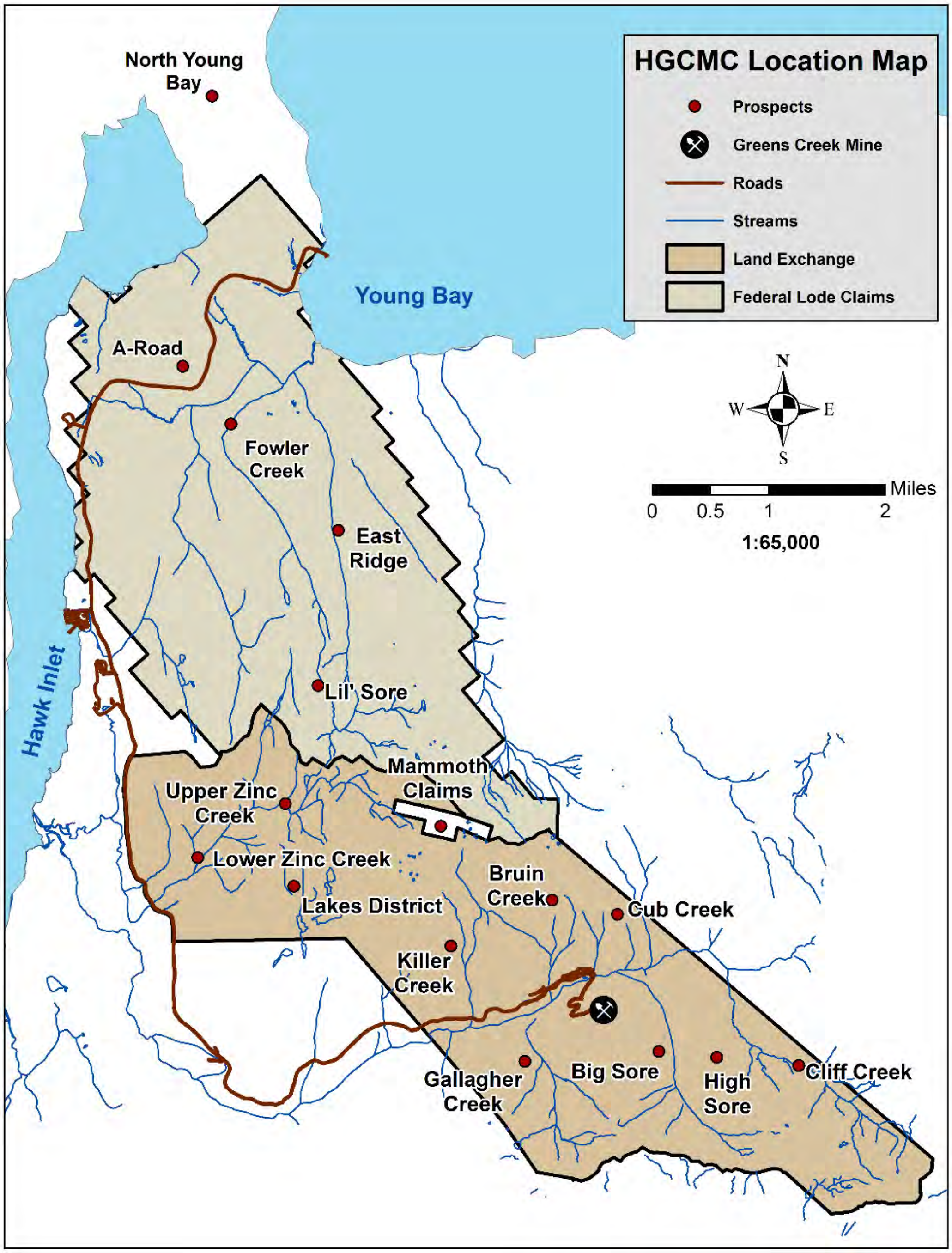


Table 6-2: Production History, 1989–2018 (Imperial Units)

Year	Tons Milled (tons)	Head Grade				Recovery				Contained Metal in Feed			
		Zn (%)	Pb (%)	Ag (oz/ton)	Au (oz/ton)	Zn (%)	Pb (%)	Ag (%)	Au (%)	Zn (ktons)	Pb (ktons)	Ag (Moz)	Au (koz)
1989	264,672	8.71	4.39	24.22	0.139	84.0	77.6	80.6	63.9	23.1	11.6	6.4	36.8
1990	382,574	10.43	4.89	23.04	0.120	89.1	82.9	86.6	83.3	39.9	18.7	8.8	45.7
1991	427,942	11.05	4.65	22.00	0.116	85.3	76.3	80.6	73.9	47.3	19.9	9.4	49.5
1992	439,828	10.82	4.66	20.78	0.113	80.2	71.4	76.3	65.1	47.6	20.5	9.1	49.8
1993	119,772	11.30	4.58	20.70	0.131	86.1	75.2	79.1	64.1	13.5	5.5	2.5	15.7
1996	143,737	9.98	4.85	23.81	0.108	80.1	72.9	80.8	66.4	14.3	7.0	3.4	15.5
1997	489,854	10.47	4.79	25.68	0.177	80.0	74.8	77.3	64.3	51.3	23.5	12.6	86.8
1998	540,028	11.93	5.13	22.74	0.170	84.1	75.8	77.3	65.9	64.5	27.7	12.3	91.9
1999	578,298	13.47	5.66	23.64	0.212	80.6	70.3	75.9	65.7	77.9	32.7	13.7	122.7
2000	619,438	13.57	5.28	20.06	0.208	79.6	68.1	74.3	64.8	84.1	32.7	12.4	128.7
2001	658,008	12.12	4.75	21.76	0.194	80.1	71.7	76.6	68.6	79.7	31.2	14.3	127.7
2002	733,431	12.52	4.73	19.73	0.203	79.9	70.9	75.4	68.9	91.9	34.7	14.5	149.0
2003	781,275	12.29	4.60	19.69	0.187	79.3	69.1	76.1	68.0	96.0	35.9	15.4	146.2
2004	805,353	11.14	4.05	16.65	0.163	77.1	67.1	72.4	65.5	89.7	32.6	13.4	131.6
2005	717,564	10.34	3.98	18.17	0.149	78.6	65.1	74.1	67.9	74.2	28.6	13.0	107.1
2006	732,100	9.36	3.66	15.78	0.130	76.5	69.5	76.8	66.2	68.5	26.8	11.6	95.0
2007	732,150	9.67	3.66	15.45	0.137	79.1	70.0	76.4	68.0	70.8	26.8	11.3	100.1
2008	734,907	10.09	3.58	13.38	0.142	78.5	70.5	72.7	64.5	74.2	26.3	9.8	104.7
2009	790,871	10.13	3.64	13.01	0.133	79.1	68.5	72.5	63.8	80.1	28.8	10.3	105.5
2010	800,397	10.66	4.09	12.30	0.134	78.1	68.0	73.2	64.3	85.3	32.8	9.8	107.1
2011	772,068	9.81	3.52	11.49	0.118	78.8	68.1	73.2	62.3	75.7	27.2	8.9	91.2
2012	789,569	9.35	3.49	11.13	0.115	77.7	67.8	72.8	61.0	73.8	27.5	8.8	91.0
2013	805,322	8.47	3.33	13.04	0.118	74.1	67.6	70.9	60.6	68.2	26.8	10.5	94.9
2014	816,213	8.38	3.22	13.24	0.115	75.9	69.3	72.4	62.5	68.4	26.3	10.8	93.9
2015	814,398	8.74	3.30	13.50	0.111	75.1	73.3	76.9	67.0	71.2	26.9	11.0	90.5
2016	815,639	8.08	3.11	14.55	0.097	75.0	74.7	78.0	68.2	65.9	25.4	11.9	79.1
2017	839,589	7.25	2.72	12.88	0.093	74.6	72.7	77.2	65.0	60.9	22.9	10.8	78.2
2018*	845,398	7.47	2.80	12.16	0.094	87.7	80.1	77.4	65.1	63.1	23.7	10.3	79.1

Notes:

Zinc recovery: to Zn concentrate, bulk concentrate, (Pb concentrate in 2018 only)

Lead recovery: to Pb concentrate, bulk concentrate, (Zn concentrate in 2018 only)

Silver recovery: to doré, Pb concentrate, Zn concentrate, bulk concentrate

Gold recovery: to doré, Pb concentrate, Zn concentrate, bulk concentrate

*In 2018, zinc in the lead concentrate and lead in the zinc concentrate became payable, so they are included in the 2018 recovery percentages

Table 6-3: Production History, 1989–2018 (Metric Units)

Year	Tonnes Milled (tonnes)	Head Grade				Recovery				Contained Metal in Feed			
		Zn (%)	Pb (%)	Ag (g/t)	Au (g/t)	Zn (%)	Pb (%)	Ag (%)	Au (%)	Zn (kton)	Pb (kton)	Ag (Moz)	Au (koz)
1989	240,106	8.71	4.39	830	4.77	84.0	77.6	80.6	63.9	20.9	10.5	6.4	36.8
1990	347,065	10.43	4.89	790	4.11	89.1	82.9	86.6	83.3	36.2	17.0	8.8	45.7
1991	388,222	11.05	4.65	754	3.98	85.3	76.3	80.6	73.9	42.9	18.1	9.4	49.5
1992	399,005	10.82	4.66	712	3.87	80.2	71.4	76.3	65.1	43.2	18.6	9.1	49.8
1993	108,655	11.30	4.58	710	4.49	86.1	75.2	79.1	64.1	12.3	5.0	2.5	15.7
1996	130,396	9.98	4.85	816	3.70	80.1	72.9	80.8	66.4	13.0	6.3	3.4	15.5
1997	444,388	10.47	4.79	880	6.07	80.0	74.8	77.3	64.3	46.5	21.3	12.6	86.8
1998	489,905	11.93	5.13	780	5.83	84.1	75.8	77.3	65.9	58.5	25.1	12.3	91.9
1999	524,623	13.47	5.66	811	7.27	80.6	70.3	75.9	65.7	70.7	29.7	13.7	122.7
2000	561,945	13.57	5.28	688	7.13	79.6	68.1	74.3	64.8	76.3	29.6	12.4	128.7
2001	596,935	12.12	4.75	746	6.65	80.1	71.7	76.6	68.6	72.3	28.3	14.3	127.7
2002	665,357	12.52	4.73	676	6.96	79.9	70.9	75.4	68.9	83.3	31.5	14.5	149.0
2003	708,761	12.29	4.60	675	6.41	79.3	69.1	76.1	68.0	87.1	32.6	15.4	146.2
2004	730,604	11.14	4.05	571	5.59	77.1	67.1	72.4	65.5	81.4	29.6	13.4	131.6
2005	650,963	10.34	3.98	623	5.11	78.6	65.1	74.1	67.9	67.3	25.9	13.0	107.1
2006	664,150	9.36	3.66	541	4.46	76.5	69.5	76.8	66.2	62.2	24.3	11.6	95.0
2007	664,195	9.67	3.66	530	4.70	79.1	70.0	76.4	68.0	64.2	24.3	11.3	100.1
2008	666,696	10.09	3.58	459	4.87	78.5	70.5	72.7	64.5	67.3	23.9	9.8	104.7
2009	717,466	10.13	3.64	446	4.56	79.1	68.5	72.5	63.8	72.7	26.1	10.3	105.5
2010	726,108	10.66	4.09	422	4.59	78.1	68.0	73.2	64.3	77.4	29.7	9.8	107.1
2011	700,408	9.81	3.52	394	4.05	78.8	68.1	73.2	62.3	68.7	24.7	8.9	91.2
2012	716,285	9.35	3.49	382	3.94	77.7	67.8	72.8	61.0	66.9	25.0	8.8	91.0
2013	730,576	8.47	3.33	447	4.04	74.1	67.6	70.9	60.6	61.9	24.3	10.5	94.9
2014	740,456	8.38	3.22	454	3.95	75.9	69.3	72.4	62.5	62.1	23.9	10.8	93.9
2015	738,809	8.74	3.30	463	3.81	75.1	73.3	76.9	67.0	64.6	24.4	11.0	90.5
2016	739,935	8.08	3.11	499	3.33	75.0	74.7	78.0	68.2	59.8	23.0	11.9	79.1
2017	761,662	7.25	2.72	442	3.20	74.6	72.7	77.2	65.0	55.2	20.7	10.8	78.2
2018	766,932	7.47	2.80	417	3.21	87.7	80.1	77.4	65.1	57.3	21.5	10.3	79.1

Notes:

Zinc recovery: to Zn concentrate, bulk concentrate

Lead recovery: to Pb concentrate, bulk concentrate

Silver recovery: to doré, Pb concentrate, Zn concentrate, bulk concentrate

Gold recovery: to doré, Pb concentrate, Zn concentrate, bulk concentrate

*In 2018, zinc in the lead concentrate and lead in the zinc concentrate became payable, so are included in the 2018 recovery percentages

Table 6-4: Life of Mine Production 1989–2018

Imperial Units			**Metric Units**		
Items		**Production**	**Items**		**Production**
Tons milled		17,990,395	Tonnes milled		16,320,612
Head Grade			*Head Grade*		
Zinc	%	10.12	Zinc	%	10.12
Lead	%	3.95	Lead	%	3.95
Silver	oz/ton	16.51	Silver	g/tonne	566
Gold	oz/ton	0.140	Gold	g/tonne	4.79
Metal in Feed			*Metal in Feed*		
Zinc	ktons	1,821	Zinc	ktonnes	1,652
Lead	ktons	711	Lead	ktonnes	645
Silver	Moz	297	Silver	Moz	297
Gold	koz	2,515	Gold	koz	2,515
Metal Recovered			*Metal Recovered*		
Zinc	ktons	1,439	Zinc	ktonnes	1,306
Lead	ktons	505	Lead	ktonnes	459
Silver	Moz	224	Silver	Moz	224
Gold	koz	1,656	Gold	koz	1,656

7.0 GEOLOGICAL SETTING AND MINERALIZATION

7.1 Regional Geology

Regional geological interpretations are largely based on work completed by the United States Geological Survey (USGS). USGS Professional Paper 1763 (Taylor and Johnson, 2010) and subsequent work by the USGS (Wilson et.al, 2015 and Karl and Wilson, 2016) best summarize the regional geology surrounding the Greens Creek deposit.

The Greens Creek Mine lies within the Alexander Triassic Metallogenic Belt which lies unconformably on Late Proterozoic to Permian aged strata of the Alexander Terrane. The tectono-stratigraphic map of Figure 7-1 shows these units as they now exist against the North American continent and where other deposits similar in type to Greens Creek have been discovered.

Amalgamation of the Alexander and Wrangellia terranes by Permian time resulted in sub-aerial exposure of the region and the formation of an erosional unconformity. The unconformity appears to have variably removed Devonian to Permian units from the Alexander terrane in the vicinity of the Greens Creek claim block.

Post-amalgamation of the Alexander and Wrangellia terranes, late Triassic rifting developed a restricted basin on the east side of the composite terrane as evidenced by the Hyd Group marine sediments and flood basalts of Carnian and Norian ages. The Greens Creek deposit is hosted within the Hyde marine sediments (Tr hgs) of Carnian to Norian age immediately below the Hyd basalts (Tr hgv) as shown in Figure 7-2 (Karl and Wilson, 2016).

Beginning in the middle Jurassic and continuing through the Mid-Cretaceous, compressional tectonism attended the suturing of the Alexander/Wrangellia superterrane to continental North America. Crustal thickening during the Mid-Cretaceous collision resulted in intense fold and thrust style structural deformation. Toward the end of the Cretaceous compressional tectonism waned as tectonic plates along the coast of North America began to move in a dextral fashion which motion continues to the present.

Brittle dextral movement in the Tertiary affected the entire accreted coast of North America. The Chatham Strait Fault is one of many north-northwest striking faults of this brittle faulting which has caused significant strike-slip dislocation across the superterrane (Figures 7-1 and 7-2). Two such Tertiary faults run through the Greens Creek deposit. The Maki Fault and Gallagher Fault have dextral offsets 1,800 feet (549 m) and 2,750 feet (838m) respectively. The faults generally dip steeply to the west and have reverse movement (west side up) of 110 feet (33m) and 650 feet (198m) respectively. Taylor and Johnson (2010) place Greens Creek into a series of deposits and prospects that they term the Alexander Triassic Metallogenic Belt (Figure 7-1). The belt is located along the eastern margin of the Alexander terrane throughout southeastern Alaska and northwestern British Columbia and exhibits a range of characteristics consistent with a single rift basin deepening to the north. Occurrences included in this group include: Windy Craggy, Mt. Henry Clay, Greens Creek, Glacier Cree, Pyrola, and Yellow Bear Mountain among others.

Figure 7-1: Regional Tectono-Stratigraphic Map

From Steeves (2018), modified from Taylor (2008) and Campbell and Dodds (1983)

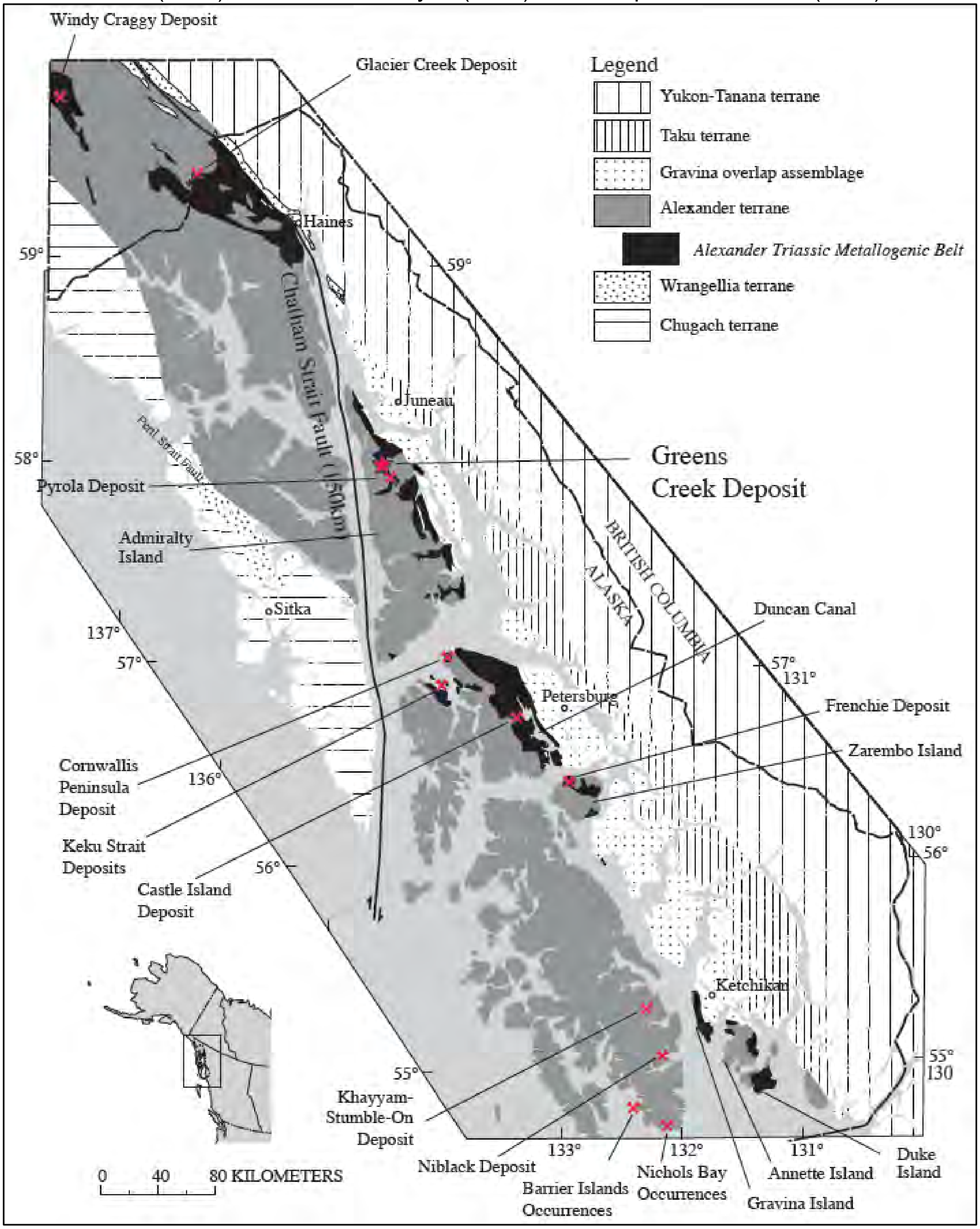
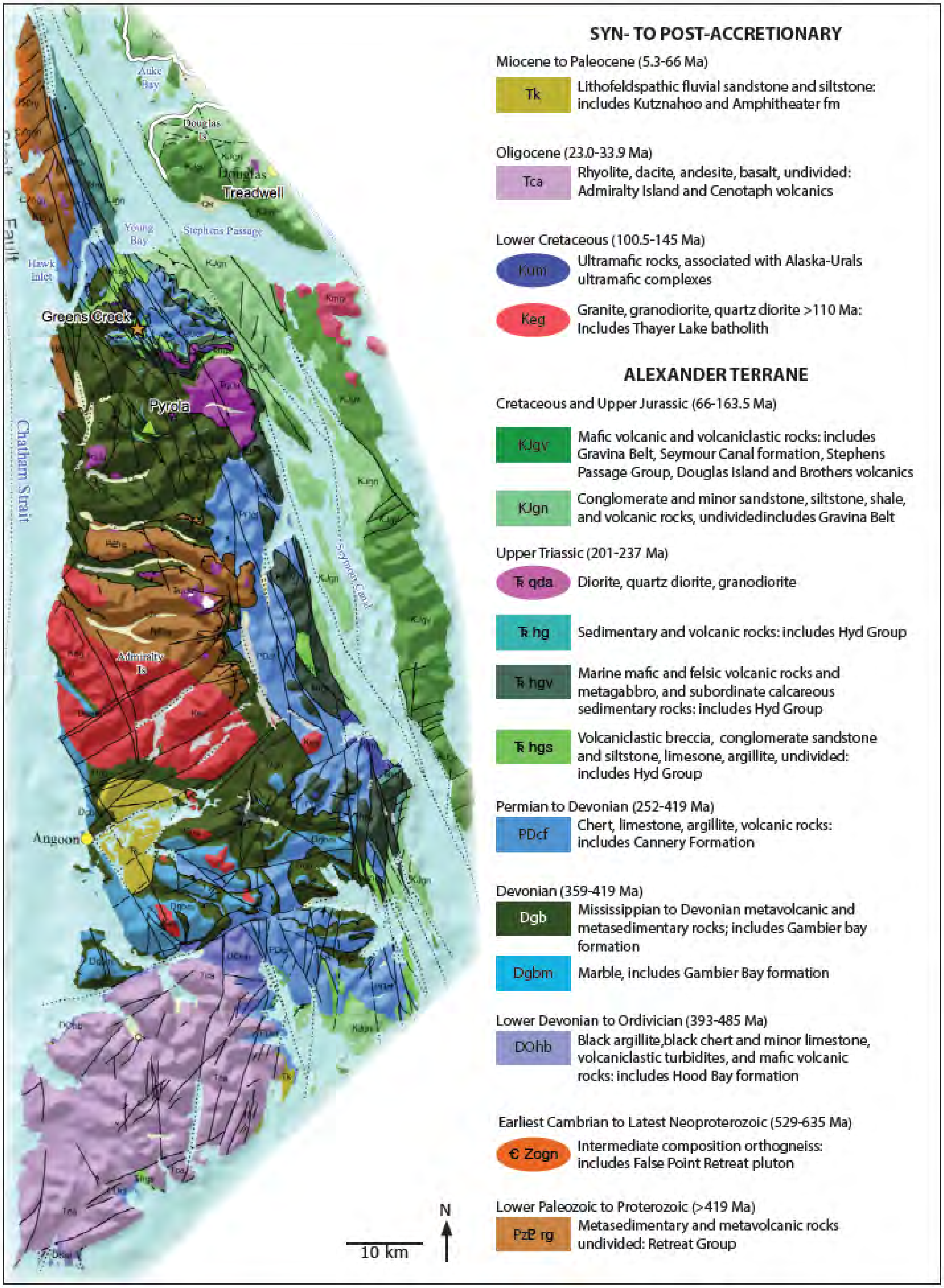


Figure 7-2: Geologic Map of Admiralty Island

Karl and Wilson (2016)



7.2 Project Geology

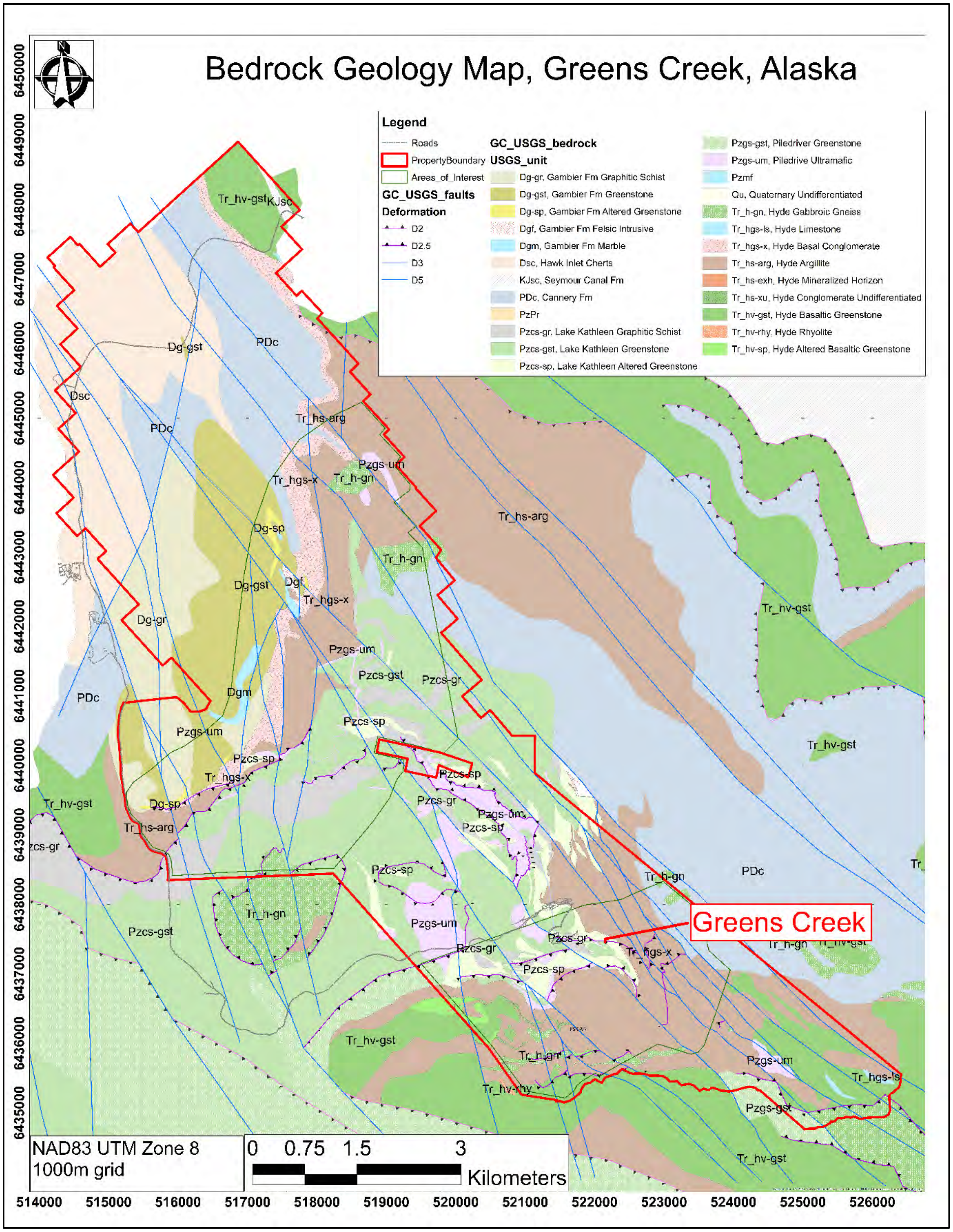
7.2.1 Geologic Mapping

Extensive surface mapping on the Greens Creek claim block has allowed a detailed bedrock map to be produced for the project area. USGS units were not typically used in mapping lithologies, but Figure 7-3 provides mapped lithologies according to USGS defined units. Table 7-1 equates the surface mapping geologic units of Figure 7-3 to lithologies utilized in underground mapping and core drilling.

Table 7-1: Correlation of USGS Units to Greens Creek Mine Lithologic Units

USGS unit/ GC surface mapping unit	Explanation	GC underground mine geology units
Dg-gr	Gambier Bay Formation graphitic schist	not present
Dg-gst	Gambier Bay Formation greenstone	not present
Dg-sp	Gambier Bay Formation altered greenstone	not present
Dgf	Gambier Bay Formation felsic intrusive	not present
Dgm	Gambier Bay Formation marble	not present
Dsc	Hawk Inlet cherts	not present
KHsc	Seymour Canal Formation	not present
PDc	Cannery Formation	not present
Pzcs-gr	Lake Kathleen Unit graphitic schist	SPgr
PZcs-gst	Lake Kathleen Unit greenstone	GST
Pzcs-sp	Lake Kathleen Unit altered greenstone	SP, SPc
Pzgs-gst	Piledriver Unit greenstone	GST
Pzgs-um	Piledriver Unit ultramafic	SC
Tr_h-gn	Hyde Group gabbro gneiss	GB
Tr_hgs-ls	Hyde Group limestone	MB
Tr_hgs-x	Hyde Group basal conglomerate	SPcx
Tr_hs-arg	Hyde Group argillite	SA, MA, CHT
Tr_hs-exh	Hyde Group mineralized horizon exhalites	MFB, MFP, WBA, WCA, WSI
Tr_hs-xu	Hyde Group undifferentiated conglomerate	SPcx
Tr_hv-gst	Hyde Group basaltic greenstone	CR, GST
Tr_hv-rhy	Hyde Group rhyolite/dacite	RHY
Tr_hv-sp	Hyde Group basaltic greenstone - altered	SP, SPs

Figure 7-3: Geologic Map of the Greens Creek Claim Area



7.2.2 Lithology

While the regionally mapped units are mostly present at the Greens Creek Mine, some are absent, and others have been subdivided according to mine scale mapping and logging of drillholes. The Greens Creek mineralization is conformable to the contact between the Alexander Terrane Paleozoic rocks and the late Triassic Hyd Group though intensely folded, and to the bedding of the Hyd Group sediments. As the mineral zones are located at this unconformable contact the local lithologies are discussed according to footwall, mineralized horizon and hanging wall groups. Some dikes and sills cross-cut the Paleozoic units and in rare situations cut the mineral body.

Footwall Lithologies

The Admiralty subterrane makes up the stratigraphic footwall to the Greens Creek mineral deposit. The subterrane is variable in composition and spans Ediacarian through Permian time. North of the mine, but still on the claim block, Devonian aged metavolanics, cherts and graphitic sediments have been mapped. East and south of the mine, younger Permian marine sediments have been mapped. This apparent younging of the Admiralty subterrane from the northwest to the southeast may be explained by some combination of the erosional unconformity immediately above the Permian boundary, which may be an angular unconformity and tectonic exhumation of deeper units on the northern end of the subterrane.

The erosional unconformity is marked by a polymictic conglomerate composed entirely of footwall lithologies. This conglomerate is found extensively within the Alexander terrane and is common below the Hyd Group metasediments. It is variably present in the mine area with thickness varying up to 10's of feet. The conglomerate is hypothesized to have formed as debris flows over the basin bounding faults which formed the Triassic basin.

In the immediate mine area and directly below the polymictic conglomerate, the footwall is composed of Mississippian aged metavolcanics (Sack, 2016). These metavolanics dominate footwall lithologies within a couple miles of the mineral deposit though some gabbroic and graphitic sedimentary units are present. The metavolanics are further distinguished into the following mine units by mine geologists:

- Greenstone (GST) – a massive greenstone with pervasive foliation formed by chlorite and weak segregation of quartz into banding.
- Marble (MB) – though very rare in the immediate mine area this gray, coarse-grained dolomitic marble is present in the claim block.
- Graphitic phyllite (SPgr) – a well foliated carbonaceous quartz mica schist.
- Chloritic phyllite (SPc) – a well foliated and banded quartz chlorite muscovite schist.
- Sericitic phyllite (SP) – a well foliated and sericitically altered unit likely derived from the greenstone, graphitic phyllite and chloritic phyllite units.
- Siliceous phyllite (SPsr) – a dark grey quartz rich schist found proximal to the mineral bodies. This unit is likely derived from the other phyllite units by hydrothermal alteration related to mineral deposit formation.

- Altered ultramafic (AUM) – a fuchsite bearing quartz carbonate chlorite muscovite schist.
- Serpentinite (SC) – massive to talc altered serpentinite likely cross-cutting the mafic metavolcanics but clearly metamorphosed during the Cretaceous collision. This unit has not been radiometrically dated and is debated by some to cut the Triassic Hyd Group. Mapping and logging of core at the mine indicates the unit is pre-Hyd Group.
- Polymictic conglomerate (SPcx) – a highly strained sub-rounded to angular breccia/conglomerate that is found at the erosional unconformity between the footwall Mississippian age metavolcanics units and the overlying Hyd Group. Other polymictic conglomerates appear within the Hyde Group above the erosional unconformity but these have zircons dominated by Triassic ages, not Mississippian as in the basal conglomerate (unpublished data, O'Sullivan, 2019).

The relative age relationships are, from youngest to oldest, polymictic conglomerate, serpentinite, and all other units undifferentiated.

Hanging Wall Lithologies

The hanging wall of the mineral deposit, which is located immediately above the basal polymictic conglomerate, is entirely composed of the Hyd Group. In the immediate mine area, the mine geologists break the unit into the following lithologies:

- Massive Argillite (MA) – dolomitic argillite typically found close to the base of the Hyd Group. Beds tend to be 1in to 10in (2.5-25cm) thick and have quartz-carbonate ladder veining normal to bedding due to post-depositional folding. Conodont samples have provided a Carnian-Norian age of 220Ma.
- Slatey Argillite (SA) – finely laminated siliciclastic carbonaceous argillite, often with thin sulfide banding. Often grades into a phyllite were post-depositional deformation has strained the unit.
- Gabbroic sills (GB), basalts (BSLT) and a thin rhyolite (RHY) occur up in the Hyd Group section, structurally and/or stratigraphically over the mineral deposits. These volcanic bodies also cross the Paleozoic footwall units but are not generally recognized in the immediate mine area due to intense alteration and deformation.
- Relative ages of the hanging wall units from youngest to oldest are basalt, then argillite, rhyolite and gabbroic sills intermixed and finally massive argillite at the base. Some researchers put the polymictic conglomerate at the base of the Hyd group, but the conglomerate appears to be devoid of any Hyd group lithologies, at least in the immediate mine area.

7.2.3 Structural Setting

An early and poorly preserved S_1 metamorphic segregation foliation is present in the footwall lithologies. As such it is likely pre-Triassic and may have developed as a result of the amalgamation of Alexandria and Wrangellia in the Permian.

Intense mountain building throughout the Cretaceous resulted in D_2 thrusting and penetrative S_2 foliation in muscovite-rich lithologies. In the hanging wall argillite, the

S_2 foliation is less apparent though F_2 folding is well preserved. The F_2 folds in the argillite are generally non-cylindrical, isoclinal and often recumbent. The shallow dipping “benches” of mineralization developed across the mineral deposit are pronounced recumbent F_2 folds with amplitudes up to 1,000 ft.

Following D_2, the mine area was subjected to protracted D_3 transpression which created open to isoclinal upright folding and north-northwest striking shear zones.

Several post-D_2 ductile shears have been mapped across the claim block which are nearly age equivalent to the upright D_3 shears and have been assigned to a $D_{2.5}$ event in the literature. These $D_{2.5}$ shears have C-S fabrics indicating top to the west-northwest movement. The two prominent $D_{2.5}$ shears mapped in the mine area are the Upper Shear and the Klaus Shear. The cross-cutting relationship between D_3 and $D_{2.5}$ shears have not been observed directly though regional mapping of a $D_{2.5}$ shear appeared to fold up into a D_3 shear.

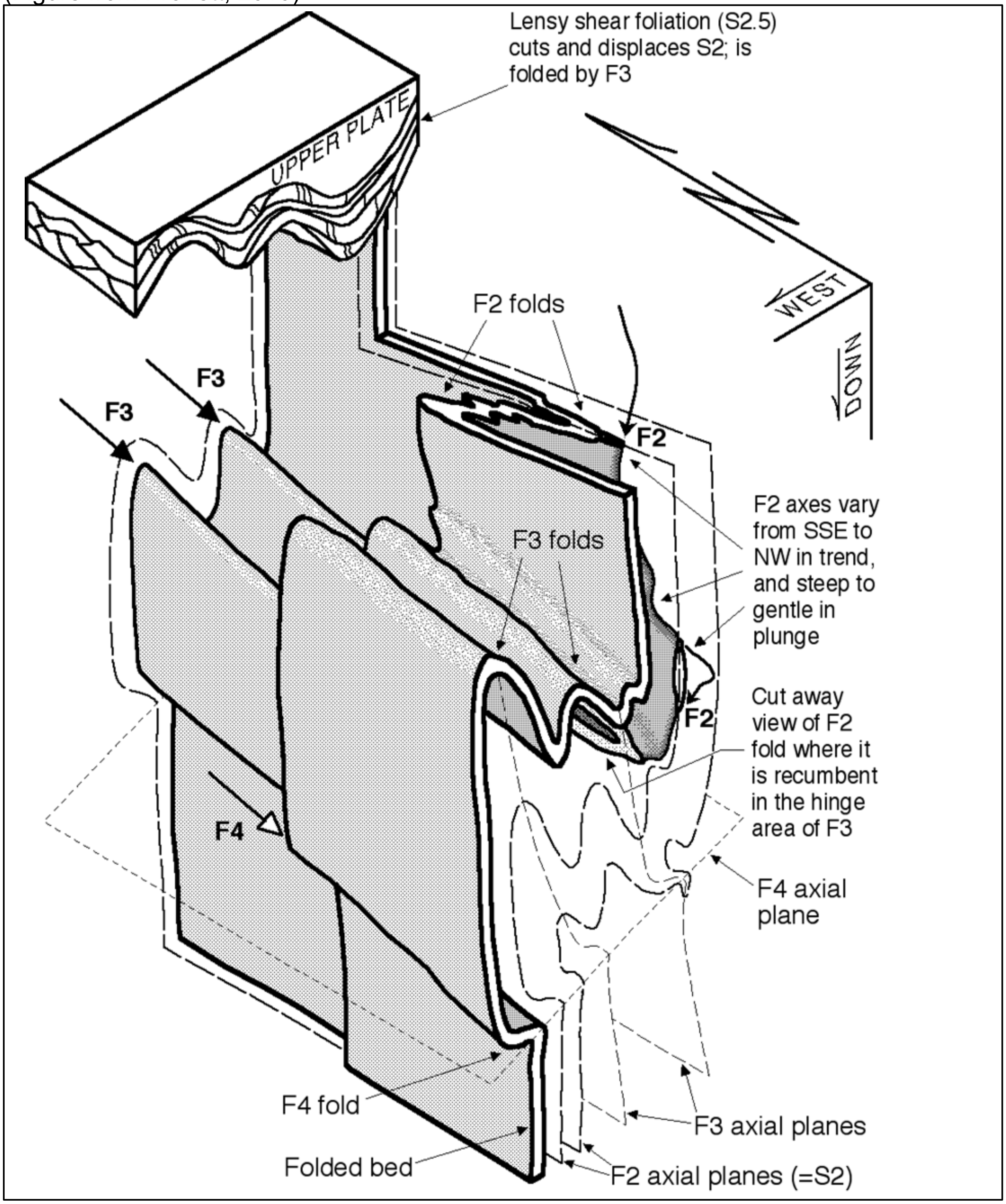
A pronounced S_3 crenulation cleavage is present as thin 0.05 to 0.125 in bands cutting S_2 foliation. The cleavage bands are spaced 1 to 10 inches apart where present and are nearly axial planar to the F_3 folds they helped create. These cylindrical folds are generally of low amplitude, typically less than 20 feet, but can be more than 100 feet in amplitude, significantly deforming the deposit.

A weak D_4 folding event affected the mine area. The folds are open and of very low amplitude to wavelength ratio with amplitudes rarely exceeding several feet. These folds do not appreciably deform the mineralization. Figure 7-4 illustrates the superposition of folding present within the mine area.

Mid- to late-Tertiary dextral transform faulting caused brittle D_5 faults such as the Maki Fault system, which cuts through the immediate Greens Creek Mine site area. The similar orientations of D_3-ductile and D_5-brittle structures indicate that the D_3 structural grain was utilized in D_5. The Maki Fault system has approximately 1,800 ft (550 m) of right-lateral and 110 ft (33 m) of reverse, west side up, offset. The other significant D_5 fault in the mine area is the Gallagher Fault with 2,750 ft (840 m) of right-lateral and 650 ft (200 ft) of reverse, west side up, offset.

Figure 7-4: Fold and Shear Relationships at Greens Creek

(Figure from Proffett, 2010)



7.3 Geology of Mineralization

7.3.1 Locations and Relationships

The Greens Creek sulfide mineralization is localized on the Mississippian/Late Triassic contact marked by the Hyd basal conglomerate. This erosional unconformity is referred to as the “mine contact” by geologists at the mine. Though mineralization and significant alteration extend into the footwall mafic/ultramafic rocks and though some lenses of mineralization occur in the overlying argillites, the bulk of mineable material is located immediate to the mine contact.

The mine contact is variably mineralized over the claim block and nearly continuously mineralized in the mine area. Three main trends of mineralization have been traced along the mine contact with multiple centers of mineralization along those trends. Though the trends are folded with the mine contact the general mineralization trends strike 160^0 and plunge 20^0 to the south. Figure 7-5 displays the mineralized wireframes of each mineral zone of the Greens Creek Mineral Resource and Mineral Reserve with the faults that displace them. Figure 7-6 shows a section through the mineralized zones with major fault offsets.

Figure 7-5: Plan View of the Mineral Resource and Mineral Reserve Mineralization Shells of the Mineralized Zones at the Greens Creek Mine

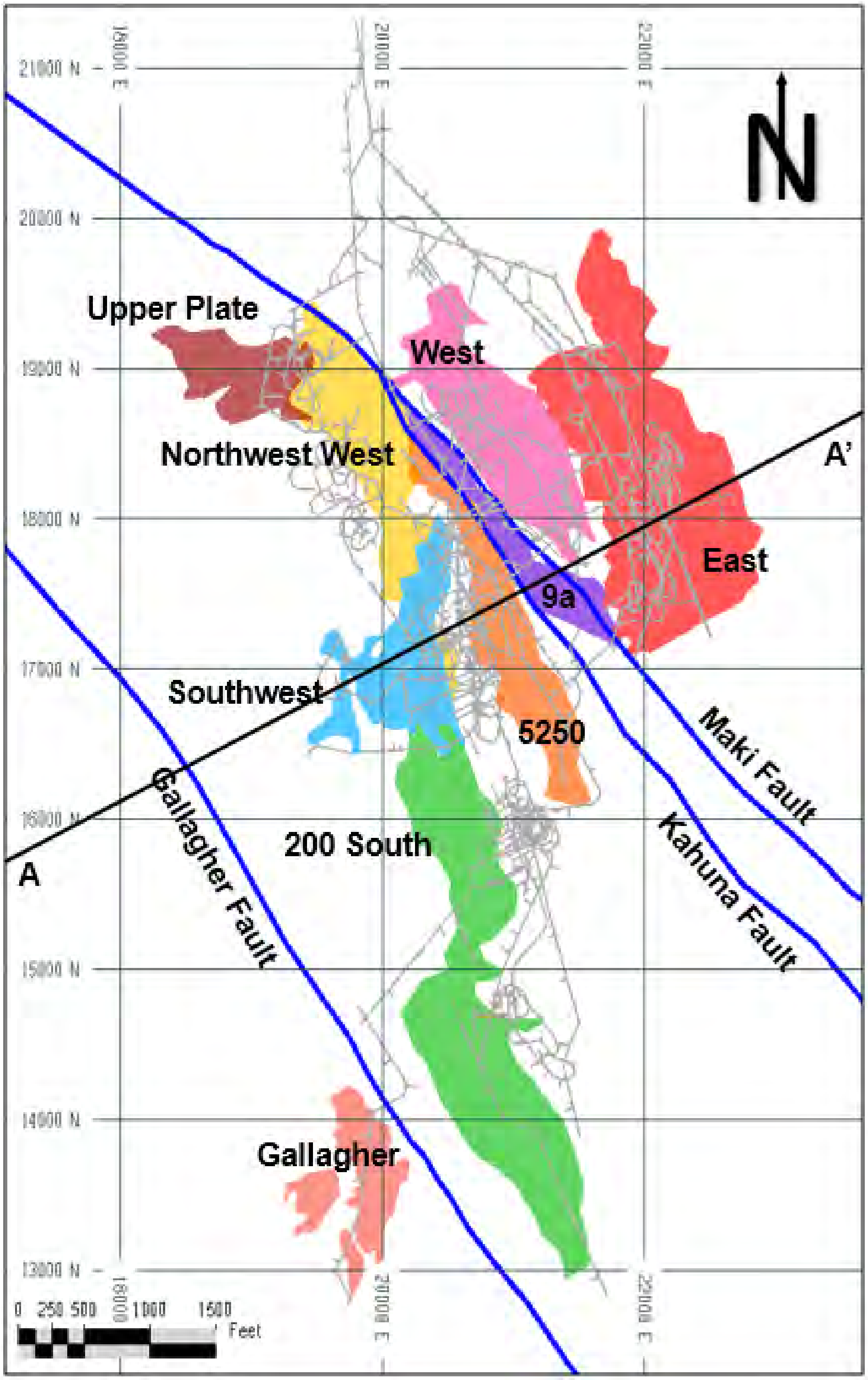
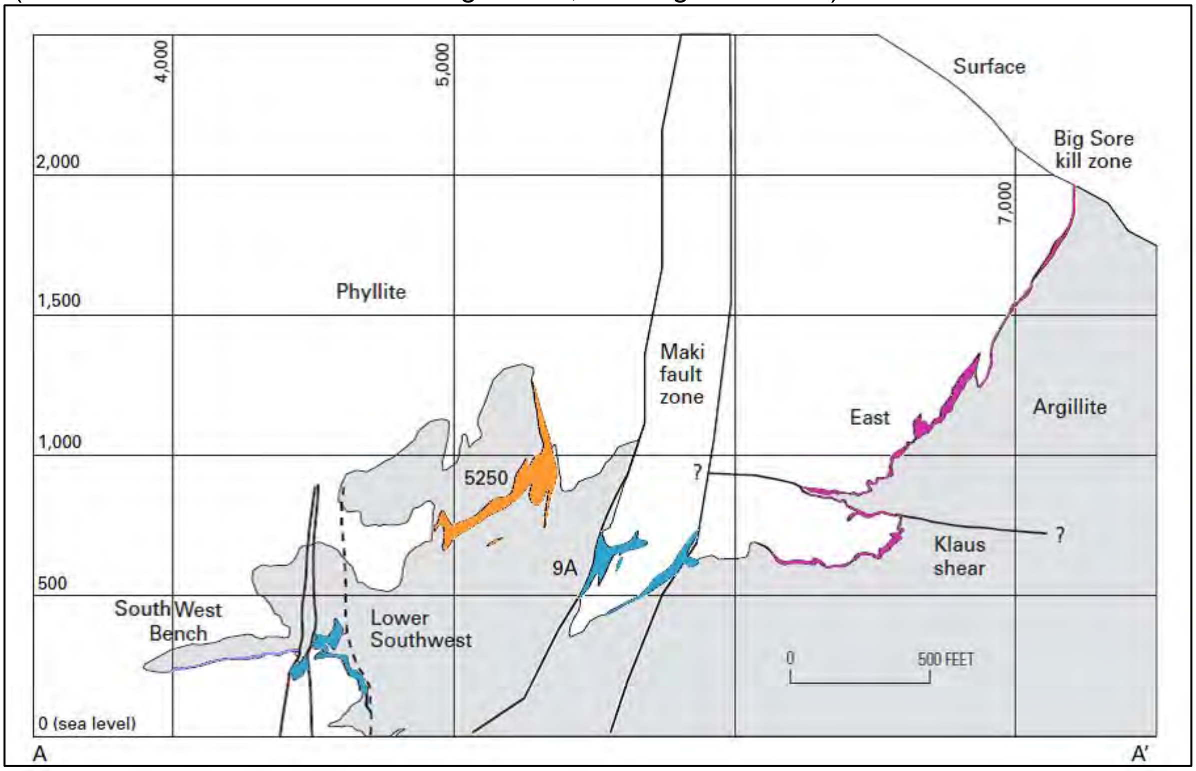


Figure 7-6: Section through the East, 9A, 5250 and Southwest Zones

(Line of section A-A' is shown in Figure 7-5, Looking Northwest)



In general, the mineralized bodies are zoned over a silica flooded, pyrite-rich footwall phyllite (SPsr). Semi-massive stringer mineralization is often present in the footwall below significant massive sulfide centers. The central mineralization immediately above the stringers are rich in copper, iron, arsenic and gold and called massive pyritic (MFP) due to the high pyrite content. Grading immediately outward from the MFP zones are the base metal and silver rich mineral zones (MFB). Massive carbonate-rich material (WCA) is present within the MFB and towards the MFB's outer margins. More distal mineralization is characterized by quartz and barite-rich white mineral styles, WSI and WBA respectively (Figure 7-7).

Figure 7-7: Simplified Mineralization Cross –Section

(Steeves, 2018)

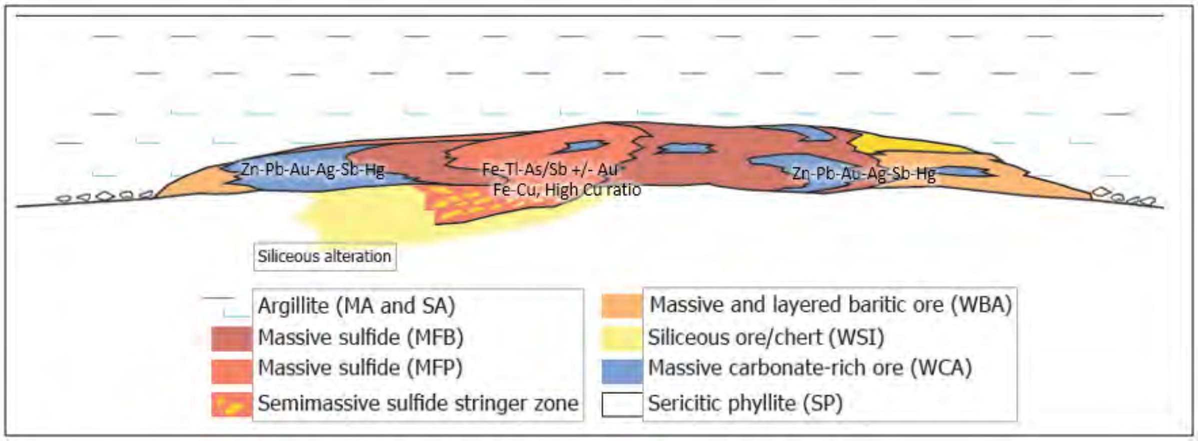


Figure 7-8 provides a plan view of the entire mineral deposit separated according to the mineral types. Clear centers of mineralization are seen with at least four major MFP/MFB cores along the linear mineralization trends. The largest MFP/MFB core is centered on the West and Northwest-West (NWW) zones. Two more centers are present in the SW and upper 200S zones. Another core is present in the deeper, more southern, 200S Zone. Finally, there appears to be two more centers of mineralization at the farthest southern end of the current mineral resource; one on the deep vertical limb below the southern 200S Zone and the other possibly emerging at the southern end of the Gallagher Zone.

While minable grades exist within all the mineral types, the MFB, MFP and WBA types typically have the highest overall grades. Base metals typically are lower in the white mineral type though some baritic material can have high sphalerite. Baritic material (WBA) is particularly silver rich while the white siliceous mineral style (WSI) is typically of the lowest grade.

Ore minerals are dominantly sphalerite, galena, tetrahedrite, electrum, and proustite-pyrargyrite. A weak, epigenetic, high-sulfidation event overprinted portions of the mineral deposit producing bornite, covellite, chalcocite and stromeyerite. Figure 7-9 provides relative mineral abundances for each of the mineral types.

Figure 7-8: Plan View of Mineral Types across the Greens Creek Mineral Deposit (Steeves, 2018)

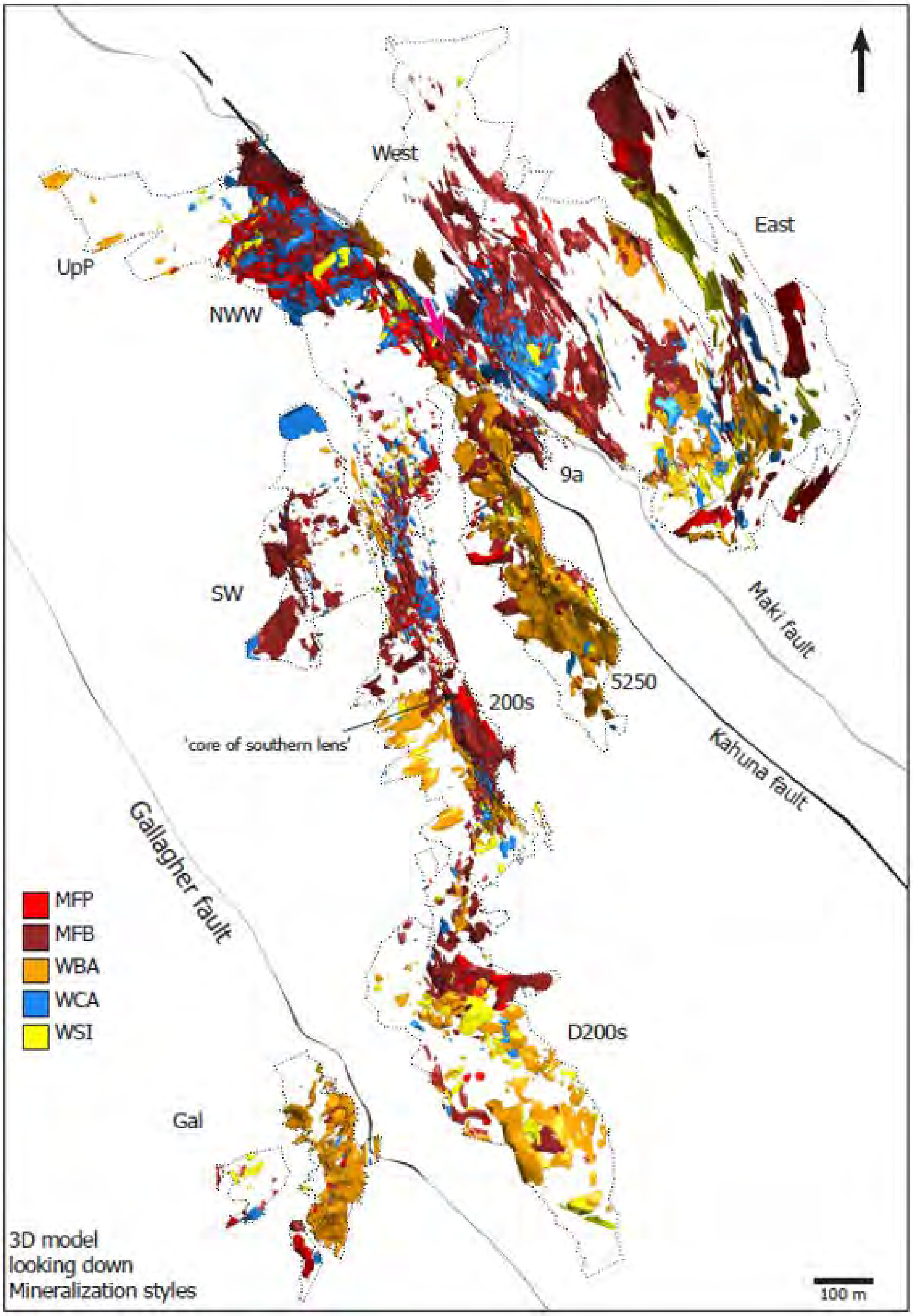


Figure 7-9: Mineral Zonation at Greens Creek by Mineral Type

(Steeves, 2018)

Mineral	Formula	WCA	WBA	WSI	MFP	MFB
Pyrite	FeS_2	●●●	●●●	●●●	●●●	●●●
Sphalerite	(Zn,Fe,Mn)S	●●●	●●●	●●	●●●	●●●
Galena	PbS	●●	●	●	●	●●●
Tetrahedrite (Ag)	$(Cu,Fe,Zn,Ag)_{12}Sb_4S_{13}$	●	●	○	●	●
Chalcopyrite	$CuFeS_2$	●	○	○	●	●
Colusite	$Cu_{12-13}V(As,Sb,Sn,Ge)_3S_{16}$	+	●	○	○	○
Arsenopyrite	FeAsS	+	-	-	●	○
Proustite-Pyrargyrite	Ag_3AsS_3–Ag_3SbS_3	-	●	+	-	-
Electrum, Ag°, Au°	AuAg	○	○	+	○	+
Pearceite-Polybasite	$(Ag,Cu)_6(As,Sb)_2S_7$	-	+	-	-	-
Furutobeite	$(Cu,Ag)_6PbS_4$	-	+	-	-	-
Bornite	Cu_5FeS_4	+	●	○	-	-
Enargite/Luzonite-Famatinite	Cu_3AsS_4–Cu_3SbS_4	-	●	○	+	+
Tennantite	$(Cu,Fe,Zn)_{12}As_4S_{13}$	+	●	+	-	-
Chalcocite Group	Cu_2S	-	●	○	-	-
Covellite	CuS	-	●	+	-	-
Stromeyerite	AgCuS	+	●	+	-	-

Mineral abundance: ●●● Major mineral phase >10 vol.% present in most samples; ●● Moderate mineral phase 5–10 vol.% present in most samples; ● Minor mineral phase 1–5 vol.%; ○ Trace mineral phase <1 vol.% present in some samples; + Rare mineral phase; - not found.

7.3.2 Mineral Type Descriptions

Massive Fine Pyritic Mineral Type (MFP)

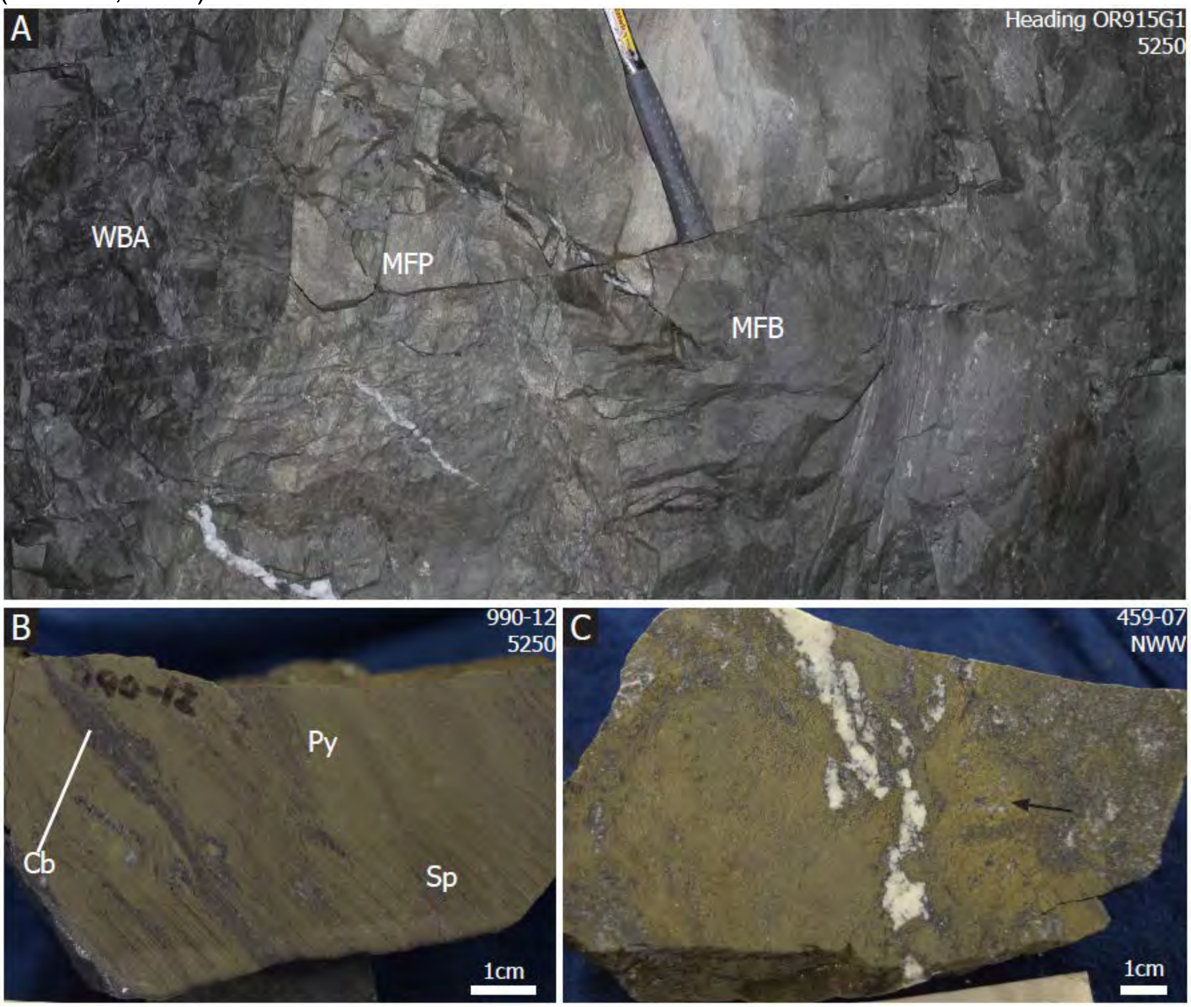
The massive fine pyritic mineral type contains at least 50% overall sulfide with pyrite being the more abundant than the other sulfides combined. Sphalerite and galena dominate the base metal sulfides though chalcopyrite, arsenopyrite and tetrahedrite are common. Gangue consists of quartz, carbonate, barite and muscovite.

The MFP material is finely bedded generally with the pyrite often framboidal and colloform. Sometimes the MFP unit displays coarser textures suggesting annealing during metamorphism. Near faults the pyritic material becomes brecciated and has late carbonate gangue.

Figure 7-10 provides photographs of MFP as it appears at the stope and hand sample scales. Photo A from a mine heading shows the stratification between MFB and MFP mineral styles. Photo B displays the massive sulfide texture and fine segregation of minerals present in the MFP in a cut hand sample. Photo C shows intense deformation and late carbonate gangue in veinlets in cut hand sample.

Figure 7-10: Massive Pyritic Material (MFP) at Greens Creek

(Steeves, 2018)

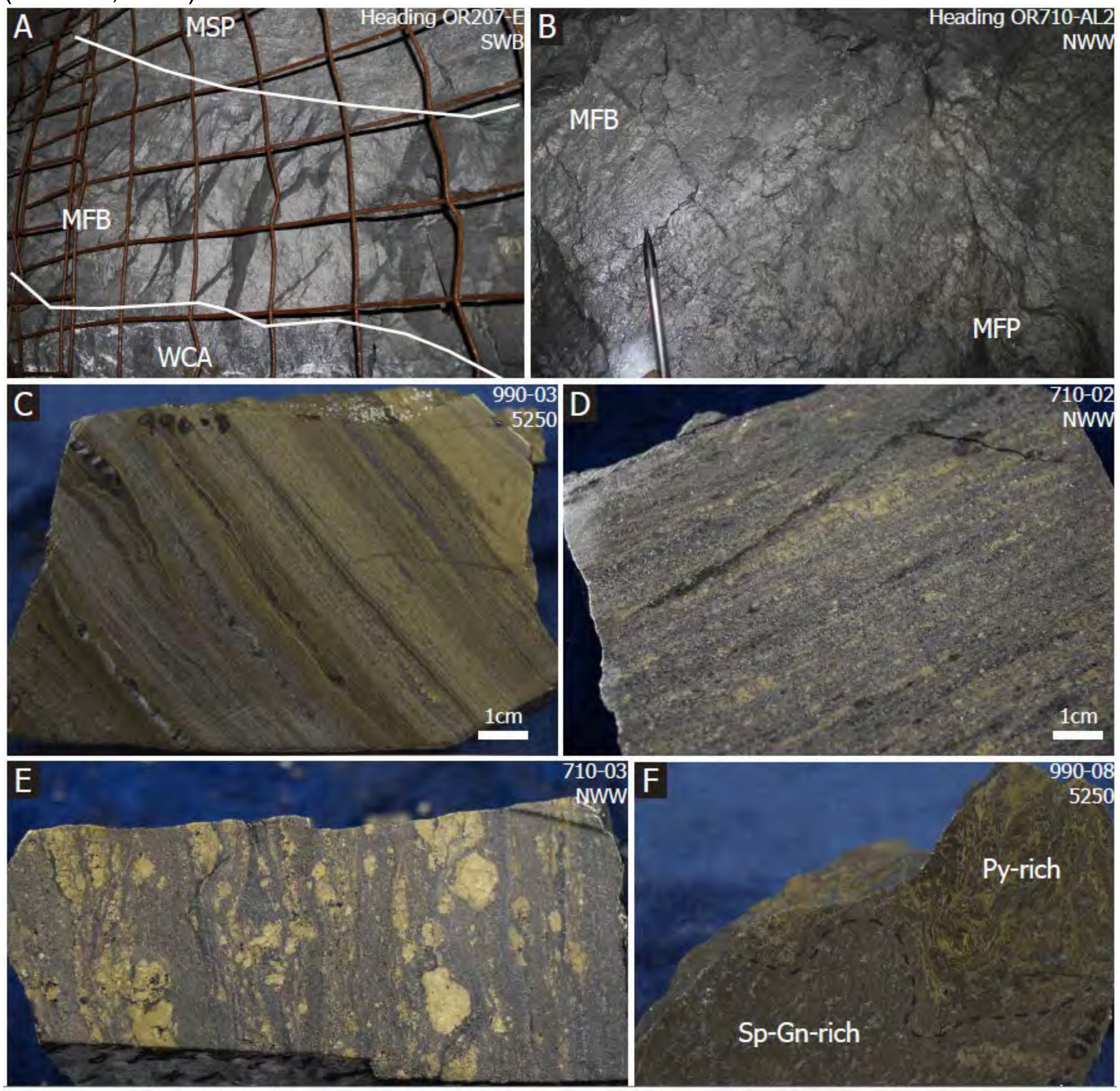


Massive Fine Base Metal Mineral Type (MFB)

Massive base metal-rich mineral type has >50% sulfide with sphalerite, galena and tetrahedrite dominate over pyrite. The textures are similar to MFP material but with more sphalerite and galena. Figure 7-11 displays the MFB at heading and hand sample scales. Photos A through D show the stratification, massive and finely bedded natures of the MFB material at outcrop and hand specimen scales. Photos E and F show boudinage, rolled clasts and intense folding within the material at hand specimen scale.

Figure 7-11: Massive Base Metal-rich Mineral Type (MFB) at Greens Creek

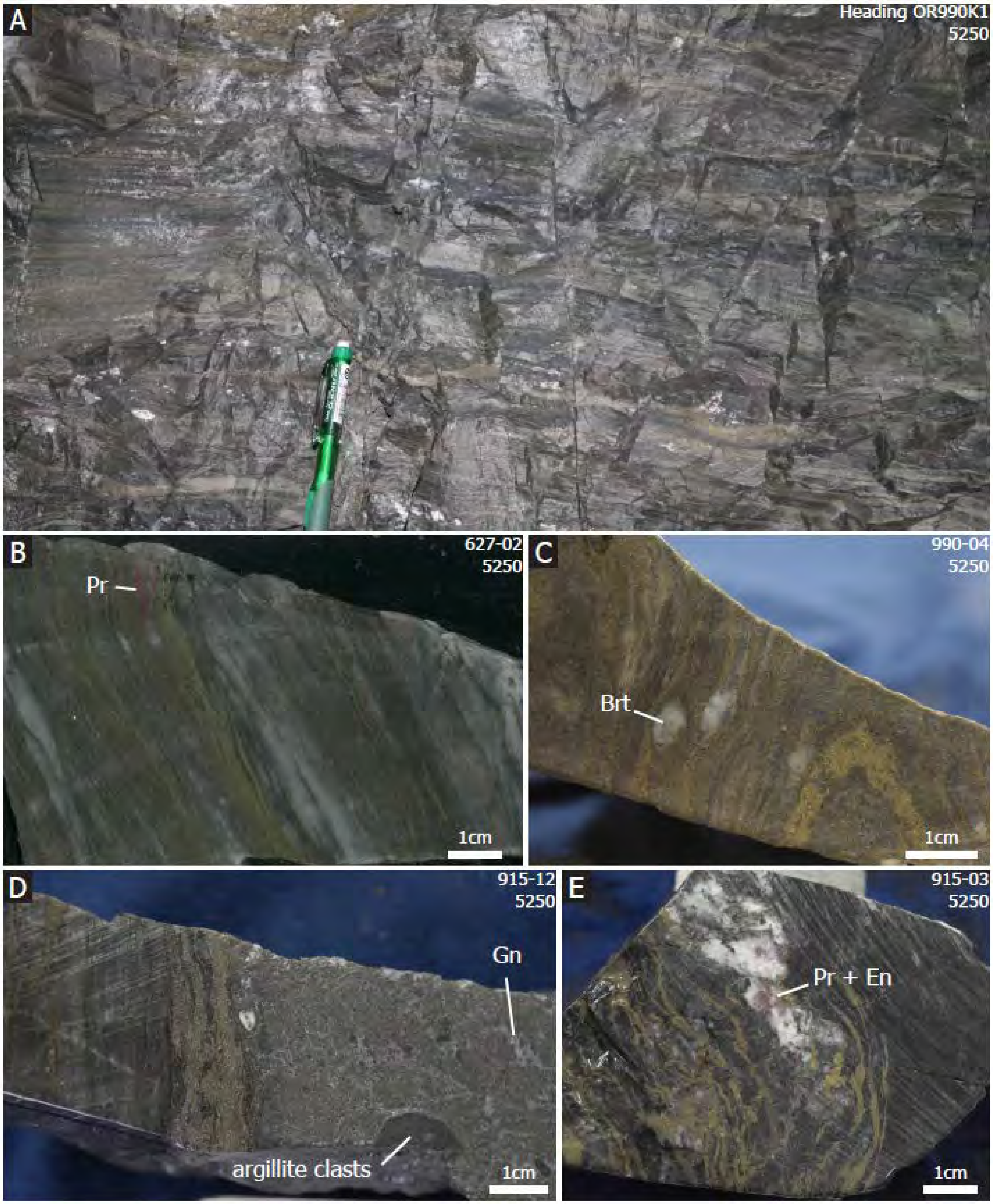
(Steeves, 2018)



Baritic Mineral Type (WBA)

The baritic mineral type contain less than 50% total sulfide and a lower pyrite to zinc and lead base metal sulfide ratio than the MFP material. Pyrite, sphalerite, galena, tetrahedrite, proustite-pyrargyrite and stromeyerite are common minerals of WBA material. Gangue is dominated by barite, carbonate, quartz and muscovite. Figure 7-12 shows the baritic mineral type at outcrop and hand sample scales. Photo A shows a heading in the 5250 Zone where massive baritic material is common. The material is well layered and dark brown with fine banding. The hand samples of photos B through E show the fine banding of sulfide and gangue and the presence of proustite which commonly bedecks the material.

Figure 7-12: Massive Base Metal-rich Mineral Type (MFB) at Greens Creek
(Steeves, 2018)



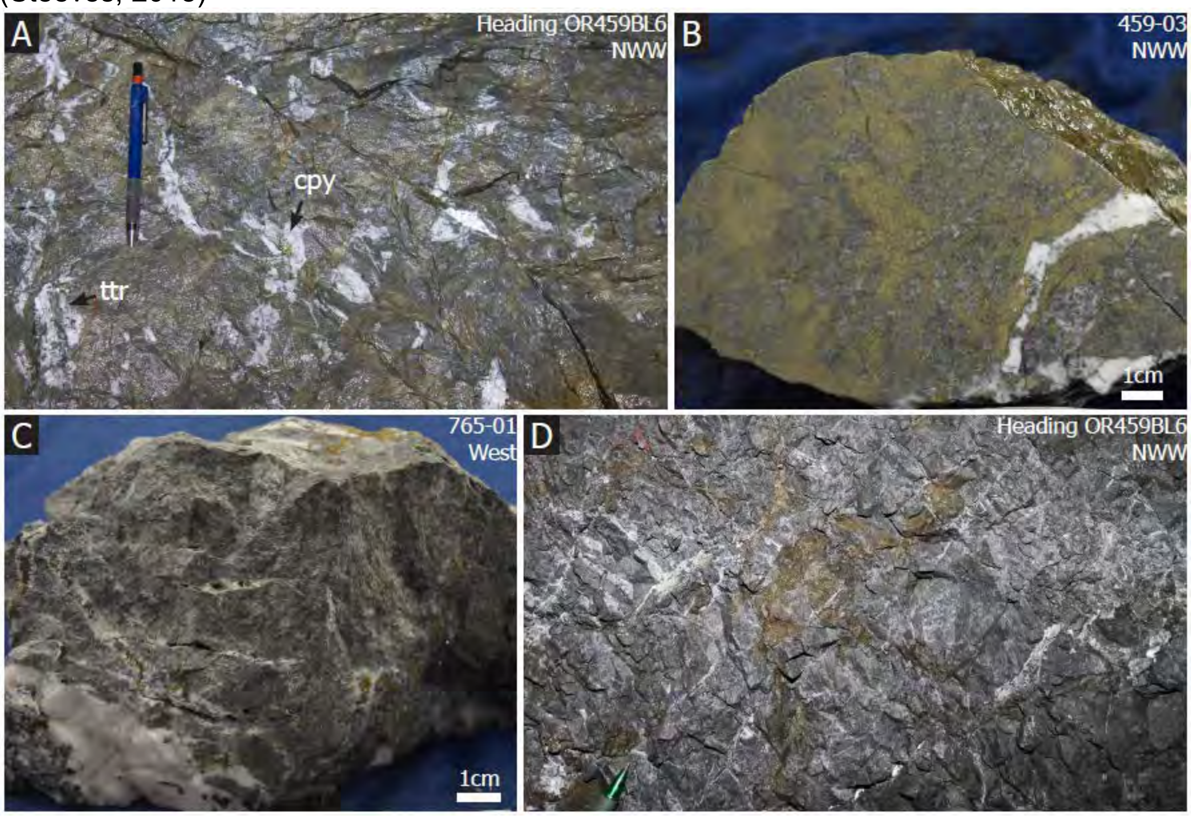
Carbonate Mineral Type (WCA)

The carbonate mineral types at Greens Creek contain less than 50% sulfide by volume and are dominated by carbonate gangue. Pyrite, sphalerite, galena, tetrahedrite and chalcopyrite are the dominant sulfides while dolomite, calcite, Ba-carbonate, biotite, barite, quartz, muscovite and graphite make up the gangue. The carbonate material tends to be massive and recrystallized due to metamorphism. Carbonate veining is common to the unit.

Figure 7-13 displays the textures common to the carbonate mineral type. The photos show a typically gray massive rock with disrupted sulfide and carbonate lenses. Possibly due to repeated carbonation and brecciation the original host lithology is largely destroyed; only small fragments of argillite remain intact. Possibly this unit was originally a carbonate-rich sediment mostly replaced by dolomitization, void creation, breccia collapse and re-dolomitization during the original mineralization event.

Figure 7-13: White Carbonate-Rich Mineral Type (WCA) at Greens Creek

(Steeves, 2018)



Siliceous Mineral Types (WSI)

Siliceous mineral types have less than 50% sulfide and pervasive quartz flooding. As with the previous mineral styles, pyrite, sphalerite, galena, tetrahedrite, chalcopyrite are dominant sulfides. Muscovite, albite and carbonate are accessory gangue minerals accompanying the dominant quartz.

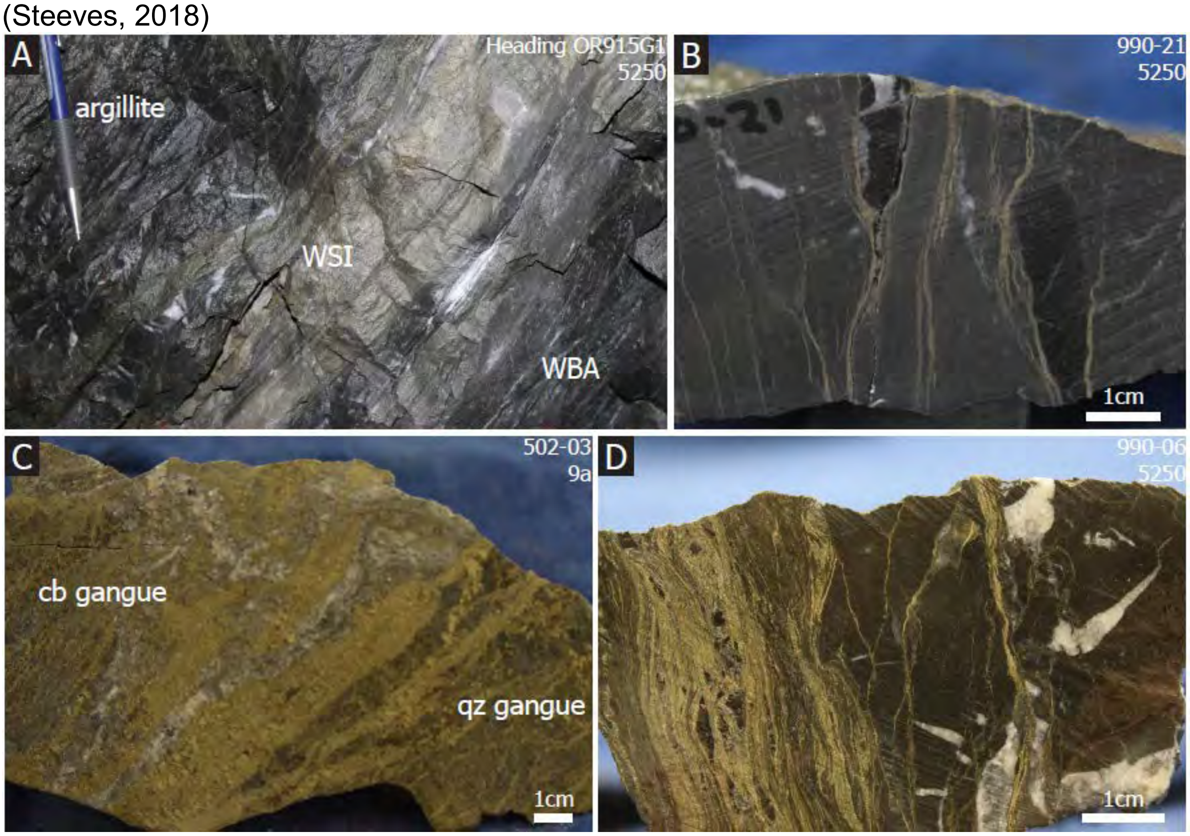
Steeves (2019) makes the important observation that the WSI material occupies three different stratigraphic locations and represent differing processes during mineralization at Greens Creek. At the lowest stratigraphy within the fossil hydrothermal system there is widespread silica flooding of the footwall host rock. Due to the sulfide and quartz replacement of the footwall and the brecciation of the unit during mineralization and later metamorphism, the original host lithology is undiscernible except through trace element lithogeochemistry.

The second stratigraphic level and occurrence of the WSI material is within the MFP mineral style as separate layers indicating episodes or growth of the early hydrothermal system. The last stratigraphic, and highest level, occurrence of the WSI mineral type is at the mineral-argillite contact, likely representing the cap and coolest portion of the observable VMS system.

Figure 7-14 illustrates the common forms of WSI material at Greens Creek. Photo A shows the WSI altered contact between baritic material toward the footwall and argillite in the hanging wall (uppermost stratigraphic level). Photo B shows the massive quartz flooding typical in the WSI sometimes mistaken for chert. The lower right corner of photo C shows stringer sulfide material with quartz only gangue would be from second stratigraphic episode discussed above. Photo D shows finely banded sulfide mineral in a quartz flooded rock; late, white quartz veining in this photo is from tensional cracking of the primary siliceous material during metamorphism.

Figure 7-14: White Siliceous Mineral Type (WSI) at Greens Creek

(Steeves, 2018)



7.4 Mineralized Zones

7.4.1 Overview

Due to variations in mineralization, structural complexity, and spatial location, the Greens Creek mineralization is segregated into nine separate mineralized zones. In order from easternmost and highest elevations to westernmost, the zones are:

- East
- West
- 9A
- Northwest West
- Upper Plate
- 5250
- Southwest
- 200 South
- Gallagher

The mineralization is stratigraphically controlled and typically found at the contact between the phyllites (stratigraphic footwall) and the argillites (stratigraphic hanging wall). Due to the intense structural deformation, mineralization may be tightly folded into the phyllite or argillite packages such that the original stratigraphic relationships are unclear. In rare cases there may be areas where the mineralized materials are stratigraphically above the phyllite/argillite contact but still proximal to it.

On a gross deposit scale the mineralization trends N 30° W and plunges to the south at approximately 20°. The East Zone outcrops at the eastern edge of the mineral deposit, dips to the west, and transitions into the West Zone near a tight F_2 fold where the mineral horizon transitions from a nearly flat orientation to a nearly vertical wall dipping steeply to the west. The East and West zones are bounded on the west by the Maki Fault system which offset the mineral horizon to the north in a dextral sense. The western deformation boundary of the Maki Fault tends to be a continuous fault splay which is called the Kahuna Fault. The mineralization hosted inside the fault zone are called the 9A Zone.

West of the Kahuna Fault, the Northwest West Zone represents the offset portion of the West Zone. Above and to the south of the Northwest West Zone is the main trend of mineralization which includes the Southwest Zone followed by the 200S Zone further down plunge. The 5250 Zone is the along the upper mineralized trend evidenced in the East Zone, just offset across the Maki-Kahuna Fault system (Figure 7-8).

The Gallagher Zone lies to the west of the 200 South Zone and is west of a second major dextral fault zone known as the Gallagher Fault. Offset on a post-mineralized dike swarm, the trend of the 200S Zone into the Gallagher Fault and the similar structural and chemical styles between the southern 200S and Gallagher mineral zones all indicate that the Gallagher Zone is simply the fault offset of the 200S Zone.

7.4.2 East Zone

The East Zone outcrops at the discovery "Big Sore" gossan and extends down-dip to the west until it is deformed and offset by the $D_{2.5}$ Klaus Shear at depth or by the Maki Fault at its southern extent. The mineralization occurs along the phyllite/argillite contact and varies from 1 to 30 feet (0.3-9 m) in thickness.

At the surface the mineralization dips at 60–80° to the west with the argillite on the bottom or eastern side. The dip shallows with depth to near-horizontal as a result of F_2 folding. Where the mineral body terminates into the Maki Fault drag folding has rotated the mineralization nearly 900 to 850 feet along strike. This geometry indicates that the entire Greens Creek deposit is on an overturned major antiform with stratigraphic up being down.

Figure 7-15 shows a $140NSR mineralized envelope as created in Leapfrog™ 3D software. Figure 7-16 shows a level plan of drilling and the mineral resource block model at the 1,110 ft elevation, which is about the middle of the zone's vertical extent of 750 to1,980 ft elevation. Figure 7-17 shows the XS2600 section (located on the plan map) with drilling and block interpolation displayed by $NSR.

The East Zone is not deformed as the other mineral bodies at Greens Creek with basically one long, steeply dipping limb folding to horizontal near its base at the Klaus Shear. The Klaus Shear and related F_2 fold deforms the East Zone and offsets it approximately 600 ft to the northwest over the top of the West Zone. One high angle, ductile shear striking northwest and dipping to the west has drag folded the East Zone at about the 1,200 ft elevation, causing the zone to have an apparent repeat of mineralization (Figure 7-17).

The mineral trends rake shallowly at approximately 250 ft from north to south across the steeply dipping limb of the East Zone. These trends can then be followed across the Maki-Kahuna Fault system into the other mineralized bodies.

Figure 7-15: East Zone - 3D Model

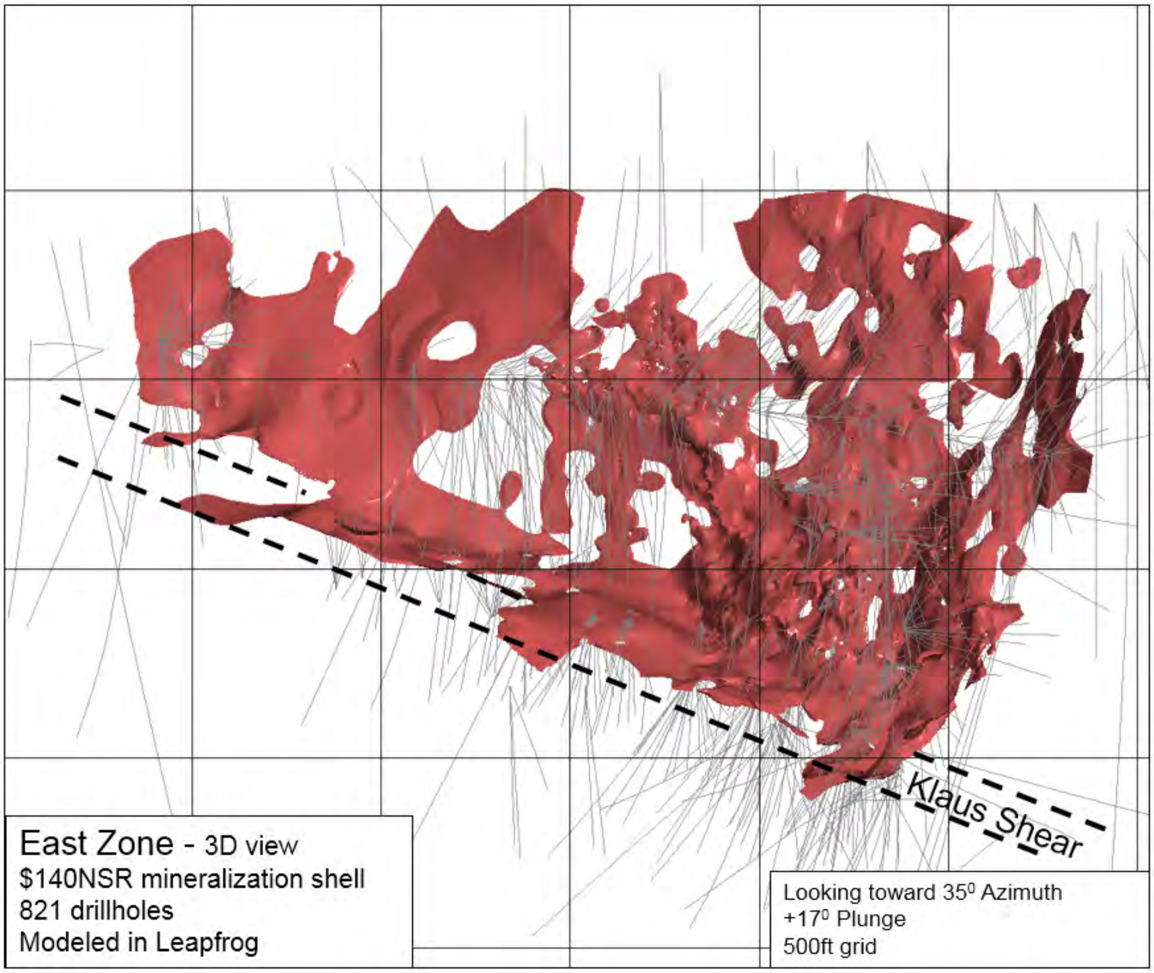


Figure 7-16: East Zone - Level Plan 1100

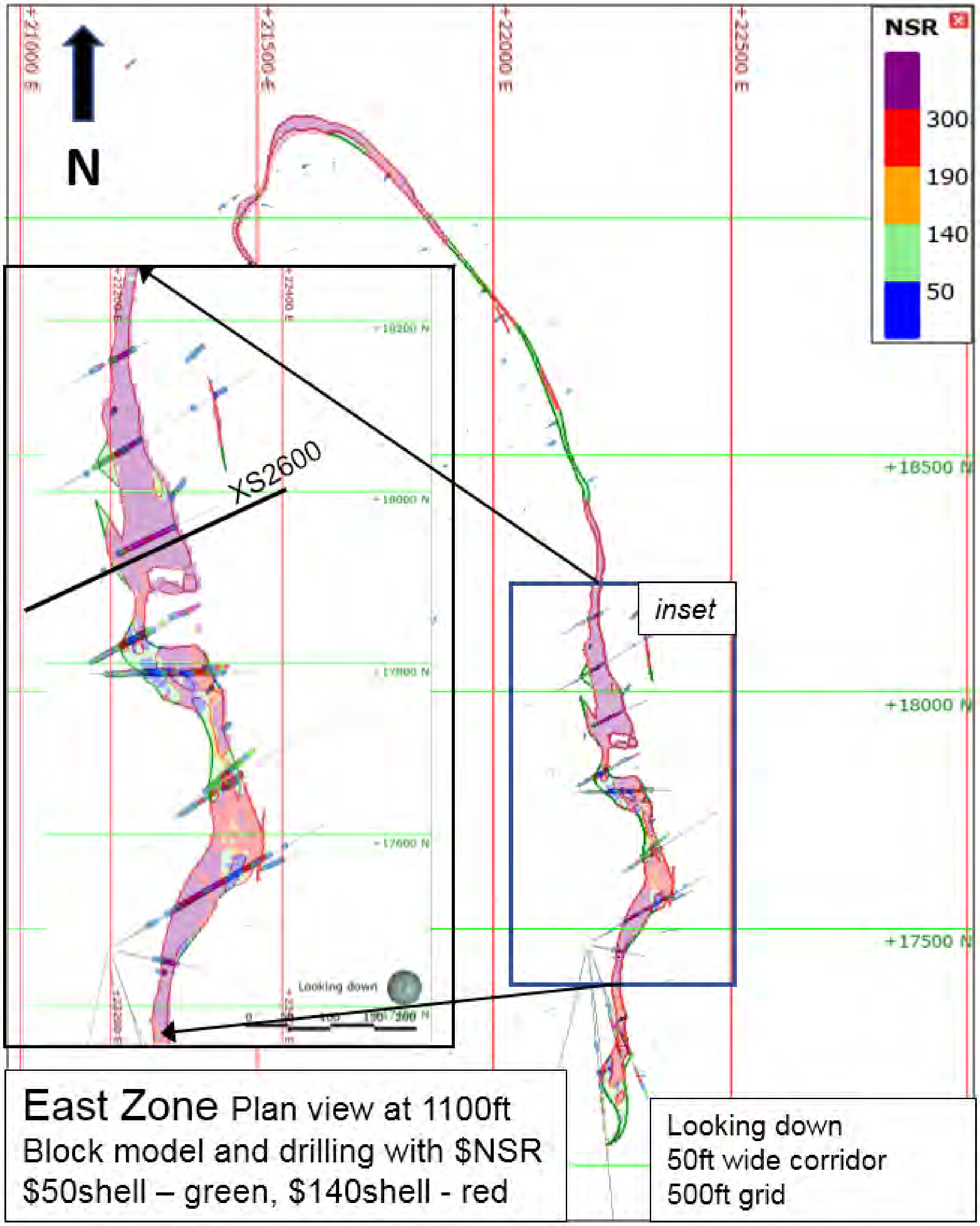
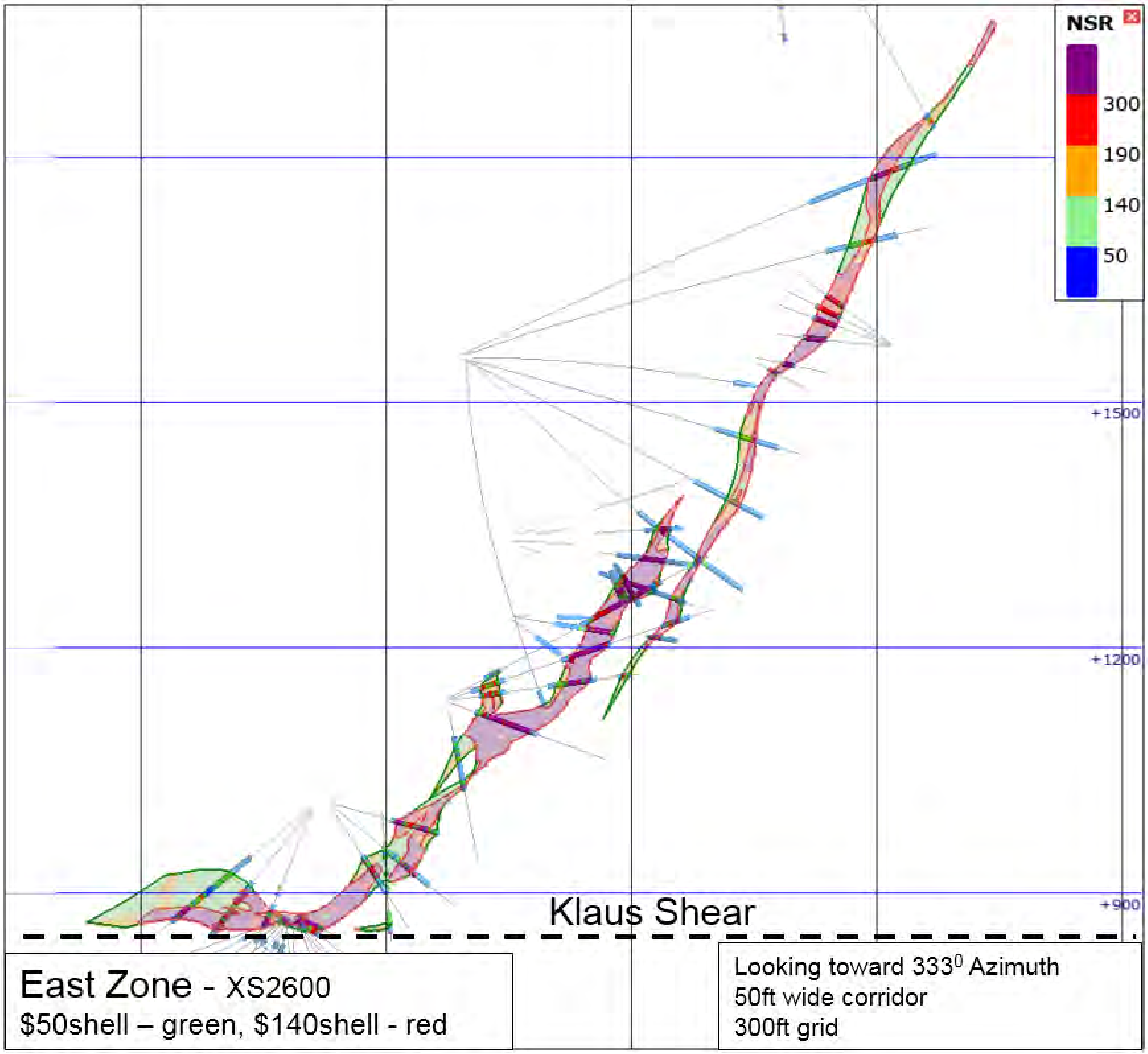


Figure 7-17: East Zone - Cross Section 2600



7.4.3 West Zone

The West Zone is the down-dip extension of the East Zone below the Klaus Shear, and from 75 to 1100 ft in elevation. While quite variable, the overall trend strikes N 30°W for over 2,500 ft (762 m) of strike length and 1,025 ft of vertical extent (75 to 1,110 ft). The thickness is also highly variable from less than 10 ft (3 m) to over 300 ft (91 m) in the central portions.

The West Zone shows well developed zoning patterns with silver rich fringes around a central high iron, copper and high zinc to lead ratioed core of MFP. Baritic material tend to form more commonly surrounding the core of MFP as well.

Figure 7-18 is an illustration of the 3D model for the West Zone. Figure 7-19 is a level plan at 700 ft elevation showing drilling and the mineral resource block model by $NSR values. Figure 7-20 is a cross- section through the West Zone as located on the level plan map.

Figure 7-18: West Zone - 3D Model

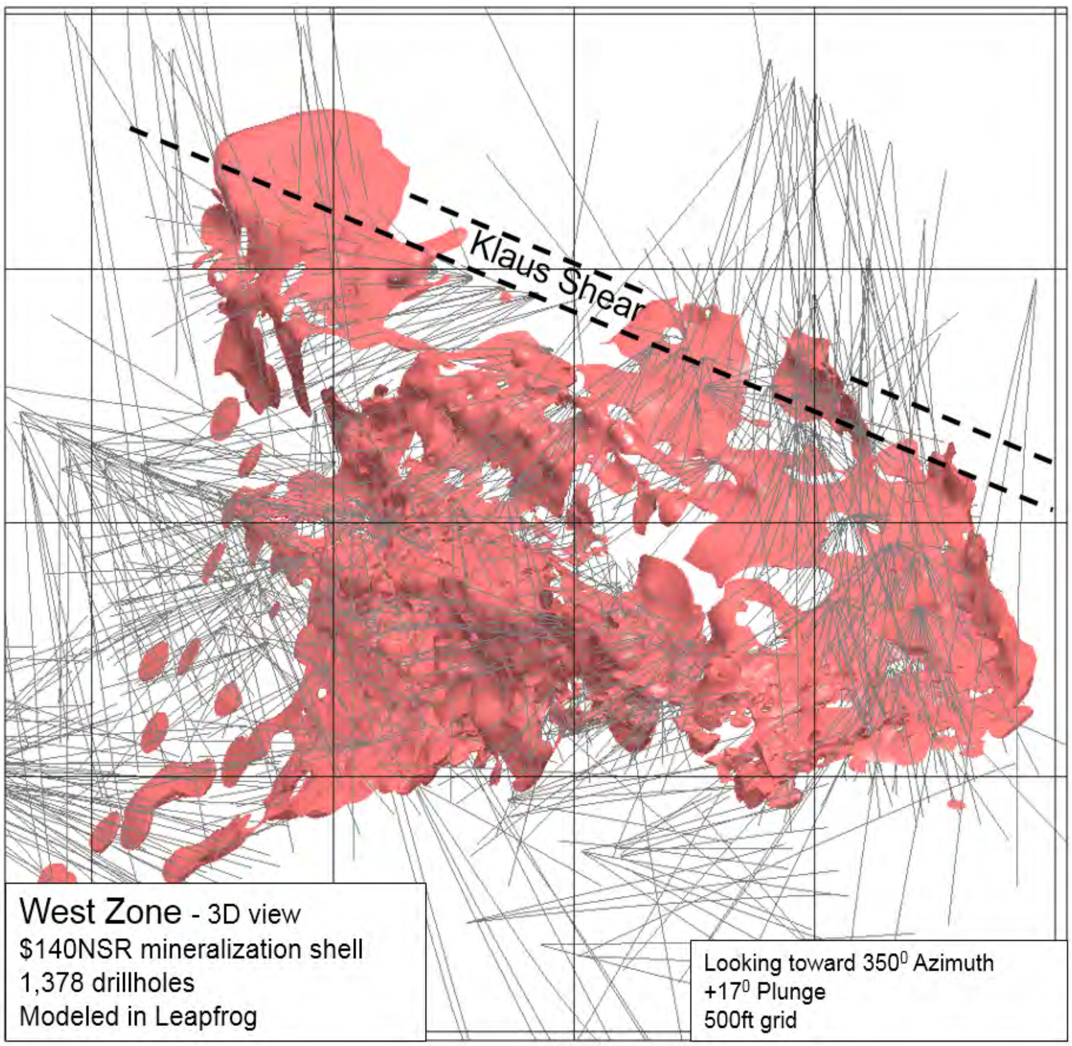


Figure 7-19: West Zone - Level Plan 700

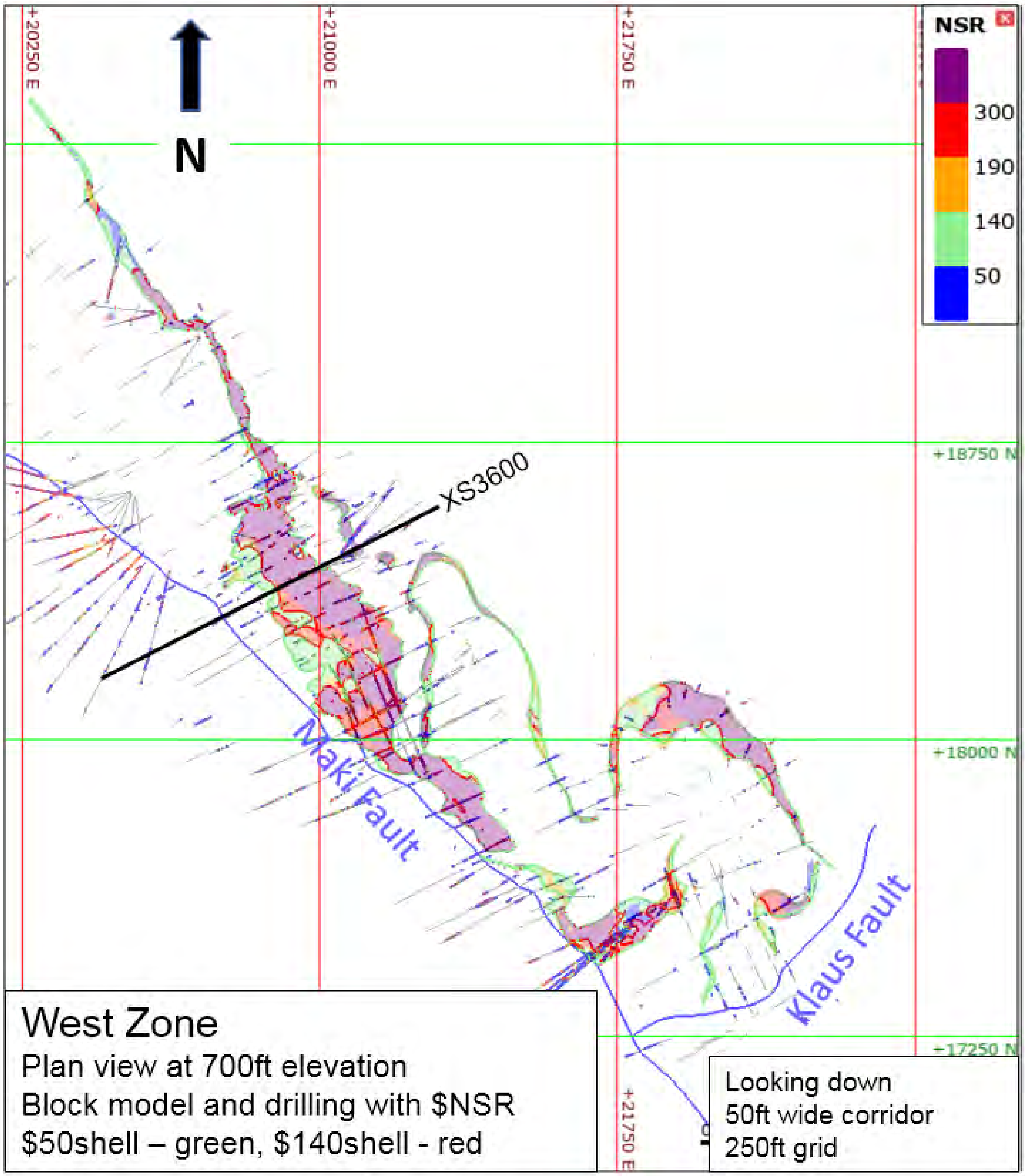
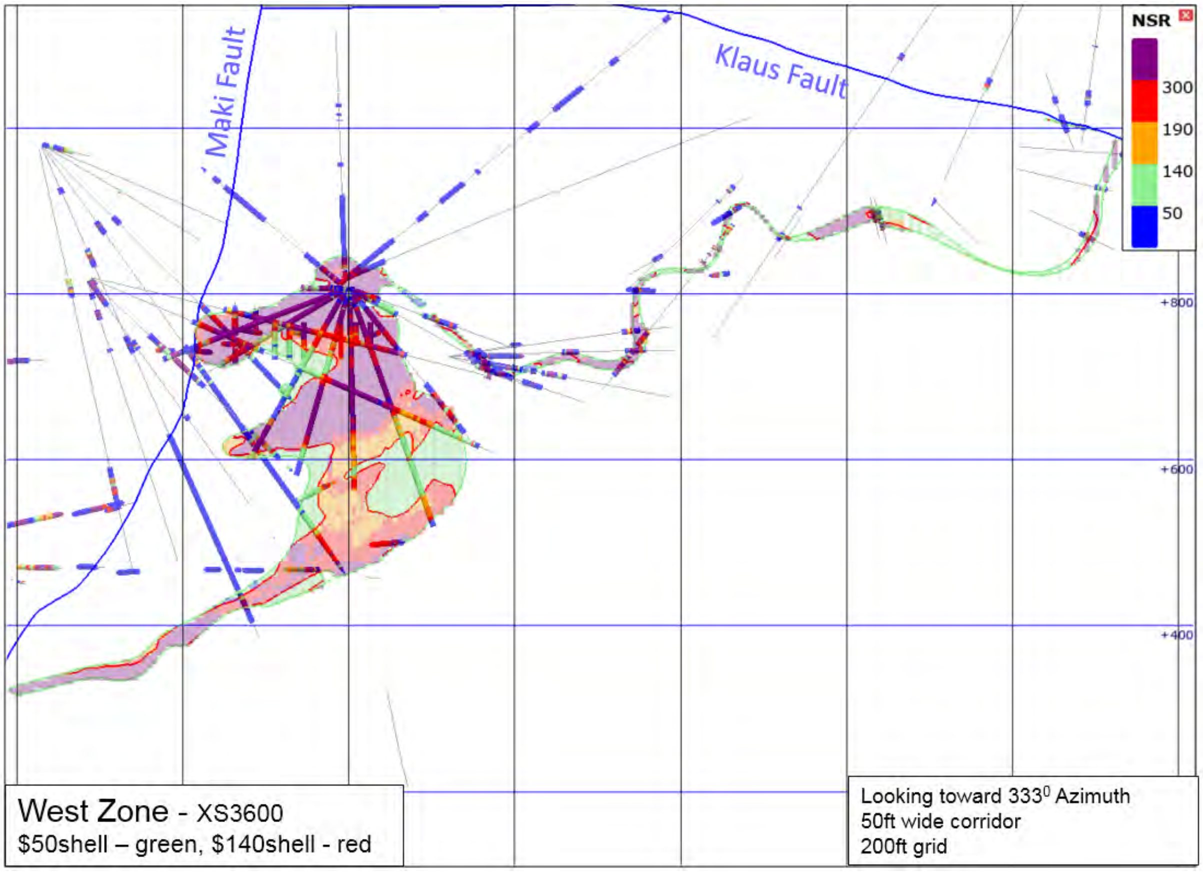


Figure 7-20: West Zone - Cross Section 3600



7.4.4 9A Zone

The 9A Zone is the most structurally dismembered zone at Greens Creek as it lies within the Maki-Kahuna Fault Zone. The general orientation of the mineral body is striking to the northwest and dipping steeply to the west but many internal fault splays cut mineralization at differing orientations. In plan, mineralized widths range between less than 5 ft (1.5 m) up to 100 ft (30 m).

Restoration of the movement along the Maki Fault suggests that the 9A Zone represents the fault-bounded connection between the East and West zones to the south and the Northwest West Zone to the north. As such, the mineral types within the 9A Zone tends to be similar to the East, West and Northwest-West zones. MFB and MFP materials dominate with less carbonate, siliceous and baritic material intermixed. The intense deformation within this fault zone, which appears to have early ductile deformation prior to the brittle faulting, has remobilized precious metals so that exceptionally high silver grades can be found in brittle fractures cutting S_2 foliation.

Figure 7-21 is an illustration of the block model extents. Figure 7-22 is a cross-section through the 9A Zone. Figure 7-23 is a level plan that shows the orientation of the mineralization in relation to the Maki Fault, and the trace of the mine contact.

Figure 7-21: 9A Zone - 3D Model

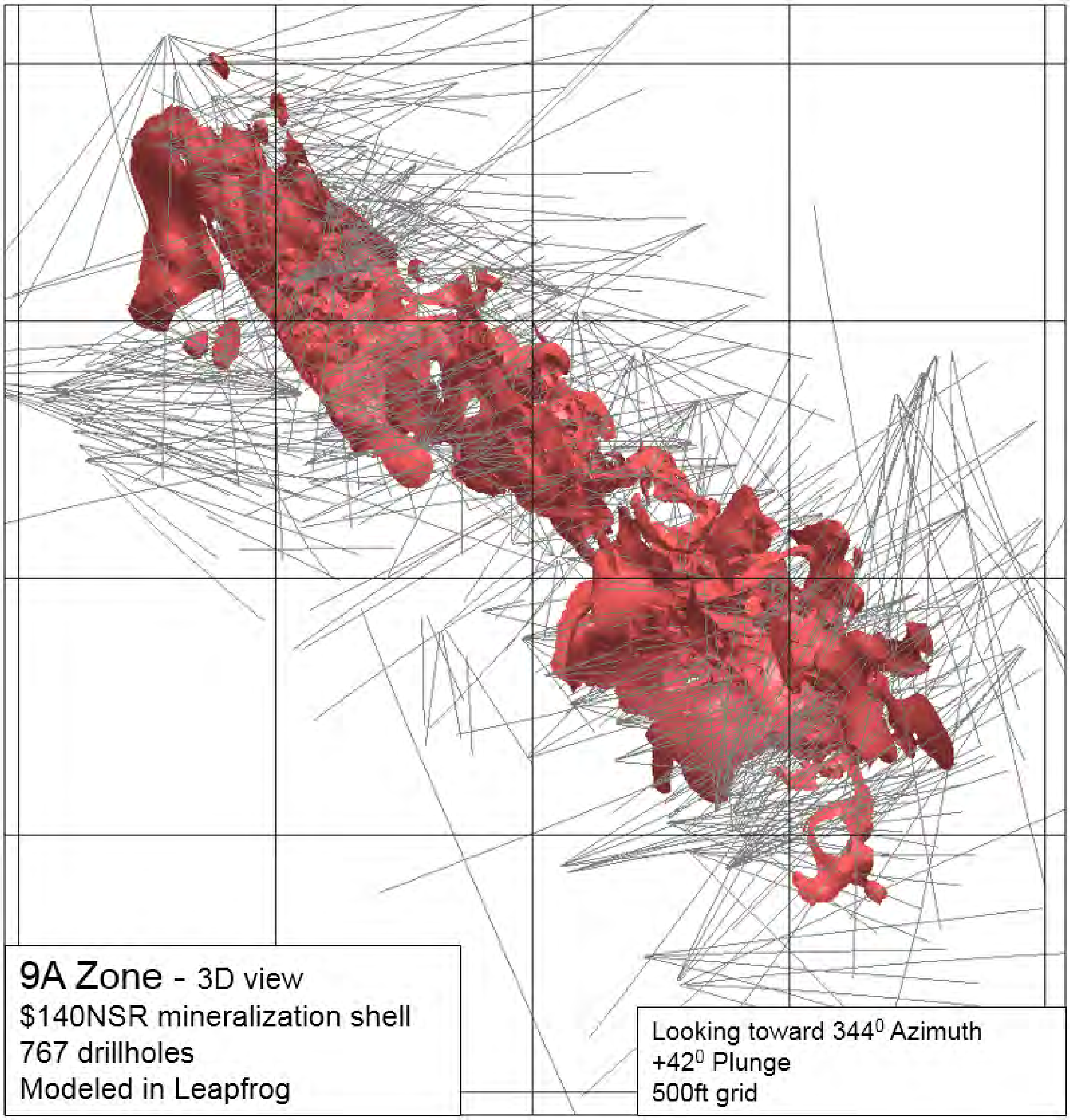


Figure 7-22: 9A Zone - Level 800

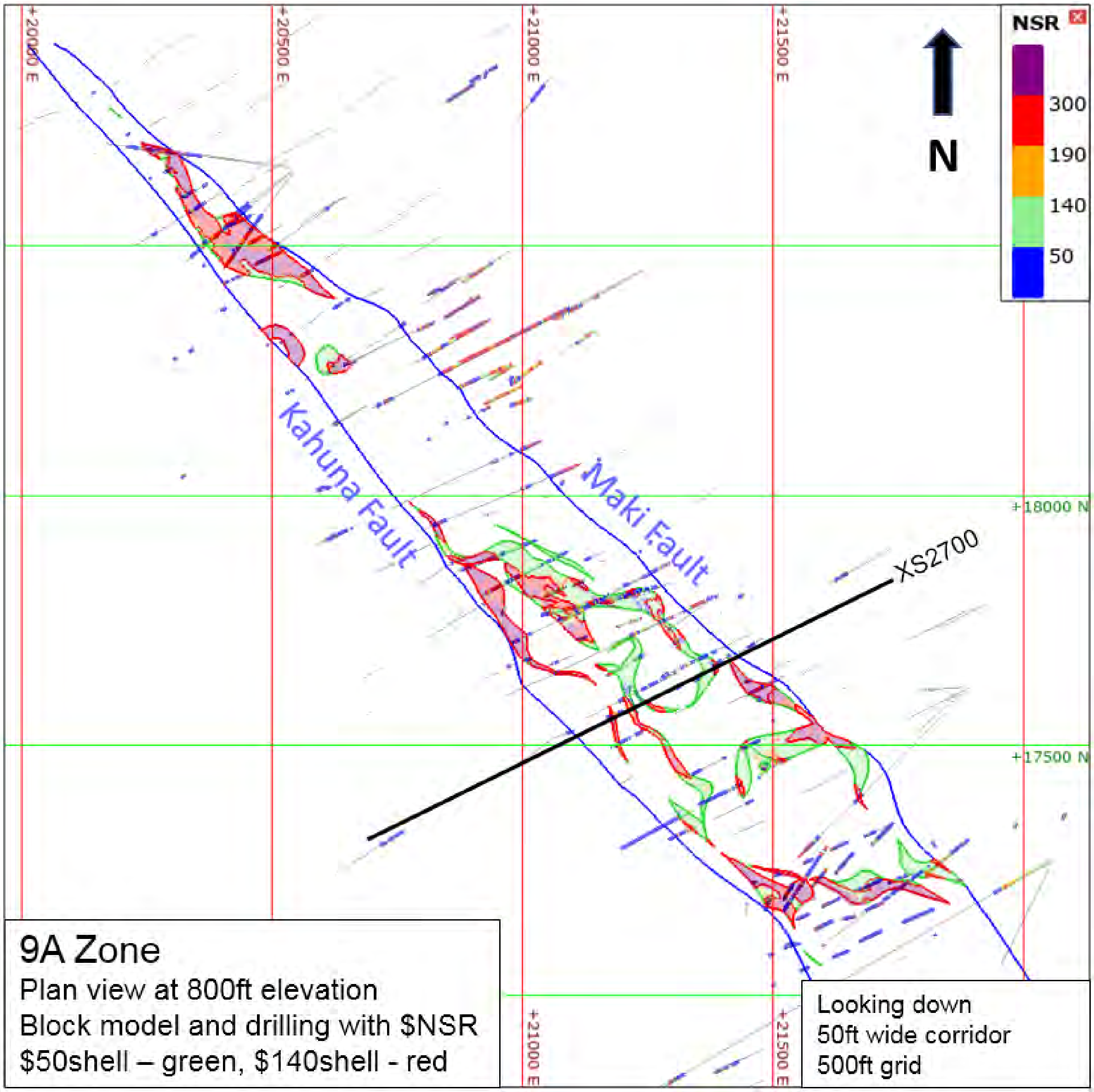
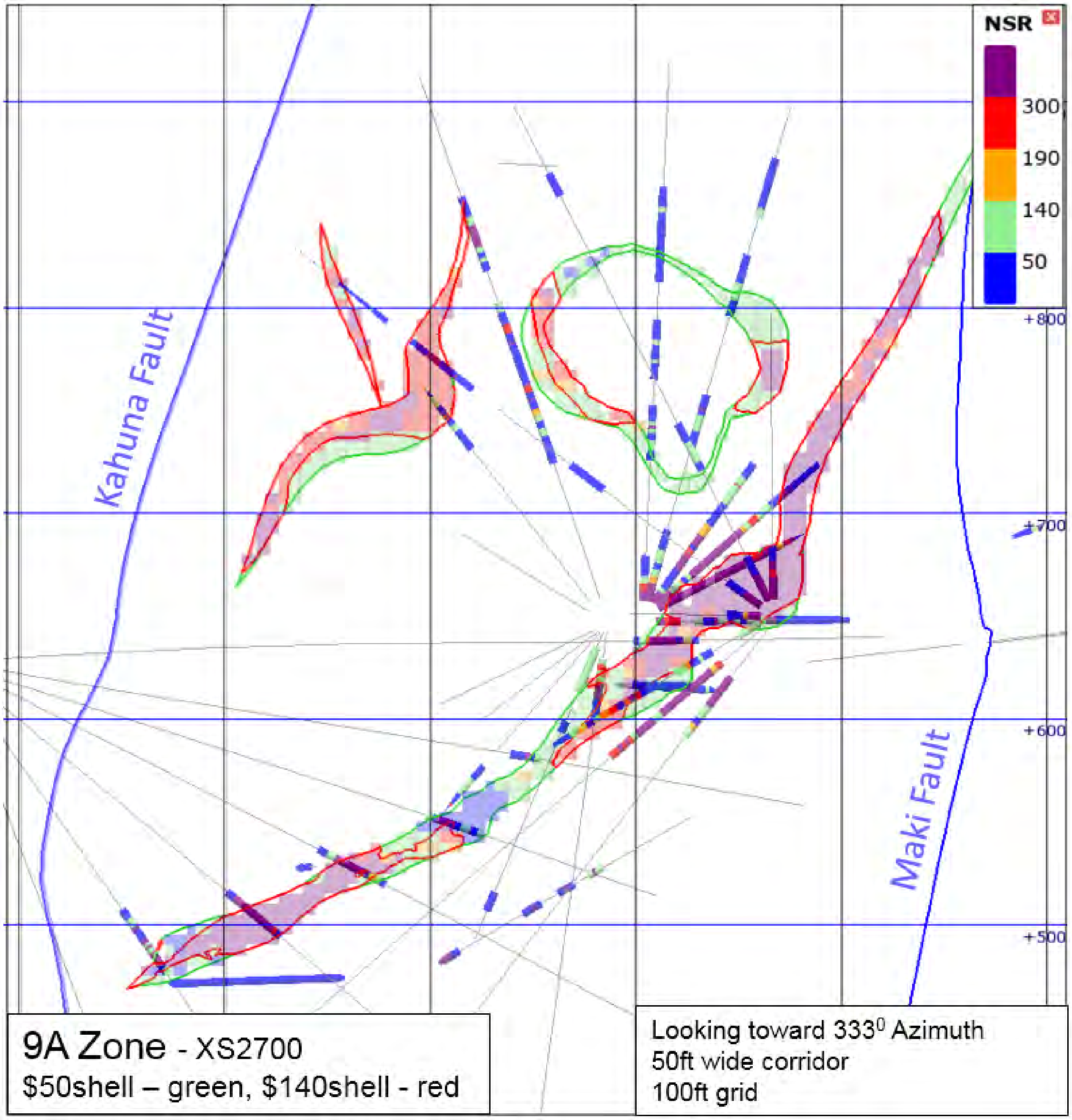


Figure 7-23: 9A Zone - Cross Section 2700



7.4.5 Northwest West Zone

The Northwest West Zone is an extension of the West and East zones with the 9A Zone tying the three together through the Maki-Kahuna Fault system. The structural setting is dominated by a pair of recumbent F_2 folds. The upper fold is an argillite-cored syncline while the lower fold is a phyllite-cored anticline. Mineral types and mineralization are similar to what has previously been described for the West Zone, with MFB and MFP dominate with some WSI and WCA intermixed.

In the Northwest Zone some mineralization is located up to 100 ft off the mine contact into the hanging wall argillite. Mineral types are a mixture of mostly massive and white-siliceous material types with lesser carbonate, baritic material and mineralized argillites. This zone is particularly rich in zinc, iron and copper with lower silver relative to most of the Greens Creek deposit, again because this is part of the main core of the deposit encompassing the lower East, West, 9A, and Northwest West zones.

Figure 7-24 illustrates the Northwest West Zone mineralization envelope in 3D with definition drilling completed within the area. Figure 7-25 provides a plan view of the drilling and mineral resource block model at the 450 ft elevation. Figure 7-26 displays a cross section through the middle of the Zone at XS2700. In the cross section the two large F_2 folds are apparent.

Figure 7-24: Northwest West Zone - 3D Model

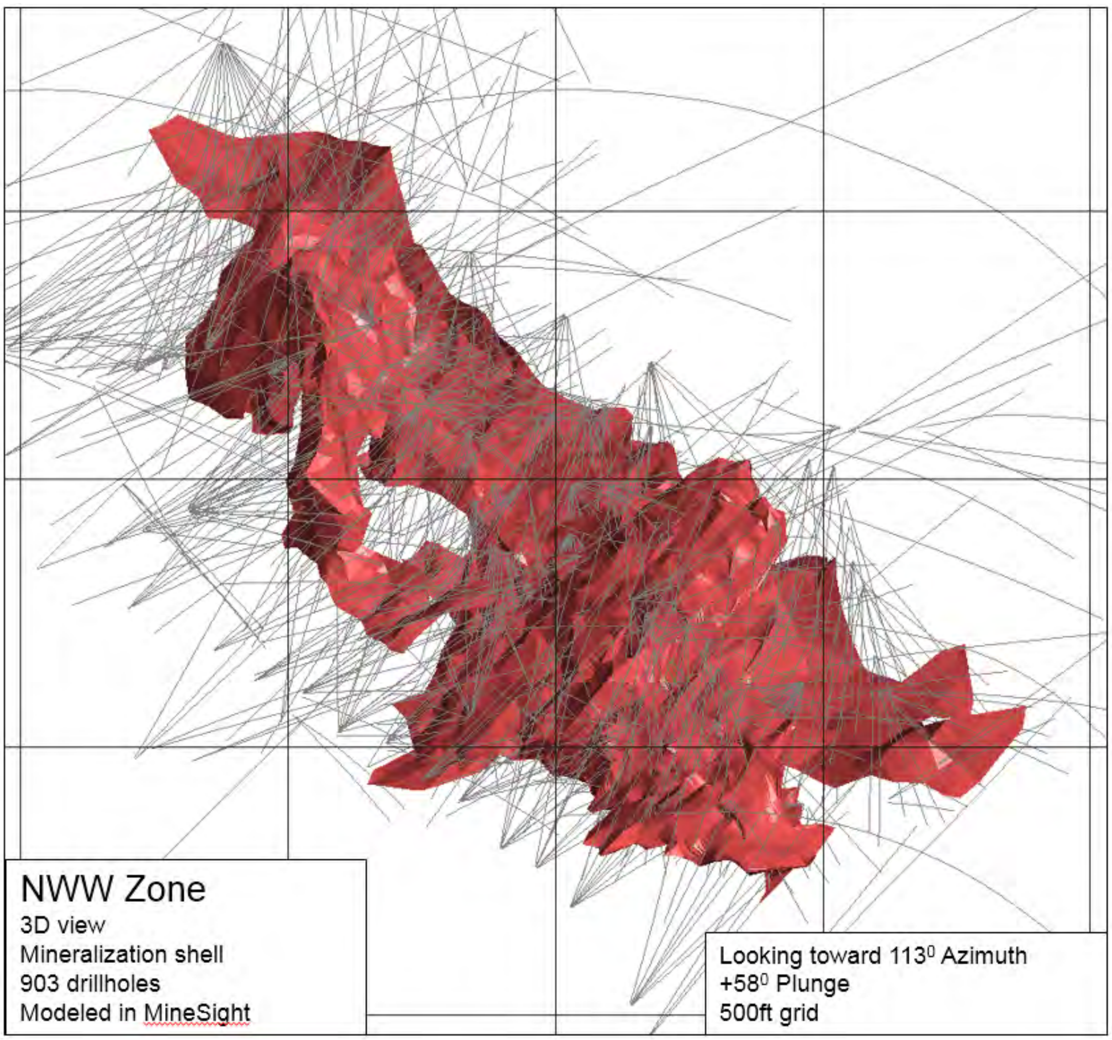


Figure 7-25: Northwest West Zone - Level Plan 450

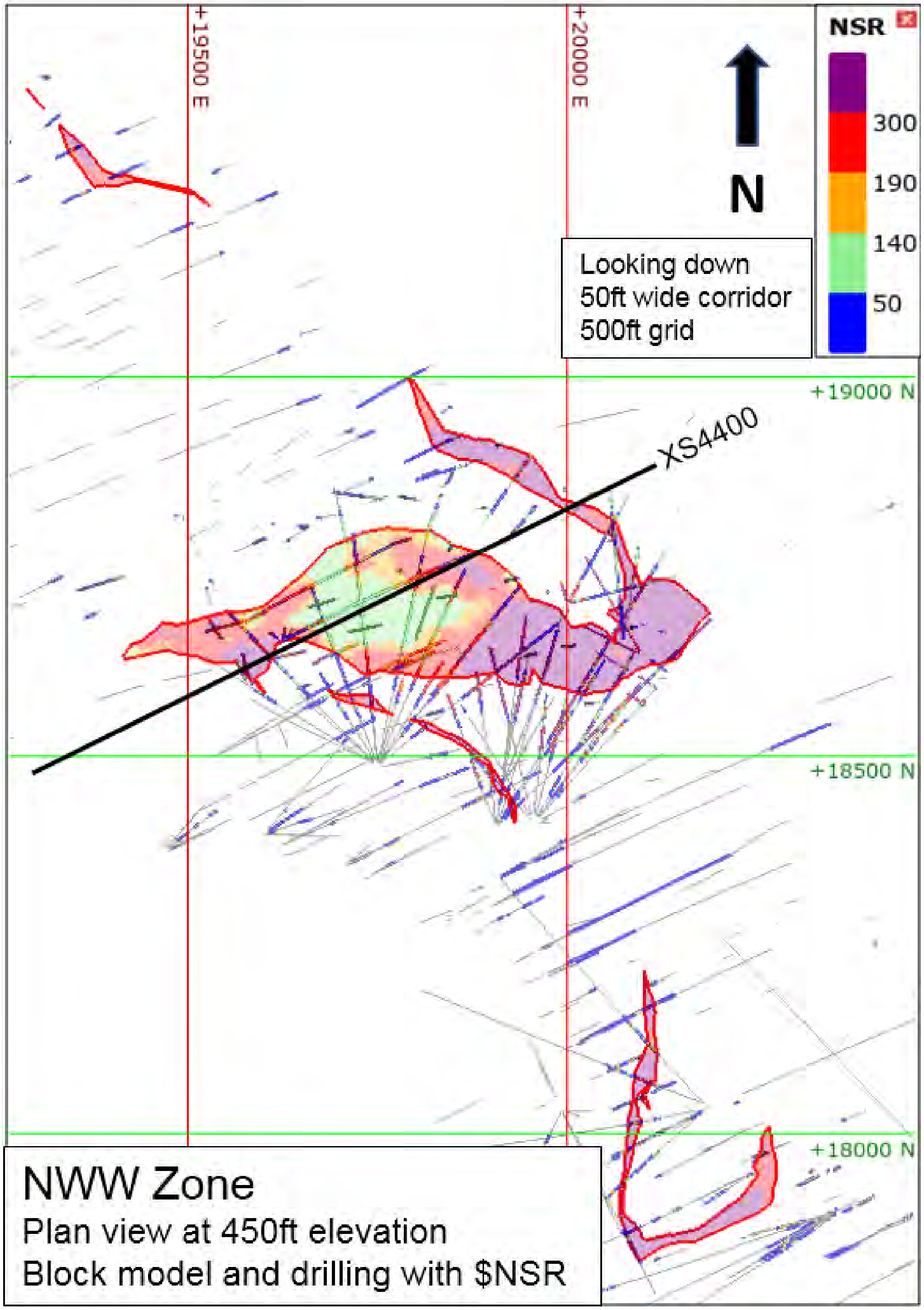
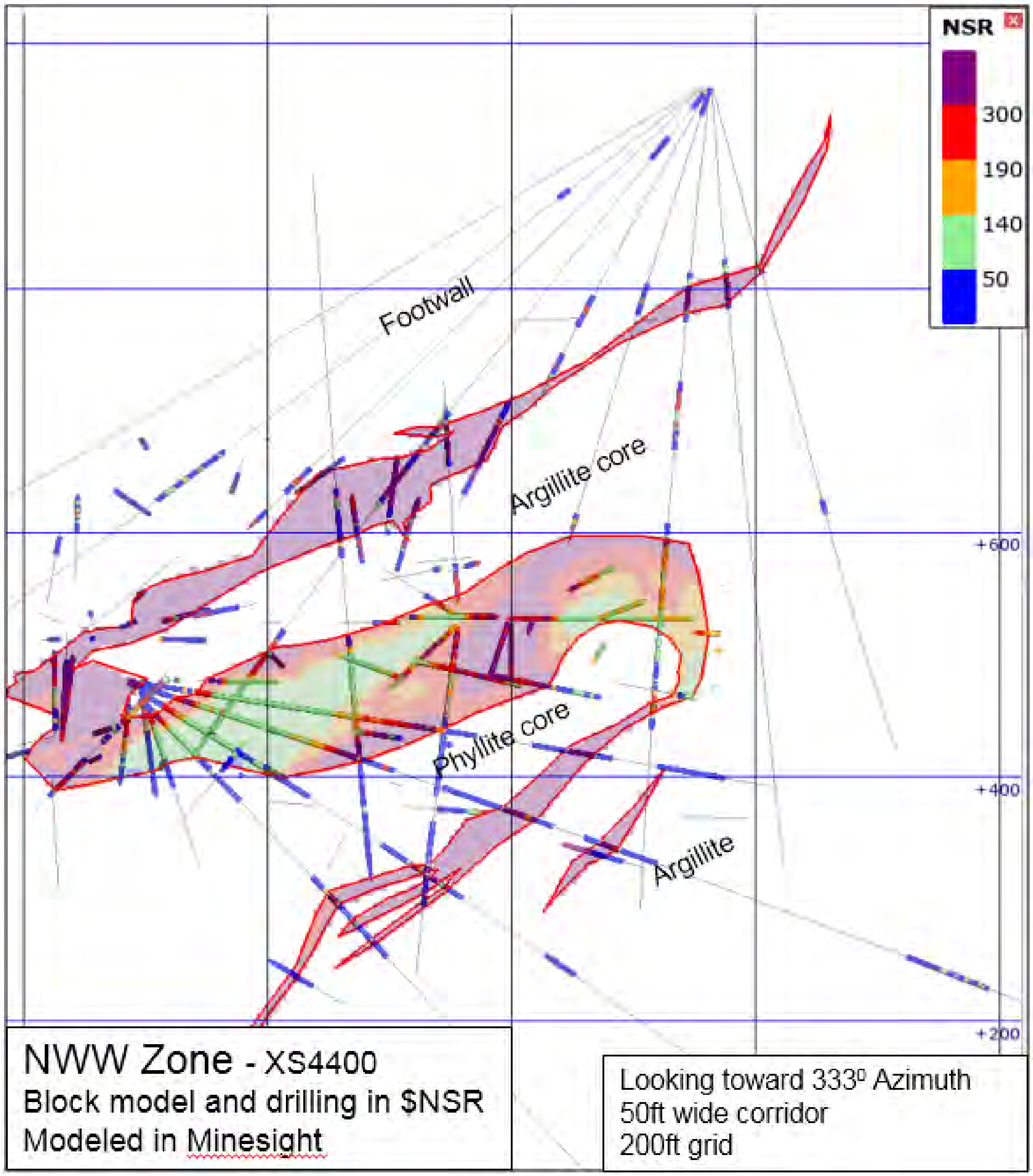


Figure 7-26: Northwest West Zone - Cross Section 4400



7.4.6 Upper Plate Zone

The Upper Plate Zone is located at the far northern end of the Greens Creek deposit and above the Northwest West Zone. It is a smaller body representing the top of the Northwest West Zone which was caught up in a very large F_2 fold located on the bottom of a major $D_{2.5}$ shear known locally as the Upper Shear Zone. The recumbent fold has an amplitude of over 3,000 ft with an argillite core no more than 200 ft thick. Mineralization is found mostly on the upper and lower contacts of the fold but does in places cross into the argillite core.

Ore types for this relatively thin zone are generally MFB or mineralized argillite. The prevalence of MFB without the lower temperature white mineral style supports the deformation explanation of an exceptional shear and related fold pulling the Northwest West Zone to the northwest. Two late, brittle, northwest striking faults cut the Upper Plate body – the Up Fault and the SW-D Fault, though offsets have minimal displacement. Figures 27, 28 and 29 provide a 3D view of the $140 NSR mineralization shell, a level plan through the 1,100 ft elevation and a cross section through the southeastern end of the mineral zone, respectively.

Figure 7-27: Upper Plate Zone - 3D Model

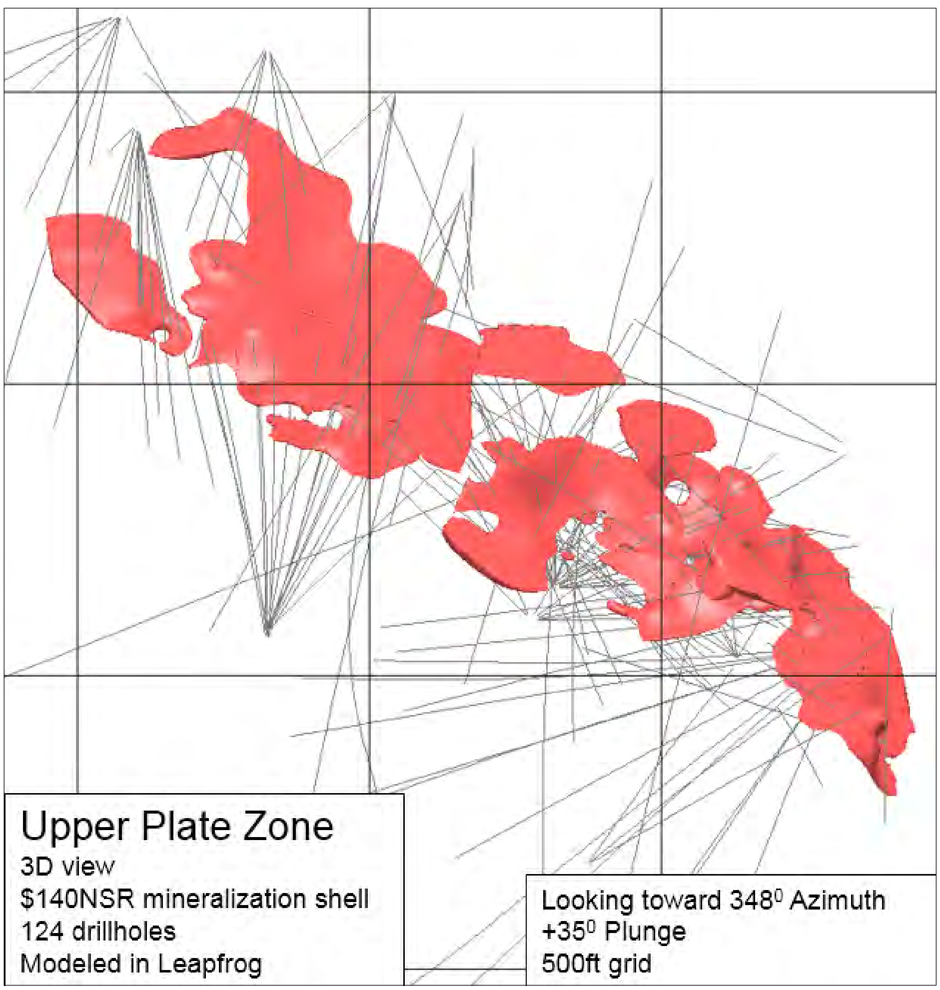


Figure 7-28: Upper Plate Zone - Level Plan 1100

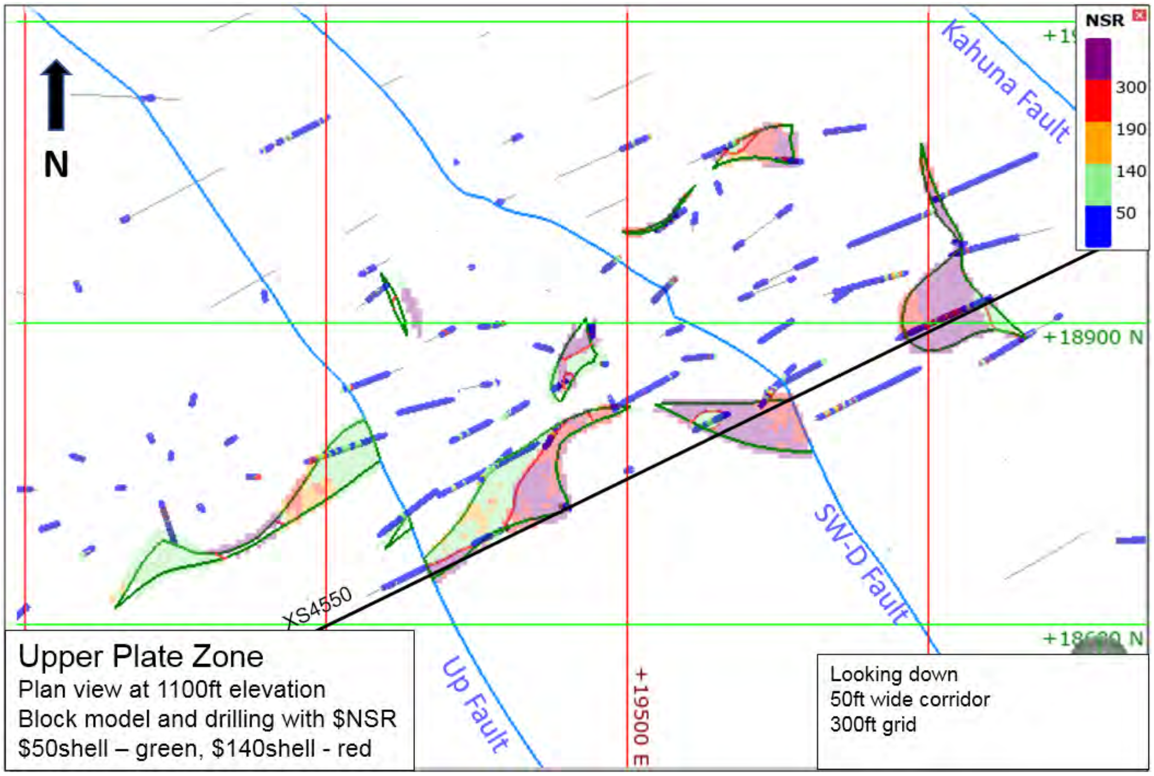
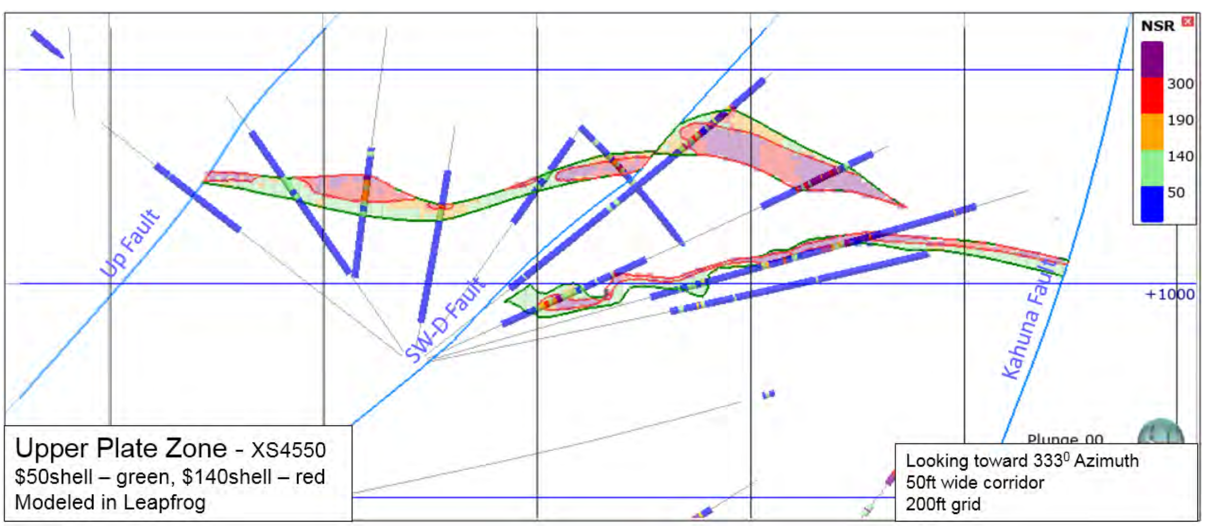


Figure 7-29: Upper Plate Zone - Cross Section 4550



7.4.7 5250 Zone

Immediately west of the Kahuna-Maki Fault system is a lower temperature lens of barite-rich mineralization which links to the north with the Northwest-West Zone mineral body. This lens, known as the 5250 Zone is continuous for up to 1,200 ft (366 m) along a N300W trend and represents the uppermost mineralization trend at Greens Creek.

The mineral types are dominated by white baritic material (WBA) with lesser massive mineral and minor amounts of carbonate and siliceous mineral types. The silver grades are typically higher than average for the Greens Creek mineral bodies while zinc, lead and gold are below average. The mineralized material occurs along the phyllite/argillite mine contact and trends approximately N 35° W. The interpretation shows two limbs of a fold; the western limb dips generally 30º to the west/southwest and the eastern limb dips more steeply at approximately 80º.

Figure 7-30 is an illustration of the mineralized wireframe with definition drilling shown. Figure 7-31 is a level plan map of the drilling and mineral resource block model for the 5250 Zone. Figure 7-32 shows cross-section XS2200 through the 5250 Zone showing the block model and drill traces.

Figure 7-30: 5250 Zone - 3D Model

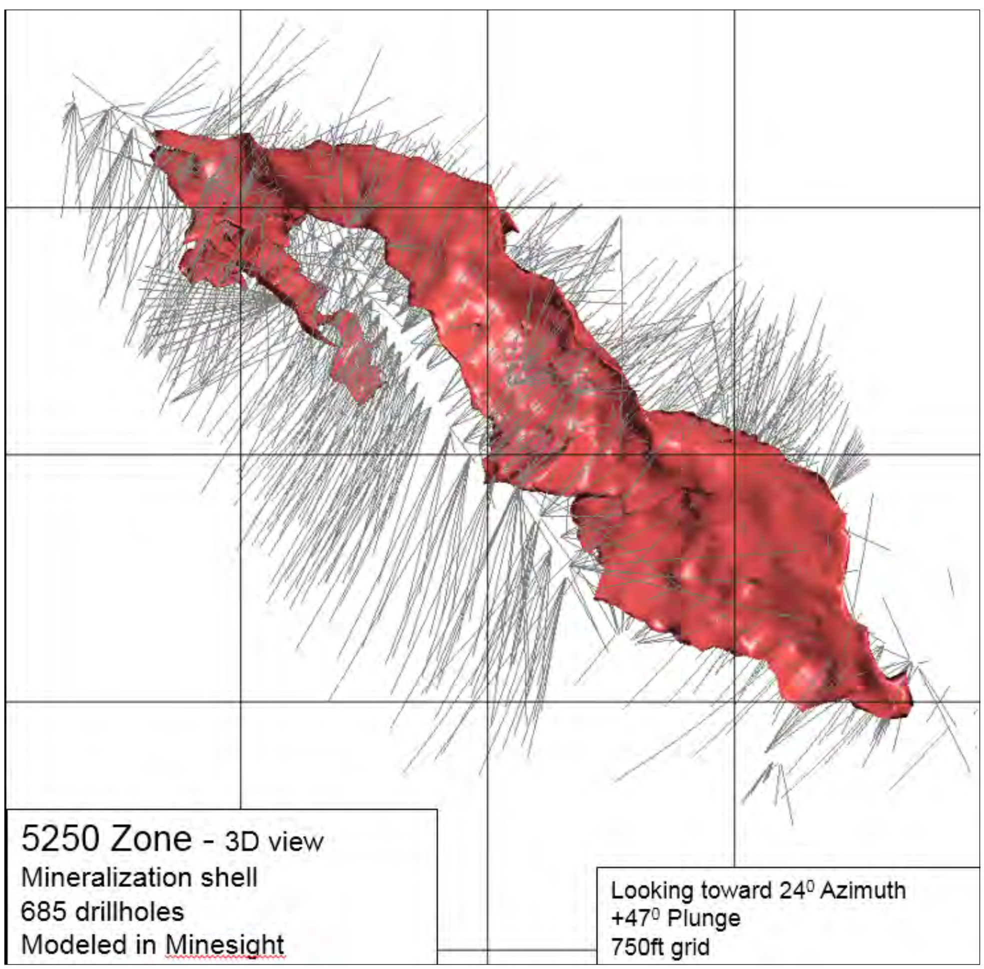


Figure 7-31: 5250 Zone - Level 650

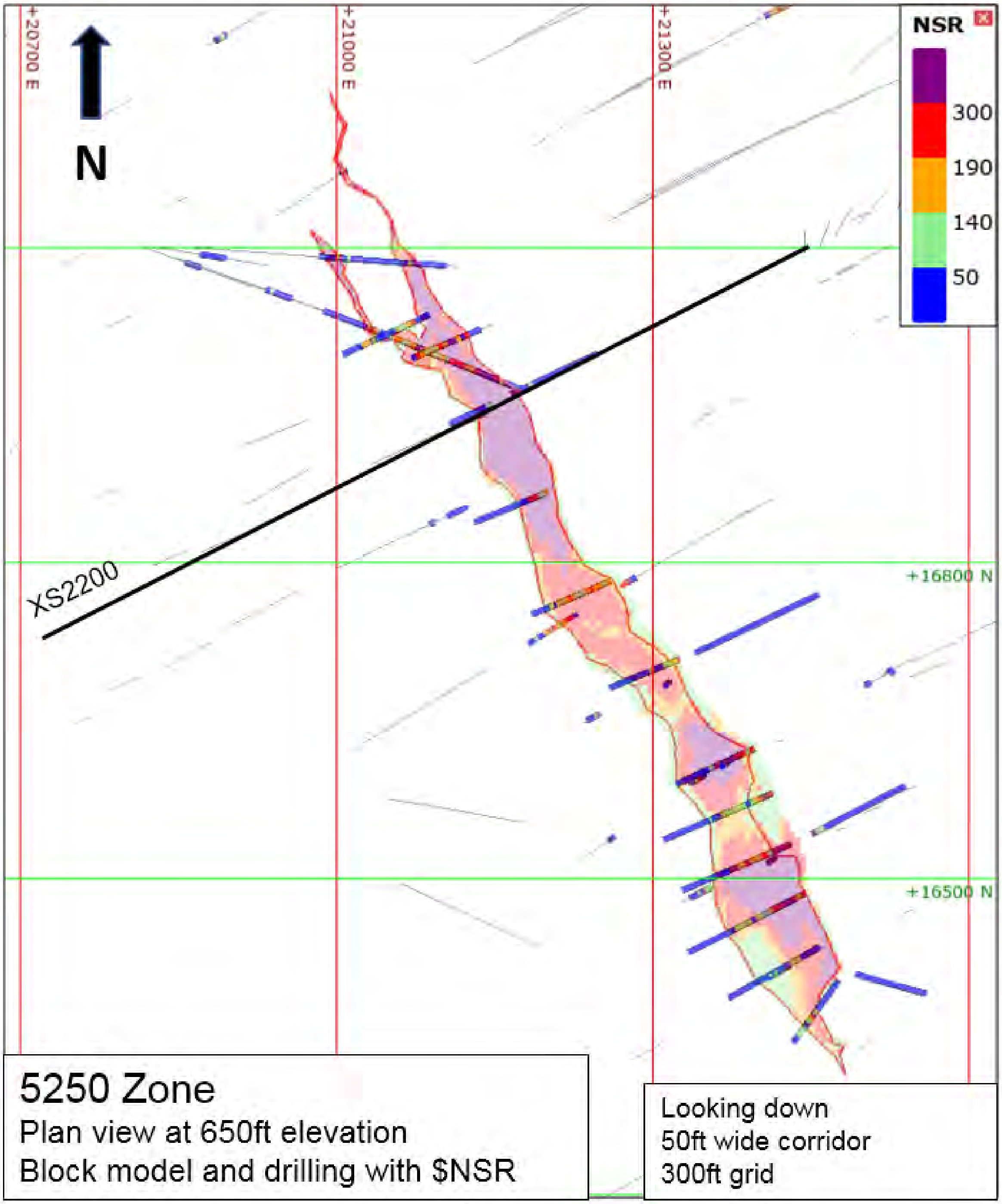
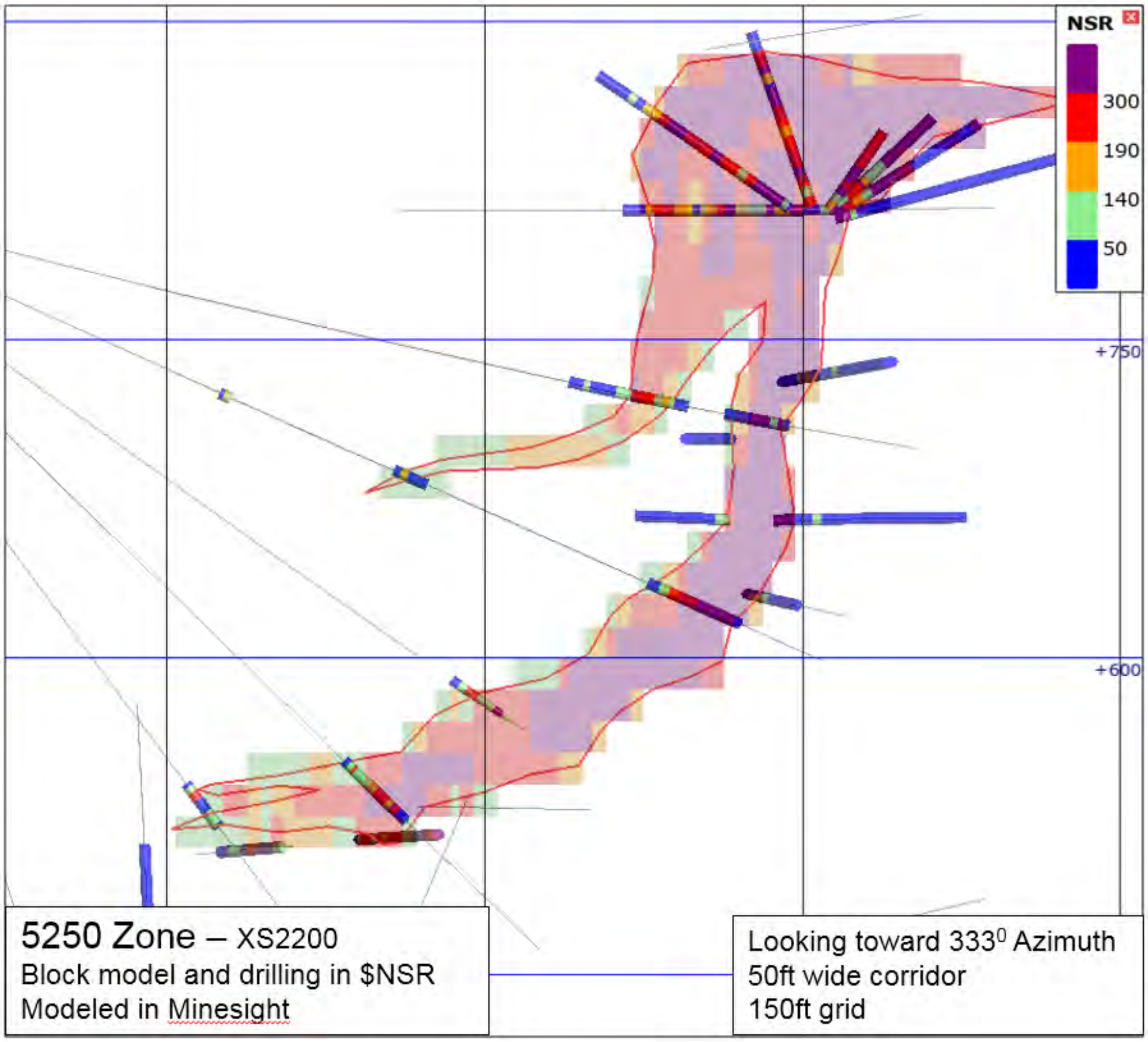


Figure 7-32: 5250 Zone - Cross Section 2200



7.4.8 Southwest Zone

The Southwest Zone is comprised of a large phyllite cored F_2 anticline with a nearly horizontal argillite syncline (also F_2) on its upper limb. The lower limb of the anticline is steeply east dipping to moderately westerly dipping with increasing depth. Mineralization wraps around the anticline's mine contact, staying on the contact except at the hinge of the fold where multiple lenses of mineralization have folded up into the argillite above the hinge along steep parasitic folds as is commonly seen over large intensely folded structures. Some late F_3 folding has significantly deformed the mine contact and F_2 argillite cored syncline.

The Southwest Zone body continues down dip and trends directly into the 200S Zone, the boundary between the 200S and SW Zone being somewhat arbitrarily set to keep modeling calculations manageable.

The high amount of deformation in the Southwest Zone has remobilized and enriched precious metals, especially silver. As the zone sits atop a hydrothermal center and has secondary enrichment it has historically been one of the highest-grade areas at Greens Creek. Even after being mostly mined out this zone still contains the highest silver mineral resource and mineral reserve numbers for the mine. Mineral types are a mixture of MFB, WSI, WCA, and MFP; indicating that the location is in a focused vent area.

Figure 7-33 provides a 3D view of the Southwest Zone mineralization envelope at a $140 NSR cut-off. Figure 7-34 is a level plan view through the zone at the 300 ft elevation. Note the north-northwest striking F_3 folds on the plan map at the 19800E and 20200E gridlines. Figure 7-35 displays a cross section through the middle of the Southwest Zone as located on the plan map.

Figure 7-33: Southwest Zone - 3D Model

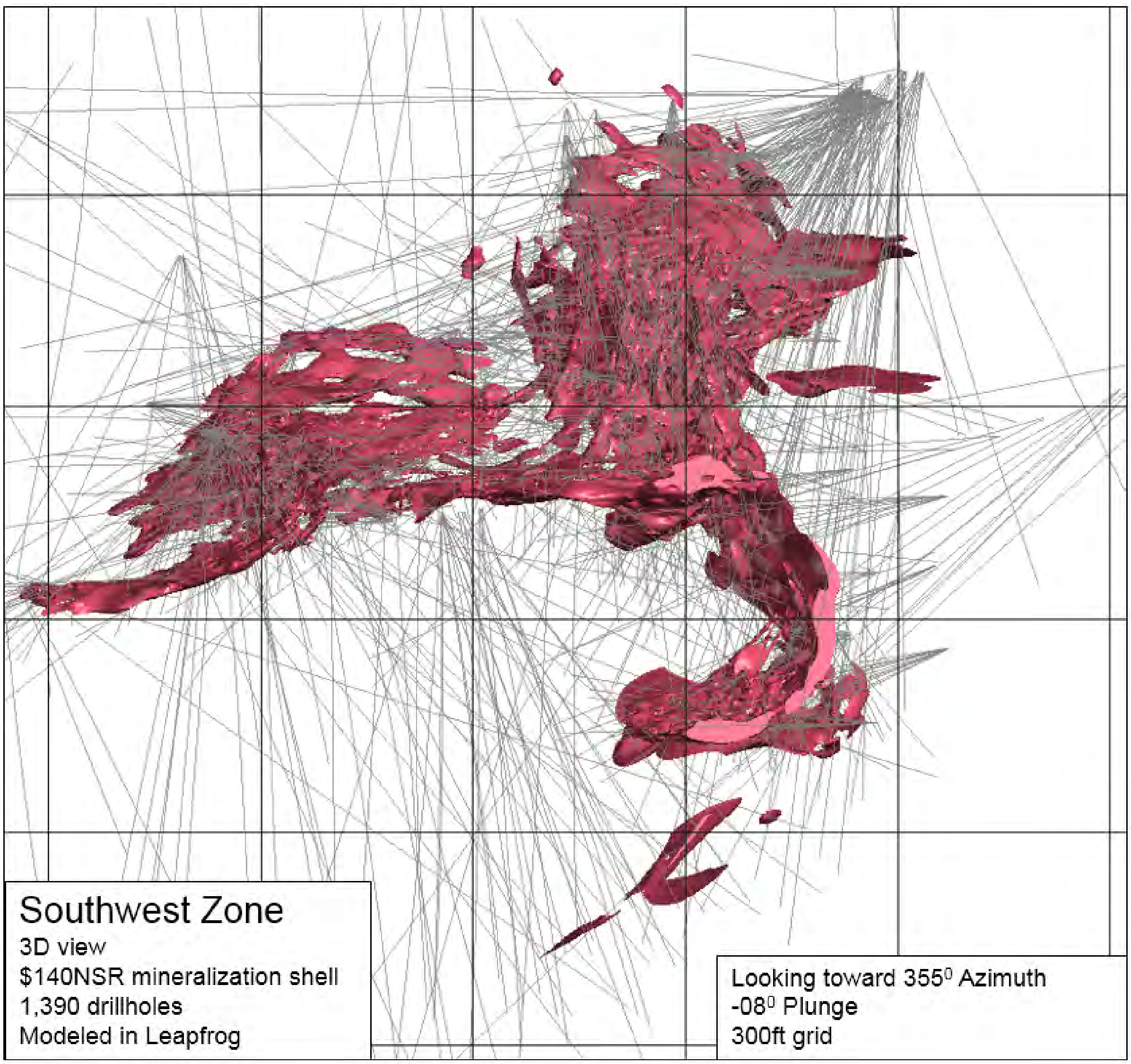


Figure 7-34: Southwest Zone - Level Plan 300

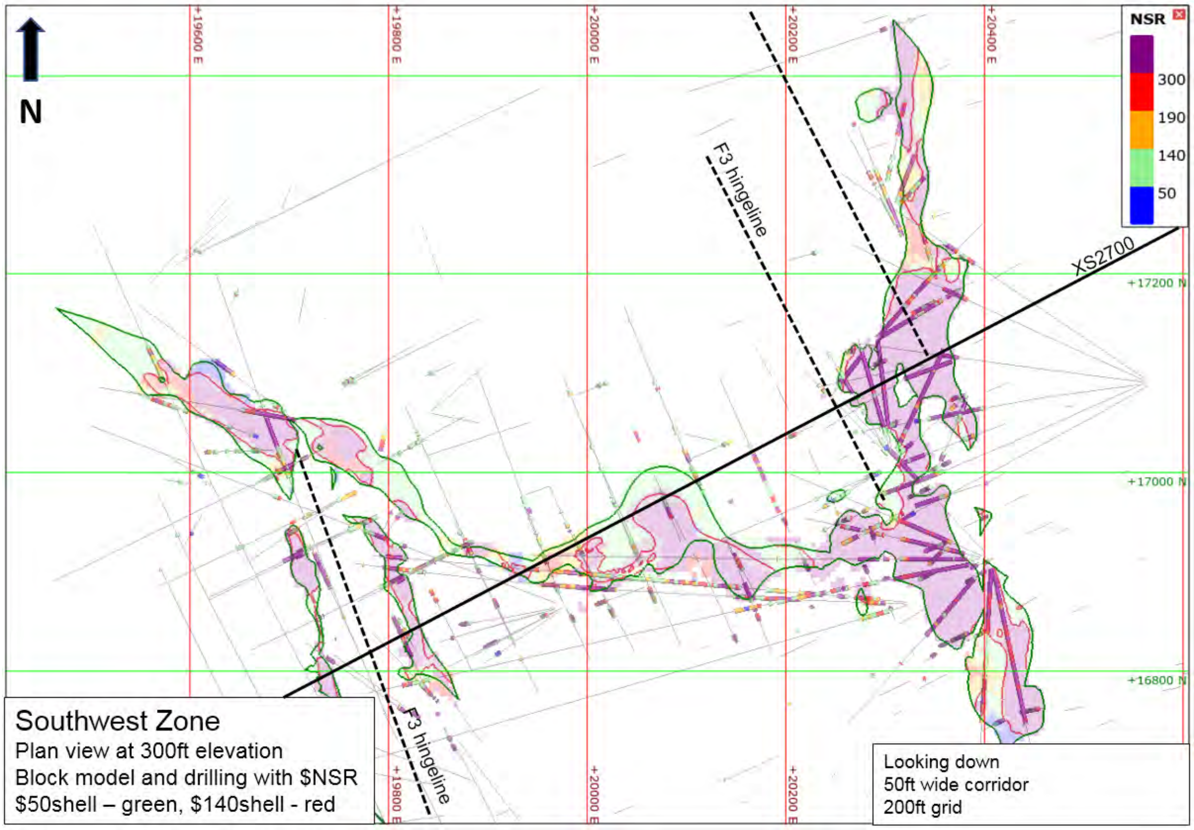
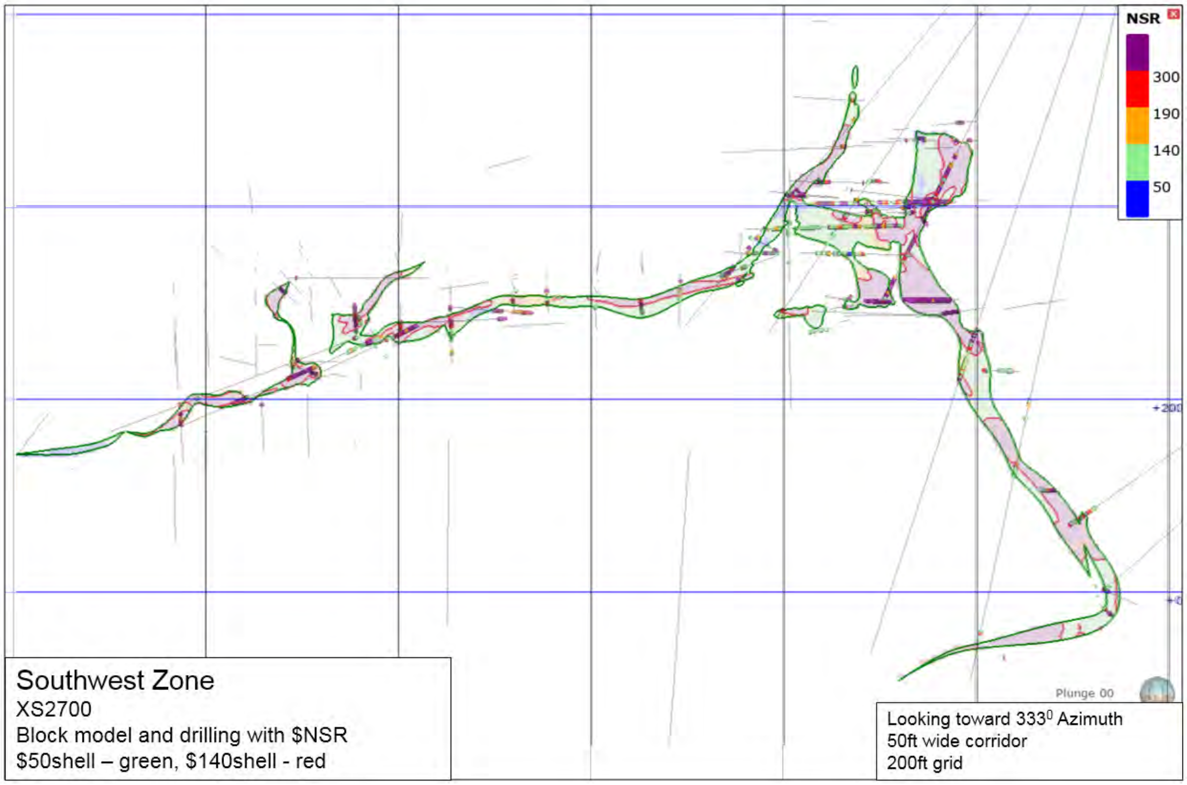


Figure 7-35: Southwest Zone - Cross Section 2700



7.4.9 200 South Zone

The 200 South (200S) Zone is a continuation of the Southwest Zone trend and has been historically sub-divided into two major areas, the main 200 South and the Deep 200 South zones. As the division was due to naming before continuity was established this differentiation is not recognized in this report; rather one continuous 200S Zone is described beginning at the arbitrary XS2200 boundary between the Southwest and 200S zones.

The main 200 South Zone displays the same general anticlinal geometry as the Southwest Zone, with a steeply dipping eastern limb and a flat-lying western limb. Mineralization continues for 1,200 ft (366 m) along a strike of N 15° W.

There appears to be at least one major F_2 anticline in the core of the deposit that has been affected by an F_3 fold with east-dipping axial plane. One major $D_{2.5}$ shear offsets the 200S Zone at approximately the 550 ft elevation, top to the northwest. Mineralization is bounded on the east by a steep, brittle fault zone that offsets the mineral horizon several hundred feet (75 to 100 m) in a dextral sense.

Figure 7-36 is a 3D illustration of the mineralized wireframe and definition drilling. Figure 7-37 is a level plan at Level 100 that shows the outline of the block model in relation to the mine contact, and the major drillhole orientations. Figure 7-38 is a cross-section through the 200 South Zone that shows the relationship of the drilling to the block model.

Figure 7-36: 200S Zone -3D Model

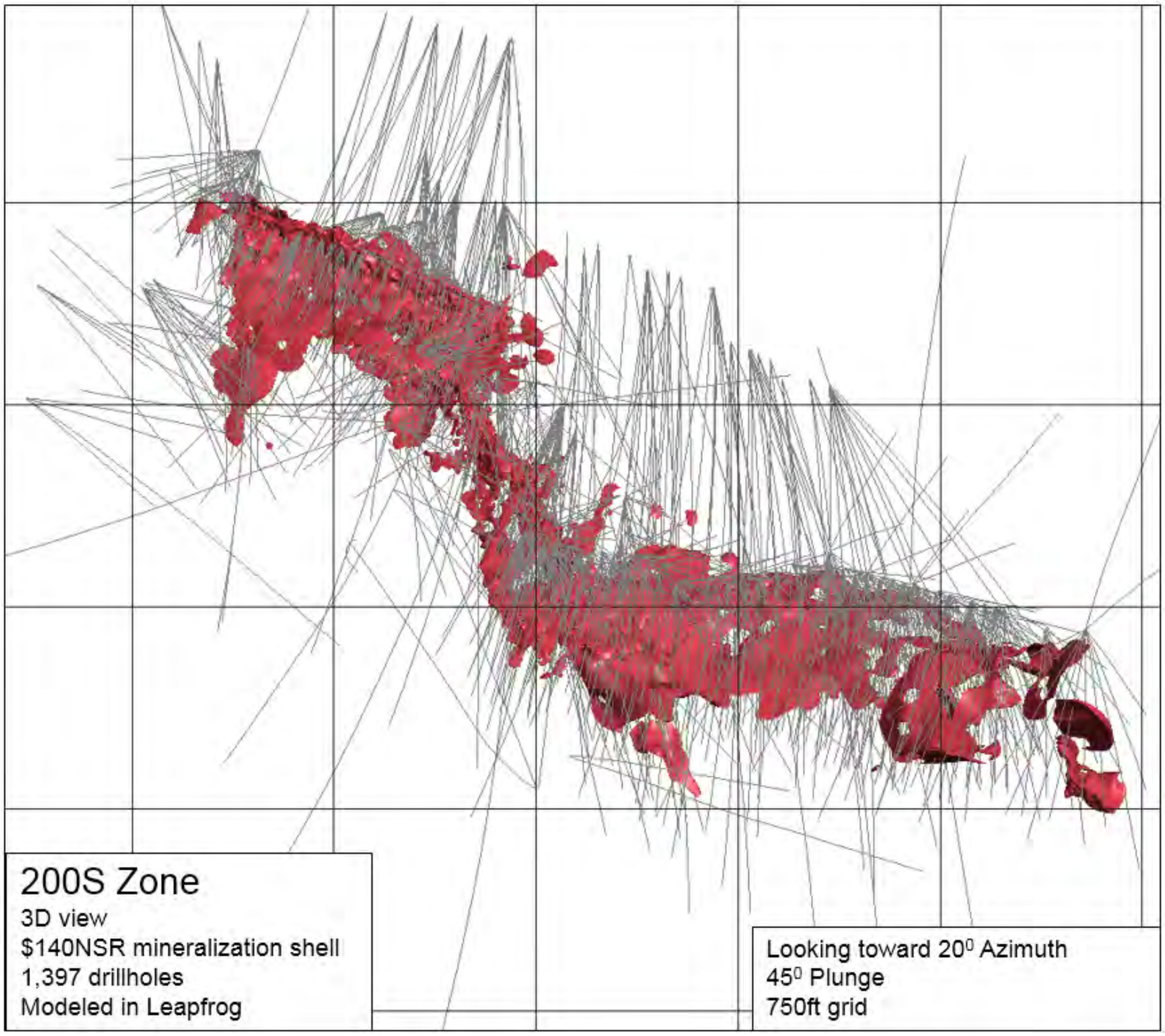


Figure 7-37: 200S Zone - Level Plan 100

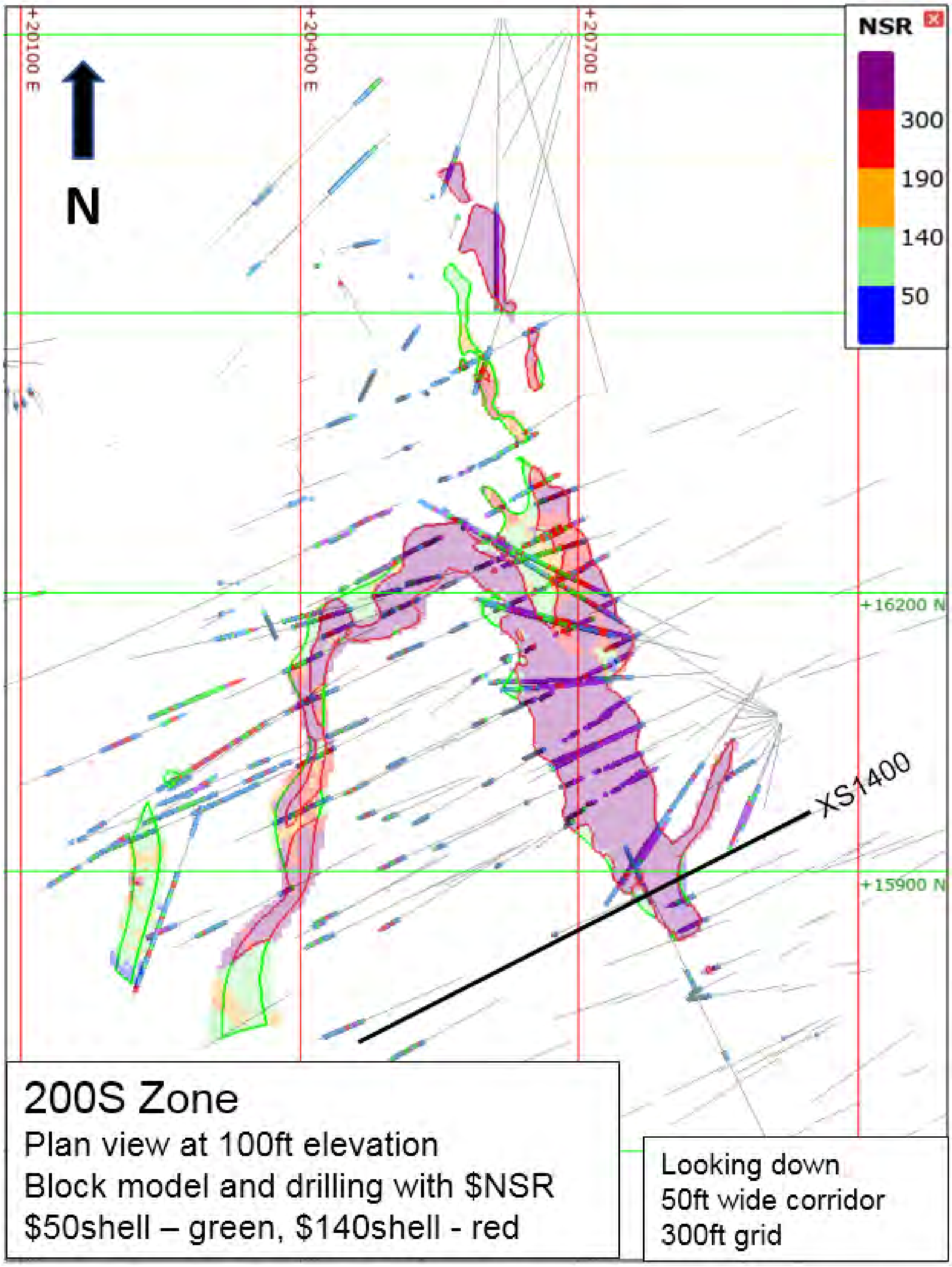
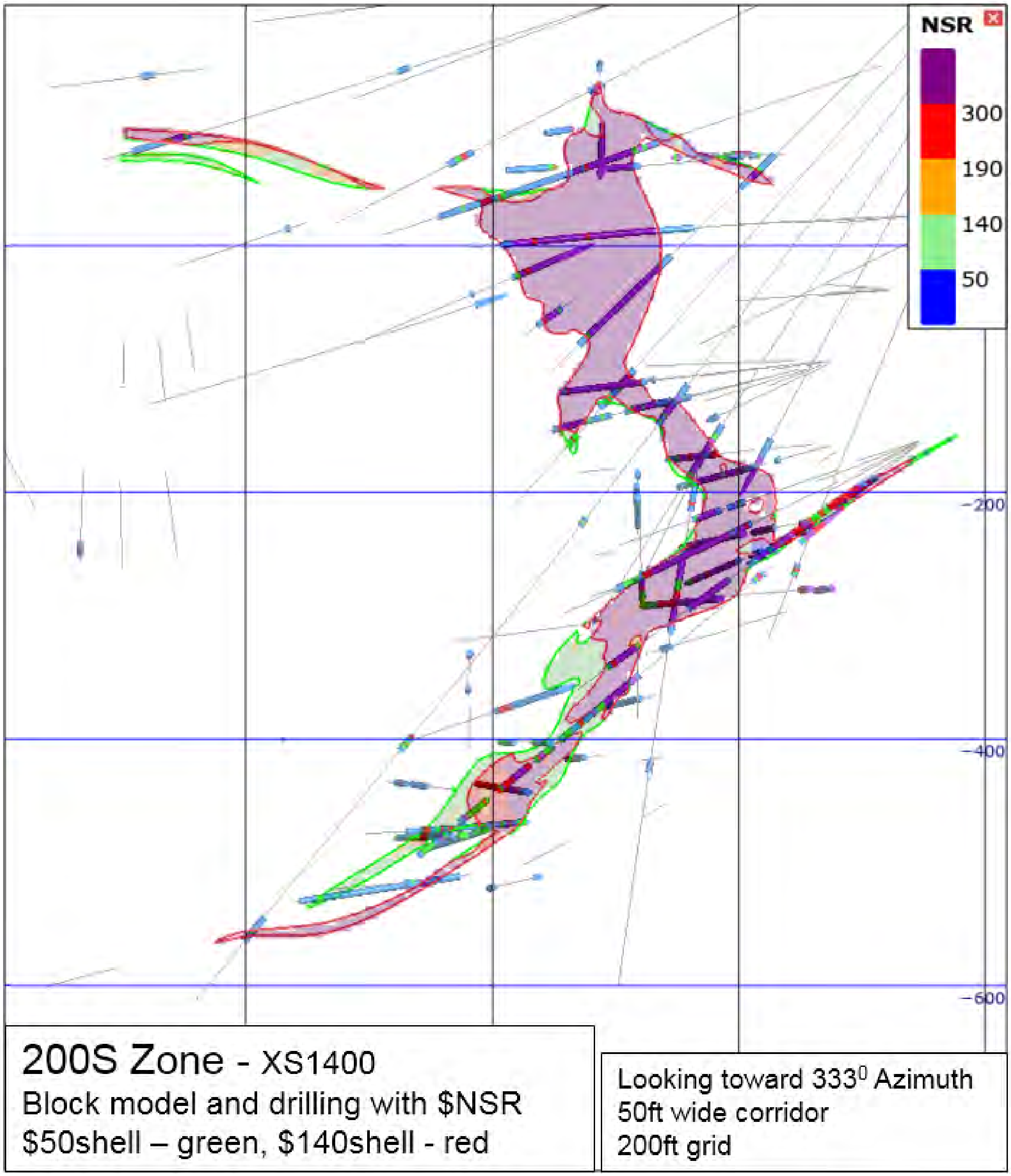


Figure 7-38: 200S Zone - Cross Section 1400



As the 100 Level is mostly mined out, Figure 7-39 is at the -600ft elevation, which is in the deepest area of active mining at Greens Creek. Figure 7-40 is a cross section XS000 through the Deep 200 South Zone showing the relationship of the drilling to the mineral resource block model. Figure 7-41 is a level plan at -800 ft elevation, which is below any historic or active stopes at Greens Creek. Figure 7-42 displays cross section XS-1300 which reaches near the maximum southern extent of definition drilling on the 200 South Zone (and for the entire mine).

At the northern end of the 200 South Zone a mixed group of mineral types are present such as MFB, MFP, WCA and WBA which are interpreted to be localized at an original hydrothermal seafloor vent. At the southern extents of the 200 South Zone baritic material (WBA) dominates with high silver grades. Two to three benches are present with a high angle mine contact on the western side of the deposit which is also mineralized.

A deeper mineralized trend is present below the benches shown in Figures 7-40 and 7-42, at the -1,100 ft elevation. This deeper, poorly explored trend is thought to be the main Greens Creek mineralization trend, and displays hotter, or more proximal, MFP, WSI and MFB mineral types.

Figure 7-39: 200S Zone - Level Plan at -600 Elevation

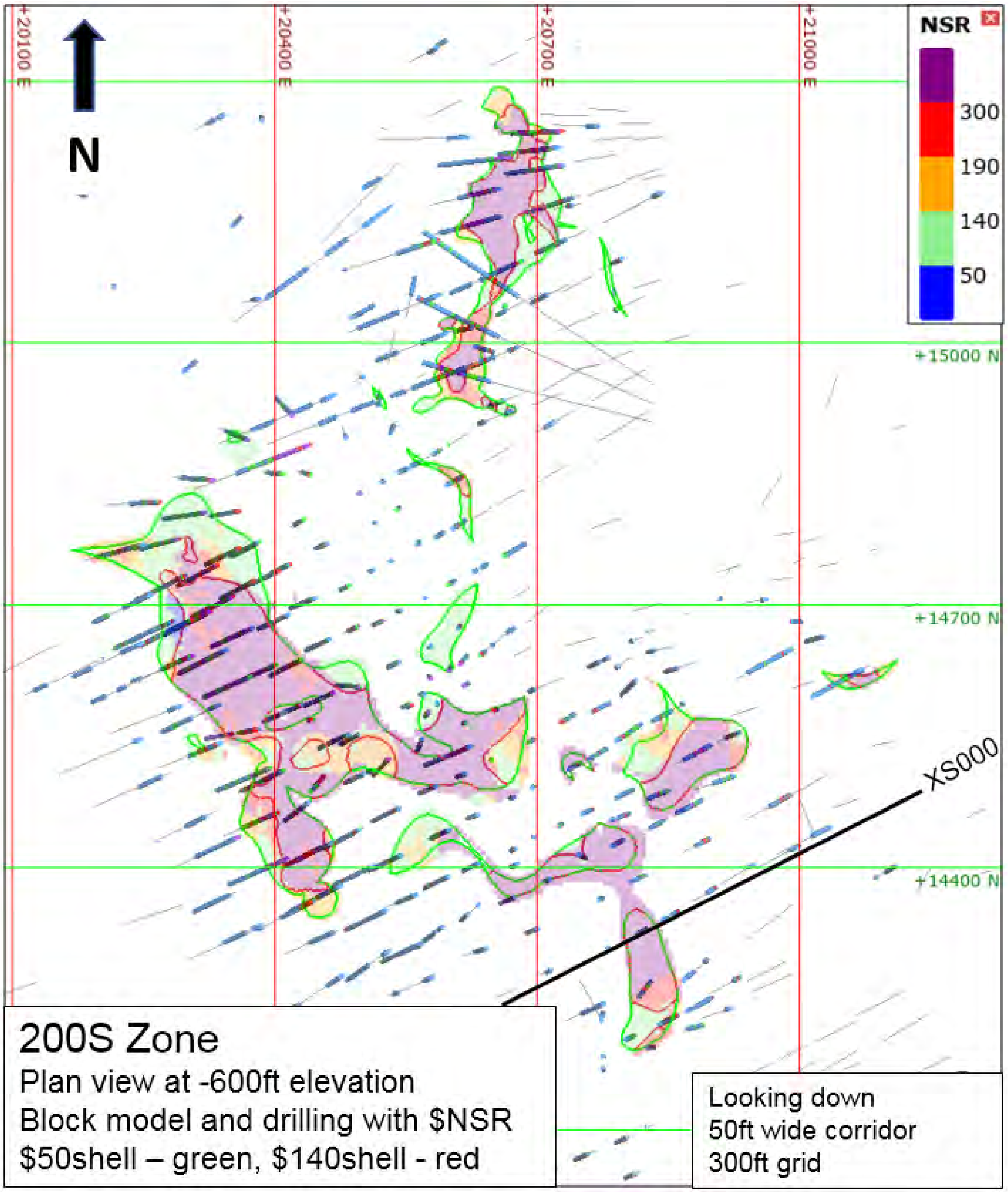


Figure 7-40: 200S Zone - Cross Section XS000

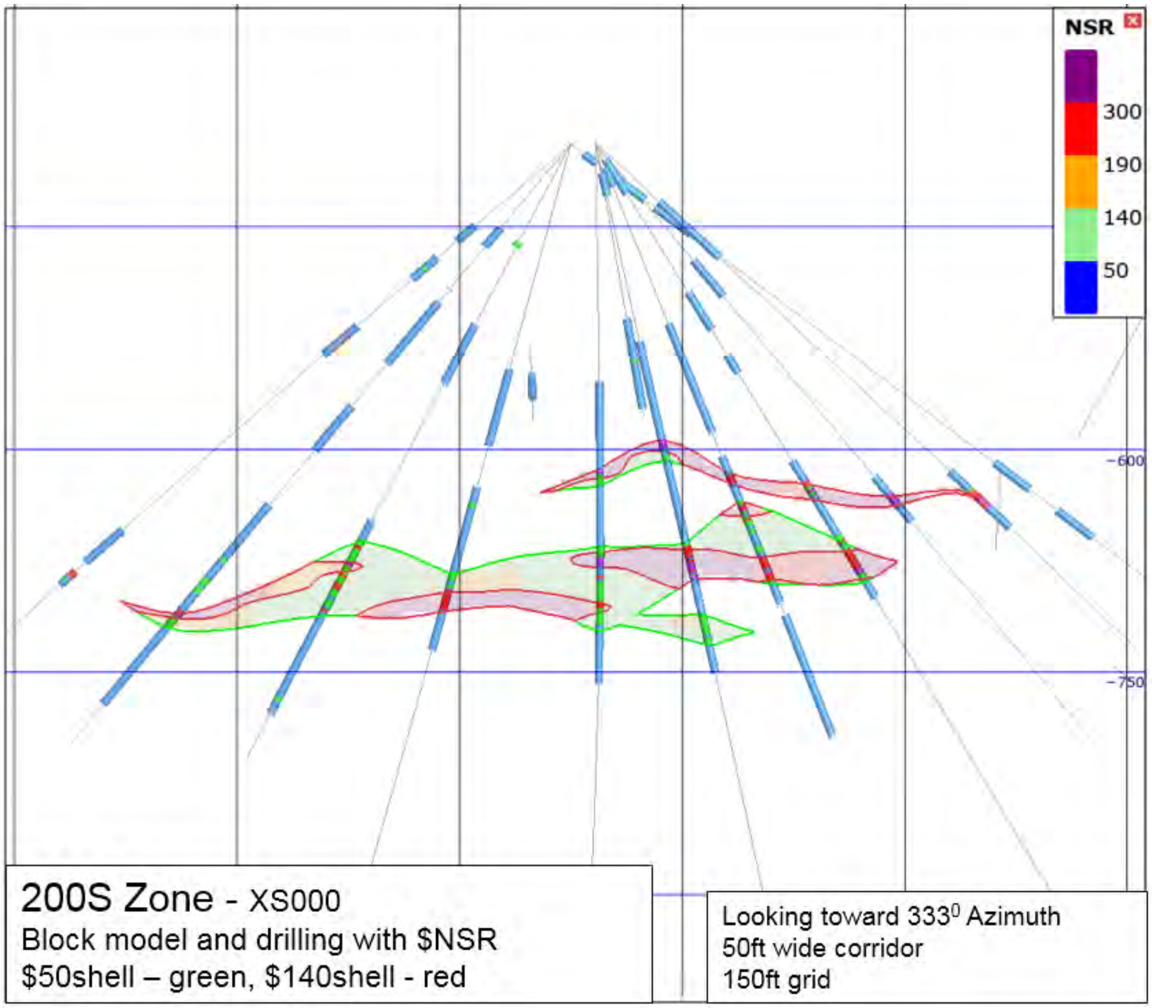


Figure 7-41: 200S Zone - Level Plan - 800 Elevation

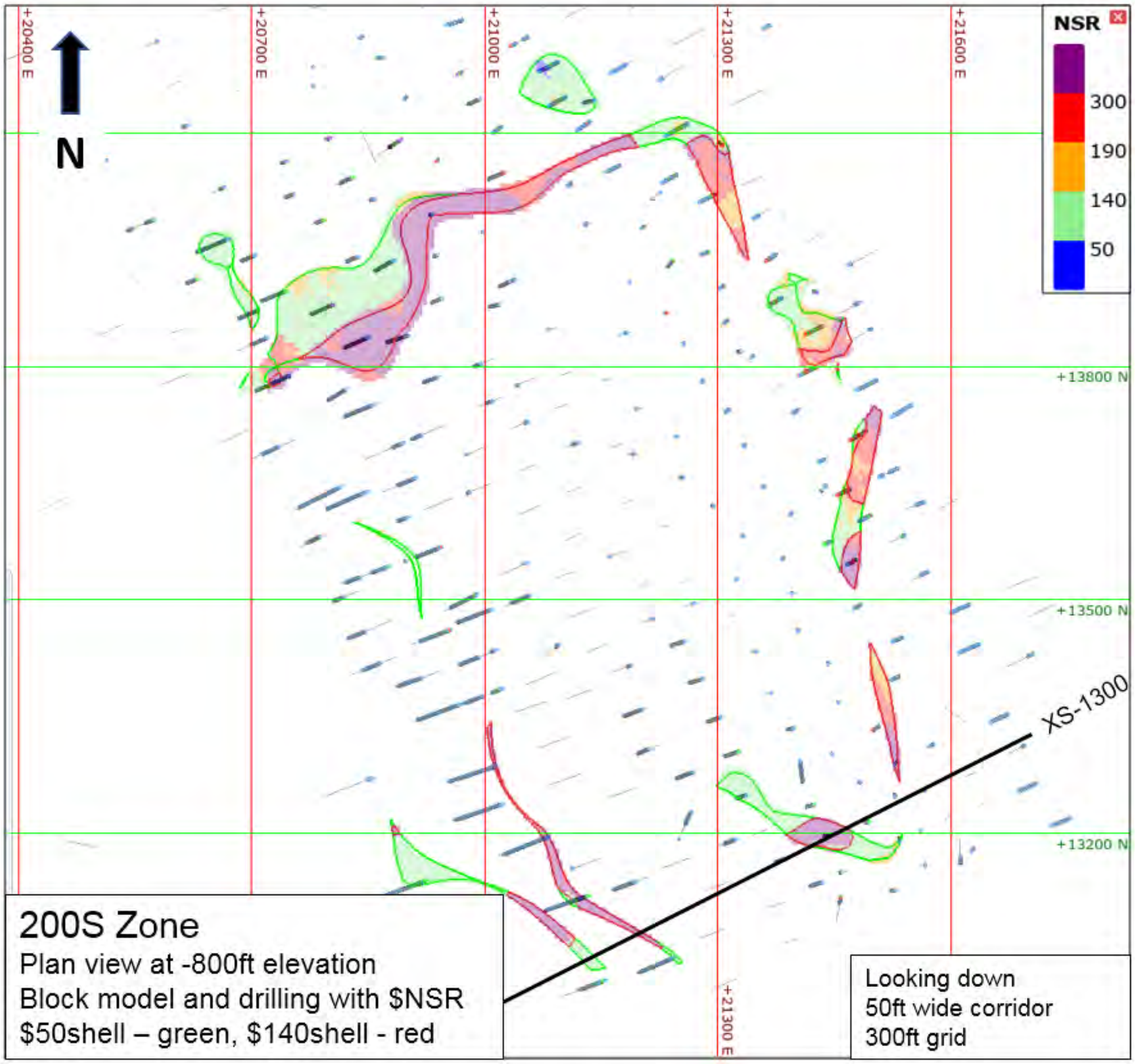
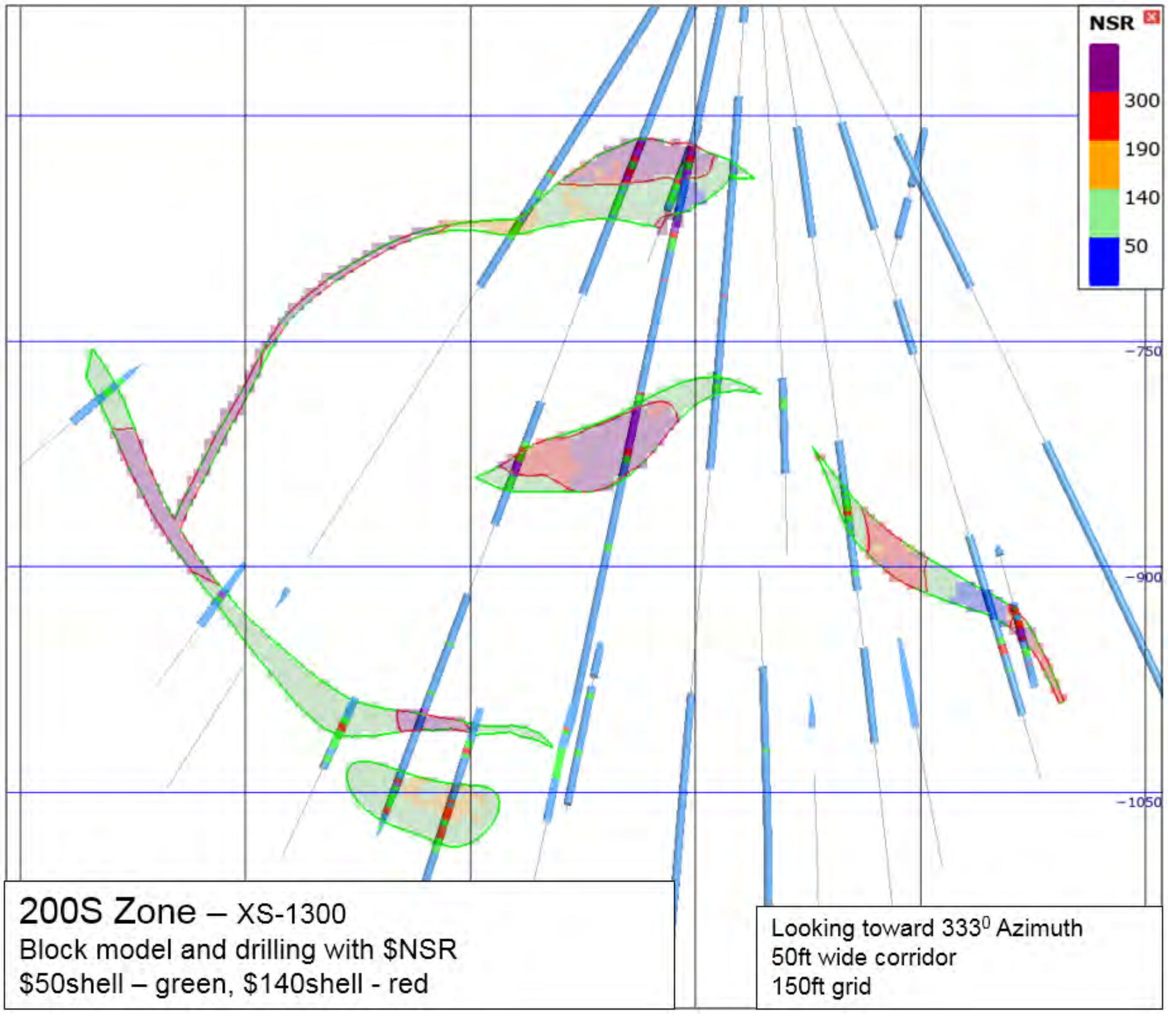


Figure 7-42: 200S Zone - Cross Section XS-1300



7.4.10 Gallagher Zone

The Gallagher Zone is located west of the Gallagher Fault and is the westernmost of the known zones of the Greens Creek Mine (refer to Figure 7-5). The overall Gallagher Zone strikes N70°E and dips 25° SE.

The thickness of the mineralized horizon is highly variable. In the northwest portion of the zone where the horizon is sub-horizontal the true thickness ranges for less than 5 ft (1.5 m) up to a maximum of 15 ft (4.6 m). To the south, where the mineralized horizon becomes conformable to the phyllite/argillite contact the thicknesses typically range from 10 ft (3.0) to 20 ft (6.1 m).

The Gallagher Zone does show some broad-scale zonation patterns with Fe-rich massive mineralization dominate in the lower southern sections, a middle barite-rich relatively metal-poor central section, and a more typical mixture of white and massive mineralization types in the northern sections. As discussed in the 200 South Zone section, the Gallagher Zone appears to be the offset extension of the 200 South Zone across the Gallagher Fault as is evidenced by similarities in structural style and mineral types, and post-D_4/pre-D_5 late Cretaceous dike offset across the fault.

Figure 7-43 displays the mineralized $140 NSR wireframe with definition drilling. Figure 7-44 is a level plan map at the 0 ft elevation showing the mineral resource block model and drilling. Figure 7-45 shows cross section XS-250 through the mineral body.

Figure 7-43: Gallagher Zone - 3D Model

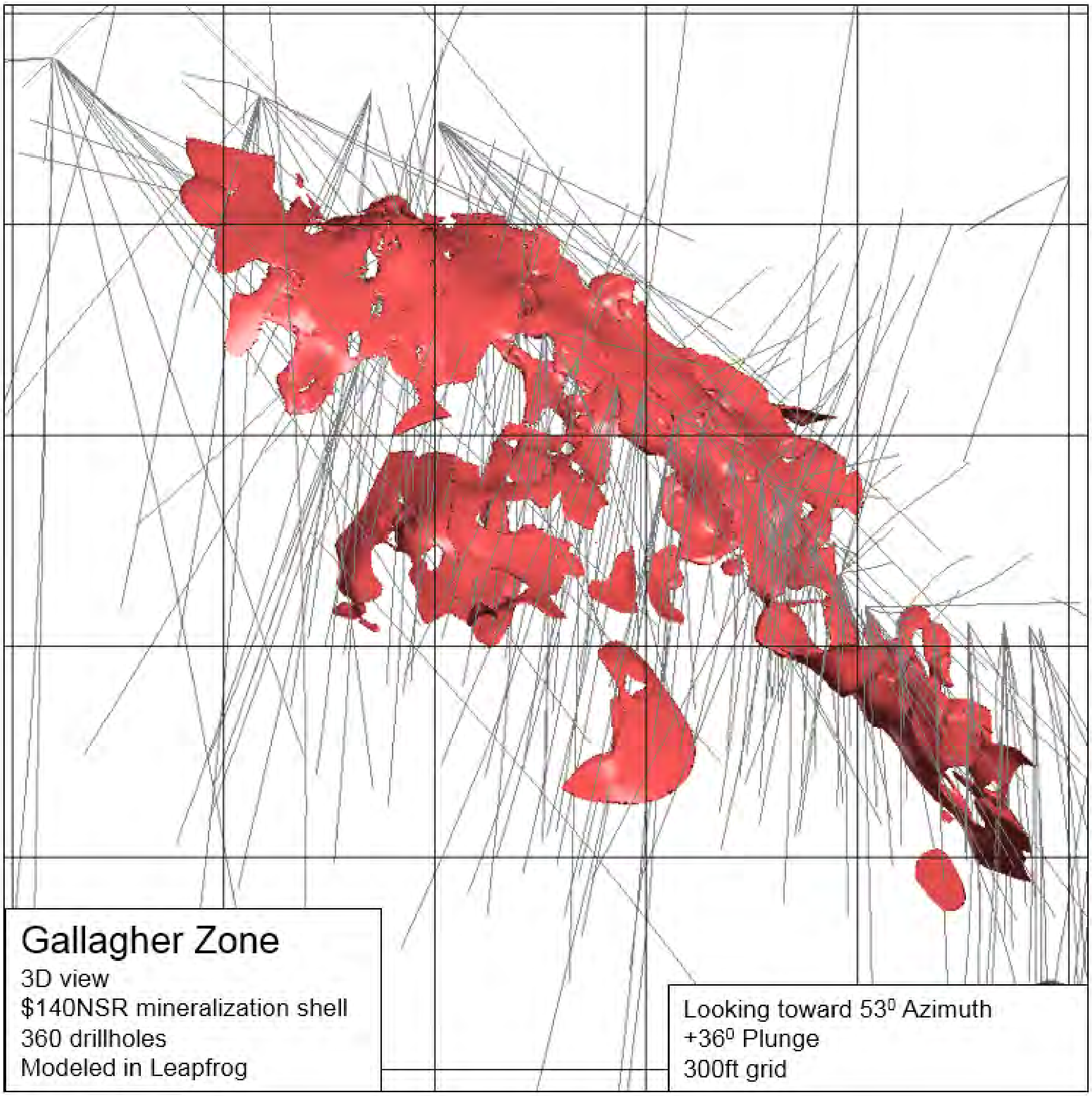


Figure 7-44: Gallagher Zone - Level Plan at 0 ft Elevation

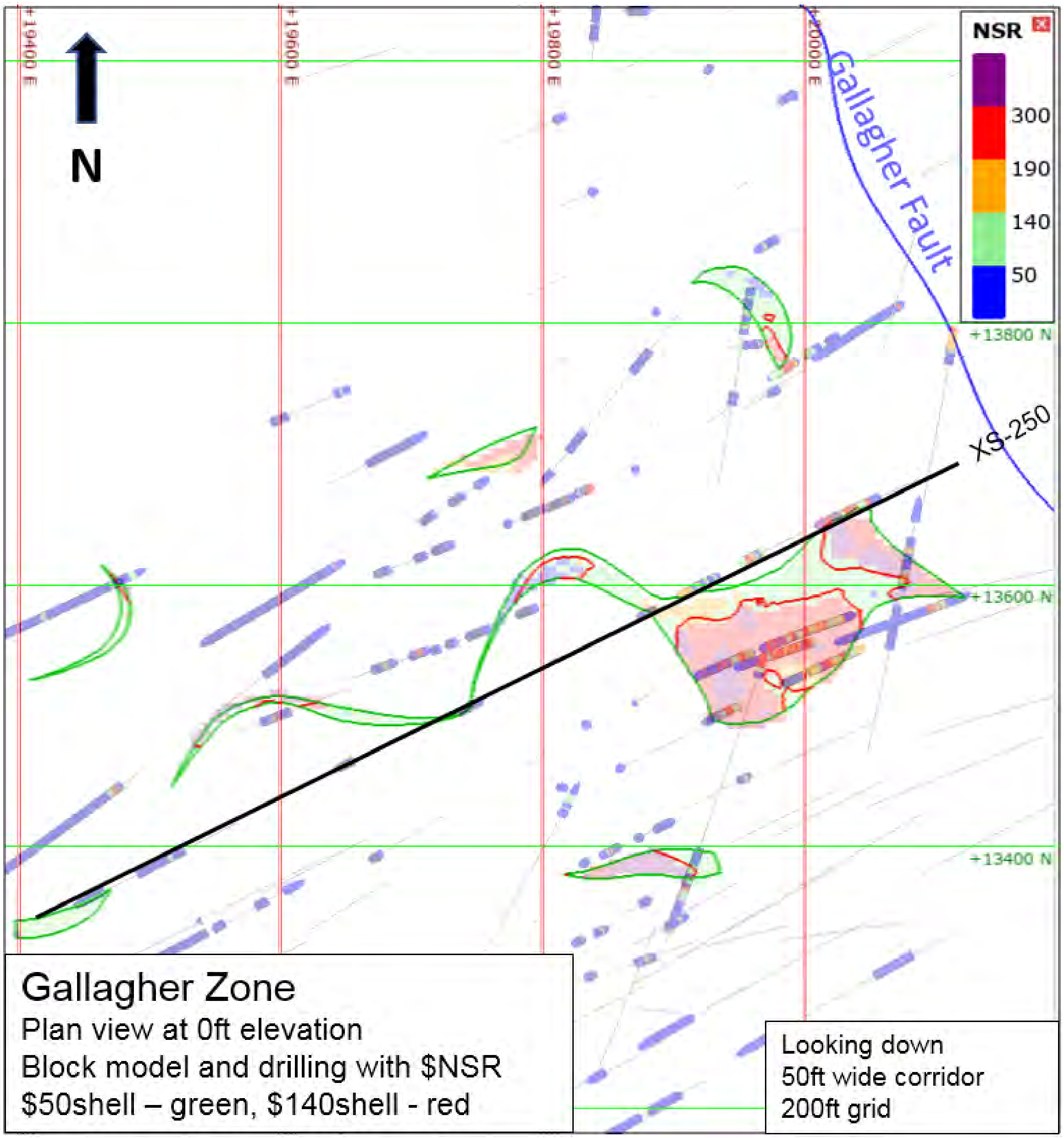
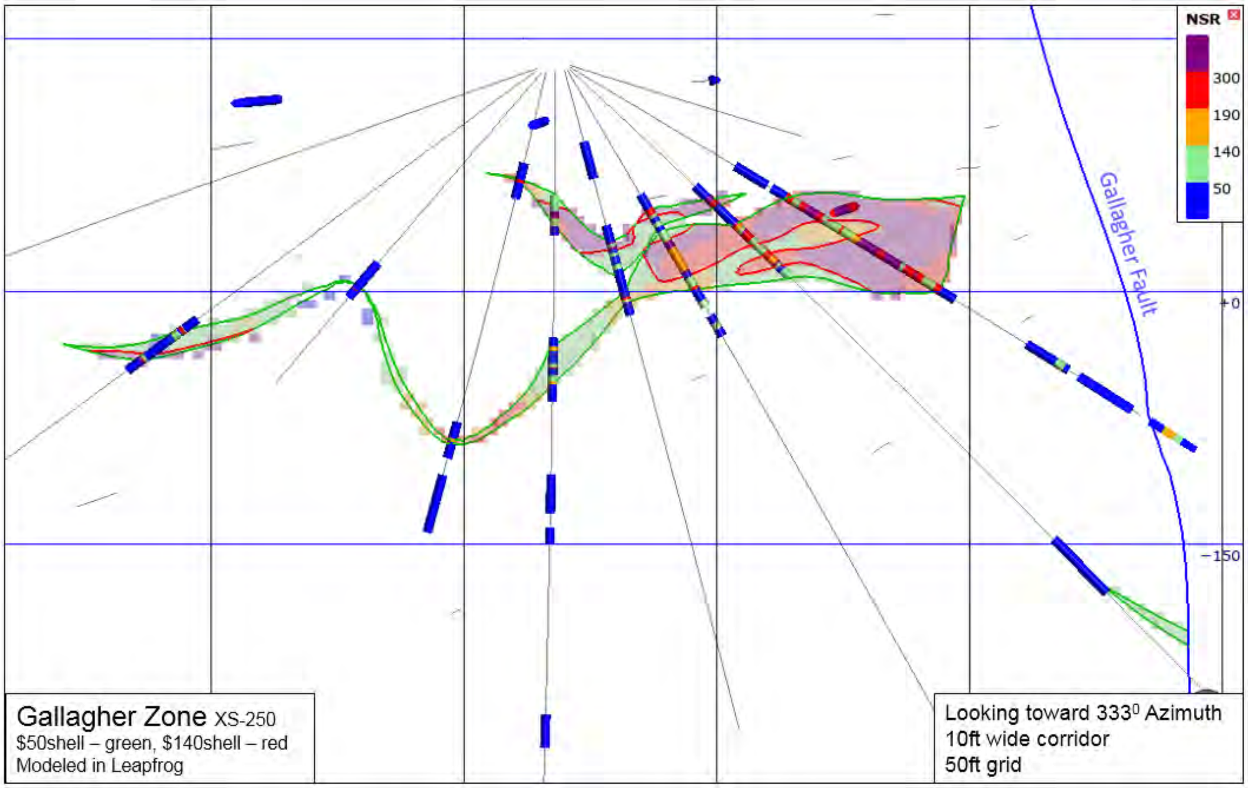


Figure 7-45: Gallagher Zone – Cross Section -250



7.5 Comments on Geological Setting and Mineralization

In the QP's opinion, the geological understanding of the settings, lithologies, structural and alteration controls on mineralization, and mineralization continuity and geometry in the defined mineral zones is sufficient to support estimation of Mineral Resources and Mineral Reserves. The geological knowledge of the area is also considered sufficiently acceptable to reliably inform mine planning. The mineralization style and setting are well understood and support the declaration of Mineral Resources and Mineral Reserves.

Other prospects identified within the Project area (see Section 9.6.7) are at an earlier stage of exploration, and the lithology, structural, and alteration controls on mineralization, as well as the continuity and geometry of the mineralization, are currently insufficiently understood to support estimation of Mineral Resources.

8.0 DEPOSIT TYPES

8.1 Research on Greens Creek Deposit Type

Work by Taylor and Johnson (2010) in the USGS Professional Paper 1763 indicated that the Greens Creek deposit displays a range of syngenetic, diagenetic, and epigenetic features that are typical of volcanic massive sulfide deposits (VMS), sedimentary exhalative (SEDEX), and Mississippi Valley-type (MVT) genetic models. Based on those observations the investigators indicated that the Greens Creek mineral deposit was a 'hybrid' type with elements of several deposit models.

Since that earlier work, two PhD thesis out of the Center for Ore Deposit and Earth Sciences at the University of Tasmania (Sack, 2009, 2016 and Steeves, 2018) have added significantly to the observations available for the deposit from which to evaluate previous interpretations. More mapping of the mineralization, structures and alteration across the claim block has also added to the data from which to classify the deposit.

8.2 Interpretation of the Greens Creek Depositional Setting

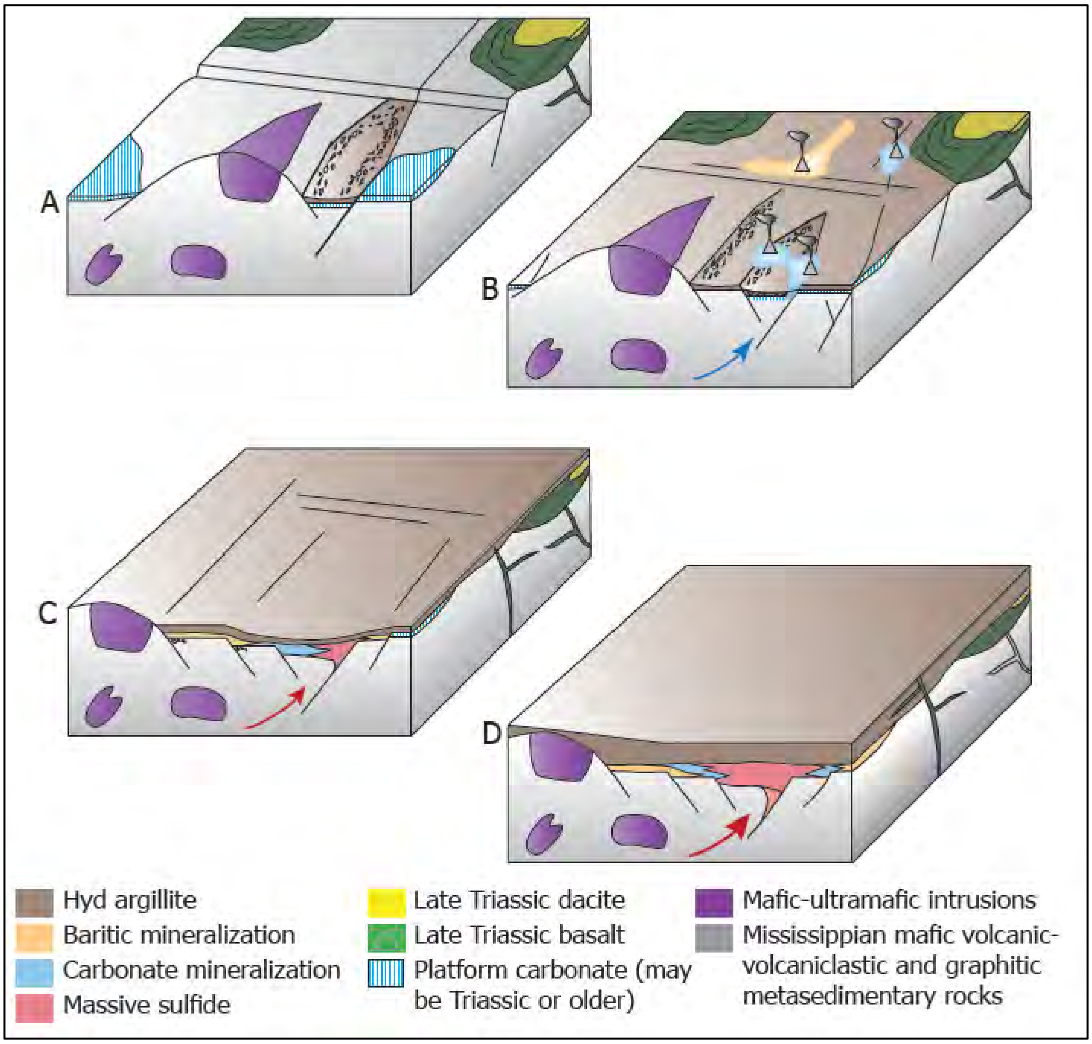
Based on the most recent data, the Greens Creek deposit most fully follows that of a volcanogenic massive sulfide (VMS) deposit (Steeves, 2018). This classification puts the Greens Creek deposit more in line with the other VMS deposits of the Alexander Triassic Metallogenic Belt.

8.2.1 Support for VMS Classification

Characteristics that are displayed at Greens Creek that fit the VMS model include:

- A zinc–lead–silver–gold–copper metal endowment similar to Kuroko-type VMS deposits
- Bimodal volcanism is present in the Triassic, mineralization-age, host lithologies
- A zoned alteration profile with a copper-iron-zinc core grading outward into baritic, precious metal rich fringes and silicified cap
- Presence of quartz-sericite-sulfide stringers in the footwall directly below the massive sulfide accumulations; and massive chloritic alteration around the stringers.
- Mineralogy similar to that of white smoker systems of the southwestern Pacific Ocean. Baritic and carbonate mineral styles with framboidal and colloform pyrite indicate seafloor primary deposition.
- The Greens Creek mineral deposits are within a well-established metallogenic belt where numerous other VMS deposits of Late Triassic age have been identified.

Figure 8-1: Depositional Setting for the Greens Creek Mineral Deposit
(Steeves, 2018)



Earlier investigators accepted the Triassic rifting, deep circulation of seawater and seafloor deposition but pointed to several observations out of line with 'typical' VMS deposits such as:

- An intra-arc setting
- Apparent sub-seafloor replacement mineralization
- Lack of felsic igneous rock and a preponderance of ultramafics
- A lack of focused feeder systems
- Chromium and barium rich silicates and carbonate alteration
- High zinc, lead and silver grades without typical high (several percent) copper grades

Steeves (2018) responds to these arguments using observations from other VMS deposits which have the same characteristics. VMS deposits have been identified in other intra-arc settings whereas SEDEX and MVT deposits tend to form on craton margins only. SEDEX deposits are limited to anoxic basins whereas the argillites of Greens Creek show pronounced negative Ce anomalies and high Y/Ho ratios indicative of oxic conditions in the basin. The abundant barite also argues for oxic conditions in the basin. Sub-seafloor replacement is common at other VMS deposits as well, a condition that only requires longevity of the hydrothermal system post-burial.

Further mapping, drilling and age dating of units has confirmed bimodal volcanism of similar age to the Greens Creek deposit, which is typical for VMS deposits and not SEDEX or MVT deposits. Continued mapping and drilling have located two major feeder systems in the footwall unknown to the earlier investigators, which is understandable as the feeders are sub-parallel to the footwall/hanging wall mine contact and immediately underlie most of the mined zones. As the mafic to ultramafic footwall was enriched in chromium it is not surprising that high chromium is found in the alteration products as well as direct sedimentary input to the base of the Hyd Group.

The main feeder system responsible for Greens Creek has also been shown to be zoned over several miles of strike length with the more copper-rich core north of the mine area. It is only the zinc-rich and copper-poor portion of the feeder system which underlies the mine. Rather than the Greens Creek hydrothermal system being low in copper, only the cooler zinc, lead and silver southern limb was preserved below current topography. Zonation of the preserved mineral deposit shows a hotter core on the northern end and cooler baritic mineral styles on the southern end. The mineral styles do not zone back to cooler types north of the Greens Creek mineral body but were eroded off above the copper rich feeder zone north of Greens Creek.

Steeves (2018) also argues that the enrichment of gold, silver, zinc and lead are incompatible in a typical low temperature SEDEX type deposit as the solubility of gold is inverse to the other metals given chloride and bi-sulfide complexing activities, and therefore could not explain the rich endowment of all the metals at Greens Creek. Steeves also explains the exceptional metal budget of high gold with high silver, zinc and lead as being derived from Devonian – Mississippian mafic metavolanics (CR, SP) and graphitic metasedimentary (SPgr) footwall rocks enriched in the metals.

In summary data obtained since the original USGS (2010) publication explains the apparent incongruities of the Greens Creek deposit relative to other VMS deposits. The only remaining oddity is that the Greens Creek deposit formed directly on a 100Ma unconformity, a very unique stratigraphic location for a VMS deposit. There is no reason why the VMS system shouldn't form at this stratigraphic location however, and some have proposed that the conglomerate at the unconformity may have been a permeable aquifer for the hydrothermal fluids creating the deposit.

The QP concurs with the interpretation that the Greens Creek mineral deposit is of the VMS type and consider the model and interpreted deposit genesis to be appropriate to support exploration activities.

9.0 EXPLORATION

Historical exploration activities at the Greens Creek project prior to Hecla's acquisition of the land package in March 2008, are extensive. Exploration commenced in 1973. A complete overview of exploration activities at Greens Creek, including work completed by Hecla since its acquisition of Greens Creek in 2008, is included in Table 6-1.

This section focuses mainly on exploration activities since Hecla acquired sole possession of the property. Hecla's exploration targeting and activities have been built upon refined historical exploration data combined with more recent systematic exploration data.

Since 2008, Hecla has completed surface and underground core drilling programs (see Section 10), auger and MMI soil geochemistry, ground and borehole pulse electromagnetic (EM) geophysical surveys, and historic survey compilation. Reconnaissance and detailed scale geologic mapping have been done by Dr. Norm Duke, Dr. John Proffett, and various Hecla staff geologists. These exploration programs are summarized in Table 9-1.

9.1 Grids and Surveys

The original regional identification of the Greens Creek deposit was likely done with USGS topographic maps. The USGS quadrangle maps from this period use the horizontal North American Datum of 1927 (NAD27).

By 1977 an assumed or local plane grid was developed for the immediate area surrounding the Big Sore. This grid is orthogonal to true north and is still in use for all current underground surveying and is referred to as the "mine grid".

A second assumed grid was also developed prior to commencement of the underground drill program in 1978. This grid was rotated 26° 33' 54'' W (counter-clockwise) of the mine grid to parallel the average strike of the East Zone. The origin was offset to the southwest of the East Zone. This grid, known as the "geo-grid", is still in use for planning drillhole layouts, sectional geologic interpretations and mineral resource modeling. All grid coordinates are in U.S. Geological Survey Feet. The coordinate transform coefficients for conversion from/to mine grid to geo-grid are shown in Table 9-2.

Beginning in 1983 the horizontal datum was changed from NAD27 to North American Datum of 1983 (NAD83). All surface exploration mapping, geochemistry grids, drill collars and geophysical surveys exist in both NAD27 and the NAD83 datum. Affine transform parameters used for coordinate transformation of mine grid to Alaska State Plane Zone 1, NAD83 are shown in Figure 9-3.

Table 9-1: Summary Table of Hecla Greens Creek Exploration Activities 2008-2018

Year	Exploration Activity	Contractor	Exploration Activity Completed	Purpose	Results
2008	Geologic Mapping	John Proffett, Norm Duke, Greens Creek Exploration Staff	Reconnaissance and detailed geologic mapping	Reconnaissance mapping for extensions of mine contact, originating from a known favorable target area into unknown areas. Detailed mapping for refining targets, identified from regional mapping and geochemical anomalies.	Reconnaissance mapping resulted in expansion of the known mine contact. Detailed mapping began to bring an understanding of the Killer Creek target area.
	Soil Geochemistry	Greens Creek Exploration Staff	658 auger soil geochemical samples and 658 MMI soil geochemical samples along 67,800 feet of gridlines in the Young Bay area.	Begin to identify geochemical anomalies in the Young Bay area.	Minor soil anomalies identified.
	Core Drilling	Connors Drilling	15 underground core holes totaling 9,935 feet. 18 surface core holes totaling 20,649 feet.	Surface drilling in North Big Sore, East Ridge, East Lil Sore, Cub, and Young Bay targets. Underground drilling to expand mineral resources.	Surface drilling advanced geologic and geochemical knowledge of the target areas. Underground drilling expanded mineral resources.
2009	Geologic Mapping	John Proffett, Norm Duke, Greens Creek Exploration Staff	Reconnaissance and detailed geologic mapping	Reconnaissance mapping for extensions of mine contact, originating from a known favorable target area into unknown areas. Detailed mapping for refining targets, identified from regional mapping and geochemical anomalies.	Reconnaissance mapping resulted in expansion of the known mine contact. Detailed mapping included interpretation of cross-section in the area of the Northeast Contact.
	Core Drilling	Connors Drilling	20 underground core holes totaling 18,064 feet. 4 surface core holes totaling 8,292 feet.	Surface Drilling to test the Northeast Contact. Underground drilling to expand mineral resources.	Surface drilling intersected repeated folds of the Northeast Contact as expected. Underground drilling expanded mineral resources.
2010	Geologic Mapping	John Proffett, Norm Duke, Greens Creek Exploration Staff	Reconnaissance and detailed geologic mapping	Reconnaissance mapping for extensions of mine contact, originating from a known favorable target area into unknown areas. Detailed mapping for refining targets, identified from regional mapping and geochemical anomalies.	Reconnaissance mapping resulted in expansion of the known mine contact. Detailed mapping focused in the Killer Creek target area and assisted in definition of the geologic interpretation for drilling in 2011 and 2012.
	Soil Geochemistry	Greens Creek Exploration Staff	580 auger soil geochemical samples and 580 MMI soil geochemical samples taken in the North Young Bay area.	To identify geochemical anomalies in the Young Bay area.	Minor soil anomalies identified.
	Core Drilling	Connors Drilling	25 underground core holes totaling 31,464 feet. 17 surface core holes totaling 21,217 feet.	Surface drilling continued testing the Northeast Contact, Killer Creek, and East Ridge targets. Underground drilling to expand mineral resource.	Surface drilling continued to define the Northeast Contact and the one hole in the Killer Creek target intersected anomalous silver and zinc mineralization. Underground drilling expanded mineral resources.

Year	Exploration Activity	Contractor	Exploration Activity Completed	Purpose	Results
2010	Geophysics	Ken Robertson	Compilation of Historic Geophysical Data	To identify geophysical survey methods that could be effective in future work	Results from this compilation re-defied the Killer Creek target area as a priority for exploration. This target had been drilled by Noranda Exploration in the late 1970's then abandoned when the Greens Creek deposit was discovered.
2011	Geologic Mapping	John Proffett, Norm Duke, Greens Creek Exploration Staff	Reconnaissance and detailed geologic mapping	Reconnaissance mapping for extensions of mine contact, originating from a known favorable target area into unknown areas. Detailed mapping for refining targets, identified from regional mapping and geochemical anomalies.	Reconnaissance mapping resulted in expansion of the known mine contact. Detailed mapping focused in the Killer Creek and upper Bruin Creek target area and assisted in definition of the geologic interpretation for drilling in 2011 and 2012.
	Soil Geochemistry	Greens Creek Exploration Staff	818 auger soil geochemical samples taken in the North Young Bay area.	To identify geochemical anomalies in the Young Bay area.	Minor soil anomalies identified.
	Core Drilling	Connors Drilling	28 underground core holes totaling 38,098 feet. 14 surface core holes totaling 27,384 feet.	Surface drilling continued testing the Northeast Contact, West Bruin Contact, and East Ore targets. Underground drilling to expand mineral resources.	Surface drilling continued to define the Northeast Contact and began to define the West Bruin Contact and the East Ore target. Underground drilling expanded mineral resources.
	Geophysics	Ken Robertson, Techno Imaging, and Crone Geophysics & Exploration Limited	3D Inversion of 340-line kilometer subset of the 1,227 line-kilometers from the 1996 Aerodat Ltd frequency domain electromagnetics survey. Borehole Pulse Electromagnetic Surveys at Killer Creek target	3D Inversion analysis on a portion of the historic Aerodat data was completed to identify overlooked anomalies. Surface and Borehole Pulse EM surveys were used to define EM anomalies identified from the 3D Inversion	3D Inversion re-identified the Killer Creek conductor. Pulse EM defined the re-identified conductor in sufficient detail for exploration drilling.
2012	Geologic Mapping	John Proffett, Norm Duke, Greens Creek Exploration Staff	Reconnaissance and detailed geologic mapping	Reconnaissance mapping for extensions of mine contact, originating from a known favorable target area into unknown areas. Detailed mapping for refining targets, identified from regional mapping and geochemical anomalies.	Reconnaissance mapping resulted in expansion of the known mine contact. Detailed mapping focused in the Killer Creek target area and assisted in definition of the geologic interpretation for drilling in 2012.
	Soil Geochemistry	Greens Creek Exploration Staff	253 auger soil geochemical samples taken in the North Young Bay area.	To identify geochemical anomalies in the Young Bay area.	Minor soil anomalies identified.
	Core Drilling	Connors Drilling	24 underground core holes totaling 20,817 feet. 8 surface core holes totaling 17,710 feet.	Surface drilling to test the Killer Creek and West Gallagher target areas. Underground drilling to expand mineral resources.	Surface drilling in the Killer Creek target identified a broad copper-rich vein zone varying from 2.1 to 7.0 feet and accompanying values up to 7.0%Cu and 5.0 opt Ag. This area is interpreted to be the center of a mineralizing vent. Underground drilling expanded mineral resources.
	Geophysics	Ken Robertson	Review of 2011 geophysical survey results	To propose additional geophysical survey if needed.	Still in review.

Year	Exploration Activity	Contractor	Exploration Activity Completed	Purpose	Results
2013	Core Drilling	Falcon Drilling	Ten surface drillholes totaling 28,746 feet at the Killer Creek target	Continuation of 2012 program testing extent of shallow and broad copper and zinc-rich zones in the area.	Zoned Copper and Zinc-rich extents further defined as potential for higher-grade mineralization in the area.
	Geologic Mapping	John Proffett, Norm Duke and Exploration Staff	Reconnaissance mapping of the anomalous Zinc Creek area and detailed structural mapping of Mariposite ridge	Continued mapping of major s2.5 shears north and west of known locations. Mapping mine contact and associated mineralization north of Zinc Creek and along Mariposite ridge (east and west of Mammoth claims).	Large and silicified shear zone mapped north and west along mariposite ridge. Mine contact was expanded from Lower Zinc Creek to Upper Zinc Creek-Lakes District.
2014	Core Drilling	Falcon Drilling	Six surface drillholes totaling 23,214 feet in the Killer Creek target area	Continuation of 2013 program testing extent of shallow and broad copper and zinc-rich zones and exploring for mine contact at Killer Creek target.	A deep mine contact was intercepted in five drillholes likely corresponding to the 'Deep mine syncline' below the 'Mine syncline' and associated mineralization at the mine. This contact was weekly mineralized.
	Geologic Mapping	John Proffett, Norm Duke and Exploration Staff	Reconnaissance mapping of the Killer-Lakes district area and detailed structural mapping of the Killer Creek - Mammoth areas	Reconnaissance mapping to determine extensions of Mine Contact and mineralization in the Lakes District and Killer Creek areas. Detailed mapping of s2.5 shears and mineralization in the Mammoth and Killer Creek areas.	Expanded known mine contact in the Zinc Creek area north and east into the Lakes District. Detailed mapping of mineralization in the Killer Creek target yielded a better understanding the habit and orientation of mineralization.
	Geophysics	SJ Geophysics	One downhole EM survey was conducted in Killer Creek to define mineralization and 'mine contact' in the area	Determine geometry of possible mine contact and mineralization in the Killer Creek area.	Recognized district deep mine contacts and alteration changes between lithologies though no sulfide horizons were outlined from the survey.
2015	Core Drilling	Falcon Drilling	Four surface drillholes totaling 8,085 feet were completed in the Lower Killer Creek and High Sore target areas	Exploring for offset mineralization east of known East Ore mineral resource and across Cub and High Sore Faults. Test the Big Sore syncline in Lower Killer Creek target between the Gallagher and Maki Faults.	Several bifurcating s2.5 shears were intercepted in the High Sore drillholes though no offset mineralization was found. A weakly mineralized Big Sore syncline was encountered at depth north of known mineralization.
	Geologic Mapping	John Proffett and Exploration Staff	Mapping of the High Sore and Big Sore areas with a focus on local s2.5 shears	Mapping s2.5 age shears east of known intercepts and mineralization/mine contact in Big Sore Creek.	Detailed orientation of local $S_{2.5}$ shearing in High Sore prospect and down into the Big Sore drainage was captured.
	Geophysics	Exploration Staff	Physical property data (density), Magnetic Susceptibility and conductivity measurements were taken in every drillhole	Provide base-line data for future surveys	Collected data for all units not just mineral lithologies which will further refine future geophysical surveys.
2016	Core Drilling	Falcon Drilling	Two surface drillholes totaling 3,074 feet were completed in Big Sore Creek area	Testing offset East Ore mine contact and mineralization east of the Cub Fault and known mineral resource.	One drillhole intersected expected East Ore mineralization close to surface. Drilling east of known East Ore Zone mineralization and targeting displaced mineral across the Cub Fault intersected anomalous zinc mineralization in hanging wall argillite nearing a likely eroded mine contact. A barren Northeast contact was also encountered in each drillhole.

Year	Exploration Activity	Contractor	Exploration Activity Completed	Purpose	Results
2016	Geologic Mapping	Exploration Staff	Reconnaissance mapping of Big Sore Creek, and Lil Sore areas and east of the Mammoth claims was completed.	Verify historic mapping in the Big Sore Creek area and follow extents of shearing at East and West of the Mammoth claims. Map geochemical anomaly at Lil Sore prospect and sample Rhyolite occurrence.	Mapping in the Big Sore Creek drainage confirmed no mine contact was present where historical mapping showed. Several s2.5 shears, known to offset mineral at the mine, were mapped north and west of Mammoth Ridge. Further defined mine contact at Lil Sore Rhyolite and determined unit is Devonian.
2017	Core Drilling	Falcon Drilling	Nine drillholes totaling 20,419 feet were completed in the West Gallagher, Upper Gallagher and Big Sore prospects.	Testing potential western extents of Southwest bench mineralization east of the Gallagher Fault, offset 'Bench' mineralization west of the Gallagher Fault, and southern extents of the East Ore and 5250 zones of the mine.	Five drillholes targeted west of the Gallagher Fault for offset 'Bench' mineralization in the mine while one drillhole targeted western extensions of the Southwest Bench Zone east of the Gallagher Fault. Broad zinc mineralization was encountered at the 'Bench' Contact west of known mineral resource east of the Gallagher Fault and higher-grade mineralization was encountered west of the Gallagher Fault within the interpreted Klaus Shear. Drilling south of the mine in Upper Gallagher targeting southern extensions of the 5250 Zone encountered a weakly mineralized mine contact. Drilling south of the Big Sore target area tested southern continuations of the East Ore Zone between the Kahuna and Maki Faults. No mine contact was encountered in this area. A single 5250 drillhole tested a mineralized anticline 2,000 feet south of known mineral resource and above the 200S zone. No significant mineralization was encountered.
	Geologic Mapping	Exploration Staff	Mapping was completed in the Lower Zinc Creek area with a focus on $S_{2.5}$ shearing.	Determine location of 'Zinc Creek Thrust' and link with structures seen north and east in North Mammoth.	Location of 'Zinc Creek Thrust' changed.
2018	Core Drilling	Timberline Drilling	Fifteen drillholes totaling 20,941 feet were completed in the West Gallagher and Lower Gallagher Areas targeting Southwest Bench - 200S Bench and the Upper Plate Zone respectively.	A continuation of the 2017 program testing for western extensions of 'Bench' Mineralization east and west of the Gallagher Fault and western extensions of the Upper Plate Zone.	Upper Plate ore-grade mineralization was extended 150 feet west of known mineral resource on either limb of a flat-lying F_2 fold. Four drillholes further defined western extensions of 'Bench' mineralization east of the Gallagher Fault and west of known mineral resource. Mineralization is generally broad and zinc-rich at or near the 'Bench' mine contact. One drillhole was extended to test the 'Deep Mine Syncline' below known mine mineralization. This drillhole intersected a very silicified and pyrite-rich footwall immediate to the mine contact with trace base metal mineralization.
	Geologic Mapping	John Proffett and Exploration Staff	Detailed mapping was completed in the Upper Gallagher and Mariposite ridge west of Gunsight pass.	Map conglomerate units of Upper Gallagher and extend mapping south along the Gallagher Ridge. Link mapping of units and structures in Upper Zinc Creek and Northwest Mammoth.	Collected several conglomerate samples for detrital zircon analysis to determine if they are of similar age to the basal conglomerate of the mine. Extended mapping of mine contact west of Mammoth Ridge.

Table 9-2: Coordinate Transform Coefficients to Convert from/to Mine Grid to Geo-Grid

Origin Offset in US Survey Feet		
	Mine grid	**Geo-grid**
X (Easting)	0.00	17438.42
Y (Northing)	0.00	12635.93
Z (Elevation)	0.00	0.00
Rotation Angle (deg)		
ATAN(1/2)=	-26.56505	

Table 9-3: Affine Transform Parameters Used for Coordinate Transformation of Mine Grid to Alaska State Plane Zone 1, NAD83

Horizontal Conversions: State Plane to Mine Grid		
Formulas	**Coeff.**	**Value**
	a	1.000097656
X' = ax + by + c	b	-0.010449167
Y' = dx + ey + f	c	-2455614.471
x,y (state plane)	d	0.010566122
(X',Y') calc mine grid	e	1.000969256
	f	-2290833.4
Horizontal Conversions: Mine Grid to State Plane		
Formulas	**Coeff.**	**Value**
	a	0.999792212
X' = ax + by + c	b	0.010435993
Y' = dx + ey + f	c	2479013.084
x,y (mine grid)	d	-0.010553352
(X',Y') calc state plane	e	0.998919067
	f	2262447.0
Vertical Conversions		
Grid to MLLW	-61.11	
MLLW to Ortho	-3.742	

9.2 Geological Mapping

Mapping at Greens Creek has been ongoing since 1976. A basic understanding of the lithologic units was first gathered from early drillholes in the Big Sore Creek area immediately east of the current mine. In 1977, a Noranda geologist, John Dunbier, realized that the mineralized zone was at a lithologic contact between argillite and tuffites (the tuffites were later recognized as phyllites). This lithologic contact has been dubbed the "Mine Contact". To date, over 30 miles (48 km) of Mine Contact have been identified through mapping efforts and less than 10 miles (16 km) have been tested by diamond drilling.

Figure 7-3 in Section 7 displays a compilation of mapping undertaken from 1974 through to the present day. The map has been compiled from different sources and has changed over time as new data are available. The major contributors to this regional geology map are Paul A. Lindberg, Norman A. Duke, John M. Proffett, Andrew W. West, Paul W. Jensen, and Christopher D. Mack.

Dr. Paul Lindberg made mapping contributions from 1995–2000. His efforts are reflected in the current geological understanding of the deposit and through numerous cross-section interpretations. On the regional map, Dr. Lindberg's mapping is visible in the Mariposite Ridge prospect area, Upper Gallagher, East Lil' Sore and Upper Big Sore Basin prospects; his maps range from a very detailed 1:200 scale to 1:10,000 metric scale.

Dr. Norm Duke has been responsible for the regional (1:10,000) metric scale mapping of the geology at Greens Creek from 1995 through 2014. His regional mapping sheets are usually the first observations made in an unknown area and influence future decisions for follow-up efforts. It is in part through Dr. Duke's efforts that the Mine Contact has been extended for the distance it has. Dr. Duke has covered most of the land package north of Greens Creek.

Dr. John Proffett conducts detailed mapping at 1:24,000 scale. His contributions have been in both underground and surface mapping with structural interpretations. Dr. Proffett started with a month of mapping in 1987, with mapping of the 1350 drift in the underground. After 1987, Dr. Proffett did not return to the Greens Creek property until 1996. Since that time, he has mapped at Greens Creek every year to the present. His areas of focus have been Big Sore Basin, Upper Big Sore Ridge, Upper Big Sore, Lakes District, High Sore, Cliff Creek, Big Boil, Killer Creek and the underground mine.

Andrew West, Greens Creek's exploration superintendent from 1998 to January 2011, contributed to the map shown in Figure 7-3 in portions of the Upper and Lower Zinc Creek areas as well as in the Cub Creek, Bruin Creek, Little Sore, and Gallagher prospects. His mapping was also performed at 1:24,000 scale.

9.3 Soil Sampling

Table 9-4 summarizes the soil sampling programs since 1974. The auger and MMI soil geochemistry maps shown in Figures 9-1 and 9-2 are contours of the silver in auger drilling and silver in MMI data respectively. Additional maps reflecting contoured values for gold, lead, zinc, and copper have also been developed.

The auger soil sampling grids cover every prospect from the southern to the northern boundaries within the Greens Creek's land package. Within each prospect, the grid spacing of samples is 100 ft (30 m) apart along grid lines spaced 300 ft (90 m) apart, which originate from an established baseline. Standard auger soil samples are taken at each station. All soil campaigns were successful in delineating geochemical anomalies within many of the prospects.

Since 2008, Hecla has continued investigating the land package for economic mineral potential by compiling historical rock and soil geochemistry into comprehensive maps.

Most recent efforts focus on developing soil geochemistry from within the North Young claim group. Prior to 2008, Mine Contact lithologies were identified by regional scale mapping within this area. This mapping successfully extended the contact 9,500 ft (2,896 m) in the district, warranting further follow-up exploration. This included establishing a soil-sampling grid over the contacts' location and flanks. So far, the sampling has revealed some small anomalies which will be followed-up by in-fill sampling in order to develop targets. Hecla has mostly employed the use of inductively coupled plasma mass spectrometry (ICP-MS) analyses for 53 elements within this area. However, in 2010–2011 the use of MMI analysis was used on samples taken within the Greens Creek land boundary.

A total of 1,443 MMI and 2,309 auger soil samples have been collected since 2008. Results of the exercise suggested several single point anomalies within the soil data. Overall, the soil data points to the East Lil' Sore, Killer Creek, Gallagher Creek, and Bruin Creek target areas as the best surface geochemical targets. The soil geochemical data also appears to identify the two main structural trends dominated by the northwest-trending Maki and Gallagher Fault systems. The data also indicate that precious metals appear to favor the Maki Fault system and the base metals have a stronger relationship with the Gallagher Fault system.

Table 9-4: Summary Table of Greens Creek Sampling Activities 1974-2018

Year	Exploration Activity	Contractor	Exploration Activity Completed	Purpose	Results
1974	Soil geochemistry	Watts, Griffis and McQuat, Inc.	Initial soil geochemical sampling in Big Sore	Define anomalies in the Big Sore target	Defined numerous silver-zinc anomalies.
1975	Soil geochemistry	Watts, Griffis and McQuat, Inc.	Expansion of the soil geochemical sampling grid at Big Sore	Expansion of the previous Big Sore soil grid	Expanded soil anomalies in the Big Sore area.
1976	Soil geochemistry	Noranda	Soil geochemical sampling at Gallagher and Killer Creeks	Expand soil sampling coverage in Gallaher and Killer Creek areas	
1977	Soil geochemistry	Noranda	Soil geochemical sampling at Big Sore, Gallagher, Killer Creek, Zinc Creek, and Mariposite Ridge.	Expand soil sampling coverage in all of the target areas at the time.	Local silver and zinc anomalies along the contact zone at Big Sore were identified. The expanded Killer Creek soil results identified 16 primary soil anomalies. Weak soil anomalies identified in Zinc Creek. The Mariposite soil results identified 9 soil anomalies associated with mineralization located along the contacts of a mariposite-carbonate contact.
1988	Soil geochemistry	Noranda	Soil geochemical sampling at Lil Sore and Mariposite claims	Define anomalies in the Lil Sore and Mariposite target areas.	Six anomalous soil geochemical zones were outlined.
1997	Soil geochemistry	Kennecott	Soil sampling along seven new grids totaling 230,000 linear feet in the High Sore, Bruin, Lower Zinc, Upper Zinc, "A" Road, and Gallagher target areas.	Define anomalies in these target areas	Soil sampling and geologic mapping outlined drill targets or areas for detailed follow-up work in the Bruin, Gallagher, and Lower Zinc Creek target areas.
1988	Soil geochemistry	Kennecott	One new soil grid in the Upper Big Sore target and extensions to three of the 1997 grids in Lower Zinc, Bruin, and the "A" Road target areas.	Define additional anomalies in these target areas	Outlined numerous soil anomalies but none significant enough to warrant drill testing.
1999	Soil geochemistry	Kennecott	Large Killer Creek soil survey and a new survey in the Cub Creek target areas.	Define additional anomalies in these target areas	Numerous multi-element soil anomalies were defined.
2000	Soil geochemistry	Kennecott	904 soil samples collected in the Bruin, High Sore, Killer Creek, Upper Gallagher, and Upper Zinc Creek target areas.	Define additional anomalies in these target areas	Numerous multi-element soil anomalies were defined.

Year	Exploration Activity	Contractor	Exploration Activity Completed	Purpose	Results
2002	Soil geochemistry	Kennecott	583 Soil samples collected in the Gallagher, Lil Sore, and Lower Zinc Creek target areas.	Define additional anomalies in these target areas	Identified numerous multi-element soil anomalies of which the most significant occurred at the southern end of the Zinc Creek target.
2003	Soil geochemistry	Kennecott	757 soil samples collected in the Gallagher, Killer, and Lil Sore target areas.	Expand and fill in previous soil sampling in these target areas to follow up on the anomalies identified in 2002.	Identified numerous multi-element soil anomalies of which the most significant occurring within the Lil Sore target area. The 2003 Gallagher soil results, when combined with the 2002 soil results, outlined two significant multi-element anomalies coincident with the mine contact zone.
2004	Soil geochemistry	Kennecott	238 soil samples collected in the High Sore and Lil Sore target areas.	Further define previous anomalies in these target areas.	In combination with the 1997 High Sore sampling, the 2004 results identified 11 multi-element soil anomalies.
2005	Soil geochemistry	Kennecott	486 soil samples collected in the Cliff Creek, High Sore, and Killer Creek target areas.	Define additional anomalies in these target areas	Eight multi-element soil anomalies identified in the Cliff Creek target area. Five multi-element anomalies identified in the Killer Creek target area.
2006	Soil geochemistry	Kennecott	586 soil samples collected in the Cliff Creek, High Sore, Upper Zinc, and Young Bay target areas.	Define additional anomalies in these target areas	Minor soil anomalies identified.
2008	Soil geochemistry	Greens Creek Exploration Staff	658 auger soil geochemical samples and 658 MMI soil geochemical samples along 67,800 ft (20,665 m) of gridlines in the Young Bay area.	Begin to identify geochemical anomalies in the Young Bay area.	Minor soil anomalies identified.
2010	Soil geochemistry	Greens Creek Exploration Staff	580 auger soil geochemical samples and 580 MMI soil geochemical samples taken in the North Young Bay area.	To identify geochemical anomalies in the Young Bay area.	Minor soil anomalies identified.
2011	Soil geochemistry	Greens Creek Exploration Staff	818 auger soil geochemical samples taken in the North Young Bay area.	To identify geochemical anomalies in the Young Bay area.	Minor soil anomalies identified.
2012	Soil geochemistry	Greens Creek Exploration Staff	253 auger soil geochemical samples taken in the North Young Bay area.	To identify geochemical anomalies in the Young Bay area.	Minor soil anomalies identified.

Figure 9-1: Greens Creek Soil Auger Geochemical Sample Location and Silver Contour Map

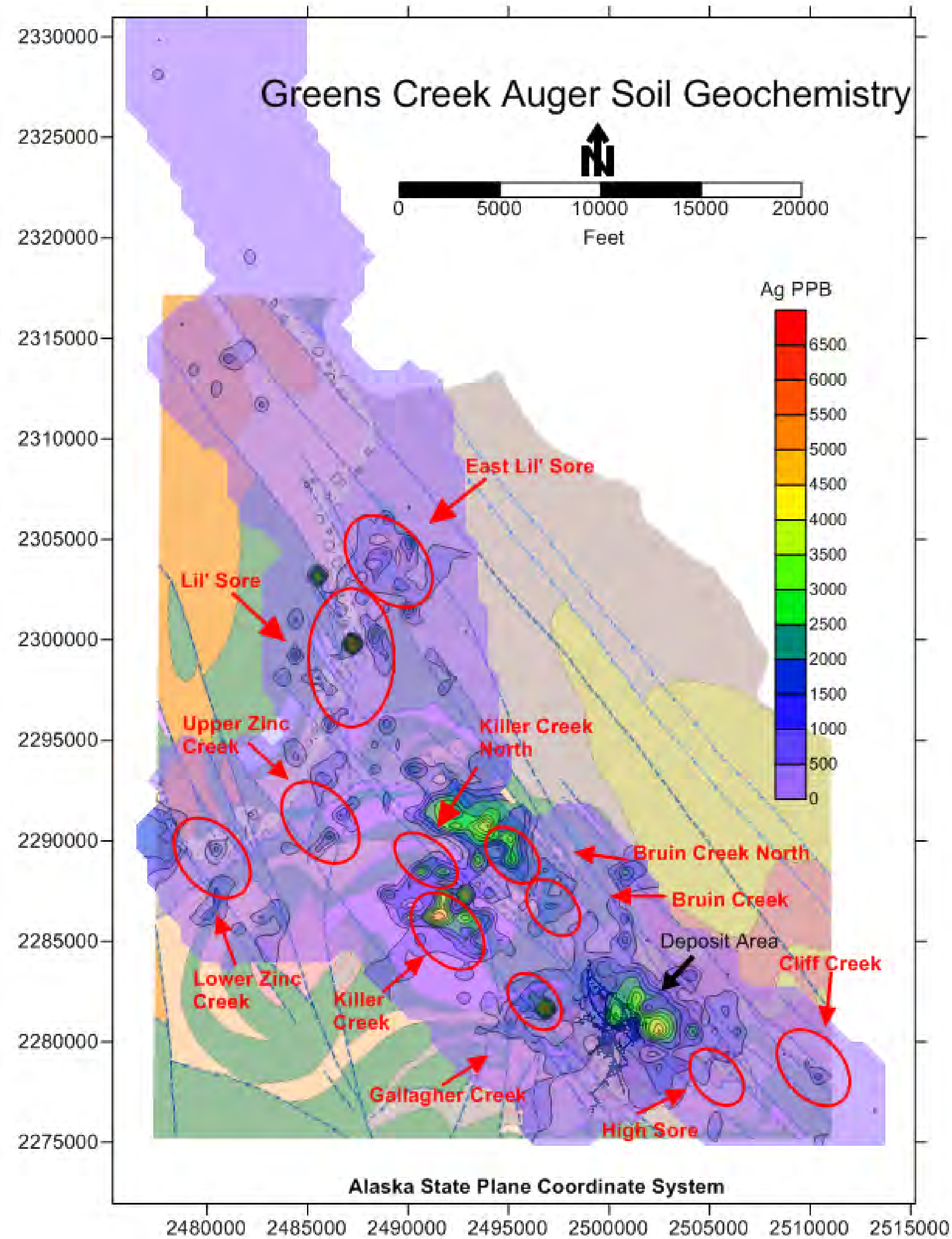
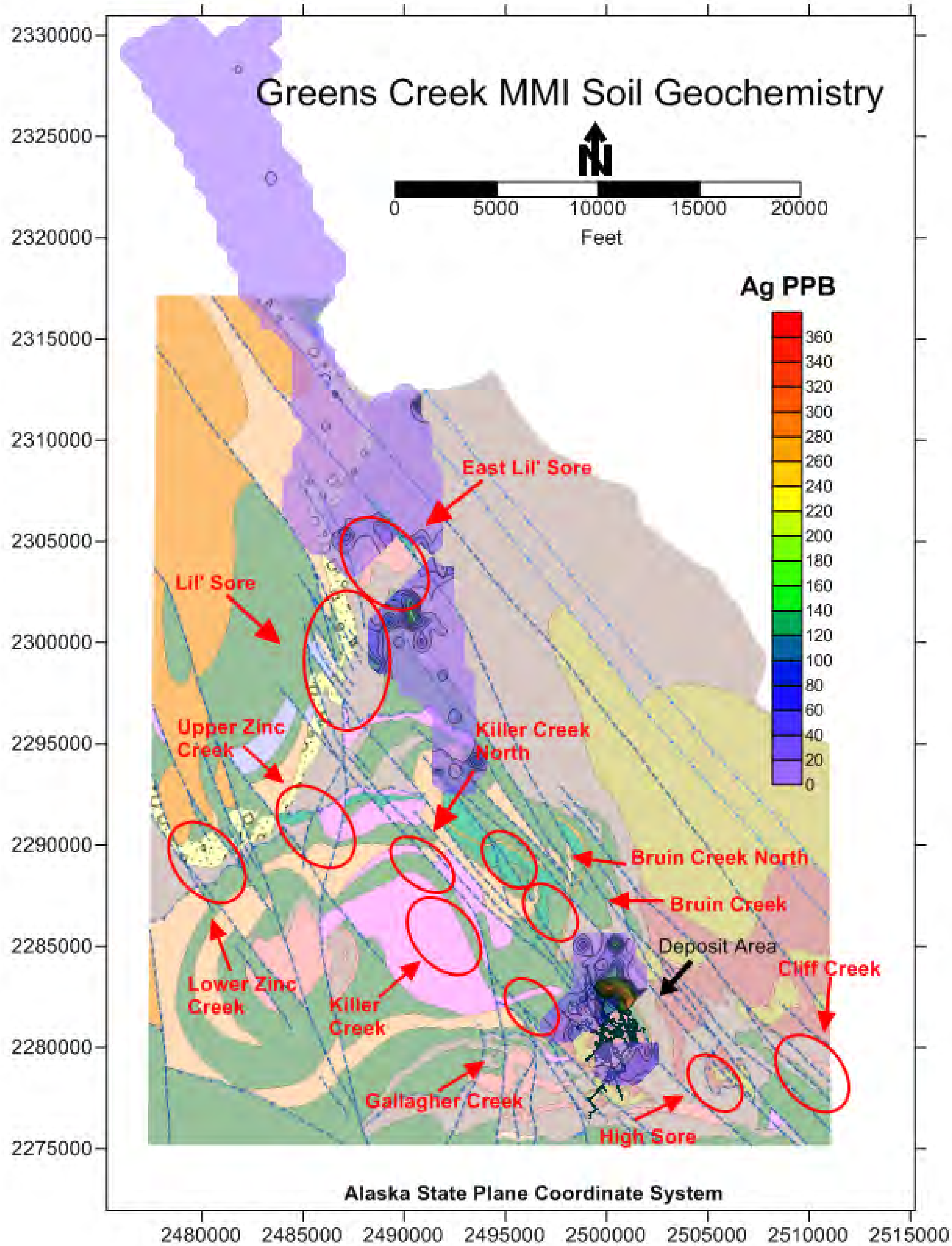


Figure 9-2: Greens Creek Soil MMI Geochemical Sample Location and Silver Contour Map



9.4 Geophysics

Various geophysical surveys have been conducted at Greens Creek since 1996 by several geophysical contractors and the previous Greens Creek owners.

Historic geophysical surveys prior to Hecla's acquisition of the property in March 2008 include airborne, ground and bore-hole surveys. Details of these geophysical surveys are summarized in Table 9-5 and Section 6 of this report. Table 9-5 also summarizes the surveys undertaken between 1996 and 2007 including 1,227 line kilometers of AeroDat airborne frequency-domain electromagnetic, magnetic, and radiometric surveys (1996), ground pulse EM (1998-99), gravity (1996–98), magnetic (1997–2003), controlled-source audio-frequency magneto-telluric (1996–2007), and audio-frequency magneto-telluric (2004–05) surveys, and bore hole TEM and UTEM3 surveys (1996–2004).

The results from the ground gravity surveys are summarized in Figure 9-3, those of the ground magnetic surveys in Figure 9-4, and the AeroDat geophysical survey results are included as Figure 9-5.

VOX Geoscience Ltd. based out of Vancouver BC, Canada, was contracted in 2010 to assist in the compilation of the historical geophysical surveys completed on the property and to recommend geophysical survey methods that could be effective in future exploration work. Data from the 1996 AeroDat airborne survey was high quality but in the 15 years since the survey was flown; geophysical software and processing methods have steadily improved.

Beginning in late 2010 and early 2011, Hecla began a program of re-processing the survey results. The first step involved micro-levelling the aeromagnetic data to remove the effects of line offsets and line corrugation. The survey was studied line by line and any spurious readings that could be attributed to man-made cultural interference were removed by hand. The resulting, cleaned, grid was then filtered. Figure 9-6 shows a close up of the Greens Creek Mine and Big Sore areas with the re-processed tilt derivative contouring. A very good fit between the mapped northeastern Mine Contact and the western edge of the strong magnetic low (blue) can be observed.

Techno Imaging of Salt Lake City was contracted in late 2010 to use their 3D EM Inversion software on a 211 linear mile (340 line-kilometer) subset of the 1996 AeroDat EM survey. The inversions showed little more than draping the AeroDat low and mid-frequency resistivity grids over Lidar did. The remaining 551 line-miles (887 line-kilometers) of data were not inverted.

Table 9-5: Greens Creek Geophysical Surveys 1996 through 2018

Survey Type	Year	Contractor	Survey Location(s)	Spacing	Purpose	Results
Fixed Loop TEM	1996	Zonge Engineering	Gallagher Gridlines 3800N to 5400N	50-foot	Orientation survey over the western-most extent of the GC mineral body to see what geophysical method may provide useful data and help optimize future surveys	Able to detect the West Ore as a large 400' by 200' .1 ohm-m conductor at depth of 800 feet
Downhole TEM	1996	Zonge Engineering	PS-111, PS-112, GC1530	5-meter	Test DH-TEM	GC1350 detected the West Ore body and the PS-holes had an anomalous response coincident with a narrow sulfide band.
CSAMT	1996	Zonge Engineering	Gallagher Gridlines 5000N and 4600N	100-foot spacings, all scalar measurements	Underground Orientation survey over the NW-W mineral zone to determine if gravity could detect a GC mineral zone	Sub-surface conductors coincide with the west projection of the Upper plate NW-W Zone, suggests taking E-filed measurements parallel to strike.
Gravity (UG)	1996	Greens Creek personnel, data processed by James Fueg, KEX geophysists	59 Drift,36 Decline,33 X-Cut and 52 X-Cut over the West Ore Zone	95 stations over 6,400-line feet (50 to 100-foot spacings)	Orientation survey over the western-most extent of the GC mineral body.	Detected a 1.5 mgal high over the West Ore Zone.
Surface Gravity	1996	Greens Creek personnel, data processed by James Fueg, KEX geophysists	Gallagher Gridlines 5000N and 4600N	50-foot	Test surface gravity over the West Ore Zone and Maki Fault	Only a minor to non-existent response over the West Ore, mineral body may be too deep to detect.
Aerial Magnetics, EM, and radiometrics (K, Th, U)	1996	AeroDAT	Over entire Land Package and much of Mansfield Peninsula	200-meter line spacings, 100-meter spacings near mine	Provide property wide geophysical maps for regional geologic mapping and 1st order targeting	EM survey outlined the mine contact very well through-out the property, mag data shows the ultramafic bodies also very well. Was very useful to the regional geologic map. Selected EM anomalies not rigorously evaluated.
Pulse EM Grid Surveys	1997	Crone Geophysics	Gallagher, Bruin, Lower Zn, Upper Zn (East), 'A' Road, and High Sore grids	100-foot station spacings with 400-foot line spacings (800-foot spacings in the 'A' Road grid)	Provide ground EM data on recently cut and sampled gridlines to map geology and outline possible conductive anomalies	Agrees well within existing known trend of lithologic units and aerial EM.
3D Downhole Pulse EM	1997	Crone Geophysics	PS-120, PS-121, and PS-122	uncertain	Test for any off hole conductive horizons that may represent mineralization, also map project intersected sulfide bands away from the hole.	Conductor 200 feet below the TD of PS-120 was identified, hole was re-entered in 1998 and intersected 24 feet of graphic phyllite at the conductor target.

Survey Type	Year	Contractor	Survey Location(s)	Spacing	Purpose	Results
Ground Gravity	1997	Tony Newman (operator) Clarke Jorgenson (processor)	Gallagher, Bruin, Lower Zn, Upper Zn (East), 'A' Road, and High Sore grids	100-foot station spacings with 400-foot line spacings (800-foot spacings in the 'A' Road grid)	Detect possible massive sulfide or baritic bodies at depth	No significant anomalies found that do not correlate with topography
Pulse EM Grid Surveys	1998	Crone Geophysics	New extensions of the Gallagher, Bruin (north-end), Lower Zn, 'A' Road Grids, Upper Big Sore grid and other KEX grids.	100-foot station spacings with 400-foot line spacings (800-foot spacings in the 'A' Road grid)	Provide ground EM data on recently cut and sampled gridlines and extensions to map geology and outline possible conductive anomalies	Agrees well within existing known trend of lithologic units and aerial EM.
Downhole Pulse EM	1998	Crone Geophysics	PS-123, PS-124, PS-125, PS-126, and PS-127	uncertain	Test for any off hole conductive horizons that may represent mineralization, also map project intersected sulfide bands away from the hole.	All significant responses are due to lithologic changes at footwall-argillite contacts, West Bruin contact could be seen off hole with increasing conductivity to the south and/or west in PS-126 and Zn-Pb mineralization 400M down in PS-123 correlates with conductive body centered to the south of hole.
Ground Magnetometer	1998	KGCMC Personnel	Bruin (north-end), Upper Big Sore, Lower Zn, and 'A' Road grids.	~ every 10 feet, was run in walking mag mode (must verify) along lines, 400-foot line spacings (800-foot in 'A' Road grid)	Aid in geologic mapping of the newly emplaced grids.	Ground mag data generally replicates the trends seen in the aeromagnetic data. Highlights exposed and suspected ultramafic bodies
Ground Gravity	1998	Clarke Jorgenson	Bruin (north-end), Upper Big Sore, Lower Zn, and 'A' Road grids.	100-foot station spacings with 400-foot line spacings (800-foot spacings in the 'A' Road grid)	Detect possible massive sulfide or baritic bodies at depth	Generally, correlates well with topography. High along Bruin line 2400N and another within the 'A' Road grid that is coincident with a PEM anomaly are features of interest.
Downhole 3-Component TEM	1999	Zonge Engineering	PS-130 through PS-137	10-foot	Detect possible off-hole conductive anomalies	All but PS-135 had indicated conductive anomalies that correlated with conductive lithologic units.
Ground Magnetometer	2000	KGCMC Personnel	Killer Creek, Cub Creek, and Lakes District grids	20-foot	Aid in geologic mapping of the newly emplaced grids.	Ground mag data generally replicates the trends seen in the aeromagnetic data. Highlights exposed and suspected ultramafic bodies

Survey Type	Year	Contractor	Survey Location(s)	Spacing	Purpose	Results
CSAMT	2000	Zonge Engineering	Bruin and Cub Creek lines 2400N, 2800N, and 3200N, and Killer Creek lines 800N, 1200N, and 2000N	100-foot	Map out the various exposed contacts in the Bruin and Cub Creeks to a greater depth, explore for buried argillite contact in Killer Creek where no argillite is exposed	Detected the buried East Bruin contact (argillite syncline), defined the geometry of the exposed Bruin contact. Steep conductors on the west side of Killer Creek remain unexplained.
CSAMT	2002	Zonge Engineering	Killer line 2800N, Bruin lines 800N and 4400N, Lower Zn lines CSAMT1, CSAMT2, and CSAMT3	100-foot spacing along selected lines. Mostly vector measurements	Provide sub-surface resistivity mapping for determining contact (target) geometry for drillhole orientation.	The three lines in Lower Zn defined the geometry of the argillite and graphitic phyllite units. Bruin line 4400N shows a deep conductor that may be the northern extensions of the East Bruin Contact. Deep conductor along Killer 2800N was attributed as the West Bruin Contact, however drilling did not intersect any conductive units.
CSAMT	2003	Zonge Engineering	Killer line 2000S, Bruin lines 2000N and 3200N, Upper Zn lines line 2000N, and Gallagher Line 4400N and 5200N	100-foot spacings, mostly vector measurements	Provide sub-surface resistivity mapping for determining contact (target) geometry for drillhole orientation. Killer line (2000S) was exploring for the north projection of the West Gallagher argillite.	All lines surveyed showed conductive units that conform with surface mapping and adding greatly in understanding the subsurface geology.
Ground Magnetometer	2003	KGCMC Personnel	West Gallagher, East Lower Zn extension, South Lil' Sore, NW Mammoth	50-foot	Aid in geologic mapping of the newly emplaced grids.	Maps out geology, especially the ultramafics that outcrop in the South Lil Sore and NW Mammoth grids
AMT	2004	Phoenix Geophysics	Upper Gallagher Lines XS200b and LS2000	150-foot	Test the AMT technique at Greens Creek and explore for the Gallagher Mineral Resource Zone and conductive argillite on west side of Gallagher Fault at a depth of >2,000 feet from surface	Two conductive bodies were mapped the correlates with the Gallagher argillite and an upper argillite unit intersected in PS-223
Complex Resistivity Bench Tests	2004	Zonge Engineering	Selected UG and surface drill core	N.A.	Provide resistivity data for modeling the MT/AMT survey in upper Gallagher. Most core samples were from Gallagher drillholes.	CR results from representative lithology shows a wide range of resistivities.
Downhole UTEM3	2004	SJ Geophysics	GC2459, GC2463, GC2551, PS0153, PS0161, PS0166, PS0169, PS0203, PS0210, PS0219, and PS0223	uncertain	Original aim was to downhole survey GC2551 and PS0223 which intersect or comes close to the new Gallagher Mineralized zone to determine its possible extent and structural orientation.	GC2551 could not be surveyed and only half of PS0223, thus other holes were surveyed. The survey of PS-210
MT/AMT	2005	Phoenix Geophysics	Upper Gallagher, 12 XS and 11 LS lines spaced 100 to 200 feet apart.	150-foot	Expand on the 2004 AMT survey in Upper Gallagher to determine the possible extend of the Gallagher mineral resource and use MT frequencies to model deeper.	Four anomalies were identified, most related to known and drilled argillite horizon near surface.

Survey Type	Year	Contractor	Survey Location(s)	Spacing	Purpose	Results
Gravity re-modeling	2005	Big Sky Geophysics	Gallagher, Bruin, Upper Zn (East), Upper Big Sore, Lower Zn, and 'A' Road and High Sore grids	100-foot	Remodel the gravity data from the 1997 and 1998 surveys using the greatly improved LidAR terrain data for the terrain corrections.	Forward modeling shows much better resolution with Lidar data as opposed to inclinometer measurements at stations. Gravity highs in High Sore and 'A' Road grids need further investigation.
MT 3D Model	2007	GeoSystems	Upper Gallagher grid	used data from MT/AMT survey	Use the closed spaced grid data from the 2004 and 2005 MT/AMT to create a 3D model below Upper Gallagher	Upper argillite is well modeled across the entire survey area, lowest conductor that can be modeled is at 700-meter depth (Above the Gallagher Zone). Modeled only down to sea-level.
CSAMT	2007	Zonge Engineering	East Lil Sore lines 2000N, 4400N, 4800N, and 5600N, Young Bay lines 5600S, 6400S, and 8000S, and NW Mammoth 6000N.	100-foot spacings, mostly vector	Survey above the East Ridge prospect and its projection of the north to determine the geometry of the contact.	East Ridge contact well mapped out by conductive units. Young Bay gridlines define graphitic phyllite over conglomerate contact much better than the conglomerate over argillite (Mine) contact.
PEM	2011	Crone	Killer Creek	10-meter	Determine location and geometry of argillite contact in Killer Creek.	No contact encountered
PEM	2011	Crone	Killer Creek	25-meter	Determine location and geometry of argillite contact in Killer Creek.	No contact encountered
Volterra Borehole EM	2014	SJ Geophysics	Killer Creek		Determine location and geometry of argillite contact in Killer Creek.	Frequencies employed were too high. The U and V components of the magnetometer were too noisy, so no 3D orientation of conductors available.

Figure 9-3: Greens Creek Ground Gravity Surveys

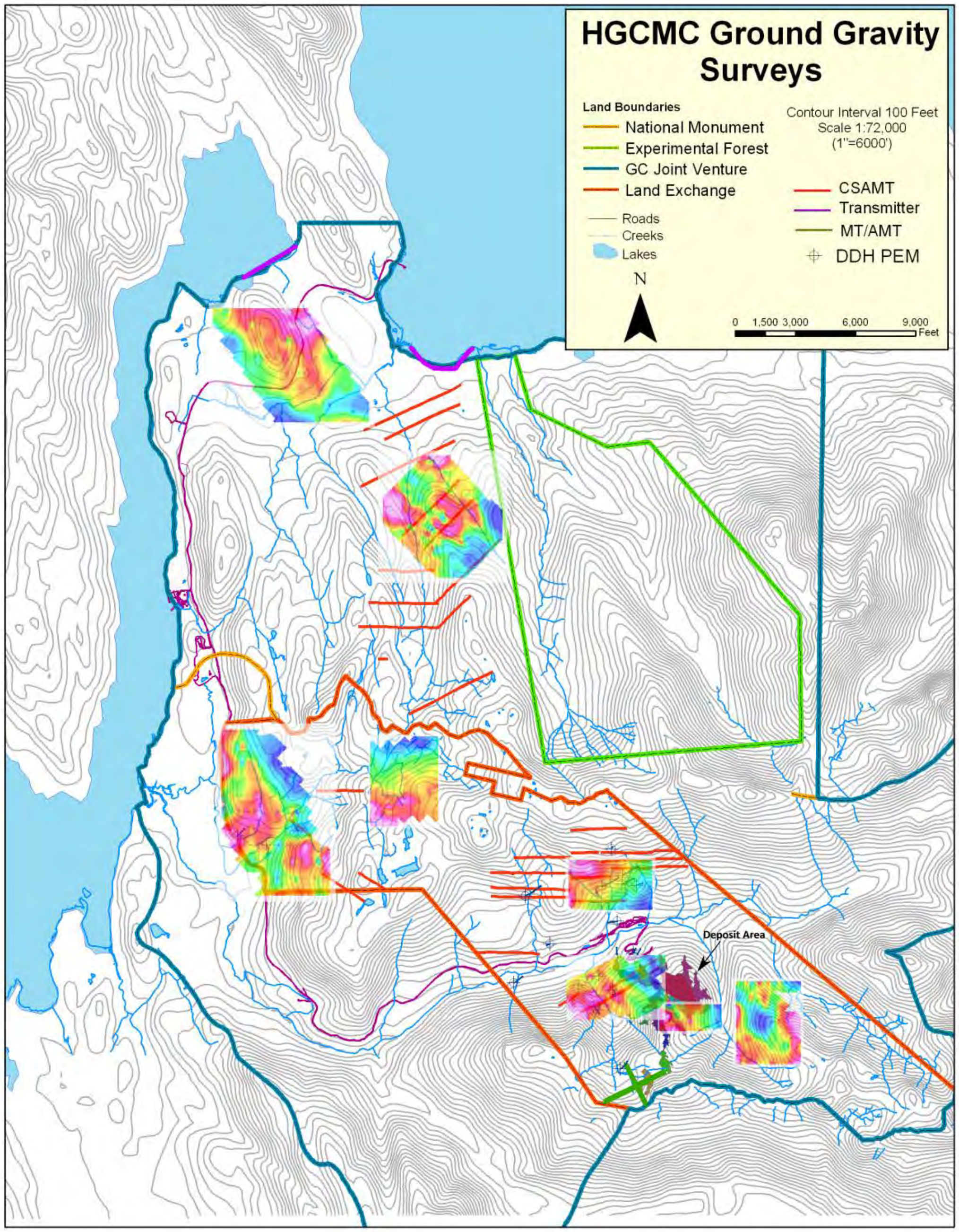


Figure 9-4: Greens Creek Ground Magnetic Surveys

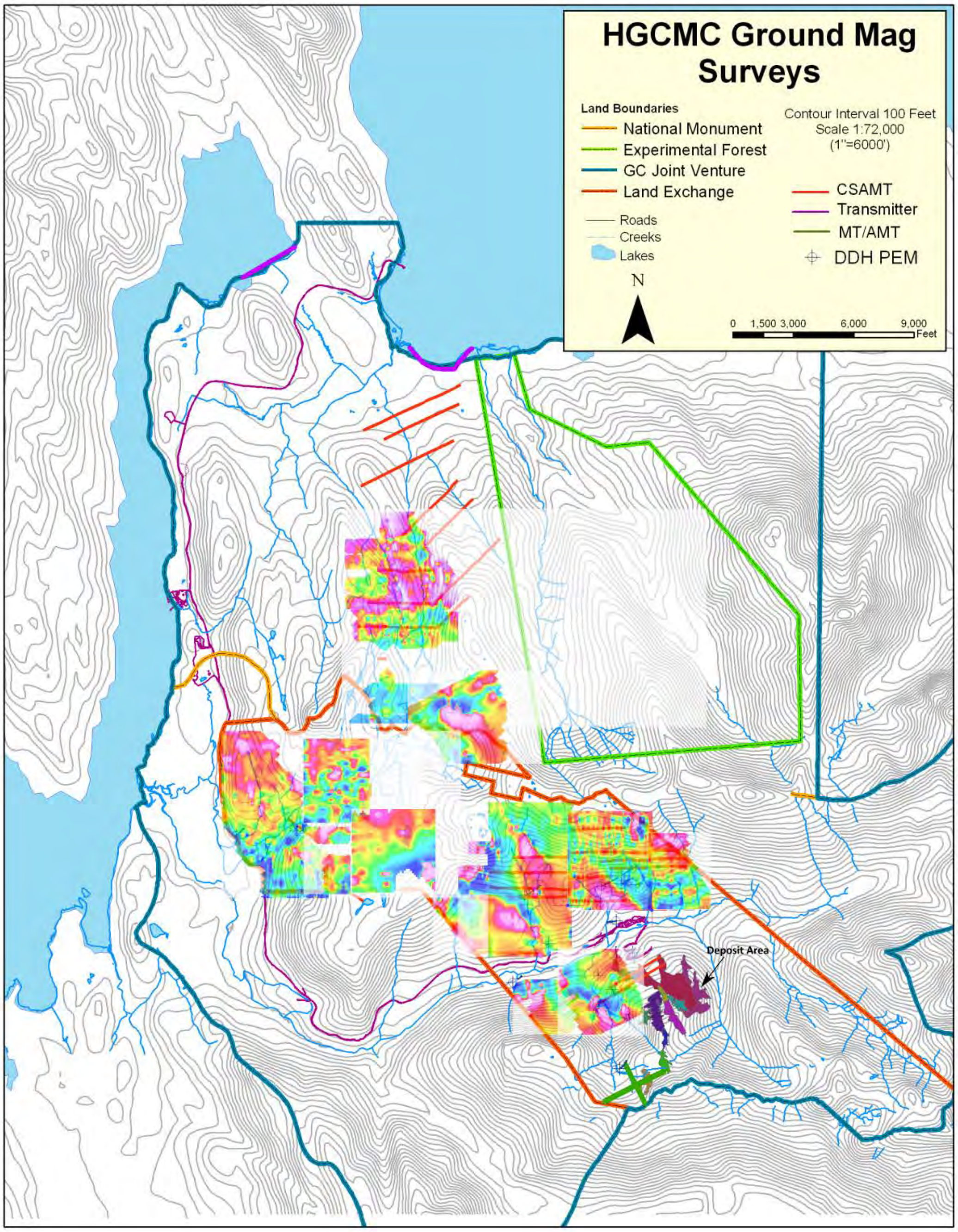


Figure 9-5: Greens Creek AeroDat Surveys Total Radiometrics

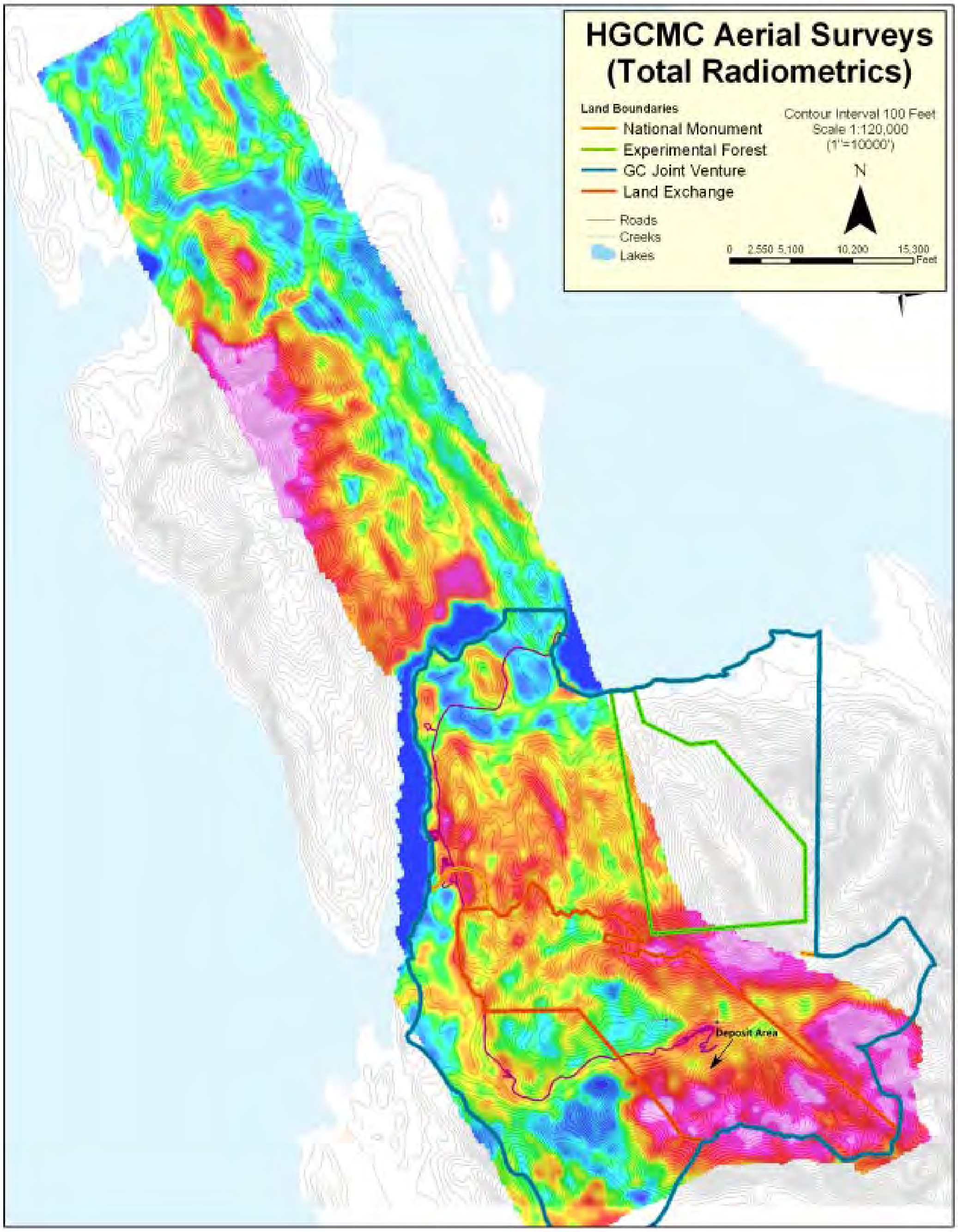
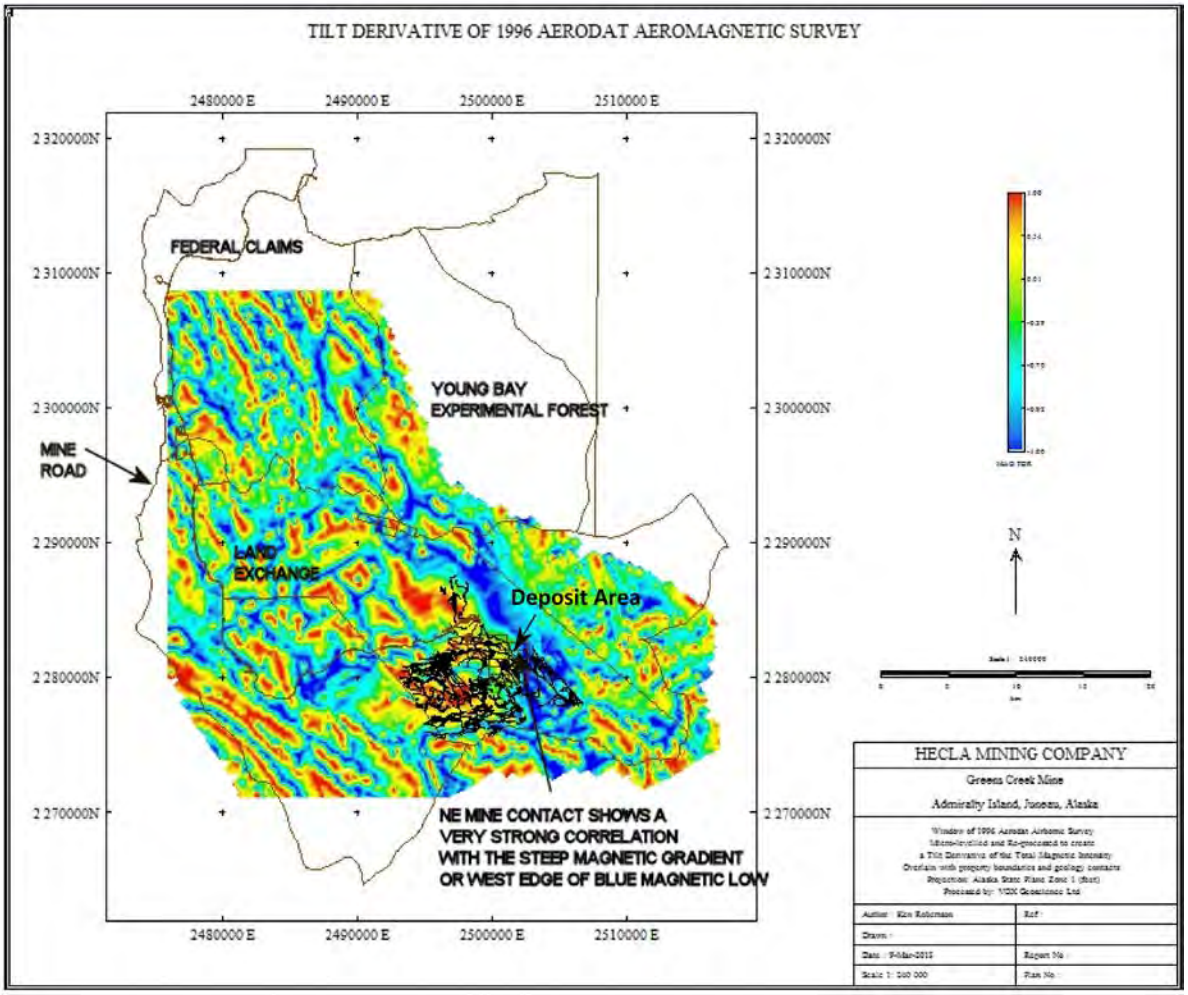


Figure 9-6: Greens Creek 2010-2011 Tilt Derivative Reprocessing of the AeroDat Survey Magnetics Data



In 2011, Crone Geophysics & Exploration Limited based in Mississauga, Ontario, Canada, was contracted by Hecla to conduct surface and borehole pulse electromagnetic surveys on the Killer Creek target area. Twelve surface lines utilizing two surface loops and two boreholes were surveyed form one transmitter loop. The surface surveys were carried out using a time base of 100.00 msec (2.5Hz) with a 1.5 m/sec shut-off ramp time. Vertical and in-line data were collected at a nominal station spacing of 82 ft (25 m).

Some interesting but confusing data were acquired as the host lithologies in the area can be very conductive. In particular, discriminating graphitic sediments from sulfides is problematic for electromagnetic surveys. However, the Crone Pulse Electro Magnetic data was modelled with Electromagnetic Imaging Technology Maxwell software, which resulted in the isolation of a small conductor from the background conductivity. This small conductor was drill tested in 2012 and copper-rich sulfide mineralization was intersected in a vein zone varying from 2.1 to 7.0 ft (0.6–2.1 m) with anomalous copper and silver values.

9.5 Petrology, Mineralogy, and Research Studies

Hecla and its predecessor companies have commissioned specialist petrographic and mineralogic reports in support of elucidation of mineral species and lithological determinations. A number of professional papers and research studies have been completed on the Greens Creek deposit and surrounding area, including:

USGS Professional Paper 1763: Geology, Geochemistry, and Genesis of the Greens Creek Massive Sulfide Deposit, Admiralty Island, Southeastern Alaska;

Anderson, V.M., and Taylor, C.D., 2000: Alteration Mineralogy and Zonation in Host Rocks to the Greens Creek Deposit, Southeastern Alaska: Geological Society of American Cordilleran Section Meeting, Abstracts with Programs, v. 32. no. 6, p. A-2;

Dressler, J.S., and Dunbire, J.C., 1981: The Greens Creek ore deposit, Admiralty Island, Alaska: Canadian Institute of Mining and Metallurgy Bulletin, v. 74, no. 833, p. 57;

Franklin, J.M., and McRoberts, S., 2009: Report on Analytical Reliability and Method Selection for Hecla Greens Creek Mining Company.

Freitag, K., 2000: Geology and Structure of the Lower Southwest Orebody, Greens Creek Mine, Alaska: Colorado School of Mines Thesis;

Freitag, K., 2010, Structure of the Lower Southwest Orebody, Structural Comparison to Neighboring Orebodies, and Tectonic Model for the Greens Creek Deposit, in Taylor, C.D. and Johnson, C.A., eds., Geology, Geochemistry, and Genesis of the Greens Creek Massive Sulfide Deposit, Admiralty Island, Southeastern Alaska: U.S. Geological Survey Professional Paper 1763, p. 367–401.

Fulton, R.L., Gemmell, J.B., West, A., Lear, K., Erickson, B., and Duke, N., 2003: Geology of the Hanging Wall Argillite Sequence, Greens Creek VHMS Deposit, Admiralty Island, Alaska, GAC-MAC Abstract, v. 28, p. 299.

Newberry, R.J. and Brew, D.A., 1997, The Upper Triassic Greens Creek VMS (volcanogenic massive sulfide) deposit and Woewodski Island VMS prospects, Southeastern Alaska; chemical and isotopic data for rocks and ores demonstrate similarity of these deposits and their host rocks: U.S. Geological Survey Open File Report 97-539, p. 49.

Sack, P., 2009: Characterization of Footwall Lithologies to the Greens Creek Volcanic-Hosted Massive Sulfide (VHMS) deposit, Alaska, USA: PhD thesis, Univ. of Tasmania;

Steeves, N., 2018. Mineralization and Genesis of the Greens Creek Volcanogenic Massive Sulfide (VMS) Deposit, Alaska, USA. Unpublished PhD, University of Tasmania, Hobart, Australia, 416p.

Taylor, D.D., Newkirk, S.R., Hall, T.E., Lear, K.G., Premo, W.R., Leventhal, J.S., Meier, A.L., Johnson, C.A., and Harris, A.G., 1999: The Greens Creek Deposit Southeastern Alaska – A VMS-SEDEX Hybrid: *in* Stanley, D.J., and others, *eds*., Mineral Deposits – Processes to Processing, Rotterdam, Balkema, v. 1, p. 597–600;

Taylor, D.D., Premo, B.R., and Lear, K.G., 2000: The Greens Creek Massive Sulfide Deposit – Premier Example of the Late Triassic Metallogeny of the Alexander Terrane, Southeastern Alaska and British Columbia [abs.]: Geological Society of America Abstracts with Programs, v. 32, no. 6, p. A-71;

9.6 Exploration Potential

Greens Creek exploration programs are designed to continually develop prospective target areas, evaluate emerging prospects, and test potential economic targets. Development of favorable areas includes regional mapping, followed by geochemical sampling and/or geophysical surveys. Evaluation activities include detailed geologic mapping and the incorporation of refined historical data with new exploration data to establish target potential. Testing involves diamond core drilling with the assessment of new information. Since Hecla assumed 100% ownership of Greens Creek in 2008, surface exploration programs have tested several prospects per season.

In 1977, it was recognized that the mineralization at Greens Creek is associated with the lithologic contact between argillite and phyllite. This was dubbed the “mine contact”. To date, much of the mine contact on the Greens Creek claim block has not been tested, even at 1,000-ft drill spacing.

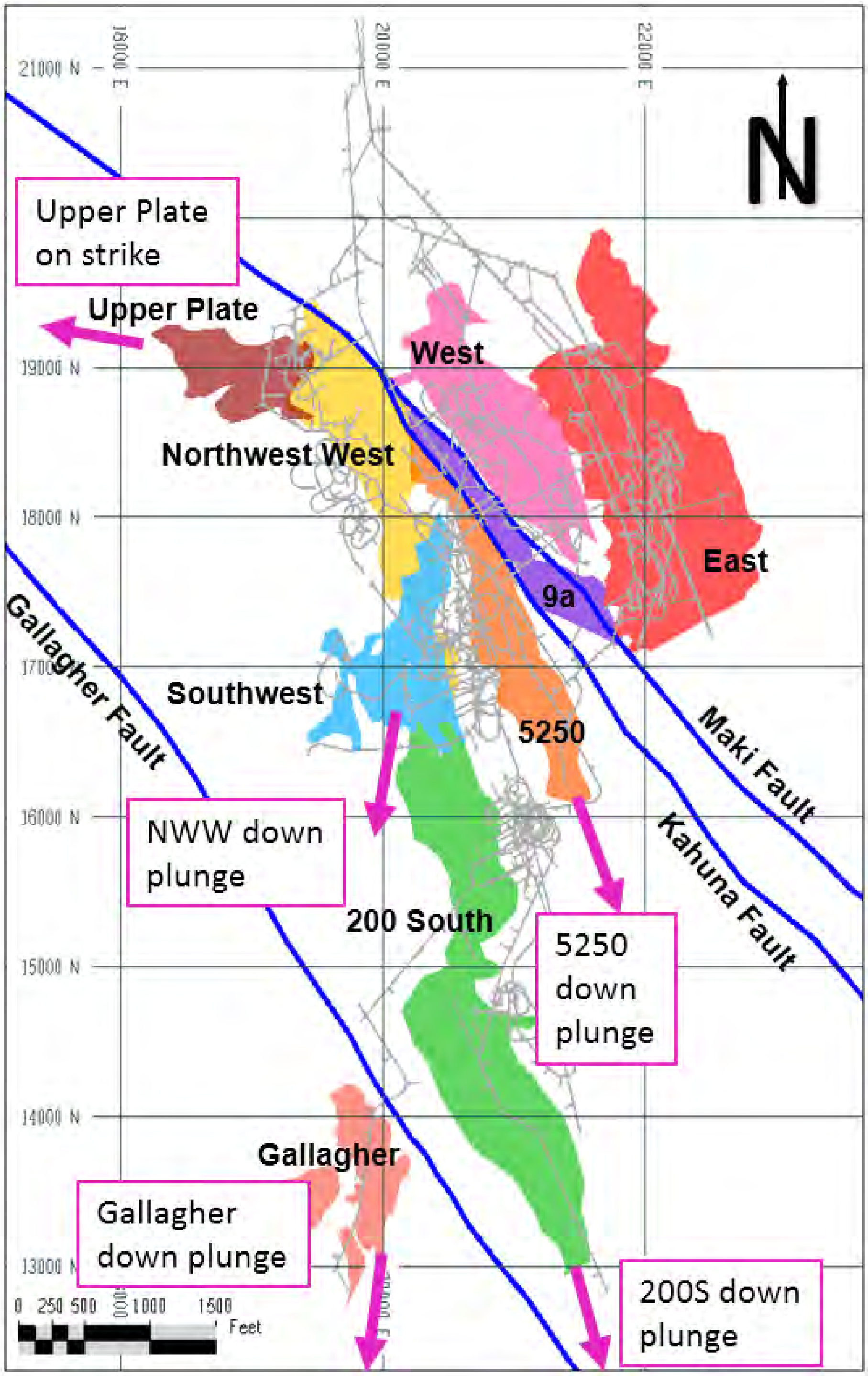
The main feeder system under the Greens Creek deposit is still being targeted where it meets the Mine Contact in the mine area. A separate, lower feeder system was found to mineralize the Mine Contact on a major anticline below the mine workings. This lower system has not been tested over most of the northern claim area.

Underground exploration at Greens Creek has historically followed the Mine Contact down dip and down plunge. When the contact is interrupted by major structural boundaries such as the Klaus Shear or the Maki and Gallagher Fault systems, exploration strategy concentrates on locating the Mine Contact across the structure, then continuing to follow it down plunge. After the initial discovery of the East Zone, the implementation of this strategy has led to the discovery the West, Northwest West, 9A, 5250, Southwest, 200 South zones, and most recently the Deep 200 South and Gallagher zones.

Exploration targets underground are categorized as emerging or advanced based upon the amount of drill testing that has been applied to that target. Currently there are five major exploration targets being tested at Greens Creek, all on the main Greens Creek feeder system. They are: 1) down plunge on the 200 South Zone, 2) down plunge on the Gallagher Zone, 3) down plunge on the Northwest-West Zone, 4) down plunge on the 5250 Zone and 5) out strike on the Upper Plate Zone. These targets are shown in relationship to the current mineral resources in Figure 9-7.

Figure 9-7: Plan View of Underground Exploration Targets in Relation to the Mineral Zones

(Magenta boxes and arrows show exploration targets.)



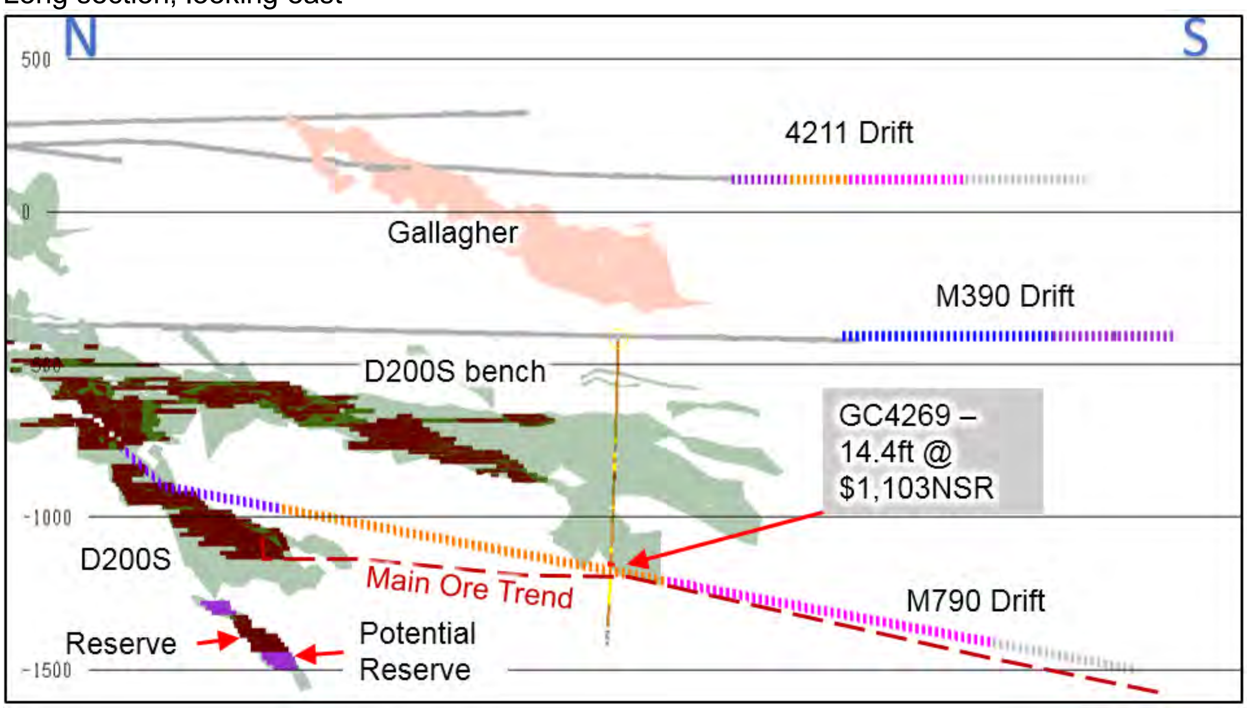
9.6.1 200 South Down Plunge

The Deep 200 South Zone projects to the south 750 to 1,000 ft from current mineral resource to the Gallagher Fault where it is likely cut and offset to become the Gallagher Zone. As ore grade mineralization is present in drilling at the southern end of the known 200 South Zone, and as the Gallagher Zone also has mineable grades, it is expected that drilling down plunge on the 200 South Zone will intercept 750 to 1,000 ft of well mineralized rock before being cut off by the Gallagher Fault.

Exploration down plunge has typically been from an exploration drift at the -390 ft elevation, which will continue to work for defining the upper benches of mineralization described in Figure 7-42 of Section 7. This bench mineralization does not represent the main mineral trend of the 200S Zone at the southern end however as the hotter MFP and MFB mineralization diverged from the bench and are now on an anticlinal hinge below the benches at about -1,100 ft elevation. To adequately test and convert this main trend of mineralization another exploration drift at the -790 ft elevation is planned. This exploration work will continue for several years into the future. Figure 9-8 shows the Deep 200 South Zone and the Gallagher Zone planned drifts.

Figure 9-8: Drifts Planned for Exploring Down Plunge on the Gallagher Zone (4211 Drift), Upper Bench of 200S Zone (M390 Drift), and Lower Trend of 200S Zone (M790 Drift)

Long section, looking east



9.6.2 Gallagher Zone Down Plunge

The Gallagher Zone is interpreted as the faulted offset of the 200 South Zone. Based on this interpretation, the zone represents the down plunge continuation of the upper bench of the 200 South as depicted in Figure 7-42 of Section 7. Below this bench the main trend of Greens Creek has been identified under the 200 South Zone, but drilling has not been carried out to follow this trend to the south. The M790 drift shown in Figure 9-8 will be necessary to follow this main trend to the south. The 4211-exploration drift will also continue to advance to the south to follow the upper level bench mineralization as shown in Figure 7-42 of Section 7.

9.6.3 Northwest West Zone Down Plunge

The Northwest West Zone represents the lowest of three mineralized trends identified at Greens Creek. Down plunge from the current mineral reserve significant inferred mineral resource is present and is open to the south. Recent completion of the PD150 ramp has given access for drilling this down plunge extension which has begun in 2019. This mineralization will be followed to the south until it terminates or connects with the lower levels of the Southwest Zone.

9.6.4 5250 Zone Down Plunge

Underground exploration drilling in 2016 and surface drilling in 2017 identified mineralized Mine Contact approximately 2,000 ft south of, and on trend with, the current 5250 Zone mineral resource. This drilling indicates that the 5250 Zone trend may host significant mineralization between the mineral resource and the exploration drilling. Surface exploration drilling was planned to step closer to the 5250 Zone mineral resource but was canceled due to focus on Upper Plate Zone drilling in 2018. As this 2,000 ft of open ground is highly prospective it will be targeted in the future from both surface and underground drilling.

9.6.5 Upper Plate along strike

Surface drilling in 2018 pushed the Upper Plate mineral resource westward and indicates the mineralization is still open to the northwest to southwest direction. Further drilling is planned to follow up on this high grade MFB material to the west.

9.6.6 Lower Feeder System

Below the entire mine, but still on the Mine Contact mineralization has been found on a major anticline which closes to the east. The mineralization, called the “Northeast Contact” target, was tested in the mine area and to the north across the Greens Creek drainage from 2008 to 2011. Though a hydrothermal system was clearly active in this area, and some high-grade intercepts were encountered, no mineral resource or mineral reserve was created.

While better defining the main feeder system for the Greens Creek deposit in drilling and on surface, a second, lower feeder system was apparent. This feeder system coincides with the “Northeast Contact” target and appears be the source of mineralization at the Lil’Sore prospect (Figure 6-1 of Section 6.) Between these two target areas, a distance of over 2.5 miles (4 km), significant mine contact is expected at depth and remains to be tested. As VMS mineralization is typically located where feeder systems intersect the mine contact, this area is highly prospective.

9.6.7 Other Prospects

Many other prospects are present across the claim block as the geochemical sampling maps indicate. Exploration is difficult as geochemical anomalies may be in the footwall and geophysical anomalies such as magnetic, gravity or conductive highs can just as easily be associated with greenstone, serpentinite or graphitic argillites and schists, respectively. Overturned F_2 folding also complicates exploration as mine contact may be folded under footwall lithologies at any place on the claim block.

Mineralization at Zinc Creek is folded and likely associated with the main Greens Creek feeder system but has a large thrust complicating the geology (Figures 6-1 and Figure 7-3 of Sections 6 and 7). Mineralization is present between the Zinc Creek and Lil'Sore prospects with very few drillholes. More drilling is needed to adequately assess the mineral potential of this area.

Southeast of the mine several square kilometers of the claim block is essentially unexplored. The USGS has indicated that the Mine Contact is present less than 1,500 ft below surface in this area (Karl, 2016). Furthermore, the Hyd Group which dominates the surface outcrop in this area may yet have VMS deposits within the section as others VMS deposits are in the Triassic Metallogenic Belt.

9.7 Comments on Exploration

In the QP's opinion:

- The exploration programs completed to date are appropriate to the style of the deposit and prospects;
- The research work supports Hecla's genetic and affinity interpretations for the deposits;
- Additional drilling has a likelihood of generating further exploration successes, particularly down-plunge of known zones.

10.0 DRILLING

A total of 7,655 drillholes adding up to 3,821,250 feet (1,164,717 m) have been completed over the entire Project area from 1975 to 2018 (Figure 10-1; Tables 10-1 and 10-2). Of these drillholes, 412 drillholes for 508,454 feet (154,977 m) are surface holes drilled for exploration or mineral resource development purposes. Underground exploration or mineral resource definition drillholes number 5,029 for 2,820,521 feet (859,695 m) and are typically drilled on 50 to 200 ft (15 to 60 m) spaced vertical sections. The remaining 2,214 drillholes, adding up to 492,287 ft (150,049 m), are underground pre-production drillholes that are drilled on cross- and plan-sections spaced from 20 to 50 ft (15 to 60 m).

All bedrock drilling has been completed using core methods. Surface drillholes collared in unconsolidated sediments utilize RC methods until bedrock is encountered (typically less than 100 ft or 30 m) and are then completed using core methods.

10.1 Pre-2008 Legacy Drilling

Prior to 2008, a total of 4,792 drillholes (2,196,695 ft or 669,553 m) had been completed (Table 10-1). Of these drillholes, 307 (305,887 ft or 93,234 m) are surface holes drilled for exploration or mineral resource development, 2,963 (1,590,079 ft or 484,656 m) are underground mineral resource definition drillholes, and 1,522 (300,728 ft or 91,662 m) are underground pre-production drillholes.

10.2 Hecla Drilling

Since 2008, a total of 2,863 drillholes (1,624,566 ft or 495,168 m) have been completed (Table 10-2). Of these drillholes, 105 (202,567 ft or 61,742 m) are surface holes drilled for exploration or mineral resource development, 2,066 (1,230,442 ft or 375,039 m) are underground mineral resource definition drillholes, and 692 (191,559 ft or 58,387 m) are underground pre-production drillholes. Figure 10-1 shows the locations of surface and underground diamond drillholes.

Figure 10-1: Plan View Map with Drillhole Locations

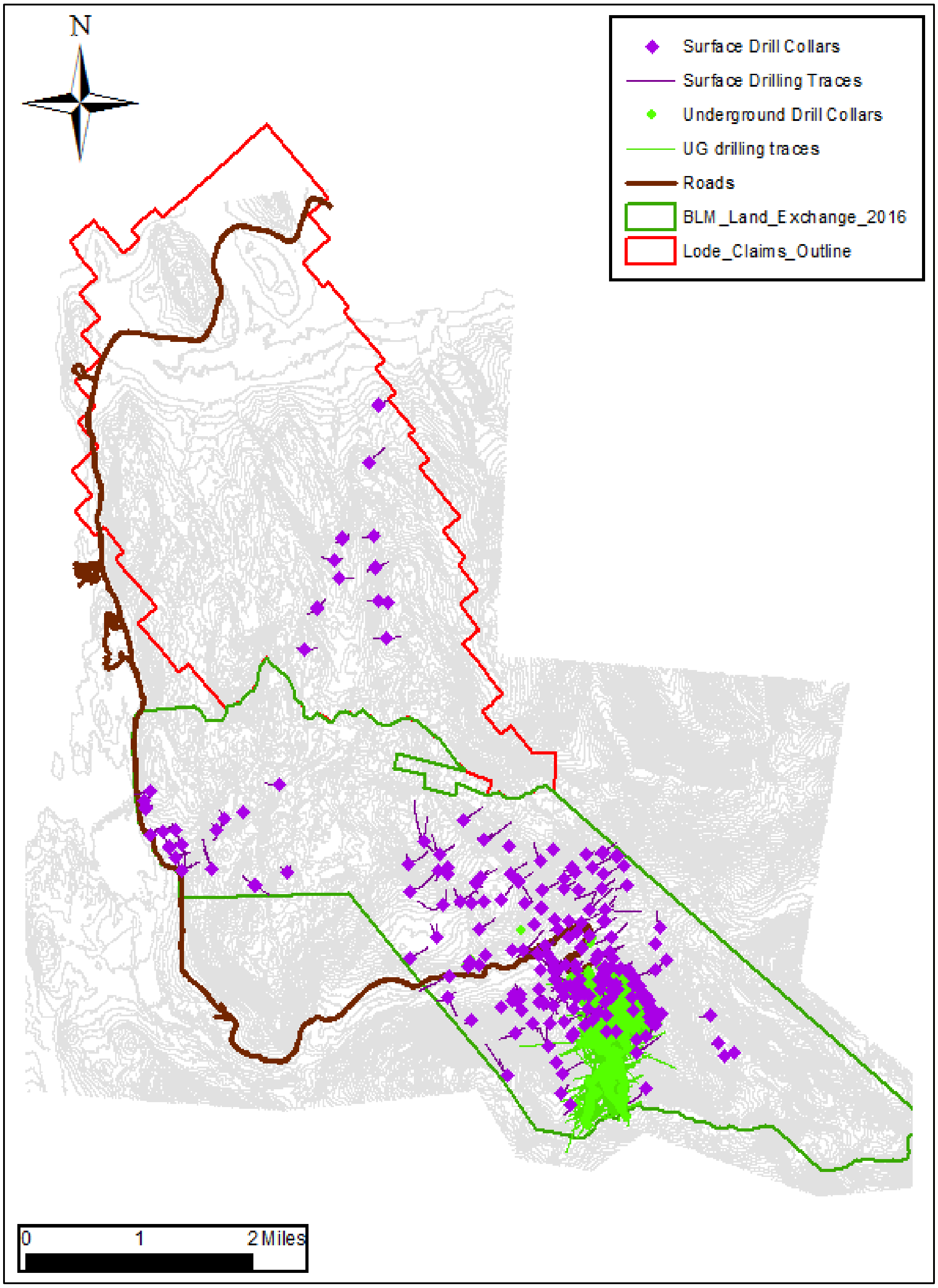


Table 10-1: Summary of Legacy Drilling- 1975 to 2007

Year	Surface Exploration (PS Series)		Underground Definition & Exploration (GC-series)		Pre-production / Stope Planning (PP+ST-series)		Annual Totals		Drill Contractor
	Holes	Feet	Holes	Feet	Holes	Feet	Holes	Feet	
1975	3	997					3	997	
1976	16	5,350					16	5,350	Wink Brothers
1977	19	7,901					19	7,901	
1978			4	1,427			4	1,427	
1979			40	17,094			40	17,094	Unknown
1980			34	13,528			34	13,528	
1981							0	0	
1982	13	12,220					13	12,220	
1983	17	7,438					17	7,438	
1984	15	12,424	10	8,970			25	21,393	Diamond Drill Contracting Co
1985	10	11,721	44	33,760			54	45,482	
1986	3	4,692	7	2,068			10	6,760	
1987			12	3,426			12	3,426	
1988			164	47,011			164	47,011	
1989	2	2,562	98	27,676			100	30,238	
1990	9	21,053	139	68,488			148	89,541	Greens Creek (Underground) Surface (Unknown)
1991			247	138,613			247	138,613	
1992			226	74,899			226	74,899	
1993			17	17,856			17	17,856	
1994			200	132,998			200	132,998	NANA Dyantech
1995			184	96,787	103	21,118	287	117,905	
1996	8	7,420	127	83,694	101	30,880	236	121,994	
1997	4	7,071	166	111,381	242	39,474	412	157,926	
1998	5	8,484	157	92,651	224	30,567	386	131,702	
1999	11	12,148	127	78,285	144	28,425	282	118,858	
2000	15	15,812	206	90,333	83	22,430	304	128,575	
2001			98	87,278	43	8,991	141	96,269	Connors Drilling, LLC
2002	20	17,258	109	73,212	73	14,109	202	104,579	
2003	25	27,743	85	60,598	87	13,830	197	102,171	
2004	45	52,174	95	54,923	89	18,957	229	126,054	
2005	34	35,920	158	82,807	108	18,552	300	137,279	
2006	19	16,555	78	40,893	106	17,744	203	75,192	
2007	14	18,946	131	49,425	119	35,652	264	104,023	
Total	**307**	**305,887**	**2,963**	**1,590,079**	**1,522**	**300,728**	**4,792**	**2,196,694**	

Table 10-2: Summary of Hecla Drilling 2008–2018

Year	Surface Exploration (PS series)		Underground Definition & Exploration (GC-series)		Pre-production / Stope Planning (PP+ST-series)		Annual Total		Surface Drill Contractor	Underground Drill Contractor
	Holes	Feet	Holes	Feet	Holes	Feet	Holes	Feet		
2008	16	20,041	132	54,530	23	2,822	171	77,392	Connors Drilling, LLC	
2009	4	8,292	51	39,556	55	12,830	110	60,678		
2010	17	21,805	67	89,373	29	9,677	113	120,854		
2011	14	27,397	88	88,345	25	6,210	127	121,952		
2012	7	19,858	186	105,929	35	19,593	228	145,380		
2013	11	29,873	220	140,199	60	17,168	291	187,240	Falcon Drilling, Inc.	Connors Drilling, LLC
2014	6	23,316	145	84,886	67	20,454	218	128,656		
2015	4	7,587	317	173,177	125	19,960	446	200,723	Falcon Drilling, Inc.	First Drilling, LLC
2016	2	3,074	229	140,949	110	37,282	341	181,305		
2017	9	20,419	309	156,358	66	16,397	384	193,174		
2018	15	20,906	322	157,141	97	29,167	434	207,213	Timberline Drilling, Inc.	First Drilling, LLC
Total	**105**	**202,567**	**2,066**	**1,230,442**	**692**	**191,559**	**2,863**	**1,624,566**		

10.3 Drill Methods

10.3.1 Pre-2008 or Legacy Drilling

The drilling methods of prior operators were similar to the practices employed by Hecla. Underground core was mostly NQ or NQTK diameter, and minor footage of BQ and BQTK diameter core was used for longer holes. In some drillholes, the drill core diameter was reduced from NQ/NQTK to BQ/BQTK (telescoping) due to problematic ground conditions, typically as a result of faulting.

Surface legacy exploration drilling also utilized methods similar to current Hecla practices. Drilling in the overburden (unconsolidated sediments) utilized HQ as casing and drill core was typically reduced to NQ or NQTK once bedrock was encountered. In some drillholes, the drill core diameter was reduced from NQ to BQ due to problematic ground conditions.

Legacy drilling methods, where known, are summarized in Table 10-3. Information concerning the number and types of drill rigs utilized for the legacy underground and surface drill programs are not available.

Table 10-3: Summary of Legacy Drill Methods- 1975 to 2007

Core Type	Diameter (in)	Diameter (mm)	Typical Use
BQ	1.44	36.5	Legacy (pre-2000) - used to extend drilling in difficult ground conditions
BQTK	1.61	40.9	Legacy - when required to extend holes in difficult ground conditions and some legacy ST holes.
NQ	1.87	47.6	Legacy (pre-2000) - standard surface and underground core size
NQTK (NQ2)	2.00	50.8	Standard surface and underground core size
HQ	2.50	63.5	Typically used on surface for overburden drilling and underground for long holes

10.3.2 Hecla Drilling

Hecla has explored Greens Creek deposits since 2008 with core holes spaced at various intervals depending on the stage of exploration and development.

Surface exploration holes (PS-prefix series drillholes) are drilled primarily with HQ and NQTK tools. To drill through the unconsolidated overburden HQ-diameter tri-cone methods are utilized. Typically, one to six holes are drilled from remote, helicopter-accessible sites, and more rarely from the existing mine road system. All sites require USFS approval prior to construction of a wooden drill platform. A typical remote site requires a 60 ft x 60 ft (18 x 18 m) clearing to ensure safe access by helicopter.

All remote drilling is supported by one Greens Creek dedicated helicopter (Hughes 500D) based at Hawk Inlet. Drill rigs are moved using an A-Star B2 or B3, which is mobilized from Juneau as needed. During the active drill season one to two drills are active on a 24-hour basis, 7-days per week. Drill plans are laid out parallel to geo-grid sections (refer to Section 9.1 for an explanation of the Project grids).

Definition holes (GC-prefix series drillholes) are drilled with NQTK or HQ tools. Holes are drilled in fans principally from underground drill stations spaced from 50 to 100 ft (15.2 to 30 m) along strike of mineralization. Depending on the availability of drill stations, the vertical spacing of holes within mineralization in individual sections may range from 12 to 100 ft (3.6 to 30 m).

Pre-production holes (PP-prefix series) and stope holes (ST-prefix series) are drilled with NQTK tools. PP drill fans are drilled at 50 ft (15.2 m) intervals along strike of mineralization and on 30 to 60 ft (9 to 18 m) vertical intervals. Most PP drillholes are planned to produce a final drillhole spacing of 50 ft (15.2 m) or less in mineralized zones. ST-prefix series drillholes are drilled in areas of complex mineralized shapes to aid mine design and planning.

Drill core for exploration, in-fill and definition purposes is NQ in diameter. In some drillholes, the drill core diameter is reduced from HQ to NQ to BQ (telescoping) due to ground conditions problems, typically as a result of faulting. Longer holes or holes in areas with anticipated bad ground are generally collared using HQ tooling. Table 10-4 summarizes the size of coring at Greens Creek post-2008. Table 10-5 summarizes the makes and models of drilling equipment utilized between 2008 and 2018.

Once retrieved from the core barrel, the core is placed in sequential order in core boxes labeled with the drillhole number. Each successive section of core drilled, usually 10 ft (3 m) long, is identified by a wood block marked with the depth of the interval. At the end of each shift, core boxes are transported by the drillers to the logging area which is located at the 860 Area on surface.

Table 10-4: Summary of Current Drill Methods- 2008 to 2018

Core Type	Diameter (in)	Diameter (mm)	Typical Use
BQTK	1.61	40.9	ST-series holes; when required for difficult ground conditions.
NQTK (NQ2)	2.00	50.8	Standard surface and underground core size.
HQ	2.50	63.5	Typically used on surface for overburden drilling and underground for long holes.

Table 10-5: Drill Equipment Utilized for Core Drilling- 2008 to 2018

Make	Model	Description
Christensen	CS14	Surface Drilling, 2009 & 2011
Atlas Copco	CS1000	Surface Drilling 2008,2010-2012
Atlas Copco	U6	Underground Drilling 2008-2009
Atlas Copco	U8	Underground Drilling 2009-2018
Connors Drilling	20HH	Underground Drilling 2009-2018
Falcon Drilling	F-3500	Surface Drilling 2013-2017
Sandvik	DE-140	Surface Drilling 2018

10.4 Geological Logging

10.4.1 Legacy Drilling

The current system of logging employed by Hecla has been used with minor modifications since 1987 (starting with drillhole GC0150). Prior to 1987, lithological nomenclature differed in the names applied to various units. All of the pre-1987 logging has been translated into the current system based on the descriptive details from the original logs. Over 95% of the logged intervals contained adequate details to unequivocally place intervals into the current lithological system. Where insufficient descriptions did occur, assays and or adjacent holes were utilized to ensure continuity. Other differences found in the pre-1987 logging include the use of longer maximum sample lengths (up to 10 ft or 3 m) that may span multiple lithologies. Finally, not all of the legacy logs prior to 2000 have consistently recorded RQD and fracture counts. The majority of the legacy core was photographed wet with either 35 mm slides or digitally.

10.4.2 Hecla Drilling

Underground drill core is logged for recovery, RQD, lithology, alteration, mineralization, structure and fabric. Lithologies can be subdivided into non-mineralized/non-ore (generally not mineralized but may contain erratic high-grade values that can be mined) and mineralized/ore categories.

Surface core is logged for recovery, lithology, alteration, mineralization, structure and fabric. The surface lithologies use the same classification system as the underground. Typically, surface core logs contain a higher level of descriptive details than underground logs. All logs are recorded on paper at a 1 in = 10 ft scale.

All core is photographed wet. All logs are recorded on paper at scales ranging from 1 in = 20 ft to 1 in = 5 ft, depending on observed complexity.

10.5 Recovery

Core recovery is generally high because of the compact nature of the greenschist metamorphic rocks. Approximately 80% of drilled intervals have core recovery greater than 95%. Poor recovery, defined as less than 50%, occurs in approximately 2% of intervals. Poor recovery is generally localized to heavily-faulted areas in the argillite.

10.6 Collar Surveys

10.6.1 Legacy Drilling

The majority of the legacy underground drill collars were surveyed with conventional mine survey equipment by the mine staff. In rare cases (~ 2%), collar locations were mapped by Brunton compass and tape methods from known survey points. All collar points were recorded in the database utilizing the mine grid coordinate system.

10.6.2 Hecla Drilling

Drillholes are planned (azimuth, dip, length) by geologists on vertical cross-sections and on vertical longitudinal sections orthogonal to the geo-grid.

For surface drillholes a 2 in x 4 in (5 x 10 cm) tack board is aligned with the geo-grid sectional line (333° azimuth) during pad construction. When the rig is slung into place the skid frame is aligned with the tack board. If drillholes are planned that are not parallel with the geo-grid section line, an arrow pointing in the planned direction is painted onto the deck. After drillhole completion, surface drill collars are located using a Trimble Geo XH 600 handheld GPS instrument. Coordinates are recorded into UTM-NAD83 coordinates. Accuracy is generally ±10 ft (3 m) for northing and easting coordinates. Elevations are adjusted to match the local light detection and ranging (LiDAR) topographic survey.

Underground drill lines are marked (front sight and back sight) by the mine surveyors. After completion, underground drillhole collars are surveyed with conventional mine surveying equipment by Hecla staff.

All collar locations are recorded in the database utilizing the mine grid coordinate system.

10.7 Down-hole Surveys

10.7.1 Legacy Drilling

Prior to 1996, down-hole surveys were done by magnetic single-shot cameras. The majority used a Sperry-Sun single-shot camera with a few using a Well-Nav single-shot. Usually a shot was taken at the collar, at 50 ft (15 m), and approximately every 100 to 200 ft (30 to 60 m) thereafter. If the azimuth and inclination at the collar were more than a few degrees different from that of the shot at 50 ft (15 m), the collar azimuth and inclination were regarded as suspect (affected by steel in the equipment) and replaced by the azimuth and inclination at 50 ft (15 m). Magnetic azimuths were corrected for magnetic declination and, for the Sperry-Sun, had a high-latitude correction applied.

Between 1996 and 2000 a combination of Sperry-Sun and MAXIBOR instruments were used. The MAXIBOR system determines drillhole deviation optically relative to a survey measurement of the drillhole collar. The Sperry-Sun was replaced with a Reflex© EZ-shot survey tool in 2000. The EZ-Shot is a solid-state electronic, single-shot instrument with stated accuracy of ±0.5° azimuth and ±0.2° dip. Between 2000 and 2004, the EZ-Shot and MAXIBOR system were used in tandem. Since 2005 the EZ-Shot has been the only system used for down-hole surveys at Greens Creek.

10.7.2 Hecla Drilling

Hecla continued the use of the EZ-Shot system implemented in 2005; since 2008 all surface and underground drillholes have been surveyed using an EZ-Shot system.

For underground drillholes an initial shot at 50 ft (15 m) depth is taken and compared to the planned drillhole azimuth and dip. If the hole alignment is off by more than ±3° in azimuth or ±1° in dip the hole is typically stopped and re-collared. After the initial 50 ft (15 m) shot, surveys are typically taken every 200 ft (60 m) and at the end of the drillhole. Surveys are taken as the drillhole advances. Readings that show anomalous magnetic field strength are flagged as suspect during database entry.

For surface drillholes, an initial survey is first shot below the casing and then every 100 ft (30 m) down hole thereafter as the drillhole progress. A final shot is taken at the end of the drillhole upon completion.

10.8 Geotechnical and Hydrological Drilling

10.8.1 Legacy Drilling

Surface-based drilling methods of prior operators were similar to the practices employed by Hecla. Prior to 2008, a significant number of geotechnical and hydrological drillholes were completed in support of construction and operations of the Greens Creek surface facilities. Areas covered by these holes include the 920 Area, Site 23-D, Site E, and the TDF. An accurate tally of the number of holes and footage for this period is not currently available.

Underground geologic core drilling methods of prior operators were similar to the practices employed by Hecla. However, the portion of the legacy Ingres database that contained core recoveries and RQD data was not successfully recovered with the transfer to acQuire in 2008 (see Section 12.2 for details). These data are still available on the paper logs.

10.8.2 Hecla Drilling

Since 2008, a total of 136 geotechnical and hydrological holes for a total of 7,619.1 ft (2,322.3 m) have been completed (Table 10-6). The drill campaign in 2009 was focused on investigating existing pile conditions at the tailings disposal facility (TDF). A uniaxial hydraulic jab was used to push a 3.0 in (7.6 cm) diameter Shelby sample tube into the TDF for collection. Sample depths ranged from 20 to 45 ft (6–13.7 m).

Drilling investigations in 2010 and 2011 were in support of a proposed TDF expansion. Additionally, in 2010, Site 23, the mill back slope area, and 1350 Area were drill tested to support stability and groundwater monitoring programs. The 2010 program utilized a CME-75 track-mounted rig operated by Cascade Drilling of Woodinville, Washington; the 2011 program utilized a heli-portable CME-45C drill rig operated by Denali Drilling Inc. of Alaska.

The typical methodology for foundation and hydrogeological investigations in 2010 and 2011 included using hollow-stem auger drilling for peat, tri-cone mud rotary (water/bentonite-based) for sand/gravel/till, and HQ3 coring for bedrock lithology. Data collection included standard penetration testing (SPT), typically at 5 ft (1.5 m) intervals and sample collection using a SPT split spoon for index testing. Core samples were also taken where bedrock was encountered. Where clays were encountered, Shelby tube samples were typically collected.

For drill rigs with auto-hammer capability (2010), energy transfer efficiency measurements were taken utilizing a pile driving analyzer at initiation of the drill program to verify correlation. For drill rigs without auto-hammer capability (2011), energy transfer efficiency measurements were taken throughout the duration of the field program for blow count correction.

During the 2011 drill program, a vane borer was also utilized for in-situ shear strength data collection. Since 2012, the geotechnical drilling has focused on the tailings disposal facility.

Hecla logs geotechnical data on all standard underground drill core, and data are stored in the acQuire® database. The dataset includes core recovery (all core), RQD data, and fracture count (sampled intervals and all ST holes). The data set is used in conjunction with the lithologic rock type to classify the mining areas based on the Greens Creek Ground Support Management Plan (GCMP). The GCMP is audited and validated by outside consultants.

Table 10-6: Summary of Surface Geotechnical and Hydrological Drilling- 2008 to 2018

Year	Area	Driller	Holes	Footage
2008		No drilling	0	0
2009	Tailings	Unknown	5	152.6
	1350 Area	Cascade Drilling	4	381.5
2010	Tailings	Cascade Drilling	8	595.7
	Tailings	Cascade Drilling	11	780.8
	A-Road	Denali Drilling	3	345.5
2011	Tailings	Cascade Drilling	11	568.3
	Tailings	Denali Drilling	18	848
2012		No drilling	0	0
2013		No drilling	0	0
2014	Tailings	Denali Drilling	4	315
	Tailings	ConeTec	6	77.1
	Site E	Denali Drilling	2	49.5
	Ore Pad Backslope	Denali Drilling	2	88
2015	Tailings	ConeTec	5	271.9
	Tailings	Mud Bay	5	323.5
2016		No drilling	0	0
2017	B Road	Mud Bay	7	304.3
	Tailings	Mud Bay/ConeTec	10	793.4
2018	Tailings	Mud Bay/ConeTec	35	1724

10.9 Metallurgical Drilling

Current metallurgical testing is primarily based on actual mill feed or composite samples collected from underground faces. See Section 11.2 for a description of metallurgical drill sampling.

10.10 Sample Length/True Thickness

Drillholes are designed to intersect the mineralization as perpendicular as possible; reported mineralized intercepts are typically longer than the true thickness of the mineralization.

A series of section and plan maps for each mineralized zone are included in Section 7.4. These maps include drillhole traces, block model outlines, and an interpretation of major geologic contacts and faults. These plans and figures show that drill orientations are generally appropriate for the mineralization style and have been drilled at orientations that are optimal for the orientation of mineralization for the bulk of the deposit areas.

10.11 Comments on Drilling

In the opinion of the QP, the quantity and quality of the logging, geotechnical, collar and down-hole survey data collected in the exploration and infill drill programs are sufficient to support Mineral Resource and Mineral Reserve estimation as follows:

- Core logging performed by Hecla staff meets industry standards for exploration on polymetallic deposits;
- Core logging performed prior to Hecla acquiring 100% Project ownership met industry standards at the time of logging;
- Collar surveys for Hecla core holes have been performed using industry-standard instrumentation;
- Collar surveys for legacy drillholes were performed using methods that were industry-standard for the time;
- Down-hole surveys performed after 2008 were performed using industry-standard instrumentation;
- Prior to 1996, magnetic single-shot cameras were used for down-hole surveys. Although standard for the time, these readings can be affected by magnetic rocks and drill casings. From 1996 to 2006, industry-standard instrumentation was used;
- Drilling practices, logging, collar surveys and down-hole surveys have been periodically reviewed by independent auditors (refer to Section 12);
- Recovery data from core drill programs are acceptable;
- Geotechnical logging of drill core meets industry standards for planned open pit and underground operations;
- Drilling is normally perpendicular to the strike of the mineralization;
- Drill orientations are shown in the example cross-sections in Section 7, and are considered to appropriately test the mineralization;
- No factors were identified with the data collection from the drill programs that could affect Mineral Resource or Mineral Reserve estimation.

11.0 SAMPLE PREPARATION, ANALYSES, AND SECURITY

11.1 Sampling Methods

11.1.1 Face Samples

Nearly every mining face is marked with paint to delineate the mineral subtypes, plus argillite and phyllite wall rocks, low-grade mineralized material, and occasional high-grade precious metals zones. Usually a single face sample is taken from each mineral type; where the area represented by a mineral type is greater than 50 ft^2 (4.6 m^2), multiple face samples are taken. These samples are taken by chipping the face on an irregular grid.

The locations of stope-face samples are initially recorded in the grade control geologist's field book, wherein the geologist records the distance to the face, typically the center, from a spad, rib or other reference object/feature. On the surface, the geologist utilizes an AutoLISP program within AutoCAD to insert a "stope-face" block at the appropriate measured distance from the reference object into an as-built drawing for the appropriate bench elevation. The orientation of the stope-face (relative to the drift/drive) is determined by the geologist. The geologist adjusts the stope-face block positions manually based upon detailed stope surveys.

The area of each sampled face is calculated using two different methods. The first method is the traditional cross-sectional area (width by height). The second method relies upon digital photography of the face and then on-screen digitization of the distinct sample areas on the photo. The individual sample areas are electronically summed and then compared with the first method. Hecla tolerates up to a 20% difference between the two area methods; differences larger than this are not permitted by the data-entry procedure, which requires the data entry person to modify the input data.

A detailed survey is performed in active stopes at least every five days and preferably after every three rounds. The elevation is initially based on the mid-rib elevation and is more accurately "back determined" at the end of the month through the wire-framing of the back and floor survey points.

The survey crew consists of a single individual utilizing a special Geodimeter total station equipped with a visible red laser. The instrument calculates the distance to an object by reading the reflected laser beam. This makes for very efficient single-person surveying, although erroneous distance readings can and do occur. The distance that can be measured is limited/impacted by the reflectivity of the target object, the clarity of the air in the stope/drive, and the angle at which the laser hits the target. The erroneous distances for the detailed survey points are readily identified and removed after loading the survey data into AutoCAD.

11.1.2 Core Samples

Drill core is sampled using two methods based on the stage of drilling. Exploration and definition drilling are sampled on intervals ranging from 1 to 5 ft (0.3 to 1.5 m) that do not cross lithological boundaries. Exploration drillholes are cut and sampled as half-core; definition drillholes are whole-core sampled.

Barren contacts are sampled through 15-ft (4.6-m) ‘buffer’ zones into the hanging wall and the footwall; whereas mineralized or ore-type contacts are sampled through 30-ft (9.2-m) ‘buffers’ into the hanging wall and footwall. If a mineral type lithology is encountered off the mine contact, it will also receive a 30-ft (9.2-m) buffer on both sides. If a mineralized, but non-ore type, lithology is encountered off the mine contact, the buffer length is at the discretion of the logging geologist, but not to be less than 5 feet (1.5 m).

For sampling the buffer zones, narrower intervals of one 2-ft (0.6-m) followed by one 3-ft (1-m) sample, are placed immediately adjacent to lithological contacts; 5-ft (1.5-m) intervals are sampled through the rest of the buffer zone.

Mineralization occurring within veins or as remobilized bands away from contacts are sampled in 5-ft (1.5-m) intervals or less, depending on the thickness of mineralization, and are enclosed by 5-ft (1.5-m) buffer samples.

Geologists are responsible for identifying samples in the core, labeling each sample extent with polyvinyl chloride (PVC) flagging, and documenting them with photographic logs. Sample intervals are also recorded on the paper log sheets and in the drillhole database. Core samples are dispatched to the underground cutting facility where technicians process the sample intervals into half-core samples. The half-core sample intervals are individually bagged and then delivered to the laboratory.

Pre-production and stope drillholes are typically sampled through the majority of the drillhole as whole-core, with sample intervals ranging from 1 to 5 feet (0.3–1.5 m). Samples are documented in an identical method to exploration and definition core.

11.2 Metallurgical Sampling

Prior to 2000, composited quarter-cut definition drill core was used for metallurgical test work on a mineral zone basis in selective cases. The core was chosen from select definition drillhole intervals that had been previously sampled. Since 2000, metallurgical sampling is done using quarter-cut definition or exploration drill core on an as-needed basis when new zones or new mineral styles are encountered.

11.3 Density/SG Determinations

The procedure for measuring specific gravity (SG) of core at Greens Creek is the weight in water versus weight in air method. The weighing takes place after the core has been logged, but before the core is cut, and occurs in the underground core cutting facility. Exploration and definition core holes are considered for density sampling.

Samples of whole core approximately 1 to 5 feet (0.3 to1.5 m) in length are weighed in air and the weight is recorded on the paper SG sheet. The sample and tray are then placed in water until fully submerged and the weight recorded. Completed sheets are returned to the 860-Core Shack for manual data entry. At the time of data entry, the weight of the basket, wet and dry, is subtracted from the recorded weights accordingly and the final values are manually entered into the acQuire® database.

SG measurements are required of all exploration or definition core that is a mineralized or ore-type lithology as well as the associated buffer samples. For exploration drilling, all mineralized lithologies are sampled for SG measurements. For definition drilling, all mineralized lithologies within a 15-ft buffer of the main mineralized zones are sampled for SG measurements.

Highly fractured or faulted core is measured for SG, though it is difficult. The holes in the tray used are several millimeters in diameter. Material deemed at risk for falling or flowing through those holes is generally not weighed in water or in air. This type of material makes up a relatively small percentage of the total samples and is generally related to heavily-faulted intervals.

11.4 Analytical and Test Laboratories

Table 11-1 summarizes the laboratories utilized throughout the Project history and covers legacy and current operations. All laboratories are independent of Hecla and previous operators, except for the site laboratory and Kennecott Utah Copper laboratory. Dates of legacy contracts are best estimates and noted as “unclear” where the information was not available.

Bondar Clegg Canada Ltd. (Bondar Clegg), now part of ALS Chemex Laboratories, obtained ISO 9001 certification in 1998; however, its accreditation through the period of use at Greens Creek is not known. SVL Laboratories accreditation through the period of use at Greens Creek is also unknown. The accreditation of other metallurgical laboratories, Lakefield Research, company laboratories, Kennecott Utah Copper Labs and CESL, are not known.

McClelland Laboratories is a metallurgical laboratory with extensive experience in precious metals metallurgy and process and a good reputation within the mining industry; however, it is not a certified laboratory. SGS is an ISO 9001 certified laboratory.

Acme was ISO 9001 certified in 1997 and successfully maintained that certification until its acquisition by Bureau Veritas in 2015. Acme and Inspectorate Laboratories were acquired and successfully integrated by Bureau Veritas starting January 1, 2015. Bureau Veritas (BV) is also ISO 9001 certified. Acme/BV has been the primary lab used for exploration and definition drill core from 1987 to present. The Greens Creek Mine site laboratory is used for pre-production and grade control samples and is the secondary laboratory used for exploration and definition drill core samples since 2002. The Greens Creek Mine site laboratory has participated in round robin programs to compare its results to other laboratories intermittently throughout its history but is not a certified laboratory.

Table 11-1: Assay Laboratories used at Greens Creek

Laboratory	Location	Period of Use		Comments
Bondar Clegg Canada Ltd.	Vancouver, BC	1976	1982	Primary laboratory for early surface exploration and definition drill core
Acme Analytical Laboratories Ltd.	Vancouver, BC	1987	2015	Primary laboratory for all exploration and definition drill core
Bureau Veritas	Vancouver, BC	2015	2018	Primary laboratory for all exploration and definition drill core after acquisition of Acme Analytical
SVL Analytical	Kellogg, ID	1987	2002	Primary laboratory for all exploration and definition drill core until Acme, then secondary umpire lab until 2002
McClelland Laboratories, INC	Sparks, NV	1988	Unclear	Gravity concentrates
Site laboratory	Greens Creek Mine Site	1989	2018	Primary laboratory for some exploration and definition drill core in 1989-90 range. Primary laboratory for pre-production and stope drill core and grade control samples since 1994. Secondary laboratory for all exploration and definition drill core since 2002.
Lakefield Research		1992	1994	West Zone tests
Kennecott Utah Copper laboratory	Salt Lake City, UT	1996	2000	Acid rock drainage (ARD) samples 1996–2000
CESL	Vancouver, BC	1998	2008	ARD samples 1996–2000
SGS Canada Inc.	Toronto, On	2006	2010	Surface soil MMI analysis

11.5 Sample Preparation and Analysis

11.5.1 Legacy Sampling

Sample preparation and analytical methods have been consistent with the current methods since 1998 (MRDI, 1998). Methods prior to 1998 are not well documented and are not known in detail.

11.5.2 Hecla Sampling

From 2008 through late 2011, all drill core sample preparation was done at Acme lab locations in Whitehorse, Yukon or Vancouver, British Columbia. In late 2011, a sample preparation laboratory, purchased by Greens Creek but operated by Acme Lab personnel, was established on the Greens Creek site. From late 2011 on, nearly all exploration and definition core samples were prepared for analysis at this facility on site and then shipped to the Acme Lab facility in Vancouver for analysis. Preparation procedures were the same, whether they occurred at the Whitehorse or Vancouver sites or were prepared at the Greens Creek facility. The on-site preparation was discontinued in 2015 with the establishment of a new sample preparation facility in Juneau, AK by Bureau Veritas.

The current preparation procedure consists of crushing to 70% passing 10 mesh (2 mm), riffle splitting approximately 250 g, then ring pulverizing to 95% passing 150 mesh (106 microns). Additional cleaning of the preparation equipment is requested after high base metal content samples. Of the pulverized material 115 to 120 g is sent for analysis, and the remaining 115 to 120 g are stored as a master pulp.

Currently, all mineralized definition and exploration drill core is assayed at BV for Au, Ag, Pb, Zn, Cu, Fe, and Ba. All mineralized samples are also analyzed for a 33 element inductively coupled plasma emission spectroscopy (ICP-ES) assay suite.

Silver and base metal assays for Pb, Zn, Cu, and Fe are performed using ICP-ES on 1.0 g samples digested in hot aqua regia. Automatic re-analysis is triggered on a smaller sample size if results return above detection limits. Silver is re-assayed by fire-assay with gravimetric finish if the initial ICP-ES results are greater than 300 ppm and by metallic-screen fire assay if the original over-limit assay is greater than 80 oz/ton.

The standard assay package employed consists of fire assay for Au on a 30 g sample with an AA finish. Gold is re-assayed by gravimetric finish if the initial fire assay results return values above 7 ppm. A metallic-screen fire assay is performed on all samples with the original over-limit assay greater than 7 ppm.

Preparation for the 33-element suite involves a 0.5 g sample split digested in an aqua regia solution containing equal parts HCl, HNO_3, and de-ionized H_2O before analysis by ICP-ES.

Analysis for Ba is a lithium borate fusion of a 0.2 g sub-sample with analysis by ICP-ES.

Since 2008, the on-site laboratory has been used as the primary laboratory for pre-production and in-stope drill core as well as an umpire laboratory for definition and exploration drill core. The standard assay package employed consists of fire assay for Au and Ag, and ICP-ES analysis for Pb, Zn, Cu, and Fe.

11.6 Quality Assurance and Quality Control (QA/QC)

11.6.1 Legacy QA/QC

Previous (pre-2008) operators have used a similar system to the current QA/QC methodology. Legacy assaying protocols are typical of those employed in the mining industry and have been described in several reports (MRDI 1998 and 1999; AMEC, 2005, 2008 and 2013). The 1998 MRDI report is referenced as the source of pre-1998 legacy QA/QC procedures by all the subsequent audit reports, with QA/QC of drillholes added since 1998 covered by each subsequent report period (see Section 12 for a description of external reviews on Greens Creek data).

Standards

Different standard reference materials (SRMs) were created by the Greens Creek Joint Venture (GCJV) to reflect the different mineral types at Greens Creek, and successor SRMs were created as the stocks became exhausted. SRMs were prepared at Hazen Research by ball milling to exceed 95% passing a 150-mesh screen. Ten packets of each SRM were submitted to independent commercial laboratories to determine the recommended values for controlling quality.

Standards B, D, F and G were made from Southwest Zone cores. Standards E and H were made from Northwest West and West Zone cores. Standard I was made from mineralized material from a stope in the 200S Zone. The material was submitted to six independent laboratories: Hazen Research, Denver; SVL, Acme, Cone Geochemical Laboratories, Lakefield, CO; Rocky Mountain Geochemical Laboratories (RMG), and Chemex, Mississauga, Ontario. Standard H was characterized by Acme, CAS, RMG and SVL. Standard I was submitted to Acme, Hazen, SVL, RMG, and two laboratories not previously used: Actlabs, Wheatridge, CO; and SGS, Vancouver, B.C.

Duplicates

Duplicate assays were performed at the same laboratory as the original assays and were not "blind." Acme performed assay (same pulp) duplicates and coarse reject (second split, second pulp) duplicates on every 10th sample and reported the results on the same assay certificate. Duplicate assay (same pulp) and coarse reject duplicates (second split and second pulp) were performed for one in every 20 samples by the mine site laboratory.

Check Assays

Most of the Greens Creek drillholes were included in a check assay program where SVL Analytical, formerly Silver Valley Laboratories, of Kellogg, Idaho was the umpire laboratory.

Approximately one in 15 samples were selected for a check assay on the pulp. The checks were selected from intervals logged as massive and white mineral styles in approximately equal amounts. Any interval showing visible gold was also selected for check assay. Selected samples were recorded on the sample submission form, directing Acme to send a split of the pulp to SVL. After receiving Acme assay results, geologists examined the results for a reasonable match to geologic observation and requested additional check assays on samples that reported unreasonably high or low values.

SVL performed a fire assay for Au and Ag using a half-assay ton sample. SVL determined Pb, Zn, and Cu by AA on 1.0 g samples digested in aqua regia. SVL analyzed base metals by AA. If samples reported above 15 percent Zn or above 20 percent Pb (as determined by AA), those samples were re-assayed using titration methods.

Acme performed check assays on pulps selected from drillhole samples prepared and assayed by the mine site laboratory, using the protocols described above. The practice of submitting pulps for check assay was discontinued for pre-production drillholes on April 1, 1998.

11.6.2 Hecla QA/QC

Since 2008, Hecla has used two laboratories for drill core assays: the Hecla mine site laboratory; and Acme, followed by its successor laboratory, Bureau Veritas (BV), in Vancouver, Canada. Bureau Veritas acquired Acme in 2015 and is currently the primary commercial laboratory for Greens Creek. Batches are controlled by a system of SRMs, pulp duplicate samples, coarse reject duplicate samples, and check assay submittals.

Standards

From 2008 to 2011, standards materials were sourced from underground bulk samples or drill core and then prepared and certified by Hazen Research, Inc. of Golden, Colorado. The Hazen Research standards used from 2008 are Standard K, Standard L, Standard N, and Standard P; these materials were used until exhausted during the period between 2012 and 2015.

Beginning in 2011, standards materials were prepared and certified by CDN Resource Laboratories Ltd (CDN) of Langley, B.C., Canada. Additional standards have been prepared as needed by CDN through 2018. A summary of the various standards used since 2008 and the material from which they were sourced are summarized in Table 11-2. All reference materials used have certified values for Au, Ag, Pb, Zn, Cu, and Fe. A more detailed summary of the source, preparing company, certificate dates and certificate values for the reference standards used are presented in Table 11-3.

From 2008 to March 2018, one standard was submitted as the 10th sample of each drillhole; an additional standard was inserted for every subsequent 20 samples and as the last sample for every drillhole. Beginning in March 2018, one standard is submitted as the 10th sample of each drillhole with an additional standard inserted for every subsequent 25 samples.

Standard assay results are reported along with the primary assay results and are captured by the acQuire® database during the normal importing routine. Upon receipt, the results for the standards are compared with certified values by the project geologist using graphical reports generated by acQuire® database utilities. From 2008 to March 2018, analyses for jobs are rejected if one standard per submittal is outside of three standard deviations from the certified value, or if two standards per submittal are outside of two standard deviations from the certified value.

Beginning in March 2018, if the running mean on any standard assay over time (5 sample moving average) exceeds the 2x standard-deviation limits, the batches associated to those samples causing the exceedance are re-assayed. As in the previous period, if a single sample exceeds the 3x standard-deviation limits, the associated batch is re-assayed.

Table 11-2: Standards used at Greens Creek

STANDARD NAME		STD K	STD L	STD N	STD P	STD Q	STD-ME-15	STD S	STD T
DESCRIPTION		200S Massive Ore Standard	5250 Low Grade Ore Standard	Gallagher Low Grade Ore Standard	NWW Massive Ore Standard	200S Exploration Grade Standard	Purchased from CDN Resource Laboratories Ltd	Exploration Grade Standard	Low Grade Ore Standard
SOURCE MATERIAL		Greens Creek UG Bulk Sample	Greens Creek UG Bulk Sample	Greens Creek UG Drill Core	Greens Creek UG Bulk Sample	Greens Creek UG Drill Core	Cerro de San Pedro deposit, San Luis Potosi, Mexico	Greens Creek UG Drill Core	Greens Creek UG Drill Core
YEARS USED	2008	X	X						
	2009	X	X	X					
	2010	X		X	X				
	2011	X	X	X	X	X			
	2012	X		X	X	X	X		
	2013			X	X	X	X	X	X
	2014			X	X		X	X	X
	2015			X	X	X	X	X	X
	2016					X	X		
	2017								
	2018							X	
	2019								

STANDARD NAME		STD S14	STD T14	STD U	STD V	BLK-BHQ1	STD V17	STD T17	STD U18
DESCRIPTION		Exploration Grade Standard	Moderate Grade Ore Standard	Exploration Grade Standard	Moderate Grade Ore Standard	Blank Rock Standard (basalt)	5250 High Grade Ore Standard	9A Moderate Grade Ore Standard	Low Grade Standard
SOURCE MATERIAL		Greens Creek UG Drill Core	Greens Creek UG Drill Core	Greens Creek UG Drill Core	Greens Creek UG Drill Core	Brown's Hill Quarry, Fairbanks	Greens Creek UG Bulk Sample	Greens Creek UG Bulk Sample	Greens Creek UG Drill Core
YEARS USED	2008								
	2009								
	2010								
	2011								
	2012								
	2013								
	2014								
	2015	X	X						
	2016	X	X	X	X				
	2017		X	X	X	X			
	2018	X	X	X	X	X	X	X	X
	2019					X	X	X	X

Table 11-3: Standards used at Greens Creek – Source and Characterization

STANDARD NAME	STD K	STD L	STD N	STD P	STD Q	CDN-ME-15	STD S	STD T
DESCRIPTION	200S Massive Ore Standard	5250 Low Grade Ore Standard	Gallagher Low Grade Ore Standard	NWW Massive Ore Standard	200S Exploration Grade Standard	Low Grade Ore Standard	Exploration Grade Standard	Low Grade Ore Standard
SOURCE MATERIAL	UG Bulk Sample	UG Bulk Sample	UG Drill Core	UG Bulk Sample	UG Drill Core	Commercial	UG Drill Core	UG Drill Core
SOURCE FACILITY	Hazen Research Inc.	Hazen Research Inc.	Hazen Research Inc.	Hazen Research Inc.	CDN Labs	CDN Labs	CDN Labs	CDN Labs
CERTIFICATE DATE	5-May-2000	2-Dec-2003	6-Nov-2006	14-Apr-2010	May, 2010	2012	Oct, 2012	Oct, 2012
CERTIFICATE METALS	Au, Ag, Cu, Pb,Zn, Fe	Au, Ag, Cu, Pb,Zn, Fe	Au, Ag, Cu, Pb,Zn, Fe	Au, Ag, Cu, Pb,Zn, Fe	Au, Ag, Pb,Zn, Fe	Au, Ag, Cu, Pb,Zn	Au, Ag, Cu, Pb,Zn, Fe	Au, Ag, Cu, Pb,Zn, Fe
STANDARD NAME	STD S14	STD T14	STD U	STD V	BLK-BHQ1 *	STD V17 *	STD T17 *	STD U18 *
DESCRIPTION	Exploration Grade Standard	Moderate Grade Ore Standard	Exploration Grade Standard	Moderate Grade Ore Standard	Blank Rock Standard	5250 High Grade Ore Standard	9A Moderate Grade Ore Standard	Low Grade Standard
SOURCE MATERIAL	UG Drill Core	UG Drill Core	UG Drill Core	UG Drill Core	Quarried Basalt	UG Bulk Sample	UG Bulk Sample	UG Drill Core
SOURCE FACILITY	CDN Labs	CDN Labs	CDN Labs	CDN Labs	Browns Hill Quarry, Fairbanks	CDN Labs	CDN Labs	CDN Labs
CERTIFICATE DATE	Aug, 2014	Sept, 2014	Aug, 2016	Aug, 2016	2017	June, 2018	June, 2018	Sept, 2018
CERTIFICATE METALS	Au, Ag, Cu, Pb,Zn, Fe	Au, Ag, Cu, Pb,Zn, Fe	Au, Ag, Cu, Pb,Zn, Fe	Au, Ag, Cu, Pb,Zn, Fe	-	Au, Ag, Cu, Pb,Zn	Au, Ag, Cu, Pb,Zn, Fe	Au, Ag, Cu, Pb,Zn, Fe

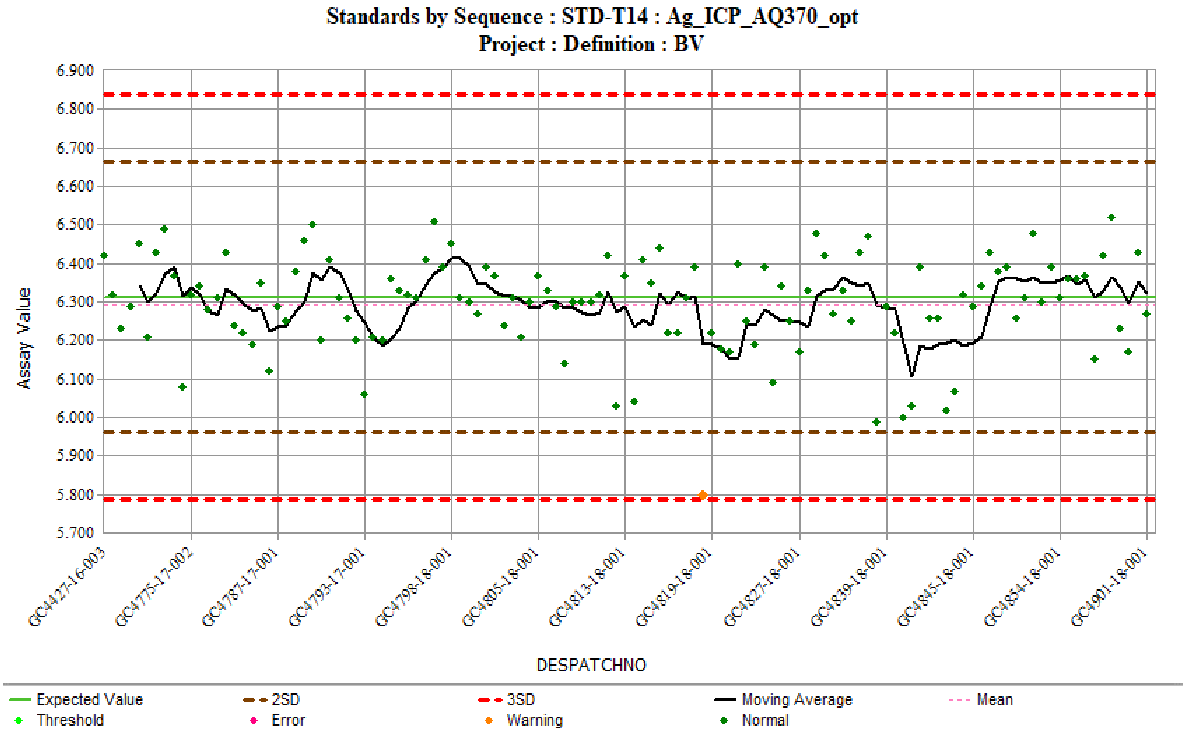
Rejected jobs are re-assayed for the element or elements that failed. Control charts are generated and reviewed by year; all standards have performed with satisfactory accuracy and precision for Au, Ag, Pb, and Zn throughout their use. An example of the statistics and control charts reviewed for Standard T14 for 2018 are presented in Table 11-4 and Figure 11-1 for Ag and Au, and Figure 11-2 for Pb and Zn.

The statistics and controls charts show some variability with a few instances outside the 2x standard deviation 'warning limits'. Most of the data and the overall trends are within the acceptance limits for the period indicating acceptable accuracy and precision for the metal analyses.

Table 11-4: Standard T14 2016 to 2018 Analytical Results – Bureau Veritas

Statistic				
# of Analyses	121	121	121	113
# Outside Warning Limit	1	1	0	2
# Outside Error Limit	0	0	0	0
# of Analyses below Threshold	0	0	0	0
	Ag_ICP_oz/st	**Au_FA_oz/st**	**Pb_ICP_%**	**Zn_ICP_%**
Mean	6.29	0.201	5.18	19.37
Median	6.31	0.201	5.20	19.38
Min	5.80	0.174	5.00	18.48
Max	6.52	0.228	5.40	19.97
Standard Deviation	0.13	0.010	0.09	0.32
% Rel. Std. Dev.	1.99	4.909	1.65	1.66
Coeff. of Var.	0.02	0.049	0.02	0.02
Standard Error	0.01	0.001	0.01	0.03
% Rel. Std. Err.	0.18	0.446	0.15	0.16
Total Bias	0.00	0.018	0.00	-0.01
% Mean Bias	-0.30	1.808	-0.09	-1.31

Figure 11-1: Standard Control Charts – Standard T14: Ag, Au – Bureau Veritas 2018



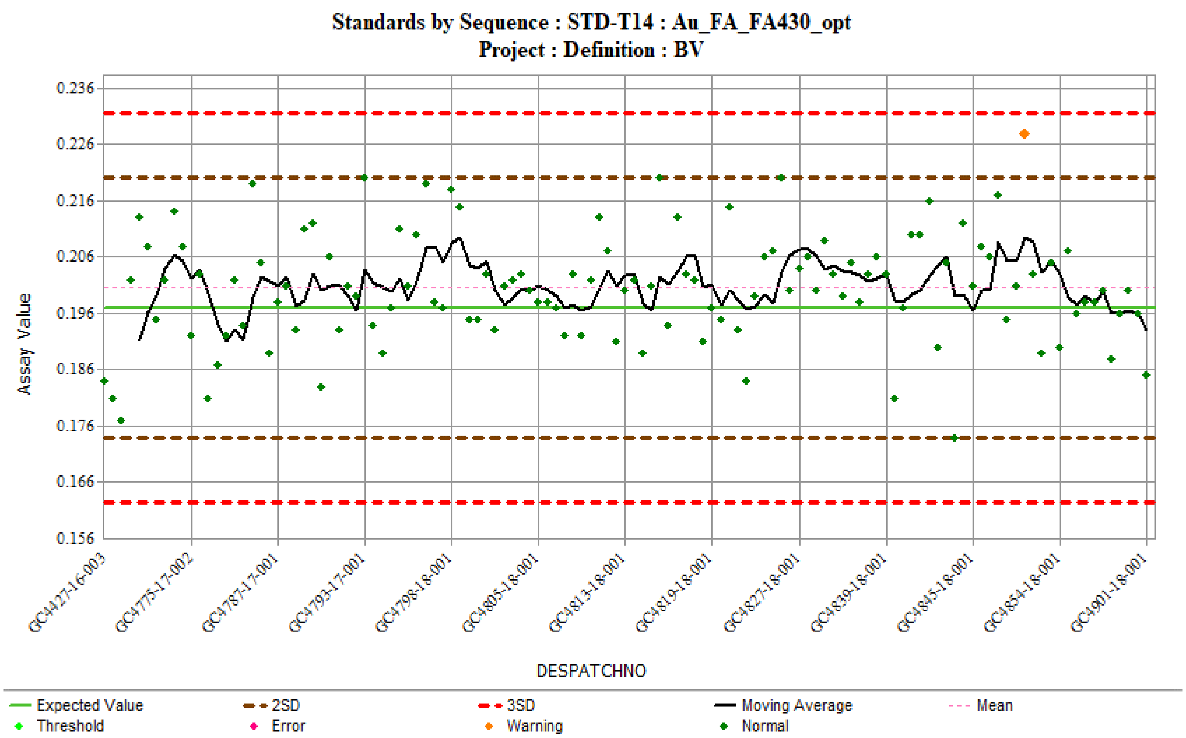
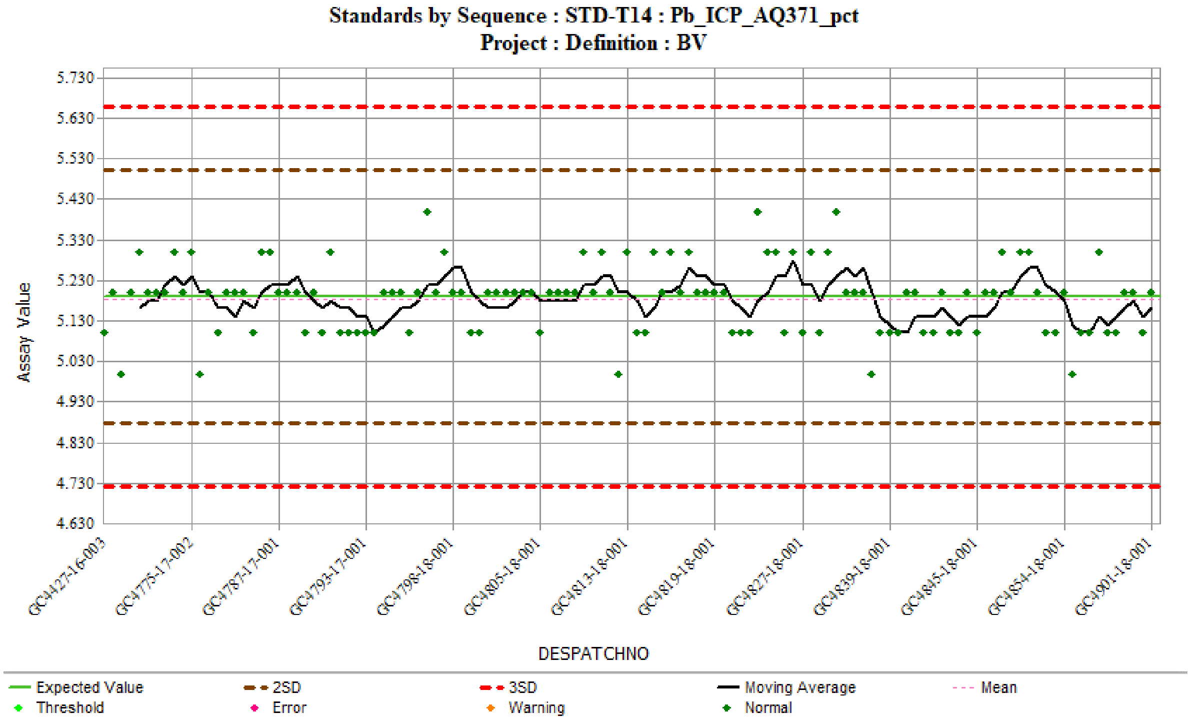
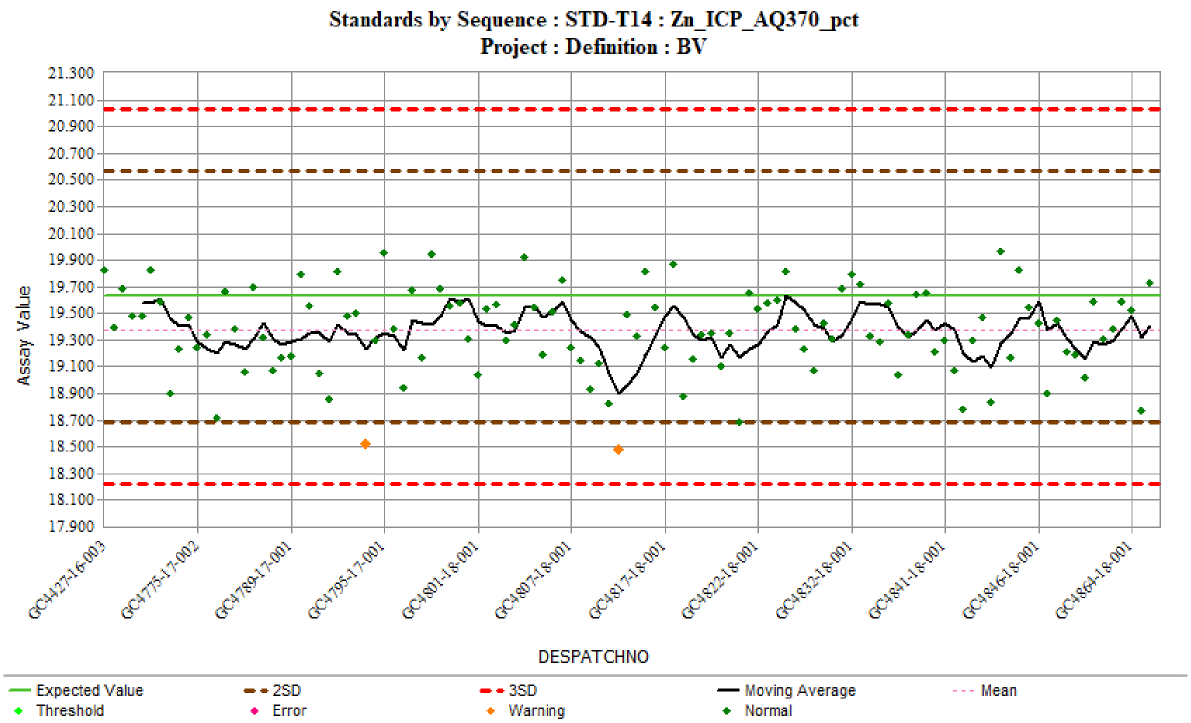


Figure 11-2: Standard Control Charts – Standard T14: Pb, Zn – Bureau Veritas 2018





Blanks

Prior to late 2017, no coarse blank material was used except for BV laboratory's internal blanks. To begin a blank program, a minus 1" crushed basalt was purchased from the Browns Hill Quarry in North Pole, AK, so that sample preparation and analytical processes could be tested. Starting in October 2017, blanks samples are inserted within each mineral intercept with an overall insertion rate of approximately 1 in 20 samples. The performance limits for this material are being evaluated as the analytical database increases.

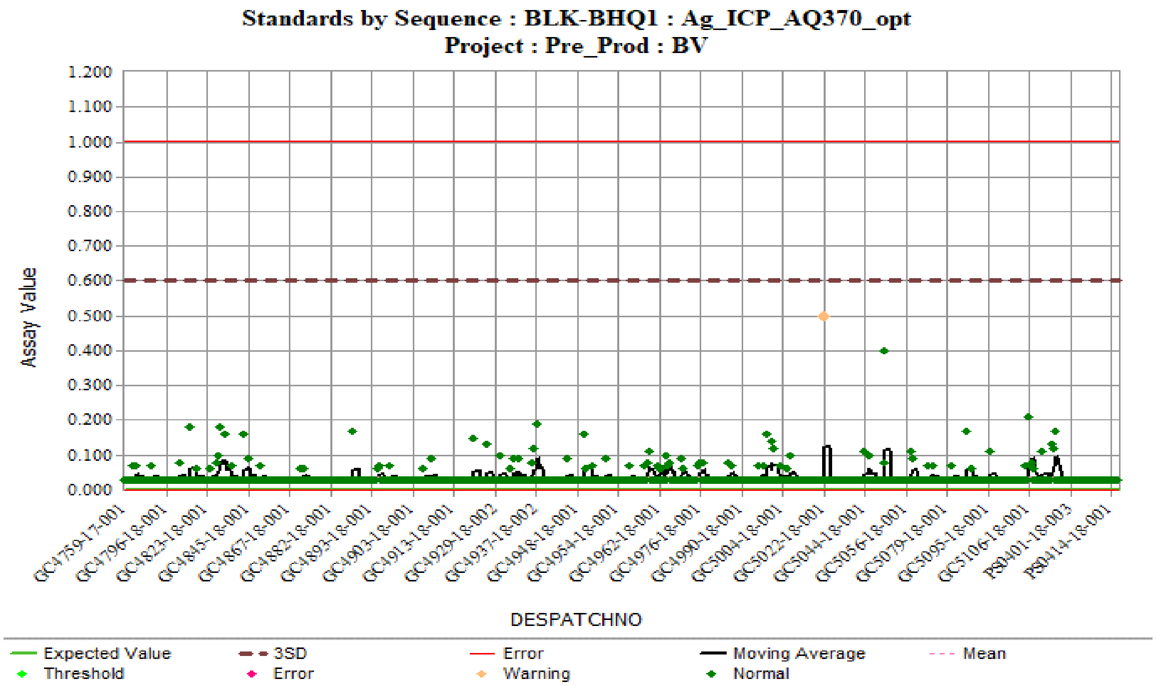
For the coarse blank standards, any blank registering more than 3x the assay detection limit is reviewed. If the amount of contamination could contribute 10% or more of the metal seen in adjoining samples, the possibly contaminated samples are noted to the resource geologist. Though the contamination may have come during the comminution stage, the pulps of the likely contaminated sample are re-assayed. Pulp blanks inserted by the lab are also reviewed to determine if the contamination is occurring during the analytical stage. A letter is also sent to the preparation lab, notifying them of any contamination.

Blanks statistics and controls charts for 2018 are presented in Table 11-5 and Figure 11-3 for Au and Ag, and Figure 11-4 for Pb and Zn. Blanks statistics and controls charts show acceptable metal analyses with few warnings and anomalous results for the period. One instance shows anomalous results for Pb and Zn; but no significant contamination is interpreted.

Table 11-5: Blank BHQ1 – 2018 Analytical Results – Bureau Veritas Laboratory

Statistics	Ag_ICP_oz/st	Au_FA_oz/st	Pb_ICP_%	Zn_ICP_%
Number of Analyses	726	726	726	726
Number Outside Warning Limit	1	3	4	3
Number Outside Error Limit	0	0	1	1
% Outside Error Limit	0	0	0.14	0.14
Mean	0.039	0.000	0.0034	0.0068
Median	0.030	0.000	0.001	0.001
Min	0.030	0.000	0.001	0.001
Max	0.500	0.024	0.36	0.86
Standard Deviation	0.033	0.001	0.0151	0.0334

Figure 11-3: Standard Control Charts- Blank BHQ1: Au and Ag- Bureau Veritas 2018



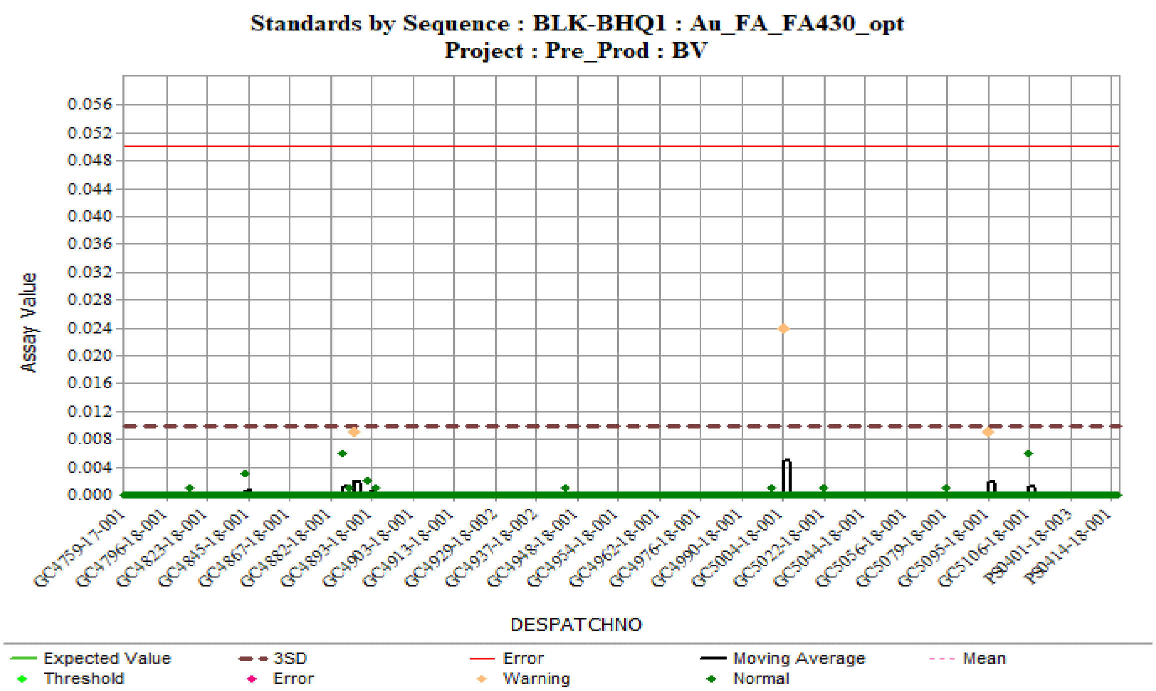
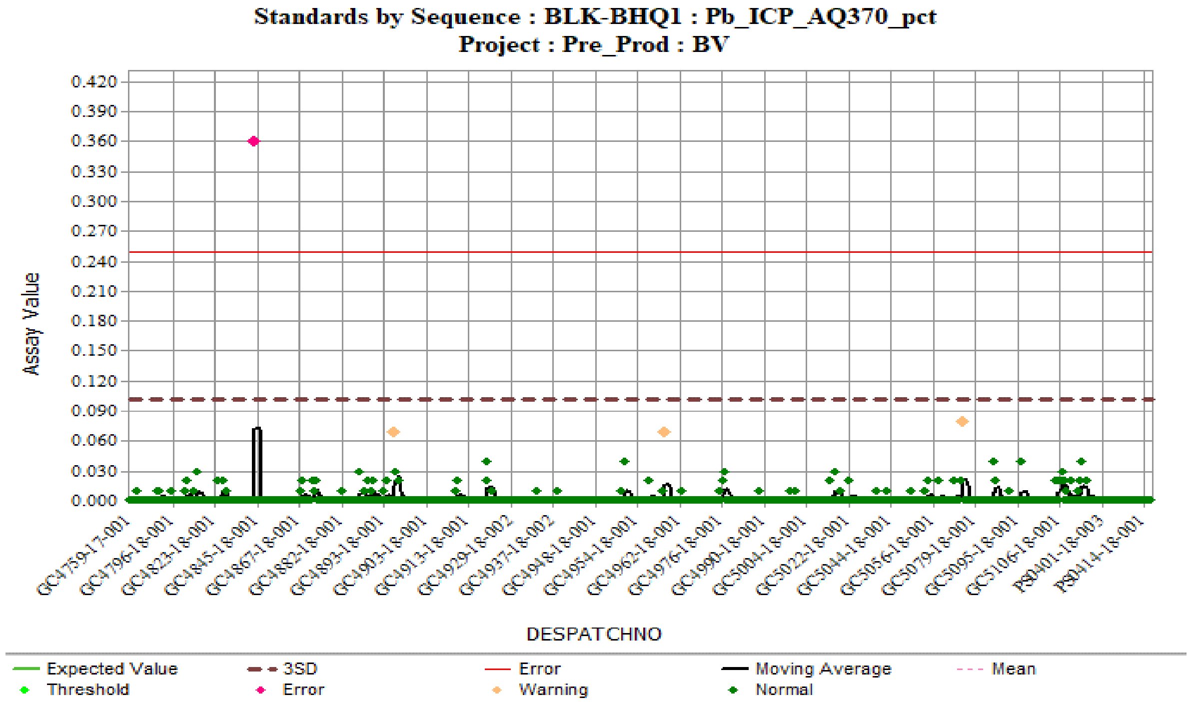
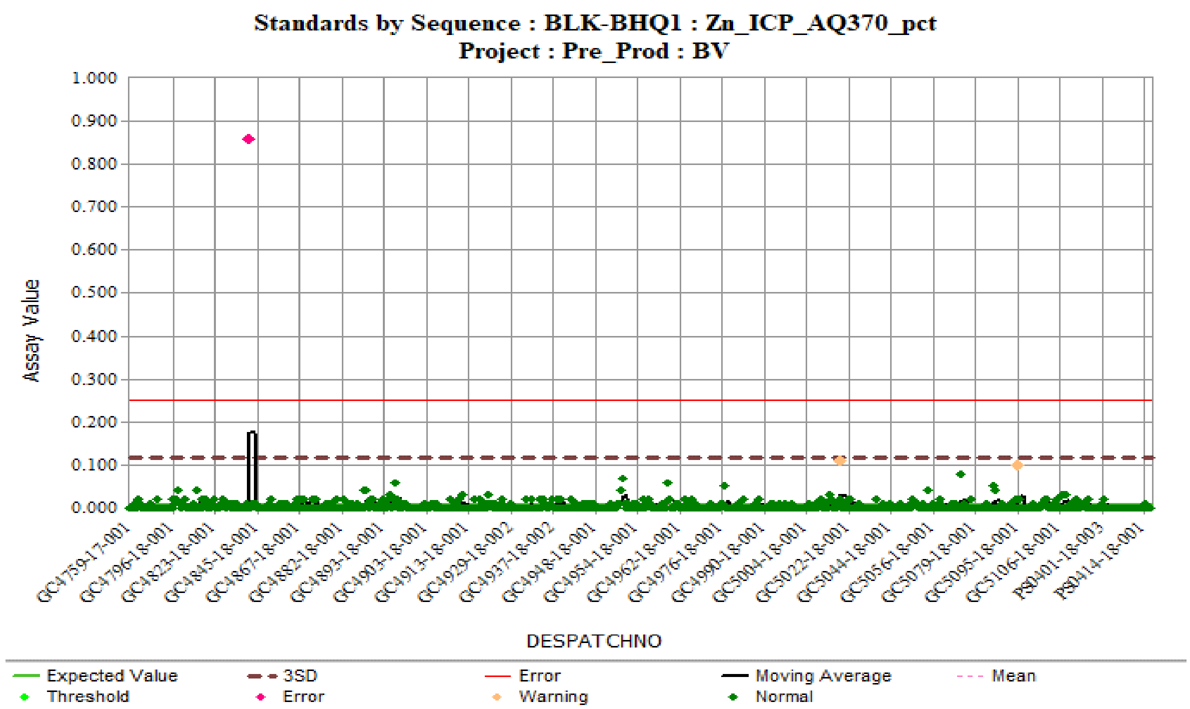


Figure 11-4: Standard Control Charts- Blank BHQ1: Pb and Zn- Bureau Veritas 2018





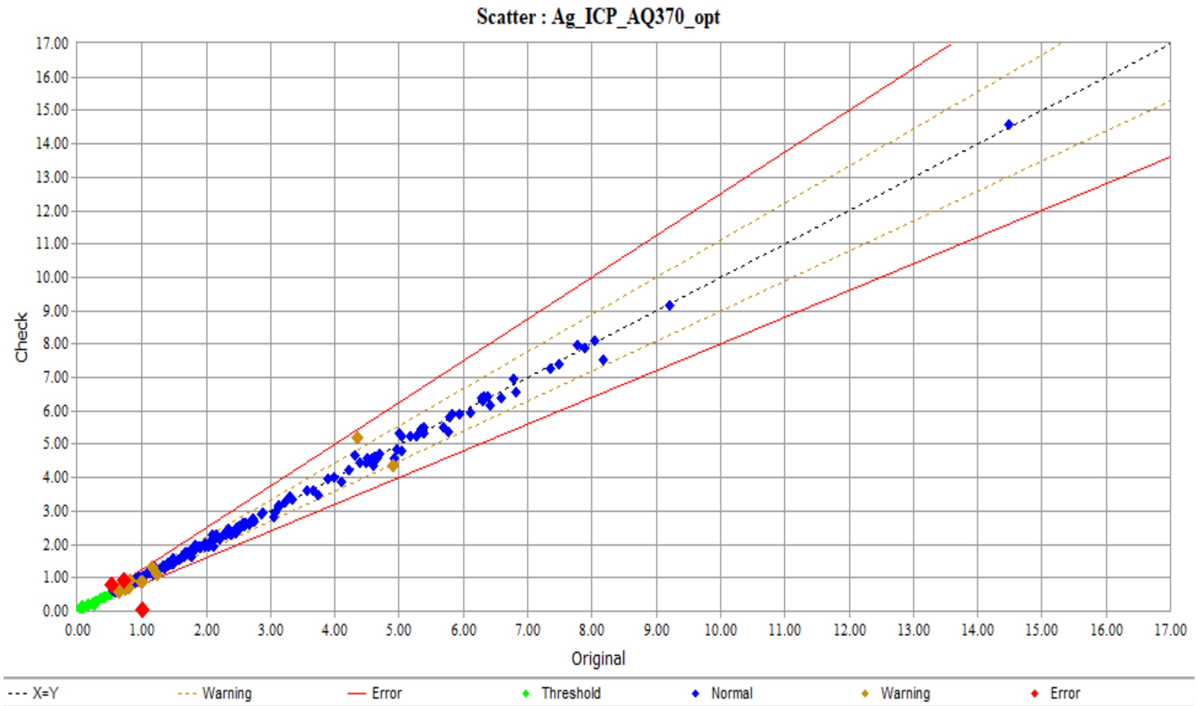
Duplicates

Coarse reject duplicate samples are randomly assigned at a rate of approximately one in every 36 samples by BV during the preparation stage of the process. These samples are an extra split from the crushed sample that is then treated as any other sample from that stage onward. Results for these samples are reported by the laboratory along with the primary assay results and are captured by the acQuire® database during the normal importing routine. The performance of these duplicates has been reviewed during various in-house quarterly and yearly studies and third-party audits.

From 2008 to 2015, pulp duplicate samples were randomly assigned at a rate of approximately one in every 36 samples and represent the repeat of a specific analytical run. From 2015 to 2017, it appears that many of these duplicates were not being analyzed at the site lab; efforts are being made to analyze some of the back-log of duplicates.

The current practice is to create a pulp duplicate for 1 in 20 samples. These duplicate samples are analyzed at BV with 50% of them also being analyzed at the Greens Creek Lab. Results for these samples are reported on the assay sheets and are imported into the acQuire® database during the normal importing routine. The performance of these duplicates has been reviewed during various in-house quarterly and yearly studies and third-party audits. Scatterplots for the 2018 pulp duplicate data analyzed at BV are presented in Figure 11-5 for Ag and Au, and Figure 11-6 for Pb and Zn. The scatterplots show good agreement for Ag, Pb, and Zn in the important grade ranges; Au shows some variability. Additional checking for Au is ongoing.

Figure 11-5: Pulp Duplicate Analyses for Ag and Au- Bureau Veritas 2018



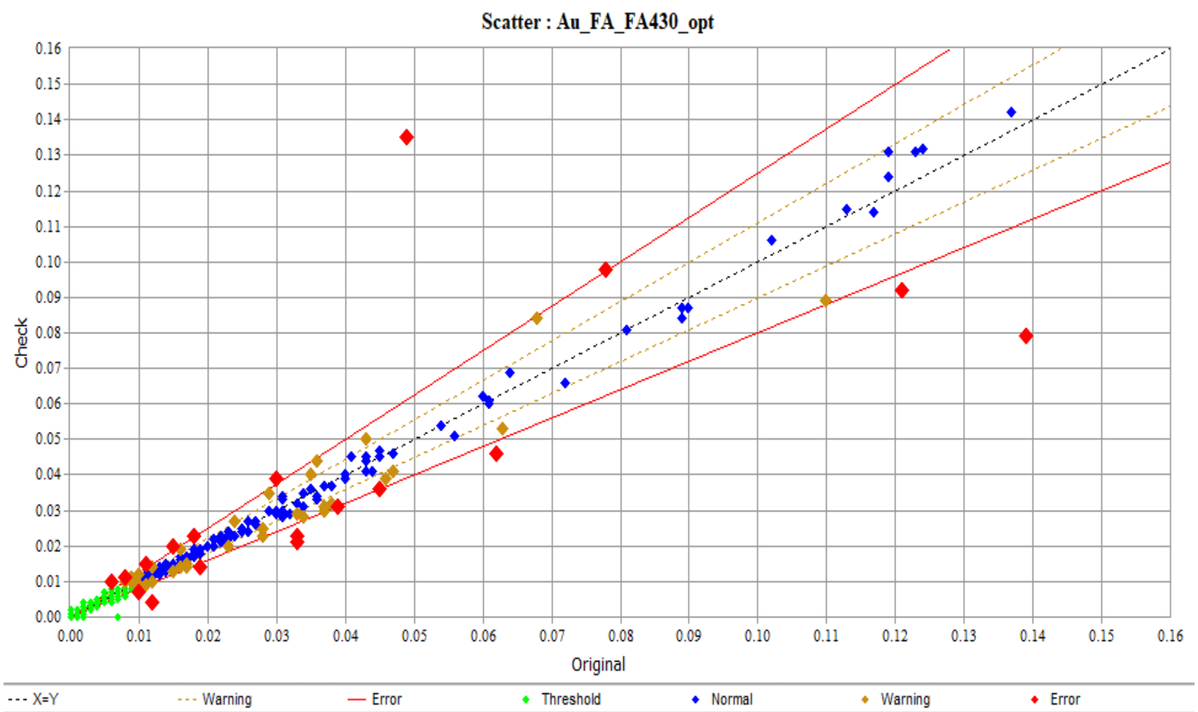
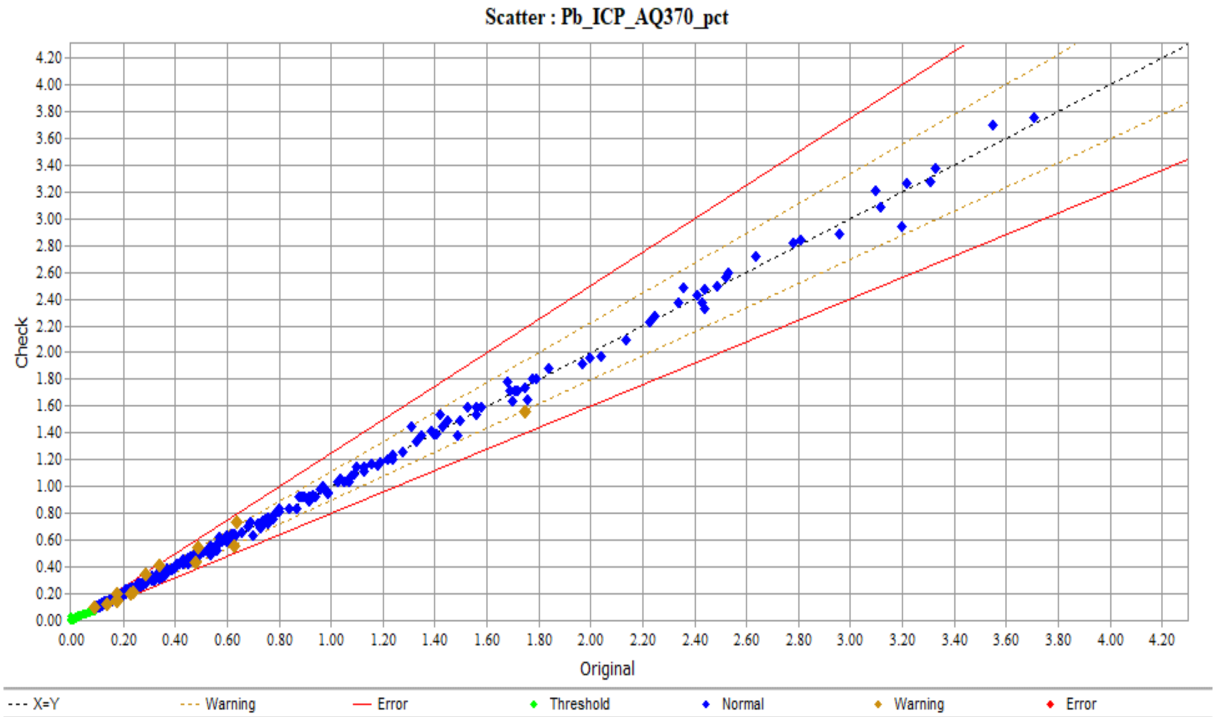
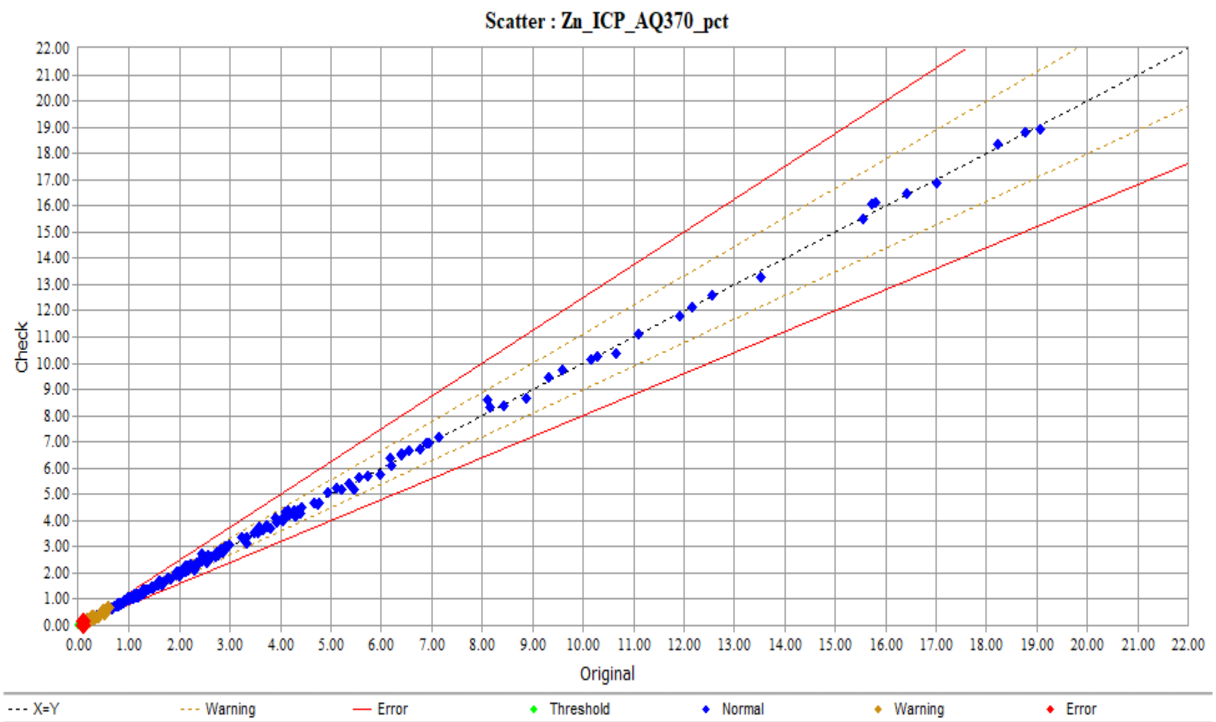


Figure 11-6: Pulp Duplicate Analyses for Pb and Zn- Bureau Veritas 2018

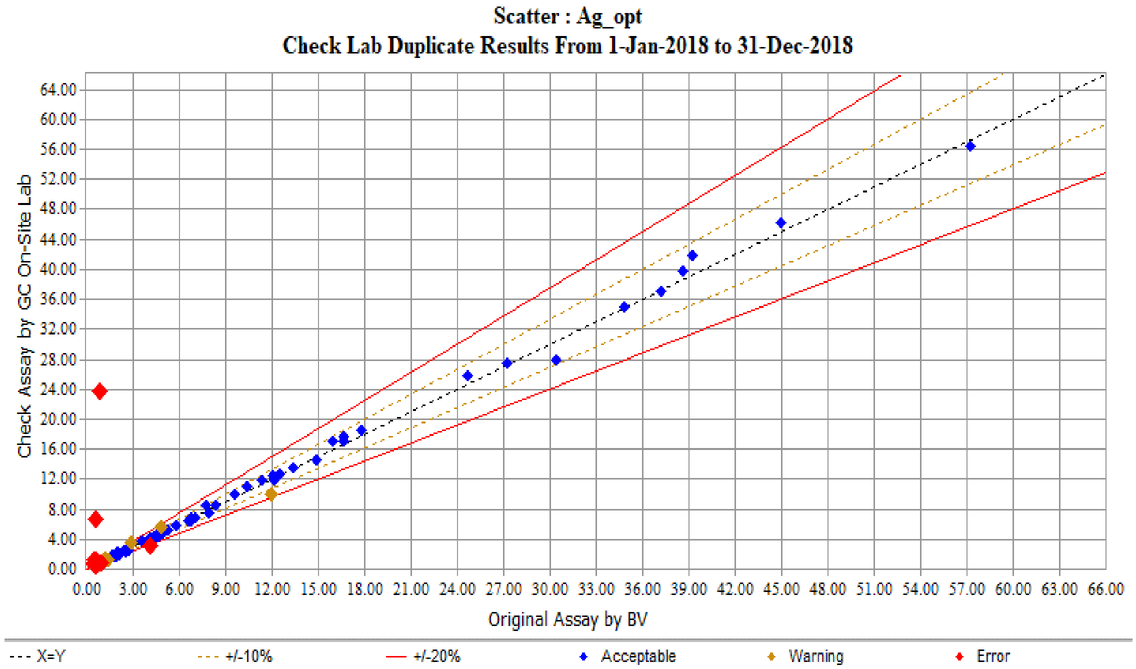




Check Assays

Samples for check assays are selected by the project geologist at a rate of approximately one in forty project samples. The project geologist assigns this designation based on lithology, with preference given to mineralized lithologies. An extra split is taken after pulverizing and returned to the project geologist. The project geologist dispatches a group of check samples to the on-site lab which is used as a check laboratory. Results are imported into the acQuire® database. The performance of these check assays has been reviewed during various in-house quarterly and yearly studies and third-party audits. Scatterplots for the 2018 pulp check data analyzed at the on-site lab are presented in Figure 11-7 for Ag and Au, and Figure 11-8 for Pb and Zn. Overall, the check assays agree satisfactorily with the original assays. There is some higher variance at low grades for all metals, but no observable bias. Further analysis of the check assays from the Greens Creek laboratory is ongoing.

Figure 11-7: Pulp Check Analyses – Greens Creek Mine Lab: Ag, Au - 2018



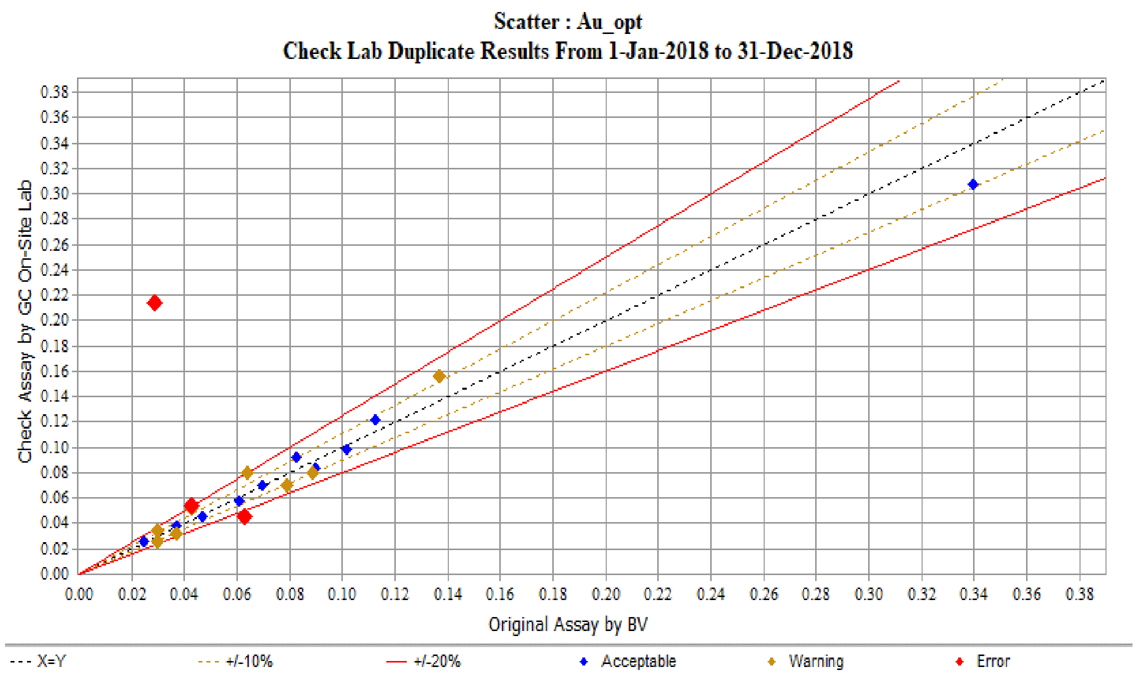
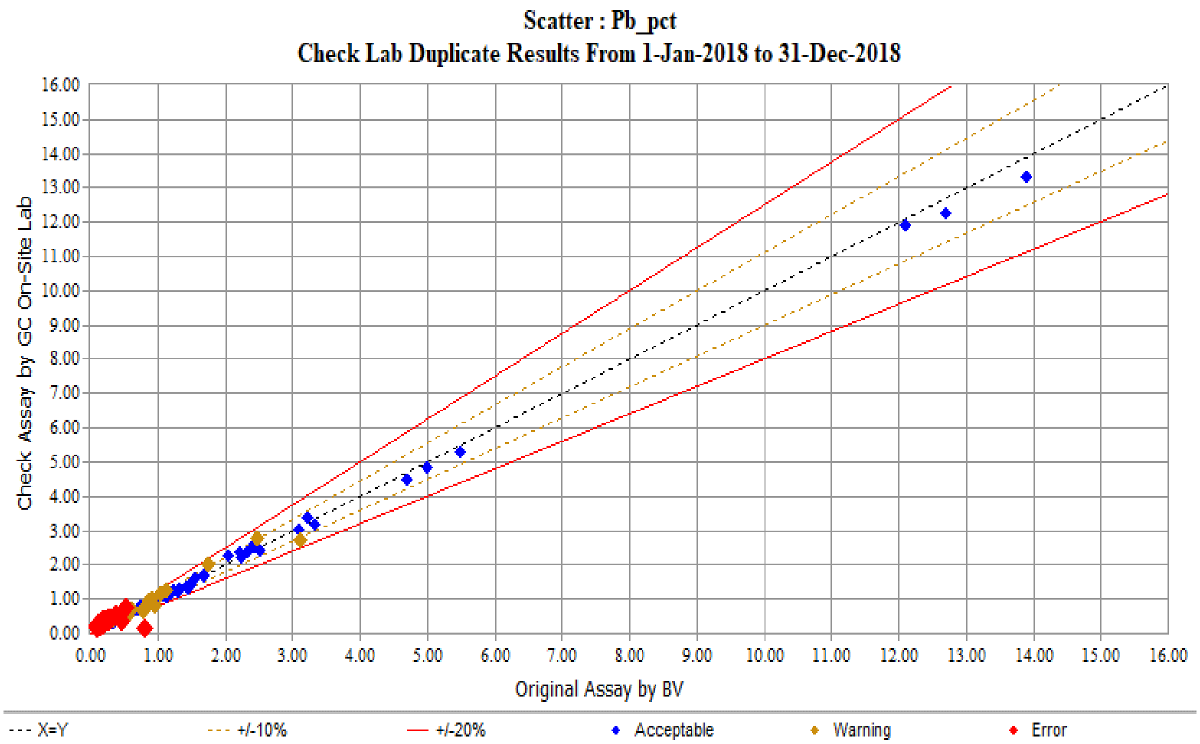
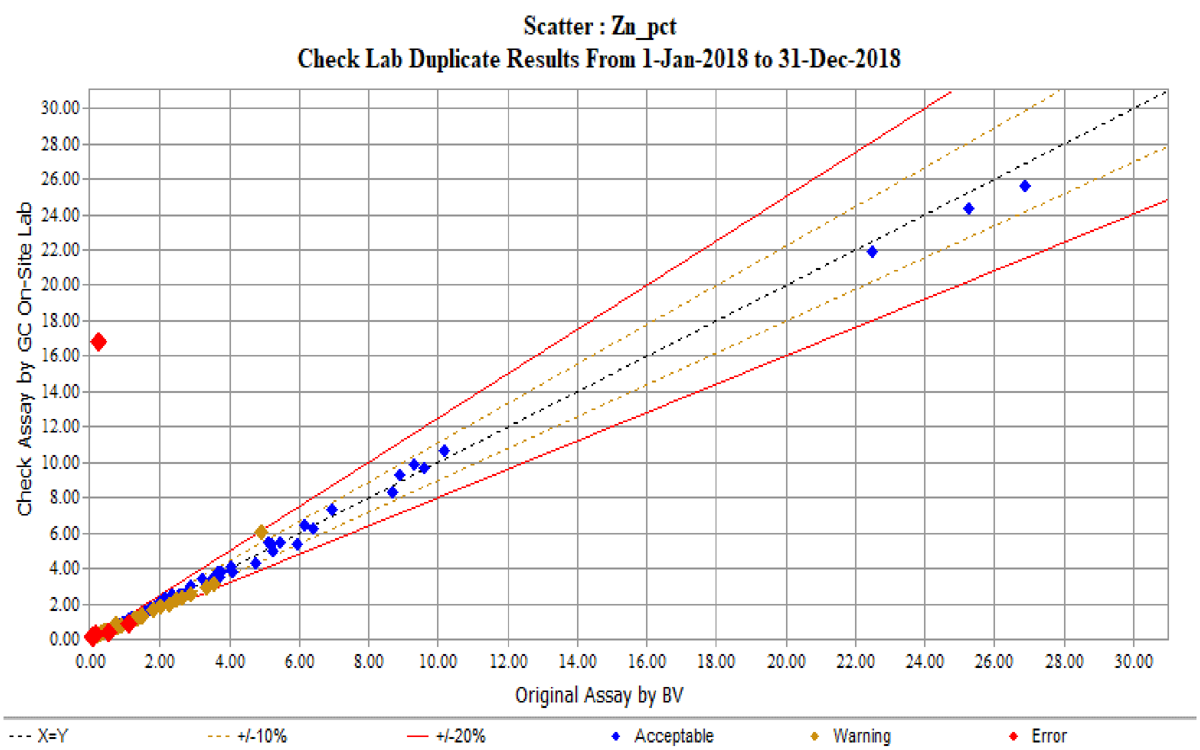


Figure 11-8: Pulp Check Analyses – Greens Creek Mine Lab: Pb, Zn – 2018





11.7 Databases

Drillhole and production face-sampling data are captured in a SQL database at Greens Creek that utilizes acQuire® software. These data include drillhole collars, down-hole surveys, assays and geological descriptions. Standard database management techniques are utilized that limit access and user rights to ensure data integrity. The acQuire® system also has many built-in features that restrict data import and approvals and perform some data checking.

A drillhole data set is created for each zone based on geographic limits. Where drilling pierces multiple zones, caution is exercised to be certain that mineralization in a drillhole is properly assigned to its appropriate zone.

Primary original documents, logs, down-hole surveys, core photographs, and assay certificates are cataloged and stored on site. Digital copies are stored on networks drives that are routinely backed-up.

11.8 Drill Core and Sample Chain-of-Custody and Security

Drill core is transported to the core shed at the end of each drill shift by the drill crews and quick-logged each morning by the geology staff. Core is stored on surface at the 860-core shed until it can be logged.

After logging, core is separated into sampled and unsampled intervals and each is placed on a separate pallet. Core Technicians transport the pallets of core to be sampled to the underground sampling facility where it is cut or whole-sampled depending on the type of hole drilled. Samples are bagged in sturdy cloth bags and labeled with barcoded sample tags with a second sample tag in the bag. Bags are tied shut with string. Two samples are placed in a rice bag which is labeled with the dispatch number and number of that rice bag in the dispatch. A sample submittal form and standard samples are included in the first rice bag of the dispatch. Rice bags are placed into a supersack with one or more dispatches to fill the sack. All samples in each dispatch are kept together in a single super sack and the super sacks are labeled with the dispatches inside.

Supersacks are loaded into a shipping container and, when ready for shipment, a shipping manifest is created for the Warehouse and Surface Operations noting the container number and the contents. The shipping manifest and digital copies of the sample submittals are emailed to the Juneau BV Prep Lab Manager. Surface Operations personnel transport the container to the dock at Hawk Inlet and it is loaded onto an Alaska Marine Lines (AML) barge. That barge is transported to Juneau and the container is delivered to the Juneau Prep lab by AML at which point the lab takes possession of the samples. AML is in possession of the container and samples while on the barge and the person receiving the container during delivery is recorded by AML. The progress of the container is tracked online from shipping to receiving.

The SRM inventory, returned coarse reject and pulp samples are secured and kept in locations with restricted access. The core is stored within the original boxes in a remote underground drift designated as a core archive.

11.9 Comments on Sample Preparation, Analyses, and Security

In the QP's opinion, the sample preparation, analyses, and security are acceptable, meet industry-standard practice, and are adequate for Mineral Resource and Mineral Reserve estimation and mine planning purposes, based on the following:

- Face sampling covers sufficient area and is adequately spaced to support mine planning;
- Drill sampling is adequately spaced to first define, then infill, base metal anomalies to provide prospect-scale and deposit-scale drill data;
- Since 2008, data have been collected following industry-standard sampling protocols (see Section 12 for discussion of third-party reviews);
- Sample collection and handling of core is undertaken in accordance with industry standard practices, with procedures to limit potential sample losses and sampling biases;
- Sample intervals in core, comprising 1 to 5-ft (0.3 to 1.5 m) intervals, are considered to adequately represent the true thicknesses of mineralization. Not all drill material may be sampled depending on location and alteration;
- Sample preparation for samples that support Mineral Resource estimation has followed a similar procedure since 2008. The preparation procedure is in line with industry-standard methods for polymetallic deposits;
- Exploration and infill core programs are analyzed by independent laboratories using industry-standard methods for gold, silver, lead, zinc, copper, iron and barium analyses. Current run-of-mine sample analyses are performed by the mine laboratory;
- Specific gravity determination procedures are consistent with industry-standard procedures. There are sufficient acceptable specific gravity measurements to support the values utilized in tonnage calculations;
- Limited information is available on the QA/QC for the pre-1998 drill programs; however, sufficient programs of reanalysis have been performed that the data can be accepted for use in estimation (refer to Section 12);
- Typically, drill programs include the insertion of blank, duplicate, and standard samples. The QA/QC program results do not indicate any problems with the analytical programs, therefore the analyses from the core drilling are suitable for inclusion in Mineral Resource and Mineral Reserve estimation;
- Data collected are subject to validation, using in-built program triggers that automatically check data upon import to the database;
- Verification is performed on all digitally-collected data on import to the main database, including checks on surveys, collar co-ordinates, lithology data, and assay data. The checks are appropriate and consistent with industry standards;
- Sample security relies on the fact that the samples are always attended or locked in the on-site logging or sampling facilities. Chain-of-custody procedures consist of filling out sample submittal forms that are sent to the laboratory with sample shipments and shipment tracking to ensure that all samples are received by the laboratory;
- Current sample storage procedures and storage areas are consistent with industry standards.

12.0 DATA VERIFICATION

12.1 External Reviews

Hecla and the Greens Creek Joint Venture (GCJV) operators have consistently involved third-party consultants in database reviews, Mineral Resource and Mineral Reserve estimates, and mine audits. This work is summarized in the following subsections, categorized below as 'legacy' (performed for the Greens Creek Joint Venture), and 'Hecla' (performed for Hecla after the company became 100% owner/operator of the Greens Creek Mine in 2008).

12.1.1 Legacy Data Review

Mineral Resource Development Inc., 1997

A face-sampling study was conducted by Mineral Resource Development, Inc. (MRDI) to check for sampling bias, and to determine the level of reproducibility obtainable from face sampling, using a modified sample preparation protocol. Sample preparation and assay protocols were formulated to provide the analytical precision required.

Mineral Resource Development Inc., 1998

A review of the 1994 Southwest Feasibility Study (1994 FS) block models and their reconciliation to production for the Southwest Zone was undertaken.

Principal conclusions were:

- The mineral zones in the Southwest Zone have been deformed by multiple events, to the extent that they can no longer be considered stratiform.
- Overall, the 1994 FS model grade and tonnage have been confirmed by production (1997), with the exception of silver, which had been of lower grade than predicted.
- The 1994 FS model is very inaccurate in terms of predicting the locations and grades of mineral types.
- There was a significant amount of over-break and ore loss (particularly high silver zones) which resulted in a higher tonnage at a lower grade reaching the mill than was predicted by grade-control data. To some extent this over-break was desirable, as the value of high-grade material in the structurally complicated Southwest Zone exceeds the cost of dilution, i.e., it is important to take some dilution to ensure as much as possible of the ore is recovered.

In June 1998, MRDI was contracted to assist in the preparation of mineral resource models for the three zones that were considered to be major contributors to the five-year production schedule. The Southwest, Northwest West and 200 South zones were selected for this work. Greens Creek staff prepared all the geologic interpretations and worked under the direction of Dr. Harry Parker to develop appropriate modeling techniques including capping for gold and silver grades, composite length studies, and appropriate model estimation parameters model.

Review of the data collection and acquisition procedures showed that it followed industry-standard practices for sampling, assaying, quality-control, and data entry and management. The interpreted mineralization envelopes were reasonable for the Southwest and 200 South zones. Concerns were expressed with the Northwest West model because the mixture of large, base metal, low-grade areas of white carbonate mineral style with more massive, base metal-rich material could result in the over-projection of gold, lead, and zinc grades from composites of base metal-rich massive mineralization, and of silver grades from white carbonate mineral type. This 1998 work has formed the basis for all subsequent modeling techniques up to 2018.

Mineral Resource Development Inc., 1999

A review was completed on the 5250 Zone model and mineral resource estimate reported in February 1999. The model was found acceptable for the purposes of reporting Mineral Resource estimates for the zone. Similar reviews were performed on the Southwest, Northwest West and 200S Zone models and estimates. The database was found to be acceptable for use in Mineral Resource estimation, and the resulting estimates were considered adequate for all three zones.

Recommendations relating to modeling and estimation focused on timely QA/QC reviews, data entry and data validation, and appropriate data archiving.

A review of the 1999 operating plan was performed in December 1999 on behalf of Standard Bank London Limited in support of the Project acquisition by Hecla and Pan American Silver Corporation. The operating plan was found to represent an appropriate response to the ongoing development of the Greens Creek operation, and the assumptions in the proposed operating and development plan were considered to be reasonable. A recommendation was made that documentation supporting mine plans should be collated.

AMEC, 2002

In October 2002, AMEC, the successor company to MRDI, audited the model for the Central Zone. The evaluation compared the updated 2001 block model with that of the block model completed in 2000 and determined that a new model would be required. Recommendations were made in relation to modeling methods and reconciliation evaluations.

A Mineral Resource/Mineral Reserve audit was performed in December 2002 on the 2002 estimates to review supporting data, mineral resource estimates, mine designs and mineral reserve estimates to give an assessment of the reasonableness of the mine mineral reserve statement. The emphasis of the audit was on the 9A, Central West, 5250, Southwest Bench and Deep Southwest zones. Reviews of mine designs were conducted for the East, 200 South, Southwest and Northwest West zone deposits. The independent review confirmed the 2002 Mineral Resource/Mineral Reserve statement.

A number of recommendations were made to address the areas of QA/QC management, consistent reproducibility of Au values at Acme, provision of documentation in relation to Mineral Resource/Mineral Reserve conversion procedures and supporting information and, establishment of grade control procedures in areas mined by long-hole methods.

AMEC, 2003

The Greens Creek Joint Venture produced new mineral resource models in 2003. AMEC reviewed changes and assisted in the completion of new models or model updates for two mineral zones, the 9A and Northwest West zones. In addition, AMEC reviewed the conversion of Mineral Resources to Mineral Reserves for the Northwest West Zone.

Drilling, sampling, sample preparation and assaying methods were considered to meet or exceed industry standard practice and results were considered adequate to support Mineral Resource estimates. Density measurements were adequate to support tonnage estimates. Minor errors with the down-hole survey data were not considered to affect estimates and could be remediated. The assay database showed an acceptable low error rate. Mineral Resource estimates for the 9A and Northwest West zones were accepted as reasonable. Conversion of the Mineral Resources at the Northwest West Zone to Mineral Reserves was considered to use appropriate modifying factors and the mine plan was achievable in the time-frame contemplated.

Recommendations included change of support analysis for Measured and Indicated Mineral Resources, and evaluation and quantification of dilution percentages to be expected by stope during mining activities.

AMEC, 2005

AMEC reviewed supporting data, mineral resource estimates, mine designs and Mineral Reserve estimates to give an assessment of the reasonableness of the Mineral Reserve statement for 2005. The deposits reviewed were Northwest West, 5250, Southwest Bench and 200S zones.

AMEC found the error rate for the lithology, sampled intervals, assays, and down-hole surveys to be acceptable, and considered the database acceptable for use in Mineral Resource estimation. Assay quality was controlled by a consistently applied system of standard reference materials (SRMs), pulp duplicate samples, coarse reject duplicate samples, and check assays. Mineral Resource and Mineral Reserve estimates were considered to be appropriately estimated.

Recommendations included: updating the database with missing Ba and ICP assays; checks of the methods whereby down-hole survey data are uploaded; review of potential assay bias at Acme for Ag and Pb; review of density values assigned to high-Ba material; and quantification of dilution percentages to be expected by stope during drift and fill, primary long-hole, and secondary long-hole mining activities.

12.1.2 Hecla Database and Verification

AMEC, 2008

In 2008, AMEC audited the databases, data transfer, and data storage procedures for the 5250N, Northwest West and Gallagher zones. No significant errors that would preclude Mineral Resource or Mineral Reserve estimates were noted. A number of recommendations were made to address program improvements and to implement incremental checks and additional validation steps in the data collection, QA/QC verification, modeling and estimation processes.

AMEC found the error rate for lithology codes within the mineral zones, sampled intervals, and assays in the Greens Creek databases to be acceptable to support Mineral Resource estimation for the Gallagher and 5250N zones, but found the error rate close to 1% for lithology and greater than 1% for assays in the Northwest West Zone. AMEC was unable to determine the precision of Au, Ag, Pb and Zn assays.

Key recommendations included: integration of the QA/QC data into the site acQuire database; reviewing of inconsistencies in Ba and ICP data; procedures to ensure that errors identified with the database during the Datamine® modeling could be updated in acQuire®; review of potential high biases in Pb and Ag results at Acme; implementation of incremental checks and additional validation steps in the data collection and model completion process, and; checks on the amount of contact dilution allowed for in the models.

AMEC also audited the Mineral Reserve and Mineral Resource statement. Scope items included auditing the database and review of supporting data, mineral resource estimates, mine designs, and mineral reserve estimates to give an assessment of the reasonableness of the Mineral Reserve statement for 2007. Mineral Resource estimates for the 5250N and Gallagher zones were reviewed, Mineral Reserve estimates were reviewed for Northwest West and 5250N zones, and the database was audited for all three zones.

AMEC, 2009

AMEC was requested to provide technical assistance with auditing the Project database and building of wireframe models for five zones (the Northwest-West, Upper Plate, Northwest-West South, 200 South-Deep, and Gallagher zones) and the old mining area of East Zone. The database audit was only partially completed, as only a portion of the QA/QC files were available at the time of the audit. Wire-frame modeling of the East Zone was also only partially completed due to time constraints.

Recommendations from this work included identifying and filing documentation of historic drill logs and collar details, maintenance of QA/QC data to facilitate data verification, validation of collar locations, review of East Zone survey measurements after magnetic declination is applied, modification of sampling protocols so that mineralization in non-traditional mineral lithologies is assayed, and improvement of database storage and import procedures between the acQuire® database and the Datamine® modeling and estimation software.

AMEC performed a review of the 2009 Mineral Resources and Mineral Reserves for 5250 and 9A zones, including reviews of supporting data, Mineral Resource estimates, mine designs, and Mineral Reserve estimates.

AMEC found the error rate for the lithology, sampled intervals, assays and down-hole surveys to be acceptable and considered the database acceptable for use in mineral resource estimation. Assay quality was controlled by a consistently-applied system of SRMs, pulp duplicate samples, coarse reject duplicate samples, and check assays. AMEC did not find a fatal flaw in mine operations, planning, scheduling, or budgeting that would prevent Hecla from executing their plans to mine the 5250 and 9A Mineral Reserves.

Recommendations arising from the audit included notations relating to inclusion of Ba and "over-limit" samples for Zn in the database, investigation of potential assay biases at Acme and the mine laboratory, continued recommendations for real-time QA/QC monitoring, density assignments for white barite ore, and reconciliation.

AMEC, 2012 - 2013

AMEC was requested to conduct a review of Hecla's 2011 Mineral Resources and Mineral Reserves for the Deep 200 South, Southwest Bench, East Zone, and Gallagher zones in early 2012. This report was finished and received in September 2014.

AMEC found that the definition of the domains was done using applicable and reasonable parameters, care, and execution. Grade capping and compositing was found to be reasonable, and variography was adequately executed. Estimation plans were found to be adequate, and AMEC agreed with the mineral resource classification methods applied.

The mining review focused on the Southwest Bench Zone, as mining was active in this zone. AMEC did not find any fatal flaws in mine operations, planning, scheduling, or budgeting that would prevent Hecla from executing its plans to mine the Southwest Bench Mineral Reserve. Reconciliation between actual mined and model depletion showed significant variation and required addressing. Regular geotechnical reviews were recommended as mining advances. The development plan and equipment were considered appropriate for the Southwest Bench Zone.

Recommendations arising from the audit included compiling more formal documentation for mineral resource model reports for each mineralized zone; improving mineral resource model archiving procedures; investigating more comprehensive variography procedures, including locally varying anisotropy; tracking each mining area by tons produced by mining method, and capturing those volumes mined for the depletion model; generating a detailed ventilation model that shows areas by equipment used to improve the effectiveness of the total allotted airflows; creating an equipment maintenance schedule that showed the equipment purchase, rebuild, breakdowns, and planned maintenance schedule by maintenance bay and the personnel allotted to each in order to enable a more proactive approach to maintenance; production histories were recommended to be kept for each mining block; and production forecasts were recommended to include appropriate dilution and recovery.

AMEC FOSTER WHEELER, 2016

Hecla Greens Creek Mining Company (HGCMC) commissioned Amec Foster Wheeler to review the Mineral Resource models constructed by HGCMC in 2016 for the NWW Zone (NWW) and the 5250 Zone (5250). This review included a site visit the HGCMC offices in Juneau, AK from 31 October to 4 November 2016. During the site visit, the construction of the mineral resource model was discussed and reviewed with HGCMC staff.

The project scope was to review the Mineral Resource models for the NWW (effective date 26 July 2016) and 5250 (effective date 14 July 2016) mineral zones. A review of the database was not included in the scope of work and Amec Foster Wheeler did not audit the database.

Amec Foster Wheeler found no significant errors in the Mineral Resource modeling methodology and found that model validations supported the grade estimates. Recommendations included better documentation of procedures and production of a final written report documenting the data used, data analysis, model construction, grade estimation methods and tabulation of the mineral resources. Alternative methods for estimating density and a modified mineral resource classification method to remove unrealistic isolated blocks were also recommended. Amec Foster Wheeler also suggested the inclusion of a complete set of cross-sections for each metal be archived with the models.

ROSCOE POSTLE ASSOCIATES, 2017

Roscoe Postle Associates Inc. (RPA) was retained in 2017 by Hecla Mining Company to complete a Mineral Resource and Mineral Reserve audit of Hecla's Greens Creek Mine to be used for internal purposes. At Hecla's request, RPA's audit focused on two of the nine mining zones, the 200 Deep South (200S) and Northwest West (NWW) zones. These zones contain approximately 50% of the Greens Creek Mineral Reserves.

RPA did not find any major issues in the Mineral Resource modeling methodologies but made many recommendations. The main recommendation was a modification to the workflow for the mineral selection/interpretation criteria to provide a more accurate reflection of the potentially economic mineralization and to be more flexible in responding to variations in metal prices and operating costs. To that end, RPA recommended that the NSR value using the Mineral Resource price deck be used to discriminate the potentially economic mineralization. Where possible, the mineral zone interpretation should also incorporate the detailed grade control mapping and sampling information. In 2017 and 2018, a new workflow was developed by the mine geology staff for mineral zone interpretation based on these recommendations. Testing and modifications of the workflow are ongoing.

Other recommendations made by RPA included updating the mineral resource classification scheme to eliminate artifacts from the model re-blocking process and to improve the accounting procedure for mined volumes. Minor recommendations focused on dilution grades, mining recovery for longhole stopes, and mining depletion.

Finally, RPA recommended that a set of Standard Operating Procedures be prepared that describe each of the steps in the preparation of the Mineral Resource and Mineral Reserve statements and include a formal peer review process and sign-off procedure to ensure that each step of the workflow is completed in a consistent and proper manner. All of RPA's recommendations have been implemented or are in the process of being implemented.

12.2 Internal Reviews

Until 2006, all geological data were stored in an Ingres database. This became corrupted, but extraction of most files was possible. A period of about two years followed where the database consisted of a number of Microsoft Access® databases. In 2007 acQuire® software was purchased, and over the following three years, all data were transferred to the database. All drillhole assay data was reloaded from the original electronic assay files. All data were checked during the transfer process.

A standard set of referential integrity 'logic' checks are applied to the data as they are entered into the acQuire® database. These checks include checking for overlapping or gaps in intervals, validation of lithologic codes against lookup tables, and enforcement of unique records for sample numbers and drillhole names.

As data are extracted from the acQuire® database and brought into Datamine® for modeling, a second set of validation checks are performed. These checks include flagging drillholes with missing survey data, checking for overlapping intervals or gaps, lithologic code validation, flagging drillholes with anomalous calculated angular deviations, flagging sampled intervals that are missing assays or have returned values greater than the detection limit. Where errors are noted, the problems are corrected prior to the database being used for mineral resource estimation purposes.

acQuire Database Health Check

In early 2018, acQuire Software Pty Ltd was retained to perform a health check for the Greens Creek acQuire® database. A thorough review was requested to identify potential issues with the data, databases, and workspaces, and to recommend possible repair options and improvements. The database backups and acQuire® workspaces used for the health check were effective March 14, 2018.

This detailed review of the databases and workspaces found no serious issues that significantly impact database contents or integrity. Areas were identified where systems could be enhanced, cleaned up, or streamlined. The key recommendations for improving the existing system dealt with training of new users, database issues with missing, duplicate, or unnecessary fields, and upgrades to the acQuire® program and SQL Server maintenance and backups. Project personnel are working through the recommendations on the database issues.

12.3 Comments on Data Verification

The process of data verification for the Project has been performed by external consultant firms from 1997 to 2013, as well as by Hecla personnel. Since 2013, all data verification has been done by project staff as the data are being collected and imported into the acQuire® database. The 2018 check on the acQuire® databases and workspaces found no serious deficiencies.

Hecla considers that a reasonable level of verification is completed, and that no material issues would have been left unidentified from the programs undertaken. External reviews of the database have been undertaken in support of acquisitions, support of feasibility-level studies, and in support of Mineral Resource and Mineral Reserve estimates, producing independent assessments of the database quality.

No significant problems with the database, sampling protocols, analytical flow sheets, check analysis program, or data storage were noted. Drill data are verified prior to Mineral Resource and Mineral Reserve estimation using various automated and manual checks.

The QP is of the opinion that the data verification programs undertaken on the data collected from the Project adequately support the geological interpretations, validate the analytical and database quality, and support the use of the data in Mineral Resource and Mineral Reserve estimation and in mine planning. No significant sample biases were identified from the QA/QC programs undertaken (see Section 11), and sample data collected adequately reflect deposit dimensions, true widths of mineralization, and the style of the deposit.

13.0 MINERAL PROCESSING AND METALLURGICAL TESTING

13.1 Metallurgical Test Work

Since mill construction and startup, numerous internal and external studies have been performed to investigate metallurgical issues and support mill modifications. Many of these are listed in Table 13-1.

Extensive initial test work programs were conducted at Noranda's Matagami Lake and Mattabi laboratories in Ontario, and at Dawson Metallurgical Laboratory in Salt Lake City, UT, as compiled and summarized by Banning (1983). Composites of various mineral types were developed using drill core samples. Results of these programs allowed the development of the basic Greens Creek lead-zinc flotation flowsheet, with inclusion of a gravity gold circuit. Primary grinding requirements for the white mineral types and massive sulfide types were developed and use of stage addition for flotation reagents was established, along with collector and modifier recommendations. These programs demonstrated the desirability of a preliminary carbon removal pre-flotation step and re-grinding of rougher concentrates prior to cleaner flotation.

Following mill start-up, investigations were pursued regarding alternatives to the originally installed plane table used for gravity recovery of relatively coarse free gold. The plane tables had proved to be labor intensive and did not perform up to expectations. Screening trials indicated that available centrifugal gravity concentrators would create water balance issues and that gravity spiral concentrators had better performance. They also indicated that re-grinding of spirals concentrate prior to final cleaning with a shaking table improved product grades significantly. Plant trials with spirals confirmed the screening results and a revised gravity circuit utilizing concentrating spirals, concentrate re-grinding and final tabling was implemented (Sawyer, 1997).

Mill expansion by way of construction of a new building primarily devoted to cleaner flotation circuits also allowed reallocation of existing equipment and floor space in the original mill building. Bench scale test work followed by plant trials in 1999–2000 produced results used to develop modifications to the mill flowsheet, size and specify required equipment and analyze economic consequences of the expansion. Resulting concentrate assay improvements, improved recoveries and economically favorable redistribution of payable metals among the various concentrates indicated overall recovery improvements of 2% for lead, 8% for zinc, 1.5% for silver and 2% for gold.

Several formal and informal studies have been performed during the life of Greens Creek which investigated causes of poor mill recoveries. Two examples are an exhaustive 2007 study (Reynolds, 2007), which examined a variety of mineral types and mill products, and a more focused 2009 study, which examined mill feeds producing particularly low recoveries, as well as examining more typical feeds for comparison (Blake, 2009). Both studies considered analytical and classic mineralogical results as well as SEM and other instrumental approaches. Both studies concluded that the principal cause of poor flotation recoveries was the presence of extremely fine-grained minerals and intergrowths that cannot be economically liberated by grinding.

Table 13-1: Greens Creek Metallurgical Studies

Title, year	Facility	Description
Metallurgical Evaluation of the Greens Creek Orebody. Approx. 1983 (Banning, 1983)	Matagami, Mattabi, Dawson Metallurgical	Mineralogical, physical evaluations. Grinding studies. Flotation studies, including flowsheet development and reagent requirements. Gravity processing studies. Product evaluations.
Recovery of Gold by Gravity Separation at the Greens Creek Mine Alaska. 1997. (Sawyer, 1997)	Greens Creek	Describes test work, plant trials, evaluation and design of spirals gravity concentration circuit replacing original plane tables.
Three-Stage Lead and Zinc Cleaning for the Greens Creek Concentrator (Scheding, 2000)	Greens Creek	Summarizes bench scale and plant trial test work used for design and economic analysis of mill expansion via new cleaner building.
Performance Assessment and Optimization of the Greens Creek Grinding Circuit. (Jankovic, 2003)	Greens Creek	Review of Greens Creek grinding circuit performance.
Green's Creek Mine: A Mineralogical Characterization of Selected Ores and Plant Products (Reynolds, 2007)	Rio Tinto Research, Bundoora, Australia	Extensive mineralogic investigation of mineral styles and mill products.
Greens Creek Mine: Silver and Base Metal Mineralogy of a Suite of Products from the Lead Circuit (Blake, 2009)	Mineralogy Consultant, Clevedon, United Kingdom	Mineralogic investigation of selected mineral feeds and mill products.
Cleaner Flotation on a New Sample of Baritic Ore: Our Project P-4167(Armstrong, 2011)	Dawson Metallurgical	Evaluation of metallurgical response of mineral from new 5250 Zone mining area.
Backfill Acid Consumption (Asarte, 2011)	Greens Creek	Investigation on effect of mine backfill on mill process pH and of effect of sulfuric acid on performance.
Report of Effects of Carbon Dioxide and Sulfuric Acid to Modify pH for Flotation of 90% Ore/10% Backfill Composite Feed (Peterson, 2012)	Dawson Metallurgical	Investigation of carbon dioxide use as process pH control reagent.
Initial Evaluation of Carbon Dioxide for pH Control at Greens Creek(Tahija, Initial Evaluation of Carbon Dioxide Use for pH Control at Greens Creek, 2012)	Greens Creek, Dawson Metallurgical	Discussion of test work results and preliminary economic evaluation of carbon dioxide use.
On-site SEM analysis 1-year trial (2013)	FEI/Bluecoast	Investigation of grind performance and flotation performance on a daily basis
Gravity gold investigation (2011-2015)	Greens Creek	Statistical studies of correlations between gravity gold recovery and mill and feed parameters.

The performance of the grinding circuit was reviewed in 2003 as part of planning for a contemplated increase in throughput. Findings included Bond Work Index values ranging from 11.9 to 12.8 kWh/st, feed specific gravities ranging from 3.5 to 4.0 and Julius Kruttschnitt Mineral Research Centre (JKMRC) abrasion parameter (ta) values ranging from 0.51 to 0.88. Bond Index values referenced from a 1993 pilot plant ranged from 10.5 to 10.7 (Jankovic, 2003).

The grind circuit and flotation circuit performance were monitored daily using an on-site SEM for over a year through 2013. This data showed that much of the lead and silver could be collected using the second carbon column. The routing of the second carbon column was adjusted so the concentrate could be directed to the overall lead concentrate and allow for much of the lead and silver to be “scalped” off without the risk of recovery losses downstream. This resulted in an increase to the silver recovery of nearly 5% starting in September 2014.

Successful metallurgical testing was conducted on using carbon dioxide for pH control beginning in 2012 and implemented in the plant in early 2015. This resulted in roughly a 2% increase in silver recovery, a 5% increase in lead recovery, and a 3% increase in gold recovery.

Plant trial testing conducted throughout 2014 and into 2015 on an additional cleaning stage of gravity concentrating spiral in the gravity circuit has shown that a gold concentrate product could be made without the need for additional regrind and shaking table and then sent off-site for further processing eliminating the need for a doré furnace as well. A third stage cleaner spiral was installed and implemented in the second half of 2015 and has resulted in a roughly 1% increase of gold recovery to gravity concentrate and has also eliminated the need for operation of a regrind mill and shaking table or the further processing of gold concentrate into doré.

On-site plant trial testing in 2016 on the use of Woodgrove SFR flotation cells showed better separation of zinc from iron in the swing cell and bulk circuit. This was implemented in 2017 to improve zinc distribution to zinc concentrate and improve silver distribution to bulk concentrate.

Metallurgical testing programs are continually conducted to evaluate possible changes in feed types from new mining areas, proposed changes in processing to improve recoveries and/or concentrate grades and to investigate factors causing lower than desired recoveries and concentrate grades. Some examples of such recent and current work include:

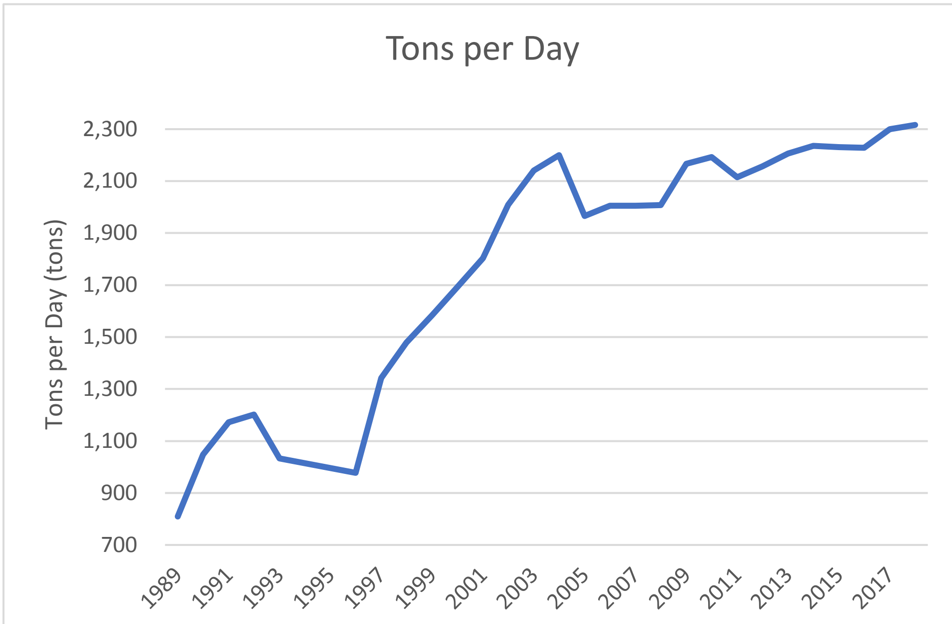
- Installation of FloatForce flotation agitators (2016-present);
- Investigation of vibratory mills for use in regrind stage (2018);
- Investigation into alternative collector and promoter reagents (2017-2018).

13.2 Recovery Estimates

13.2.1 History

Figure 13-1 shows the change in throughput rate from 1989 through 2018.

Figure 13-1: Incremental Throughput Improvements, 1989 through 2018



Production improvement efforts from commissioning through 2004 were centered mainly on increasing tonnage capabilities through the mill. This was a successful effort focused mainly in the grinding circuit and required minimal capital expenditures.

The cleaner expansion in 2000 was the first major capital project and was required to maintain the metallurgical performance at the increased throughput. Flotation capacity remained a significant issue and the cleaner circuits were again expanded in 2001 to help maintain metallurgical performance. In 2007, the lead rougher circuit capacity was expanded by 17% by adding two tank cells to the circuit.

13.2.2 Flotation Strategy Advancement

The mill was originally designed to skim off a small amount of high-grade lead concentrate and then make a small amount of high-grade zinc concentrate. The remaining flotation concentrates were directed to a bulk sulfide concentrate. This strategy was effective because of the payment terms of the smelter contracts.

Efforts were made to maximize NSR by adjusting distributions and recoveries of the payable metals. Increasing lead concentrate production was the major goal in these efforts due to the more favorable payment terms for metals in this concentrate. The grade of the lead concentrate was allowed to drop in conjunction with increased lead and silver recovery to this concentrate.

In 2004, the market for bulk concentrate was very tight due to the closure of several ISF plants. This forced a change in flotation strategy to prevent making large quantities of bulk concentrate with limited marketability. Several flow changes in the mill enabled these changes to be effective. The lead concentrate grade targets were considerably reduced which increased lead concentrate quantities. The zinc targets remained constant and the additional throughput resulted in more zinc concentrate production. The bulk production was significantly reduced to match market conditions. The change in strategy was necessary and recovery losses were minimized but evident.

In 2018, smelter terms improved and resulted in partial payment of lead in zinc concentrate and zinc in lead concentrate. This resulted in large increases of recoveries for lead and zinc to a payable concentrate. Depending on smelter market conditions, treatment terms and conditions are expected to vary and may impact payable metals recoveries and payout.

Figures 13-2 to 13-5 show the changes in concentrate production and throughput over time. The distributions of recovered silver and gold into the gravity products and concentrates are shown in Figures 13-6 and 13-7. Figure 13-8 shows the distribution of recovered zinc and lead into the respective lead, zinc and bulk concentrates.

Note that lead and zinc tonnage increased from 1989 to 2003 as the payables from bulk concentrate sales became less favorable due to smelter market conditions as well as process and plant improvements made by Greens Creek. Lead concentrate grades slightly decreased over time due to favorable smelter terms allowing lower concentrate grades that resulted in higher lead recoveries. For similar reasons, but more dramatically, the zinc concentrate grades were significantly reduced with attendant recovery increases. After initial years of high zinc grades, the ability to lower the zinc concentrate grades resulted in higher zinc recoveries to the zinc concentrate; thereby, decreasing zinc recovery to the bulk concentrate. The net effects on lead and zinc distributions to the respective primary concentrates to bulk concentrate are shown in Figures 13-4 and 13-5.

Figure 13-2: Concentrate Production History, 1989 to 2018

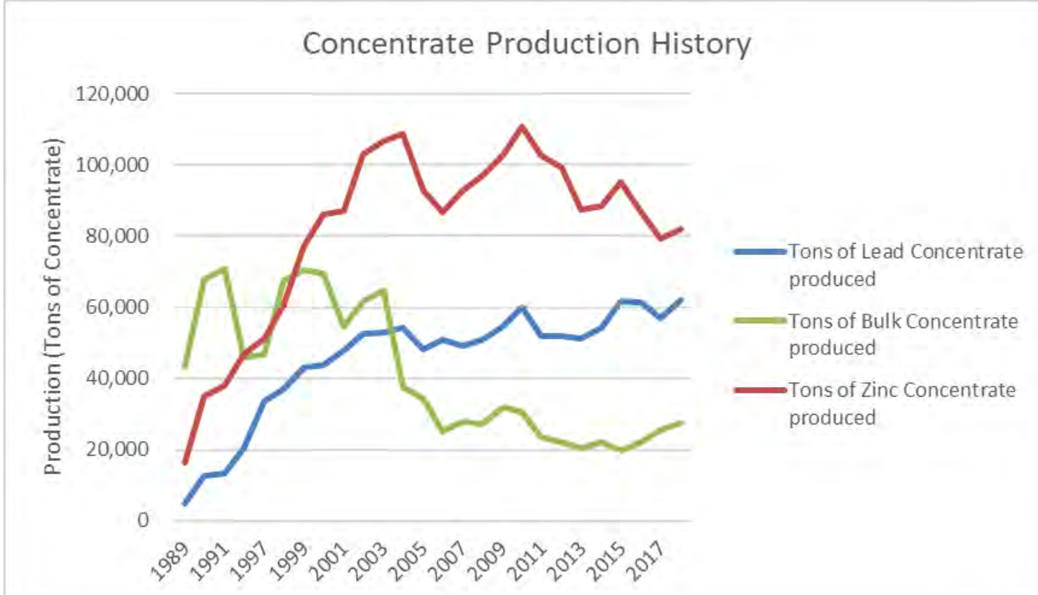


Figure 13-3: Changes in Metal Grades in Primary Concentrates, 1989 to 2018

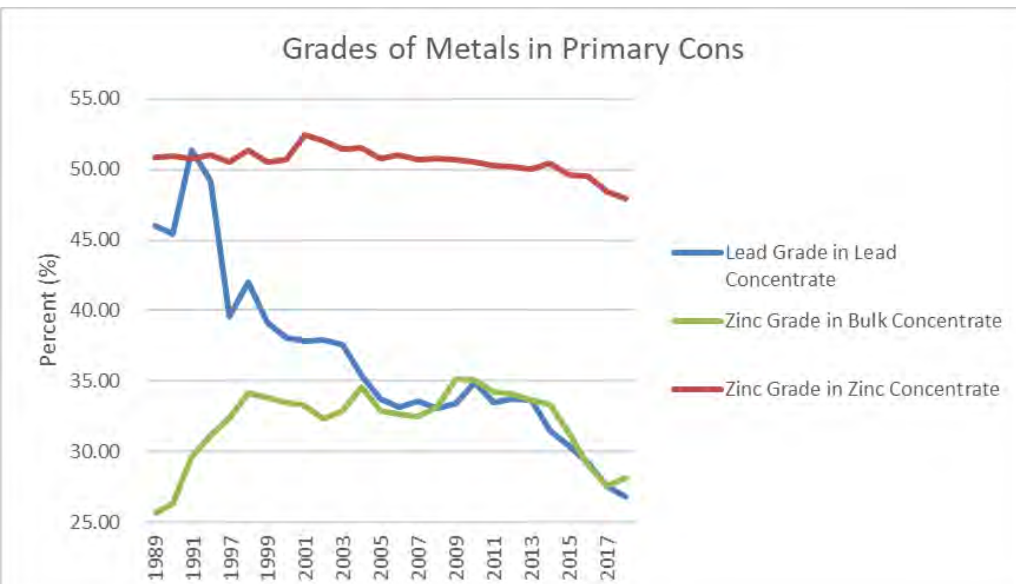


Figure 13-4: Changes in Lead Distribution in Primary Concentrates, 1989 to 2018

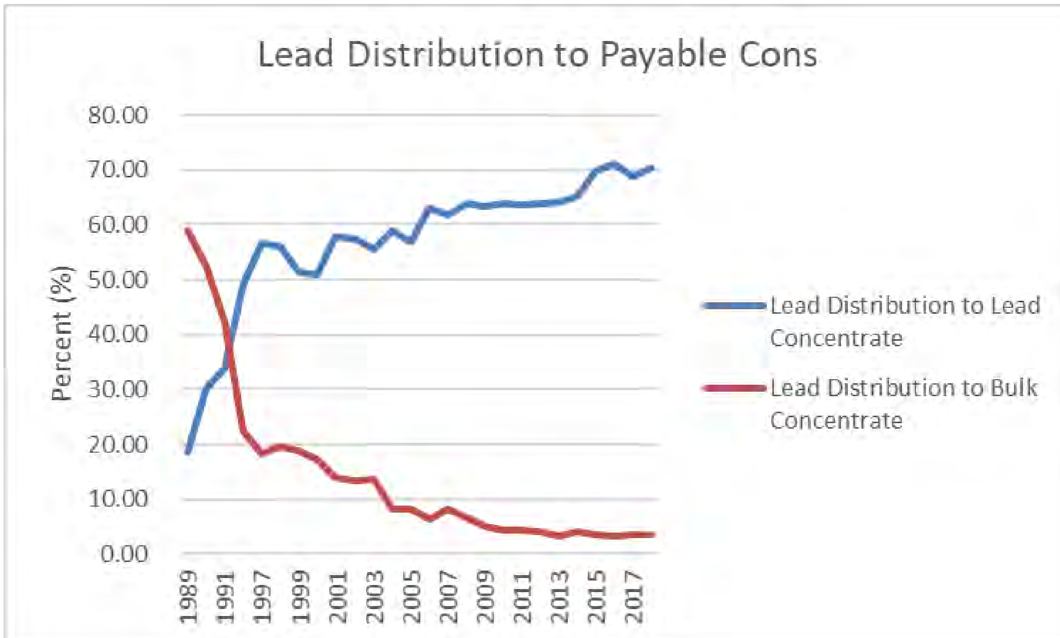


Figure 13-5: Changes in Lead Distribution in Primary Concentrates, 1989 to 2018

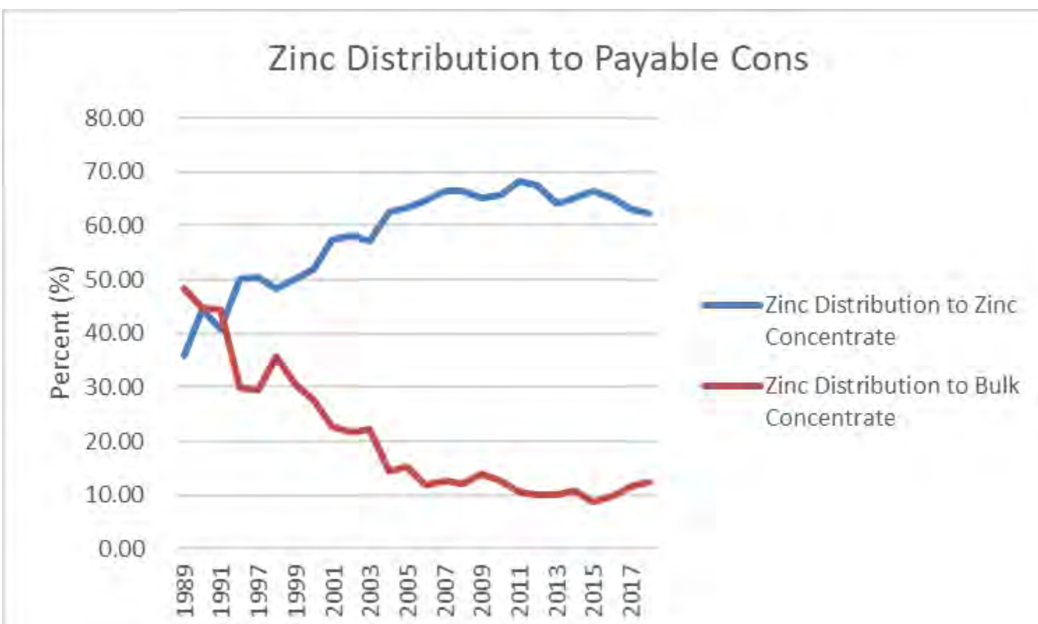


Figure 13-6: Distribution of Recovered Silver into Product Streams – 2018

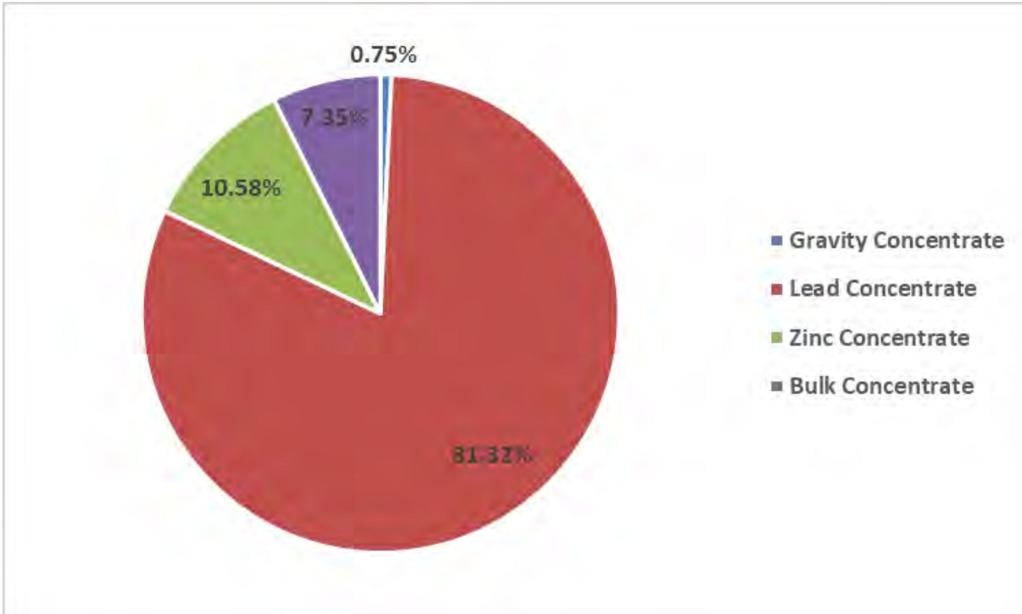
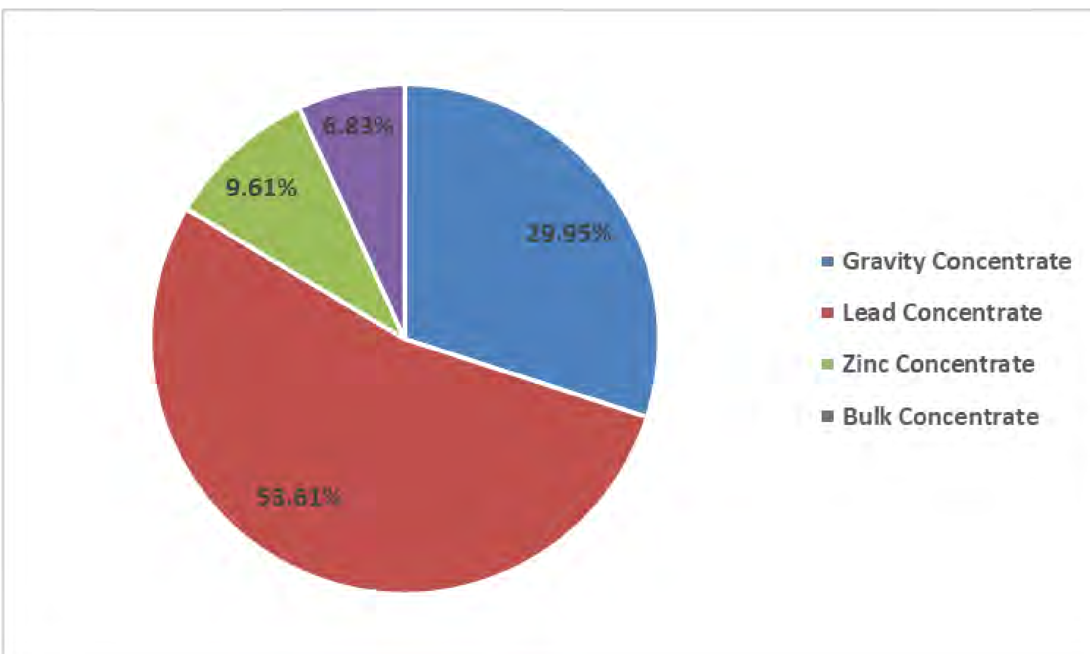
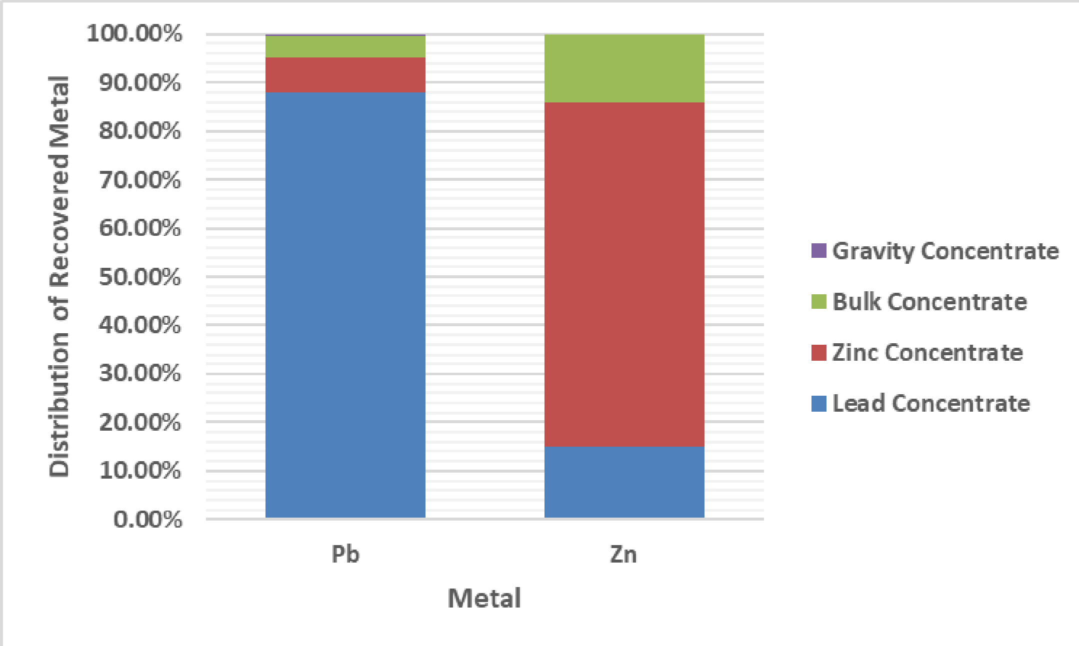


Figure 13-7: Distribution of Recovered Gold into Product Streams – 2018



In 2018, overall plant gold recoveries averaged 65-68%. A graphical view of the average 2018 metal distributions into the gold gravity, two primary concentrates and bulk concentrate are shown in Figure 13-8.

Figure 13-8: Distribution of Recovered Zinc and Lead into Product Streams – 2018



13.2.3 Optimization and NSR Estimation

The initial flotation model was developed using detailed plant surveys and laboratory flotation testing with the help of JKTech. Model development also required measuring various flotation cell parameters throughout the mill and incorporating the data into the model. A base case model was developed from this survey and research data using JKSimFloat. The base model was adjusted to match the actual plant distributions and recoveries. This adjusted simulation became the primary flotation performance model used to predict the flotation response of any set of feed grade combinations which is the data provided by mine planning based on the mineral blocks to be mined under the mine plan.

Each set of flotation performance data produced by the JKSimFloat performance model is transferred into an optimization model for calculating NSR. The optimization model is a custom metallurgical balance program developed at Greens Creek with the help of JKTech and now Mincom. This model allows constraints on concentrate specifications to be entered and adjusts distributions and recoveries to meet these constraints while using smelter contract data and metal prices to calculate the expected NSR from flotation concentrates.

The JKSimFloat/Optimizer modeling is too cumbersome to use directly in the Mineral Reserve estimation process due to the large number of blocks requiring NSR estimates. A simplified multiple linear regression equation was developed using data developed from the optimized NSR modeling as follows:

Flotation NSR = (0.1347(Au oz/ton)*(Au $/oz))+(0.6942*(Ag oz/ton)*(Ag $/oz))+ (18.65*(%Pb)*(Pb $/lb))+(9.137*(%Zn)*(Zn $/lb))*

Au oz/ton, Ag oz/ton, %Pb and %Zn are head grades provided by mine planning.

This equation only accounts for NSR from flotation. To get the NSR from gravity products, the amount of gold recovered in the gravity circuit was compared to the amount of gold in the feed over a 2-year period (January 2001 to December 2010) and a simple equation was built to calculate the amount of gold that will go to the gravity products from the grade of gold in the feed. The NSR for the gravity circuit is the product of the amount of gold in the gravity product, the price of gold, and the percentage of payout for gold in the gravity products as follows:

Gravity NSR = (0.2465(Au oz/ton)-0.0065)* (Au$/oz)*0.9289;*

Total NSR = (Flotation NSR) + (Gravity NSR)

13.2.4 Projected Life-of-Mine (LOM) Recoveries

Life-of-mine (LOM) projected recovery figures are as summarized in Table 13-2.

Table 13-2: Projected Life-of-Mine Recovery Estimates

Product	Recovery (%)			
	Lead	Zinc	Silver	Gold
Lead Concentrate	71.31	13.04	63.96	36.00
Zinc Concentrate	5.46	62.50	7.46	5.13
Bulk Concentrate	4.07	12.97	6.27	4.33
Gravity Concentrate	0.36	-	0.48	19.10

13.3 Metallurgical Variability

Samples selected for metallurgical testing during feasibility and development studies were representative of the various types and styles of mineralization within the different deposits. Samples were selected from a range of locations within the deposit zones. Sufficient sized samples were collected to ensure testing integrity.

13.3.1 Mill Feed Variability

The Greens Creek Mine produces several mineral types differing in terms of mineralogy, mineral grain size and metals grades. Dilution rock types are also variable, with backfill from prior mining cycles typically being present in mill feed as well. No practical means of selective mining or stockpiling exists, as more than one mineralization type commonly is found even in a single working face and day-to-day production from multiple working places is necessary. Blending at the mill stockpile is utilized to maintain reasonably consistent mill feed over periods of a few days.

Mill control is largely based on process stream assays, as determined by on-line analyzers of these streams. Mill metals feed grades have an influence on recoveries, while gold and silver feed grades influence the precious metals grades of concentrates. Recoveries in the future are expected to be like those observed currently and experienced in past years.

13.3.2 Backfill Materials in Mill Feed

Backfill materials can be incorporated in the mill feed as diluting material mined in those portions of active stopes that are in direct contact with previous mining areas. Once in the process plant, the backfill can raise flotation circuit pH levels, which can affect mill recoveries. Currently, Hecla manages fluctuating pH levels using carbon dioxide as a result of several studies completed (e.g. Asarte, 2011; Peterson, 2012; Tahija, 2012), and work remains ongoing to improve circuit performance on feed containing backfill.

13.3.3 Testwork Composite

In early 2011, the properties of average mill feed for 2012 to 2016 were estimated, in conjunction with geologic staff, on the basis of four major mineral types and average grades for each mineral type. During the summer and fall of 2011, mine geologists alerted the mill metallurgy staff when each mineral type would be available. Large samples of actual blasted and loaded mine muck produced from these faces were sampled to ensure that the sample would contain production-level amounts of dilution rock and backfill (Tahija, Large sample description, 2011).

Once adequate quantities of material representing each mineral type were collected, the sample lots were shipped to a firm specializing in crushing, blending and splitting large mineral composites. A large composite weighing approximately 1,700 pounds was prepared using a blending recipe, as directed by Hecla metallurgical staff, and split into smaller lots for ease in use (Phillips, 2011). These small lots, as well as leftover lots of the individual mineral types are held in refrigerated storage for use as needed in future metallurgical testing programs.

13.4 Deleterious Elements

The presence of the potentially deleterious elements arsenic, mercury and antimony was noted during initial testing (Banning, 1983). These elements are extremely difficult to separate due to the typical modes of occurrence; which are intergrowths or interstitial. Over the course of production and marketing, deleterious elements upon which customers have set limits include:

- Arsenic, mercury and antimony in lead concentrates;
- Magnesium, arsenic, mercury, and cadmium in zinc concentrates;
- Magnesium, arsenic, mercury, and cadmium in bulk concentrates.

Penalties charges have been applied against some shipments from time to time, most commonly for arsenic and mercury content. Other potential deleterious elements have been identified in geological and concentrate analyses; including selenium, fluorine, and thallium. These have not been present in high concentrations; overall these have not been and are not expected to be a significant issue from a concentrate sale standpoint.

13.5 Comments on Mineral Processing and Metallurgical Testing

Industry-standard studies were performed as part of process development and initial Greens Creek mill design. Subsequent production experience and focused investigations, as well as marketing requirements, have guided mill expansions and process changes.

Test work programs, both internal and external, continue to be performed to support current operations and potential improvements.

The QP has reviewed the information compiled by Hecla, as summarized in Section 13, and has performed a review of the reconciliation data available to verify the information used in the LOM plan. Based on these checks, in the opinion of the QP, the metallurgical test work and reconciliation and production data support LOM planning:

- Industry standard and appropriate metallurgical testing procedures consistent for the deposit's mineralogy have been consistently used by Greens Creek staff for optimizing and improving mill process capabilities and performance;
- Numerous external and internal studies have been conducted from feasibility studies to the date of this report which have been used to develop and optimize the existing flowsheet;
- The mineral samples used in the test work are considered representative of mill feed mineral types across the deposit and the mill has cold stored larger standard samples of several of the major mineral types for future metallurgical investigations;
- LOM projections are based on production results and informed by metallurgical test data that is updated in the model forecasts each year;
- Mill metallurgical results and forecasts are consistent with the deposit mineralization and wide range of mineralogy present for the process circuit used.
- Metallurgical and production models were developed from metallurgical sampling and testing which is adjusted annually to account for process and metallurgical improvements and changes. The methodologies, process and data used in making recovery projections are unbiased and provide sound projections;
- Plant recovery variability is expected on a day-to-day basis depending on mineral types and combinations of mineral types being processed and actual mill operating conditions, but these variations are expected to trend to the LOM forecast on monthly or longer reporting period bases.

14.0 MINERAL RESOURCE ESTIMATES

14.1 Summary of Estimation Methodology

Due to variations in mineralization, structural complexity, and spatial location, the Greens Creek ore bodies are segregated into nine unique model zones for both mineral resource modeling and mine planning purposes.

Table 14-1 provides an overview of the database closeout date and other cut-off dates pertinent to model construction. Table 14-2 gives an overview of the modeling parameters, and interpolation methods for the separate zone models currently in use at Greens Creek.

Drillhole intercepts are uniquely coded to each zone; however, a single drillhole may pierce multiple zones. Block size is determined by selecting a block small enough to honor the geometry of the mineralized zone as well as being a multiple of the expected SMU which is 10 ft x 10 ft x 15 ft (3 m x 3 m x 4.6 m) in x, y and z axes, respectively.

The coordinate system used for mineral resource modeling is the local geologic grid (geo-grid). The coordinate systems used at Greens Creek, and transform properties are discussed in Section 9.1.

Mineralized envelopes for seven out of nine zones were built using Leapfrog Geo software. The remaining zones were constructed utilizing Hexagon's Minesight software. All drillhole processing, compositing, and modeling utilize Datamine® macros for control.

The 2018 Mineral Resource estimates were reviewed by Mr. Paul Jensen, Chief Geologist, and Mr. Alexander Winant, Resource Geologist, for Hecla Greens Creek Mining Company. Estimates were prepared with reference to the Canadian Institute of Mining Metallurgy and Petroleum (CIM) Definition Standards (2014) and CIM Best Practice Guidelines (2003). The Qualified Person responsible for the estimates is Mr. Paul Jensen, CPG, a Hecla employee.

Table 14-1: Summary of Zone Model Dates

Zone	Drill Database Close-out Date	Wireframe Creation Date	Date of Block Model Update, Current Price/NSR Assumptions	Modeler
East	11/11/2018	12/31/2018	12/31/2018	P Jensen, A Winant
West	5/15/2018	12/31/2018	12/31/2018	P Jensen, A Winant
9A	6/23/2017	12/31/2018	12/31/2018	P Jensen, A Winant
NWW	7/9/2017	12/31/2017	12/31/2018	K Lear
SW	10/10/2018	12/31/2018	12/31/2018	P Jensen, A Winant
200S	10/10/2018	12/31/2018	12/31/2018	P Jensen, A Winant
5250	10/26/2016	12/31/2016	12/31/2018	K Lear
Gallagher	9/9/2018	12/31/2018	12/31/2018	P Jensen, A Winant
Upper Plate	11/19/2018	12/31/2018	12/31/2018	P Jensen, A Winant

Table 14-2: Summary of Modeling Parameters by Zone

Parameter	Unit/Explanation	Zone								
		East	West	9A	NWW	SW	200S	5250	Gallagher	Upper Plate
Geological Interpretation	Geologic model construction	Leapfrog implicitly modelled wireframes	Leapfrog implicitly modelled wireframes	Leapfrog implicitly modelled wireframes	wireframes from sectional interpretation	Leapfrog implicitly modelled wireframes	Leapfrog implicitly modelled wireframes	wireframes from sectional interpretation	Leapfrog implicitly modelled wireframes	Leapfrog implicitly modelled wireframes
Composite Length	feet	3	4	4	5	4	3	5	5	3
Number of composites (50NSR shell)	n (count)	5,691	17,765	7,631	17,639	17,442	21,924	10,745	1,777	869
Block Size (x*y*z)	feet	5 x 5 x 5	5 x 5 x 5	5 x 5 x 5	5 x 5 x 5	5 x 5 x 5	5 x 5 x 5	5 x 5 x 5	5 x 5 x 5	5 x 5 x 5
Up Block Size (x*y*z)	feet	5 x 5 x 15	5 x 5 x 15	5 x 5 x 15	5 x 5 x 15	5 x 5 x 15	5 x 5 x 15	5 x 5 x 15	5 x 5 x 15	5 x 5 x 15
Estimation Method	Estimation algorithm	OK*	OK	OK	OK	OK	OK	OK	OK	OK
Last External Review	Completed by AMEC or RPA	2013	2002	2010	2017	2013	2017	2016	2013	2009

*OK – ordinary kriging

14.2 Geological Models

Hecla Greens Creek geologists construct mineralized envelopes which define the extent (and tons) of the zones. These envelopes are constructed using implicit modelling techniques while viewing data in three dimensions, using a combination of ore lithologies, assay grades, and a review of structural continuity.

A net smelter revenue (NSR) of USD $50 forms the basis for interpretation, which is guided by the phyllite/argillite contact (Mine Contact). NSR is calculated using predetermined metal prices multiplied by the metal grades of zinc, silver, gold, and lead.

Typically, non-mineralized units such as phyllite and argillite are assayed if they are mineralized with visually recognizable sulfides and are near the contacts with the massive/white sulfide mineral zones (see Section 11 for more information on current sampling practice). Un-assayed samples are assigned a default grade of zero for all elements.

Three sets of wireframes are created for each zone: a $50 NSR shell, a $140 NSR shell, and a ten-foot waste shell surrounding the $50 NSR shell. Grade composites were built in order to assist in the interpretation of the $50 NSR shell, where samples are grouped (composited) and averaged continuously until the average NSR drops below $50. These composites are built using the following parameters:

- Minimum thickness of composite is 10 feet, unless high grade assays have enough metal content to mine the face economically.
- Internal waste may not be longer than 7 feet.
- Internal waste will make the composite if adjacent material on either side can average to the specified cut-off.

Wireframes are snapped to the grade composites, and also snapped to face samples that are assayed during the mining process.

Within the $50 NSR shell, $140 NSR wireframes are created using a special interpolation process available in Leapfrog called FastRBF (radial basis function). Specifically, face samples and 5-foot composites created from raw drillhole assay files are interpolated using an indicator RBF function to create the $140 shell strictly within the $50 shell. The RBF function utilizes the structural forms defined for the $50 NSR shell to give similar form to the $140 shell. A resource geologist then reviews and adjusts the result for proper volume and geologic continuity.

For grade estimation purposes, all boundaries between zones, structural domains, and NSR zones are considered hard (samples are not shared between domains). Composite samples are coded by NSR shell, with samples from each zone used in separate interpolation runs.

To better model thinner zones that are smaller than the minimum stope design, the waste shell is constructed around mineralized material to estimate dilution that may be included during stope designs. Perimeters for the waste model are created by expanding the $50 NSR wireframes 10 feet from all boundaries. This waste shell is used to create waste blocks and flag samples to be used for interpolation into these blocks.

Seven models were updated for the end of year (EOY, refers to work used to complete December 31 Mineral Resource and Mineral Reserve estimates and mine plans) 2018: 9A, SWB, East, West, 200S, Gallagher, and Upper Plate zones. The NWW and 5250 Zone wireframes have not been updated since EOY 2017 and EOY 2016, respectively.

14.2.1 East Zone

The East Zone is bounded by the Klaus Fault at lower elevations and the Maki Fault to the west. The Klaus Fault separates it from West Zone, and the Maki separates it from 9A Zone. The East Zone was modelled using Leapfrog's vein system tool. Wireframes were built around grade composites using a $50 NSR minimum and were snapped to mined-face data. The $140 NSR shell was interpolated within the $50 NSR shell using a combination of mined-face and assay data.

14.2.2 West Zone

The West Zone is bounded by the Klaus Fault at higher elevations and the Maki Fault to the west. The Klaus Fault separates the West Zone from the East Zone, and the Maki Fault separates the West Zone from the 9A Zone. It was modelled using a combination of Leapfrog's vein system tool and intrusion tool. Wireframes were built around grade composites using a $50 NSR minimum and were snapped to mined-face data. The $140 NSR shell was interpolated within the $50 NSR shell using a combination of mined-face and assay data.

14.2.3 9A Zone

The 9A Zone is bounded by the Maki Fault to the east and the Kahuna Fault to the west. The Maki separates it from East and West zones, and the Kahuna separates it from the 5250, Southwest, and Northwest West zones. It was modelled using Leapfrog's vein system tool. Wireframes were built around grade composites using a $50 NSR minimum and were snapped to mined-face data. The $140 NSR shell was interpolated within the $50 NSR shell using a combination of mined-face and assay data.

14.2.4 Northwest West Zone

The Northwest West Zone (NWW) is bounded by the Kahuna Fault to the east and the Upper Plate Shear Zone at higher elevations. Greens Creek geologists also apply domain boundaries to the zone, to separate it from SW and 5250 zones. This is due to differences in mineral trends between the three zones, as well as computational constraints seen during block model construction. The Kahuna Fault separates the 5250 Zone from the 9A Zone. The NWW Zone mineralization shell was created from sectional interpretations on mineralized intervals selected by the resource geologist. The interval selection process was done per drillhole primarily according to silver, zinc and lead grades with the general composite grade equaling $140-$190 NSR.

14.2.5 Upper Plate Zone

The Upper Plate Zone is bounded by the Upper Plate Shear Zone at lower elevations and the Kahuna Fault to the east. The Kahuna Fault separates it from the 9A and West zones, and the shear zone separates it from Northwest West Zone. It was modelled using Leapfrog's vein system tool. Wireframes were built around grade composites using a $50 NSR minimum and were snapped to mined-face data. The $140 NSR shell was interpolated within the $50 NSR shell using the structural form of the $50NSR shell and assay data.

14.2.6 Southwest Zone

The Southwest Zone is bounded by the Kahuna Fault to the east. Greens Creek geologists also apply domain boundaries to the zone to separate it from NWW and 5250 zones. This is due to differences in mineral trends between the three zones, as well as computational constraints seen during block model construction. It was modelled using a combination of Leapfrog's vein system tool and intrusion tool. Wireframes were built around grade composites using a $50 NSR minimum and were snapped to mined-face data. The $140 NSR shell was interpolated within the $50 NSR shell using a combination of mined-face and assay data.

14.2.7 200 South Zone

The 200 South Zone is bounded by the Gallagher Fault to the west. Greens Creek geologists also apply domain boundaries to the zone to separate it from the Southwest. This is due to a desire to maintain historical consistency, as well as to address computational constraints seen during block model construction. The Gallagher Fault separates it from the Gallagher Zone. The 200 South Zone was modelled using a combination of Leapfrog's vein system tool and intrusion tool. Wireframes were built around grade composites using a $50 NSR minimum and were snapped to mined-face data. The $140 NSR shell was interpolated within the $50 NSR shell using a combination of mined-face and assay data.

14.2.8 5250 Zone

The 5250 Zone is bounded by the Kahuna Fault to the east and the Upper Plate Shear Zone at higher elevations. Greens Creek geologists also apply domain boundaries to the zone to separate it from SW and NWW zones. This is due to differences in mineral trends between the three zones, as well as computational constraints seen during block model construction. The Kahuna Fault separates it from the 9A Zone. The 5250 Zone mineralization shell was created from sectional interpretations on mineralized intervals selected by the resource geologist. The interval selection process was done per drillhole primarily according to silver, zinc and lead grades with the general composite grade equaling $140-$190NSR.

14.2.9 Gallagher Zone

The Gallagher Zone is bounded by the Gallagher Fault to the east. The Gallagher Fault separates it from the 200 South Zone and modelled using a combination of Leapfrog's vein system tool and intrusion tool. Wireframes were built around grade composites using a $50 NSR minimum and were snapped to mined-face data. The

$140 NSR shell was interpolated within the $50 NSR shell using the structural form of the $50NSR shell and assay data.

14.3 Exploratory Data Analysis

Exploratory data analysis (EDA), in the form of summary statistics, correlation matrices, histograms, cumulative probability plots and XY plots are performed on both uncapped and capped sample and composite values for Au, Ag, Pb, Zn and sample length to determine suitable geological constraints to mineralization.

14.4 Density Assignment

Greens Creek has developed a stoichiometric approach to calculating SG making use of chemical formulas for principal ore and gangue minerals. The coefficients have been adjusted using a least-squares polynomial fit to a dataset of over 23,000 measurements and are based on measured core specific gravity and the corresponding assays.

The resulting equation to determine the bulk density is:

$$Density\ (g/cm^3) = 100/\ (36.74 - 0.2815*Pb(\%) - 0.1597*Zn(\%) - 0.1054*Cu(\%) - 0.3388*Fe(\%) - 0.2687*Ba(\%))$$

Depending upon the assay protocol in place at the time of sampling, some core samples do not have the full suite of validated assays required by this formula. The following hierarchical approach is taken to assign a density to a sampled interval:

- Sample has a full suite of validated assays: Use full regression formula;
- Sample has full suite except Ba: If logged as a non-baritic mineral type, assign a default value for Ba based on zone statistics for non-white baritic mineral samples and apply the full regression. The default Ba value is only used for density assignment and not for interpolation;
- Sample does not meet the criteria for 1 or 2 above but has a measured SG: Assign measured SG as final sample density;
- Sample does not meet criteria for 1–3 listed above: Assign a default SG based on logged mineral type. Default values are determined by zone/lithological type during EDA.

After metal values have been estimated into the block model blocks, the block density is calculated using only the full density calculation formula.

14.5 Grade Capping/Outlier Restrictions

Grade capping is used to limit the spatial extrapolation of the occasional high, isolated precious metal grades. Capping analyses undertaken at Greens Creek include the use of probability plots and the Parrish (1997) decile method. For all the zones modeled the results are compared and an appropriate value is determined for use as the grade cap. For low to moderate drill density areas, methods tend to compare favorably. Capping levels are applied at the sample level only. Table 14-3 summarizes the caps imposed by zone.

14.6 Composites

Composite lengths for interpolation purposes vary from 3 to 5 feet in length depending upon the zone (refer to summary in Table 14-2). Composites start and stop at the waste shell, $50 NSR, and $140 NSR boundaries.

Two methods have been utilized to handle intervals where the flagged length is not an integral multiple of the design composite length. If any un-assayed intervals are flagged the payable metal values are set to zero. Non-payable elements are left as null (missing value).

When composites do not reach the full specified interval length, shorter samples are created that are cut at the boundary. Table 14-3 shows the capping level by Zone.

Table 14-3: Sample Capping Level by Zone and Element

Element/unit	East	West	9A	NWW	SW	200S	5250	Gallagher	Upper Plate
Au (oz/ton)	1.4	1.6	1	0.9	1.4	1.4	0.4	0.49	0.5
Ag (oz/ton)	222	385	88	100	222	222	110	50	114
Pb (%)	18	28	21	18	18	18	15	13	12.5
Zn (%)	36	42.5	37.9	40.5	36	36	30	29	27
Cu (%)	2.0	2.0	3.6	3.0	2.0	2.0	2.7	1.0	1.2
% of Au samples capped	0.1%	0.3%	0.3%	2.0%	0.3%	0.2%	1.5%	0.7%	0.3%
% of Ag samples capped	0.2%	0.1%	0.3%	1.9%	0.4%	0.1%	1.7%	0.3%	0.4%
% of Pb samples capped	1.1%	0.0%	0.2%	0.7%	0.6%	0.3%	1.1%	0.5%	0.9%
% of Zn samples capped	0.7%	0.1%	0.7%	0.5%	0.5%	0.3%	1.8%	0.5%	0.1%
% of Cu samples capped	0.9%	1.7%	0.2%	0.7%	0.5%	0.3%	0.9%	0.4%	0.8%

14.7 Variography

Datamine's Advanced Estimation module was used to carry out variography for all zones apart from 5250 and Northwest West zones. Individual datasets are constructed within the interpreted $50 NSR shells for each zone. Down-hole and directional variograms are constructed for Au, Ag, Pb, and Zn. Continuity is modelled utilizing a nugget plus a one- or two-structure spherical model.

For zones with low drilling density, directional variograms are calculated along the axes of anisotropy as defined by the overall trend and geometry of the interpretations. Nugget values generally range between 0 to 50% of the sill, with Pb and Zn typically lower than Au and Ag. Structural ranges can range from less continuous (~10 ft) to showing good continuity (>200 ft) depending on the element and direction. Figures 14-1 through 14-4 show examples of experimental and modeled variograms for four different zones.

Figure 14-1: Experimental Variogram, 200S Zone, Zn Major Direction

(number of pairs labeled)

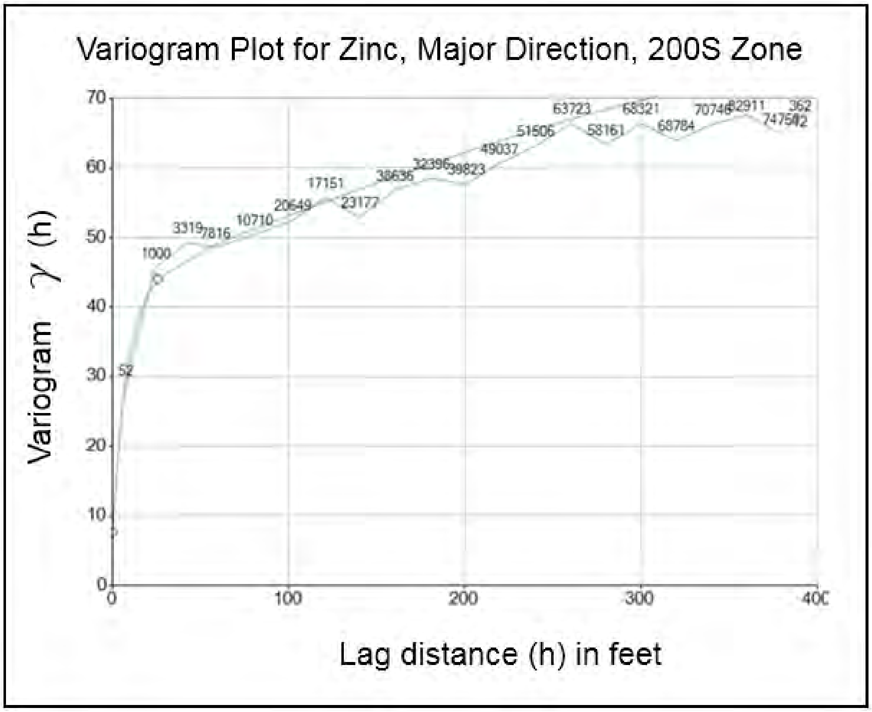


Figure 14-2: Experimental Variogram, East Zone, Ag Major Direction

(number of pairs labeled)

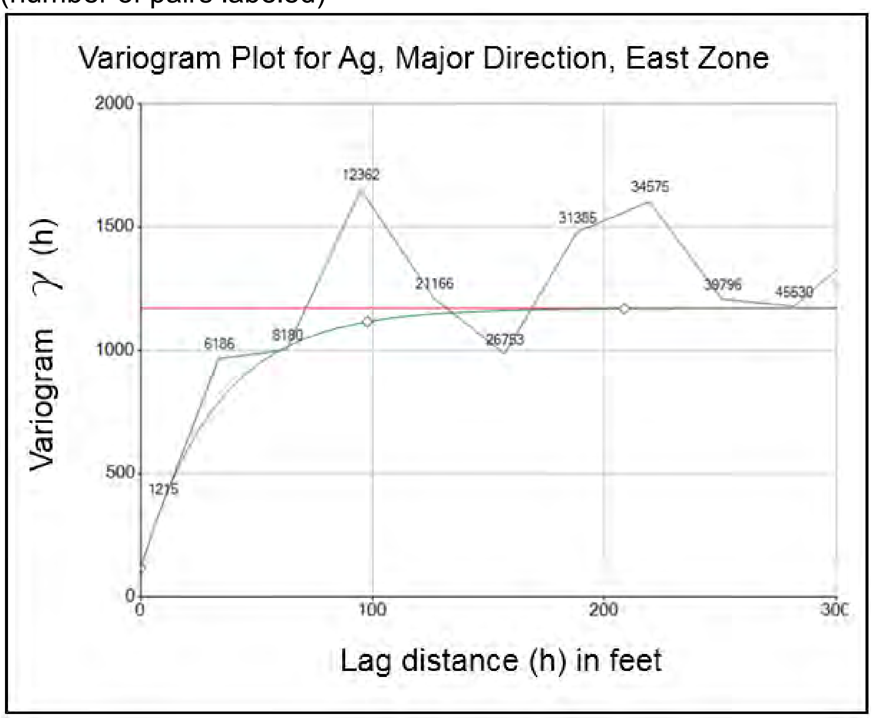


Figure 14-3: Experimental Variogram, SW Zone, Zn Major Direction

(number of pairs labeled)

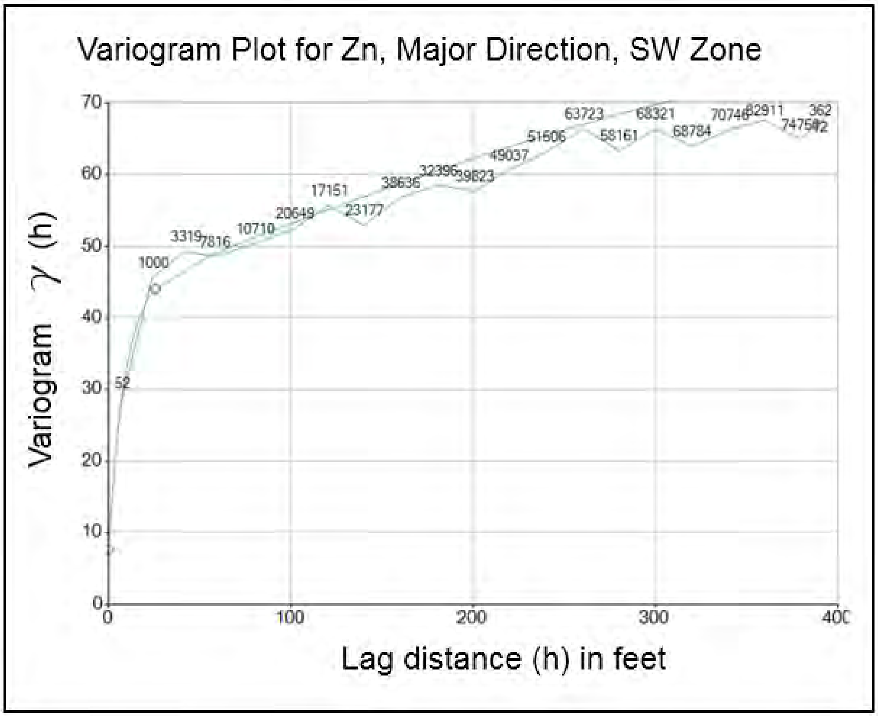
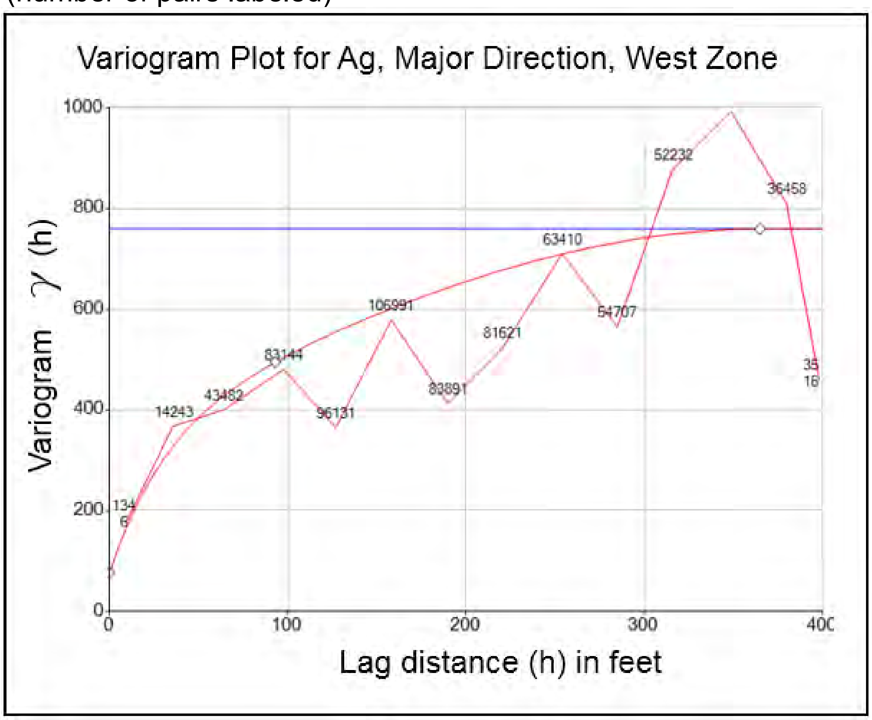


Figure 14-4: Experimental Variogram, West Zone, Ag Major Direction

(number of pairs labeled)



14.8 Block Model Prototypes

For interpolation purposes, a block size of 5x5x5 feet (x, y, z) was selected. This dimension functions well in fitting thin veins, but also can be conveniently upblocked to match the selective mining unit (SMU), or the minimum stope design dimension, of 10x10x15 ft. Blocks for all zones are upblocked to 5x5x15 ft, and these are used for mine planning purposes.

For the thin, vein-like zones or benches, the size of the mineralized material within the envelope is commonly less than the SMU size. To accommodate evaluations on the thin veins a 10-foot block model buffer is created around mineralized blocks. Blocks in the buffer model are estimated separately. The buffer blocks are then used to estimate the grade of the material that may be included as dilution to meet the minimum stope design. This step typically occurs during the stope design process.

14.9 Estimation/Interpolation Methods

Grades are estimated in the block model using the composited drillhole data sets. Variograms were constructed for all zones, and all models are estimated using ordinary kriging (OK). For all seven remodeled zones (excluding the NWW and 5250 zones), variograms provide input to search orientations and anisotropies. Search distances are set at a range that corresponds with a certain percentage of the total sill for each individual element, where the first pass uses 35% of the sill, and the second pass uses 70%. The third pass sets no distance limits. Dynamic anisotropy is employed, where the interpreted geologic structure guides the search orientations by actively reorienting the search ellipse based on the strike and dip of nearby wireframe triangles. Sample selection criteria are set as follows:

- Minimum number of composites: 1st pass: 6; 2nd pass: 2; 3rd pass: 1
- Maximum number of composites: 10;
- Maximum number of composites from a single drillhole: 7

The NWW and 5250 zones had different parameters applied for search distances. The NWW Zone used distances of 50-60 feet for the primary search axis for the first pass, and 75-90 feet for the second pass. The 5250 Zone used distances of 60-75 feet for the primary search axis for the first pass, and 90-112.5 feet for the second pass. Sample selection criteria were set as follows:

- Minimum number of composites: 1st pass: 15; 2nd pass: 15; 3rd pass: 5-20;
- Maximum number of composites: 15-30;
- Maximum number of composites from a single drillhole: n/a

14.10 Block Model Validation

Estimation validation is done by performing one or more of the following checks on the model:

- Review and inspection of parameter files (Datamine macros) used in the mineral resource estimation;
- Visual inspection of results by metal on plan and section;

- Comparison of ordinary-kriged or inverse-distance and NN distributions (Table 14-4);
- Analysis of grade profiles by easting, northing and elevation using swath plots (Figures 14-5 to 14-8);
- External spot-checks of key calculations such as block kriging and compositing.
- The checks showed the models were acceptable for use in Mineral Resource and Mineral Reserve estimation

Table 14-4: Block Statistics- Nearest Neighbor vs Ordinary Kriging

(Ag opt, Zn pct, Pb pct, Au opt)

Zone	N Blocks	AgOK	AgNN	%Diff	ZnOK	ZnNN	%Diff	PbOK	PbNN	%Diff	AuOK	AuNN	%Diff
WEST	527,885	13.21	12.98	2%	11.80	11.70	1%	3.88	3.86	1%	0.14	0.14	1%
9A	222,853	11.90	11.87	0%	11.34	11.24	1%	4.19	4.13	1%	0.12	0.12	0%
SWB	260,823	25.67	25.13	2%	10.10	9.87	2%	4.79	4.70	2%	0.15	0.14	2%
200S	438,110	19.24	18.59	4%	8.93	8.83	1%	3.66	3.63	1%	0.14	0.14	2%
GAL	29,188	6.50	6.47	0%	8.46	8.34	1%	3.73	3.71	1%	0.13	0.13	0%
UPPL	26,583	17.27	16.53	4%	6.39	6.14	4%	3.05	2.95	3%	0.04	0.04	-3%
EAST	187,967	17.74	17.06	4%	9.91	9.74	2%	4.11	4.02	2%	0.11	0.10	3%

Figure 14-5: Swath Plot- 200S Zone Zn

(Number of composite samples labeled)

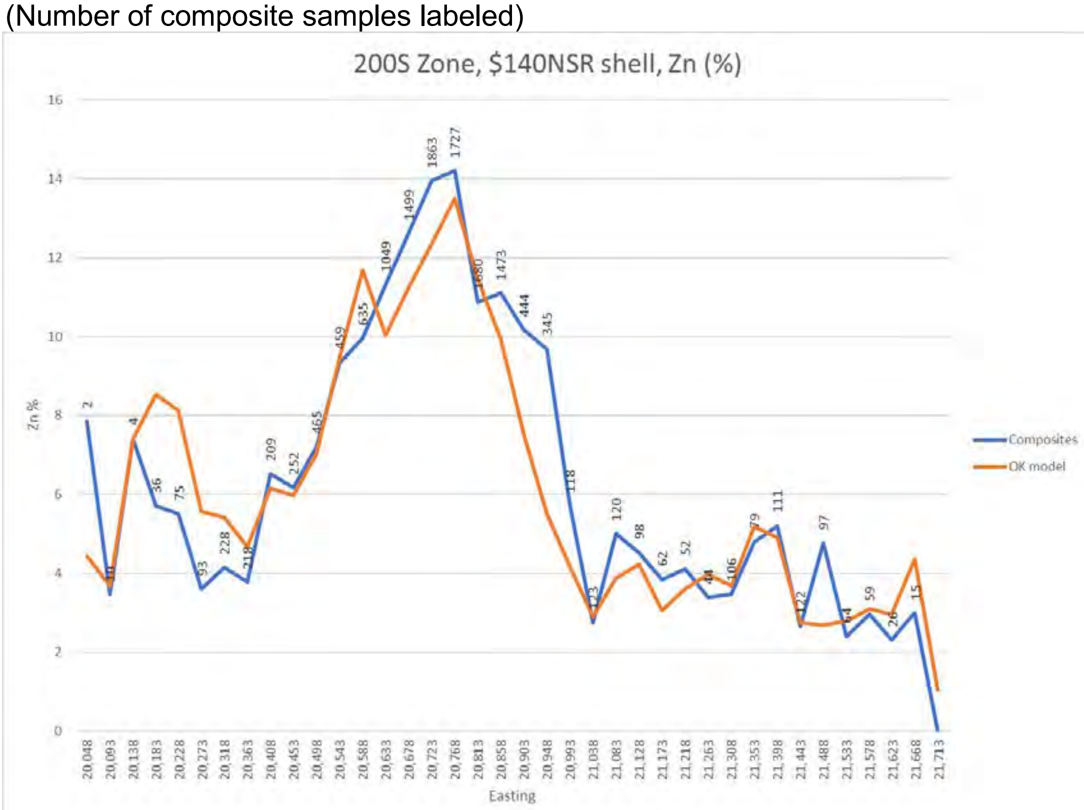


Figure 14-6: Swath Plot- 200S Zone Au

(Number of composite samples labeled)

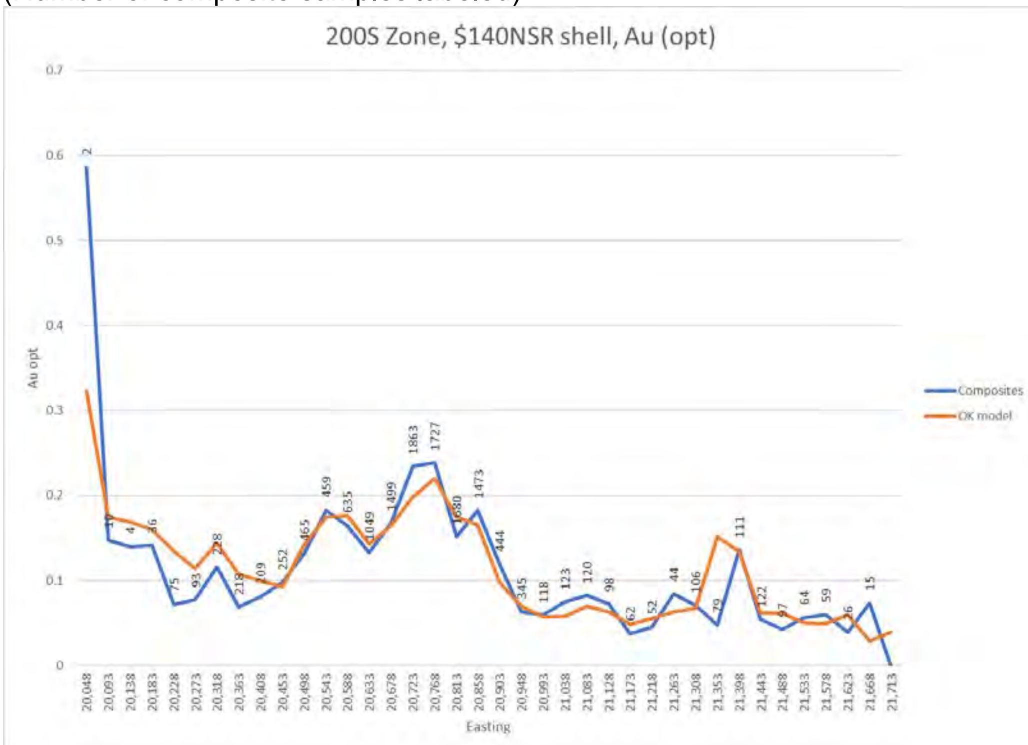


Figure 14-7: Swath Plot- 9A Zone Zn

(Number of composite samples labeled)

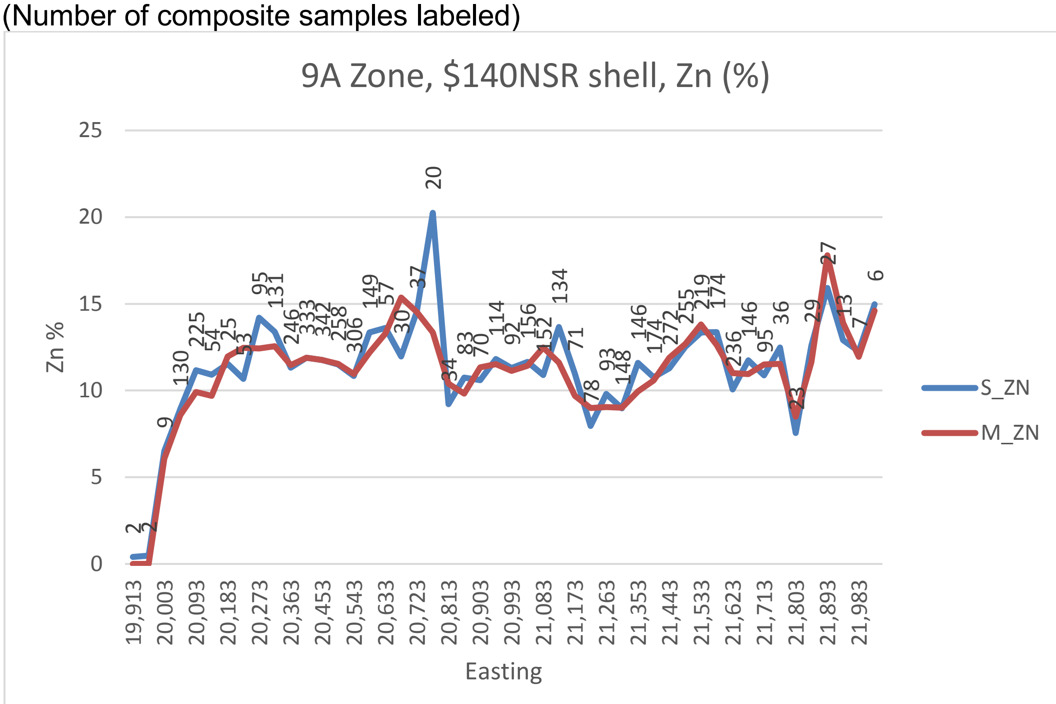
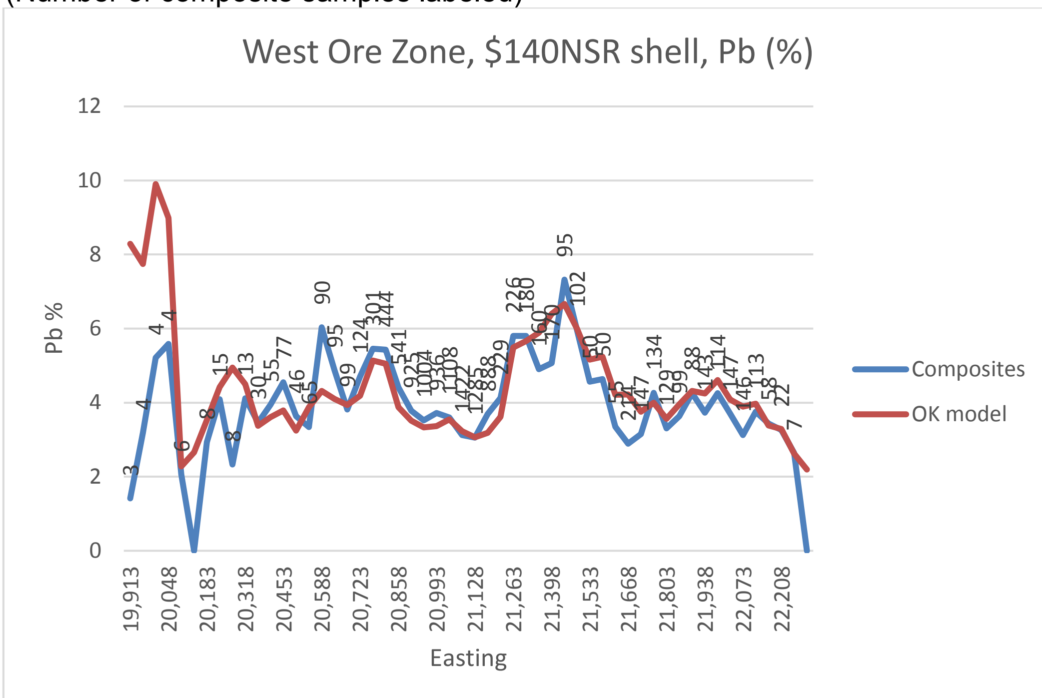


Figure 14-8: Swath Plot- West Zone Pb

(Number of composite samples labeled)



14.11 Classification of Mineral Resources

In order to determine appropriate classification standards, variograms for each zone are considered for Ag (lower continuity) and Zn (higher continuity).

Classification distances are set at a range that corresponds with a certain percentage of the total sill for Ag and Zn as read off the semi-variograms. Measured blocks need to fall within a distance calculated as the average of 35% of the sill-range for both elements. Indicated blocks need to fall within an average of 70% of the sill-range for both elements.

Table 14-5 shows the classification parameters used for the seven zones updated in 2018. The 5250 and NWW zone parameters are displayed in Table 14-6 because different standards were employed during their classification.

Table 14-5: Summary of Classification Parameters by Zone

Class	Parameter	East	West	9A	SW	200S	Gallagher	Upper Plate
Measured	Minimum distance, ft	10.9	5.9	15.9	12.25	12.3	31	12.3
	Minimum n drillholes	3	3	3	3	3	3	3
	Minimum n samples	2	2	2	2	2	30	2
Indicated	Minimum distance, ft	58.3	71	47.3	69.75	69.8	65	43
	Minimum n drillholes	2	2	2	2	2	2	1
	Minimum n samples	2	2	2	2	2	30	2

Table 14-6: Summary of Classification Parameters, 5250 and NWW Zones

Class	Parameter	5250	NWW
Measured	Ag avg. transform distance, ft	<0.5	<0.8
	Zn avg. transform distance, ft	<0.5	<0.8
	Minimum samples, Ag	8	12
	Minimum samples, Zn	9	12
Indicated	Ag avg. transform distance, ft	<1.1	<1.5
	Zn avg. transform distance, ft	<1.1	<1.5
	Minimum samples, Ag	6	8
	Minimum samples, Zn	6	8
Inferred	Ag avg. transform distance, ft	<4.0	<4.0
	Zn avg. transform distance, ft	<3.0	<4.0
	Minimum samples, Ag	6	4
	Minimum samples, Zn	6	4

14.12 Reasonable Prospects of Economic Extraction

Over 20 years of production experience demonstrates that the mineral deposits at Greens Creek are amenable to underground overhand cut-and-fill and long-hole stoping methods. Based on this production history, the following assumptions have been applied to determine the extent of the classified material that might have a reasonable expectation of economic extraction.

As with previous years a 5x5x5 ft block model and a 5x5x15 ft block model was created for each zone. The models were used by the engineering department to design mineral reserve shapes with the thinner and more horizontal mineral zones utilizing the 5x5x5 model. Once mineral reserve stopes were designed the mineral reserve was calculated based on the 5x5x5 model.

For mineral resource calculation the models were depleted for mined asbuilts and mineral reserve shapes within Deswick which generated a partial block/subcell model. Those models were then used as follows:

1. Depending on the mineral zone, either the 5x5x5 ft or 5x5x15 ft model was viewed in plan at mid-block with the NSR values displayed. Polygons were drawn at mid-block around the depleted mineral resource blocks so that:
    - All blocks >$190 NSR immediately adjacent to the designed mineral reserve were enclosed.
    - All blocks >$190 NSR separated from the designed mineral reserve were enclosed if the blocks were seen to be continuous in 3D to approximately 20,000 tons or more. Where these blocks were only a single block wide (5ft) they were not enclosed.
    - No blocks >$190 NSR immediately adjacent to asbuilts were enclosed unless those blocks looked to be continuous and wide enough to support a separate stope.
    - Once blocks were selected in the appropriate model, they were reported without any dilution from neighboring blocks with <$190 NSR values.
2. The Gallagher and Upper Plate zone mineral resource polygons were drawn every 5 ft in elevation at mid-block on the 5x5x5 ft model. Once blocks were

selected and coded the mineral resource report used the 5x5x5 ft model. This approach was taken as the mineral zones are often thin and shallowly dipping. The guiding principle on selecting the >$190 NSR blocks was to keep a 10 ft mining width over 20,000 tons if away from a mineral reserve shape.

3. The 200S Zone mineral resource polygons were drawn every 15 ft in elevation while viewing the 5x5x15 ft model and mid-block elevation. Those polygons were extruded into 15 ft high selection volumes that coded blocks as mineral resource within the 5x5x5 ft model. The 5x5x5 ft model was then used to report the mineral resource. The 5x5x5 model was chosen so as to not overly dilute (and reduce) the mineral resource with 15 ft high blocks which often split the thin vein and create artifact zones of mineral resource parallel to each other simply due to the larger blocks splitting the vein or not.
4. The remaining mineral resource polygons of the 9A, East, SWB, West, NWW and 5250 zones were drawn every 15 ft in elevation while viewing the 5x5x15 ft models. The polygons were extruded into 15ft high selection volumes to code the 5x5x15 ft model blocks as mineral resource. Only blocks > $190 NSR were selected for tabulation of the mineral resource which was performed on the 5x5x15 ft model. The thicker model was chosen for these zones as the mineralization is often thicker and does not display the artifact banding that the other thinner and more horizontal mineral bodies did.

Table 14-7: Reasonable Prospects Key Assumptions

Zone	Category	NSR Cut-off	Metal Prices			
			Au (USD/oz)	Ag (USD/oz)	Pb (USD/lb)	Zn (USD/lb)
East	Mineral Resource	$190	$1,350	$21.00	$1.10	$1.20
	Mineral Reserve	$190	$1,200	$14.50	$0.90	$1.15
West	Mineral Resource	$190	$1,350	$21.00	$1.10	$1.20
	Mineral Reserve	$190	$1,200	$14.50	$0.90	$1.15
9A	Mineral Resource	$190	$1,350	$21.00	$1.10	$1.20
	Mineral Reserve	$190	$1,200	$14.50	$0.90	$1.15
Northwest West	Mineral Resource	$190	$1,350	$21.00	$1.10	$1.20
	Mineral Reserve	$190	$1,200	$14.50	$0.90	$1.15
Southwest	Mineral Resource	$190	$1,350	$21.00	$1.10	$1.20
	Mineral Reserve	$190	$1,200	$14.50	$0.90	$1.15
200S	Mineral Resource	$190	$1,350	$21.00	$1.10	$1.20
	Mineral Reserve	$190	$1,200	$14.50	$0.90	$1.15
5250	Mineral Resource	$190	$1,350	$21.00	$1.10	$1.20
	Mineral Reserve	$190	$1,200	$14.50	$0.90	$1.15
Gallagher	Mineral Resource	$190	$1,350	$21.00	$1.10	$1.20
	Mineral Reserve	$200	$1,200	$14.50	$0.90	$1.15
Upper Plate	Mineral Resource	$190	$1,350	$21.00	$1.10	$1.20
	Mineral Reserve	$190	$1,200	$14.50	$0.90	$1.15
Stockpile	Mineral Reserve	$190	$1,200	$14.50	$0.90	$1.15

14.13 Mineral Resource Statement

Mineral Resources take geologic, mining, processing and economic constraints into account, and have been defined within a conceptual stope design and therefore are classified in accordance with the 2014 CIM Definition Standards for Mineral Resources and Mineral Reserves, and the 2003 CIM Best Practice Guidelines.

The Qualified Person for the Mineral Resource estimate is Mr. Paul Jensen, CPG, a Hecla employee. Mineral Resources are reported exclusive of Mineral Reserves and are reported using a $190NSR cut-off.

Hecla cautions that Mineral Resources that are not Mineral Reserves and have not demonstrated economic viability. Measured and Indicated Mineral Resources are reported in Table 14-8. Inferred Mineral Resources are summarized in Table 14-9.

14.13.1 Factors That May Affect the Mineral Resource Estimate

Factors which may affect the Mineral Resource estimates include:

- Metals price assumptions;
- Changes to design parameter assumptions that pertain to stope design;
- Changes to geotechnical, mining and metallurgical recovery assumptions;
- Changes to the assumptions used to generate the NSR cut-off;
- Changes in interpretations of mineralization geometry and continuity of mineralization zones;
- Changes to the assumptions related to mineral tenure rights and royalty assumptions associated with the Land Exchange properties.

Table 14-8: Measured and Indicated Mineral Resource Statement Dec. 31, 2018

Measured Resources	Tons	Gold (Oz/ton)	Silver (Oz/ton)	Lead (%)	Zinc (%)	Gold (Ounces)	Silver (Ounces)	Lead (Tons)	Zinc (Tons)
East	500	0.041	6.71	5.56	11.84	20	3,300	30	60
West	600	0.091	6.59	2.32	8.95	60	4,200	20	60
9A	2,300	0.087	12.68	4.62	10.44	200	28,800	110	240
NWW	260,900	0.118	8.31	2.52	9.90	30,800	2,169,100	6,570	25,830
SW	20,000	0.093	22.73	3.30	6.65	1,900	455,500	660	1,330
200S	5,600	0.125	10.11	2.73	13.28	700	56,500	150	740
5250	44,000	0.041	11.16	2.54	7.02	1,800	491,300	1,120	3,090
Gallagher	4,600	0.136	5.23	3.21	7.53	600	24,300	150	350
Upper Plate	-	-	-	-	-	-	-	-	-
Total Measured	**338,600**	**0.107**	**9.55**	**2.60**	**9.36**	**36,100**	**3,233,000**	**8,800**	**31,700**

Indicated Resources	Tons	Gold (Oz/ton)	Silver (Oz/ton)	Lead (%)	Zinc (%)	Gold (Ounces)	Silver (Ounces)	Lead (Tons)	Zinc (Tons)
East	454,800	0.089	12.60	2.94	7.86	40,600	5,731,200	13,390	35,760
West	2,206,600	0.120	11.37	3.14	9.47	264,700	25,082,700	69,370	208,980
9A	456,500	0.077	10.68	3.76	9.26	35,300	4,877,100	17,150	42,250
NWW	740,200	0.095	10.08	2.63	8.17	70,100	7,462,900	19,430	60,500
SW	1,031,700	0.084	18.61	3.54	7.14	87,100	19,194,600	36,500	73,620
200S	1,323,100	0.108	15.86	2.80	7.20	142,700	20,979,500	37,070	95,210
5250	490,800	0.043	11.80	2.59	6.55	21,000	5,790,200	12,730	32,150
Gallagher	177,500	0.119	6.89	3.46	7.73	21,100	1,223,000	6,130	13,710
Upper Plate	247,300	0.032	15.59	2.90	6.26	7,800	3,856,000	7,180	15,470
Total Indicated	**7,128,300**	**0.097**	**13.21**	**3.07**	**8.10**	**690,300**	**94,197,200**	**218,950**	**577,650**
Total Measured and Indicated	**7,466,900**	**0.097**	**13.05**	**3.05**	**8.16**	**726,400**	**97,430,200**	**227,740**	**609,350**

Table 14-9: Inferred Mineral Resource Statement Dec. 31, 2018

Inferred Resources	Tons	Gold (Oz/ton)	Silver (Oz/ton)	Lead (%)	Zinc (%)	Gold (Ounces)	Silver (Ounces)	Lead (Tons)	Zinc (Tons)
East	635,500	0.101	13.48	2.71	8.06	64,100	8,566,600	17,250	51,190
West	111,200	0.107	11.84	2.62	7.12	12,000	1,316,800	2,910	7,920
9A	389,000	0.079	11.73	4.17	9.41	30,600	4,561,600	16,230	36,600
NWW	387,000	0.081	15.59	3.24	8.09	31,500	6,032,900	12,540	31,300
SW	45,300	0.124	15.30	2.43	4.95	5,600	692,400	1,100	2,240
200S	322,700	0.108	22.76	1.97	3.96	35,000	7,345,200	6,370	12,770
5250	145,700	0.051	11.87	3.04	7.06	7,400	1,728,900	4,430	10,280
Gallagher	256,800	0.096	10.02	3.34	6.99	24,700	2,571,800	8,570	17,960
Upper Plate	176,700	0.043	17.92	2.83	6.30	7,700	3,166,300	5,000	11,140
Total Inferred	**2,469,900**	**0.088**	**14.57**	**3.01**	**7.34**	**218,500**	**35,982,400**	**74,410**	**181,400**

Notes to Accompany Mineral Resource Tables:

1. The Qualified Person for the Mineral Resource estimates is Paul Jensen, CPG, a Hecla employee.
2. Mineral Resources are exclusive of Mineral Reserves and do not have demonstrated economic viability.
3. Mineral Resource block models have a number of database cut-off dates from 2017 to 2018; all Mineral Resources have been depleted for mining as of December 31, 2018.
4. Mineral Resources are based on the following metal prices and cut-off assumptions: $1,350/oz Au, $21/oz Ag, $1.10/lb Pb, $1.20/lb Zn, NSR cut-off of $190/t for all zones except the Gallagher Zone, which used a $200/t cut-off.
5. Totals may not agree due to rounding.
6. Reporting units are imperial, Tons: dry short tons(dst); Au (troy ounces/dst); Ag (troy ounces/dst); Pb and Zn percent (%).

14.14 Comments on Mineral Resource Estimates

Hecla is listed on the New York Stock Exchange and is subject to SEC requirements when reporting on the Greens Creek Mine. In forms filed with the SEC, Hecla uses terminology in SEC Industry Guide 7 for reporting Ore Mineral Reserves. On its website, Hecla uses the Industry Guide 7 terms for Ore Reserves, and the 2007 Society for Mining, Metallurgy and Exploration Guide (2007 SME Guide) terms for the categories of Mineral Resources.

NI 43-101 allows mining companies incorporated outside of Canada to report mineral resources and mineral reserves under accepted foreign codes. SEC Industry Guide 7 is an acceptable foreign code under National Instrument 43-101 *Standards of Disclosure for Mineral Projects* (NI 43-101), but only for the reporting of mineral reserves. Canadian securities regulators do not accept the SEC usage of “mineralized material” as a category of mineral resources and will not accept tons and grade of mineralized material reported in technical reports unless it has been reclassified into the mineral resource categories accepted under NI 43-101.

Hecla is therefore reporting the Proven and Probable Mineral Reserves, and Measured, Indicated, and Inferred Mineral Resources in Sections 14 and 15 using the definitions and categories set out in the Canadian Institute of Mining, Metallurgy, and Petroleum 2010 Definition Standards for Mineral Resources and Mineral Reserves (2010 CIM Definition Standards) as follows:

- The term “Proven Ore Reserve” under SEC Industry Guide 7 is equivalent to “Proven Mineral Reserve” under CIM Definition Standards;
- The term “Probable Ore Reserve” under Industry Guide 7 is equivalent to “Probable Mineral Reserve” under CIM Definition Standards;
- The term “Indicated Mineral Resource” or “Mineralized Material” that Hecla is using for the Greens Creek Mine in website disclosures is equivalent to “Indicated Mineral Resource” under CIM Definition Standards;
- The term “Inferred Mineral Resources” or “Other Resources” that Hecla is using for the Greens Creek Mine in website disclosures is equivalent to “Inferred Mineral Resources” under CIM Definition Standards.

The QP is of the opinion that the Mineral Resources for the Project, which have been estimated using core drill data, have been performed to industry best practices, and conform to the requirements of CIM (2014). The QP is not aware of any environmental, permitting, legal, title, taxation, socio-economic, marketing, political, or other relevant factors that would materially affect the Mineral Resource estimate.

15.0 MINERAL RESERVE ESTIMATES

15.1 Summary of Estimation Methodology

Mineral Reserves have been estimated from the mineral resource block model, which is developed by the geology department and updated regularly to incorporate new information (see Section 14). All zones in the geological model are considered for conversion from Mineral Resource to Mineral Reserve as the models are updated.

The following criteria were used to convert Mineral Resources to Mineral Reserves:

- Only Measured and Indicated Mineral Resources are considered;
- Dilution is included in the Mineral Reserve estimate;
- Mineral Reserves are supported by an economic mine plan;
- The reference point for Mineral Reserves is the mill feed. Metallurgical process losses are not considered when determining the Mineral Reserves.

The Greens Creek NI 43-101 Mineral Reserves Estimate was created with Deswik software using similar methodologies and basic assumptions as previous annual mineral reserve estimates. All areas are designed for either longhole stoping (where the mineralized zone is sufficiently vertical), drift-and-fill stoping, or overhand cut-and-fill stoping.

15.2 Process for Conversion of Mineral Resource to Mineral Reserve

The design process begins by creating a grade shell of the resource block model to highlight Measured and Indicated Mineral Resource blocks with an NSR in excess of the $190/ton cutoff. Areas with sufficient amounts of these blocks are targeted for evaluation as potential mineral reserves.

A detailed stope design is created for each level considering appropriate stoping criteria such as stope dimensions, level spacing, geological and geotechnical factors, the shape of the mineral zone, and any nearby previous mining. This is followed with the creation of 3D primary development and access ramp designs, as well as supporting infrastructure excavations.

The minimum mining height and width is 15 ft, which is the smallest dimension that can effectively accommodate Greens Creek's mining equipment. In areas to be mined with drift-and-fill methods, the centerline of each planned drift is created to maximize the planned mineral extraction in each 15 ft vertical interval of the block model. These centerlines are then extruded into 15 ft wide by 15 ft high three-dimensional solids to reflect the nominal stoping dimension.

3D solids are also created in the areas where longhole mining is planned. The height and width of these solids reflect the actual longhole design. Most longhole stopes are 25 ft wide with a variable height. The dimensions of long-hole stopes vary significantly depending upon the shape of the mineral zone, the competence of the rock, and the limitations of drilling equipment.

The stope design wireframes are then evaluated against the geologic block model to generate tons and grade for each stope, determined from the model blocks that fall within the design. The block models are depleted as part of this process to account for historic mining, replacing previously-mined blocks with backfill grades. Dilution factors are then added to account for rock overbreak and backfill dilution. Once the mine design is completed and interrogated, the designed stopes and mine development are exported to Deswik Scheduler where an optimized schedule is generated.

15.3 Dilution and Mining Losses

Hecla assumes 100% mine recovery for all mining methods when determining the life-of-mine Mineral Reserves. Reconciliation data indicate that such recovery levels have historically been met. See Section 15.12 for further details on reconciliation.

All Mineral Reserves are reported as fully diluted tonnages and grades. Dilution in the Mineral Reserve comes from three sources:

1. **Dilution within the designed stope volume-** All Greens Creek block models have a waste model enveloping the mineral blocks which allows dilution to be accounted for in the mine design process. In some areas the mineralization may be thinner than the 15-ft minimum mining width. If the mineral zone has sufficiently high grade, this dilution will be intentionally mined and is accounted for when the designed mineral volume is evaluated against the block model.
2. **Rock Overbreak Dilution-** A certain percentage of overbreak is normal and expected when mining using drill-and-blast methods. When multiple drifts are planned to be mined adjacent to each other, some of this overbreak material will be accounted for by the tonnage otherwise expected from subsequent cuts. In other instances, the overbreak will be low-grade waste material that would not be targeted for mining. This overbreak is taken into account by applying an empirically derived dilution factor of 6% to all mineral reserve designs. The dilution metal grades are summarized in Table 15-1.

Table 15-1: Rock Dilution Grades

Rock Dilution Grades	
Ag (oz/ton)	1.000
Au (oz/ton)	0.010
Pb %	0.25%
Zn %	0.75%
Cu %	0.10%
Fe %	5.50%

3. **Backfill Dilution-** Most mining at Greens Creek takes place adjacent to previously backfilled drifts or stopes. During blasting, some amount of overbreak will occur into the backfill. An empirically derived dilution factor of 6% was applied to account for this backfill dilution. This backfill dilution is in addition to the rock dilution discussed above and is applied to all mineral reserve designs regardless of the relative length of mining which is adjacent to backfill.

Occasionally, backfill is also contained within the planned stope volume due to mining adjacent to a backfilled drift with an irregular back, rib or sill. This type of dilution is accounted for in the block model depletion process.

The backfill contains a small amount of residual metal value as it consists of cemented tailings from the Greens Creek mill. Grades used for backfill dilution are based on historical tailings assays provided by the mill and are presented in Table 15-2.

Table 15-2: Backfill Dilution Grades

Backfill Dilution Grades	
Ag (oz/ton)	4.415
Au (oz/ton)	0.056
Pb %	1.00%
Zn %	1.55%
Cu %	0.15%
Fe %	12.92%
Density (tons/ft^3)	0.075

15.4 NSR Formula

The Greens Creek mill produces four different concentrates: lead, zinc, bulk, and gravity. Each of these concentrates has different payability factors and smelter terms. Because of this complexity, the block value is typically expressed in terms of net smelter return (NSR) rather than by metal grade. NSR refers to the dollar amount of revenue that is expected from each ton of material after it is mined, milled and sold as concentrate.

The NSR formula used in the 2019 Technical Report was supplied by the Hecla Corporate metallurgy group. This formula is based on a linear regression (line of best fit) between the metal content and NSR of a wide variety of Greens Creek mineral types and grades. It accounts for the different metallurgical recoveries, payability terms, and smelter charges for the four different types of concentrate. It also accounts for transport costs.

Note that the NSR formula cannot be used to determine the actual contained NSR value of each metal in any individual ton of ore. This is due to the complex interaction of the different metal grades in the milling process. For example, silver primarily reports to the lead concentrate where it has the best payability terms. Therefore, changes to the lead grade of the mill feed can impact the recovery and payability of the contained silver by affecting the proportion of silver that reports to each type of concentrate.

The NSR formula for 2018 Mineral Reserves is expressed as follows:

Flotation NSR:

(0.1347 * [Au OPT] * [Au $/oz]**)** + **(**0.6942 * [Ag OPT] * [Ag $/oz]**)** +

(18.65 * [Pb %] * [Pb $/lb]**)** + **(**9.137 * [Zn (%)] * [Zn $/lb]**)**

Gravity NSR:

IF [Au OPT] < 0.026 0

IF [Au OPT] >= 0.026 ((0.2465 * [Au OPT]) - 0.0065) * [Au $/oz] * 0.9289

Total NSR = [Flotation NSR] + [Gravity NSR]

15.5 Metal Price Assumptions

Metal price assumptions used for this Report were supplied by Hecla Corporate. Metals prices (in USD) used were: $14.50/oz silver, $1200/oz gold, $0.90/lb lead, and $1.15/lb zinc.

15.6 Cut-off Grade and “Must-Take” Ore

The cut-off grade (COG) NSR value used for stope design of all mining methods is $190/ton. This COG reflects the actual property-wide cash costs distributed on a per-ton basis as well as an allocation for the expected cost of sustaining capital items and capitalized development. A $200/ton cutoff was applied to the Gallagher Zone to account for a potential royalty on production from this area (see Section 15.9).

Mining plans will frequently require mining through mineral resource areas of less than $190/ton NSR in order to access more distant above-cutoff ore. When low-grade mineral resource must be mined in order to access a higher-grade area, a “must-take” cutoff of $75/ton NSR is applied. Since this material must be mined regardless of NSR value it can be profitably milled if the NSR exceeds $75/ton, which covers incremental milling and administrative costs. Therefore, any Measured or Indicated Mineral Resource intersected by development and resulting in a diluted grade above $75/ton is considered ore and is included in the Mineral Reserve, while any material below $75/ton is treated as waste.

15.7 Probable and Proven Mineral Reserve Classifications

Current practice at Hecla Greens Creek is to classify all in-situ underground Reserves as Probable Mineral Reserves. The only material included in the “Proven” Mineral Reserve category is the relatively small amount of ore tonnage present in the surface stockpile.

15.8 Handling of Inferred Mineral Resource Inside Mineral Reserve Wireframes

Areas of Inferred Mineral Resource are not targeted for inclusion in the stope design wireframes used to determine the Mineral Reserve. In order to generate a feasible mining shape, block model cells of Inferred Mineral Resource class are sometimes incidentally included within the extents of stope design wireframes that primarily target Measured or Indicated Mineral Resource material.

When this occurs, the metal value is removed from the proportion of the wireframe that encompasses Inferred mineral resource blocks. The Inferred mineral resource metal values are then replaced with mineralized waste, applying the same grades as the "Rock Overbreak Dilution" discussed in Section 15.3. This reflects a small residual metal value based on the typical levels of mineralization found in the waste rind surrounding the mineral body.

Inferred Mineral Resources of 4.5 million ounces silver, 24.6 koz gold, 20.7 ktons zinc and 8.9 ktons lead lie within the boundaries of the Mineral Reserve wireframes and have been discounted (net of the mineralized waste metal values with which they were replaced). Current practice is to also exclude this material from the Inferred Mineral Resource totals since the tons (but not the metal) are already encompassed by the Mineral Reserve.

15.9 Other Mineral Reserves Criteria

All undeveloped mining levels are subjected to an economic analysis to ensure that the operating cashflow produced from the extraction of the mineral reserves (NSR above $190/ton) exceeds the marginal development cost to access the level. This becomes an important criterion for certain levels at the margins of the mineral body which require a large amount of development to access but contain relatively low ore tonnage.

For mineral reserves located at shallow depths relative to surface topography, a minimum crown pillar criterion of 100 ft has been applied.

Historic mining and backfill are considered when evaluating an area for inclusion in Mineral Reserve. Historically-mined areas with incomplete asbuilt surveys are not eligible to be included in Mineral Reserve until a complete set of reliable asbuilts is located.

Certain historical mining panels are recorded as being filled with loose waste rock or unconsolidated tailings instead of cemented backfill. This prohibits any mining adjacent or underneath the affected area, and generally results in the sterilization of the potential Mineral Reserve. Certain areas which contain adjacent ore of very high grades are evaluated on a case-by-case basis for re-entry, removal of the waste or tailings, and placement of cemented backfill.

Geotechnical factors are considered when determining Mineral Reserves. Small areas of above-cutoff grade material have been excluded from the Mineral Reserve due to high geotechnical risk (highly-stressed pillars adjacent to large backfilled longhole blocks). These areas may be added to Mineral Reserves in the future if geotechnical analysis demonstrates they can be extracted safely and economically.

The Gallagher Zone is subject to a royalty amounting to approximately 3% of NSR unless extralateral rights are established. This potential royalty has been taken into account when evaluating the economics of the area. The Greens Creek geology group is advancing the process of determining whether extralateral rights have been established for this zone which would negate the potential royalty.

15.10 Mineral Reserves Statement

Mineral Reserves have taken into account environmental, permitting, legal, title, taxation, socio-economic, marketing, and political factors and constraints. The Mineral Reserves are acceptable to support mine planning. Mr. Kyle Mehalek, P.E., a Hecla employee, is the QP for the estimate. Mineral Reserves have an effective date of 31 December 2018 and are reported using a fully diluted NSR cut-off of $190/ton for all zones and all mining methods (Table 15-3).

Table 15-3: Greens Creek Mineral Reserve Estimate

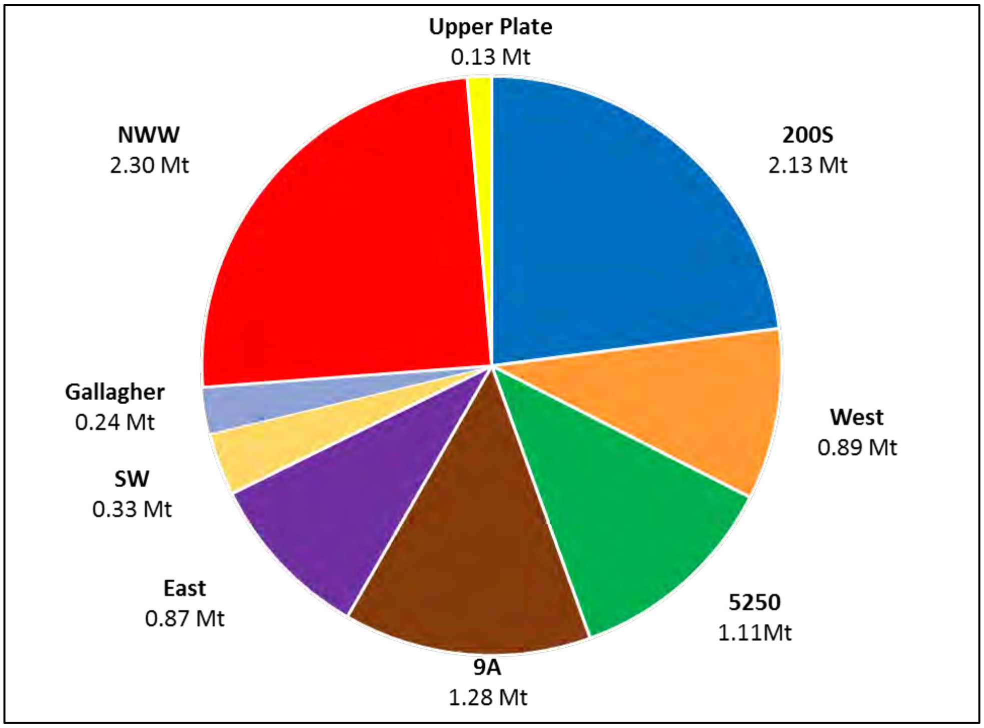
Probable Mineral reserves	Ore MTons	Gold (Oz/ton)	Silver (Oz/ton)	Lead (%)	Zinc (%)	Gold Kozs	Silver Mozs	Lead Ktons	Zinc Ktons
200S	2.13	0.110	13.16	2.39	6.23	233.0	28.0	50.8	132.4
5250	1.11	0.048	13.78	2.56	6.57	53.0	15.3	28.4	72.9
9A	1.28	0.076	9.47	3.54	8.77	96.9	12.1	45.4	112.4
East	0.87	0.086	12.81	2.56	6.43	75.1	11.2	22.3	56.1
Gallagher	0.24	0.129	5.50	3.60	8.34	30.7	1.3	8.6	19.9
NWW	2.30	0.102	9.07	2.58	8.66	234.9	20.9	59.4	199.2
SW	0.33	0.084	15.29	3.43	8.10	27.4	5.0	11.2	26.5
Upper Plate	0.13	0.039	13.32	2.36	4.78	4.9	1.7	3.0	6.0
West	0.89	0.094	12.96	3.79	9.07	83.6	11.5	33.7	80.6
Total Probable Mineral reserves	**9.27**	**0.091**	**11.54**	**2.83**	**7.62**	**839.5**	**107.0**	**262.8**	**706.0**
Proven Mineral reserves (Stockpile)	**0.01**	**0.100**	**13.81**	**2.85**	**7.04**	**0.6**	**0.1**	**0.2**	**0.4**
Total Proven and Probable Reserves	**9.28**	**0.091**	**11.54**	**2.83**	**7.62**	**840.1**	**107.1**	**262.9**	**706.5**

Notes to Accompany Mineral Reserve Table:

1. The Qualified Person for the Mineral Reserve estimates is Mr. Kyle Mehalek, P.E.
2. Mineral Reserves are based on the following metal prices and cut-off assumptions: $1,200/oz Au, $14.50/oz Ag, $0.90/lb Pb, $1.15/lb Zn, NSR cut-off of $190/t for all zones except the Gallagher Zone which used a $200/t cut-off.
3. Reporting units are imperial, Tons: dry short tons (dst); Au (troy ounces/dst); Ag (troy ounces/dst); Pb and Zn percent (%).
4. Totals may not agree due to rounding.
5. Mineral Reserves are reported fully diluted.

The distribution of Greens Creek Mineral Reserves by Mineral Zone is shown in Figure 15-1.

Figure 15-1: Distribution of Mineral Reserves by Mineral Zone



15.11 Factors That May Affect the Mineral Reserve Estimates

Factors that may affect the Mineral Reserve estimates include:

- Metals price assumptions;
- Variations in short-term marketing and sales contracts;
- Changes to the mineral resource block model;
- Changes to the assumptions that go into defining the NSR cut-off;
- Assumptions relating to the geotechnical and hydrological parameters used in mine design;
- Metallurgical recovery factors: recoveries vary on a day to day basis depending on the grades and mineralization types being processed. These variations are expected to trend to the forecast LOM recovery value for monthly or longer reporting periods;
- Variations to the permitting, operating, or social license regime.

15.12 Reconciliation

Of the 844 Ktons of ore mined in 2018, approximately 43% was mined from outside the Mineral Reserve, a somewhat higher proportion than during the period from 2015 to 2017. This reflects the mining of Inferred Mineral Resource at the margins of certain mine levels which is not included in Mineral Reserve, as well as additional ore identified during the mining process that was not previously defined with drilling and therefore was not included in the mineral resource models.

Greens Creek performs periodic reconciliations of mineral reserve models to the mine and mill performance, including three factors: mine reported production versus block model depletion (F1), mill feed versus mine reported production (F2), and mill feed versus block model depletion (F3). Reconciliation data for 2018 production is shown in the following Table 15-4.

Table 15-4: Greens Creek Reconciliation Data for 2018

Factor	Description	Ktons	Au(opt)	Ag (opt)	Pb (%)	Zn (%)	Au (Kozs.)	Ag (Mozs.)	Pb (Kt)	Zn (Kt)
	Model Depletions	487	0.087	10.9	2.9	7.9	42.5	5.3	14.0	38.6
	Mine Reported	844	0.086	11.8	2.8	7.8	72.6	10.0	23.8	66.1
	Mill Feed	845	0.094	12.2	2.8	7.5	79.1	10.3	23.7	63.1
F1	Mine/Model	1.73	0.99	1.09	0.98	0.99	1.71	1.89	1.70	1.71
F2	Mill/Mine	1.00	1.09	1.03	0.99	0.95	1.09	1.03	0.99	0.95
F3	Mill/Model	1.74	1.07	1.12	0.97	0.94	1.86	1.94	1.69	1.64

Despite the significant proportion of ore mined outside of the modeled mineral reserve, the estimated mined and mill feed grades for 2018 are close to the model predicted grades of the depleted mineral reserve. These results are in line with the historical trend over the Greens Creek mine life, which has been that the mill receives more Au and Ag but less Pb and Zn than predicted by the block model.

Historical Mill-Model reconciliation factors (F3) for the last four years are shown in Table 15-5.

Table 15-5: F3 Factors by Year: Mill Production / Mineral Reserve Depletion

Year	Au oz/ton	Ag oz/ton	Pb %	Zn %	Tons
2014	1.25	1.12	0.90	0.93	1.19
2015	1.22	1.33	1.25	1.29	1.44
2016	1.15	1.15	0.98	1.01	1.48
2017	1.07	1.08	0.97	0.94	1.46
2018	1.07	1.12	0.97	0.94	1.74

15.13 Mineral Reserve History

Greens Creek replaced or added Mineral Reserves from 1997 until 2001, both by new discoveries and by upgrading mineral resource models. In 1998, discovery and development of the 200S Zone and a change in classification of the 5250 Zone accounted for a significant increase in mineral reserves.

In 1999, there were more positive changes in these zones and in the Southwest Zone. In 2000, the West Zone mineral reserve increased substantially, but in 2001 and 2002, re-evaluation of the model and decreasing metal prices more than erased the 2000 gain.

After a notable decrease in 2001 due to metal prices, the Greens Creek mineral reserve tonnage was maintained at a fairly constant level of 7.0 to 8.5 million tons between 2001 to 2017, until experiencing a large increase with the 2018 end-of-year update due to the addition of the Gallagher and Upper Plate zones and improved mineral resource models which enabled the addition of significant remnant material that was left behind by previous mining.

Mineral Reserve grades for precious metals have remained fairly stable over the past ten years while grades for base metals have decreased steadily. Table 15-6 shows the Greens Creek Mineral Reserve History from 1997 to 2018. All estimates since Hecla's 100% acquisition of the property in 2008 are compliant with NI43-101 standards of disclosure; estimates prior to that time were conducted using industry standard practice and have been subject to external third-party reviews (see Section 12).

Table 15-6: Greens Creek Mineral Reserve History, 1997 to 2018

Year	Ore (Mtons)	Gold (oz/ton)	Silver (oz/ton)	Lead (%)	Zinc (%)	Gold (Koz)	Silver (Moz)	Lead (Kton)	Zinc (Kton)
1997	8.39	0.15	18.6	4.5	12.7	1,242	156	377	1,068
1998	9.76	0.14	15.4	4.5	12.3	1,385	150	440	1,202
1999	10.02	0.14	16.2	4.5	11.9	1,357	163	448	1,193
2000	10.01	0.13	15.7	4.4	11.9	1,335	157	442	1,190
2001	7.59	0.13	16.7	4.6	11.6	1,007	127	347	883
2002	7.05	0.13	14.9	4.2	11.4	903	105	298	801
2003	7.49	0.12	14.1	4.0	10.7	863	106	301	798
2004	7.93	0.11	14.1	3.9	10.2	880	112	313	809
2005	7.48	0.12	14.5	3.9	10.2	864	108	291	766
2006	7.68	0.11	14.4	4.0	10.4	865	111	306	798
2007	8.45	0.11	13.7	3.8	10.2	908	116	321	861
2008	8.07	0.11	13.7	3.8	10.5	870	111	309	851
2009	8.32	0.10	12.1	3.6	10.3	847	101	303	853
2010	8.24	0.09	12.1	3.5	9.3	757	100	291	767
2011	7.99	0.09	12.3	3.5	9.2	742	98	282	733
2012	7.86	0.09	12.0	3.4	9.0	721	95	267	704
2013	7.80	0.09	11.9	3.3	8.7	713	93	256	678
2014	7.70	0.10	12.2	3.1	8.3	739	94	241	640
2015	7.21	0.09	12.3	3.0	8.1	677	89	218	583
2016	7.59	0.09	11.7	2.9	7.6	673	89	217	576
2017	7.55	0.10	11.9	3.0	8.1	725	90	225	615
2018	9.28	0.09	11.5	2.8	7.6	840	107	263	706

15.14 Comments on Mineral Reserve Estimates

In the opinion of the QP, Mineral Reserves for the Project, which have been estimated using core drill data, appropriately consider modifying factors, have been estimated using industry best practices, and conform to the CIM Definition Standards (2014).

16.0 MINING METHODS

16.1 Underground Mine Access & Layout

The underground mine is accessed by a portal (920 Main) on the 920 ft elevation, which is located in the same general area as the mill, stockpile pad and administration building. The 920 Main is the primary equipment and personnel entrance to the mine as well as the primary air intake.

A secondary escapeway portal (the 59 Secondary Escapeway) is located immediately adjacent to the 920 portal and offers a secondary egress from certain areas of the mine.

A third portal is located above the mine site at the 1350 elevation, this portal is used as a ventilation exhaust and secondary escapeway. The 1350 portal is not normally used for haulage or personnel access due to the steep surface access roadway which is not maintained during winter months.

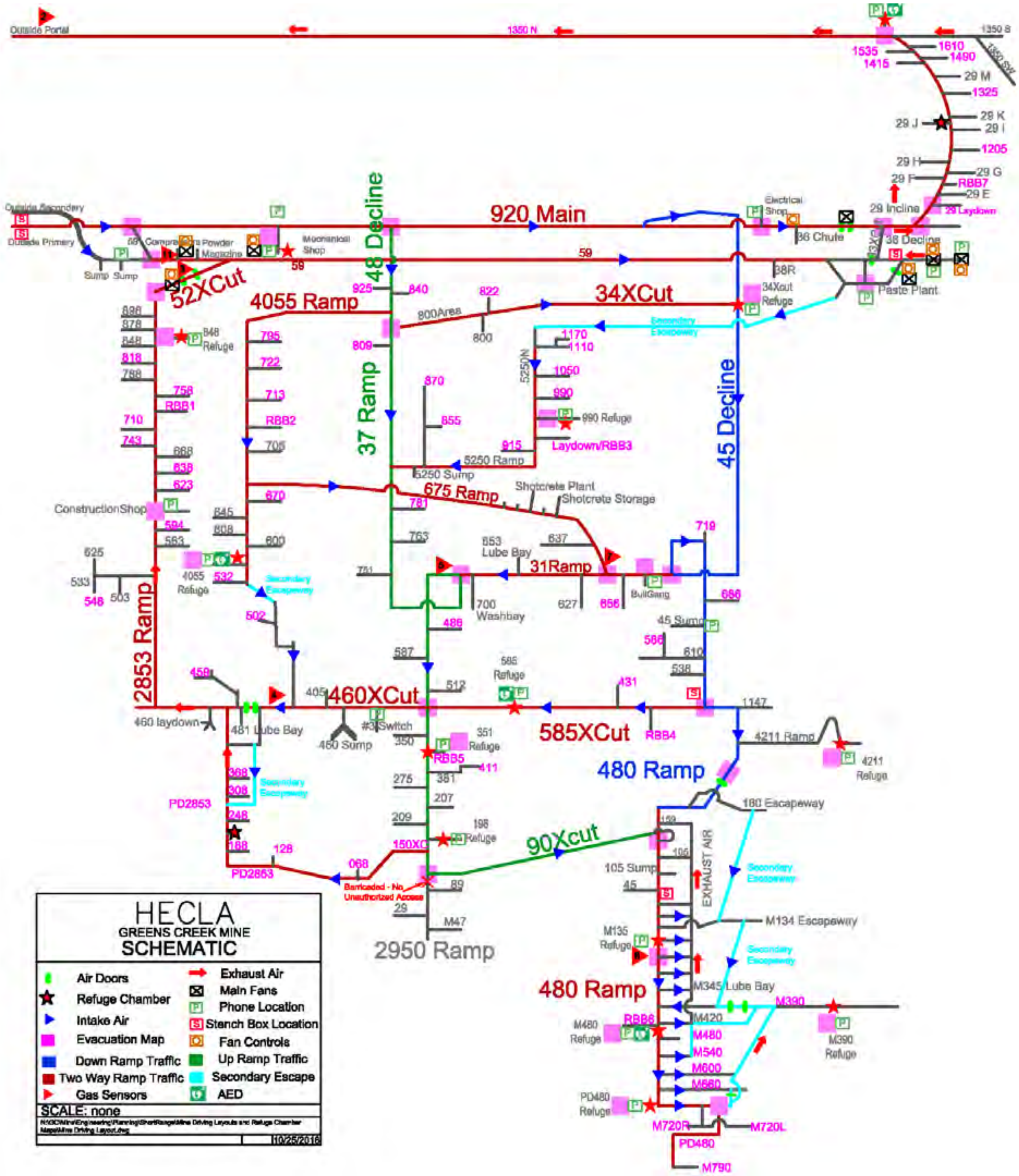
All active areas of the mine are accessed via one or more of the nine major ramp systems:

- 29 Ramp
- 4055 Ramp
- 48 Decline / 37 Ramp
- 5250 Ramp
- 45 Decline
- 31 Ramp
- 2853 Ramp
- 2950 Ramp
- PD480 Ramp

Most ramps are connected via cross-cuts at various locations, therefore most working areas have multiple options for equipment access in the event a particular ramp is blocked for rehab or utility work. However, two of the ramp systems, the 5250 and PD480 ramps, have a single route for mobile equipment access. These ramps feature laddered escapeway raises to enable airflow and a secondary means of egress.

A general mine layout schematic for the underground ramp system is shown in Figure 16-1. See Section 16.16.5 ("Mine Plan Overview") for views of the as-built wireframes for the ramp system.

Figure 16-1: Underground Mine General Layout Schematic



16.2 Mine Development

Mine development is undertaken with fully mechanized drill-and-blast methods. Conventional diesel-powered rubber-tired equipment is used. Blastholes are drilled by a fleet of twin & single boom drilling jumbos. Blasting is carried out with mobile explosives loading vehicles utilizing bulk emulsion. Mucking and hauling is via LHD and end-dump articulated haul trucks.

Ground support activities are performed with mechanized bolting equipment. Jacklegs are not used for face drilling or ground support installation. Primary ground support consists of split set and Swellex friction rock bolts and wire mesh. Cable bolts and wet-process shotcrete is applied as required, and there is an ongoing project to install fully grouted rebar bolts in existing haulageways for life-of-mine support.

Currently, most primary ramp development and ore access drives are driven with an arched profile at 16.0-ft width by 17.5-ft height. The back height is increased in areas where fans are to be installed or truck loading is to occur. Some of the historical ramp development was driven at smaller dimensions which can still accommodate most of the current equipment fleet. Primary haulage ramps are driven at a gradient of no more than -15%, with -12.5% being typical. Ore access drives are driven at a decline of -15 to -18% from the haulage ramp.

The mine workings include a number of raises which variously serve as ventilation routes, secondary escapeways, and muck transfer passes. Vertical development is currently undertaken by a raiseboring contractor. Many historical raises are in use which were developed using a variety of methods including raiseboring, Alimak, and longhole (drop) raising.

16.3 Production Mining

The planned production rate is 2300 tons per day. The overall throughput rate is limited by mill capacity; the operation is not mine-constrained. All production areas are accessed via an ore access crosscut driven from a primary haulage ramp. There are no captive stopes or other areas accessible only by raises.

Hecla utilizes two primary mining methods at Greens Creek:

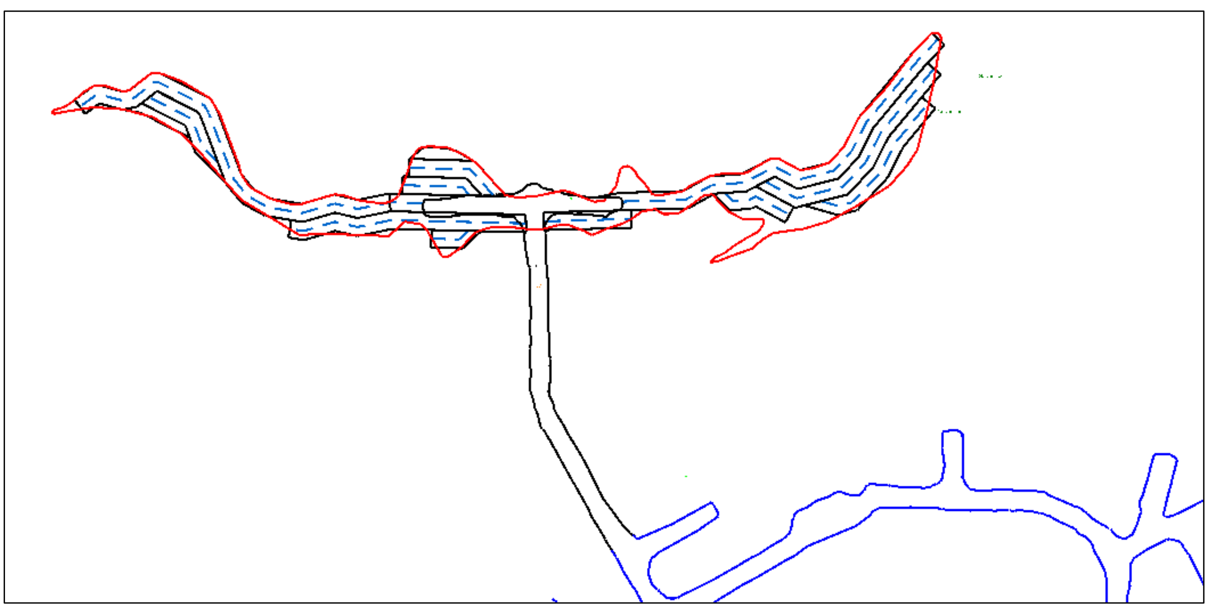
- Overhand cut-and-fill (approximately 2000 tons per day, 87% of overall production)
- Long-hole stoping (approximately 300 tons per day, 13% of overall production)

Where overhand cut-and-fill is used, production levels are mined at a minimum dimension of 15 ft wide by 15 ft high. After all ore is recovered at a given elevation of a mining area, the established ore access drive from the haulage ramp is breasted down. This provides re-access to the next “lift” of the extraction level at a higher elevation immediately above the previous mining. Where the mineral body is wide enough, multiple panels may be mined along strike prior to re-accessing to the next lift.

Production levels are named based on the sill elevation of the initial lift before re-accessing. Levels with an elevation below sea level are named using the “M” prefix to denote “minus” (for example, M660 is 660 feet below sea level). To denote the current lift, an alphabetical suffix is attached to the level name based on the number of re-access that have occurred (for example, M480D is the fourth lift of the 656 level).

Figure 16-2: Side View of Asbuilt of Typical Cut-and-Fill Mining Arrangement

Figure 16-3: Plan View of Typical Cut-and-Fill Mining Layout



Grade control is maintained by production geologists in cut-and-fill headings. The lithologies in each face are mapped and sampled to determine if any adjustments are necessary in order to keep the heading in the ore. The geometry of the mineralized lithology is frequently very complex, as shown in the face map example below.

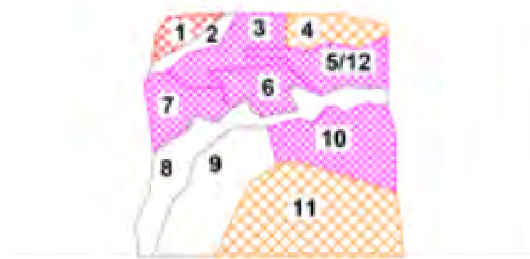
Figure 16-4: Example of Production Geology Face Mapping

73515 OR-600AL10

Date: 26-Jan-2019

Face Composites

Tons	Au(opt)	Ag(opt)	Pb(%)	Zn(%)	Cu(%)	Fe(%)	NSR
248	0.047	19.74	4.29	6.42	0.23	9.40	$360



Geologist: MD Class: O Type: SUB
Spad: 7836Q+36'=MP36L LF: CF: 90.1 RF:
Width: 16 Height: 17 Length: 12
Lined Width: Lined Height: Lined Depth:

SampleID	Type	Area	Lith	Wt.	Au(opt)	Ag(opt)	Pb(%)	Zn(%)	Cu(%)	Fe(%)	NSR
7351501	FACE	5.7	FMSA	3.1	0.006	13.16	2.43	2.55	0.20	4.58	$207
7351502	FACE	4.8	FSA	4.2	0.028	4.39	0.39	0.49	0.05	2.63	$63
7351503	FACE	15.7	FMSA	4.1	0.062	32.08	9.71	13.60	0.49	15.30	$664
7351504	FACE	10.3	FMSA	4.4	0.068	9.06	0.61	0.81	0.06	9.08	$136
7351505	FACE	15.4	MFB	4.1	0.076	34.36	7.63	12.25	0.62	11.58	$644
7351506	FACE	11.5	MFB	5.0	0.258	58.75	15.09	25.99	0.66	10.09	$1249
7351507	FACE	13.2	FMSPS	4.5	0.028	31.38	15.19	19.72	0.61	11.24	$801
7351508	FACE	27.0	GSP	4.6	0.018	2.60	0.83	1.32	0.06	7.99	$58
7351509	FACE	29.8	MA	3.8	0.002	1.23	0.22	0.12	0.02	5.29	$18
7351510	FACE	26.1	MMA	3.3	0.062	25.18	1.37	2.35	0.12	9.17	$331
7351511	FACE	47.9	MMA	4.3	0.006	14.59	0.81	1.30	0.06	9.90	$181

Long-hole stoping is used where the mineral body is sufficiently steep and/or thick and geotechnical conditions are favorable. There is no standardized design due to the highly variable geometry of the mineral zones. Both longitudinal and transverse methods are used depending on the local shape of the mineral zone.

Typically, overcut and undercut drives are driven at widths between 15 and 25 ft and separated by thicknesses ranging from 30 to 75 ft vertically. Where development of an overcut is not economic, the longhole may be mined as a backstope as long as ground conditions are good.

Ore zones are drilled and blasted from the overcut (with Cubex drill) or undercut (with Simba drill). Extraction occurs via remote mucking on the undercut level, and then the stope is filled from the overcut level. In the case of longhole backstopes, filling is achieved by drilling a borehole from higher elevation workings into which a paste pipe is inserted.

Transverse stoping layouts are designed as primaries and secondaries, with primary and secondary stopes being similar in size. This enables additional working faces as well as the opportunity to use mine development waste for backfill of secondaries.

16.4 Ore Handling

Ore handling is performed with a fleet of underground haulage vehicles and LHDs. Some LHDs are equipped with remote operating capability and provide mucking and loading activities for longhole stopes or other areas of unsupported ground.

All ore is trucked out of the mine to the surface mill stockpile, located approximately 450 ft from the 920 Portal. The underground haulage fleet consists primarily of 40-ton articulated end-dump haul trucks.

Haulage distances are highly variable since active working headings are located throughout all elevations of the mine. A round trip from the ore pad to the M720 (currently the lowest production level in the mine) covers a distance of approximately seven miles.

The two mine ramps which are driven in an upwards direction (29 Ramp and 5250) feature muck pass raises to facilitate material handling. The 5250-muck pass raise is fitted with a chute at the bottom for truck loading.

16.5 Waste Handling

Waste is either trucked out of the mine to the Site 23 waste disposal area located approximately 0.5 miles from the 920 portal or is placed in previously mined-out stopes when available. If no future mining is planned directly alongside or underneath, waste can be used to backfill cut and fill stopes by placement on the sill with subsequent placement of cemented tailings on top. The waste used to backfill secondary long-hole stopes is dumped near the top cut and pushed into the empty stope using an LHD or jammer.

16.6 Mine Backfill

Backfill of mined-out voids is achieved via three methods:

- **Paste fill**: cemented tailings are trucked from the mill to the underground paste plant where they are pumped into the mined-out voids via a network of pipes. This method is low-cost but is not practical for all areas of the mine where pumping pressures would be too high.
- **Jam (conventional) fill**: Where installation of paste pipe is not feasible, cemented tailings are trucked to the heading and compacted using jammer equipment. This method is more flexible but higher-cost than paste fill.
- **Waste fill:** Loose waste rock is placed in areas where structural support of the mined-out void is not necessary to enable future mining. This enables a reduction in the amount of waste rock that must be impounded on surface.

In the cut-and-fill excavations, extracted panels are typically “tight-filled” with a combination of cemented tailings and waste, allowing further panel extraction alongside and between backfill. The backfill mixture is typically composed of dewatered tailings and 5% cement content. When future mining is planned directly underneath a filled area, 8% cement content is used in order to enable the backfill to maintain the future back span. The tailings are batched with cement on surface and hauled either to the stope (for jam filling) or to the paste plant where water is added, and the mixture is then pumped directly to the stope.

In order to prevent the paste from flowing out of the area being backfilled, a shotcrete "pastewall" will be built or a plug of cemented tailings will be jammed into the heading. This will make the heading airtight, so "breather pipes" are installed through the pastewall in addition to the paste pipe to allow excess air and water to evacuate the heading as it is being filled in order to prevent the creation of paste voids. The paste line is flushed with air and water at the completion of each pour in order to prevent the cemented tailings from curing inside the line.

Primary longhole stopes are filled with paste backfill, containing a cement content of 5-8%. This allows the safe extraction of secondary blocks between backfill, while minimizing dilution. Secondary longholes are filled with waste rock from mine development wherever possible.

The paste plant was commissioned in 2001 and is located in the 59 Drift approximately 3,600 ft from the 920 Portal. It features a dump hopper, mixer, and three positive-displacement paste pumps. A backfill QA/QC program is in place with samples tested regularly to ensure adequate strength.

Backfill criteria are as follows.

Target % Solids:

- Paste fill: 77%
- Jam fill: 86%

Minimum fill strength requirement is dependent upon desired application:

- Ribs (for drifting alongside fill): 25psi
- Longholes (tall ribs): 70psi
- Back (for drifting underneath fill): 150psi

Typical minimum strength (UCS) achieved with 28-day cure time:

- Paste fill with 5% cement: 100psi
- Paste fill with 8% cement: 300psi

16.7 Ventilation

The Greens Creek Mine is ventilated using an exhausting system with a design capacity of 427 kcfm. Intake air is drawn into the mine from the 920 Portal and the 59 Escapeway Portal. Exhaust air exits the mine via the 1350 Portal and the 2853 Exhaust Raise. A schematic of the ventilation airflows is shown in Figure 16-5.

Primary ventilation is achieved with three main underground fans:

- 500hp, 84" dia. located near the 1350 portal (242 kcfm)

- 350hp, 84” dia. located near the bottom of the 2853 Raise (147 kcfm)
- 75hp, 42” dia. compressor room fan exhausting to the 2853 Raise (38 kcfm)

Secondary ventilation of achieved with auxiliary heading fans (ranging from 40hp-150hp) which pull air from the main ramps and force-ventilate the working faces via plastic hardline and vent bag, as shown in figure 16-6.

Both primary and auxiliary fans can be controlled from surface using the mine’s SCADA (supervisory control and data acquisition) system. Since blasting is initiated from surface, the local auxiliary fan is turned off remotely prior to the shot and then turned back on immediately afterwards in order to clear blasting gases.

The underground air flow is controlled by several sets of ventilation doors and numerous permanent bulkheads which separate intake from exhaust circuits. There is no provision for heating the intake air. Mine water and discharge lines located near the 920 Portal consist of insulated “Arctic Pipe” in order to prevent freezing.

Shop facilities include fire doors as required per MSHA regulation. The 920 Main shop includes a dedicated exhaust raise and fan which sends shop exhaust directly to the 1350 Main Fan where it promptly flows out the 1350 Portal.

Near-term plans include the installation of a 500hp booster fan in the PD480 ramp to provide for additional airflow capacity due to a planned increase in mining activity in this area, as well as to manage heat load as the mine workings progress to greater depth. This fan will be initially be run at significantly less than maximum capacity through the use of a variable frequency drive (VFD) but is intended to be ramped up in future years if ventilation requirements increase in this area.

Secondary ventilation is a material proportion of the mine’s overall electricity consumption. A ventilation on demand (VOD) system is currently in place in a limited number of headings and is planned to be extended to the remainder of the mine. This system involves the installation of a VFD on the secondary fan which is linked to the RFID transponder located on each piece of equipment and personnel cap lamp.

The VOD system automatically turns on the fan when an individual or piece of equipment enters the heading and will automatically turn off the fan when the heading has been vacant for a predetermined period of time. The VOD system also adjusts the VFD setting to the appropriate power level based on the ventilation needs of the heading’s current occupants – “low” for personnel and light utility vehicles, “high” for larger equipment.

Figure 16-5: Mine Ventilation Schematic

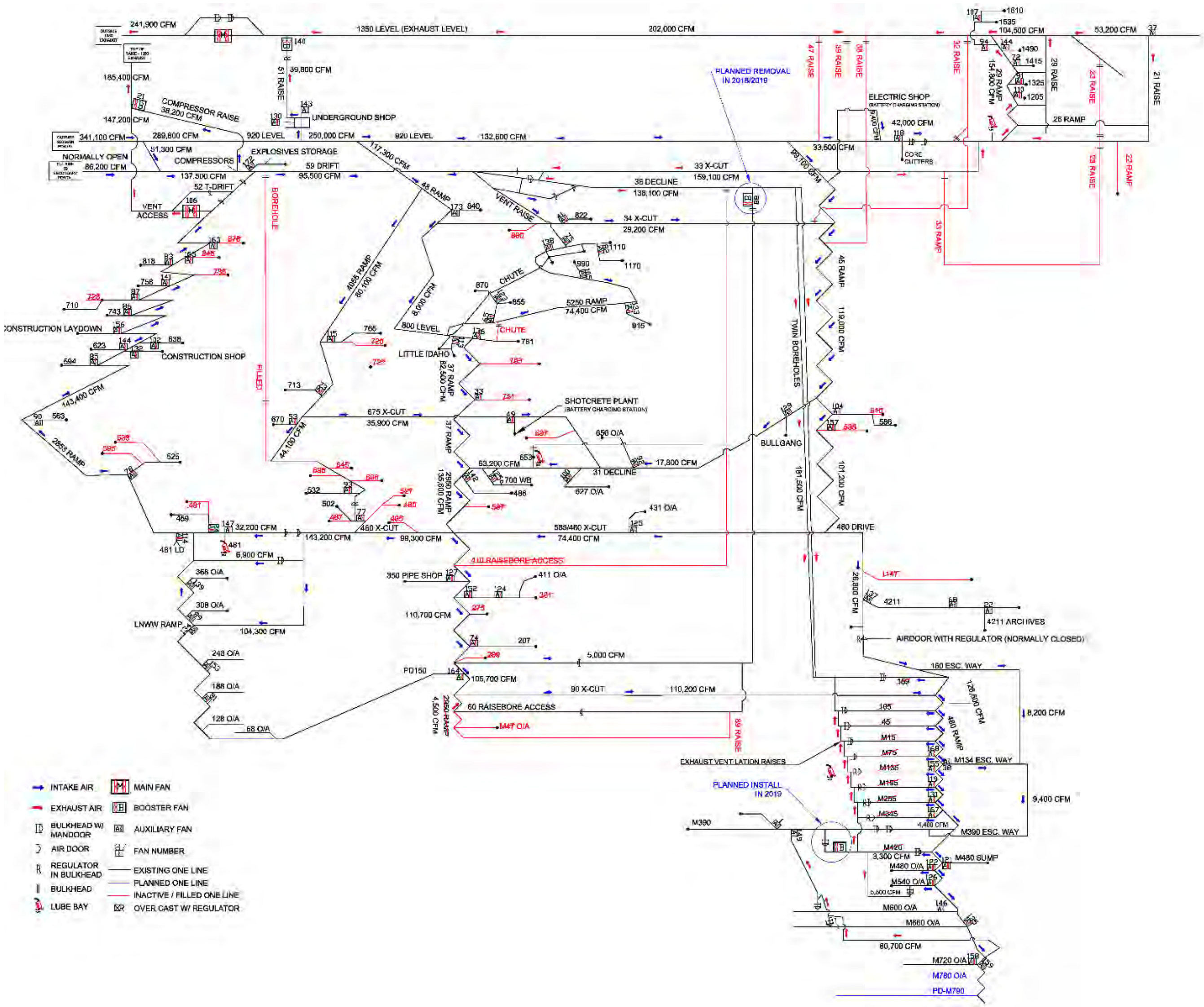


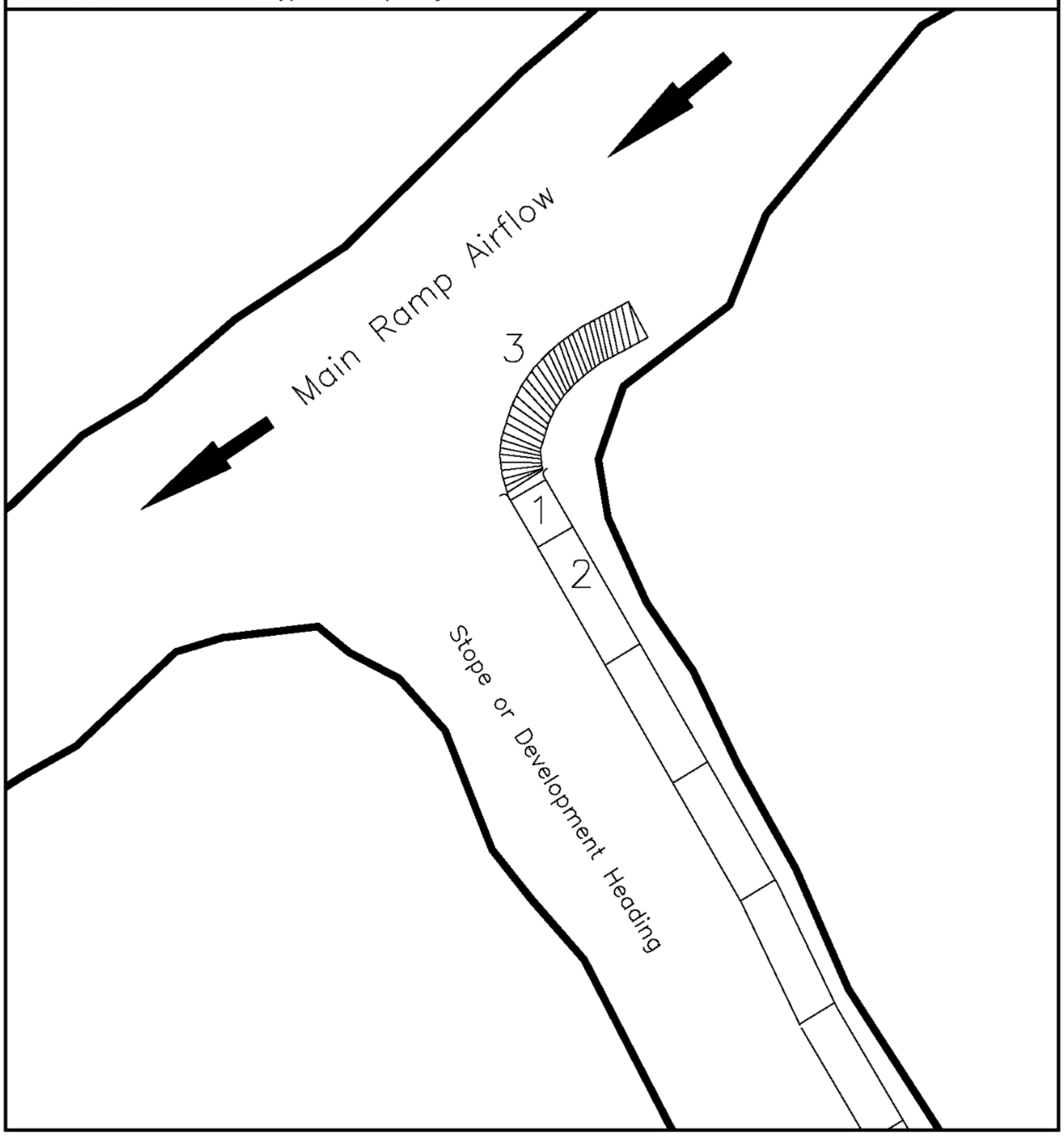
Figure 16-6: Typical Auxiliary Fan Layout

GCMC
Typical Production or Development Heading - Option 1

Typical Auxiliary Ventilation System for Production and Dev't

1. 30" - 36" Diameter Fan @ 75 - 125 HP
2. 36" Diameter plastic ducting or 36" Diameter Flexible Ventilation Bag x 25' Lengths
3. 36" Spiral Re-inforced Flexible Ventilation Ducting or Rigid Fiberglass Ducting.

Each typical type of work place is ventilated using electric fans ranging from 75 to 125 HP, with a diameter ranging from 30" to 36", and an approximate quantity of 10,000 - 28,000 CFM.



16.8 Communications & Emergency Infrastructure

Underground communications systems include: a leaky-feeder radio system, mine phones placed throughout active working areas, and an underground Wi-Fi network.

There is a stench alert system located at the 920 Portal as well as other key locations throughout the mine. This system can be activated remotely through the SCADA system or manually at the stench release locations.

There are several refuge chambers located at key areas throughout the mine; these refuge chambers are connected to the mine compressed air system to provide a breathable atmosphere in case of a mine fire or other underground hazardous atmosphere. In the event of a failure or contamination of the compressed air system, the refuge chambers have oxygen bottles and CO_2 scrubbers. The chambers also contain water, medical supplies, toilets, mine radios connected to the leaky feeder system, and mine phones.

16.9 Blasting and Explosives

Blasting is carried out primarily with the use of bulk emulsion transported to the heading with a powder truck containing an emulsion pump. Non-electric (non-el) blasting caps are used for drifting and i-Kon electronic caps are used in long-hole stoping.

Bulk emulsion is transported by ISO containers to permanent underground storage tanks located in the underground powder magazine on the 59 Drift. The cap mag is also located in this area.

Blasting takes place at the end of shift after all personnel have left the mine. Each round is initiated by an electronic cap tied into a remote blasting box which is controlled through the centralized electronic blasting system. Blasting gases are monitored remotely using a network of sensors at various locations along the airflow exhaust routes to ensure that the mine atmosphere is safe prior to re-entry.

Greens Creek is a sulfide mineral deposit and has historically experienced occasional sulfide dust ignitions with blasting. These ignitions caused minor damage to infrastructure located near the face (including ventilation bags and utility lines). Current practice is to identify high-sulfide headings based on face sampling and to wet down the back and ribs near the face immediately prior to blasting. This minimizes the quantity of sulfide dust which becomes airborne during blasting and reduces the chance of a secondary sulfide dust ignition.

16.10 Ground Support

The Greens Creek Ground Control Management Plan (GCMP) summarizes how the mine deals with the ground conditions created due to mining. The mineral deposits at Greens Creek has undergone several folding sequences that have resulted in a contorted rock mass yielding a complex structural system. Standard ground support designs are used based on design conditions, primarily related to back span.

The mineralized material is the strongest and most competent material in most areas of the mine. Mineral lithologies have a rock strength of up to 30,000 psi. The structural footwall unit, composed primarily of phyllite, has a rock strength of up to

15,000 psi. The structural hanging wall unit, composed primarily of argillite, has a rock strength of up to 7,000 psi.

The ground support strategy in use at the mine uses the concept of rock reinforcement and surface control to construct a stable support arch for the specified excavation geometry. Rock reinforcement or rock bolts clamp the arch together and assures its integrity and strength. Surface support ensures an intact and regular excavation profile that allows the bolts to perform at maximum efficiency. The combination of these two criteria establish ground control measures employed in the mine headings, and on current knowledge, providing a safe and stable work area.

The following ground support is typical for most new development and production areas at Greens Creek:

- Split sets 6 ft in length are installed on a 4 ft by 4 ft pattern in the back and ribs. Galvanized split sets are used for all development headings and other areas which will be open for longer than six months. Plain steel split sets are used in short-term production areas.
- Swellex bolts are installed on a 5 ft by 6 ft pattern in the back unless a higher density is specified due to unusual ground conditions. The length of the Swellex is dependent upon the heading width. Swellex are not installed when mining underneath backfill
- Galvanized wire mesh is used in long-term openings and plain steel in short-range production areas unless otherwise specified. Mesh is installed on the back and ribs to within 7 ft of the mine floor.
- Main haulage ramps and other life-of-mine excavations are supported by fully-grouted rebar bolts which are installed in campaigns after development of the ramp segment has been completed. This provides very long-term corrosion-resistant ground support. Rebar bolts of 6 ft length are installed on a 4 ft by 4 ft spacing in the back and ribs in addition to rebar bolts of 8 ft length installed on a 5 ft by 6 ft spacing in the back.

Cable bolts and wet-process shotcrete are applied as required to support occasional areas of large span or poor ground. Shotcrete is also applied to areas of permanent infrastructure as well as muckbays and loading areas in order to minimize damage to the wire mesh caused by inadvertent scraping with the mucker bucket.

Greens Creek experiences areas of corrosion of ground support due to the galvanic process involving the steel, sulfides, graphite and atmospheric conditions. The argillite, especially with elevated sulfide and/or graphite content, is particularly aggressive to steel. Thin walled friction bolts, such as Swellex or split sets, are susceptible because of the large surface area in contact with the ground and minimal thickness. Corrosion can occur inside the bolt (away from the collar) and not be observable. The result can be an unanticipated ground failure because the load carrying capacity of the system degrades over time.

To mitigate issues with ground support corrosion, current Greens Creek practice is to install galvanized ground support in areas which will be open for longer than six months. Very long-term openings (such as LOM haulage ramps and other infrastructure excavations) are bolted with fully-grouted rebar bolts which provide a high degree of corrosion resistance. Greens Creek also has an active rock bolt pull testing program.

A variety of historical ground support systems are still in place throughout the mine due to the large extent of haulage ramp which was developed prior to the implementation of current ground support standards. Certain older areas are supported primarily by split sets and steel mats. The mine has an ongoing rehab program and historical areas are progressively being brought to current support standards with fully-grouted rebar bolts. Approximately 25% of haulage ramp is now supported with rebar. Near-term plans include a campaign of cable bolting for haulage ramp intersections and other existing areas of wide span.

16.11 Underground Water Handling

16.11.1 Background

Greens Creek is considered to be a dry mine. The mine is overlain by mountainous topography that offers little opportunity to develop a perched water table of significant volume. The average annual precipitation at the 920 ft elevation ranges from 67 to 80 inches. Despite this surface precipitation, the water that is continuously pumped out of the mine due to groundwater sources ranges from approximately 25 to 50 gpm.

The ultimate mine depth is planned to extend to approximately 1500 feet beneath sea level and the coastline is about 5.5 miles from the mine site.

The Maki Fault is a major geological feature encountered at the mine. This fault, and sympathetic Maki-like faults, intersect the Greens Creek drainage and provide the most probable conduit for water ingress into the mine. The Maki Fault has been intersected on numerous occasions in the mine workings at various orientations and elevations. On at least one occasion it has exhibited high pressure water inflows upon exposure. These inflows bled off quickly.

16.11.2 Pumping and Discharge System

The mine features a large number of small local water collection sumps into which drill water and groundwater collected at the face is pumped. Water from these local sumps is then pumped into one of the four main sumps located in the 920 Main, the 45 Ramp, the 460 XC, and the PD480 ramp. The main sumps each include multiple bays which allow slimes to settle. The water is then decanted and pumped out of the mine to the 920 water treatment plant (see section 18.6.1). The slimes are mucked using an LHD and gobbed underground.

16.11.3 Future Plans

Groundwater determination prior to stope development is undertaken using a set of fanned diamond drill core holes (pre-production holes) that are drilled into the undeveloped mineral resource. These holes are monitored for artesian pressure and if any exists, they are allowed to drain off under controlled conditions by using packers and valves. If the flow is minor, the holes are allowed to free drain.

Ore has recently been identified at shallower depths of the East Ore Zone above elevation 1610. Definition drilling of this zone has encountered significant groundwater with instantaneous flow rates in excess of 400 gpm prior to being sealed with a packer. Greens Creek currently plans to conduct a hydrologic study of this area to better define flow rates and recharge rates, as well as the best control methods.

If recharge rates are high, this water may need to be controlled with a campaign of pre-grouting prior to development of the new mineral reserves. Limiting water inflow is important both to facilitate mining and to prevent an increase to the rate of water ingress post-closure, which could increase long-term water treatment costs. The proportion of mineral reserve tonnage which may be affected by this groundwater is very small (approximately 240kt, equivalent to 2.6% of overall mineral reserve).

16.12 Underground Electrical System

High-voltage power enters the mine at 4160V from a main switchgear room located on surface. Power is then fed from this switchgear room to three underground switchgear rooms which serve separate regions of the mine. Each underground switchgear room in turn feeds a network of mine power centers (MPCs) which reduce the voltage to 480V and supply power to local loads (including fans, pumps, and drill power). Currently, a fourth switchgear room and high-voltage feed is being installed to provide additional capacity for the PD480 ramp area as it advances further away from existing infrastructure.

16.13 Compressed Air System

The mine compressed air system consists of three 480V compressors located underground (Sullair LS-25S 250L @ 250hp ea) and one diesel compressor located on surface (Sullair 900 @ 265hp). Total system capacity is 4,550 cfm. The underground compressor room has a dedicated exhaust fan to the 2853 Raise.

16.14 Underground Mobile Equipment

Conventional underground mining equipment is used to support the underground mining activities. This equipment is standard to the industry and has been proven on site. Table 16-1 shows the major underground equipment that is currently operational at Greens Creek. Greens Creek currently uses one Sandvik LH514 LHD which is capable of semi-autonomous operation as well as one Sandvik LH514 LHD which can be operated via a tele-remote system from surface. This equipment enables production activities to continue during the shift change and post-blasting periods when no personnel are allowed underground.

16.15 Maintenance

Mobile equipment maintenance facilities are located both underground and on surface. Comprehensive maintenance tracking and reporting systems, in addition to preventive maintenance (PM) programs are well established. Frame-up rebuilds are performed based on engine hours, as recommended by the equipment supplier, and/or based on component wear factors. Major overhauls and rebuilds are often done offsite at a contracted facility.

Table 16-1: List of Major Underground Equipment

Equipment Type	Unit Make	Unit Model	Quantity
Backfill Truck	ATLAS COPCO	MT2010	4
Backfill Truck	ATLAS COPCO	MT436B	5
Bolter	SANDVIK	DS311D-EC	4
Bolter	SANDVIK	DS410-C	1
Bolter	SANDVIK	ROBOLT 320-30SSW	1
Bolter	SANDVIK	SECOMA ROBOLT 05	2
Bolter	TAMROCK	ROBOLT 07-330 S	1
Bolter	TAMROCK	ROBOLT 7 737SSW	1
Boom Truck	GETMAN	A64	2
Dozer	CATERPILLAR	D4G	2
Excavator	JOHN DEERE	50G	1
Flatdeck Truck	GETMAN	A64	1
Flatdeck Truck	NORMET	UTIMEC LF130	1
Geo Lift Truck	CATERPILLAR	414E	1
Grader	CATERPILLAR	120G	2
Haul Truck	SANDVIK	TH540	7
Haul Truck	TORO	T40	1
Jumbo Drill	SANDVIK	DD31140C	1
Jumbo Drill	SANDVIK	DD420	1
Jumbo Drill	TAMROCK	H105D	2
Jumbo Drill	TAMROCK	H205D	2
LHD	ATLAS COPCO	ST7	4
LHD	CATERPILLAR	236B	1
LHD	SANDVIK	LH514	7
LHD	TORO	T1250D	1
Lift Truck	DUX	S1SL6000	1
Lift Truck	GETMAN	A64	5
Longhole Drill	ATLAS COPCO	SIMBA H157	1
Longhole Drill	CUBEX	Orion	1
Lube Truck	GETMAN	A64	2
Port. Compressor	CATERPILLAR	900H	1
Powder Truck	GETMAN	A64	3
Shotcrete Pump	SCHWING	SP305	1
Shotcrete Sprayer	NORMET	SPRAY MEC 1050W	1
Telehandler	CATERPILLAR	TH406C	1
Telehandler	CATERPILLAR	TH514	2
Transmixer	BTI	SCT-6RD	2
Transmixer	NORMET	LF500	1

16.16 Mine Plan

16.16.1 Introduction

The Greens Creek mineral reserve wireframes have been scheduled using Deswik software. The LOM plan is detailed in the following tables. Price assumptions, cutoff grade, and all other criteria are the same as applied to Mineral Reserves as discussed in Chapter 15. All data in this section are expressed in US-Imperial units. Figure 16-7 and Tables 16-2 and 16-3 show the planned mine production and development over the LOM.

16.16.2 Ore Scheduling Criteria

The goal of the LOM plan is to create an operationally-feasible schedule which maintains a production rate of 2300 tons per day (840 kt/yr) for as long as possible while maximizing near-term grades in order to optimize NPV. A secondary objective is to minimize and smooth near-term development requirements.

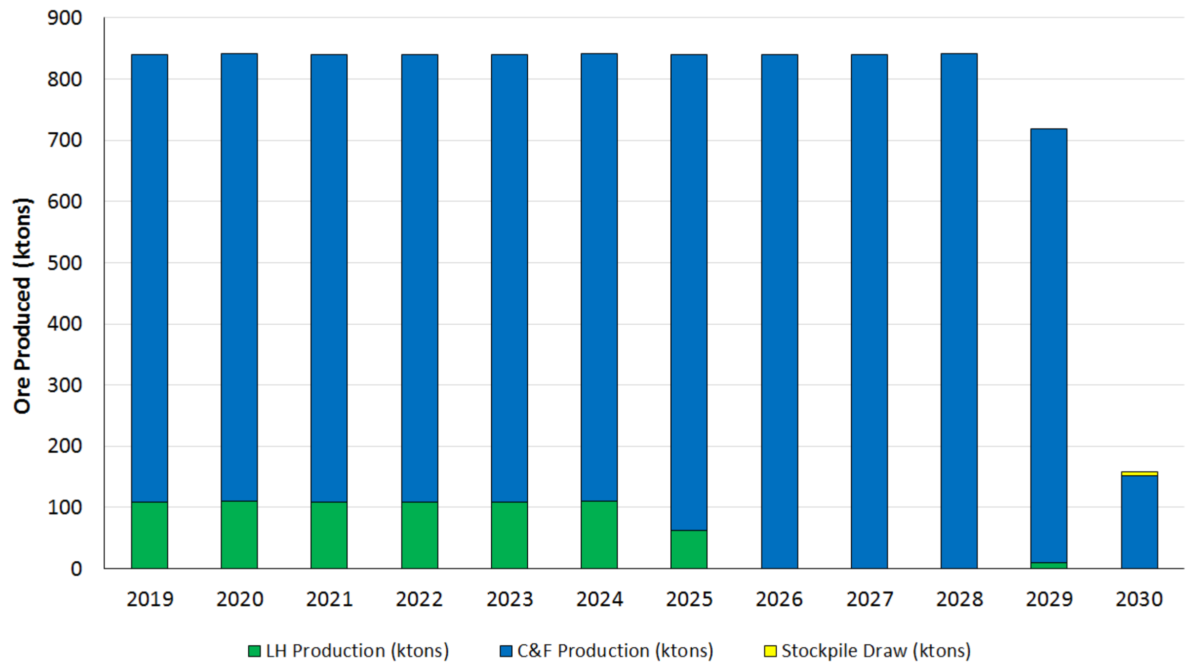
Ore drifting advance rates for cut-and-fill mining and longhole top/bottom cut development are typically no more than 4.0 ft/day per face. This is a relatively slow advance rate which allows ample time for geological mapping and sampling in order to maintain a high level of grade control due to the geometric complexity of the mineral body. Scheduled advance rates are reduced when drifting size is significantly larger than normal (for example, many longhole top/bottom cuts are 25 ft wide and therefore scheduled at 2.5 ft/day per face).

Towards the end of the mine life there are insufficient ore faces to maintain 2300 tpd at a 4.0 ft/day advance rate per face. Therefore in 2027 the maximum ore advance rate is increased to 5.0 ft/day per face, followed in 2028 by a second increase to 6.0 ft/day per face. This is achievable for the following reasons:

- With fewer available ore faces, additional mining resources can be applied to each face.
- Most of the ore to be mined near the end of the mine life will be remnants of levels which have been active for significant lengths of time. Mining will take place above, below and/or adjacent to previously mined panels. These areas are therefore well-defined with a large amount of geologic mapping and face sampling data, reducing the need for extensive mapping and sampling to maintain grade control on advance.
- An advance rate of 6.0 ft/day is in line with industry norms for similar mines.

Target longhole production is 300 tpd until all longhole stopes are depleted. From an operational perspective, longhole tonnage is used to smooth the day-to-day variations in cut-and-fill production. Current Greens Creek practice is to maintain at least one shot longhole available to be mucked to make up for any short-term cut and fill production shortfall.

Figure 16-7: Mine Plan - Ore Production Tons



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
C&F Production (ktons)	730	732	730	730	730	732	777	840	839	842	708	152	8,541
LH Production (ktons)	109	110	110	110	109	110	62	0	0	0	10	0	730
Stockpile Draw (ktons)	0	0	0	0	0	0	0	0	0	0	0	6	6
Total Mill Feed (ktons)	**839**	**842**	**839**	**839**	**840**	**842**	**839**	**840**	**839**	**842**	**718**	**158**	**9,278**

Table 16-2: Mine Plan – Mine Production Overview

	Silver (opt)	Gold (opt)	Lead (%)	Zinc (%)	NSR $/ton*
Next 5 Years (2019-2023)	12.7	0.090	3.06%	7.71%	$292
LOM Average (2019-2030)	11.5	0.091	2.83%	7.62%	$276

*NSR based on reserve prices and 2019 mine planning NSR estimation formula

Table 16-3: Mine Plan – Development Schedule

	Capital	Expensed	Total Lateral	Vertical
Avg Dev't Rate - Next 5 Years (2019-2023)	14.1 ft/d	7.5 ft/d	21.6 ft/d	*
Total Dev't - LOM (2019-2030)	47,058 ft	36,063 ft	83,121 ft	4,578 ft

*Vertical dev't consists of intermittent raiseboring campaigns which are undertaken by a contractor

16.16.3 Scheduling Criteria - Backfill

Overall backfill rates are scheduled at a placement rate of 600 tons per day per backfill heading. Planned total monthly backfill tonnages are aligned with historic actuals for a production rate of 2,300 tons of ore per day. It is assumed that 75% of the volume of mined void each month will require cemented backfill, of which twothirds is placed as paste fill and one-third is placed as jam fill with cemented tailings. Waste fill is assumed to be the lesser of 7,300 tons per month or the total monthly production of #2-4 (acid-generating) development waste. All #1 (inert) development waste is assumed to be hauled to surface since it is required for use as drystack capping material.

A delay of three days is assumed between the completion of mining in a heading and the beginning of backfill to allow for final mapping & surveying, heading cleanup, removal of utilities and installation of paste pipe.

16.16.4 Scheduling Criteria - Development

Lateral development is broken into two categories – capital and expensed:

Capital Development (typically driven at 16 ft width x 17.5 ft height)

- Haulage ramps
- Ore access drives (POA – primary ore access)
- Definition drilling drifts
- Raise accesses
- Other infrastructure excavations

Expensed Development (typically driven at 15 ft width x 15 ft height)

- In-Stope waste drives (between ore bands on a production level)
- Secondary ore access development (breasting down of an ore access drive to reach a higher elevation and access ore above a previously-mined level)

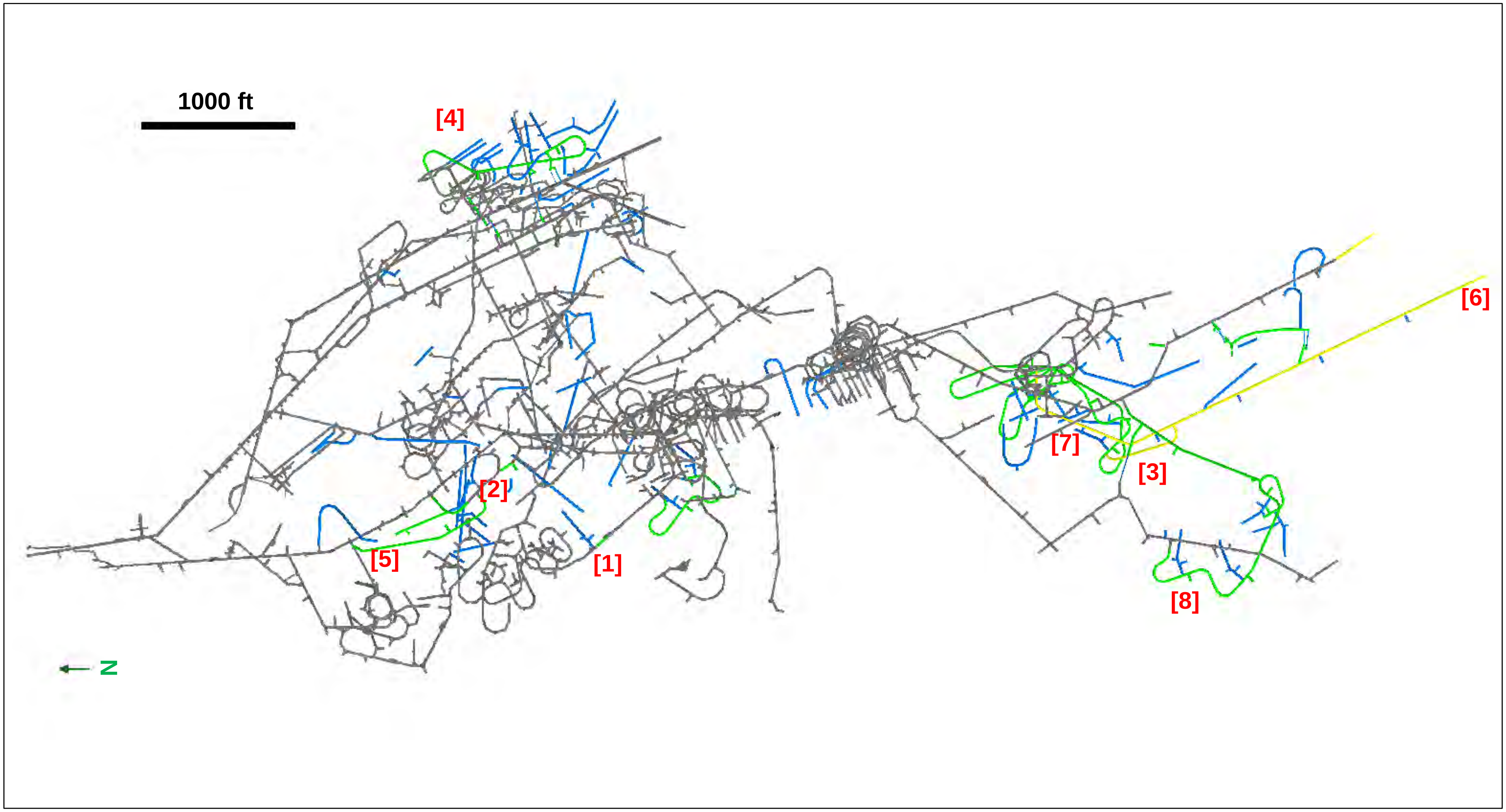
Expensed development is scheduled at a maximum advance rate of 4.0 ft/day per face. Capital development is scheduled at a maximum advance rate of 3.5 ft/day per face due to the slightly larger heading profile. These maximums rates stay constant throughout the mine life. Because mine development is undertaken by the same crews and equipment as mine production, development faces are typically advanced at relatively low rates in a stop-start fashion when mining resources are available and not required for production activities.

Vertical development is achieved via raiseboring and is undertaken by a contractor. Most vertical development remaining in the mine plan consists of paired sets of raises: an 8ft diameter bald ventilation raise adjacent to a 42-in diameter escapeway raise lined with laddertube. Vertical advance rates are scheduled at 4.0 ft/d to account for mobilization, setup, piloting, and laddertube installation in addition to the actual raisebore excavation.

16.16.5 Mine Plan Overview

Figures 16-8 to 16-13 show the existing and planned primary development at Greens Creek Mine.

Figure 16-8: Plan View- Existing and Planned Primary Mine Development through 2030



Green: Haulage Ramp - Blue: Ore Access Drive - Yellow: Definition Drilling Drift - See Section 16.6.6 for description of red numbered labels.

Figure 16-9: Plan View- Existing and Planned Mine Development including Mineral Reserves

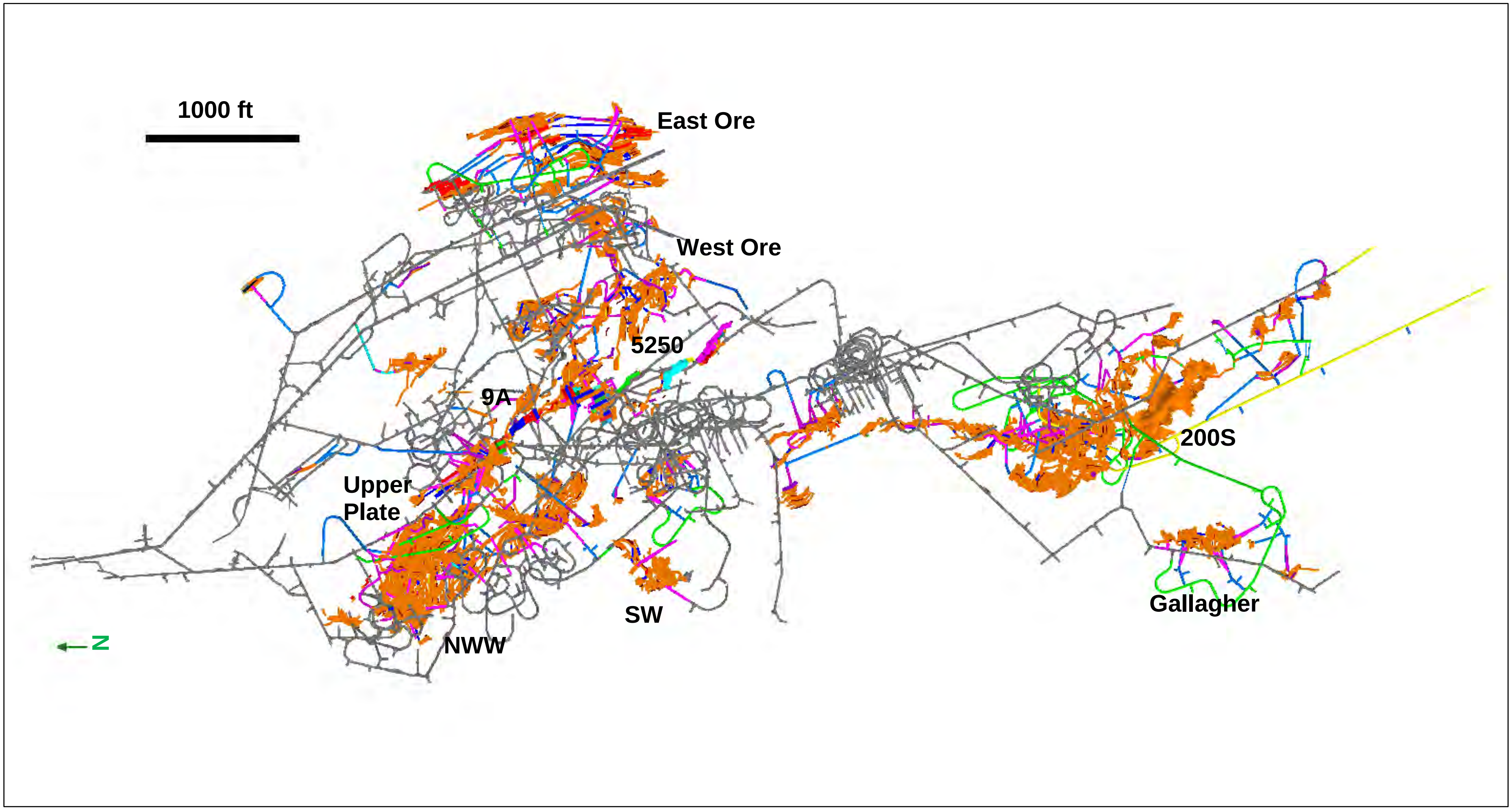
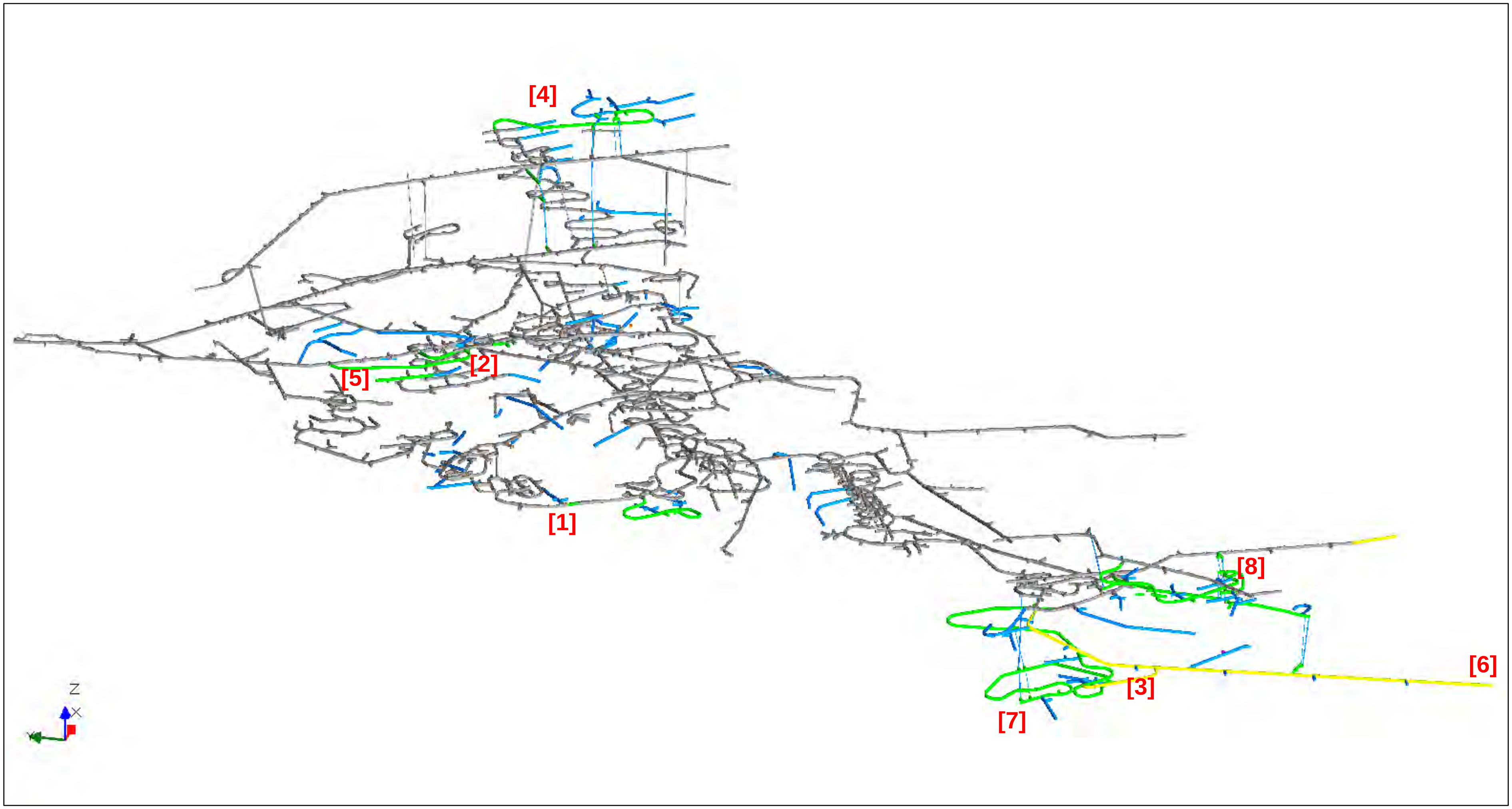


Figure 16-10: 3D View- Existing and Planned Primary Mine Development through 2030



Green: Haulage Ramp - Blue: Ore Access Drive - Yellow: Definition Drilling Drift - See Section 16.16.6 for description of red numbered labels.

Figure 16-11: 3D View- Existing and Planned Mine Development including Mineral Reserves

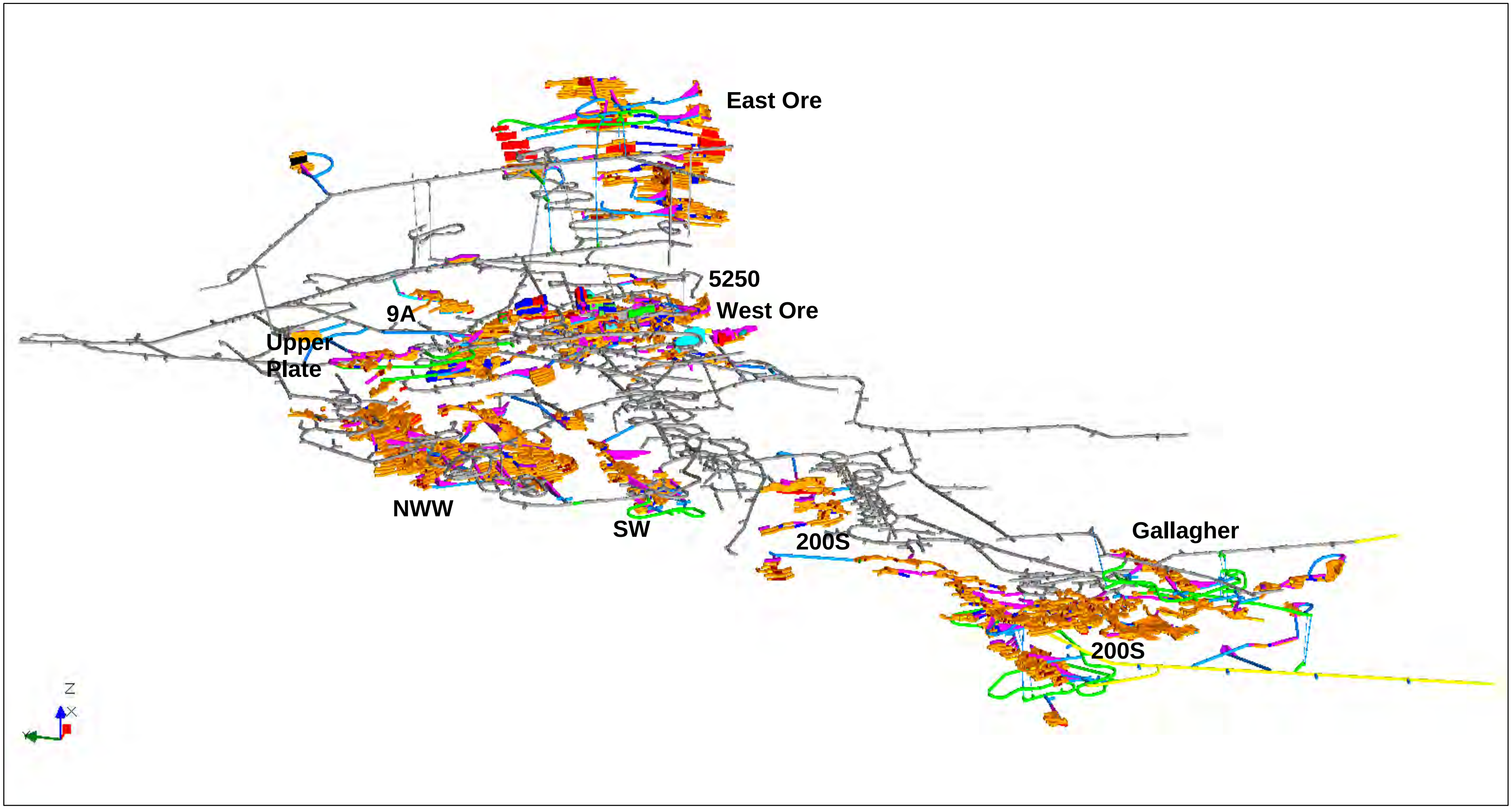
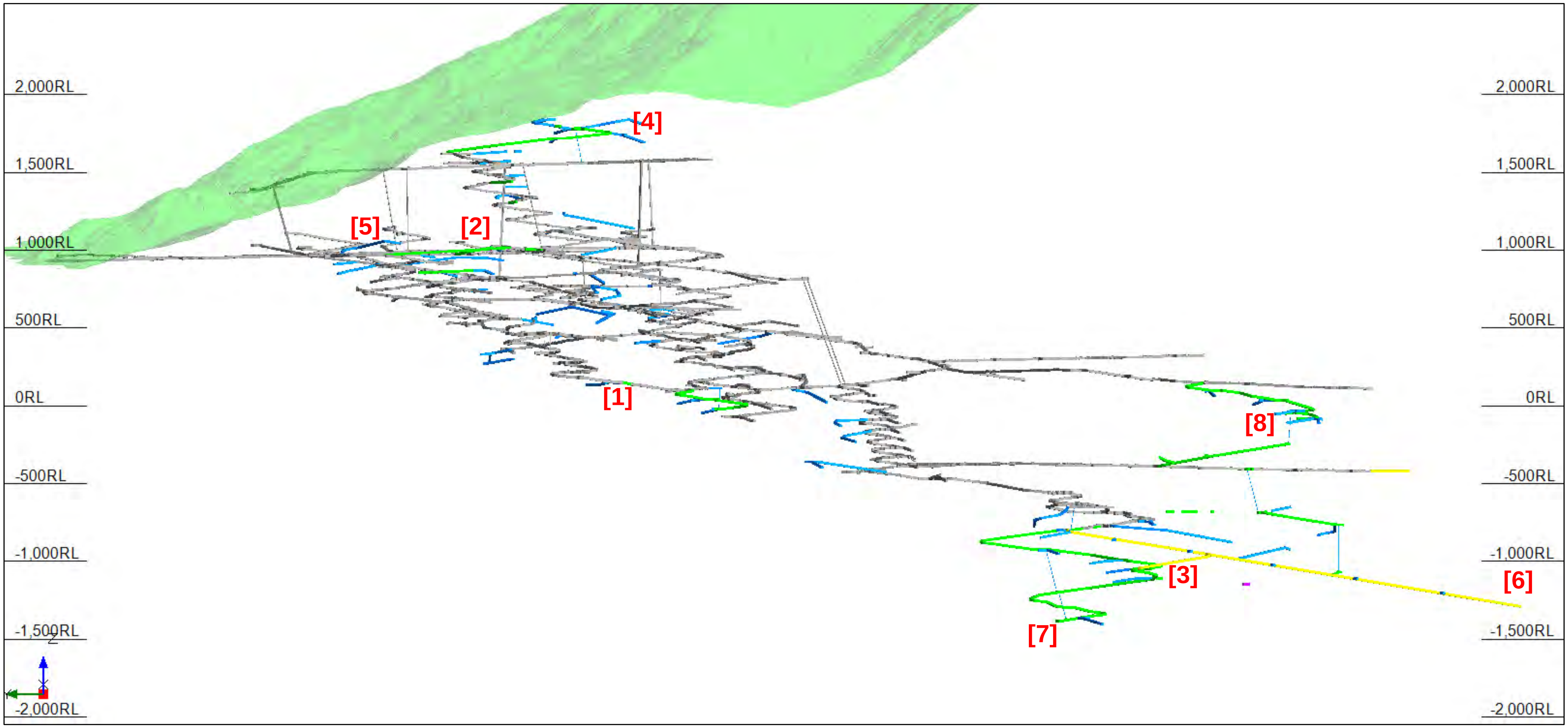
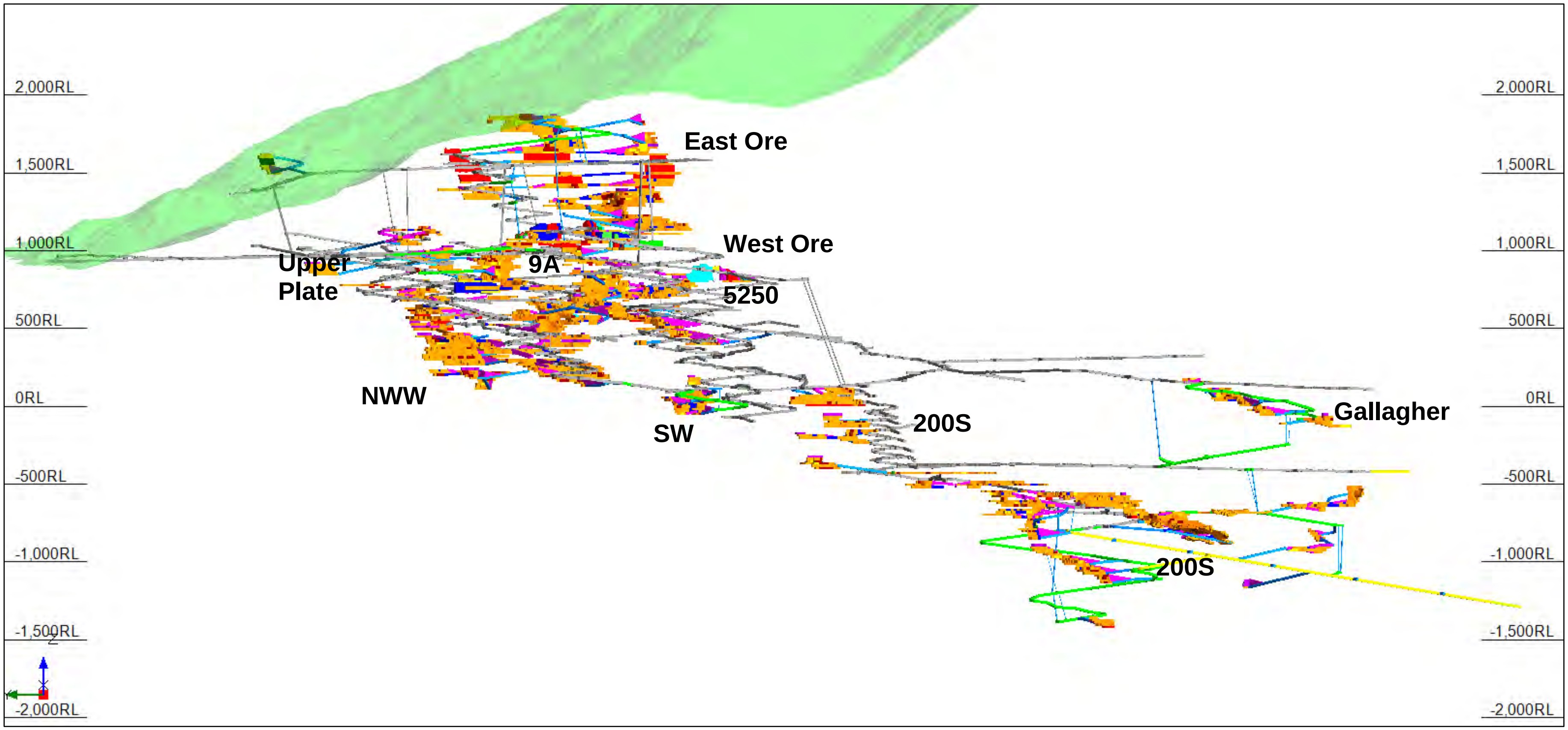


Figure 16-12: Side View with Surface Topo- Existing and Planned Primary Mine Development through 2030



Green: Haulage Ramp - Blue: Ore Access Drive - Yellow: Definition Drilling Drift - See Section 16.16.6 for description of red numbered labels.

Figure 16-13: Side View with Surface Topo- Existing and Planned Mine Development including Mineral Reserves



16.16.6 Timeline of Key Events in the Mine Plan

Red numbers indicate the location of the item discussed in the mine plan figures above.

2019

- Completion of the lower 2853 ramp, enabling production from the lowest extents of the NWW mineral zone **[1]**

2020

- Completion of the 59 Bypass and relocation of associated infrastructure. This enables production of high-grade 5250 material that was previously unminable due to close proximity with the 59 Drift which contains critical mine infrastructure (main conduit for power, drill water, discharge, and paste plant access) **[2]**

2021

- Breakthrough of the PD480 ramp to the M790 exploration drift, establishing several new high-grade production levels in the 200S Zone **[3]**

2022

- Initiation of East Ore 29 Up-Ramp development after completion of hydrologic study (see section 16.11) **[4]**
- Development of a second 59 Drift bypass in order to enable access to Upper Plate mineral reserves in proximity to the 59 infrastructure drift **[5]**

2023

- Completion of the M790 exploration drift, a key drilling platform for the most prospective remaining untested geology in proximity to the mine **[6]**

2024

- PD480 ramp reaches the bottom of the 200S body. Mining begins of the deepest mineral reserves at Greens Creek: 1410ft below sea level, approximately 4600ft below surface topography **[7]**
- Initiation of Gallagher Zone ramp development **[8]**

2025

- Completion of the East-Ore Up-Ramp
- Depletion of longhole mineral reserves

2026

- Completion of Gallagher ramp, begin mining Gallagher Zone

2030

- End of Mine Life

16.16.7 Mine Plan Optimization

The Greens Creek mine plan was optimized in 2018 with the goal of reducing required development footage and achieving earlier access to higher-grade ore. All planned development was redesigned and optimized, with large reductions to development footage including the removal of a major ramp system after it was determined that the targeted material could be accessed via crosscuts developed from existing workings.

The new mine plan results in a declining grade profile, with the highest-grade mineral reserves mined earlier in the mine life in order to optimize NPV. Previous mine plans had a relatively flat grade profile over the mine life, with an increase near the very end caused by mining of high-grade material that was unable to be extracted earlier due to proximity of critical mine infrastructure (see discussion of "59 Bypass" in Section 16.16.6).

Due to the optimization of development designs, the new mine plan displays relatively consistent yearly development footage requirements over the mine life. Previous plans required higher rates of capital development which were heavily front-loaded during the first few years of the remaining mine life.

16.16.8 Mine Plan Discussion

A large proportion of Greens Creek mineral reserves are at locations in proximity to existing haulage ramps. Approximately 80% of mineral reserve tonnage either already has an access developed or can be accessed with a relatively short cross-cut from an existing ramp. These ramps are actively used as haulageways and ventilation airflow routes and are maintained in good condition.

This results in less development schedule risk to mine production. New haulage ramps are continuously advanced in order to provide access to higher-grade ore, particularly in the deeper areas of the mine. However, if this development falls behind schedule, new ore headings can be established by driving short ore access drifts from existing haulage ramps, ensuring sufficient working areas to achieve target production tonnage.

This situation is due to the large amount of historical ramp development which was done at much lower metal prices, resulting in a large amount of current mineral reserve tonnage that was accessible but left behind as uneconomic by previous mining. In recent years, significant amounts of ore have also been located in proximity to existing ramps. This material had not been discovered previously due to limited exploration drilling budgets during periods of lower metal prices.

Ore production is sourced from a number of different mineral zones throughout every year of the mine life. This reduces the potential for equipment congestion or infrastructure bottlenecks in any one zone. Tonnage from the 200S Zone never exceeds 30% of overall production in any given year. The 200S Zone is the deepest zone in the mine and limiting tonnage from this area to a reasonable proportion of overall production is desirable to keep average haulage distances from increasing significantly which could require additional trucking capacity.

16.17 Comments on Mining Methods

In the opinion of the QP:

- The mining methods used are appropriate to the deposit style and employ conventional mining tools and mechanization;
- The LOM plan has been appropriately developed to maximize mining efficiencies, based on the current knowledge of geotechnical, hydrological, mining and processing information on the Project;
- The equipment and infrastructure requirements required for life-of-mine operations are well understood. Conventional underground mining equipment is used to support the underground mining activities.
- The underground equipment fleet is standard to the industry and has been proven on site. Numerous key units have recently been replaced or overhauled as part of the mobile equipment rebuild/replacement schedule.
- The predicted mine life to 2030 is achievable based on the projected annual production rate and the Mineral Reserves estimated.

17.0 RECOVERY METHODS

17.1 Process Flow Sheet

The Greens Creek mill produces three saleable flotation concentrates and a gravity concentrate. A carbon concentrate is produced as part of the process but is discarded as part of tailings.

A gravity circuit utilizing spiral concentrators treats a bleed stream from the grinding circuit cyclones. It produces a final gravity concentrate that is further processed off-site. Lead concentrate is produced in a rougher-cleaner circuit with re-grinding of the cleaner feed. The lead concentrate is relatively low grade, at approximately 35% lead, but carries a large proportion of the silver in mill feed.

Zinc concentrate is produced in a rougher-cleaner circuit, also with re-grinding, using lead rougher tailings as feed. The zinc concentrate typically contains 46 to 50% zinc, which is a normal grade, and considerably less silver than the lead concentrate.

Bulk concentrate is produced in a complex circuit which has as feed cleaner tailings from both the lead and zinc circuits. It is a relatively low-grade zinc concentrate, at 30% zinc, with a smaller amount of lead and some silver. Bulk concentrate has a relatively limited market so lead and zinc concentrates production is preferred over that of bulk.

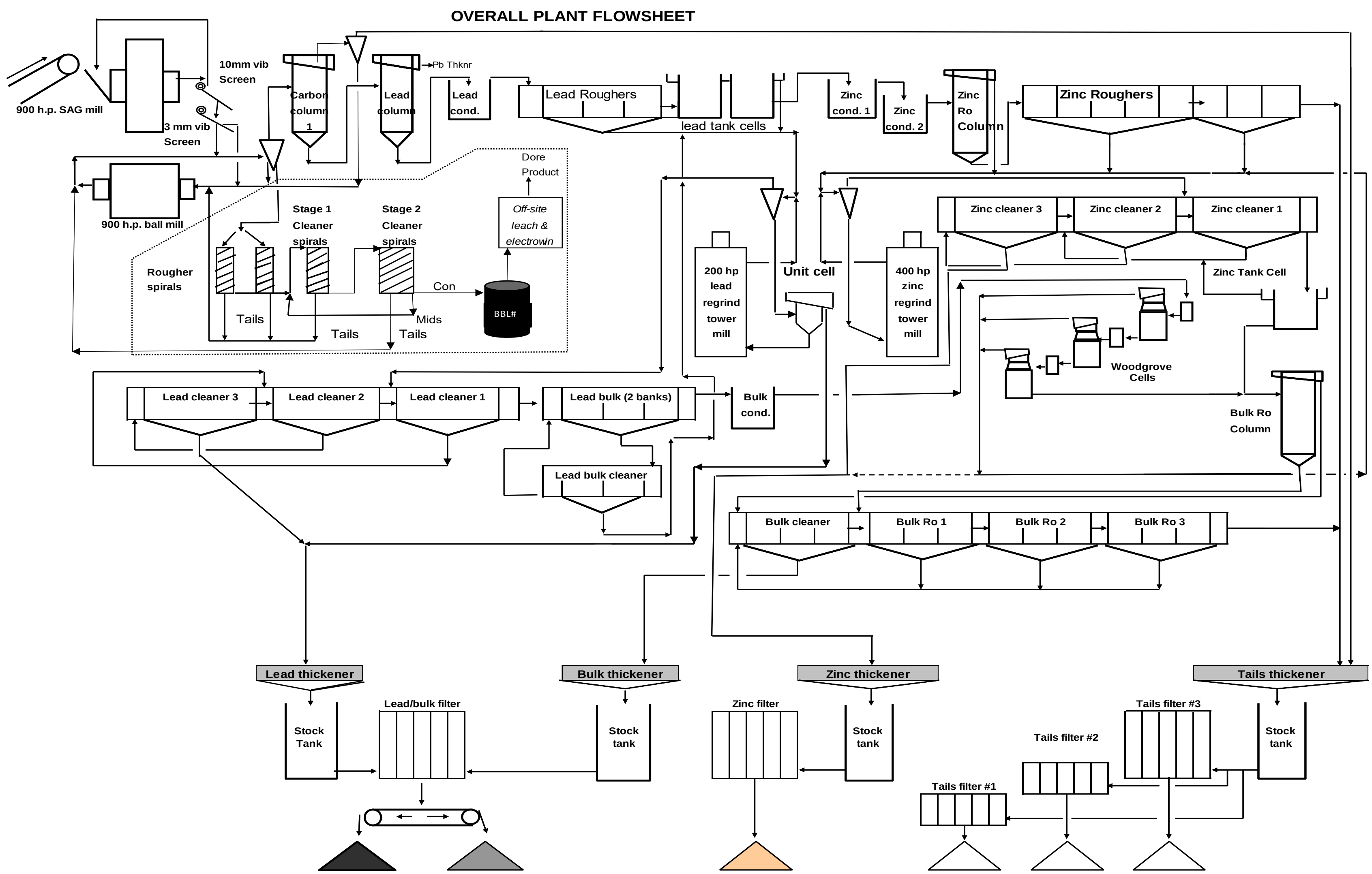
A mill flowsheet is shown as Figure 17-1.

17.2 Plant Description

Mined ore is delivered to the mill stockpile near the portal by underground haulage trucks. It is dumped into a “build” stockpile, which is regularly blended by the pad operator using either a loader or bulldozer. The pad operator at the same time uses the loader to feed the mill feed bin with material from the immediately adjacent “mill feed” stockpile, which consists of ore that has been previously delivered and blended. The mill feed stockpile is used until it is exhausted, at which point the build stockpile is designated the “mill feed” pile and is used to feed the mill.

The old mill feed area then becomes the build stockpile area and mine haulage is henceforth dumped there for blending. The two stockpile areas are thus alternated between the build and mill feed roles. A fresh mill feed stockpile can vary in size between as little as 1,000 tons (907 tonnes) to as much as 15,000 tons (13,608 tonnes) and so have a feed life ranging from less than a day to several days, depending on relative mine production rates and mill feed rates.

Figure 17-1: Greens Creek Mill Flowsheet



A Caterpillar 980 loader is used to transfer blended material to a fixed grizzly with 15-in (38-cm) square apertures located above a dump pocket with a 60-ton, 35-minute capacity. A hydraulic rock-breaker is used to break the small volume of oversize and a 48-in (122-cm) apron feeder is used to regulate the flow of grizzly undersize material onto a 48-in (122-cm) belt feeding the semi-autogenous grind (SAG) mill. The apron feeder speed is controlled to maintain target SAG mill feed rate of 85–110 wet tons/h (77– 100 tonnes) based on the feed belt weightometer output. A 16 x 5-ft (4.9 x 4.5-m) Marcy SAG mill is operated in closed circuit with a primary vibrating screen with 10-mm apertures.

17.2.1 Secondary Grinding

Primary screen undersize gravitates to the ball mill cyclone feed box where it combines with the discharge from the 900 hp 11 x 13-ft (3.3 x 4-m) Marcy overflow ball mill, before being pumped to a cluster of five 10-in (25-cm) diameter Warman Cavex cyclones. Two-inch diameter forged steel balls are added to maintain a target mill power draw of 600 kW. Four cyclones are usually in operation at 2,300 tons per day (2,087 tonnes/day); with the underflow from one cyclone being diverted through the gravity circuit for free gold recovery prior to return to the cyclone feed pumpbox. Cyclone overflow at 48 to 54% solids has a particle size range of 80% passing 70–85 µm and 95% passing 140 to 160 µm. Liberation of flotation feed is sufficient for recovery to low grade rougher concentrates, but not for production of final concentrates, which requires re-grinding prior to the cleaner circuits.

17.2.2 Gravity Circuit

A gravity circuit is operated to improve overall gold recovery. Two banks of eight double-start spirals are installed for roughing, with a single bank of two double-start spirals for open circuit first-stage cleaning. First stage cleaner spiral concentrates report to a second stage single-start cleaning spiral to produce a final gravity concentrate.

The final gravity concentrate is passed through a vibrating screen to remove relatively coarse (plus 30 mesh) material from the finer product comprising most of the gravity concentrate. The coarse fraction contains a significant amount of tramp copper wire fragments, which tend to interfere with off-site processing by intensive cyanidation. It is planned to treat the relatively small volume of coarse materially separately, simplifying and improving the treatment of the fine fraction.

The final gravity concentrate is collected and stored in barrels to be shipped to an off-site toll facility where it is treated using intensive cyanidation to produce precious metals. The gravity concentrates typically recover roughly 15-20% of the gold in mill feed and less than 1% of the silver.

17.3 Flotation Circuits

All flotation is carried out in conventional Outokumpu mechanical flotation cells, unless otherwise noted.

Cyclone overflow is diluted to a range of 52% to 45% solids before gravitating to a carbon flotation circuit that consists of one 8-ft (2.4-m) diameter column. This column removes naturally-floatable material such as graphite, carbonaceous pyrite and layer silicates (primarily clays and talc) from the mill feed and direct it to final tailings.

The first lead circuit flotation takes place at a pH of 8.5 in one 7-ft (2.1-m) diameter column. The concentrate from this column is high enough grade to be sent to the overall lead concentrate as a "scalped" lead concentrate product that is combined with the lead cleaner concentrate.

Zinc depression in the lead circuit is accomplished by pH control accompanied with the use of zinc sulfate in lead roughers. Zinc sulfate is used in the lead cleaners for both zinc and iron depression. Lead rougher tailings are conditioned with lime and then copper sulfate ahead of zinc roughing.

Lead roughing takes place at a target pH of 8.0 to 8.5 in banks of three 300-ft^3 (8.5-m^3) conventional flotation cells each followed by two 20-m^3 tank cells. Carbon dioxide is added to the SAG mill, cyclone overflow, and lead rougher conditioner to stabilize the pH of the lead rougher. A low-grade 20% Pb–18% Zn lead rougher concentrate is reground to 80% passing 20 µm with a tower mill, and then cleaned at a pH of 7.2 in ten 100-ft^3 (2.8 m^3) cells.

The lead cleaning circuit comprises three stages in closed circuit. Several options have been installed on the lead cleaning circuit. There are options to run the circuit as a three-stage cleaner or as a two-stage cleaner plus scavenger. Lead cleaner tailings are sent to the lead cleaner scavenger rougher cells at a pH of 7.2 to 7.5. The lead cleaner scavenger rougher concentrate is cleaned in closed circuit and returned to the lead cleaners. Lead cleaner scavenger rougher tailings report as feed to the zinc–bulk rougher circuit by way of the swing cell circuit which are three Woodgrove cells.

The lead cleaner scavenger tailings report to a conditioner tank where pH is raised to 10.5 using lime and copper sulfate is added to activate the zinc for flotation. This material is then pumped to the swing cells which consist of three 3-ft diameter x 10-ft tall Woodgrove SFR flotation cells in series. The concentrate from the swing cells is added to the zinc rougher concentrate to report to the zinc cleaner circuit and keep as much zinc as possible in the zinc circuit. The swing cells tailings the reports to the bulk flotation circuit to recover as much valuable mineral that remains into the bulk concentrate.

Zinc roughing is carried out at a pH between 10.0 and 10.5 in a 7-ft diameter x 30-ft high (2.1 x 9-m) zinc rougher column, followed by five 300-ft^3 (8.5-m^3) cells in series with three 100-ft^3 (2.8-m^3) cells. Zinc rougher tailings form the majority of the final tailings flow.

Rougher concentrate is reground to 80% passing 20 µm with a tower mill before being fed to three-stage zinc cleaning at a pH of 10.5 to11.0. Zinc cleaner tailings join the swing cell tailings to feed the 7-ft diameter x 30-ft high (2.1 x 9-m) bulk rougher column, the tailings from which feed nine 10-ft^3 (2.8-m^3) bulk rougher cells. Bulk rougher tailings are directed to final tailings, while bulk rougher concentrate is cleaned once in three 100-ft^3 (2.8-m^3) cells in closed circuit with the rougher to produce final bulk concentrate. Zinc cleaner cell capacity can be redistributed from three stages to two stages of cleaning during periods of high-zinc head grades.

17.3.1 Reagents

Reagents are distributed throughout the grinding and flotation circuits by means of head tanks and computerized solenoids for xanthate, copper sulfate, zinc sulfate, 3413 and MIBC reagents. Carbon dioxide is added to the circuit by way of carbonated water that is formed by introducing gaseous carbon dioxide to water under controlled pressure and flow. This carbonated water is then added as the main source of water for SAG mill grinding and density control feeding flotation in the cyclone overflow. This is also added to the lead regrind circuit to control pH in the lead cleaner cells. There is also an addition to the lead rougher condition in which gaseous carbon dioxide is introduced to the bottom of a slurry tank by sparger for fine pH control.

17.3.2 Dewatering

Lead, bulk, and zinc concentrates and final tailings are pumped to their separate thickeners, which are respectively 30 ft, 20 ft, 30 ft, and 60 ft in diameter (10 m, 6 m, 10 m, and 20 m). All thickeners have been retrofitted with high-capacity auto dilution feedwells.

Thickener underflows are pumped by Warman variable speed horizontal spindle pumps or Denver diaphragm pumps at 65 to 70% solids to individual stock tanks and into Sala filter presses using high pressure Warman pumps. Thickener underflows are fully instrumented for flow, density and pressure to allow thickener inventory control and to eliminate sanding problems.

There are three tailings filters, a zinc filter and a shared lead/bulk filter. Filter cake produced from these filters falls into the appropriate bin below the filter. These filter cakes are the final concentrate products and tailings from the milling operation.

17.4 Product/Materials Handling

All three flotation concentrates, as well as the final tailings, are thickened and filtered to approximately 10% moisture. Storage capacity at the mill is limited and all products are hauled to longer-term storage on a daily basis, using highway-type trucks.

Concentrates are separately hauled and stored to a storage–loadout facility at Hawk Inlet, approximately eight miles (10 km) from the mine. At the Hawk Inlet facility, they are stored indoors in piles until being loaded periodically into ocean-going ships for transport to a variety of smelters.

Tailings are sent to the surface batch plant as required by the needs of the mine for underground backfill. Remaining tailings are hauled daily to the tailings repository approximately seven miles from the mill for final storage. Tailings sent to the batch plant are fed to a pug mill, into which cement is also added, for thorough blending before being discharged to a hopper. Underground mine trucks haul the tailings backfill either directly to a heading for use as conventional backfill or to the underground paste plant. At the underground paste plant, tailings backfill is blended with water and the resulting slurry pumped to headings for use as paste backfill.

Overflow from the three concentrate thickeners and the tailings thickeners is sent to one of two water treatment plants. One plant is rated to treat 400 gpm and the other 800 gpm, but otherwise the plants are similar. Ferric chloride and flocculants are added to treatment plant feed water to coagulate and flocculate fine solids particles. Solution pH is adjusted, as needed, by lime. The flocculated solids are allowed to settle out in settling tanks and are then sent to tailings. The overflow is used for mill process purposes or sent to the site water treatment plant via pipeline.

17.5 Energy, Water, and Process Materials Requirements

Table 17-1 summaries the process consumables used in the concentrator.

Table 17-1: Reagent and Consumable Summary Table

Item	Usage
Mill Consumables	
4.5" SAG mill balls	Primary grinding
2" ball mill balls	Secondary grinding
1/2" regrind balls (12% Cr)	Lead and zinc re-grinding
Plant Reagents	
Carbon Dioxide	pH modifier, (Lead roughing/cleaning)
Zinc sulfate monohydrate	Zinc depressant, (Lead roughing/cleaning)
Sodium isopropyl xanthate	Collector, all circuits
Aerophine 3413 promoter	Collector/promoter, Lead roughing and cleaning
Copper sulfate pentahydrate	Activator, zinc and bulk circuits
MIBC	Frother (all circuits)
Lime (unslaked)	pH modifier (zinc circuit, treatment plants)
Flocculants and Coagulants	
Z Flocc 2525	Non-ionic flocculant (thickeners)
Ferric chloride (42%)	Coagulant - water treatment plants
Goldenwest 774	Anionic flocculant - treatment plants

The Greens Creek Mine is allowed by permit to withdraw 700 gallons per minute of fresh water from Greens Creek. This provides the fresh water to the entire site, including the mine and potable water system, with approximately 520 gpm of fresh water being available for mill use. However, the mill requires approximately 1,600 gpm of total water to operate. The difference between the fresh water and total water required for the mill is made up using recycled water. Some process recycle water is taken directly from the tailings thickener overflow, with the balance supplied by treated mill discharge water.

The mill requires approximately 4.8 MW of power to operate at full capacity.

17.6 Production and Recovery Forecasts

The Greens Creek LOM production plan for the mill assumes similar throughputs, recoveries, and concentrate grades to those achieved in recent years, based on projected mill feed grades provided by geology and mine staff for the LOM.

Table 17-2 shows the forecast mill feed tonnages and grades in imperial units; Table 17-3 presents the same data in metric units. Mill throughput is based on an average of 2,300 tons per day, or 2,087 tonnes/day, of ore.

The forecast concentrate production by concentrate type is shown in Table 17-4 in imperial units and in Table 17-5 in metric units. Table 17-6 and Table 17-7 show the concentrate grade forecasts in imperial and metric units respectively.

Table 17-2: Production Forecast by Feed Grade (Imperial units)

		5 Year Average (2019-2023)	LOM Total (2019-2030)
Ore Milled	**Units**		
	Tons/year	839,952	9,277,510
Mill Feed Grades			
Zinc	%	7.71	7.62
Lead	%	3.06	2.84
Silver	oz/ton	12.70	11.54
Gold	oz/ton	0.090	0.091

Table 17-3: Production Forecast by Feed Grade (Metric units)

		5 Year Average (2019-2023)	LOM Total (2019-2030)
Ore Milled	**Units**		
	Tonnes/year	761,992	8,416,415
Mill Feed Grades			
Zinc	%	7.71	7.62
Lead	%	3.06	2.84
Silver	g/tonne	435	396
Gold	g/tonne	3.07	3.11

Note to accompany Tables 17-2 to 17-7:
Conversion factors used for converting imperial to metric units were:

Short ton to metric tonne	1 short ton = 0.90718474 metric tonnes
Troy ounce to gram	1 troy ounces = 31.1034768 grams
Pounds per tonne	1 tonne = 2204.6 tonnes

Table 17-4: Production Forecast by Concentrate Type (Imperial units)

	Year	5 Year Average (2019-2023)	LOM Total (2019-2030)
Gravity Product Contained Metals			
Lead	tons	93.57	955.2
Silver	oz	51,014	511,175
Gold	oz	14,408	160,446
Lead Concentrate Contained Metals			
Zinc	tons	9,034	92,170
Lead	tons	18,577	187,562
Silver	oz	6,926,094	68,482,267
Gold	oz	27,841	302,459
Zinc Concentrate Contained Metals			
Zinc	tons	40,305	441,642
Lead	tons	1,373	14,349
Silver	oz	805,786	7,992,460
Gold	oz	4,086	43,121
Bulk Concentrate Contained Metals			
Zinc	tons	8,165.09	91,624
Lead	tons	984.64	10,716
Silver	oz	654,796	6,708,928
Gold	oz	3,327	36,341
Total Recovery			
Zinc	%	88.8	88.5
Lead	%	81.9	81.2
Silver	%	79.1	78.2
Gold	%	66.0	64.6

Table 17-5: Production Forecast by Concentrate Type (Metric units)

	Year	5 Year Average (2019-2023)	LOM Total (2019-2030)
Gravity Product Contained Metals			
Lead	tonnes	84.9	866.5
Silver	oz	51,014	511,175
Gold	oz	14,408	160,446
Lead Concentrate Contained Metals			
Zinc	tonnes	8,195	83,615
Lead	tonnes	16,853	170,154
Silver	oz	6,926,094	68,482,267
Gold	oz	27,841	302,459
Zinc Concentrate Contained Metals			
Zinc	tonnes	36,565	400,651
Lead	tonnes	1,246	13,017
Silver	oz	805,786	7,992,460
Gold	oz	4,086	43,121
Bulk Concentrate Contained Metals			
Zinc	tonnes	7,407	83,120
Lead	tonnes	893	9,721
Silver	oz	654,796	6,708,928
Gold	oz	3,327	36,341
Total Recovery			
Zinc	%	88.8	88.5
Lead	%	81.9	81.2
Silver	%	79.1	78.2
Gold	%	66.0	64.6

Table 17-6: Concentrate Grade Forecasts (Imperial)

	Year	5 Year Average (2019-2023)	LOM Total (2019-2030)
Lead Concentrate Grade			
Zinc	%	13.53	13.71
Lead	%	27.80	27.90
Silver	oz/ton	103.7	101.9
Gold	oz/ton	0.417	0.450
Zinc Concentrate Grade			
Zinc	%	48.27	48.66
Lead	%	1.64	1.58
Silver	oz/ton	9.6	8.8
Gold	oz/ton	0.049	0.048
Bulk Concentrate Grade			
Zinc	%	28.76	29.01
Lead	%	3.47	3.39
Silver	oz/ton	23.1	21.2
Gold	oz/ton	0.117	0.115

Table 17-7: Concentrate Grade Forecasts (Metric units)

	Year	5 Year Average (2019-2023)	LOM Total (2019-2030)
Lead Concentrate Grade			
Zinc	%	13.53	13.71
Lead	%	27.80	27.90
Silver	g/tonne	3,555	3,493
Gold	g/tonne	14.3	15.4
Zinc Concentrate Grade			
Zinc	%	48.27	48.66
Lead	%	1.64	1.58
Silver	g/tonne	330	302
Gold	g/tonne	1.67	1.63
Bulk Concentrate Grade			
Zinc	%	28.76	29.01
Lead	%	3.47	3.39
Silver	g/tonne	791	728
Gold	g/tonne	4.02	3.94

17.7 Comments on Recovery Method

The process plant is operational, and there is 29 years of production history that allows for a reasonable assessment of plant performance in a production setting. Metallurgical and production models were developed from extensive baseline sampling and are further adjusted annually to account for process and metallurgical improvements and changes. The QP has reviewed the methodologies used and the data uses and considers the projection process and methods used are unbiased and provide sound projections.

The QP has reviewed the information in this section provided by Hecla and considers that there are no data or assumptions in the LOM plan that are significantly different from previous plant operating experience, previous production throughputs and recoveries, or the Project background history.

In the opinion of the QP, the current process facilities are appropriate to the mineralization types provided from the mine. The flowsheet, equipment and infrastructure are expected to support the current life-of-mine plan.

18.0 PROJECT INFRASTRUCTURE

18.1 Roadways

Two mine roads link the Young Bay and the Hawk Inlet sites with the mine/mill site. A five-mile long, 18-foot wide road ("A Road") allows transport of personnel from the Young Bay dock to Hawk Inlet. An 8.5-mile, 20-foot wide road ("B Road) allows transport of personnel, supplies, and concentrate between Hawk Inlet and the mine/mill site, as well as transport of dry tailings from the mine/mill site to the tailings disposal facility (TDF). Several borrow pits lie along the roadways.

Hecla's policy for travel on these single-lane roads with turnouts requires that all employees and contractors maintain radio contact during transit. Limited public access to the road system is allowed. The roads are occasionally used by hunters who access Admiralty Island via private boat.

18.2 Mine Layout

The major infrastructure areas (Figure 18-1) supporting operations at Greens Creek include the 920/860 Area, Site 23, Hawk Inlet, TDF Area, Young Bay dock, 13 miles of connecting roadways, a power intertie connecting Greens Creek to the Juneau area power grid, and various pipelines and outfalls for wastewater and stormwater.

The 920 Area is located adjacent to the main portal at the 920-foot elevation or approximately eight road miles from the tidewater facilities located at Hawk Inlet. Located at the 920 Area are the mill, backfill batch plant, power-house, water treatment plants, surface maintenance shop, main warehouse, administrative offices, and fuel storage tanks. There is also a summer-only road to the 1350 exhaust portal.

The 860 Area, which is immediately adjacent to the 920 Area, has additional office buildings, assay laboratory, and core-logging facilities. Site 23, which is adjacent to the 860 Area or approximately 0.2 miles from the 920 Area, is the active waste rock storage facility and includes a helipad and shotcrete batch plant.

The dry stack tailings disposal facility (TDF) includes all the tailings produced to date that have not been placed as backfill underground. Ponds 7 and 10 and a 2500 GMP industrial wastewater treatment plant are located at the TDF Area.

Support facilities at Hawk Inlet include core storage; concentrate storage; a deep-water port that accommodates cargo ships, freight barges and fuel barges; warehouse; sanitary sewer and potable water treatment; fuel storage; and camp housing.

The Young Bay facility consists solely of a boat dock for the crew transport ferry that runs twice daily from Juneau, parking for buses, and a generator for powering lighting.

Figure 18-1: Infrastructure Layout Map

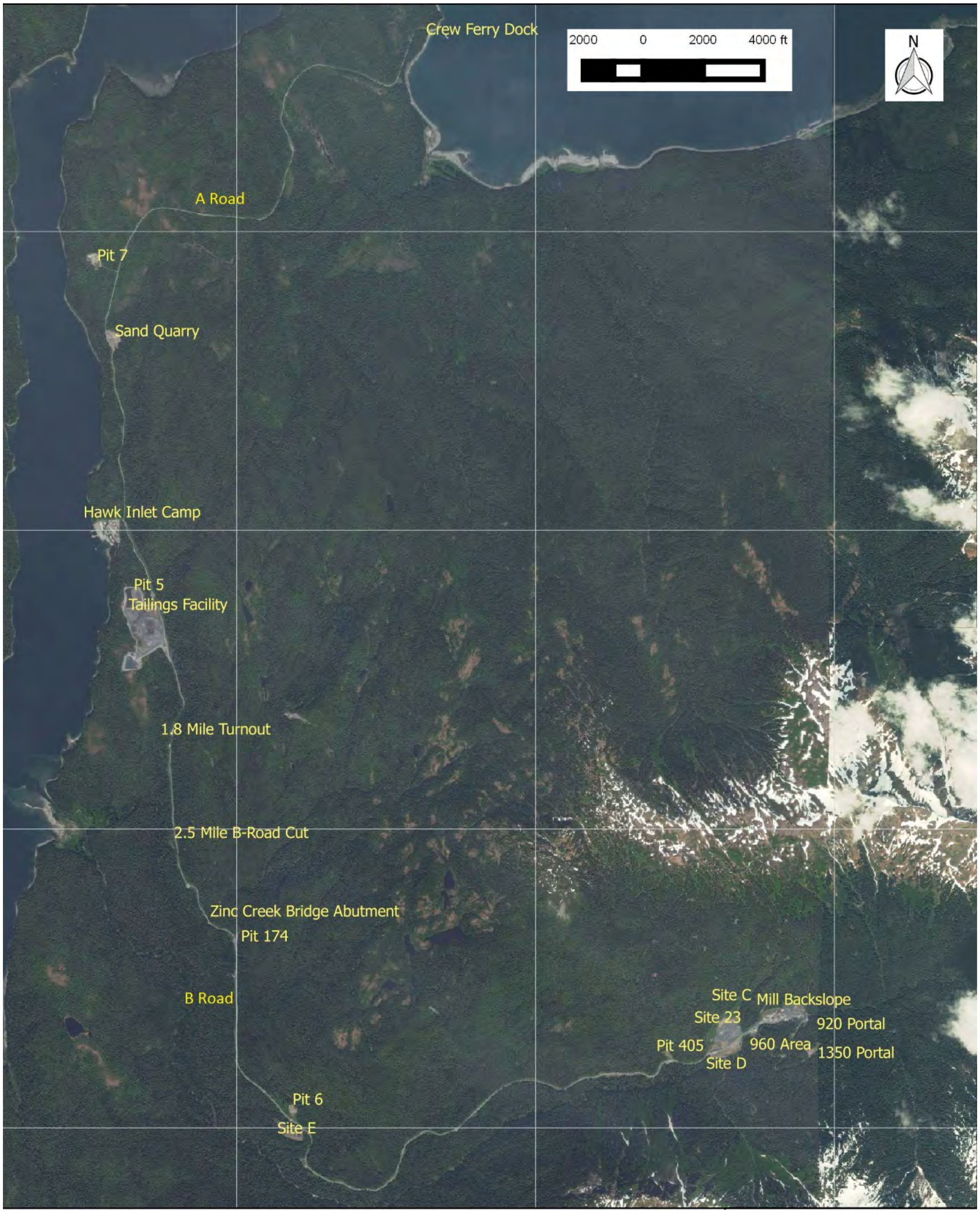


Figure 18-2: Hawk Inlet Infrastructure

Figure 18-3: 920 & 860 Mine Site Area

Figure 18-4: Hawk Inlet Facilities

Figure 18-5: 920 Area Facilities

18.3 Tailings Disposal Facilities

The mill at the Greens Creek Mine generates approximately 1,800 dry tons of filter-pressed tailings per day, or approximately 650,000 tons annually. These tailings are dewatered in a filter press at the mill, with about 50% of the tailings being mixed with cement and hauled back into the underground mine for disposal in mined-out areas as backfill.

The remaining 50% of the tailings are transported from the mill on the B Road using covered 45-ton haul trucks to a surface tailings disposal facility (TDF) located near Hawk Inlet.

At the TDF, tailings are end dumped and placed using bulldozers. The tailings are placed and compacted in lifts in a manner to minimize surface infiltration and promote runoff.

Leachate is contained using a system of geomembrane liners, cutoff walls, and above- and below-liner drainage systems. Surface water is managed via a system of lined ditches and culverts. Outside slopes are capped with carbonate-rich mine development rock (argillite or type 1) to protect against erosion and to provide geochemical buffering capacity for the potentially acid-generating tailings.

The TDF has undergone multiple staged, incremental expansions as the Greens Creek mine life has been extended over time. The "Stage 3" expansion was recently completed which will accommodate projected mine tailings storage requirements through the end of the mine life in 2030. Early-stage engineering studies are underway to determine modifications to the plan of operations in order to accommodate additional material beyond the current Greens Creek mineral reserve life.

The following items are monitored at the TDF:

- surface and ground water quality;
- water levels with wells and piezometers;
- geochemical properties of the tailings;
- geotechnical stability; and
- aquatic biology in several small, adjacent creeks.

Figure 18-6: Hawk Inlet Dry Stack Tailings Disposal Facility

18.4 Mine Development Rock Disposal Facilities

The current development rock storage area is Site 23 located 1,100 feet west of the 920-mine site. It is used to store potentially acid-generating mine development rock which cannot be used for capping tailings (see Section 18.3). Site 23 currently has a total capacity of 2.1 million tons and is expected to reach this capacity in early 2021 based on the planned mine development schedule.

At this time several options are being evaluated to optimize the development of Site 23 within approved boundaries to provide additional storage for development rock. Once the capacity of Site 23 is exhausted, development rock can be hauled to the TDF and/or used to backfill abandoned access ramps underground.

Ultimately, the material stored at Site 23 will be hauled underground during reclamation activities. This material will fill most of the void left by mine access ramps and other workings.

Historic development rock storage areas are found primarily at two locations:

- Site D, immediately down slope of Site 23 and
- Site E, located at mile marker 4.6 on the B Road, approximately half the road distance between Hawk Inlet and the mine portal.

Site E is currently undergoing a multi-year removal and reclamation effort. The material from Site E is disposed of with tailings at the TDF.

18.5 Stockpiles

In addition to Site E, discussed in Section 18.4, reclamation material storage stockpiles are located at various points along the haul road (B Road) connecting the 920 Area and Hawk Inlet.

Figure 18-7: Site 23 Waste Rock Storage Facility

18.6 Water Supply

18.6.1 920 Water System

The 920-water system draws up to 700 gallons per minute (GPM) from Greens Creek via three intake screens in stream bed for use in the mill and the mine. This water is referred to as fresh water. Fresh water is pumped to a head tank at elevation 1160 feet or directly to the mill.

Two discharge pipelines are installed in the head tank providing gravity flow for the fresh and fire water systems. The fire water pipeline is installed in the bottom of the 1160 head tank. The fresh water pipe line is installed above the fire water pipeline allowing storage for the firewater system.

Up to 10 GPM is pulled from the fresh water and is filtered, chlorinated, and stored in three tanks totaling 28,000 gallons for potable water.

18.6.2 Hawk Inlet Water System

Water infiltrates from Cannery Creek into two caisson-type wet wells:

- Caisson no. 1 pumped/gravity feed to the Hawk Inlet storage/fire tanks and
- Wet well 18 pumped feed to the TDF wheel wash area supply tank.

The withdrawal from Cannery Creek is limited to 104,000 gpd. Control of each system is based on demand and corresponding storage tank levels.

Water from caisson no. 1 is pumped to three 20,000-gallon tanks located outside the Hawk Inlet water utilities building. Of this initial 60,000 gallons, 45,000 gallons are reserved for the fire suppression systems. Water demand by the camp facilities, wash down and domestic uses is drawn from these storage tanks. These tanks also supply the potable water filtration system where fresh water is filtered, chlorinated and stored in a fourth 20,000-gallon tank before distribution in the Hawk Inlet camp.

18.7 Water Management

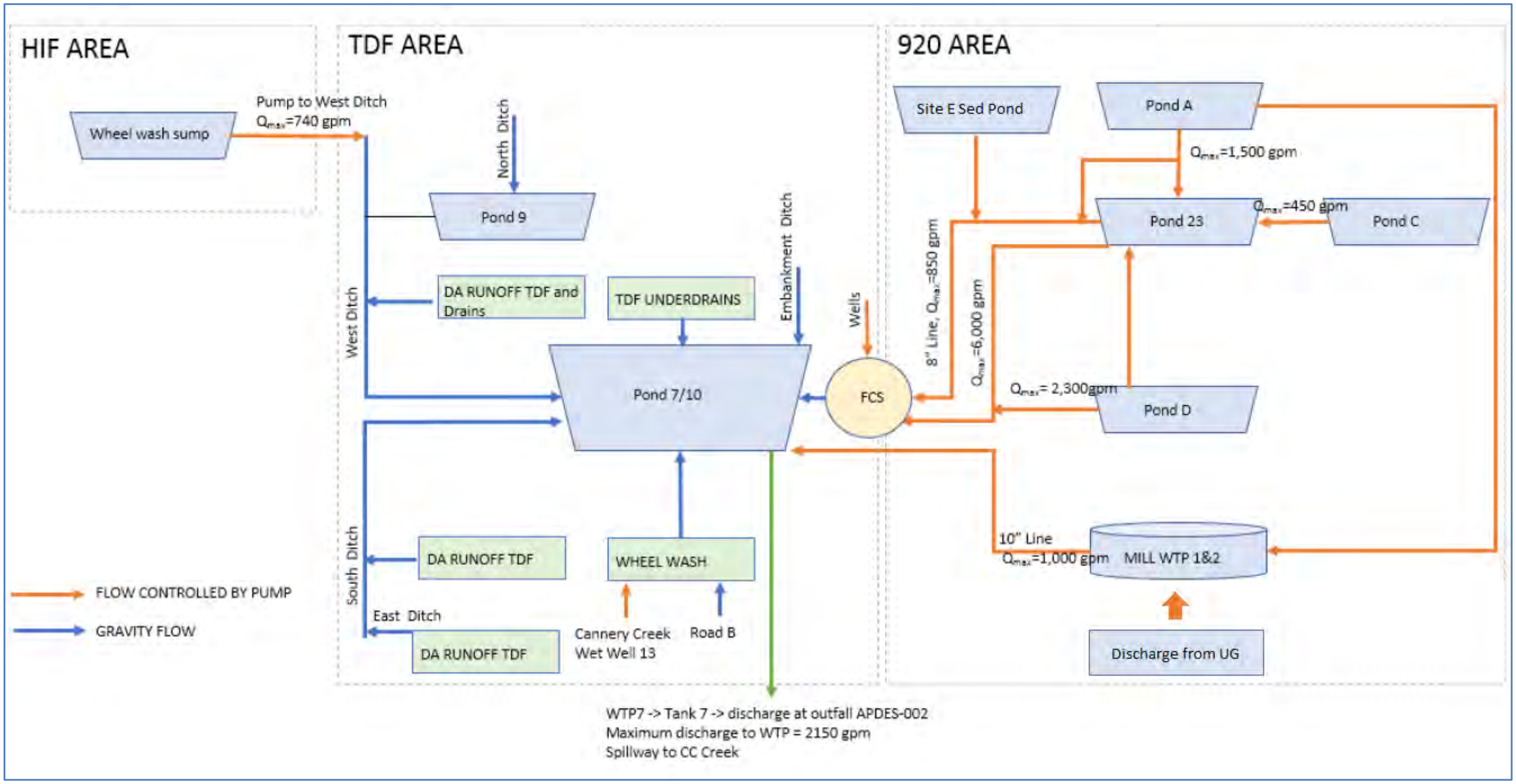
Greens Creek is in a maritime environment and receives considerable precipitation (refer to Section 5.2). Non-contact water is diverted from the site by upland ditches and drains and discharge to the numerous fresh water courses found adjacent to the site.

Management of contact water is undertaken to protect the environment. Contact water includes the following:

- water withdrawn from Greens Creek and Cannery Creek;
- stormwater, and;
- ground water from underdrain systems, curtain drains, and collected seeps.

The following flow chart displays the current water management system at Greens Creek. Note that all contact water reports to Ponds 7 and 10 collectively referred to as Pond 7/10.

Figure 18-8: Greens Creek Water Management Flowchart



18.7.1 920 Area Water Management

All water collected and/or used at the 920 Area is ultimately piped to Pond 7/10 at the TDF, and from there is treated by the TDF water treatment plant (TDF WTP) prior to discharge into Hawk Inlet.

Underground discharge water is sent to the mill where it is combined with tails thickener discharge and sent to the two 920 water treatment plants (920 WTP) and ultimately piped to Pond 7/10.

Contact Water

The main objective of the 920 Area stormwater systems is to protect the environment by controlling contact water at the site for treatment. The stormwater system at the 920 Area mill site is in place to route, contain, treat, store, recycle and export stormwater from the mine and mill site.

Water is routed through the system as follows:

1. site collection ditches and lift stations to sediment removal basins;
2. detention Pond A; and
3. to mill for recycling or Pond 7/10 via pipelines buried adjacent to the B Road.

In general, all water considered “contact” water is contained at the 920 Area and eventually treated at the TDF WTP. Surface water conveyance systems at the 920 Area are designed to handle a 10 year/24-hour storm event.

Water Treatment

Two chemical precipitation plants (CPPs) are used to treat wastewater and are configured and designed to route water back to the mill or to Pond 7/10.

Site 23 Water Management

All water collected and/or used at the 860 and Site 23 area is ultimately piped to Pond 7/10 at the TDF, and from there is treated by the TDF water treatment plant (TDF WTP) prior to discharge into Hawk Inlet.

Pond D receives water from run-off and the Site D curtain drain system. This water is generally recycled for use in the mill but can be routed to Pond 23 as needed. Pond 23 receives stormwater from Site 23 curtain drains and discharge from Pond A, Pond D, and Pond C. Water from Pond 23 reports to Pond 7/10.

18.7.2 TDF & Hawk Inlet Water Management

Hawk Inlet Contact Water

The Hawk Inlet system routes, stores, collects and exports water to the TDF area for additional treatment and ultimate discharge.

Contact water is received from the following sources:

- hawk Inlet stormwater drainage;

- hawk Inlet wheel wash facility;
- wash-down from concentrate storage and ship loader; and
- treated and disinfected domestic sewage treatment effluent.

These waters report to de-gritting basin number DB-04, where the heaviest material settles out. Flows are then routed by gravity to the stormwater wet well (integral to the wheel wash building), where it is pumped to Pond 7/10 for additional treatment at the TDF WTP and ultimate discharge to seawater through the APDES outfall 002 located in Hawk Inlet.

TDF Contact Water

A series of perimeter ditches at the TDF capture surface contact water from precipitation. All surface flows report to Pond 7/10. A series of complex underdrains exist throughout the TDF and at Pond 7/10. All underdrains gravity flow to perimeter ditches or lift stations referred to as wet wells. Water is pumped from the wet wells to perimeter ditches or via pipes to Pond 7/10.

TDF Water Treatment Plant

All waste, contact, and process water from the 920, 860, Site 23, Hawk Inlet Facility, and the TDF areas ultimately report to Pond 7/10. Pond 7/10 stores water before treatment in the TDF WTP. It provides surge protection for stormwater flows. It is designed to handle the 25-year / 24-hour storm site wide. Pond 7/10 has a total capacity of 66.66-acre feet. Water collected in Pond 7/10 is pumped to the TDF WTP, which is a chemical precipitation plant (CPP). Effluent water (post treatment) is discharged to Hawk inlet via APDES outfall 002.

18.8 Power and Electrical

The mine’s electrical power needs are met by utilizing a combination of two sources. The primary source is from purchased power generated by the local Juneau power utility. The Juneau power grid is connected to the Greens Creek grid by an undersea cable and a 13-mile-long 69 kV aerial power line. This power is generated by hydroelectric dams and is available to Greens Creek except when reservoir levels fall below predetermined limits.

The secondary source is on-site diesel-powered generation. This system includes two separate power-houses that contain nine generating units capable of producing 11.25 MW. The on-site generators include a mixture of reciprocating and turbine generators.

18.9 Concentrate Handling

Concentrates are transported from the mill to Hawk Inlet using the same 45-ton trucks that are used for transporting tailings. The Hawk Inlet facilities include an approximately 30,000-ton capacity concentrate storage building located near tidewater. Concentrates are loaded onto bulk transport ships using a covered telescoping conveyor.

18.10 Fuel

Fuel arrives at the Hawk Inlet port facility by ocean barges that serve southeast Alaska. It is pumped directly into a 200,000-gallon storage tank that is equipped with full spillage containment. The fuel is then delivered by 9,500-gallon tanker trailers to the 920 Area fuel storage area, which consists of three fully contained tanks yielding a storage capacity of approximately 156,000 gallons.

When electricity is supplied by the local utility intertie, fuel is delivered at one to two-month intervals as needed. When the mine is required to operate the diesel generators to supply power to the site approximately 150,000 gallons is delivered weekly.

18.11 Other Supplies

All supplies are delivered to the Hawk Inlet port facility via freight barge. Supplies destined for the 920 area are transported by truck. Trash, waste and empty shipping containers are also loaded back onto barges at the Hawk Inlet port. Both Hawk Inlet and the 920 area have warehouse facilities for material storage and handling. Aggregates are delivered to Hawk Inlet by barge and are stockpiled at various locations throughout the mine site.

18.12 Communications

Corporate communications on the Greens Creek mine site are handled over fiber-optic cables, leased from GCI Communication Corp, utilizing voice-over-internet-protocol technology.

Process control management is accomplished over an internal Ethernet system utilizing both fiber optic and Cat5 communications. The internal fiber optic system extends into the mine and is utilized to monitor/control fan systems, monitor mine gasses, and track equipment and personnel. A supervisory control and data acquisition (SCADA) program is used, allowing remote monitoring and control from multiple sites. A single, site-wide standard is accomplished utilizing “Ignition SCADA” software.

Vehicle safety and emergency reporting and communication are accomplished using an island- and mine-wide radio system with dedicated channels for mill operations, mine operations, and road operations. The radio system extends throughout the underground mine by use of a leaky feeder system. Vehicle safety on the surface and underground is enhanced with a proximity detection and collision avoidance system.

A hard-wired mine phone system is also installed throughout the mine with direct communication to supervisory offices and the medical office.

In the event of a fiber optic failure, a backup microwave system is in place to ensure site safety. Emergency satellite phones are also available at both the Hawk Inlet and 920 offices.

18.13 Comments on Infrastructure

In the opinion of the QP, the existing infrastructure is appropriate to support the current life-of-mine plan to 2030. Further work is recommended to advance the following:

- Modifications to the Plan of Operations and engineering that are necessary to optimize waste storage capacity at Site 23.
- Early-stage engineering studies are underway to determine modifications to the plan of operations in order to accommodate additional material beyond the current Greens Creek mineral reserve life. The QP recommends this continue as planned.
- Engineering studies to gain an understanding of options for final disposal of historic waste rock piles including potential for impoundment in the TDF or underground disposal.

19.0 MARKET STUDIES AND CONTRACTS

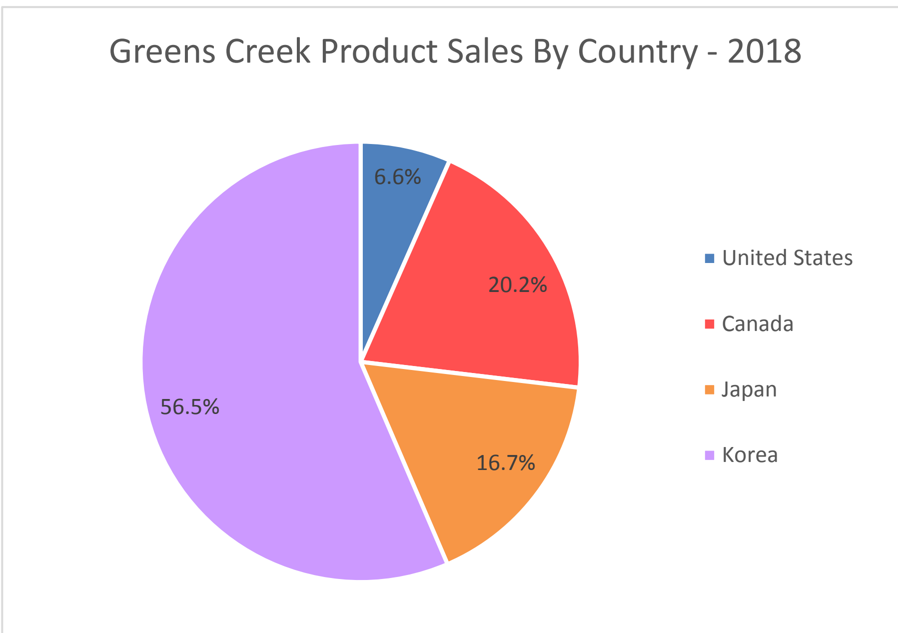
19.1 Market Studies

The mine has now been operational for a 30-year period, and continuously operational for the last 23 years, and has current contracts in place for concentrate sales, doré refining, concentrate transportation, metals hedging, and other goods and services required to operate an underground mine.

19.2 Concentrate Sales, Smelting, and Refining

Hecla has agreements at typical lead and zinc concentrates industry benchmark terms for metal payables, treatment charges and refining charges for concentrates produced from the Greens Creek Mine. The major customers in 2018 included, Korea Zinc (39.3%), Cliveden (13.6%), Mitsui Mining & Smelting (11.8%), and Teck Metals Limited (14.7%). These custom smelters are located in Canada, Japan, South Korea and China. Figure 19-1 shows the product sales by country for Greens Creek products.

Figure 19-1: Concentrate Destinations



Hecla has had concentrate sales frame contracts in place since the beginning of operations in 1989 and these contracts are typical sales contracts in the industry. New frame contracts are negotiated at the end of their terms. When surplus tonnage is available, spot sales contracts are arranged 6 to12 months in advance of shipment. For all of Hecla's sales contracts, the title and risk of ownership of the concentrates transfers either at the load port or discharge port.

Treatment costs and refining costs vary depending on the concentrate type and the destination smelter. Table 19-1 summarizes the average metal payability factors.

Table 19-1: Payability and Treatment Charges Summary

Description	Lead	Zinc	Bulk
Pb	90-95	None	90-95
Zn	0-10	83-85	83-85
Ag	90-95	50-65	70-80
Au	90-95	25-45	55-65
Base TC $/dmt	160-180	200-220	Zinc +10-15

Greens Creek concentrates are higher in precious metals content, but lower in lead and zinc content than typical lead, zinc and bulk concentrates. With regard to Greens Creek's bulk concentrate, this product requires treatment at Imperial Smelting Furnaces (ISFs) which are declining in number due to more efficient technologies coming on-line. All bulk concentrate tonnage anticipated to be produced at Greens Creek is committed to our current frame contract on an evergreen basis. Hecla has also previously delivered bulk concentrate to China and Korea and has those relationships in place should it be necessary to place additional bulk concentrate tonnage at any time during life-of-mine operations.

Gravity concentrate is shipped to a processor in Kimberly, ID (Metals Research) for treatment through their oxygenated-cyanide leach process. Once treated, Metals Research produces doré bars and forwards them to Metalor on Hecla's behalf for further refining under a toll refining agreement. Upon receipt of doré bars from Greens Creek, Metalor further refines the material and Hecla's pool accounts are credited with ounces of gold and silver bullion from this process. The gold bullion is sold on a biweekly basis to a large bank at prevailing spot prices. The silver bullion is sold to Metalor on a quarterly basis at prevailing spot prices.

Lastly, the tailings resulting from the oxygenated-cyanide leach process at Metals Research are sent via truck to Teck's smelter in Trail, B.C. on a quarterly basis for further processing and eventual disposal.

19.3 Other Contracts

A Contract of Affreightment is in place with an international shipping company covering the shipments of the lead, zinc and bulk concentrates from the Greens Creek port facilities at Hawk Inlet, AK to overseas discharge ports serving the smelter customers. The current Contract of Affreightment has a term of two years and expires at the end of December 2019. Negotiations are currently underway for a new Contract of Affreightment with the same shipping company.

Hecla utilizes financially-settled forward contracts to manage the exposure to changes in prices of zinc, lead, silver, and gold contained in concentrate shipments between the time of sale and final settlement. In addition, we utilize financially-settled forward contracts to manage the exposure to changes in prices of zinc and lead (but not silver and gold) contained in our forecasted future concentrate shipments. These contracts do not qualify for hedge accounting and are marked-to-market through earnings each period.

Several other contracts have been utilized for other goods and services required to operate an underground mine. Large contracts include lease of office facilities in Juneau, lease of a boat dock at Auke Bay, AK for employee parking and boat dock facilities, employee marine transportation services for the Greens Creek workforce to commute from Auke Bay to Admiralty Island, contract drilling services for surface exploration and underground core drilling, camp catering and housekeeping for an employee camp facility, barge transportation of supplies and equipment from Seattle to Admiralty Island and small float plane and helicopter support.

A contract is in place with the local Juneau electric utility for any excess hydroelectric power not required for the City and Borough of Juneau.

On occasion, mining contractors are employed for specific mine development projects.

Many supplies contracts are in place with suppliers for purchase of various goods; the largest contracts include purchase of fuel, reagents, ground support, and leases of mining equipment.

19.4 Comments on Market Studies and Contracts

In the opinion of the QP:

- Hecla is able to market the gravity products, lead, zinc, and bulk concentrates produced from the Project;
- The terms contained within the gravity products and concentrate sales contracts are typical and consistent with standard industry practice, and are similar to contracts for the supply of doré and concentrates elsewhere in the world;
- Although ISFs are being phased out, which can affect long-term marketing of bulk concentrates, Hecla has an existing frame contract in place and relationships with other buyers for such concentrates, and it is a reasonable expectation that the bulk concentrates will be able to continue to be marketed;
- Metal prices are set by Hecla management and are appropriate to the commodity and mine life projections.

20.0 ENVIRONMENTAL STUDIES, PERMITTING, AND SOCIAL OR COMMUNITY IMPACT

20.1 Overview

The land comprising the Greens Creek Mine, inclusive of all Admiralty Island facilities, consists of both publicly and privately-owned uplands and tidelands. Hecla leases parcels from the United States on both the Monument and non-Monument lands. Hecla also uses other public lands pursuant to special use permits issued by the USFS and leases issued by the State of Alaska (see Section 4 for more information).

The Greens Creek Mine is currently regulated by approximately 70 separate permits and approvals issued by various Federal, State and Municipal agencies covering activities at and around the Greens Creek Mine operation. The operation of the mine and associated facilities are authorized in part under a series of leases and other land use authorizations from the United States Forest Service (USFS) and are carried out in accordance with the General Plan of Operations (GPO) approved by the USFS. Certain areas of the mine's operation are also subject to other Federal and State permits, and approvals issued by other Federal and State agencies.

The USFS has issued special use permits and leases for various aspects of the operations. In addition, Hecla holds approximately 7,301 acres (2,955 ha) classified as a Land Exchange Area for which the USFS has granted Hecla exclusive rights to explore and mine, with specified restrictions, for 99 years. This area is inclusive of the patented mining claims and some previously leased and permitted sites from the USFS within the area. All lands owned by or leased to Hecla by the USFS will be conveyed to the United States at the end of mine life, or in 2095 at the latest.

The Alaska Department of Environmental Conservation (ADEC) regulates mill tailings and production rock disposal facilities at the mine, as well as other aspects of the operation primarily through Title 18 of the Alaska Administrative Code (AAC), Chapters 50, 60, 70, 72 and 80. Several permits are issued by ADEC, including, but not limited to the Air Quality Operating Permit No. 302TVP03, the Alaska Pollutant Discharge Elimination System (APDES) permit AK-004320-6 and the Waste Management Permit 2014DB0003 (WMP), which authorizes tailings and production rock disposal and prescribes monitoring, reporting, closure, post-closure and financial responsibility requirements. ADEC also regulates point source surface water discharges under the Alaska Pollution Discharge Elimination System. For more information on the tailings and rock disposal see Section 18.

The Alaska Department of Natural Resources (ADNR) issues certain land and water use authorizations and dam safety certificates covering site wide operations, including some of the tailings management infrastructure. In addition, ADNR works with the USFS and ADEC to oversee the reclamation and closure plan and bonding for the mine.

Oversight by the EPA includes hazardous waste disposal regulated by the Resource Conservation and Recovery Act, and the management of fuel and oil under the oil pollution prevention requirements of 40 CF112. Other federal agencies involved in the operation of the mine include the U.S. Coast Guard, Nuclear Regulatory

Commission (nuclear sources), Bureau of Alcohol, Tobacco and Firearms (explosives), Federal Communication Commission (radio station authorization) and Federal Aviation Administration (float-plane landing facility).

Hecla has implemented workplace processes and training programs designed to minimize waste and prevent pollution, and to comply with all applicable laws, regulations, and corporate requirements.

20.2 Baseline Studies and Annual Reports

The technical and environmental library containing baseline reports and ongoing studies at the Greens Creek Mine contains hundreds of documents from 1980 to 2018. Annual reports that are required under various permits that are submitted to the regulatory agencies, and which are available to the public are summarized in Table 20-1.

Table 20-1: Primary Reporting Requirements

Report Title	Permit	Subjects Covered
Fresh Water Monitoring Program (FWMP) Annual Report	State Waste Management Permit (WMP) 2014DB0003	Upgradient and down gradient water quality sites are sampled monthly and reported herein. A comparison to AWQS is required. Trend analysis is carried out by two different methods. The first method is a visual trend analysis for each analyte. For each site sampled a series of time-concentration graphs are constructed for the previous five years of data collected. The second method is a non- parametric statistical method, Kendall seasonal trend analysis.
Tailings and Site 23 Annual Report	WMP 2014DB0003	Monitoring results for the past year are presented with historical data with trend discussions for the tailings disposal facility and waste rock disposal facility (Site 23). Monitoring of water quality, stability, compaction, acid base accounting (ABA), material volumes, inspections and summaries of pertinent studies are included.
Inactive Rock Sites and Quarries Annual Report	WMP 2014DB0003	Monitoring results for the past year are presented with historical data with trend discussions for five inactive production rock sites and five quarries. Monitoring of water quality, ABA, material volumes, reclamation projects, inspections and summaries of pertinent studies are included.
Greens Creek Biomonitoring Report	WMP 2014DB0003	Documents stream health in Greens Creek and Tributary Creek, two streams near mine development and operations. The aquatic biomonitoring includes sampling of three levels of aquatic productivity, reporting of results, and analysis for trends so that stream health can be determined.
Hawk Inlet Monitoring Program Annual Report	APDES AK0043206	The Hawk Inlet monitoring program documents the water quality, sediment and biological conditions in receiving waters and marine environments that may be impacted by the mine's operations.
Best Management Practices (BMP)and Stormwater Monitoring Report	APDES AK0043206	Summarizes the scope and dates of the comprehensive site compliance inspections/evaluations, major observations related to implementation of the Best Management Practices (BMP) Plan, corrective actions taken as a result of the inspections/evaluations, identification of potential incidents of noncompliance as they pertain to the BMP Plan, description of the quantity and quality of the stormwater discharged, and BMP Plan modifications made during the year
Hawk Inlet Owner Requested Limit (ORL) Annual Report	ADEC AQ0853ORL02	Reporting on emissions for Hawk Inlet area generators and camp incinerator
Greens Creek Flow and Withdrawal Report	ADNR LAS 11807	Daily Greens Creek flow and the mine's withdrawal

Report Title	Permit	Subjects Covered
Facility Operating Report	ADEC AQ302TVP03	Emission report and description of permit condition requirements satisfied
Fiscal Year Emissions Estimates	AQ302TVP03	Estimated air emission for subsequent fiscal year for billing purposes
Toxic Release Inventory		As per EPA requirements

20.3 Monitoring Activities

20.3.1 Integrated Monitoring Plan

Compliance monitoring is undertaken to verify that the project operates within permit limitations thereby minimizing impact to the environment during operations and post closure. The objective of the Integrated Monitoring Plan (IMP) is to provide mine operations and state and federal regulators with a clear and concise plan that lists monitoring and sampling criteria for surface and ground water quality, geochemical characterization of materials, geotechnical stability of structures, and aquatic biological resources present at the site. The relevant historical and procedural information important to the development and implementation of this monitoring plan for sample collection/analysis, data analysis, and reporting are contained in the IMP.

Monitoring activities outlined in this plan include surface, ground, and process water monitoring, geochemical characterization of tailings, waste rock, and construction rock, geotechnical monitoring of Site 23 and the tailings disposal facility (TDF) Pond 7/10, and biological monitoring of activities during operations and closure.

In general, monitoring will be similar during operations and closure, with monitoring decreasing as reclamation activities are completed and performance goals are met. Long-term water treatment may be required for some components of the contact water through active water treatment facilities. The water treatment plant (WTP) has the capacity to treat approximately 2,500 gpm and has adequate capacity to efficiently treat identified sources from the mine drainage, and seepage from the TDF at closure.

20.4 Environmental Issues

Greens Creek mines mineralized material made up of massive sulfides in a temperate rainforest environment. Proper management of the waste materials from the mining process is of primary importance due to potential acid rock drainage (ARD) and metals leaching considerations. Regulatory oversight is rigorous, and the relationship between the agencies and the mine is transparent. Waste materials are regulated under the State's Waste Management Permit, which involves provisions for building contained waste storage facilities, diverting water from the facilities, and capturing and treating all water that contacts the waste.

During operation of the Greens Creek Mine, water collected from the underground workings, seepage collected beneath waste rock facility (Site 23) and the TDF, and stormwater run-off from the waste rock facility (Site 23/D), the mill area and the TDF are collected and treated. The contact water is collected and treated prior to discharge under an APDES permit.

20.5 Closure Plan

Hecla has prepared a reclamation and closure plan to address interim, concurrent, final reclamation and post-mining land use of the Greens Creek Mine. The reclamation and closure plan and closure cost estimates are submitted to the USFS as required under 36 CFR 228.1 et. seq. and 36 CFR 228A (Training Guide for Reclamation Bond Estimation and Administration 2004). Concurrently, the reclamation and closure plan and cost estimate are submitted to ADNR and ADEC in accordance with AS 27.19.010 et. seq., 11 AAC 97.100 et. seq., AS 46.03.010 et. seq., and 18 AAC 60.25 et seq.

The reclamation and closure plan sets performance goals applicable to interim, concurrent, and final reclamation, and addresses post-closure monitoring requirements. It also sets scheduling and other standards for reclamation and for final closure planning requirements, and it explains how detailed, regularly-updated reclamation task planning will be used for purposes of calculating a reclamation bond. Reclamation practices will utilize best practicable established and accepted technologies and methodologies suitable for the southeast Alaska environment.

Hecla will reclaim exploration, development, mining and process-related disturbances at the Greens Creek Mine in a manner compatible with the final land use selected and applicable regulations. The final land use likely will be limited primarily to Admiralty Island National Monument-related activities, and therefore returning the surface to a near-natural condition will satisfy post-mining land use needs. Private lands will retain their status after mining and were developed for non-Monument uses prior to creation of the Admiralty Island National Monument. After closure, Hecla will consult with the ultimate landowners, as well as any agencies having regulatory authority over reclamation of such lands, to determine the final disposition of structures and facilities. The estimated cost of reclamation and closure, net of salvage, at the end of mine life, is $89.9 million.

Hecla plans to phase out collection and conventional treatment of surface stormwater (contact water) from some of these sources as areas are reclaimed, the engineered cover is constructed on the TDF, vegetation established, and water monitoring demonstrates the applicable AWQS are met. Long-term water treatment may be required for some components of the contact water through active water treatment facilities. The WTP has the capacity to treat approximately 2,500 gpm and has adequate capacity to efficiently treat identified sources.

20.6 Permitting

The land comprising the Greens Creek Mine, inclusive of all Admiralty Island facilities, consists of both publicly and privately-owned uplands and tidelands. Greens Creek leases parcels from the United States on both the Monument and non-monument lands. Hecla uses other public lands pursuant to special use permits issued by the USFS and leases issued by the State of Alaska. It owns land on Admiralty Island both as a result of patenting mining and mill site claims and through transfer of private lands in the historic cannery area from its predecessor. Additionally, Greens Creek holds subsurface and restricted surface use rights to approximately 7,301 acres (2,955 ha) of public lands as a result of the Land Exchange made pursuant to the Greens Creek Land Exchange Act of 1995 (Pub. L. 104-123 April 1, 1996).

Under the Land Exchange agreement, certain private lands (e.g. patented claims) owned by Hecla ultimately will be transferred to the United States, and the 7,301 acres (2,955 ha) of subsurface and restricted-use surface lands patented to Greens Creek in 1999 will revert to the United States. The Land Exchange agreement does not impose special reclamation requirements on these lands. It requires that they must be reclaimed in accordance with applicable laws and the approved reclamation plan. Surety bonds are in place for reclamation and closure, which satisfy permit requirements. A list of the current permits in place is included in Table 20-2.

Table 20-2: Current Project Permits/Approvals

Agency	Description	Number	Issue Date	Category
ADEC/EPA	APDES/NPDES Permit Name Change Renewal Request	AK-004320-6	05/20/05; Effective 07/01/05 Renewal 10/01/15-09/30/20	WATER
ADEC	401 certification for NPDES permit	For AK-004320-6	3/31/2005	WATER
ADEC	401 certification for 404 permit	For 404 permit	6/20/2014	WATER
ADEC	Health Permit Cannery Camp - (Food Service)	113010178	01/2018	FACILITIES
ADEC	Waste Management Permit	2014DB0003 [Replaces 0211-BA001]	8/11/2014 – 8/10/2019	WASTE
ADEC	Title V Air Quality Operating Permit	AQ0302TVP03 (replaces AQ302TVP02 Revision 1)	07/01/08 (orig.) Revised 07/13/2016 – 6/16/2021	AIR
ADEC	Owner Requested Limit (ORL) Air Quality Operating Permit	0853ORL02	3/11/10	AIR
ADEC	Cooperative Service Agreement	Letter of Agreement	04/27/09	OTHER
ADEC SPAR	Underground Secondary Containment Agreement	Letter of Agreement	12/30/08	SPILL
ADEC	Corrosion Control Addition Approval	Plan Rev #4874; PWSID #113560	11/19/09	WATER
ADEC	Drinking Water System Classification Letter	PWSID #113560	3/7/2017	WATER
ADEC	Drinking Water System Classification Letter	PWSID #119205	3/7/2017	WATER

Agency	Description	Number	Issue Date	Category
ADEC	Waiver Asbestos Monitoring Affidavit	PWSID #113560	12/28/2001	WATER
ADEC	Waiver Asbestos Monitoring Affidavit	PWSID #119205	12/28/2001	WATER
ADEC	Waiver SOC & OOC Monitoring; PMP Certification	PWSID# 113560	01/01/11; 06/03/15; 10/30/18	WATER
ADEC	Waiver SOC & OOC Monitoring; PMP Certification	PWSID# 119205	01/01/11; 06/03/15; 10/30/18	WATER
ADNR	Certificate of Approval to Operate a Dam – Pond 7	AK00307 FY2018-18-AK00316	4/19/2018	FACILITIES
ADNR	Hazard Potential Classification and Jurisdictional Review Pond 10	NID ID# AK00316	2/2/2018	FACILITIES
ADNR	Hazard Potential Classification and Jurisdictional Review Pond 23		2/2/2018	FACILITIES
ADNR	Hazard Potential Classification and Jurisdictional Review A Pond		2/2/2018	FACILITIES
ADNR	Hazard Potential Classification and Jurisdictional Review C Pond		2/2/2018	FACILITIES
ADNR	Hazard Potential Classification and Jurisdictional Review D Pond		2/2/2018	FACILITIES
ADNR	Hazard Potential Classification and Jurisdictional Review Sand Pit	NID ID# AK00317	2/2/2018	FACILITIES
ADNR	Certificate of Approval to Modify a Dam	FY2019-11-AK00317	9/6/2018	FACILITIES
ADNR	Certificate of Approval to Operate a Dam	FY2019-12-AK00317	9/17/2018	FACILITIES
ADNR	Right of Way Permit (Marine Outfall to Hawk Inlet)	ADL 105124 Amendment 2	07/01/91 Amended 05/01/08 for name change; 7/2016: renewed for 25 years	LAND
ADNR	Tideland Lease (Young Bay Dock)	ADL 106488; Amendment 1	01/25/00 05/01/08	LAND

Agency	Description	Number	Issue Date	Category
		Amendment 2	04/28/2015	
ADNR	Tideland Permit (Mooring Buoy in Hawk Inlet)	LAS 19928	10/6/2015	LAND
ADNR	Water Right # 656 (Cannery Creek - 17,000 Gal/Day - Public Supply) Name Change	ADL 43347	10/06/86	WATER
ADNR	Temporary Water Use Permit (Cannery Creek 103,400 gal/day)	TWUP J2000-10	10/6/00	WATER
ADNR	Water Use Permit (700 gal/min-Greens Creek-for milling purposes) Name Change	LAS 11807	10/05/88	WATER
ADNR	Water Use Permit (5 dewatering wells within mill site complex, 10 gpm limit) Name Change	LAS 11808	10/05/88	WATER
ADNR	Temporary Water Use Authorization - 109	TWUA F2015-109	2/23/2016	WATER
ADNR	Temporary Water Use Authorization - 110	TWUA F2015-110	2/23/2016	WATER
ADNR	Temporary Water Use Authorization - 111	TWUA F2015-111	2/23/2016	WATER
ADNR	Temporary Water Use Authorization - 112	TWUA F2015-112	2/23/2016	WATER
ADNR	Temporary Water Use Authorization - 113	TWUA F2015-113	2/23/2016	WATER
ADNR	Temporary Water Use Authorization - 114	TWUA F2015-114	2/23/2016	WATER
ADF&G	Fish Habitat Permit	FH-08-III-0210	07/15/08	WILDLIFE
ADF&G	Fish Habitat Permit	FH14-I-0040	6/20/14	WILDLIFE
ADF&G	Culvert 1 – Stream No. 111-41-10190	FH14-I-0109	04/27/15 (does not expire)	WILDLIFE
ADF&G	Culvert 2 – Drainage to Fowler Creek	FH14-I-0110	04/27/15 (does not expire)	WILDLIFE
ADF&G	Culvert 3 – Drainage to Fowler Creek	FH14-I-0111	04/27/15 (does not expire)	WILDLIFE
ADF&G	Water Withdrawal Point 1 – Zinc Creek	FH15-I-0024	04/27/15 (does not expire)	WILDLIFE
ADF&G	Water Withdrawal Point 2 – Little Sore Creek	FH15-I-0025	04/27/15 (does not expire)	WILDLIFE
ADF&G	Water Withdrawal Point 3 – Little Sore Creek	FH15-I-0026	04/27/15 (does not expire)	WILDLIFE
ADF&G	Plywood flume for stream gauge – Tributary Creek	FH15-I-0133	08/18/15 (does not expire)	WILDLIFE

Agency	Description	Number	Issue Date	Category
ADF&G	Water Withdrawal Point	FH18-I-0128	9/7/2018	WILDLIFE
ADOR (AK Dept. Of Revenue)	Mining License	APMA Ref # J55571 License No 99475	5/1/2018	LAND
CBJ	Large Mine Permit	M-02-95	Summary approval granted 8/12/14	LAND
EPA / USCG	Facility Response Plan	EPA #FRPAKA0096 USCG GPO Append 9	Reviewed and accepted by USCG 9/3/2014	SPILL
EPA	Underground Injection Well Class V (Tailings Materials to Active Stope Areas)		Notification sent 09/03/98	WASTE
EPA	Underground Injection Well Class V (#33 Decline in Mine/Mill used for temporary storage of approximately one million gallons of water)		Notification sent 11/16/94	WASTE
EPA	Underground Injection Well Class V (Stope 21AS in Section 21, Zone 8 of the mine used to permanently store sludge and sediment)		Notification sent 11/16/94	WASTE
EPA	Underground Injection Well Class V (380 cy of settleable solids and water stored temporarily in stope off the 33 Cross Cut)		Notification sent 11/21/94	WASTE
FAA	Landing Facility Location Identifier (Hawk Inlet Federal Aviation Administration)	HWI Private Airport	09/06/01	TRANSPORTATION
FCC	Radio Station Authorization (FCC Registration Number (FRN) 0008396178)	WNMG649	10/4/14	OTHER
FCC	Radio Station Authorization	WPLY665	06/05/13	OTHER
FCC	Radio Station Authorization	WPMJ594	12/05/13	OTHER

Agency	Description	Number	Issue Date	Category
FCC	Radio Station Authorization	WQBL479	10/10/14	OTHER
FCC	Radio Station Authorization	WRV305	06/05/14	OTHER
Multi-Agency	Memorandum of Understanding (USFS, ADEC, ADNR MOU for single bond)	Reclamation Bond	2014 Amended 06/08/09 for name change	OTHER
NRC	Radioactive Material License (Radioactive materials license (Fixed & mobile))	50-23276-01 Amendment 17	5/22/2018	OTHER
USCOE	Tailings Expansion October 31, 2019	POA-1988-269-M7	01/06/15	FACILITIES
USCG	Certificate of Adequacy Waiver (Waiver to the Oil & Garbage requirements of 30 CFR 158.150)	16450	01/27/92	TRANSPORTATION
USCG	Certificate of Documentation (UMTB 165 Replacement Young Bay Breakwater (in Juneau)	642888	8/24/2017	TRANSPORTATION
USDJ	ATF Explosives Permit	9-AK-110-33-8G-91620		OTHER
USDOT	Hazardous Materials Certificate of Registration	050615 551 053XZ for registration years 2018-2021	7/1/2018 – 6/30/2021	TRANSPORTATION
USFS	Lease-Mine Portal/Mill Site (61.19 acres)	4050-03 Amendment 6	Original 08/12/86; Amend 6 issued 04/27/94	LAND
USFS	Lease for Milling - 1350 Portal and Campsite (9.82 acres)	4050-09	12/31/86	LAND
USFS	Communications Site (microwave tower) Special Use Permit (0.18 acres) Amendment 2	ADM113 (renum.4050-11); Amendment 2 name change ADM227	06/15/09	LAND/COMM
USFS	Special Use Permit-Road (146 acres) Amendment 1	ADM4050-02; ADM228	12/31/97; 06/15/09	LAND
USFS	Waste Area E (10.8 acres) Amendment 3	4050-08; Amendment 1; Amendment 2; Amendment 3 number changed to ADM229	10/27/87; 11/23/87; 01/24/01; 06/15/09	LAND
USFS	Lease for Mining (123 acres) Tailings & Pipeline – Stage II Expansion Amendment 2	ADM 4050-10 Amendment 1: Amendment 2 number changed to ADM230	09/01/88; 04/05/04; 06/15/09	LAND

Agency	Description	Number	Issue Date	Category
USFS	Decision Notice – Approval of Surface Exploration EA 2017	Decision Notice	4/14/2017	LAND/ EXPLORATION
USFS	GPO Appendices Appendix 1 Appendix 2 Appendix 3 Appendix 4 Appendix 5 Appendix 6 Appendix 7 Appendix 8 Appendix 9 Appendix 10 Appendix 11 Appendix 12 Appendix 13 Appendix 14 Appendix 15	GPOs	 11/1/2014 5/1/2002 8/1/2017 8/1/1995 3/1/2016 6/1/2016 8/1/2014 1/1/1999 3/1/2014 2/1/2013 11/1/2014 6/1/2016 12/1/2005 7/1/2016 11/1/2014	
Other	Joint Venture Agreement-Hawk Inlet Warranty Deed		01/10/78 Effective 09/30/84	

20.7 Considerations of Social and Community Impacts

Hecla conducts a community relations program with the communities and stakeholders potentially impacted by the project. This includes, in conjunction with external consultants as required, monitoring socio-economic trends, community perceptions and impacts. The involvement of third-party professional assistance for consultation provides an independent view for the stakeholders.

Hecla executes the charitable contribution aspects of the community relations plan in great part through the Hecla Charitable Foundation and encourages employee membership in civic and business-related groups and conducts research on surrounding community attitudes toward the Greens Creek Mine by utilizing internal and external resources.

20.8 Comments on Environmental Studies, Permitting, and Community Impact

In the opinion of the QP:

- Hecla has sufficiently addressed the environmental impact of the operation, and subsequent closure and remediation requirements that Mineral Resources and Mineral Reserves can be declared, and that the mine plan is appropriate and achievable. Closure provisions are appropriately considered. Monitoring programs are in place.
- Hecla has developed a communities' relations plan to identify and ensure an understanding of the needs of the surrounding communities and to determine

appropriate programs for filling those needs. The company appropriately monitors socio-economic trends, community perceptions and mining impacts.

- Permits held by Hecla for the Project are sufficient to ensure that mining activities are conducted within the regulatory framework required by Alaskan State and Federal regulations. Work is ongoing regarding modifications to the TDF Plan of Operations to accommodate tailings beyond the current Greens Creek mineral reserve life.
- Exploration permits are dependent on USFS annual review. For the past 10 years, Hecla has received the appropriate permits, and expects this to continue.
- There are no currently known environmental, permitting, or social/community risks to the Mineral Resources or Mineral Reserves.

21.0 CAPITAL AND OPERATING COSTS

21.1 Capital Cost Estimates

21.1.1 Basis of Estimate

Total LOM remaining undiscounted capital costs are estimated at $256.0 million in 2019 US dollars. Future capital costs are estimated based on expected sustaining capital requirements of the mine. Development costs are estimated based on past experience and are adjusted for any future anticipated changes in factors which would affect cost and amount of development. The timing of equipment replacement and rebuilds are based on replacement and rebuild schedules, and the anticipated cost is based on actual experience. In the later years of the LOM, costs are estimated for equipment required to sustain production.

21.1.2 Mine Capital Costs

Mine capital costs consist predominantly of replacement of equipment and major equipment rebuilds to sustain production through LOM, as well as anticipated underground development and capitalized drilling and infrastructure needs.

Capital development costs have been estimated based on the expected amount of development in each year and the anticipated costs of development. This is derived from past experience with updates to the cost based on projected changes in items that would affect costs. Total LOM mine development is estimated at $98.1 million.

Included within the mine capital cost estimate is provision for mine rehabilitation; these costs are primarily ground support and labor costs, which are estimated based on expected rehabilitation activities to be performed in specific years.

Capitalized drilling expenditures are estimated based on the anticipated amount of drilling in a specific year and an expected cost for the drilling program for each specific year. Total LOM capitalized drilling costs are projected to be $26.6 million.

21.1.3 Process Capital Costs

Process capital costs are estimated based on specific projects which are anticipated to be undertaken. In these cases, cost estimates are provided by project management, and long-term capital is anticipated based on prior experience regarding the amount of sustaining capital which is expected for the mill to maintain anticipated production levels.

Specific projects which are expected to be completed include:

- On-stream analyzer replacement ($0.3 million)
- Replacement of the zinc side bulk cells ($0.2 million)
- Tailings press rebuild ($0.2 million)
- Tailings thickener center well ($0.2 million)

21.1.4 Infrastructure Capital Costs

Various surface infrastructure and environmental capital costs are anticipated to maintain operation of the mine and are detailed in Table 21-1.

Major projects allocations include:

- Dry stack tailings project engineering to accommodate material beyond the current LOM ($8.2 million).
- Outfall capacity improvements ($6.0 million)
- Bridge upgrades ($5.0 million)
- Tailings pile cover ($4.0 million)

21.1.5 General and Administrative Capital Costs

General and administrative (G&A) capital costs are anticipated to be $1.3 million over the LOM, and the estimate is primarily composed of sustaining capital items.

21.1.6 Owner (Corporate) Capital Costs

Owner's costs are included in the estimate of certain construction and development costs; these are primarily composed of labor; however, other costs are included such as internally-procured supplies, fuel and electricity.

21.1.7 Sustaining Capital

Included within each department above are costs related to other sustaining capital which is an estimate made for items not specifically planned. However, it is expected that capital costs will be incurred to maintain anticipated production levels. The LOM sustaining capital estimate, included in total capital in Table 21-1, totals $79.8 million.

21.1.8 Contingency

Contingency is added to the planned capital estimates. Contingency percentages typically applied range from 5% to 30% based on the characteristics of the underlying work program.

21.1.9 Capital Cost Summary

Capital costs over the LOM total $256.0 million. The LOM capital cost estimate is summarized in Table 21-1.

Table 21-1: Capital Cost Estimate (Figures in $000s)

Item	5 Year (2019- 2023) Annual Avg.	LOM Total (2019-2030)
Mine Mobile Equipment	6,650	46,251
Other Mine Equipment	717	4,887
Total Mine	7,368	51,138
Process/Mill	1,621	12,353
Surface Infrastructure - Amortizable Assets	5,080	41,602
Surface Infrastructure - Other Assets	1,532	7,662
Surface Mobile Equipment	2,133	15,917
Environmental	160	1,450
Administration	160	1,250
Surface, Environmental and Administration	*9,065*	*67,881*
Capital Excluding Mine Development, Rehab and Development	*18,053*	*131,372*
Capitalized Mine Development and Rehabilitation Costs	12,126	98,121
Capitalized Definition Drilling Costs	5,315	26,573
Total Capital Costs	***35,495***	***256,066***

Totals may not agree due to rounding.

21.2 Operating Cost Estimates

21.2.1 Basis of Estimate

Total LOM operating costs are anticipated to be $165.39/ton ($182.32/tonne) milled. The operating costs included in the LOM are derived from the 2019 budget for the near-term and adjusted for factors regarding expected cost changes in the later years. The budget is built using various cost inputs including operating experience, quotes from various service providers, anticipated personnel changes, and changes in production.

Fuel and power costs are variable by year, averaging about 6% and 10%, respectively, of total production costs in 2018, but ranged from 3 to 10% each in the last five years. A key driver of the cost fluctuation is the unpredictable availability of less expensive hydroelectric power to the site. When precipitation in southeastern Alaska is low, and hydroelectric power is unavailable or reduced, the mine must generate electricity on-site using diesel generators.

21.2.2 Mine Operating Costs

The LOM mining cost per ton is anticipated to be $73.81/ton ($81.37/tonne) milled. These costs include expected direct cost for the mining process (drilling, blasting, mucking, hauling) such as labor, ground support, explosives, and diesel fuel. Diesel fuel was estimated at $2.70/gallon ($0.71/liter) in the LOM; however, fluctuations in the price of diesel fuel will affect operating costs.

In addition, mining costs include production drilling costs, ore access development costs, backfill, equipment and electrical maintenance, underground service crews and mine management and technical service costs.

21.2.3 Process Operating Costs

LOM milling cost per ton is anticipated to be $34.18/ton ($37.68/tonne) milled. These costs include labor, maintenance, reagents, grinding media, and electricity. Mill consumables and electricity were estimated based on an expected usage rate per ton milled; other costs such as labor were estimated as fixed costs.

Power is both purchased from the local utility company at a rate of approximately $0.13 per kWh and generated on site for an expected LOM rate of $0.39 per kWh. The LOM plan estimates purchasing 749 million kWh of power from the locally utility and generating 107 million kWh on site.

21.2.4 Infrastructure Operating Costs

Surface infrastructure costs are estimated at $25.31/ton ($27.90/tonne) milled. These costs primarily consist of labor, surface maintenance costs, fuel, and power usage. Activities included in these costs include concentrate and tailings haulage, road maintenance, tailings placement, buildings maintenance, concentrate ship loading, freight haulage and water treatment operations.

21.2.5 General and Administrative Operating Costs

G&A operating costs are estimated to be $32.09/ton ($35.37/tonne) milled over the LOM. This includes $3.25/ton ($3.58/tonne) milled for the environmental department operating costs. These costs mainly consist of labor for accounting, human resources, purchasing, health and safety, management, various insurance costs, property taxes, communications and IT services. In addition to these costs, G&A costs include costs for providing camp facilities and transportation services for the Greens Creek workforce.

21.2.6 Owner (Corporate) Operating Costs

Included within the G&A costs are Owner management costs paid to the corporate entity.

21.2.7 Operating Cost Summary

Operating costs total $1.5 billion, or $165.39/ton ($182.32/tonne) milled. The LOM operating cost estimate is summarized in Table 21-2.

Table 21-2: LOM Operating Cost Estimate

Item	5 Year (2019-2023) Annual Avg.	Total LOM (2019-2030)
Mine	61,318	684,809
Process	28,615	317,116
Surface Operations	20,858	234,850
Environmental	2,730	30,165
Administration	24,140	267,505
Total Production Costs	*137,661*	*1,534,445*
Tons of Ore Milled	839,952	9,277,510
Mine	73.00	73.81
Process	34.07	34.18
Surface Operations	24.83	25.31
Environmental	3.25	3.25
Administration	28.74	28.83
Total Cost per Ton Milled	***163.89***	***165.39***
Tonnes of Ore Milled	761,992	8,416,415
Mine	80.47	81.37
Process	37.55	37.68
Surface Operations	27.37	27.90
Environmental	3.58	3.58
	5 Year (2019-2023) Annual Avg.	**Total LOM (2019-2030)**
Administration	31.68	31.78
Total Cost per Tonne	**180.66**	**182.32**

21.3 Comments on Capital and Operating Costs

The QP has reviewed the capital and operating cost provisions for the LOM plan that supports Mineral Reserves and considers the basis for the estimates, including mine budget data, vendor quotes, and operating experience, to be appropriate to the known mineralization, mining and production schedules, marketing plans, equipment replacement, and maintenance requirements. Appropriate provision has been made in the estimates for the expected mine operating usages including labor, fuel, power, closure, and environmental considerations. Capital cost estimates include appropriate Owner, sustaining and contingency estimates.

22.0 ECONOMIC ANALYSIS

22.1 Methodology Used

The results of the economic analysis to support Mineral Reserves represent forward-looking information that is subject to a number of known and unknown risks, uncertainties, and other factors that may cause actual results to differ materially from those presented here.

Forward-looking statements in this Report include, but are not limited to, statements with respect to future metals prices and concentrate sales contracts, the estimation of Mineral Reserves and Mineral Resources, the realization of Mineral Reserve estimates, the timing and amount of estimated future production, costs of production, capital expenditures, costs and timing of the development of new mineral zones, permitting time lines, requirements for additional capital, government regulation of mining operations, environmental risks, unanticipated reclamation expenses, title disputes or claims, and limitations on insurance coverage.

Additional risk can come from: actual results of current reclamation activities; conclusions of economic evaluations; changes in Project parameters as mine and process plans continue to be refined; possible variations in mineral reserves, grade or recovery rates; geotechnical considerations during mining; failure of plant, equipment or processes to operate as anticipated; shipping delays and regulations; accidents, labor disputes, and other risks of the mining industry; and delays in obtaining governmental approvals.

22.1.1 Basis of Economic Analysis

To support declaration of Mineral Reserves, Hecla completed an economic analysis which confirmed positive economics based on the Mineral Reserves using mineral reserve price assumptions.

The Project was further evaluated at a base case scenario using a 5% discount rate, and all costs prior to 31 December 2018 were treated as sunk costs. The base case metals prices used in this evaluation were:

- Gold: $1,303.70/oz;
- Silver: $15.32/oz;
- Lead: $0.91/lb;
- Zinc: $1.30/lb.

As of the filing date of this report, these prices represented applicable current prices.

Results of this assessment indicated positive Project economics until the end of mine life. This analysis resulted in total gross revenue of $3.2 billion, $474 million in treatment and freight charges, $1.5 billion in production/operating costs, a LOM net cash flow, before taxes, of $828.8 million, and a 5% discounted pre-tax net cash flow of $658.8 million; the post-tax discounted (5%) net cash flow is $638.3 million.

Throughout the LOM (2019 to 2030), 9.28 million tons of ore will be processed at the mill. The average LOM mill grades for zinc and lead are 7.62% and 2.84%, respectively, resulting in 1.25 billion pounds of recovered zinc and 427.17 million pounds of recovered lead. Silver production is estimated at 83.69 million ounces and gold production is estimated at 542,400 ounces (Table 22-1).

Table 22-1: Life of Mine Cash Flow

	Unit	Five Year Annual Average (2019-2023)	Life of Mine (2019-2030)
PRODUCTION:			
Tons Milled	Tons	840,000	9,280,000
Zinc Grade	%	7.71	7.62
Lead Grade	%	3.06	2.84
Silver Grade	OPT	12.70	11.54
Gold Grade	OPT	0.090	0.091
Avg. Zinc Metallurgical Recovery	%	88.82	88.51
Avg. Lead Metallurgical Recovery	%	81.85	81.20
Avg. Silver Metallurgical Recovery	%	79.10	78.17
Avg. Gold Metallurgical Recovery	%	65.98	64.55
Recovered Zinc	Pounds	115,008,000	1,250,872,000
Recovered Lead	Pounds	42,057,000	427,165,000
Recovered Silver	Ounces	8,437,700	83,694,800
Recovered Gold	Ounces	49,700	542,400
REVENUE:			
GROSS REVENUE	US $000s	307,399	3,224,831
Smelting and Refining Costs	US $000s	27,840	368,666
Freight and Selling Expenses	US $000s	9,969	105,374
NET TOTAL REVENUE	**US $000s**	**269,590**	**2,750,791**

Operating and capital costs used for this assessment are shown in Table 22-2. The costs per unit are shown in Table 22-3.

Table 22-2: Operating and Capital Costs and Cash Flow for the Greens Creek Mine

	Five Year Annual Average (2019-2023)	Life of Mine (2019-2030)
OPERATING COSTS:	**In thousands of US dollars ($000s)**	
Mine	61,318	684,809
Mill	28,615	317,116
Surface Operations	20,858	234,850
Environmental	2,730	30,165
Administration	24,140	267,505
TOTAL OPERATING COSTS ($000s)	**137,661**	**1,534,445**
OPERATING CASH FLOW	**131,929**	**1,216,346**

	Five Year Annual Average (2019-2023)	Life of Mine (2019-2030)
CAPITAL COSTS:	**In thousands of US dollars ($000s)**	
Mine	7,368	51,138
Mill	1,621	12,353
Surface Infrastructure - Amortizable Assets	5,080	41,602
Surface Infrastructure - Other Assets	1,532	7,662
Surface Mobile Equipment	2,133	15,917
Environmental	160	1,450
Administration	160	1,250
Capitalized Mine Development and Rehab	12,126	98,121
Definition Drilling	5,315	26,573
TOTAL CAPITAL COSTS ($000s)	**35,495**	**256,066**
CASH FLOW BEFORE RECLAMATION AND OTHER COSTS	**96,434**	**960,280**
OTHER COSTS:		
RECLAMATION	135	92,763
ROYALTY	756	7,712
CAPITAL LEASE FINANCING	(1,992)	(9,990)
WORKING CAPITAL	(1,465)	(21,030)
TOTAL OTHER COSTS ($000s)	**4,348**	**131,495**
CUMULATIVE NET PRE-TAX CASH FLOW	**92,086**	**828,785**
Alaska Mining License Tax	2,670	26,680
Federal and State Income Taxes	-	-
CUMULATIVE NET AFTER-TAX CASH FLOW	**89,416**	**802,105**

Table 22-3: Greens Creek Mine Costs Per Unit

Cost per Unit	Unit	Cost
Operating	US$/Ton	165.39
Capital	US$/Ton	27.6
All-in Sustaining Cost	US$/Ton	192.99
Cash Cost*	US$/Oz Ag	0.37
Total Cost*	US$/Oz Ag	5.67

*Net of byproduct credits, includes royalties.

Mining companies doing business in Alaska are primarily subject to U.S. corporate income tax, Alaska State income tax and Alaska Mining License tax. The State of Alaska levies a mining license tax on mining net income received in connection with mining properties and activities in Alaska, at a rate of $4,000 plus 7% over $100,000. The effect of this tax is approximately $27 million undiscounted and $20.5 million discounted at 5% over the life of the mine.

The U.S. corporate and Alaska State income tax rates are 21% and a graduated rate from 0% to 9.4%, respectively, and are not included in the economic model. Income tax is typically not incorporated at the local level and is calculated for all the sites together; however, Hecla's U.S. consolidated group provides tax benefits as well as net operating losses that are expected to offset the project's taxable income in the foreseeable future.

22.1.2 Sensitivity Analysis

The Project's pre-tax cumulative cash flow undiscounted and discounted at five percent (NPV_5) from the model presented above were analyzed for sensitivity to variations in revenue, operating, and capital cost assumptions. Sensitivity analysis was performed on the base case net cash flow. Positive and negative variations were applied independently to each of the following parameters:

- Metal prices;
- Metal grades;
- Metal recoveries;
- Capital costs;
- Operating costs.

The results of the sensitivity analysis demonstrate that the Mineral Reserve estimates are most sensitive to variations in metals prices, less sensitive to changes in metals grades and recoveries, and least sensitive to fluctuations in operating and capital costs.

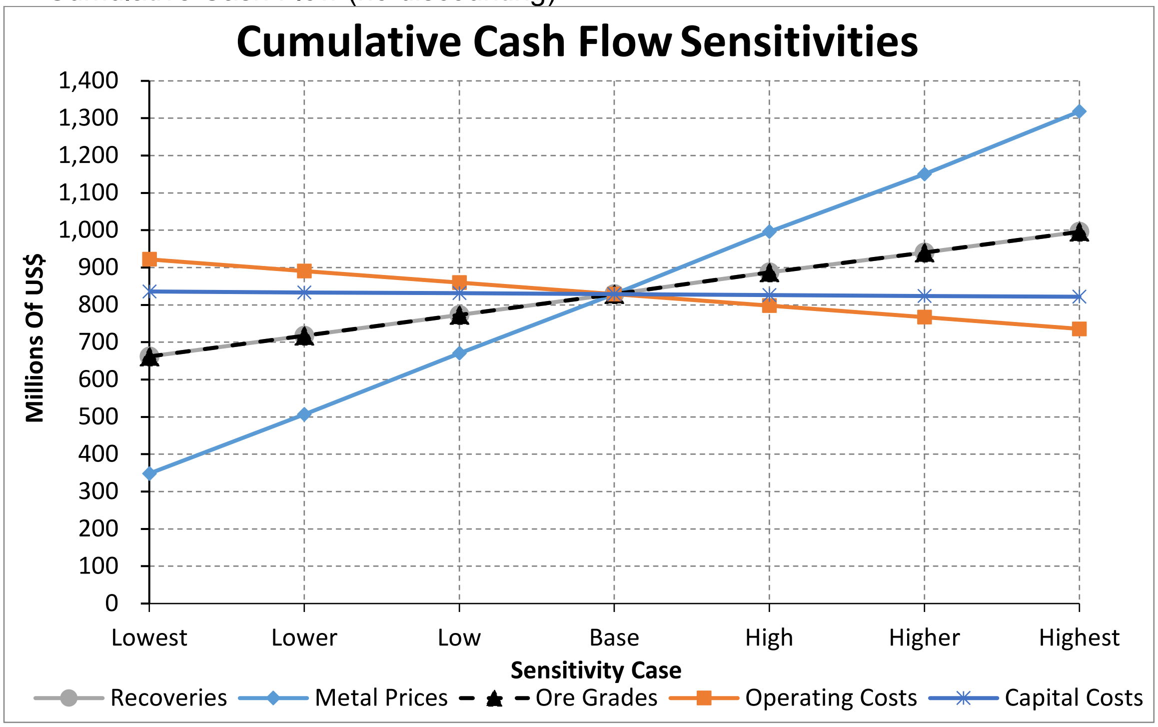
Table 22-4 shows the sensitivity cases analyzed, which are shown in the chart in Figure 22-1. Because of the Project's 30-year operating history, values for capital and operating costs, metals recoveries, and metal grades are well understood. Therefore, these parameters were flexed over a smaller range compared to metals prices, which are more volatile and were evaluated over a wider range of sensitivity.

Table 22-4: Sensitivity Analysis Cases

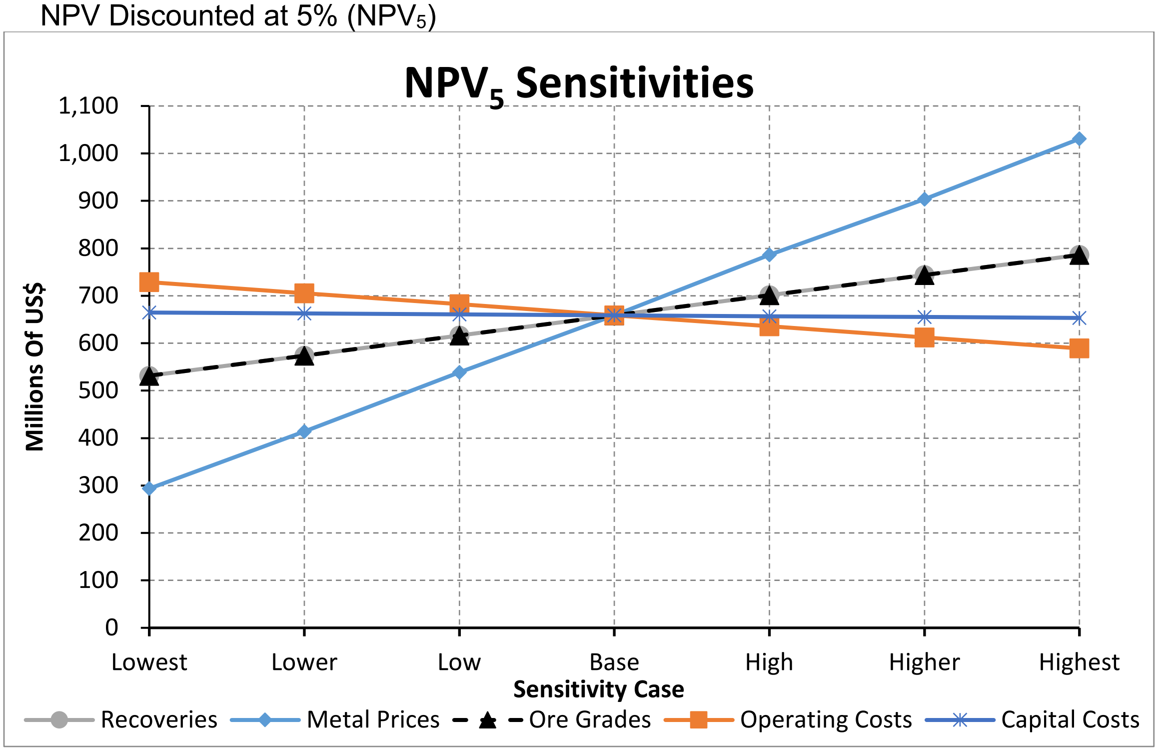
Parameter	Lowest Case	Lower Case	Low Case	Base Case	High Case	Higher Case	Highest Case
Metals Prices	-15%	-10%	-5%	-	5%	10%	15%
Ore Grades	-6%	-4%	-2%	-	2%	4%	6%
Recoveries	-6%	-4%	-2%	-	2%	4%	6%
Operating Costs	-6%	-4%	-2%	-	2%	4%	6%
Capital Costs	-6%	-4%	-2%	-	2%	4%	6%

Figure 22-1: LOM Economic Sensitivity Analysis

Cumulative Cash Flow (no discounting)



NPV Discounted at 5% (NPV_5)



The project is most sensitive to changes in the prices of metals, most significantly silver and zinc, with cash flows in the lowest scenario ($13.02 silver, $1,108 gold, $1.11 zinc, $0.77 lead) being $348.2 million on an undiscounted basis and cash flows in the highest scenario ($17.62 silver, $1,499 gold, $1.50 zinc, $1.05 lead) being $1.3 billion on an undiscounted basis.

22.2 Comments on Economic Analysis

The QP has reviewed the financial analysis and confirms that the Project has positive economics until the end of mine life, which supports Mineral Reserve declaration.

The QP notes the following:

- The grade of the Greens Creek mineral deposit is not uniform and has distinct higher- and lower-grade areas. This provides opportunities to defer the mining of lower-grade areas and prioritize production from higher-grade areas in the event of decreased metal prices or higher economic cutoff grade.
- There is upside for the Project if some or all of the Inferred Mineral Resources estimated for the Project can be upgraded to higher confidence Mineral Resource categories.

23.0 ADJACENT PROPERTIES

There are no adjacent properties that are relevant to the Report.

24.0 OTHER RELEVANT DATA AND INFORMATION

There are no additional data that are relevant to this Report.

25.0 INTERPRETATION AND CONCLUSIONS

In the opinion of the QPs, the Greens Creek Mine is a long-established operation with a clear understanding of the mining, metallurgical, and infrastructural requirements to successfully extract the Greens Creek mineral deposits. Mining and milling operations are performing as expected, and reconciliation between mine production and the Mineral Resource model is acceptable. This indicates that the data supporting the Mineral Resource and Mineral Reserve estimates were appropriately collected, evaluated, and estimated.

Aside from those risks expressly stated in this and other sections of this report, the QPs are not aware of any other environmental, permitting, legal, title, taxation, socio-economic, marketing, political, mining, metallurgical, infrastructure, permitting, or other factors that could materially affect the Mineral Resources, Mineral Reserves, or LOM plan described in this report.

25.1 Risks

Factors that may materially affect the Mineral Resource estimate include:

- Metals price assumptions;
- Changes to design parameter assumptions that pertain to stope design;
- Changes to geotechnical, mining and metallurgical recovery assumptions;
- Changes to the assumptions used to generate the NSR cut-off;
- Changes in interpretations of mineralization geometry and continuity of mineralization zones;
- Changes to the assumptions related to mineral tenure rights and royalty assumptions associated with the Land Exchange properties.

Factors that may materially affect the Mineral Reserve estimate include:

- Metals price assumptions;
- Variations in short-term marketing and sales contracts;
- Changes to the mineral resource block model;
- Changes to the assumptions that go into defining the NSR cut-off;
- Assumptions relating to the geotechnical and hydrological parameters used in mine design;
- Metallurgical recovery factors: recoveries vary on a day to day basis depending on the grades and mineralization types being processed. These variations are expected to trend to the forecast LOM recovery value for monthly or longer reporting periods;
- Variations to the permitting, operating, or social license regime.

Additional risks which may affect the life-of-mine plan, production schedule, or economic results are shown in Table 25-1.

Table 25-1: Possible Risks to the Green's Creek Project

Risk	Mitigation
Metals prices are volatile and inherently difficult to predict. Actual prices will differ to some extent from the forecasts used in this report. Smelter terms are volatile and may change substantially over time. Mining costs may be higher or lower than expected.	The grade of the Greens Creek mineral deposit is not uniform and has distinct higher- and lower-grade areas. This provides opportunities to defer the mining of lower-grade areas and prioritize production from higher-grade areas in the event of decreased metal prices or higher economic cutoff grade. Metal price assumptions used to evaluate Greens Creek mineral reserves and economics are conservative, utilizing a base case silver price significantly less than the three-year trailing average. Sensitivity analysis indicates that the mine plan maintains a positive NPV even with a 20% decrease in metal prices compared to the base case.
Ground support at Greens Creek experiences significant sulfide corrosion. Failure of ground support may result in temporary loss of access through travelways.	Most mining areas have several access options due to the presence of multiple parallel ramp systems. Greens Creek has an active and ongoing rebar rehab program which is upgrading existing ramps with LOM corrosion-resistant support. Areas which cannot be rehabbed with rebar (such as raises) are closely monitored.
Mine development may not meet targets due to equipment availability or other challenges	Nearly 80% of mineral reserves are located in proximity to existing haulage ramps, requiring only a short ore-access crosscut in order to be brought into production. Delays in advancement of haulage ramps can be mitigated by bringing this near-mine material into production, with a slight negative effect on grades.
Water inflows from development of certain shallower mineral reserves (Upper East Ore) could result in: • Mining difficulties/reduced rates • Need for additional underground and surface water handling infrastructure • Increased closure costs	A hydrological study is currently planned in order to define the nature and extent of the East Ore groundwater. This will inform the plan for prevention and mitigation, including possibly a campaign of pre-grouting. The proportion of mineral reserve which may be affected by this groundwater is very small (equivalent to 2.6% of overall mineral reserve)

25.2 Opportunities

Project opportunities include:

- Upside potential if some or all of the Inferred Mineral Resources estimated for the Project can be upgraded to higher confidence Mineral Resource categories and eventually to Mineral Reserves. Additional potential exists where existing Measured or Indicated Mineral Resource categories may be able to be upgraded to Mineral Reserves.
- Future exploration potential which, with appropriate drilling and mineral resource modelling, may result in additional Mineral Resources.
- Digitization and evaluation of historic face mapping and sampling data. A large amount of geological data from early in the Greens Creek Mine life exists only as archival hardcopy and is not included in current geological models. Incorporation of this data may result in better geological understanding and identification of opportunities for remnant mining, possibly leading to increased Mineral Reserves.
- Continued metallurgical testwork may show mineral treatment adjustments that could increase metal recoveries or create more attractive metal

concentrates to the target smelters. Improvements made in the processing plant could have a positive impact on costs and recovery, improving the mine's profitability.

- Further development and application of automated and tele-remote equipment may result in additional efficiencies, particularly the ability to continue work between shifts while the mine is cleared for blasting.

26.0 RECOMMENDATIONS

The QPs recommend that exploration, mining, engineering, and operations activities continue as planned.

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28.0 CERTIFICATES OF QUALIFIED PERSONS

Paul Jensen, CPG

To accompany the report entitled: Technical Report for the Greens Creek Mine, Juneau, Alaska, USA, dated effective December 31, 2018 (the Technical Report).

I, Mr. Paul W Jensen, CPG., residing in Juneau, Alaska, USA, do hereby certify that:

1) I am the Chief Geologist, for Hecla Greens Creek Mining Company;
2) I graduated with a B.Sc. in Science (Geology) from Utah State University in 1996, and a MSc in Economic Geology, from University of Arizona, 1998. I have practiced my profession continuously since 1997. I have worked at operating mines and exploration projects in Arizona, Idaho and Alaska. I have extensive experience with base and precious metal deposits;
3) I am a Certified Professional Geologist registered with the American Institute of Professional Geologists (AIPG), registration number 11258;
4) I have read the definition of "qualified person" set out in National Instrument 43-101 – Standards of Disclosure for Mineral Projects (NI 43-101) and certify that by virtue of my education, affiliation to a professional association and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101;
5) I have personally inspected the Greens Creek Mine, and continue to do so on an ongoing basis as a function of my normal duties with the company as Chief Geologist at the Greens Creek Mine;
6) I am an author of the Technical Report and responsible for Sections 4 through 10, 14, and Appendix B, of the Technical Report;
7) I am not independent of Hecla Mining Company as described in Section 1.5 of NI 43-101;
8) I have been employed by Hecla Greens Creek Mining Company since June 21, 2014;
9) I have read NI 43-101 and the Sections of the Technical Report for which I am responsible have been prepared in compliance with NI 43-101 and Form 43-101F1; and
10) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Sections of the Technical Report for which I am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Juneau, Alaska
April 1, 2019

(Signed & Sealed) "Paul W. Jensen"

Paul W. Jensen, CPG
Chief Geologist
Hecla Greens Creek Mining Company

Dr. Dean McDonald, P.Geo

To accompany the report entitled: Technical Report for the Greens Creek Mine, Juneau, Alaska, USA, dated effective December 31, 2018 (the Technical Report).

I, Dr. Dean W.A. McDonald, P.Geo, residing in Vancouver, British Columbia, Canada, do hereby certify that:

1) I am the Senior Vice President, Exploration for Hecla Mining Company, with an office at Suite 970, 800 West Pender Street, Vancouver, British Columbia, V6C 2V6 Canada;
2) I graduated with a B.Sc. in Science (Geology) from McMaster University in 1981, MSc in Science, from University of New Brunswick, 1984, PhD in Science (Mineral Deposits), from University of Western Ontario, 1990. I have practiced my profession continuously since 1981. I have worked at operating mines in Canada and worked on exploration and development programs in the U.S., Canada, Mexico, Australia, Argentina and Chile. I have extensive experience with base and precious metal deposits such as the Greens Creek;
3) I am a Professional Geologist registered with the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC), registration number 24217;
4) I have read the definition of "qualified person" set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* (NI 43-101) and certify that by virtue of my education, affiliation to a professional association and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101;
5) I have personally inspected the Greens Creek Mine and continue to do so on an ongoing basis as a function of my normal duties with the company.
6) I am not independent of Hecla Mining Company as independence is described by Section 1.5 of NI43-101;
7) I am an author of the Technical Report and responsible for Sections 1, 2, 3, 19, 23, 24, 25, 26, 27 and Appendices of the Technical Report;
8) I have been employed by Hecla since September 1, 2006 and have made regular site visits to Greens Creek since that time. I have been closely involved in the review of exploration programs, resource and reserve estimates and related external audits;
9) I have read NI 43-101 and the Sections of the Technical Report for which I am responsible have been prepared in compliance with NI 43-101 and Form 43-101F1; and
10) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Sections of the Technical Report for which I am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Vancouver, B.C. Canada
April 1, 2019

(Signed & Sealed) "Dean McDonald"
Dean McDonald, PhD, P.Geo
Senior Vice President
Hecla Mining Company

Kyle Mehalek, PE

To accompany the report entitled: Technical Report for the Greens Creek Mine, Juneau, Alaska, USA, dated effective December 31, 2018 (the Technical Report).

I, Kyle Mehalek, PE, residing in Juneau, Alaska, United States, do hereby certify that:

1) I am the Senior Mining Engineer, Mine Planning for Hecla Greens Creek Mining Company, with an office at the Greens Creek mine site on Admiralty Island, Alaska;
2) I graduated with a B.Sc. in Mining Engineering from the Colorado School of Mines (2009) and M.Sc. in Mining and Earth Systems Engineering from Colorado School of Mines (2010). I have practiced my profession continuously since 2010. I have worked at operating mines and development projects located in Alaska, Colorado and Arizona. I have extensive experience with base and precious metal deposits such as Greens Creek;
3) I am a Professional Engineer registered with the US state of Colorado, registration number 48235;
4) I have read the definition of "qualified person" set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* (NI 43-101) and certify that by virtue of my education, affiliation to a professional association and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101;
5) I have personally inspected the Greens Creek Mine and continue to do so on an ongoing basis as a function of my normal duties with the company.
6) I am not independent of Hecla Mining Company as independence is described in Section 1.5 of NI 43-101;
7) I am an author of the Technical Report and responsible for Sections 15, 16, 21, and 22 of the Technical Report;
8) I have been employed by Hecla at the Greens Creek mine site since May 30, 2017. I have been responsible for mine design, long-range planning, reserve determination and life-of-mine scheduling.
9) I have read NI 43-101 and the Sections of the Technical Report for which I am responsible have been prepared in compliance with NI 43-101 and Form 43-101F1; and
10) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Sections of the Technical Report for which I am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Juneau, Alaska, United States
April 1, 2019

(Signed & Sealed) "Kyle Mehalek"

Kyle Mehalek, PE
Senior Mining Engineer
Hecla Mining Company

Keith Blair, CPG

To accompany the report entitled: Technical Report for the Greens Creek Mine, Juneau, Alaska, USA, dated effective December 31, 2018 (the Technical Report).

I, Keith R. Blair, Certified Professional Geologist, residing in Spokane, Washington do hereby certify that:

1) I am currently employed as the Chief Resource Geologist for Hecla Limited, a wholly-owned subsidiary of Hecla Mining Company (the "Issuer"), with an office located at 6500 N. Mineral Drive, Suite 200, Coeur d'Alene, Idaho, 83815
2) I graduated from the Montana College of Mineral Science and Technology in MT, USA with a BSc in Geological Engineering in 1986. I graduated from of the University of Arizona in AZ, USA with a MSc in Geosciences in 1990. I have practiced my profession continuously since 1989 and have worked on mineral exploration and development programs in the U.S., Canada, Mexico, Bolivia, Chile, Ecuador, and Venezuela, on many different mineral deposit styles including deposits similar to Greens Creek;
3) I am a Certified Professional Geologist registered with the American Institute of Professional Geologists (AIPG) with certificate number 10744 and a Registered Member of The Society for Mining Metallurgy & Exploration (SME) with member number 274892;
4) I have read the definition of "qualified person" set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* (NI 43-101) and certify that by virtue of my education, affiliation to a professional association and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101;
5) I have visited the Greens Creek Mine many times and continue to do so on an ongoing basis as a function of my normal duties with the Issuer. I most recently visited the project office for 3 days from 14 to 16 November 2018;
6) I am not independent of Hecla Mining Company as independence is described in Section 1.5 of NI 43-101;
7) I am an author of the Technical Report and responsible for Sections 11 and 12 and contributed to section 14 of the Technical Report;
8) I have been employed by Hecla since April 1, 2013 and have made regular site visits to Greens Creek since that time. I have been closely involved in the review of exploration programs, mineral resource and reserve estimates and related external audits;
9) I have read NI 43-101 and the Sections of the Technical Report for which I am responsible have been prepared in compliance with NI 43-101 and Form 43-101F1; and
10) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Sections of the Technical Report for which I am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Coeur d'Alene, Idaho, U.S.A.
April 1, 2019

(Signed & Sealed) "Keith R. Blair"
Keith R. Blair, MSc, CPG
Chief Resource Geologist
Hecla Limited

Bill Hancock, SME RM

To accompany the report entitled: Technical Report for the Greens Creek Mine, Juneau, Alaska, USA, dated effective December 31, 2018 (the Technical Report).

I, Bill A. Hancock, SME RM, residing in Wilsonville, OR, do hereby certify that:

1) I am the Principal of Argo Consulting, LLC, with an office at 31196 SW Orchard Drive, Wilsonville, OR 97070.
2) I graduated with a B.Sc. in Mineral Engineering from the University of Minnesota in 1977. I have practiced my profession continuously since 1977 and have directly worked at operating mines in Michigan and Wyoming and at technical process focused suppliers to many mines in the Western USA. Since 2001, I have worked as a mineral processing consultant at many mines in the US, Canada, South America and Europe. I have broad experience with base and precious metal process operations such as Greens Creek;
3) I am a Qualified Professional with registrations with the Society of Mining Engineers (SME #1311450RM) and the Mining and Metallurgical Society of America (MMSA # 01177QP).
4) I have read the definition of "qualified person" set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* ("NI 43-101") and certify that by virtue of my education, affiliation to a professional association and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101;
5) I have conducted projects at Greens Creek beginning with operations training before mill start-up and thereafter on a periodic basis for companies and clients conducting metallurgical lab and plant tests and having on-site discussions with Hecla personnel assessing process responses and results and flowsheet performance. My last visit was March 14, 2019 specifically related to process and metallurgical review for this NI 43-101 report. I was the plant and metallurgy reviewer for the March 2013 Hecla Greens Creek NI 43-101.
6) I am a reviewer of the Technical Report and responsible for Sections 13 and 17 of the Technical Report;
7) I am independent of the Hecla Mining Company applying all of the tests in Section 1.5 of National Instrument 43-101;
9) I have read NI 43-101 and the Sections of the Technical Report for which I am responsible have been prepared in compliance with NI 43-101 and Form 43-101F1; and
10) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Sections of the Technical Report for which I am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Wilsonville, OR

(Signed & Sealed) "Bill A. Hancock"

April 1, 2019

Bill A. Hancock, RM
Principal

Argo Consulting, LLC

M. Dale Butikofer, PE

To accompany the report entitled: Technical Report for the Greens Creek Mine, Juneau, Alaska, USA, dated effective December 31, 2018 (the Technical Report).

I, Michael Dale Butikofer, PE, residing in Juneau, Alaska, USA, do hereby certify that:

1) I am the Senior Civil Engineer for Hecla Greens Creek Mining Company, with an office at Admiralty Island, Juneau, Alaska, USA and mailing address PO BOX 32199, Juneau, Alaska 99803, USA;
2) I graduated with a B.S. in Civil Engineering from Utah State University in 2003. I have practiced my profession continuously since 2003. I worked in design and construction of municipal water systems, streets, and other civil related projects from 2003 to 2010. I have worked at Greens Creek from 2010 to present with mine operations groups, contractors, and engineering consultants to operate, maintain, and improve surface infrastructure site wide including the Tailings Disposal Facility, site wide water systems, roads, and bridges. I have extensive experience in the field of civil engineering;
3) I am a Professional Engineer registered with the Alaska State Board of Registration for Architects, Engineers, and Land Surveyors (AELS), registration number 11995;
4) I have read the definition of "qualified person" set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* (NI 43-101) and certify that by virtue of my education, affiliation to a professional association and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101;
5) I have personally inspected the Greens Creek Mine and continue to do so on an ongoing basis as a function of my normal duties with the company.
6) I am not independent of Hecla Mining Company as independence is described by Section 1.5 of NI 43-101;
7) I am an author of the Technical Report and responsible for Section 18 of the Technical Report;
8) I have been employed by Hecla since June 14, 2010 and have worked at Greens Creek since that time. I have been closely involved in the day to day operations, maintenance, and several capital projects involving surface infrastructure at Greens Creek since that date;
9) I have read NI 43-101 and the Section of the Technical Report for which I am responsible has been prepared in compliance with NI 43-101 and Form 43-101F1; and
10) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Sections of the Technical Report for which I am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Juneau, AK, USA
April 1, 2019

(Signed & Sealed) "M. Dale Butikofer"
Michael Dale Butikofer, PE
Senior Civil Engineer
Hecla Greens Creek Mining Company

Paul Glader, PE

To accompany the report entitled: Technical Report for the Greens Creek Mine, Juneau, Alaska, USA, dated effective December 31, 2018 (the Technical Report).

I, Paul Glader, P.E., residing in Coeur d'Alene, Idaho, USA, do hereby certify that:

1) I am the Corporate Environmental Director for Hecla Limited, with an office at Suite 200, 6500 Mineral Drive, Coeur d'Alene, Idaho, 83814 USA;
2) I graduated with a B.Sc. in Mineral Engineering (Mining Engineering) from Institute of Technology, University of Minnesota in 1978, Master of Business Administration from University of Phoenix, 1990, Master of Environmental Science and Engineering from Colorado School of Mines, 1993. I have practiced my profession continuously since 1978. I have worked at exploration development and operating mines in the United States, Mexico, Canada, and Venezuela. I have experience with base and precious metal deposits such as Greens Creek;
3) I am a Professional Engineer registered with the State Board of Licensure for Architects, Professional Engineers and Professional Land Surveyors of Colorado, registration number PE 0029092;
4) I have read the definition of "qualified person" set out in National Instrument 43-101 – Standards of Disclosure for Mineral Projects (NI 43-101) and certify that by virtue of my education, affiliation to a professional association and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101;
5) I am not independent of Hecla Mining Company as independence is described by Section 1.5 of NI 43-101;
6) I have personally inspected the Greens Creek Mine most recently on April 18, 2018 and continue to do so on an ongoing basis as a function of my normal duties with the company;
7) I am an author of the Technical Report and responsible for Section 20 of the Technical Report;
8) I have been employed by Hecla since February 14, 2000 and have made regular site visits to Greens Creek since 2006. I am closely involved in the review of permitting, environmental compliance, reclamation and closure planning;
9) I have read NI 43-101 and the Section of the Technical Report for which I am responsible has been prepared in compliance with NI 43-101 and Form 43-101F1; and
10) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Section of the Technical Report for which I am responsible for contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Coeur d'Alene, Idaho USA
April 1, 2019

(Signed & Sealed) "Paul Glader"

Paul Glader, M.Sc., PE
Corporate Environmental Director
Hecla Limited

Appendix A: Glossary

Term	Definition
acid rock drainage/ acid mine drainage (ARD)	Characterized by low pH, high sulfate, and high iron and other metal species.
adit	A passageway or opening driven horizontally into the side of a hill generally for the purpose of exploring or otherwise opening a mineral deposit. An adit is open to the atmosphere at one end, a tunnel at both ends.
adjacent property	A property in which the issuer does not have an interest; has a boundary reasonably proximate to the property being reported on; and has geological characteristics similar to those of the property being reported on
advanced argillic alteration	Consists of kaolinite + quartz + hematite + limonite. Feldspars leached and altered to sericite. The presence of this assemblage suggests low pH (highly acidic) conditions. At higher temperatures, the mineral pyrophyllite (white mica) forms in place of kaolinite
advanced property	A means a property that has mineral reserves, or mineral resources the potential economic viability of which is supported by a preliminary economic assessment, a pre-feasibility study or a feasibility study.
alluvium	Unconsolidated terrestrial sediment composed of sorted or unsorted sand, gravel, and clay that has been deposited by water.
ANFO	A free-running explosive used in mine blasting made of 94% prilled aluminum nitrate and 6% No. 3 fuel oil.
aquifer	A geologic formation capable of transmitting significant quantities of groundwater under normal hydraulic gradients.
argillic alteration	Introduces any one of a wide variety of clay minerals, including kaolinite, smectite and illite. Argillic alteration is generally a low temperature event, and some may occur in atmospheric conditions
assay	To test, or a test performed on, mineralized material by chemical or other method of examination to determine the proportion of metals in the ore.
autogenous grinding	The process of grinding in a rotating mill which uses as a grinding medium large pieces or pebbles of the material being ground, instead of conventional steel balls or rods.

Term	Definition
azimuth	The direction of one object from another, usually expressed as an angle in degrees relative to true north. Azimuths are usually measured in the clockwise direction, thus an azimuth of 90 degrees indicates that the second object is due east of the first.
backfill	The process of filling, and/or the material used to fill, a mine opening.
background concentration	Naturally-occurring concentrations of compounds of environmental concern.
ball mill	A piece of milling equipment used to grind material into small particles. It is a cylindrical shaped steel container filled with steel balls into which crushed material is fed. The ball mill is rotated causing the balls themselves to cascade, which in turn grinds the ore.
beneficiation	Physical treatment of crude ore to improve its quality for some specific purpose. Also called mineral processing.
bullion	Unrefined gold and/or silver mixtures that have been melted and cast into a bar or ingot.
comminution/crushing/grinding	Crushing and/or grinding of ore by impact and abrasion. Usually, the word "crushing" is used for dry methods and "grinding" for wet methods. Also, "crushing" usually denotes reducing the size of coarse rock while "grinding" usually refers to the reduction of the fine sizes.
concentrate	The concentrate is the valuable product from mineral processing, as opposed to the tailing, which contains the waste minerals. The concentrate represents a smaller volume than the original ore
critical path	Sequence of activities through a project network from start to finish, the sum of whose durations determines the overall project duration. Note: there may be more than one such path. (The path through a series of activities, taking into account interdependencies, in which the late completion of activities will have an impact on the project end date or delay a key milestone.)
crosscut	A horizontal opening driven across the course of a vein or structure, or in general across the strike of the rock formation; a connection from a shaft to an ore structure.
crown pillar	An ore pillar at the top of an open stope left for wall support and protection from wall sloughing above.

Term	Definition
cut and fill stoping	If it is undesirable to leave broken ore in the stope during mining operations (as in shrinkage stoping), the lower portion of the stope can be filled with waste rock and/or mill tailings. In this case, ore is removed as soon as it has been broken from overhead, and the stope filled with waste to within a few feet of the mining surface. This method eliminates or reduces the waste disposal problem associated with mining as well as preventing collapse of the ground at the surface.
cut-off grade	A grade level below which the material is not “ore” and considered to be uneconomical to mine and process. The minimum grade of ore used to establish mineral reserves.
data verification	The process of confirming that data has been generated with proper procedures, has been accurately transcribed from the original source and is suitable to be used for mineral resource and mineral reserve estimation
decline	A sloping underground opening for machine access from level to level or from the surface. Also called a ramp.
density	The mass per unit volume of a substance, commonly expressed in grams/ cubic centimeter.
depletion	The decrease in quantity of ore in a deposit or property resulting from extraction or production.
development	Often refers to the construction of a new mine or; Is the underground work carried out for the purpose of reaching and opening up a mineral deposit. It includes shaft sinking, cross-cutting, drifting and raising.
development property	A property that is being prepared for mineral production or a material expansion of current production, and for which economic viability has been demonstrated by a pre-feasibility or feasibility study.
diabase	US terminology for an intrusive rock whose main components are labradorite and pyroxene, and characterized by an ophiolitic texture. Corresponds to a diorite.
dilution	Waste of low-grade rock which is unavoidably removed along with the ore in the mining process.

Term	Definition
disclosure	Any oral statement or written disclosure made by or on behalf of an issuer and intended to be, or reasonably likely to be, made available to the public in a jurisdiction of Canada, whether or not filed under securities legislation, but does not include written disclosure that is made available to the public only by reason of having been filed with a government or agency of government pursuant to a requirement of law other than securities legislation.
discounted cash flow	Concept of relating future cash inflows and outflows over the life of a project or operation to a common base value thereby allowing more validity to comparison of projects with different durations and rates of cash flow.
drift	A horizontal mining passage underground. A drift usually follows the ore vein, as distinguished from a crosscut, which intersects it.
easement	Areas of land owned by the property owner, but in which other parties, such as utility companies, may have limited rights granted for a specific purpose.
effective date	With reference to a technical report, the date of the most recent scientific or technical information included in the technical report.
EM	Geophysical method, electromagnetic system, measures the earth's response to electromagnetic signals transmitted by an induction coil.
encumbrance	An interest or partial right in real property which diminished the value of ownership, but does not prevent the transfer of ownership. Mortgages, taxes and judgements are encumbrances known as liens. Restrictions, easements, and reservations are also encumbrances, although not liens.
exploration information	Geological, geophysical, geochemical, sampling, drilling, trenching, analytical testing, assaying, mineralogical, metallurgical, and other similar information concerning a particular property that is derived from activities undertaken to locate, investigate, define, or delineate a mineral prospect or mineral deposit.
feasibility study	A comprehensive study of a mineral deposit in which all geological, engineering, legal, operating, economic, social, environmental, and other relevant factors are considered in sufficient detail that it could reasonably serve as the basis for a final decision by a financial institution to finance the development of the deposit for mineral production.

Term	Definition
flotation	Separation of minerals based on the interfacial chemistry of the mineral particles in solution. Reagents are added to the ore slurry to render the surface of selected minerals hydrophobic. Air bubbles are introduced to which the hydrophobic minerals attach. The selected minerals are levitated to the top of the flotation machine by their attachment to the bubbles and into a froth product, called the "flotation concentrate." If this froth carries more than one mineral as a designated main constituent, it is called a "bulk float". If it is selective to one constituent of the ore, where more than one will be floated, it is a "differential" float.
flowsheet	The sequence of operations, step by step, by which ore is treated in a milling, concentration, or smelting process.
footwall	The wall or rock on the underside of a vein or ore structure.
free milling	Ores of gold or silver from which the precious metals can be recovered by concentrating methods without resort to roasting or chemical treatment.
frother	A type of flotation reagent which, when dissolved in water, imparts to it the ability to form a stable froth
gangue	The fraction of ore rejected as tailing in a separating process. It is usually the valueless portion, but may have some secondary commercial use
geosyncline	A major downwarp in the Earth's crust, usually more than 1000 kilometers in length, in which sediments accumulate to thicknesses of many kilometers. The sediments may eventually be deformed and metamorphosed during a mountain- building episode.
gravity separation	Exploitation of differences in the densities of particles to achieve separation. Machines utilizing gravity separation include jigs and shaking tables.
greenschist facies	One of the major divisions of the mineral facies classification of metamorphic rocks, the rocks of which formed under the lowest temperature and pressure conditions usually produced by regional metamorphism. Temperatures between 300 and 450 °C (570 and 840 °F) and pressures of 1 to 4 kilobars are typical. The more common minerals found in such rocks include quartz, orthoclase, muscovite, chlorite, serpentine, talc, and epidote
hanging wall	The wall or rock on the upper or top side of a vein or ore deposit.

Term	Definition
historical estimate	An estimate of the quantity, grade, or metal or mineral content of a deposit that an issuer has not verified as a current mineral resource or mineral reserve, and which was prepared before the issuer acquiring, or entering into an agreement to acquire, an interest in the property that contains the deposit. A Qualified Person has not done sufficient work to classify the historical estimate as current mineral resources or mineral reserves and the company is not treating the historical estimate as current mineral resources or mineral reserves.
Indicated Mineral Resource	An 'Indicated Mineral Resource' is that part of a Mineral Resource for which quantity, grade or quality, densities, shape and physical characteristics can be estimated with a level of confidence sufficient to allow the appropriate application of technical and economic parameters, to support mine planning and evaluation of the economic viability of the deposit. The estimate is based on detailed and reliable exploration and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes that are spaced closely enough for geological and grade continuity to be reasonably assumed.
Inferred Mineral Resource	An 'Inferred Mineral Resource' is that part of a Mineral Resource for which quantity and grade or quality can be estimated on the basis of geological evidence and limited sampling and reasonably assumed, but not verified, geological and grade continuity. The estimate is based on limited information and sampling gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes.
internal rate of return (IRR)	The rate of return at which the Net Present Value of a project is zero; the rate at which the present value of cash inflows is equal to the present value of the cash outflows.
IP	Geophysical method, induced polarization; used to directly detect scattered primary sulfide mineralization. Most metal sulfides produce IP effects, e.g. chalcopyrite, bornite, chalcocite, pyrite, pyrrhotite
liberation	Freeing, by comminution, of particles of specific mineral from their interlock with other constituents of the ore.
life of mine (LOM)	Number of years that the operation is planning to mine and treat ore and is taken from the current mine plan based on the current evaluation of mineral reserves.

Term	Definition
lithogeochemistry	The chemistry of rocks within the lithosphere, such as rock, lake, stream, and soil sediments
Measured Mineral Resource	A ‘Measured Mineral Resource’ is that part of a Mineral Resource for which quantity, grade or quality, densities, shape, and physical characteristics are so well established that they can be estimated with confidence sufficient to allow the appropriate application of technical and economic parameters, to support production planning and evaluation of the economic viability of the deposit. The estimate is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes that are spaced closely enough to confirm both geological and grade continuity.
merger	A voluntary combination of two or more companies whereby both stocks are merged into one.
mill	Includes any ore mill, sampling works, concentration, and any crushing, grinding, or screening plant used at, and in connection with, an excavation or mine.
mineral project	Any exploration, development or production activity, including a royalty or similar interest in these activities, in respect of diamonds, natural solid inorganic material, or natural solid fossilized organic material including base and precious metals, coal, and industrial minerals
Mineral Reserve	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 Resource	A Mineral Resource is a concentration or occurrence of diamonds, natural solid inorganic material, or natural solid fossilized organic material including base and precious metals, coal, and industrial minerals in or on the Earth’s crust in such form and quantity and of such a grade or quality that it has reasonable prospects for economic extraction. The location, quantity, grade, geological characteristics and continuity of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge.

Term	Definition
mining claim	A description by boundaries of real property in which metal ore and/or minerals may be located.
NAD27	North American Datum of 1927; It uses all horizontal geodetic surveys collected at this time using a least-square adjustment. This datum uses the Clarke Ellipsoid of 1866 with a fixed latitude and longitude at Meade's Ranch, Kansas. (39°13'26.686″ north latitude, 98°32'30.506″ west longitude).
NAD83	North American Datum of 1983; it provides latitude and longitude and some height information using the reference ellipsoid GRS80. Geodetic datums like the North American Datum 1983 form the basis of coordinates of all horizontal positions for Canada and the United States. NAD83 corrects some of the distortions from NAD27 over distance by using a more sense set of positions from terrestrial and Doppler satellite data.
net present value (NPV)	The present value of the difference between the future cash flows associated with a project and the investment required for acquiring the project. Aggregate of future net cash flows discounted back to a common base date, usually the present. NPV is an indicator of how much value an investment or project adds to a company.
net smelter return (NSR)	The revenue received by the company from the sale of concentrate less transportation, insurance, and refining/processing costs.
net smelter return (NSR) royalty	A defined percentage of the gross revenue from a resource extraction operation, less a proportionate share of transportation, insurance, and processing costs.
open stope	In competent rock, it is possible to remove all of a moderate sized ore body, resulting in an opening of considerable size. Such large, irregularly-shaped openings are called stopes. The mining of large inclined ore bodies often requires leaving horizontal pillars across the stope at intervals in order to prevent collapse of the walls.
orogeny	A process in which a section of the earth's crust is folded and deformed by lateral compression to form a mountain range.
ounce (oz) (troy)	Used in imperial statistics. A kilogram is equal to 32.1507 ounces. A troy ounce is equal to 31.1035 grams.
overburden	Material of any nature, consolidated or unconsolidated, that overlies a deposit of ore that is to be mined.

Term	Definition
overbreak	Rock which is broken by blasting outside the intended area or line of break.
petrography	Branch of geology that deals with the description and classification of rocks.
phyllic alteration	Minerals include quartz-sericite-pyrite.
plant	A group of buildings, and especially to their contained equipment, in which a process or function is carried out; on a mine it will include warehouses, hoisting equipment, compressors, repair shops, offices, mill or concentrator.
portal	The surface entrance to a tunnel or adit.
potassic alteration	A relatively high temperature type of alteration which results from potassium enrichment. Characterized by biotite, K-feldspar, adularia.
preliminary economic assessment	A study, other than a pre-feasibility or feasibility study, that includes an economic analysis of the potential viability of Mineral Resources.
preliminary feasibility study, pre-feasibility study	A comprehensive study of the viability of a mineral project that has advanced to a stage where the mining method, in the case of underground mining, or the pit configuration, in the case of an open pit, has been established and an effective method of mineral processing has been determined, and includes a financial analysis based on reasonable assumptions of technical, engineering, legal, operating, economic, social, and environmental factors and the evaluation of other relevant factors which are sufficient for a Qualified Person, acting reasonably, to determine if all or part of the Mineral Resource may be classified as a Mineral Reserve.
Probable Mineral Reserve	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.

Term	Definition
producing issuer	An issuer with annual audited financial statements that disclose gross revenue, derived from mining operations, of at least $30 million Canadian for the issuer's most recently completed financial year; and gross revenue, derived from mining operations, of at least $90 million Canadian in the aggregate for the issuer's three most recently completed financial years.
propylitic	Characteristic greenish color. Minerals include chlorite, actinolite and epidote. Typically contains the assemblage quartz-chlorite-carbonate
Proven Mineral Reserve	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.
raise	A vertical or inclined underground working that has been excavated from the bottom upward
reclamation	The restoration of a site after mining or exploration activity is completed.
refining	A high temperature process in which impure metal is reacted with flux to reduce the impurities. The metal is collected in a molten layer and the impurities in a slag layer. Refining results in the production of a marketable material.
resistivity	Observation of electric fields caused by current introduced into the ground as a means of studying earth resistivity in geophysical exploration. Resistivity is the property of a material that resists the flow of electrical current.
right-of-way	A parcel of land granted by deed or easement for construction and maintenance according to a designated use. This may include highways, streets, canals, ditches, or other uses.
royalty	An amount of money paid at regular intervals by the lessee or operator of an exploration or mining property to the owner of the ground. Generally based on a specific amount per tonne or a percentage of the total production or profits. Also, the fee paid for the right to use a patented process.
run-of-mine	A term used to describe ore of average grade for the deposit.

Term	Definition
shaft	A vertical or inclined excavation for the purpose of opening and servicing a mine. It is usually equipped with a hoist at the top, which lowers and raises a conveyance for handling men and material.
specific gravity	The weight of a substance compared with the weight of an equal volume of pure water at 4°C.
stope	An excavation in a mine, other than development workings, made for the purpose of extracting ore.
strike length	The horizontal distance along the long axis of a structural surface, rock unit, mineral deposit or geochemical anomaly.
tailings	Material rejected from a mill after the recoverable valuable minerals have been extracted.
tunnel	A horizontal underground passage that is open at both ends; the term is loosely applied in many cases to an adit, which is open at only one end.
World Geodetic Reference System of 1984 (WGS-84)	The United States Defense Mapping Agency's Datum. This datum is a global datum based on electronic technology which is still to some degree classified. Data on the relationship of as many as 65 different datums to WGS-84 is available to the public. As a result, WGS-84 is becoming the base datum for the processing and conversion of data from one datum to any other datum. The GPS is based on this datum.
written disclosure	Any writing, picture, map, or other printed representation whether produced, stored or disseminated on paper or electronically, including websites.
XYZ coordinates	A grouping of three numbers which designate the position of a point in relation to a common reference frame. In common usage, the X and Y coordinate fix the horizontal position of the point, and Z refers to the elevation.

Appendix B: Claims List

Unpatented Lode and Mill Claims

Summary- Unpatented Mill Claims

Claim Name	Certificate of Location Recorded in Juneau Recording District, State of Alaska at		BLM Serial Number
	Book	Page	
Big Sore Millsite No. 900	394	511-512	AA 77046
Big Sore Millsite No. 901	394	513	AA 77047
Big Sore Millsite No. 902	394	514	AA 77048
Big Sore Millsite No. 1001	394	515	AA 77049
Big Sore Millsite No. 1002	394	516	AA 77050
Big Sore Millsite No. 1003	394	517	AA 77051
Big Sore Millsite No. 1108	394	518	AA 77052
Big Sore Millsite No. 1505	394	519	AA 77053
Big Sore Millsite No. 1506	394	520	AA 77054
Big Sore Millsite No. 1507	394	521	AA 77055
Big Sore Millsite No. 1509	394	522	AA 77056
Big Sore Millsite No. 1510	394	523	AA 77057
Big Sore Millsite No. 1516	394	524	AA 77058
Big Sore Millsite No. 1517	394	525	AA 77059
Big Sore Millsite No. 1610	394	526	AA 77060
Big Sore Millsite No. 1611	394	527	AA 77061
Big Sore Millsite No. 1710	394	528	AA 77062
Big Sore Millsite No. 1711	394	529	AA 77063
Big Sore Millsite No. 1712	394	530	AA 77064
Big Sore Millsite No. 1713	394	531	AA 77065
Big Sore Millsite No. 1714	394	532	AA 77066
Big Sore Millsite No. 1715	394	533	AA 77067
Big Sore Millsite No. 1716	394	534	AA 77068
Big Sore Millsite No. 1717	394	535	AA 77069
Big Sore Millsite No. 1718	394	536	AA 77070
Big Sore Millsite No. 798	2002-005167-0		AA 84088
Big Sore Millsite No. 802	2002-005168-0		AA 84089
Big Sore Millsite No. 803	2002-005169-0		AA 84090
Big Sore Millsite No. 899	2002-005170-0		AA 84091
Big Sore Millsite No. 904	2002-005171-0		AA 84092
Big Sore Millsite No. 905	2002-005172-0		AA 84093
Big Sore Millsite No. 906	2002-005173-0		AA 84094
Big Sore Millsite No. 907	2002-005174-0		AA 84095
Big Sore Millsite No. 996	2002-005175-0		AA 84096
Big Sore Millsite No. 1004	2002-005176-0		AA 84097
Big Sore Millsite No. 1005	2002-005177-0		AA 84098
Big Sore Millsite No. 1006	2002-005178-0		AA 84099
Big Sore Millsite No. 1007	2002-005179-0		AA 84100
Big Sore Millsite No. 1008	2002-005180-0		AA 84101
Big Sore Millsite No. 1009	2002-005181-0		AA 84102

Claim Name	Certificate of Location Recorded in Juneau Recording District, State of Alaska at Book	Page	BLM Serial Number
Big Sore Millsite No. 1010	2002-005182-0		AA 84103
Big Sore Millsite No. 1096	2002-005183-0		AA 84104
Big Sore Millsite No. 1097	2002-005184-0		AA 84105
Big Sore Millsite No. 1103	2002-005185-0		AA 84106
Big Sore Millsite No. 1104	2002-005186-0		AA 84107
Big Sore Millsite No. 1105	2002-005187-0		AA 84108
Big Sore Millsite No. 1106	2002-005188-0		AA 84109
Big Sore Millsite No. 1107	2002-005189-0		AA 84110
Big Sore Millsite No. 1202	2002-005190-0		AA 84111
Big Sore Millsite No. 1203	2002-005191-0		AA 84112
Big Sore Millsite No. 1204	2002-005192-0		AA 84113
Big Sore Millsite No. 1205	2002-005193-0		AA 84114
Big Sore Millsite No. 1508	2002-005194-0		AA 84115
Big Sore Millsite No. 1511	2002-005195-0		AA 84116
Big Sore Millsite No. 1514	2002-005196-0		AA 84117
Big Sore Millsite No. 1612	2002-005197-0		AA 84118
Big Sore Millsite No. 1613	2002-005198-0		AA 84119
Big Sore Millsite No. 1614	2002-005199-0		AA 84120

Summary- Unpatented Lode Claims

Claim Name	Certificate of Location Recorded in Juneau Recording District, State of Alaska		BLM Serial Number
	Book	Page	
BIG SORE GROUP			
Big Sore 1321	125	423	AA 25819
Big Sore 1322	126	236	AA 25820
Big Sore 1323	126	237	AA 25821
Big Sore 1324	126	238	AA 25822
Big Sore 1421	126	239	AA 25845
Big Sore 1422	126	240	AA 25846
Big Sore 1423	126	241	AA 25847
Big Sore 1424	126	242	AA 25848
Big Sore 1521	125	437	AA 25867
Big Sore 1522	125	438	AA 25868
Big Sore 1523	125	439	AA 25869
Big Sore 1524	125	440	AA 25870
Big Sore 1623	125	448	AA 25888
Big Sore 1624	125	449	AA 25889
Big Sore 1625	125	450	AA 25890
Big Sore 1626	125	451	AA 25891
Big Sore 1627	125	452	AA 25892
Big Sore 1723	125	459	AA 25909
Big Sore 1724	125	460	AA 25910
Big Sore 1725	125	461	AA 25911
Big Sore 1726	125	462	AA 25912
Big Sore 1727	125	463	AA 25913
Big Sore 1728	125	464	AA 25914
Big Sore 1824	125	479	AA 25929
Big Sore 1825	125	480	AA 25930
Big Sore 1826	125	481	AA 25931
Big Sore 1827	125	482	AA 25932
MARIPOSITE GROUP			
Mariposite 1	254	238	AA 55244
Mariposite 2	254	239	AA 55245
Mariposite 3	254	240	AA 55246
Mariposite 4	254	241	AA 55247
Mariposite 5	254	242	AA 55248
Mariposite 6	279	233	AA 55249
Mariposite 7	279	234	AA 55250
Mariposite 8	251	962	AA 55251
Mariposite 9	251	963	AA 55252
Mariposite 10	251	964	AA 55253
Mariposite 11	279	235	AA 55254
Mariposite 12	279	236	AA 55255
Mariposite 13	279	237	AA 55256

Claim Name	Certificate of Location Recorded in Juneau Recording District, State of Alaska		BLM Serial Number
	Book	Page	
Mariposite 14	279	238	AA 55257
Mariposite 15	251	969	AA 55258
Mariposite 16	254	245	AA 55259
Mariposite 17	254	246	AA 55260
Mariposite 18	254	247	AA 55261
Mariposite 19	254	248	AA 55262
Mariposite 20	254	249	AA 55263
Mariposite 21	254	250	AA 55264
Mariposite 22	251	976	AA 55265
Mariposite 23	251	977	AA 55266
Mariposite 24	251	978	AA 55267
Mariposite 25	279	239	AA 55268
Mariposite 26	279	240	AA 55269
Mariposite 27	279	241	AA 55270
Mariposite 28	279	242	AA 55271
Mariposite 29	279	243	AA 55272
Mariposite 30	279	244	AA 55273
Mariposite 31	279	245	AA 55274
Mariposite 32	279	246	AA 55275
Mariposite 33	279	247	AA 55276
Mariposite 34	254	256	AA 55277
Mariposite 35	254	257	AA 55278
Mariposite 36	279	248	AA 55279
Mariposite 37	279	249	AA 55280
Mariposite 38	251	992	AA 55281
Mariposite 39	251	993	AA 55282
Mariposite 40	251	994	AA 55283
Mariposite 41	251	995	AA 55284
Mariposite 42	251	996	AA 55285
Mariposite 43	251	997	AA 55286
Mariposite 44	251	998	AA 55287
Mariposite 45	251	999	AA 55288
Mariposite 46	252	1	AA 55289
Mariposite 47	252	2	AA 55290
Mariposite 48	252	3	AA 55291
Mariposite 49	252	4	AA 55292
Mariposite 50	254	258	AA 55293
Mariposite 51	254	259	AA 55294
Mariposite 52	254	260	AA 55295
Mariposite 53	254	261	AA 55296
Mariposite 54	254	262	AA 55297
Mariposite 55	254	263	AA 55298
Mariposite 56	254	264	AA 55299

Claim Name	Certificate of Location Recorded in Juneau Recording District, State of Alaska		BLM Serial Number
	Book	Page	
Mariposite 57	254	265	AA 55300
Mariposite 58	254	266	AA 55301
Mariposite 59	254	267	AA 55302
Mariposite 60	254	268	AA 55303
Mariposite 61	252	16	AA 55304
Mariposite 62	252	17	AA 55305
Mariposite 63	252	18	AA 55306
Mariposite 64	252	19	AA 55307
Mariposite 65	252	20	AA 55308
Mariposite 66	252	21	AA 55309
Mariposite 67	254	269	AA 55310
Mariposite 68	254	270	AA 55311
Mariposite 69	254	271	AA 55312
Mariposite 70	254	272	AA 55313
Mariposite 71	252	26	AA 55314
Mariposite 72	252	27	AA 55315
Mariposite 73	254	273	AA 55316
Mariposite 74	254	274	AA 55317
Mariposite 75	254	275	AA 55318
Mariposite 76	254	276	AA 55319
Mariposite 77	252	32	AA 55320
Mariposite 79	254	278	AA 55322
Mariposite 80	254	279	AA 55323
Mariposite 81	252	36	AA 55324
Mariposite 82	254	280	AA 55325
Mariposite 83	254	281	AA 55326
Mariposite 84	254	282	AA 55327
Mariposite 85	254	283	AA 55328
Mariposite 86	254	284	AA 55329
Mariposite 87	292	664	AA 63033
Mariposite 100	320	601	AA 71489
Mariposite 101	320	602	AA 71490
Mariposite 102	320	603	AA 71491
Mariposite 103	320	604	AA 71492
Mariposite 104	320	605	AA 71493
Mariposite 105	320	606	AA 71494
Mariposite 106	320	607	AA 71495
Mariposite 107	320	608	AA 71496
Mariposite 108	320	609	AA 71497
Mariposite 109	320	610	AA 71498
Mariposite 110	320	611	AA 71499
Mariposite 111	320	612	AA 71500
Mariposite 112	320	613	AA 71501

Claim Name	Certificate of Location Recorded in Juneau Recording District, State of Alaska		BLM Serial Number
	Book	Page	
Mariposite 113	320	614	AA 71502
Mariposite 114	320	615	AA 71503
FOWLER GROUP			
Fowler 543	262	546	AA 57281
Fowler 544	262	548	AA 57282
Fowler 545	262	549	AA 57283
Fowler 546	262	550	AA 57284
Fowler 547	262	551	AA 57285
Fowler 548	262	552	AA 57286
Fowler 549	262	553	AA 57287
Fowler 550	262	554	AA 57288
Fowler 551	262	555	AA 57289
Fowler 552	262	556	AA 57290
Fowler 553	262	557	AA 57291
Fowler 554	262	558	AA 57292
Fowler 555	262	559	AA 57293
Fowler 556	262	560	AA 57294
Fowler 557	262	561	AA 57295
Fowler 558	262	562	AA 57296
Fowler 643	262	563	AA 57297
Fowler 644	262	564	AA 57298
Fowler 645	262	565	AA 57299
Fowler 646	262	566	AA 57300
Fowler 647	262	567	AA 57301
Fowler 648	262	568	AA 57302
Fowler 649	262	569	AA 57303
Fowler 650	262	570	AA 57304
Fowler 651	262	571	AA 57305
Fowler 652	262	572	AA 57306
Fowler 653	262	573	AA 57307
Fowler 654	262	574	AA 57308
Fowler 655	262	575	AA 57309
Fowler 656	262	576	AA 57310
Fowler 657	262	577	AA 57311
Fowler 658	262	578	AA 57312
Fowler 743	262	579	AA 57313
Fowler 744	262	580	AA 57314
Fowler 745	262	581	AA 57315
Fowler 746	262	582	AA 57316
Fowler 747	262	583	AA 57317
Fowler 748	262	584	AA 57318
Fowler 749	262	585	AA 57319
Fowler 750	262	586	AA 57320

Claim Name	Certificate of Location Recorded in Juneau Recording District, State of Alaska		BLM Serial Number
	Book	Page	
Fowler 751	262	587	AA 57321
Fowler 752	262	588	AA 57322
Fowler 753	262	589	AA 57323
Fowler 754	262	590	AA 57324
Fowler 755	262	591	AA 57325
Fowler 756	262	592	AA 57326
Fowler 757	262	593	AA 57327
Fowler 758	262	594	AA 57328
Fowler 843	262	595	AA 57329
Fowler 844	262	596	AA 57330
Fowler 845	262	597	AA 57331
Fowler 846	262	598	AA 57332
Fowler 847	262	599	AA 57333
Fowler 848	262	600	AA 57334
Fowler 849	262	601	AA 57335
Fowler 850	262	602	AA 57336
Fowler 851	262	603	AA 57337
Fowler 852	262	604	AA 57338
Fowler 853	262	605	AA 57339
Fowler 854	262	606	AA 57340
Fowler 855	262	607	AA 57341
Fowler 856	262	608	AA 57342
Fowler 857	262	609	AA 57343
Fowler 858	262	610	AA 57344
Fowler 943	262	611	AA 57345
Fowler 944	262	612	AA 57346
Fowler 945	262	613	AA 57347
Fowler 946	262	614	AA 57348
Fowler 947	262	615	AA 57349
Fowler 948	262	616	AA 57350
Fowler 949	262	617	AA 57351
Fowler 950	262	618	AA 57352
Fowler 951	262	619	AA 57353
Fowler 952	262	620	AA 57354
Fowler 953	262	621	AA 57355
Fowler 954	262	622	AA 57356
Fowler 955	262	623	AA 57357
Fowler 956	262	624	AA 57358
Fowler 957	262	625	AA 57359
Fowler 958	262	626	AA 57360
Fowler 1043	262	627	AA 57361
Fowler 1044	262	628	AA 57362
Fowler 1045	262	629	AA 57363

Claim Name	Certificate of Location Recorded in Juneau Recording District, State of Alaska		BLM Serial Number
	Book	Page	
Fowler 1046	262	630	AA 57364
Fowler 1047	262	631	AA 57365
Fowler 1143	262	632	AA 57366
Fowler 1144	262	633	AA 57367
Fowler 1145	262	634	AA 57368
Fowler 1146	262	635	AA 57369
Fowler 1147	262	636	AA 57370
LIL SORE GROUP			
Lil Sore 41	443	333-335	AA 78220
Lil Sore 42	443	336-338	AA 78221
Lil Sore 43	443	339-341	AA 78222
Lil Sore 44	443	342-344	AA 78223
Lil Sore 45	443	345-347	AA 78224
Lil Sore 46	443	378-350	AA 78225
Lil Sore 47	443	351-353	AA 78226
Lil Sore 48	443	354-356	AA 78227
EAST FOWLER GROUP			
East Fowler 538	443	357-359	AA 78228
East Fowler 539	443	360-362	AA 78229
East Fowler 540	443	363-365	AA 78230
East Fowler 541	443	366-368	AA 78231
East Fowler 542	443	369-371	AA 78232
East Fowler 641	443	372-374	AA 78233
East Fowler 642	443	375-377	AA 78234
East Fowler 741	443	378-380	AA 78235
East Fowler 742	443	381-383	AA 78236
East Fowler 841	443	384-386	AA 78237
East Fowler 842	443	387-389	AA 78238
East Fowler 941	443	390-392	AA 78239
East Fowler 942	443	393-395	AA 78240
East Fowler 1042	443	396-398	AA 78241
WEST MARIPOSITE GROUP			
West Mariposite 115	443	162-164	AA 78242
West Mariposite 116	443	165-167	AA 78243
West Mariposite 117	443	168-170	AA 78244
West Mariposite 118	443	171-173	AA 78245
West Mariposite 119	443	174-176	AA 78246
West Mariposite 120	443	177-179	AA 78247
West Mariposite 121	443	180-182	AA 78248
West Mariposite 122	443	183-185	AA 78249
West Mariposite 123	443	186-188	AA 78250
West Mariposite 128	443	201-203	AA 78255
West Mariposite 129	443	204-206	AA 78256

Claim Name	Certificate of Location Recorded in Juneau Recording District, State of Alaska		BLM Serial Number
	Book	Page	
West Mariposite 130	443	207-209	AA 78257
West Mariposite 131	443	210-212	AA 78258
West Mariposite 132	443	213-215	AA 78259
West Mariposite 133	443	216-218	AA 78260
West Mariposite 134	443	219-221	AA 78261
West Mariposite 135	443	222-224	AA 78262
West Mariposite 136	443	225-227	AA 78263
West Mariposite 137	443	228-230	AA 78264
West Mariposite 138	443	231-233	AA 78265
West Mariposite 139	443	234-236	AA 78266
West Mariposite 140	443	237-239	AA 78267
West Mariposite 141	443	240-242	AA 78268
West Mariposite 142	443	243-245	AA 78269
West Mariposite 143	443	246-248	AA 78270
West Mariposite 144	443	249-251	AA 78271
West Mariposite 145	443	252-254	AA 78272
West Mariposite 146	443	255-257	AA 78273
West Mariposite 147	443	258-260	AA 78274
West Mariposite 148	443	261-263	AA 78275
West Mariposite 149	443	264-266	AA 78276
West Mariposite 150	443	267-269	AA 78277
West Mariposite 151	443	270-272	AA 78278
West Mariposite 152	443	273-275	AA 78279
West Mariposite 153	443	276-278	AA 78280
West Mariposite 154	443	279-281	AA 78281
West Mariposite 155	443	282-284	AA 78282
West Mariposite 156	443	285-287	AA 78283
West Mariposite 159	443	294-296	AA 78286
West Mariposite 160	443	297-299	AA 78287
West Mariposite 161	443	300-302	AA 78288
West Mariposite 162	443	303-305	AA 78289
West Mariposite 163	443	306-308	AA 78290
West Mariposite 164	443	309-311	AA 78291
West Mariposite 165	443	312-314	AA 78292
West Mariposite 168	443	321-323	AA 78295
West Mariposite 169	443	324-326	AA 78296
West Mariposite 170	443	327-329	AA 78297
West Mariposite 171	443	330-332	AA 78298
WEST FOWLER GROUP			
West Fowler 559	443	399-401	AA 78299
West Fowler 560	443	402-404	AA 78300
West Fowler 561	443	405-407	AA 78301
West Fowler 659	443	411-413	AA 78303

Claim Name	Certificate of Location Recorded in Juneau Recording District, State of Alaska		BLM Serial Number
	Book	Page	
West Fowler 660	443	414-416	AA 78304
West Fowler 661	443	417-419	AA 78305
West Fowler 662	443	420-422	AA 78306
West Fowler 663	443	423-425	AA 78307
West Fowler 664	443	426-428	AA 78308
West Fowler 759	443	429-431	AA 78309
West Fowler 760	443	432-434	AA 78310
West Fowler 761	443	435-437	AA 78311
West Fowler 762	443	438-440	AA 78312
West Fowler 763	443	444-446	AA 78313
West Fowler 764	443	447-449	AA 78314
West Fowler 765	443	450-452	AA 78315
West Fowler 766	443	453-455	AA 78316
West Fowler 767	443	456-458	AA 78317
West Fowler 859	443	462-464	AA 78319
West Fowler 860	443	465-467	AA 78320
West Fowler 861	443	468-470	AA 78321
West Fowler 862	443	471-473	AA 78322
West Fowler 863	443	474-476	AA 78323
West Fowler 864	443	477-479	AA 78324
West Fowler 865	443	480-482	AA 78325
West Fowler 959	443	492-494	AA 78329
West Fowler 960	443	495-497	AA 78330
West Fowler 961	443	498-500	AA 78331
West Fowler 962	443	501-503	AA 78332
West Fowler 963	443	504-506	AA 78333
West Fowler 964	443	507-509	AA 78334
West Fowler 965	443	510-512	AA 78335
West Fowler 966	443	513-515	AA 78336
NORTH FOWLER GROUP			
North Fowler 41	442	882-884	AA 78341
North Fowler 141	442	885-887	AA 78342
North Fowler 142	442	888-890	AA 78343
North Fowler 143	442	891-893	AA 78344
North Fowler 144	442	894-896	AA 78345
North Fowler 226	442	912-914	AA 78351
North Fowler 227	442	915-917	AA 78352
North Fowler 228	442	918-920	AA 78353
North Fowler 229	442	921-923	AA 78354
North Fowler 230	442	924-926	AA 78355
North Fowler 231	442	927-929	AA 78356
North Fowler 232	442	930-932	AA 78357
North Fowler 233	442	933-935	AA 78358

Claim Name	Certificate of Location Recorded in Juneau Recording District, State of Alaska		BLM Serial Number
	Book	Page	
North Fowler 234	442	936-938	AA 78359
North Fowler 235	442	939-941	AA 78360
North Fowler 236	442	942-944	AA 78361
North Fowler 237	442	945-947	AA 78362
North Fowler 238	442	948-950	AA 78363
North Fowler 239	442	951-953	AA 78364
North Fowler 240	442	954-956	AA 78365
North Fowler 241	442	957-959	AA 78366
North Fowler 242	442	960-962	AA 78367
North Fowler 243	442	963-965	AA 78368
North Fowler 244	442	966-968	AA 78369
North Fowler 245	442	969-971	AA 78370
North Fowler 246	442	972-974	AA 78371
North Fowler 336	442	990-992	AA 78377
North Fowler 337	442	993-995	AA 78378
North Fowler 338	442	996-998	AA 78379
North Fowler 339	0442/0443	999/001-002	AA 78380
North Fowler 340	443	003-005	AA 78381
North Fowler 341	443	006-008	AA 78382
North Fowler 342	443	009-011	AA 78383
North Fowler 343	443	012-014	AA 78384
North Fowler 344	443	015-017	AA 78385
North Fowler 345	443	018-020	AA 78386
North Fowler 346	443	021-023	AA 78387
North Fowler 347	443	024-026	AA 78388
North Fowler 348	443	027-029	AA 78389
North Fowler 349	443	030-032	AA 78390
North Fowler 350	443	033-035	AA 78391
North Fowler 351	443	036-038	AA 78392
North Fowler 352	443	039-041	AA 78393
North Fowler 353	443	042-044	AA 78394
North Fowler 354	443	045-047	AA 78395
North Fowler 355	443	048-050	AA 78396
North Fowler 356	443	051-053	AA 78397
North Fowler 357	443	054-056	AA 78398
North Fowler 358	443	057-059	AA 78399
North Fowler 436	443	075-077	AA 78405
North Fowler 437	443	078-080	AA 78406
North Fowler 438	443	081-083	AA 78407
North Fowler 439	443	084-086	AA 78408
North Fowler 440	443	087-089	AA 78409
North Fowler 441	443	090-092	AA 78410
North Fowler 442	443	093-095	AA 78411

Claim Name	Certificate of Location Recorded in Juneau Recording District, State of Alaska		BLM Serial Number
	Book	Page	
North Fowler 443	443	096-098	AA 78412
North Fowler 444	443	099-101	AA 78413
North Fowler 445	443	102-104	AA 78414
North Fowler 446	443	105-107	AA 78415
North Fowler 447	443	108-110	AA 78416
North Fowler 448	443	111-113	AA 78417
North Fowler 449	443	114-116	AA 78418
North Fowler 450	443	117-119	AA 78419
North Fowler 451	443	120-122	AA 78420
North Fowler 452	443	123-125	AA 78421
North Fowler 453	443	126-128	AA 78422
North Fowler 454	443	129-131	AA 78423
North Fowler 455	443	132-134	AA 78424
North Fowler 456	443	135-137	AA 78425
North Fowler 457	443	138-140	AA 78426
North Fowler 458	443	141-143	AA 78427
North Fowler 459	443	144-146	AA 78428
North Fowler 460	443	147-149	AA 78429
North Fowler 461	443	150-152	AA 78430
EAST RIDGE GROUP			
East Ridge 1011	2009-007170-0		AA 91926
East Ridge 1012	2009-007171-0		AA 91927
East Ridge 1013	2009-007172-0		AA 91928
East Ridge 1014	2009-007173-0		AA 91929
East Ridge 1015	2009-007174-0		AA 91930
East Ridge 1111	2009-007175-0		AA 91931
East Ridge 1112	2009-007176-0		AA 91932
East Ridge 1113	2009-007177-0		AA 91933
East Ridge 1114	2009-007178-0		AA 91934
East Ridge 1115	2009-007179-0		AA 91935
East Ridge 1210	2009-007180-0		AA 91936
East Ridge 1211	2009-007181-0		AA 91937
East Ridge 1212	2009-007182-0		AA 91938
East Ridge 1213	2009-007183-0		AA 91939
East Ridge 1214	2009-007184-0		AA 91940
East Ridge 1215	2009-007185-0		AA 91941
East Ridge 1310	2009-007186-0		AA 91942
East Ridge 1311	2009-007187-0		AA 91943
East Ridge 1312	2009-007188-0		AA 91944
East Ridge 1313	2009-007189-0		AA 91945
East Ridge 1314	2009-007190-0		AA 91946
East Ridge 1315	2009-007191-0		AA 91947
East Ridge 1408	2009-007192-0		AA 91948

Claim Name	Certificate of Location Recorded in Juneau Recording District, State of Alaska		BLM Serial Number
	Book	Page	
East Ridge 1409	2009-007193-0		AA 91949
East Ridge 1410	2009-007194-0		AA 91950
East Ridge 1411	2009-007195-0		AA 91951
East Ridge 1412	2009-007196-0		AA 91952
East Ridge 1413	2009-007197-0		AA 91953
East Ridge 1414	2009-007198-0		AA 91954
East Ridge 1415	2009-007199-0		AA 91955
East Ridge 1416	2009-007200-0		AA 91956
East Ridge 1417	2009-007201-0		AA 91957
East Ridge 1510	2009-007202-0		AA 91958
East Ridge 1511	2009-007203-0		AA 91959
East Ridge 1512	2009-007204-0		AA 91960
East Ridge 1513	2009-007205-0		AA 91961
East Ridge 1514	2009-007206-0		AA 91962
East Ridge 1515	2009-007207-0		AA 91963
East Ridge 1611	2009-007208-0		AA 91964
East Ridge 1612	2009-007209-0		AA 91965
East Ridge 1613	2009-007210-0		AA 91966
East Ridge 1614	2009-007211-0		AA 91967
East Ridge 1615	2009-007212-0		AA 91968